

Progress Report on Strategic Research Programme Delivery



SEFARI, the Scottish Environment, Food and Agriculture Research Institutes, are responsible, with Higher Education Institute partners, for delivering the Scottish Government (Rural and Environment Science and Analytical Services, RESAS) funded Strategic Research Portfolio on environment, food, agriculture, land and communities.* The Portfolio includes the Strategic Research Programme 2016-2021 (SRP), the Centres of Expertise, Innovation partnerships and underpinning capacity funding for national resources within SEFARI.

The SEFARI Gateway is the knowledge exchange and impact hub for SEFARI. The Gateway works to improve the flow of research-knowledge and expertise to and from the Portfolio to policy, industry-sector representative and public audiences, and to improve the impacts of those activities.

Here we provide highlights from the SRP for the period of March to August 2019, as presented to the Operational Group of the Strategic Advisory Board for RESAS Science. This edition also includes a new section expanding on selected key highlights.

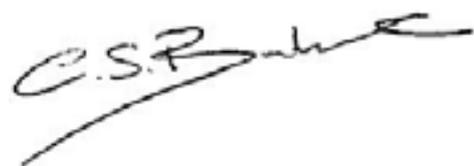
Amongst these highlights: SEFARI research is helping to conserve native oak-associated biodiversity due to the threat of decline in native oak from pests, disease and climate change; has contributed to ground breaking international research mapping the global distribution of soil nematodes, information which may be used to improve global climate change models; identification of a mechanism for how high temperature leads to reduced tuber yield in potato, with new opportunities to underpin breeding strategies for climate and economic resilience in this crop; provision of evidence on the socio-economic impacts of estates involved in driven grouse management and research that is quantifying the scale of depopulation pressures for Scotland's rural and island communities. In supporting the latter, a Gateway Responsive Opportunity Fund project, "Islands Revival" has been instigated to directly engage communities and wider rural community stakeholders in experiences of demographic change and their perspective on strategies for social and economic development.

Islands Revival is an example of a range of SEFARI Gateway funded programmes including bespoke Fellowships, Think Tanks and Responsive Opportunity projects. Amongst other benefits, these programmes inform, add value to and/or provide new perspectives on SRP research. Other examples include a Fellowship supporting the Just Transition Commission, who are advising on transition to a net-zero carbon economy that is fair for all; a Think Tank to assist SEPA develop their Crop Production Sector Plan; and a Responsive Opportunity Project visioning future opportunities for Scotland's food and drink sector. Over the last year, the Gateway has funded over twenty projects across policy, industry and civic society organisations.

A key feature for all SEFARI interactions is genuine co-construction with the stakeholder(s) to ensure a priority need is addressed. We want to build strong partnerships and knowledge networks for the benefit of environment, food, agriculture, land use and communities.

Contact details for research-specific and Gateway enquiries are provided at the end of these SRP highlights and we look forward to hearing from you.

Very best wishes,



Director, SEFARI Gateway



* You can find more information about the structure of the Strategic Research Portfolio and the partners involved (SEFARI, SEFARI Gateway and CoEs) [here](#).



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Summary

Theme 1 - Natural Assets

As part of an international collaboration involving 70 scientists, SEFARI researchers contributed to a recent Nature paper detailing the global biogeography of soil nematode communities. Nematodes are the most abundant animals on earth (estimated to be 4.4×10^{20} nematodes in surface soils globally) and are key mediators of soil processes. The relative abundance of different nematode groups can be predictive of soil greenhouse gas emissions and soil health more broadly. The study serves as a platform for future modelling efforts to explicitly represent the pivotal role that soil biology has in biogeochemical cycling and soil-atmosphere climate feedbacks.

Working closely with SEPA, the Environment Agency and the Scottish Government, SEFARI scientists co-organised the international Nature Based Solutions symposium bringing together three international projects (EU COST Action Land4Flood, US Army Corp Engineers Engineering with Nature, and Scottish Government led 'catchments' work-package of Interreg Building with Nature) and wider delegates in Edinburgh in May'19. The event attracted over 90 delegates from 14 countries, and presented case studies on natural flood management, allowing for international knowledge exchange on best practice, effective evidence gathering, and identification of future knowledge gaps for international action.

