Theme B – Sustainable Food System and Supply

Lay Summaries of Projects

March 2023

Contents

1. B1 Crop Improvement

JHI-B1-1 Protecting Scotland's Crops – Disease Resistance and Pathogen Biology

PI: Ingo Hein (ingo.hein@hutton.ac.uk)

We aim to address the risks posed by pathogens and pests for sustainable production of potato and soft fruits that are of great importance to Scotland. The project is highly interdisciplinary and utilises established expertise in plant and pathogen genomics, genetics, phenotyping and cell biology, through to breeding.

JHI-B1-2 Exploring Barley Diversity for Resilience and Sustainability (BARGAIN)

PI: Joanne Russell (joanne.russell@hutton.ac.uk)

BARGAIN (JHI-B1-2) will explore the biological consequences and potential practical applications of natural genetic variation found in the primary barley genepool to address future priorities in low carbon cereal agriculture. BARGAIN is a contemporary barley genetics/genomics/informatics research program focused on scientific discovery and impactful translational biology.

JHI-B1-3 The impact of novel crops and farming practices on the Scottish agricultural landscape

PI: Rob Hancock (rob.hancock@hutton.ac.uk)

Changing policy, market and environmental conditions necessitate diversification in Scotland's agricultural systems. The research will adopt natural and social science approaches to identify barriers to the adoption of novel crops and cropping systems, develop innovative technical solutions and explore the consequences of change amongst rural and wider society.

JHI-B1-4 Tools and Technologies: Development of new populations, genotyping tools and methods for trait dissection to support horticultural crop improvement, sustainability and resilience

PI: Julie Graham (Julie.graham@hutton.ac.uk)

Crop production in Scotland faces many threats. Varieties that withstand the many challenges' growers face are essential. Here novel plant populations and tools that examine behaviour under complex stresses and examine the plants' genetic content will be used to develop high quality resilient crops, reducing inputs and allowing the Scottish population to locally source more fruit and vegetables.

JHI-B1-5 Crop Improvement for Sustainable Production in a Changing Environment

PI: Tim George (tim.george@hutton.ac.uk)

Changing environmental conditions necessitate adaptations in Scottish agriculture. This project will investigate the development of crop species that are resilient to combinations of environmental stresses whilst using resources more efficiently. We will test the hypothesis that utilisation of latent diversity in crop species can improve both resource efficiency and stress tolerance.

JHI-B1-6 Monitoring the environmental impact of controlled environment agriculture

PI: Gordon McDougall (gordon.mcdougall@hutton.ac.uk)

Vertical farming (VF) is an emerging food manufacturing process with potential to change how food is produced and distributed in rural and (peri)urban areas. Reliable food production 24/7/365 and significantly reduced inputs and waste makes the approach a prospectively valuable option for food

producers. We will establish baseline energy use, GHG emissions and inputs/outputs for VF and compare them to alternative/established production systems.

R1-B1-01 Hemp: a climate resilient crop for the future of Scottish agriculture

PI: Madalina Neascu (m.neacsu@abdn.ac.uk)

Scottish Government's Climate Change Plan includes reference to carbon sequestration options for agriculture. This project research supports a climate resilient crop as hemp for: stimulating Scottish farming sector to run GHG removal activities; Identifying opportunities for Scottish food and drink sector to promote sustainability and by understanding nutrition sufficiency and consumer acceptance of hemp food as part of low carbon footprint diet.

RI-B1-02 Extending Food Production to Scotland's Underutilised Lands

PI: Wendy Russell (w.russell@abdn.ac.uk)

This project will evaluate the potential of Scotland's underutilised lands to contribute towards a sustainable food system and provide economic motivation to protect our natural capital. The focus will be wild species that can contribute towards sustainable food production, while meeting environment and biodiversity targets. Engagement with a wide range of stakeholders will provide a RoadMap that will meet cross-sector needs.

2. B2 Livestock Improvement

MRI-B2-1: Improving livestock productivity and sustainability through management and genetics

PI: Philip Skuce (Philip.Skuce@moredun.ac.uk)

The aims of the project are to investigate livestock traits for improved performance and reduced environmental impact through management and nutrition that will safeguard the future profitability of the Scottish livestock industry, whilst maintaining the high-quality reputation of Scottish food.

Key drivers are the need to: 1. Promote resilience to potential impacts of climate change on livestock productivity; 2. Improve farming practices to enhance efficiency, profitability and sustainability; 3. Improve food security sustainably and less intensively to help free up land for carbon capture/sequestration; 4. Assist the livestock sector in reaching its net zero/carbon neutral targets prior to 2045; 5. Enhance and promote biodiversity through the minimisation of impact by agricultural practices; 6. Reduce the reliance of producers on chemicals and veterinary medicines and 7. Improve livestock health and welfare.

