UKRI

TRANSFORMING UK FOOD SYSTEMS
Strategic Priorities Fund

Funded Projects

Call 2: Transforming the UK Food System for Healthy People and a Healthy Environment SPF Programme

Transforming the UK Food System for Healthy People and a Healthy Environment SPF Programme

Projects funded under Call 2

Eleven new interdisciplinary research projects have received a share of £14 million through the second call of the Transforming the UK Food System for Healthy People and a Healthy Environment SPF Programme.

Each project spans between two and three years in total and will address key issues such as obesity and public health, sustainable agriculture, alternative protein sources and consumption patterns.

Through taking a food systems approach, the projects integrate aspects from food production, processing, manufacturing and food environments, as well as addressing healthier diets and consumption.

The projects will join the four large consortia projects and Centre for Doctoral Training programme previously funded, to complete the Transforming UK Food Systems SPF Programme's portfolio.

"The food system affects all of us every day and plays an essential role in both human health and the health of the planet. The 11 new projects joining our consortia and CDT means we now have a network of more than 37 UK research organisations across England, Scotland, Wales and Northern Ireland. That network is also supported by approximately 200 additional stakeholder organisations, including the private sector colleagues and other government departments and agencies.

The range of projects engaged in the SPF programme will help to address the complex challenges we face around dietary choice and methods of farming and will help to ensure there is sustainable and healthy food for everyone in the UK. The excellent research and researchers will also help to establish solutions and frameworks that can be tried and tested across the global food system, with the UK leading the way towards healthier and more sustainable food for all.

Professor Guy Poppy, Programme Director of the Transforming the UK Food Systems SPF Programme

Call 2 Projects

- Sustainable nutrition, environment, and agriculture, without consumer knowledge (SNEAK)
  Professor Brunstrom, University of Bristol

- Sus-Health. Sustainable and Healthy diets for all.
  Professor Frewer, Newcastle University

- Pasture to Plate (P2P): realising the enormous potential of UK grasslands
  Dr Green, Harper Adams University

- 'Thinking beyond the can': Mainstreaming UK-grown beans in healthy meals (BeanMeals)
  Dr Ingram, University of Oxford

- FIO-FOOD, Food Insecurity in people living with Obesity - improving sustainable and healthier food choices in the retail FOOD environment.
  Professor Johnstone, University of Aberdeen

- 'Raising the Pulse' (RtP): Systems analysis of the environmental, nutritional and health benefits of pulse-enhanced foods
  Professor Lovegrove, University of Reading

- Social enterprise as a catalyst for sustainable and healthy local food systems
  Professor Lyon, Middlesex University

- Is cultured meat a threat or opportunity for UK farmers?
  Professor MacMillan, Royal Agricultural University

- TRAnsforming the DEbate about livestock systems transformation (TRADE)
  Professor Moran, University of Edinburgh

- Increasing UK Dietary Fibre - The Case for the Great White British Loaf"
  Dr Tindall, University of Reading

- Transformational blueprint for a blue economy on UK terrestrial farms: integrating sustainable shrimp production in a changing agricultural landscape
  Professor Wilson, University of Exeter

Sustainable nutrition, environment, and agriculture, without consumer knowledge (SNEAK)

Professor Jeffrey Brunstrom, University of Bristol

In the UK, food consumed out of the home accounts for a significant proportion of the impact of diet on health and the environment. For example, 42% of workers eat at a canteen and 7 million school lunches are served daily. In response, we will deliver a simple tool that; a) generates a 15-30% reduction in both the carbon footprint of meals and their sugar, fat, and salt content, b) can be implemented without compromising food acceptability and without consumers even being aware that changes have been made, and c) will be ready for immediate application at a city-wide level and beyond.

We recognise the bold nature of these claims. However, they are grounded on our modelling of food choices in a real-world context - a university catered hall of residence. Our approach exploits a simple, yet previously overlooked, principle. In any canteen setting where menu options rotate on a fixed-term basis (e.g., menu options A, B, and C are available on Monday, options D, E, and F on Tuesday, and so on), consumers eat only one meal per day. As such, the longer-term (weekly/yearly) nutritional and environmental performance of an establishment will depend on the combination of options that happen to be served on the same day. Our findings confirm that marked improvements in diet (respectively, 21%, 28%, and 27% reductions in salt, sugar, and fat) can be achieved merely by reorganising menu options in a way that increases within-day competition between undesirable meals. In practical terms this is a multidimensional problem (salt, sugar, fat, and carbon footprint must be jointly minimised) that is possible to address using well-established techniques in computational mathematics.