Native oaks (*Quercus*) are at risk of declining due to pests, disease and climate change, and potential impacts on biodiversity and ecosystem function have been identified by SEFARI scientists. A list of all 2300 species known to be found on oak has been made available; the work shows that over 500 obligate and highly associated oak species may decline if oak tree species decline (Mitchell et al., 2019a, Mitchell et al., 2019b). It has also identified alternative trees that could replace oak to support some oak-associated biodiversity such as the oak lutestring and great oak beauty moths. Results have been used in case studies to show how woodland managers can adapt management to help conserve oak-associated biodiversity. The findings from this research were presented to the Westminster Secretary of State for Rural Affairs and Biosecurity, Lord Gardiner, and Defra Chief Plant Health officer Dr Nicola Spence at events in London in February and July. The information was used by Defra in their Action Oak initiative and in an oak knowledge review report. The work was also published in the Woodland Trust magazine "Woodwise."

Theme 1 research can be found in the report [here](#).

Theme 2 - Productive and Sustainable Land Management and Rural Economies

A new resource has been developed to enable rapid and accurate quantification of barley gene expression datasets. This barley reference transcript dataset called BaRTv1.0 has been used to identify changes in gene expression associated with cold stress. A research article was published by The American Society of Plant Biologists which highlights the reach and scope of the research. These experiments identify key genes induced within two hours of cold application that have potential to have a role in winter hardiness. The impact of the research into cold stress in barley could have international multi-sector reach and enable further development and sustainable production of barley in the UK and further afield.

As part of an International collaboration, SEFARI scientists have identified a mechanism of how high temperature leads to reduced tuber yield in potato. An article was published by the Journal of Experimental Botany and the work gives new insights into how plants respond to elevated temperature and will find application in developing climate resilient crops. The research provides a strategy to mitigate elevated temperature stress in tubers which has potential to inform elevated heat stress in other plants, therefore improving yields, crop sustainability, allowing agriculture and the rural economy to benefit and move towards meeting the sustainable development goals, such as SDG2 Zero Hunger and SDG8 Decent Work and Economic Growth. Working with scientists across Themes 1 and 3 researchers from Theme 2 led two of the sections on the recently published work on The Socio-Economic and Biodiversity Impact of Driven Grouse Moors in Scotland. This work helps to deliver a Scottish Government Programme for Government commitment to "examine the impact of large shooting estates on Scotland's economy and biodiversity" and has also helped inform the Grouse Moor Management Group chaired by Professor Werritty.

Theme 2 scientists led the evidence review examining the socio-economic impacts of estates involved in driven grouse management - as well as the impacts of potential alternative land uses. Theme 2 researchers also led and undertook novel GIS analysis using data amassed through the current and previous research programmes to assess the extent of Scotland's grouse moors. The GIS analysis uniquely provides a scientific method to assess: the extent of Scotland's driven grouse moors; levels of intensity of management, the quality of land involved; the types of alternative land-use that grouse moors could be used for, and; potential limitations / restrictions on alternative uses.

SEFARI scientists will be heavily involved in the Phase 2 commissioned research on Grouse moor management having recently been awarded the contract. The research on grouse moors presents an incredibly topical and thorough demonstration of how valuable and important the resources in the SRP are, as this work utilises resources from right across the SRP and informs policy on a very topical and ongoing debate in relation to grouse moors. The recent calls by politicians to review grouse shooting amid concerns around natural habitat damage and ecosystem degradation highlight the extent of the impact that this work has by means of informing policy, stakeholders and researchers alike.

Theme 2 research can be found in the report [here](#).

Theme 3 - Food, Health and Wellbeing

Early-life nutrition in adolescent mothers and their offspring: Thirty years ago, Professor David Barker's seminal paper on the fetal origins of heart disease led to the establishment of developmental programming as a discipline. This important area of research has grown to form the evidence base that underpins the international and Scottish Government focus on the importance of getting nutrition right in the early years when susceptibility to chronic non-communicable disease is established.

RESAS funding in this area has been sustained since the mid-1990s, providing the continuity to allow the establishment and detailed investigation of developmental programming models and the interrogation of clinical databases. Impact from this sustained support is highlighted by invitations to contribute to a series of reviews commissioned to mark this anniversary, and specifically on adolescent pregnancy, which is a significant public health problem for Scotland, and to join in preparation of an international expert consensus statement of recommendations on nutritional needs before and during pregnancy, and how these impact on the lifelong health of mother and baby. The completed document will represent the current status of knowledge in this important area and will be available to inform policy nationally and internationally.