MRI-B2-2: Monitoring veterinary medicine usage to improve animal performance and efficiency

PI: Adam Hayward (adam.hayward@moredun.ac.uk)

The research aims of this project are to:
1. Quantify patterns of usage of common veterinary medicines in beef cattle, such as antibiotics, anthelmintics and vaccines and producers' adherence to best practice guidelines;
2. Quantify associations between the treatments applied to cattle on-farm and animal performance in terms of growth and carcass quality.
The main drivers of this project are:
1. That infectious diseases cause reductions in animal performance and health and impact on the environmental and economic sustainability of the livestock industry;
2. We currently have little understanding of the extent to which diseases are being targeted with the right treatments, at the right dose, and at the right time;
3. Inappropriate treatments represent a financial cost to the producer, but also potentially contributes to anti-microbial and anthelmintic resistance, environmental damage and biodiversity loss;
4. While we can test the impact of veterinary medicines and vaccines on performance in single-pathogen experimental trials, we have less information on how performance is affected when individuals are exposed to a variety of (co-)infections and treatments in a commercial 'real-world' setting

SRUC-B2-1 Feeding and breeding strategies for climate resilient and sustainable dairying.

PI: Richard Dewhurst (richard.dewhurst@sruc.ac.uk)

We will work with Holstein cows from representative genetic lines and typical feeding systems to investigate relationships between milk production, efficiency and the ability to withstand the effects of climate change on feed supply and composition. We will develop new measures of feed variability, describe it for typical feeding systems and investigate effects on milk production and cow health. This will be done with diets designed to reduce C footprints. Our aim is to develop optimal breeding and management strategies for climate smart production, climate resilience and enhanced biodiversity.

SRUC-B2-2 Breeding and management strategies for sheep in the Scottish hills and uplands, to meet future economic, environmental and climatic challenges.

PI: Nicola Lambe (nicola.lambe@aruc.ac.uk)

The project aims to equip upland sheep systems and associated businesses with the best combinations of genetics and management strategies to adapt to future challenges. In addition to productivity, future systems must consider environmental sustainability, GHG emissions, resilience to climate change and biodiversity effects. This will require system-wide changes so the project will adopt a systems approach, incorporating state-of-the-art phenotyping for efficiency and resilience traits into breeding programmes and evaluating best combinations of management and grassland strategies to be used alongside these breeding strategies.

SRUC-B2-3 Genetic diversity and adaptability in livestock.

PI: Georgios Banos (georgious.banos@sruc.ac.uk)

Maintaining genetic diversity and enhancing farm animal adaptability to environment are key drivers of long-term sustainability of livestock production in Scotland. The proposed research will use genomic data to evaluate genetic diversity in major breeds of cattle and sheep in Scotland and link this the ability of animals to adapt to variability or extremes in their environment, particularly in the context of the effects of climate change. Results will be incorporated into selective breeding programmes aiming to achieve improved productivity, while protecting and enriching diversity and livestock sustainability in Scotland.

SRUC-B2-4 Data driven innovations for improved sustainability of ruminant productions systems.

PI: Carol-Anne Duthie (carol-anne.duthie@sruc.ac.uk)

Use of precision livestock farming tools is increasing globally. When exploited fully, these can aid farm-level management, improve animal health, welfare and productivity, monitor or reduce emissions, and improve traceability. This project will explore current and new digital innovations, key barriers to adoption and solutions, and provide a robust evidence base demonstrating benefits of integrated data use within beef, sheep and dairy systems.

SRUC-B2-5 Data driven techniques to develop new phenotypes for dairy cows and chains

PI: Mike Coffey (mike.coffey@sruc.ac.uk)

We will use experimental and national farm data to develop new analytical methods to create new predictions, alerts and management tools for dairy cow, herd and supply efficiency, health and sustainability.

SRUC-B2-6 Integration of data to drive data driven approaches for livestock improvement.

PI: Mike Coffey (mike.coffey@sruc.ac.uk)

Working with public and private data sources, we will work with partners to develop new systems to integrate data to help develop, test and identify implementation routes for national level livestock improvement tools.

SRUC-B2-7 Modelling our livestock futures.

PI: Eileen Wall (eileen.wall@sruc.ac.uk)

Building on knowledge from previous Scot Gov funding and industry initiatives we will model scenarios of alternative livestock futures for Scotland and the identify appropriate improvement tools to get there considering policy and sustainability of the transition paths.

3. B3 Improving Agricultural Practice

JHI-B3-1 Co-designing and implementing best-fit farming practices

PI: Lee-Ann Sutherland (Lee-Ann.Sutherland@hutton.ac.uk)

Assess the influence of trigger events on basic and best-fit practices. New approaches for influencing farmer behaviour will be co-designed with farmers and industry stakeholders, empirically tested through applied agroecology, parasitology and experimental economics, and promoted through on-farm demonstrations, workshops, training events and multimedia campaigns.