To achieve these ambitious targets, this project brings together a unique combination of expertise in behavioural psychology, agricultural/environmental modelling (integrating social and natural sciences), and commercial catering.

With this 'action-focused research,' we will demonstrate direct application in a university hall of residence (actual effects on diet and carbon footprint will be measured). Building on this, we will produce a co-designed online platform for non-experts to transform other catering services. To deliver this impact, we will demonstrate the real-world benefits of our approach by collecting canteen recipe data from schools across Bristol. We will then partner with an exceptional advisory team (Bristol City Council and Bristol Food Network) to develop a strategy for city-wide rollout in schools. Importantly, we will also consult with partners from the Born in Bradford Study, who have expertise in dietary interventions for children in multi-ethnic and socially deprived areas.

We will also broaden the application of our methods to a commercial food outlet. Recognising the potential of this idea, the University of Bristol has agreed to support the project by developing the UK's first 'Consumer Lab' - a public-facing facility in which lunchtime food offerings can be experimentally manipulated. This is unique, because it combines ecological validity (actual purchases are made) with the opportunity to manipulate menu offerings on any given day.

Here, we will monitor the diet quality and carbon footprint of purchases, and then show how both can be improved. Again, to develop practical next steps for application, we have co-designed a detailed plan for consulting with local food outlets (e.g., cafés and takeaways).

Finally, in addition to factoring in ways to mitigate risk, we have built-in opportunities to capitalise on 'high risk (high gain) endeavours.' Specifically, because financial reward is a strong motivator, and because rapid and wide-reaching impact is needed, we plan to show how our computational approach can return significant health and environmental benefits, alongside a reduction in food costs in schools and care homes, etc, and even an increase in profit in outlets such as cafés and takeaways.

Sus-Health. Sustainable and Healthy diets for all.

Professor Frewer, Newcastle University

Major transformation of the food system is required, which is focused on the production and consumption of healthy and sustainable food. Change will need to be facilitated through a number of means, both direct and indirect. The Sus-Health project will establish and demonstrate a blueprint of a system that incentivises both directly and indirectly the consumption of sustainable and healthy food.

The project will demonstrate to stakeholders how the use of a codesigned, combined measure of environmental impact and nutritive value (the Sus-Health Index) of foods, meals and ingredients can be used to influence the future direction of our food system and the stakeholders within it. Sus-Health will co-create a systemic strategy and innovative solution for influencing food choices and consumption, so that they better align with planetary boundaries and nutritional guidelines. The resulting consumer preferences (obtained through living lab experiments and through simulation) will feed back down the entire food chain driving the processes and raw materials used, towards more sustainable and health-inducing foods and diets.

Comprising two academic partners and a range of stakeholder involvement Sus-Health will demonstrate a range of stakeholder focused communication vehicles, in a range of interventions in Northern Ireland followed by upscaling activities in the rest of the UK. The consortium comprises a mix of academic, and food industry partners with expertise in consumer behaviour, sustainability, nutrition, agri-economics, software design, agriculture, food service, and food systems. Key outputs of the project will be:

- The development, validation and demonstration of the use and applicability of a combined measure for assessing sustainability and nutritive value in real settings (restaurants, fast food outlets, canteens and related supply chains)
- A range of communication tools and approaches aimed at influencing change in consumer food choices
- Interventions focused on food affordability including economic assessments of direct policy interventions that would make healthy sustainable food more affordable.

- Stakeholder guidelines for using the Sus-Health index and related communication tools together with extensive stakeholder focused communication and dissemination activities

Pasture to Plate (P2P): realising the enormous potential of UK grasslands

Dr Green, Harper Adams University

Our vision is to maximise the food potential of UK pasture by using targeted chemical processing and novel biotechnology to convert grass into nutritious edible fractions for healthier and more affordable alternative foods, making UK agriculture more resilient and sustainable.