Population trends in remote and Sparsely Populated Areas (SPA) of Scotland: This is an area of high current policy profile, not least due to fears about the likely impact of post-Brexit migration policy, a new facet of a longstanding concern which touches a nerve in the national consciousness. Whilst more accessible rural areas have growing populations, the SPA continues to decline, and if recent trends continue, seem to face a bleak future. Research findings, by quantifying the scale of the challenge in different parts of remote rural Scotland, have brought these issues into sharp focus. Rural "shrinking" is a Europe-wide phenomenon, being explored through an ESPON project in which SEFARI is a key partner. However, some suspect that the tide is already turning in some parts of the Scottish Islands, challenging the assumptions underpinning our projections for the future, and causing us to reflect on the approach and ethos of policy at both local and national levels. Conventional estimates of migration (based upon NHS indices) are blunt tools for exploring ongoing and localised trends, and the validity of this more optimistic view can only be assessed through engagement with local stakeholders. This is currently being explored by a Gateway Responsive Opportunity Fund project, "Islands Revival". Research will try to identify appropriate policy approaches which could mitigate and adapt to likely demographic trends, both in terms of economic activity and the provision of services to sustain communities within the SPA.

Theme 3 research can be found in the report [here](#).

Theme 1 - Natural Assets

Work Package 1.1 - Soils

Major Achievements

- **Impacts of nitrogen deposition on carbon and nitrogen cycling in alpine moss heath.** Deposition of nitrogen is a major threat to terrestrial ecosystems. In alpine *Racomitrium* moss heath, nitrogen deposition is associated with moss mat degradation and a shift to grass-dominated vegetation. SEFARI researchers found that high nitrogen deposition reduces above ground carbon and nitrogen stocks and that nitrogen accumulates in the soil, where it can be leached to waters. When nitrogen deposition is reduced, soil water quality rapidly improves, but past exposure to high nitrogen deposition reduces ecosystem ability to retain future nitrogen inputs. The research highlights the rapid benefits from policies to reduce nitrogen deposition and the long-term damage caused by air pollution. The work is published in [Environmental Pollution](#).
- **Global distribution and functionality of soil nematode communities.** SEFARI research contributed to a [paper published in Nature](#) detailing the global distribution of soil nematode

communities. This international collaboration utilised data generated from 6,759 georeferenced samples from across the globe to quantify distribution of nematode functional groups. The paper closely aligns with SRP research utilising nematode functional group abundances to infer soil health and biogeochemical cycling. The paper highlights how the global dataset can be used to improve representation of biological processes in global climate change models.

- **Caring for 'Cinderella':** Perceptions and experiences of peatland restoration in Scotland. SEFARI researchers explored why people involved in the use, conservation and restoration of peatlands care about peatbogs. Results highlight the importance of personal experiences, relationships and embodied learning. They also show that a lack of knowledge can be a barrier to good care. On the other hand, acknowledging uncertainty and a lack of knowledge can allow for inclusion of other co-created knowledge and caring practices. For this to happen, appropriate structures (e.g. flexible peatland restoration funding) and open and inclusive attitudes are needed.



- **Invited presentations to academia and industry.** SEFARI scientists have been invited to present work from the SRP at a range of key international meetings (e.g. [Slope Processes and Vegetation Effects](#), [Soil Organic Matter in a Stressed World](#), [BES Annual Meeting](#)), to industry stakeholders (e.g. [CHAP Soil Forum](#), [Finding Fertile Fields for the Future](#)) and for industry publications (e.g. [Farmers Journal Scotland](#)) emphasising the work's sectoral and international interest in and impact of SRP-soils research.

pooling data and resources to investigate how widespread the issue is in international headwaters.

- **Report available on the functioning of catchment-scale partnerships:** Catchment partnerships in complex river catchments often have goals that reflect multiple agency objectives, e.g. to improve water quality and reduce flood risks. A [report](#) examines the current understanding of the role and effectiveness of catchment partnerships in delivering flooding and water quality goals.