MRI-B3-1 Strategies to promote sustainable parasite control and reduce anthelmintic usage

PI: Dave Bartley (Dave.bartley@moredun.ac.uk)

Investigation of the environmental impacts of grazing and the use of traditional wormers along with an assessment of the impacts of a range of alternative parasite management strategies on livestock productivity and environmental impact.

SRUC-B3-1 Ensuring positive behavioural change for farmers towards best practice for clean growth: economic and behavioural investigations.

PI: Klaus Glenk (Klaus.Glenk@sruc.ac.uk)

The project uses existing and new data on farm businesses to provide a baseline of basic and best practice adoption in Scotland that can be used to evaluate future change. Using information provided by farmers in surveys and workshops, it also aims to identify opportunities for promoting best practice uptake across the agricultural sector to achieve enhanced agricultural productivity while reducing the overall impact on the environment.

4. B4 Food Supply and Security

JHI-B4-1 - Incentivising resilient and innovative food supply chains and sustainable consumer choices

PI: Liz Dinnie (liz.dinnie@hutton.ac.uk

This project will develop understanding of increasing production and use of Scotland's fruit and vegetables through a multidisciplinary, systems-led approach examining production, supply and distribution. The project will focus on scientific practices underpinning sustainable agroecology and draw in external stakeholders and socio-technical innovations along food supply chains.

RI-B4-1 - Building food and nutrition security in Scotland

PI: David Watts (d.watts@abdn.ac.uk)

This project aims to inform transformative policies to build food and nutrition security in Scotland. The research will review and generate evidence and will explore and recommend new ways of providing dignified options for Scotland's more vulnerable residents to consume healthy food and drink in ways that provide opportunities for Scotland's food and drink sector to operate in an environmentally and financially sustainable manner.

SRUC-B4-1 - Issues related to the demand of fruits and vegetables in Scotland

PI: Cesar Revoredo-Giha (Cesar.Revoredo@sruc.ac.uk)

This project complements regarding the increase in production of fruits and vegetables (F&V) in Scotland by considering the demand for those products. Plans to increase alone the supply of F&V will not provide any benefit or value to Scottish producers or the society if it is not accompanied with an increase of the demand for them. The research aims of this project are: (1) to complement the supply side work with a demand analysis (e.g., demand analysis, seasonality analysis and competitors of Scottish F&V). (2) To address topics such as: consumers' willingness to buy products out of season, consumers' interest on alternative to supermarkets retailing models, consumers' provenance preferences, interest on plant-based products.

SRUC-B4-2 - Improving the resilience to shocks of Scottish food and drink supply chains

PI: Cesar Revoredo-Giha (Cesar.Revoredo@sruc.ac.uk)

This project will develop tools and/or a framework to serve as the basis for future reviewing of the resilience of supply chains. This will be used to understand the vulnerabilities and strengths within the Scottish food and drink supply chain - both considering it as a whole and sub-industry specific. The supply chains to consider are pigs, beef, dairy and potatoes. Finally, within each supply chain the project will identify practical applications of the framework to demonstrate the value of potential investment as well as novel forms of intervention.

SRUC-B4-3 - Understanding the mismatch between domestic consumption and production in Scotland

PI: Cesar Revoredo-Giha (Cesar.Revoredo@sruc.ac.uk)

This proposal addresses regarding the mismatch between what is consumed within Scotland and what is produced. In this context, the purpose of the project is through an empirical analysis of large detail datasets, combined with qualitative work that will allow interaction with stakeholders to: (1) to generate new insights into the practical understanding into how current Scottish food production matches or differs with what Scottish households consume; (2) to use the information about the mismatch between local supply and demand to identify opportunities for increased food security; (3) to generate insights between what is produced and what should be consumed based on recommendations; (4) to identify how climate change may affect the local food supply and discuss how to deliver increased resilience.

SRUC-B4-4 - Food and drink innovations - models of policy support and other incentive mechanisms

PI: Luiza Toma (luiza.toma@sruc.ac.uk)

This project will provide evidence for understanding factors leading to demonstrable change in innovation and investment in Scottish food supply chains, in particular the role of policy and government support through (1) mapping and (2) ranking incentives to innovation uptake by their effectiveness; and (3) developing models of support to innovation uptake at supply chain level feeding into an innovation uptake incentive framework at sectoral level.