Our proposal aims to use novel chemical processing methods to extract the central edible fractions from grass (protein, digestible carbohydrates, vitamins, lipids, fibre) before culturing the yeast Metschnikowia pulcherrima on the cellulosic fraction to produce mycoprotein and a lipid suitable as a palm oil substitute. These ingredients will then be combined in a range of alternative meat and dairy products, displacing environmentally damaging imported ingredients currently used. Further processing of the waste products from the process will produce nutrient rich fertilizers and help create a model for future circular farming economies. When optimised this process would only need 10 to 15kg of fresh grass (20% dry matter content) to produce 1kg of edible food ingredients, of which approximately 25% would be lipid and 35% protein. Whilst not entirely comparable on a nutritional basis this represents a ten-fold increase in productivity compared to cattle raised for meat, or twice the productivity of dairy cows. By converting grass into edible food components, a number of advantages are realised including:

- UK produced substitutes for palm oil, soya protein, and other imported food ingredients. This has environmental benefits in the UK and abroad. It will provide UK produced healthy nutritional substitutes for ingredients grown on former rainforest sites, whilst significantly reducing food miles;
- Produce UK food substitutes for over two billion pounds worth of annual food imports, with the opportunity to export significant quantities of surplus produce;
- Improved UK resilience to climate change as grass is more resilient to flooding and other extreme weather conditions than most other crops;
- As the process is feedstock agnostic, it should work equally well with wildflower rich pasture grass. This potentially enables the reintroduction of grasslands with greater biodiversity without having an impact on the grasses usability, an environmentally beneficial by-product of the process;
- Providing a commercially viable non-livestock based market for forage production that would also allow arable land that is prone to flooding to profitably return to meadow grass production;
- The profitable inclusion of grass in arable rotations to help combat blackgrass and other pesticide resistant weeds;

- At present, in some areas it is uneconomic to build and maintain livestock fencing, resulting in grassland in these regions having little commercial agricultural value. These grasslands will now become commercially viable, and contribute to UK food production;
- Limited risk in scaling up as there is no need to invest in new farm machinery, existing forage equipment and storage facilities will suffice and the bio-processing technology is mature and already used for many other industrial applications;
- Opportunities for investment in a new UK food industry;
- With the production of more digestible fractions, this project would produce more sustainable, UK sourced, feed for monogastric livestock;
- Initial research suggests that sufficient unutilised grass is available for the P2P process, therefore, this system should have little or no impact on grass supplies for dairy and livestock farming.

'Thinking beyond the can': Mainstreaming UK-grown beans in healthy meals (BeanMeals)

Dr Ingram, University of Oxford

A key challenge for the UK food system is how to move towards healthier diets with lower environmental impact while also enhancing local and national enterprise. However, moderating consumption of foods that are high in fats, sugar and salt (HFSS) requires coordinated action across the food system.

BeanMeals will directly address this by researching how to transform the food system based on systemic innovation in institutional catering and home-cooking by using healthier ingredients, new public procurement practises and more-local products. By starting with the meal and working backwards through the supply chain to the grower, research will be based on a 'fork-to-farm' concept (a disruption of the productionist 'farm-to-fork' paradigm). It will feature meals made from two quick-cooking navy bean varieties ('Capulet' and 'Godiva') which have recently been developed at the University of Warwick for UK growing conditions. it is also suitable for a wide range of easily prepared institutional and home-cooked meals with lower fat, salt and sugar content. Capulet production is poised to scale with commercial partners, and increased UK production would reduce the amount of dry navy beans (used in tinned baked beans) imported from North America, thereby lessening the environmental costs of shipping and opening new local enterprise opportunities.

Environmental benefits of increased production and consumption of UK bean-based meals include reduced fertilizer demand on subsequent crops (beans are a N-fixing rotation crop), and hence reduced GHG related to its manufacture and reduced N2O emissions and runoff from agriculture; reduced water and energy use from more efficient processing (the beans cook quickly); and reduced transport emissions from having more local supply chains and lower importation of dry beans.

BeanMeals aims to develop and analyse systemic innovations (i.e. innovations that require collaboration between multiple actors) for reducing HFSS consumption in institutional and home-cooking by using UK-grown navy beans. Research will develop a new 'fork-to-farm' paradigm of the systemic innovation of dietary change, which can be seen as 'reverse engineering': start with preparation and consumption of the meal, and work backwards though the 'missing middle' (i.e. the retailers/wholesalers, distributors, secondary and primary processors, and the associated logistics), to the grower. By crossing research disciplines with innovation topics in its research design, we will determine both how best to bring about systemic innovation, and analyse the health, environment and enterprise impacts of the transformed system.