Work Package 1.2 - Water

Major Achievements

- **Flood risk scientists co-develop an international workshop in Edinburgh.** Working with the Scottish and UK environment agencies, (SEPA and EA) and Scottish Government, SEFARI scientists co-organised the international Nature Based Solutions (NBS) symposium in Edinburgh May'19. The event consisted of keynote speeches, including an opening address by Rosanna Cunningham, field trips and workshop sessions. The aim was to share international best practice around implementing NBS measures within catchments and coasts to reduce flood risk and provide wider ecosystem services.
- **Development of approaches for typing catchments:** Methods have been further developed for exploring commonalities in catchment water quality responses to multiple stressors and drivers of change (notably climate & land use). Two talks based on Scottish case studies were given to the Land Use and Water Quality conference (Aarhus, Jun'19) exploring (i) long-term changes in water quality variables and their relationship with changing river flow, and (ii) reasons for differing response groups by combining spatial data into a model of phosphorus loading.
- **Demonstration of issues of internal phosphorus loading from river sediments interacting with management.** Research into sediment P release (internal P loading, a cause of rising river phosphorus concentrations which lead to water quality deterioration in a Scottish research catchment) was presented at the 9th International Phosphorus workshop (Zurich, Jul'19). Aligned mechanisms were corroborated by other scientists who are

Work Package 1.3 - Biodiversity

Major Achievements

- **Long-term consequences of upland grazing:** [SEFARI scientists have demonstrated](#) that likely changes in grazing levels in the uplands (e.g. in response to changes in agricultural support payments, profitability of upland farming and conservation priorities) can take many years to affect upland plant communities. Specifically, it took 15 years for the tripling of sheep numbers or the complete removal of sheep to impact on most species. Some communities were very resistant to change, particularly those most attractive to grazers, which had lost plant species capable of responding to reduced grazing levels.
- **Monitoring biodiversity through citizen science:** SEFARI scientists have [analysed citizen science data](#) to document a five-decade decline in species that are associated with Scotland's ancient woodlands. Solutions to reverse the trend were identified and have been used to inform the new strategy of the [AtlanticWoodlandAllianceconsortium](#). This includes targeting efforts to the expansion of existing woodlands with old-growth structure, and which include populations of dispersal-limited species.
- **Managing oak woods in the face of oak decline:** Our native oak trees are at risk of declining due to pests, disease and climate change. The impacts of this decline on biodiversity and ecosystem function have been [identified](#) and a list of all 2300 species known to be found on oak has been [made available](#). The results have been used in case studies to demonstrate how woodland managers can adapt their management to help conserve oak-associated biodiversity.



- **Princes Trust achieve awards:** SEFARI scientists have helped Cumbernauld school pupils to produce participatory videos of their experiences of local greenspace (available on Vimeo, access details available from antonia.eastwood@hutton.ac.uk). This has transformed pupil interactions and behaviours towards greenspace and secured their Prince's Trust Achieve Award for teamwork and effective engagement with local communities. The videos will be used for monitoring and evaluating the impacts of the [Creating Natural Connections](#) programme.

Work Package 1.4 - Integrated Land Use Systems

Major Achievements

- **Monitoring Land Use Systems and the development of the Natural Asset Register:** A stakeholder Steering Group has been established for the [Natural Asset Register-Data Portal](#) (NAR-DP) and has held its first two meetings. The Steering Group comprises representatives from Scottish Government, SEPA, Scottish Natural Heritage, and SEFARI, and will promote continual improvement of the NAR-DP's sharing of relevant spatial data arising from the SRP. We are also working to add more datasets, and to improve user experience of the NAR-DP and linkages with other online data-

information-knowledge resources e.g. [Scotland's Environment Web](#). In parallel, researchers have developed indicators enabling inclusion of Cultural Ecosystem Services, such as Cultural Heritage and Entertainment

- **Managing integrated Land Use Systems: Adaptive co-management of the Scottish Uplands.** SEFARI researchers have produced a [research brief](#) summarising the role of social relationships and networks in how land managers adapt their management to change. Based on interviews with land managers it outlines the factors that facilitate or constrain learning and adaptive co-management. Recommendations include explicit attention to learning and reflection in collaborative management groups and a need for concerted efforts to build trust and bridges between different land managers and actors.
- **Aligning Policy Instruments:** In March 2019, Kirsty Blackstock gave a presentation on "Scotland's Multiple Land-Uses. Objectives, Benefits and Trade-offs", during the inaugural [Scottish Parliament Citizen's Jury on Land Management](#). This presentation was informed by SRP research on delivering multiple environmental benefits using existing Scottish policies and steering strategies such as the Land Use Strategy. It also resulted in a [blog post](#) reflecting on the experience of translating research for a diverse public audience.