5. B5 Food and Drink Improvement

JHI-B5-1 Food and drink manufacturing: Establishing baseline contributions to climate change and identifying scope for Reduction of Environmental impACTs (REACT)

PI: Derek Stewart

This project will provide baseline meaurements of greenhouse gas emissions & energy usage for various Scotland's food & drink production & manufacturing processes. It will also develop two case studies on vertical farming & malting. This will provide datasets & tools that will show how these processes can be optimized to reduce the environmental impact of producing and manufacturing food & drink products.

JHI-B5-3 Tools to support provenance of Scottish food produce

PI: Carol-Ann Craig (carol-ann.craig@hutton.ac.uk)

We will measure the Strontium isotopes in Scottish soils to create a map (isoscape) which can be used as an aid in determining where conventionally grown crops were grown. For crops grown in soilless, controlled environment units the link to the location is severed. We will analyse their crops, waters and nutrients using isotope and chemical methods to see if they can be used for provenancing.

Project ended.

RI-B5-03 Supply-chain-driven food and drink reformulation to achieve Scotland's dietary and climate targets

PI: Wendy Russell (w.russell@abdn.ac.uk)

This project will contribute towards supporting Scotland's dietary and climate targets though supply-chain-driven food and drink reformulation. This will be achieved through developing new supply chain networks for crops that can be sustainably produced in Scotland. We will develop innovative prototype products for multi-sector use, which we will widely disseminate to encourage wider adoption.

RI-B5-04 Understanding the Scottish food supply chain.

PI: Baukje de Roos (b.deroos@abdn.ac.uk)

We will build data to map production, imports and exports of fresh and processed foods for major Scottish agri-food supply chains, and map these against purchasing and intake data, as well as dietary recommendations. We will also model the impacts and requirements of a transition to more healthy and sustainable scenarios of production and consumption in Scotland.

RI-B5-05 Novel Multi-Sector Approaches to Provenance and Food Tracking for use in Distributed Ledger Protocols

PI: Paul Haggarty (p.haggarty@abdn.ac.uk)

This project is designed to develop Distributed Ledger (blockchain) compatible methods - based on DNA and chemical analysis - to determine provenance across key Scottish produce and sectors to protect the safety, integrity, and quality of the food chain and the environment and the status of key Scottish produce. It addresses questions 4b, 4c in the RESAS ITGF and is relevant to Brexit and large-scale shifts in international food trade.

RI-B5-06 Drivers and barriers for adopting healthy and sustainable food swaps in young adults

PI: Baukje de Roos (b.deroos@abdn.ac.uk)

We aim to identify the most effective food swaps, based on an individual's diet, that makes their shopping basket more healthy and environmentally sustainable, and monitor in real-time whether physiological, psychological and environmental factors, at an individual level, affect the adoption of such food swaps and make individual diets healthier and more environmentally sustainable, in young adults.

RI-B5-07 Optimizing intervention strategies via social prescribing as a means of encouraging and enabling healthy and sustainable dietary behaviours in individuals from low-income families

PI: Frank Thies (f.thies@abdn.ac.uk)

This project will review existing community interventions designed to support healthy eating, identifying effective elements that people from low-income households value and engage with. These elements will be combined with strategies shown to effectively helping people to change behaviour, and used to create a new holistic healthy eating intervention for delivery to clients from low income families through the social prescribing service.

RI-B5-08 Understanding public attitudes and preferences for healthy and sustainable diets

PI: Patricia Norwood (p.norwood@abdn.ac.uk)

The main aim of this project is to understand how to influence consumers to make long-term changes in dietary behaviours, more specifically, assess UK and international approaches to driving long-term changes in dietary behaviour at population level and understand facilitators and barriers for consumers to make healthier and more sustainable food choices, with a focus on reducing health inequalities

RI-B5-09 Pathways to healthy and sustainable diets: Identifying facilitators, barriers and unintended consequences of switching to a more plant-based diet

PI: Jennie Macdiarmid (j.macdiarmid@abdn.ac.uk)

We will explore dietary choices people make when they switch to a more plant-based diet. Plant-based diets are viewed as healthier and sustainable, but little is known about the plant-based foods people

choose in place of meat and why. We will conduct a series of studies to explore personal and social barriers, both perceived and real, to eating less meat and the health and environmental impacts when meat consumption and purchasing patterns vary.

RI-B5-10 Costs and opportunities for Scottish products with higher value status

PI: David Watts (d.watts@abdn.ac.uk)

This project aims to generate insights on the economics of higher-value status food and drink products. The research will: quantify the extent to which such products hold a price premium and face higher production costs than standard products; examine the key factors are in achieving a higher/lower gross margin; understand the impact of EU exit and other developments in international trade; and identify opportunities to develop and promote them.