The project will be centred on Leicestershire and has been co-designed with a range of local partners co-convened by Leicestershire County Council (LCC), including Leicester City Council, Food for Life and the Leicester and Leicestershire Enterprise Partnership (LLEP), who all see the potential for enhanced outcomes for local health, environment and enterprise. The potential benefits at the UK-level have been identified by organisations with a national remit, including Defra, FSA, NFU, WWF and CIWF.

FIO-FOOD, Food Insecurity in people living with Obesity - improving sustainable and healthier food choices in the retail FOOD environment.

Professor Johnstone, University of Aberdeen

Obesity levels in the UK represent a key public health issue, with 67% of its population living with overweight or obesity. People living with obesity are more likely to experience a range of health issues including heart conditions, and Type 2 diabetes. They are also more likely to be living in areas of high deprivation. Reducing obesity levels has been a public health priority in the UK for decades but we have not yet managed to achieve that goal. This is partly due to the range of factors that influence body weight. One key challenge facing people living with obesity is being able to afford a healthy, balanced diet. Nutritionally poor and energy-dense foods that are often ultra-processed, are cheaper and more readily available.

To start to address this challenge, we need better evidence on how to support healthier food purchasing patterns to improve their health and wellbeing, while considering environmental impact and sustainability. Food insecurity is 'the state of being without reliable access to a sufficient quantity of affordable, nutritious food'. Families on low incomes are more likely to be food insecure and they spend a greater proportion (three quarters) of their monthly food budget in supermarkets. Supermarket promotions, advertising, and online product placement decisions can impact this group's access to healthy foods. Importantly, healthy diets also need to be sustainable in terms of greenhouse gas emissions, water consumption, and land use; described as the 'sustainability footprint'. Our research will bring together food insecure people living with obesity, consumers, retailers, policy makers, and academics to co-develop and test strategies that can support future transformative potential in the food system.

Our diverse team of academic experts in social science, applied health, obesity, and data science, will combine our knowledge of large-scale population data with an understanding of lived experiences of food shopping for people living with obesity and food to develop practical solutions to promote sustainable and healthier food choices in this group. To achieve this, we have designed an innovative four-part project.

Perspective: we will work with people living with obesity and food insecurity to understand the key issues facing them while shopping. We will also engage with the retail sector and policy makers to understand their perspectives too. This will identify limitations and barriers of current strategies and scope out future opportunities for our project to make sure our work remains relevant and useful.

Big Data: we will use anonymous large-scale data (from >1.6 million shoppers) obtained from a national high-street supermarket to understand what foods people buy, how healthy these purchases are, their sustainability footprints and how these choices vary across different household types including those on low income. This will help identify in- store changes that would encourage healthier and more sustainable food purchasing for people living with obesity and food insecurity.

Solution Space: we will use the findings from the first two parts of this project to co-design new approaches and test these in-store and online assess their effect on healthier and sustainable food purchasing behaviours. We will also test and measure the effectiveness of these strategies in a group of people who are actively seeking to lose weight (MoreLife patient cohort) and living with food insecurity. This will help to identify strategies that can help transform supermarkets to promote healthier and more sustainable foods.

Delivery: we will engage with food producers, food retailers, patient groups, policy makers, and charity group representatives to ensure our project is relevant and transformative. We will do this by sharing our findings with those groups, using webinars, social media, workshops, and research briefing notes.

‘Raising the Pulse' (RtP): Systems analysis of the environmental, nutritional and health benefits of pulse-enhanced foods

Professor Lovegrove, University of Reading

'Raising the Pulse (RtP)' is based on the concept that considerable health and environmental benefit would result if we could make it easier for the UK population to eat more UK grown pulses. The pulse best suited to the UK, the faba bean, is naturally high in protein, micronutrients and fibre, and has the lowest environmental impact of all crops, as it can 'fix' nitrogen from the atmosphere with no need for polluting nitrate fertilizers. However, most of the population will not significantly increase their consumption unless they are successfully incorporated into familiar looking and tasting, economic and convenient staple foods, such as bread. This has not been done to date because economic incentives do not exist for producers to supply raw materials with defined end use quality, nor for processors to reconfigure their processing plant to accommodate a new raw material. A major stimulus

such as that provided by this study is required to encourage food manufacturers to use UK pulses to satisfy consumer demand for plant-based and pulse-rich foods rather than importing chiefly soy-based ingredients.