Theme 2 - Productive and Sustainable Land Management and Rural Economies

Work Package 2.1 - Crop and Grassland Production and Disease Control

Major Achievements

- **Quantifying adoption of Integrated Pest Management (IPM):** SEFARI scientists, in collaboration with English and Irish researchers, devised a method for assessing uptake of IPM practices on arable farms. The [IPM metric](#) showed that all farmers have adopted IPM to some extent but only 6% had adopted more than 85% of what is theoretically possible. This metric should be a viable and cost-effective method to facilitate benchmarking and monitoring of national IPM programmes in temperate arable farming systems.
- **Using next generation sequencing to improve virus testing in soft fruit crops:** Research into the broad range of viruses infecting soft fruit crops, including raspberry, blueberry and blackcurrant, and using recently developed and rapid technologies for nucleic acid sequence analysis, has enabled SEFARI researchers to design a suite of virus molecular diagnostic tests. These are being used in house and also by commercial companies to ensure fruit crop health. The range of available tests will be expanded as new virus information is obtained.
- **Improved methods for identifying important barley genes.** A new resource has been developed to enable rapid and accurate quantification of gene expression [datasets](#). This barley reference transcript dataset called BaRTv1.0 has been used to identify changes in gene expression associated with [cold stress](#). These experiments identify key genes induced within two hours of cold application that have the potential to have a role in winter hardiness.
- **Understanding how environmental stress impacts on potato tuber yield.** As part of an International collaboration, SEFARI scientists have identified a mechanism of how high temperature leads to [reduced tuber yield](#) in potato. The work

gives new insights into how plants respond to elevated temperature and will find application in developing climate resilient crops.

- **Potato disease resistance research:** SEFARI scientists have developed new tools with direct relevance for potato breeding. These include [dRenSeq](#), enabling the deployment of defence genes in potato varieties and to inform parental selection for informed resistance breeding. The same technology has enabled the mapping of the H2 nematode resistance gene in [potato](#). Importantly, a complementary technology, PenSeq, tracks the diversity of pathogen molecules that determine the outcome of [infection](#).

Work Package 2.2 - Livestock Production, Health, Welfare and Disease Control

Major Achievements

- **Novel vaccines:** SEFARI scientists have successfully demonstrated the ability of two new vaccine delivery platforms to elicit immune responses in sheep. In this approach, common sheep viruses are, 're-purposed' as vehicles to deliver proteins from other pathogens (viruses, bacteria or parasites) to appropriate cells of the sheep immune system and provoke immunity against these other pathogens. At the same time, the virus vehicles are modified to abolish their own ability to cause disease. Experiments performed so far have shown that robust antibody and cellular immune responses can be generated against the pathogen proteins by using these vehicles and studies are in progress to establish the degree to which these responses protect against disease development. This work has the potential to provide a new strategy for developing vaccines for a range of sheep diseases and the technology should also be transferable to cattle and other livestock species.



- **Animal welfare:** Data collected from a research flock of sheep have been analysed linking lamb performance, disease and immunological traits at phenotypic and genotypic levels. Favourable associations among disease indicators and lamb growth indicate that selection for reduced faecal egg counts will not impact on lamb growth potential. The new data were collated and now include 10,351 records from 4,898 sheep of known pedigree. Estimated breeding values were computed for the resource flock of which 1/3 has been selected for resistance to parasites. Analysis shows that genetic selection of sheep for resistance to intestinal parasites is feasible and will not compromise productivity.
- **Zoonotic disease:** Zoonotic disease research includes that into verocytotoxigenic *E. coli* (VTEC) and cryptosporidium spp. SEFARI scientists have explored the genetic basis as to why some VTEC isolates are more successful at surviving and persisting in the environment. Genetically divergent *E. coli* isolates were identified, so providing evidence of an extensive *E. coli* gene pool. Research into the parasite *Cryptosporidium parvum* suggested that adult cattle might not be a major source of transmission to their calves as was previously believed.