RI-B6-02 Developing metabolomics and proteomics tools to identify the provenance of foods and beverages of economic importance in Scotland

PI: Jules Griffin (jules.griffin@abdn.ac.uk)

The consumer has a right to know what is contained within the food they eat. Allied to this, there is a significant risk in the food supply chain of fraud where a food is replaced by a cheaper or inferior alternative. This project will develop mass spectrometry-based approaches for determining the provenance of food and beverages. We will develop methods for determining the composition of whisky and meats to ensure their integrity.

SRUC-B5-1 Mapping major supply chains within the Scottish food and drink industry

PI: Cesar Revoredo-Giha (Cesar.Revoredo@sruc.ac.uk)

The purpose of this research projects is, using a value chain approach that combines quantitative and qualitative methods, to map major food supply chains both within Scotland and those where Scottish industries are heavily involved elsewhere (i.e., UK and Europe) to improve the understanding in the way they operate. To propose a methodology to be able to update changes in the maps. To provide a modelled analysis of individual sectors that demonstrates where value is created, added, and lost during the supply chain and to use the modelled analysis to simulate various scenarios whereby the value in the supply chain could be increased and distributed in Scotland among producers and processors.

SRUC-B5-2 Collaboration within Scotland's food and drink supply chain

PI: Cesar Revoredo-Giha (Cesar.Revoredo@sruc.ac.uk)

Effective business relationships in vertical supply chains are thought to: (a) reduce uncertainty (b) improve access to crucial resources and ? or (c) raise business productivity. The purposes of this project are: to review the status-quo of collaboration and engagement between various stages of Scotland's food and drink supply chain; to identify those points under acute pressure in the wake of recent shocks

and recognising their strengths and weaknesses and to identify means by which collaboration can be enhanced.

Project ended.

SRUC-B5-3 Opportunities for Scottish food industries in existing and new markets

PI: Cesar Revoredo-Giha (Cesar.Revoredo@sruc.ac.uk)

This proposal addresses the following question: in the current economic climate, what are the opportunities available to Scottish food industries, both in existing markets and new, to add greater value to Scottish branding? Using large datasets related to trade, launching of products, and consumer purchases, this project will study current trends in markets the Scottish food sector operates (e.g., consumers trends) and how these might be supported, identify those opportunities associated with future UK trade deals. In addition, the project will map the co-product producing arm of Scotland's Food and Drink industry for its production potential, nutritional value as animal feedstuff, utilisation attributes and constraints and typical market prices.

SRUC-B5-4 Assessing the impact of dietary health interventions for driving long-term positive changes in diet and nutrition in Scotland

PI: Faical Akaichi (faical.akaichi@sruc.ac.uk)

The project aims to evaluate the impact of selected dietary health interventions (e.g., fiscal measures, nutrition education, nutritional labelling, advertising control, and social marketing) for improving Scotland's diet and nutrition and investigate whether and how their impact varies over time and across demographic groups. It also investigates potential unintended consequences of implementing the selected dietary interventions (e.g. increased health inequalities).

Project ended.

6. B6 Diet and Food Safety

JHI-B6-1 Flows of Antimicrobial resistance (AMR) and pathogens through environment to food chain

PI: Lisa Avery (lisa.avery@hutton.ac.uk)

This research aims to quantify the flow of AMR genes and pathogens from the environment to the food chain and directly to humans in the farm environment under different farming practices (e.g. organic, conventional). This will be integrated with social science work on antimicrobial use. Both quantitative and qualitative data will be used to develop a risk assessment model based on a Bayesian Belief Network.

JHI-B5-2 Tools to support healthier, safer, Scottish food produce

PI: Gordon McDougall (Gordon.McDougall@hutton.ac.uk)

Accurate and reliable food safety testing is a key requirement to underpin Scotland's Food and Drink reputation and to produce nutritious and safe food. Accurately identifying food and feedstuff ingredients contaminated with chemical or biological toxins is crucial to protect the public from harm but also to reduce waste due to unsuitable foodstuffs being manufactured then rejected. The prevalence of **persistent organic pollutants** in the environment and their possible accrual in foods requires monitoring and methods developed for monitoring in environmental samples may be adapted to foodstuffs. Biological contaminants such as **ergot or plant alkaloids** have various toxic effects, and effective state-of-the art methods using spectrometric techniques will be developed to provide information to ensure that safe levels can be set and then agreed through industry engagement and ultimately legislation.

Two thirds of the UK population is overweight, and 28% of adults are obese with higher BMIs more common as the population ages. There is a disconnect between people's goals and reality as most Scottish adults think they meet dietary guidelines on salt, sugar, fat, calories, fruit & vegetables, and fibre but only a minority do, and fewer make substantial changes to habitual diets. Therefore, reformulation of commonly eaten foods to reduce fats, sugars, and salt could be a powerful tool to reduce harm from over-consumption of calories, obesity, and related diseases. Such reformulated foods provide health by stealth but appear to be well received by the public to improve overall diet outcomes. **This project aims to provide new components to further enable reformulation of sugar, fat, and salt content.** The examination and re-valorisation of food-grade co-products also feeds into Scotland's strategy to reduce food waste and become a zero-waste circular economy nation.