RtP addresses this market failure by bringing together a consortium to develop feasible routes to market for UK produced foods with added faba beans. The project includes experts in diverse areas, including environment, agriculture, food, nutrition, health and consumer behaviour, who have a demonstrated track record in this area and who will work with industry, government and civil society to tackle five linked challenges:

Challenge 1: how can environmental impacts of faba beans grown to meet specific quality standards be minimised? We will conduct extensive field trials to establish growing protocols to maximise the amount of nutrients produced per unit area using the best available genetics, agronomy and post-harvest technologies while making detailed measurements of environmental impacts.

Challenge 2: how can faba beans from Challenge 1 be prepared for incorporation into a variety of food products such that they retain the highest possible nutritional value and minimal change in taste? Following successful pilot breadmaking trials conducted to demonstrate feasibility, we will optimise cultivar selection, pre-processing and milling steps to obtain faba bean flours that can be successfully combined with wheat flour to make RtP bread that is an acceptable alternative to conventional bread, but with added nutritional and environmental benefits.

Challenge 3: what effects do eating more pulses have on nutritional intake and human health? A human study will be performed using RtP bread to determine nutrient availability and its effects on hunger and health markers. Furthermore, two consumer studies, one in student halls of residence and one in the catering outlets on the University of Reading campus, will be conducted. These will investigate whether faba beans offered as RtP breads and in other foods result in a healthier diet and better nutritional knowledge when information of their benefits is given.

Challenge 4: how can understanding of consumer attitudes, preferences and behaviours be used to achieve optimum increase in pulse intake? Addressing this crucial point will involve reviewing evidence, performing focus groups, surveys, choice experiment and test market launch. This will include determination of how RtP bread and related foods are perceived, whether they are liked and, therefore, chosen and whether knowledge of their benefits promotes their consumption.

Challenge 5: will combine all data collected across the project to create an over-arching mathematical model of interactions between pulse (particularly faba bean) production, manufacturing and consumption. This model will be used to determine the influence on environment and health of legislation and consumer behaviour and to predict the outcomes of specific interventions to hasten the transition of the UK population to a diet that contains more pulses.

Social enterprise as a catalyst for sustainable and healthy local food systems

Professor Lyon, Middlesex University

Researchers at Middlesex University (lead), the University of Surrey (co-lead), Glasgow Caledonian University and Shared Assets are researching how social enterprises can bring innovations in healthy and sustainable food. The £380,000 project grant from UKRI is part of the Transforming UK Food Systems programme.

The scale of change needed to transform UK food systems for health, social justice and environment requires new ideas, organisational models and collaborative approaches that can meaningfully engage individuals and communities. Existing top-down approaches to the challenge of sustainable food provision and diet have failed to tackle the crisis of poor dietary health and sustainable food production. The research will focus on the distinctive role of social enterprises (trading with a core social and environmental purpose), exploring and enhancing their unique contribution to food systems that are more inclusive, sustainable and healthy. This will include social enterprises providing community growing spaces and distribution schemes, leisure and fitness centres, children's nurseries and other community-based services.

The project will work closely with six partner social enterprises: Community Transport Glasgow (tackling access to affordable food), Cultivate Powys (local growing and social prescribing), London Early Years Foundation (nursery chef initiative), Selby Trust London (food and community hub), Social Adventures Salford (therapeutic growing and local food hub), Windmill Hill City Farm Bristol (growing space and community hub).

The research findings will be used to co-design resources and toolkits to support the scaling-up or replication of successful models and innovations and the sharing of good practice across the country. This is not without its challenges and the project will examine the various barriers and constraining factors and how they can best be addressed. In addition to good practice guides for social enterprises and other organisations across the country, policy briefings will be prepared, focusing on the different levels of local, regional and national policy making.

Professor Fergus Lyon of Director of Middlesex University’s Centre for Enterprise and Economic Development Research said “This project comes at a crucial time when there is a need for affordable, healthy food, grown in a sustainable manner. This collaboration between researchers and innovative social enterprises will be able to explore ways of tackling obesity and also tackling the impact of food production on climate change and biodiversity loss. They can do this in ways that other initiatives have been lacking”.

Is cultured meat a threat or opportunity for UK farmers?