MRI-B6-1 Addressing knowledge gaps in the sources, epidemiology and genetic diversity of important foodborne pathogens.

PI: Clare Hamilton (Clare.Hamilton@moredun.ac.uk)

This project will investigate the role of Scottish livestock and their environments in transmission of important foodborne pathogens, *Toxoplasma gondii* and *Campylobacter* spp., to humans. *Toxoplasma gondii* is a zoonotic parasite of global importance and a major transmission route to people is through the consumption of undercooked meat from infected animals. Despite this, there are still significant

knowledge gaps surrounding the sources and epidemiology of foodborne toxoplasmosis. We will investigate the genetic diversity of *T. gondii* in livestock, humans and the environment (water) in Scotland and the seroprevalence of *T. gondii* in food animals, and will identify interventions to reduce disease. *Campylobacter* is a versatile foodborne pathogen with the ability to evolve rapidly. While the major source of campylobacteriosis in Scotland is raw or undercooked poultry, studies have also highlighted livestock as an important reservoir. This project will address several key knowledge gaps regarding circulating genotypes within Scottish sheep and deer farms, and we will apply comparative genomics to investigate farm ecosystems for routes of transmission. We will also exploit an existing *Campylobacter* whole genome sequence data resource to explore the role of metabolic versatility in host association and clinical outcome.

MRI-B6-2 Establish an understanding of the flow of antimicrobial resistance genes (ARGs) through soil, animals and humans in different agricultural practices.

PI: Nuno Silva (Nuno.Silva@moredun.ac.uk)

Major gaps still exist in surveillance and data sharing related to the emergence of AMR and its potential impact on both animal and human health. A One- Health approach is needed to contain AMR, and this has to include improved integrated-surveillance of AMR genes (ARGs) and mobile genetics elements in food-producing animals, and surrounding farm environments. In this project, we propose to use a One Health approach to evaluate the impact of different farms management and agriculture practices in the spread of AMR bacteria and, how ARGs can flow between environment, food-producing animals, and humans (farmers). Environment samples (water and soil); animal and human samples (farmers septic tanks) will be compared in two research farms, University of Glasgow and MRI farm. The research farms comprises several materials spread on different grazing land plots, including sludge pellets; different manures and slurries from the farm; commercial fertilise, etc. The indicator bacteria *Escherichia coli* and obligately anaerobic bacteria will be evaluate for AMR and content of antimicrobial resistant genes (ARGs). In addition, WGS will be used for most promising isolates and, a high throughput qPCR analysis for the detection and abundance of AMR genes at sample level. This study, will allow not only to obtain knowledge how the AMR bacteria and AMR genes flow between farm and environment and the risk of different farms practices in the spreading of AMR to humans via the food chain. Antibiotic and heavy metal residues will be analyse for his role in AMR selection in soil samples. The data is expected to provide additional information to develop a risk model to help assess the impact of different farm management approaches.

RI-B6-01 Incorporation of whole ecosystem approaches to reduce transmission of foodborne pathogens and antimicrobial resistance

PI: Karen Scott (k.scott@abdn.ac.uk)

There are approximately 2.4 million cases of foodborne pathogen infections per year in Scotland, with a financial cost of ~£9 billion. These pathogens, often transmitted to humans via the food chain, include Campylobacter, Salmonella, and toxigenic E. coli. Moreover, the overuse of antibiotics in clinical practice and in animal husbandry has been a key factor in the global crisis of antibiotic resistance, resulting in the emergence of many clinically important multi-drug resistant pathogens. It is vital to understand the transfer of antibiotic resistance between bacteria, and the role that non-harmful bacteria resident in the intestines of livestock or wider environment play in the chain of transmission.

The first aim of this project is to identify specific non-harmful bacteria isolated from livestock and the environment that can inhibit growth of a range of pathogens, in order to interrupt the spread of foodborne pathogens across a range of different environments. The second aim is to screen genome sequences from our collection of Campylobacter strains and non-harmful gut bacterial isolates to identify identical genes, and understand their role in the spread of antimicrobial resistance through the environment.

RI-05-01 Evaluation and mitigation of mycotoxin contamination across the Scottish cereal supply chain to assess human exposure and inform risk analysis

PI: Silvia Gratz (s.gratz@abdn.ac.uk)

Mycotoxins are toxic fungal contaminants which are often found in cereal foods. In addition to the fungal mycotoxins additional modified mycotoxin metabolites can be present in raw materials and finished foods. It is therefore crucial to understand the level and chemical profile of mycotoixn contamination in raw materials and cereal foods to minimize human exposure and ensure consumer safety.