Professor MacMillan, Royal Agricultural University

This research will critically assess the potential impact on UK agriculture of cultured meat, a technology with possibly profound and uncertain implications for the future of food and farming. Also known as 'clean', 'cell-based' and 'cultivated' meat, cultured meat is engineered animal tissue intended for people to eat. It is a type of alternative protein. Alternative proteins are strategically important to UK and global food systems because they can use less land and water than livestock products, lower greenhouse gas (GHG) emissions, cut antibiotic use and the risk of new zoonotic diseases, and help promote animal welfare. Early data suggest that cultured meats could yield such benefits but may struggle to compete with other meat alternatives on energy efficiency and cost. They are important because they could substitute more directly for livestock meat than other alternatives, and are at an earlier stage of development, so more open to influence by policy-makers and investors.

While cultured meat is potentially transformative, its benefits therefore remain speculative. It also brings risks in nutrition, food fraud and food safety. Technical, regulatory, market and cultural uncertainties mean that the sector may not develop in the UK commercially, or may develop but fail to deliver public benefits.

This project focuses on how cultured meat could affect farming in the UK. This is relevant to its environmental, economic and animal welfare impact, and to public and political attitudes that will shape how it gets regulated. Cultured meat is commonly assumed to be a threat to farmers, producing food in ways that could put some out of business. However, nobody has actually looked into this in-depth, or explored these issues with farmers in the UK.

In practice, the different ways that cultured meat might develop could bring diverse risks and opportunities for farmers. The technology may create demands for new agricultural products, such as cells (donor herds for cell harvesting), feedstock for growth media (arable, forage, sugar beet), feedstock for edible scaffolds (cellulose, pea, bean, soya) and current waste streams (glucose, cellulose). In some scenarios, cultured meat might even be produced on farms, in facilities owned and operated by farmers, or could complement campaigns for 'less and better' meat. Alternatively, it may not reduce livestock meat consumption at all, or it may compete directly with high-welfare meat production.

This research is designed to influence how this potentially transformative technology affects the UK food system. We will work with farmers and other people who may be affected by the technology to investigate whether they can see responsible ways of developing cultured meat. We will examine what farmers currently think of cultured meat, and explore different ways the technology could develop. We will work with farmers in a wide range of different situations to model how their businesses could get involved in or be affected by cultured meat production, and assess the environmental, social and economic consequences.

We aim to answer the following questions:

1. How do UK farmers currently perceive cultured meat?
2. What threats and opportunities does the development of cultured meat pose to UK farm businesses in different scenarios?
3. Under what conditions, if any, would on-farm production of cultured meat be practical, economically viable and desirable in the UK?

In answering these questions, we will consider not only the direct effects of cultured meat on farm businesses and livelihoods, but also wider ecological, nutritional, cultural and ethical implications, and how cultured meat might complement or conflict with the ways land use and diets in the UK could change to become sustainable.

TRAnsforming the DEbate about livestock systems transformation (TRADE)

Professor Moran, University of Edinburgh

Livestock (farmed mammalian species, poultry, and fish) has been central to UK agriculture for centuries, being culturally embedded in the popular image of national farming systems. But the sustainability of the sub sector is increasingly questioned due to environmental and health impacts related to production methods and meat and dairy consumption. Livestock will have to play a role if the UK is to meet climate change mitigation targets. Meat consumption, particularly processed meat, is under scrutiny for its potentially detrimental health impacts. Some production systems are constantly criticized due to their animal welfare impacts. There is some consensus around the idea that livestock farming must change or transform, but there is less agreement on how this might happen. A shared view of a specific system challenges and opportunities is a prerequisite to the development of a system transformation. Yet, it is unclear whether stakeholders in the livestock sector share the same vision of the system and its current structure and where it needs to get to.

TRADE will work with sector stakeholders including scientists, farmers, processors, retailers, consumers, investors and policy makers. It will seek a consensus on the increasingly contested role of livestock in the UK agricultural economy, balancing its market value and opportunities for innovation with its less tangible contributions to food systems, health, rural economies and social wellbeing. Consensus will be substantiated with the evidence on the innovation potential in production systems (e.g. genetics and breeding techniques), and with reference to public preferences for the future of livestock systems in the UK and internationally.

Ultimately, the objective is to understand and measure the environmental, health, economic and societal trade-offs inherent in transformation scenarios. Without better quantification of these trade-offs we are unlikely to develop consensus on transformational pathways that acknowledge and addresses relative gainers and losers.

TRADE will comprise 5 work packages using mixed qualitative and quantitative methods to explore better integration of social science with biological sciences to understand and mitigate societal, political and economic barriers that may hinder uptake of new solutions into practice. Objectives are:

1) Mapping UK stakeholders and determining baseline production and consumption patterns and associated market and non-market impacts (net external costs), their origin, distributional impact and regulation;
2) Understanding competing views on the technical, economic, behavioural and policy potential of production technologies and supply side shifts to regulate market and non-market impacts;
3) Understanding evolving health and social impacts and public preferences for livestock goods and related ecosystem services;
4) Understanding regulatory objectives and establishing consensus on roles and responsibilities of market participants and government;
5) Iterative modelling of the livestock system using participatory methods and co-constructed scenarios;
6) Development of a co-constructed pathway to specific and measurable outcomes related to market, environment health and social impacts related to production and consumption of livestock products.

The project will ultimately define an agreed pathway to transform the UK livestock in readiness for a changing future.

Increasing UK Dietary Fibre - The Case for the Great White British Loaf

Dr Tindall, University of Reading

Around 90% of the UK population consumes less than the government recommended 30g of fibre per day. Low fibre intake is linked to higher risk of bowel cancer (the second highest mortality rate cancer for men and women in the UK) and long-term chronic diseases (particularly type 2 diabetes and cardiovascular disease). White bread accounts for 76% of bread sold in the UK with around 12 million loaves being sold each day. Coupled with its high popularity, the need for increased fibre in the diet and gradual rather than abrupt changes to dietary fibre intakes (e.g. from white to wholegrain) to keep consumers onside, increasing the fibre content of white bread is highly likely to contribute to increasing overall UK dietary fibre intake. Current fibre enhanced white breads (e.g. 50:50) use expensive imported wholemeal wheat, which cannot be grown in the UK. We will use newly developed fibre enhanced white flour, which can grow in the UK, to maintain the white nature of the bread and keep costs down. The white flour also has the potential to be used in other bakery related products such as croissants, naan breads and pizzas, which will be explored by industry stakeholders in this project.

Utilising a combined behavioural, food technology and predictive modelling approach, informed by close collaboration with industry, our project will identify what transformation in the UK wheat agri-food chain is needed to deliver high fibre white loaf bread to consumers. Our project has been developed in collaboration with ASDA, their associated millers and bakers (Allied Technical Centre; ATC), seed producers (Limagrain), UK wheat chain associated bodies (UK Flour Millers and the Agricultural Horticultural Development Board) and a grain broker (Agricole).

Our combined consumer behaviour and food technology studies will determine the acceptability of fibre-rich white bread, whilst economic behavioural studies will focus on how sectors in the wheat agri-food supply chain (production to manufacturing and distribution) relate to one another. The first piece of work will ensure bread is produced which consumers want to purchase, whilst the second will inform the development of our Wheat Chain Model (WCM). This will be developed in collaboration with industry and informed by concurrent modelling of UK farming land usage (LUAM model), UK seasonal weather variation and changing climate impacts on UK domestic wheat production (GLAM-UK model) and international imports (GLAM model). Both the LUAM and GLAM models have previously accounted for wheat, and the GLAM model will be adapted to the UK during our project. Life Cycle Assessment work will help determine which environmental impacts might be affected by the change in wheat cultivars and include an uncertainty and sensitivity analysis of these impacts.

The WCM will account for the dynamics of the UK wheat agri-food chain and take account of domestic production versus flour received from imports. Industry informed modelling with all industry partners and their respective associations will quantify the transformational steps needed to increase fibre-rich flour production against a complex backdrop of domestic and imported wheat demand. We will utilise a range of data to inform the WCM including publicly available data such as the Farm Business Survey, data available via our industry partners, surveys of UK Flour Miller members and other industry stakeholders. Data collected during the project on how participants in the chain relate to one another will be analysed. It will both inform our WCM, and be available to other researchers and the public via our project website. We will create a graphical user interface (GUI) for our Wheat Chain Model. This will allow stakeholders and policy makers access to the model both during and after the project and the generic nature of the model will mean it can easily be applied to other agri-food chains, besides wheat.