This project is focussed on assessing the levels of mycotoxin contamination in the Scottish cereal supply chain and inform risk assessment of human exposure. The project spans the whole supply chain looking at i) levels of contamination in Scottish cereal crops, ii) assessing the impact of processing on the levels of contamination and carry-over into cereal foods and iii) assessing human exposure through food analysis and biomonitoring.

RI-B5-02 Cell-based bioassay solutions for food contaminant testing

PI: Andreas Kolb (a.kolb@abdn.ac.uk)

Food safety relies on continuous testing of materials entering the food chain. Toxins which could impact on consumer health could be derived from natural sources (e.g. mycotoxins or plant alkaloids) or man-made sources (e.g. persistent organic pollutants, like Dioxin). Current testing of food products relies on chemical and immunological techniques which may be unable to detect compounds related to toxins or toxin metabolites generated by enzymatic activities in the natural environment or in the gut and liver of the consumer. Cell-based assays can help to identify and define these “masked” toxic compounds and detect emerging toxin risks from novel foods or novel eco-friendly packaging materials. The proposed research aims to develop cell-based assays to identify these health risks and to develop immunological or biosensor assays which allow the rapid in-situ detection of these chemicals.

SRUC-B6-1 Understanding the diversity of STEC and its relationship with human pathogenic potential

PI: Sue C. Tongue (Sue.Tongue@sruc.ac.uk)

Per head of population, more cases of human illness from infection with Shiga toxin producing E. coli (STECs) occur in Scotland than elsewhere in the United Kingdom. We will use detailed information from whole-genome sequences to improve knowledge of STEC that exist in the ecosystems of Scottish dairy cattle, sheep, farmed deer and leafy produce. We will compare them with sequenced isolates from Scottish human cases, to help develop ways to reduce the burden of disease in the Scottish

human population. We will also investigate if current laboratory diagnostic detection methods can be improved, which would save time and money.

SRUC-B6-2 A systems understanding of the flow of AMR from livestock production to the environment and humans: informing risk analyses

PI: Mike Hutchings (Mike.Hutchings@sruc.ac.uk)

Our research in the previous Strategic Research Programme (SRP) provided the first detailed characterisation and quantification of the AMR gene profile of a pig farm (Pollock et al. 2019). The high levels of AMR gene carriage within the pig microbiome showed that on average every bacteria within the pig gastrointestinal tract carried AMR genes, and suggested that the pig unit could be seen as a source of AMR gene pollution for the wider environment and linked food systems. The aim of this project is to characterise and quantify the flow of AMR genes within and from livestock holdings to the wider environment and human population, to inform antimicrobial stewardship and optimal use, and human risk via the food chain. Using a study site comprised of co-located pig, beef, poultry and sheep holdings: Top down descriptions of AMR patterns found in the environment will be matched with bottom up hypothesis testing experimental characterisation of the processes driving AMR gene flow through the system. The resultant data will feed in to AMR risk analyses and simulation modelling studies of the population dynamics of AMR genes in livestock and their linked environments. Year 1 research will focus on quantifying the patterns of AMR genes found in the environment and the potential for AMR gene flow from and between livestock holdings.

BioSS-3-LSM Framework for modelling farm to fork transmission and control of foodborne hazards

PI: Glenn Marion (glenn.marion@bioss.ac.uk)

7. B7 Human Nutrition

RI-B7-01 Healthy diets for a healthy weight: exploring physiological mechanisms related to dietary fibre and non-nutritive sweeteners

PI: Alex Johnstone (Alex.Johnstone@abdn.ac.uk)

The Scottish diet remains poor quality and is a main contributing factor driving unhealthy weight and dietary inequalities. To reduce the burden of diet related disease, this project explores public attitudes towards nutritional factors influencing food choice, namely food additives (specifically artificial sweeteners) and dietary fibre. The purpose of the study is to understand how dietary fibre influences appetite and food intake and then, how sweeteners may disrupt this response. We will implement two human diet trials to investigate these key dietary components on physiological mechanisms associated with appetite control for a healthy weight. We will also examine the changes in the profile of bacteria that inhabit the gut and the associated metabolic products. We will investigate the effects on human blood metabolites such as blood sugar and circulating changes in hormones that are thought to influence appetite.