Transformational blueprint for a blue economy on UK terrestrial farms: integrating sustainable shrimp production in a changing agricultural landscape

Professor Wilson, University of Exeter

Terrestrial farming is the greatest driver of biodiversity loss, a major contributor to greenhouse gas emissions and water pollution and faces its most transformational reform in 50 years to improve both environmental and economic sustainability. The new Agriculture

Act, 25YEP, has commitment to net zero carbon emissions and policies to enhance environmental stewardship, sustainability and support the production of public goods. This project aims to demonstrate the socio-economic benefit of a world-leading 'terrestrial blue economy', contributing multiple public goods to reform UK agriculture.

Combining high value shrimp aquaculture with farm-based renewable energy will provide a novel home-grown output with considerable but poorly understood economic and health potential. The public goods benefits of a switch from beef/sheep production to shrimp include lower greenhouse gas emissions, water pollution, and land use, freeing land for other public goods such as trees, biodiversity, biodiversity net gain, and recreation. Furthermore, co-locating self-contained, indoor shrimp production units with UK farm anaerobic digesters (AD) will maximise use of their (otherwise wasted) heat energy, enhancing sustainability and circularity of both industries. Extra income will also boost the farm-based renewable energy sector, helping the UK meet emissions targets.

Shrimp is a healthy seafood with high protein, low calories, low fat, rich in vitamins, minerals and antioxidants, promoting brain and heart health. Warm water shrimp is already highly popular seafood in the UK, with 22,852 tons (UK retail £319M) imported annually from Central America and SE Asia. However, traditional overseas production is vulnerable to climate/disease crises, has high transport-related CO2 emissions, and often uses environmentally unsustainable practices, e.g., destroying up to 80 % of nations' mangrove forests which absorb and trap more CO2 than any other of Earth's ecosystems. They also provide coastal protection against storms and coastal erosion. There is also the problem of illegal use (or just misuse) of chemicals such as pesticides and antibiotics resulting in contaminant residues in some of the shrimp exported to the UK, EU and US that can cause health issues.

This proposal aims to completely avoid these problems and ensure a risk-free, healthier and sustainable supply chain of this heart- and brain- healthy seafood for UK-consumers, by facilitating a major expansion of UK's shrimp RAS production sector which currently supplies equivalent to <1% of imports. We aim to co-locate RAS production with renewable energy sources on UK terrestrial farms. We conservatively estimate that if only 20% of the UK's current Anaerobic Digestor (AD) plants were adapted for shrimp farming, we could sustain 960 shrimp production units and harvest 5,520 tonnes of shrimp per year (~25 % of current UK warm water shrimp imports). With the rapid growth of AD plants across UK farms (10-fold increase since 2010), there is clear potential for truly sustainable, healthier, home-grown shrimp to provide the majority consumed in the near future, in addition to enhancing environmental stewardship, sustainability and supporting the production of public goods from UK agricultural practices. Importantly, this project will generate data to evaluate the true potential of sustainable UK shrimp production using renewable energy technology, as well as providing this shrimp industry with the necessary world-class scientific support.

This project will therefore address 3 goals to transform the UK Food System:

1) increased environmental sustainability of farm practices (e.g., sustainable use of existing waste heat from ADs),
2) economically sustainable expansion of UK land-based aquaculture production & employment,
   and
3) establishing the UK as a leader regarding capability, expertise and innovation in co-reforming agriculture and aquaculture.

TRANSFORMING UK FOOD SYSTEMS
Strategic Priorities Fund

About the 'Transforming the UK Food System for Healthy People and a Healthy Environment' Programme

The £47.5M 'Transforming the UK Food System for Healthy People and a Healthy Environment SPF Programme' is delivered by UKRI, in partnership with the Global Food Security Programme, BBSRC, ESRC, MRC, NERC, Defra, DHSC, Innovate UK and FSA. It aims to fundamentally transform the UK food system by placing healthy people and a healthy natural environment at its centre, addressing questions around what we should eat, produce and manufacture and what we should import, taking into account the complex interactions between health, environment and socioeconomic factors. By co-designing research and training across disciplines and stakeholders, and joining up healthy and accessible consumption with sustainable food production and supply, this Programme will deliver coherent evidence to enable concerted action from policy, business and civil society.

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www.foodsecurity.ac.uk/research/foodsystems-spf/