RI-B7-02 Revalorisation potential of agricultural waste materials into a sustainable source of health-promoting dietary fibre

PI: Petra Louis (p.louis@abdn.ac.uk)

Dietary fibre, which mainly consists of plant-based carbohydrates that cannot be digested in the upper gut, is an important part of a healthy diet. It is fermented by the microbial community (microbiota) in the large intestine to a range of compounds which have health-promoting effects. Plant-based agricultural and food production waste materials are a potential novel source of fibre. Easily fermentable soluble fibre is largely removed during food production processes and the human microbiota has limited capacity to break down and ferment the residual complex insoluble material. In this project we will investigate whether agricultural and food-processing waste materials can be modified to increase their fermentability by gut microbes. If successful, this project will lay the foundation for the development of approaches to convert current waste materials to valuable products, thus improving the sustainability of agricultural practice. This will not only contribute to reducing the environmental impact of Scotland's food and drink sector, but will also identify opportunities for innovation in the Scottish food and drink industry and expand on effective pathways to increase fibre in the Scottish diet.

Project completed

RI-B7-03 Barley to support food and drink innovation

PI: Wendy Russell (w.russell@abdn.ac.uk)

The project will evaluate if whole grain phytochemical-rich barley accessions developed from ancient grain (for improved climate credentials) can produce a significant change in blood sugar levels to complement the established lipid lowering health claims related to barley β-glucan. This will support. new food and drink market opportunities and promote barley as a healthy and sustainable crop.

Project completed

RI-B7-04 Investigation of the Covid 19 pandemic on dietary behaviour in Scotland and accompanying health and well-being impacts

PI: Paul MacNamee (p.mcnamee@abdn.ac.uk)

This project considers the effect of the COVID-19 pandemic on dietary behaviours and impacts on health and well-being in Scotland using information from a large household survey. We focus on whether people changed how much fruit and vegetables they ate, how much alcohol they drank, and whether they worried more about buying healthy food. We also assess whether mental health and overall life satisfaction changed, and whether that affected diet.

Project completed

I-B7-05 Risk-benefit analysis of Scottish seaweeds as a sustainable food source.

PI: Alan Sneddon (a.sneddon@abdn.ac.uk)

The aim of this research is to test the evidence that Scottish seaweeds can provide rich, sustainable, plant-based sources of essential dietary micronutrients with an eventual goal to include these as dietary ingredients within food products. A key driver for this research is the need to provide alternative, sustainable sources of important dietary micronutrients which are predicted to decrease as agricultural and consumer practices are transformed to address the climate emergency and the need to achieve Net Zero. This project will determine levels of micronutrients (sodium, calcium, magnesium, potassium, copper, phosphorous, selenium, iron, zinc, and vitamin B_{12}) as well heavy metals (mercury, lead, arsenic and cadmium) within selected Scottish seaweed species. This work will identify seaweed species with low levels of heavy metals but dietary-relevant levels of micronutrients which could be used to provide a sustainable, plant-based source of these micronutrients.

Project completed

RI-B7-06 Investigation of nutrition and health properties of new soft fruit crops grown in Scotland.

PI: Fiona Campbell (fiona.campbell@abdn.ac.uk)

Soft-fruit producers have an increasing need to find more climate resilient crops that require fewer inputs in terms of labour and pesticides. To make these changes producers, need help, namely getting the public to have confidence in the new types of soft fruit. The aim of this project is to investigate the healthiness of the alternative soft fruit crops grown in Scotland to help to market them.

This is a human intervention study, where the aim is to compare the health benefits, particularly in relation to glucose metabolism and memory of the consumption of 3 soft fruits, raspberries which are currently grown in Scotland and two new crops recently introduced to Scotland, which are more climate tolerant.

Project completed

RI-B7-07 Climate change, biodiversity loss and changing diets

PI: Baukje de Roos (b.deroos@abdn.ac.uk)

We will review current insights on the potential impact of changing to more healthy, environmentally sustainable and affordable diets on climate change and biodiversity loss and gather knowledge on how this impact can be practically measured and communicated. We will also assess how cultural factors and socio-economical/demographical factors are associated with a 'readiness-to-change' towards more environmentally sustainable food choices.

Project completed

RI-B7-08 Understanding how fibre reduces food intake and adiposity

PI: Sandy Ross (a.ross@abdn.ac.uk)

Dietary fibre has several health benefits. Amongst these is acting as a restraint on food intake, body weight gain and adiposity. This study examines the gut response to high dietary fibre (pectin, FOS or mixed fibre) in mice fed a high fat diet to understand the mechanisms involved. The purpose of the study is to investigate how type of fibre and dose may alter the response, with the aim of being able to provide new insights to strengthen our understanding of the public health benefits, so that we can advise policy, the food drink industry and the public which type of fibres work and how. To achieve this the study will examine the changes in the profile of bacteria that inhabit the lower gut and the associated metabolic products from bacterial fermentation (short chain fatty acids). It will also investigate the effects on the mouse as host, by measuring changes in gene expression in the gut as well as changes in gut hormones.

Project completed