WorkPackage2.3-Productive and Sustainable Land Management

Major Achievements

- **Livestock improvement:** Milk mid-infrared (MIR) spectral data, which is routinely recorded on milk at a national level, could be used to estimate milk production efficiency and milk nutrient levels in dairy cattle and, furthermore, could be used to better inform selective breeding programmes. It was demonstrated that levels of serum antibodies associated with production efficiency in dairy cows were highly correlated in milk and serum, indicating that more welfare friendly measurements could be performed on milk rather than the current serum samples.
- **Improving wildlife disease management:** New epidemiological tools have been used to provide better wildlife disease surveillance. '[Hindcasting](#)' methods were developed that exploit currently underused characteristics of disease diagnostic tests to recover epidemic trends not otherwise apparent when outbreaks are first detected. Furthermore, when results were modelled it was demonstrated that, for many wildlife disease systems, fluctuations in population size and disease lead to [bias in surveillance-based estimates](#) of prevalence. In conclusion, the work has demonstrated that ecological effects cannot be ignored if correct assessments of the risks posed by disease in wildlife are to be made.

- **Beef production efficiency:** Work has shown that altering the efficiency of beef animals during growing and finishing can have supply chain benefits, in terms of reducing the costs of production and its environmental footprint. This can help to inform supply chain managers as to key targets for farmers to improve across-supply chain performance metrics. This work focussed on integrating individual beef animals' records of feed intake (2000 animals) and subsequent final carcass weights, age at finishing and grading and price paid. The analysis highlighted that the value of faster growing animals compared to the average, for days to slaughter based on feed energy saved through earlier slaughter, was estimated at £0.20 worth of feed saved per day.

Work Package 2.4 - Rural Industries

Major Achievements

- **Brexit:** Staff knowledge on agricultural policy and potential implications for the farming sector under various Brexit scenarios is in high demand. Using SEFARI Gateway and UK Brexit Consequential funding, researchers undertook engagement with a wide array of stakeholders to ensure the consequences and opportunities are better understood. Written and verbal evidence was provided to the Scottish Affairs Committee's inquiry on the [Future of Scottish agriculture post-Brexit](#) and researchers presented evidence at a variety of events on Brexit-issues around labour, tariffs, business viability, Common Agricultural Policy support and regulations. Audiences included, MSPs, peers, MPs, Scottish Government, Defra, bankers, councillors, farmers, crofters and other stakeholder groups. In addition, evidence was provided to Lord Bew's [Independent Review of the Intra-UK Allocation of Domestic Farm Support Funding](#).
- **Grouse moor management:** Working with scientists in Theme 1 and Theme 3 researchers led two of the sections on the [recently published](#) work on The Socio-Economic and Biodiversity Impact of Driven Grouse Moors in Scotland. This helps

to deliver a Scottish Government Programme for Government commitment to "examine the impact of large shooting estates on Scotland's economy and biodiversity" and also informs the [Grouse Moor Management Group](#). Researchers led the evidence review examining the [socio-economic impacts of estates](#) involved in driven grouse management - as well as the impacts of potential alternative land uses. Novel GIS analyses, using data from the current and previous research programmes, was undertaken to assess the extent of Scotland's grouse moors. The [GIS analysis](#) uniquely provides a scientific method to assess: the extent of Scotland's driven grouse moors; levels of intensity of management, the quality of land involved; the types of alternative land-use that grouse moors could be used for, and; potential limitations and/or restrictions on alternative uses. A follow up contract (Phase 2) on Grouse moor management has recently been obtained.

- **2018/19 Rural business survey published:** The [Rural Report 2018/19](#) is the second out of three survey based annual reports focussing on the wider rural business base, providing evidence to help fill the knowledge gaps beyond farming, forestry and rural estate sectors. The survey was co-constructed with Scottish Government and Scottish Enterprise (co-funders). The report surveyed 1,203 businesses in Aberdeenshire, Dumfries & Galloway, the Scottish Borders and Tayside. The findings from ongoing research make a significant contribution to improving our understanding of Scotland's rural business base, at a time when rural economies are receiving considerable policy attention (for example through the recent work of the [National Council of Rural Advisers](#) and the creation of [outh of Scotland Enterprise](#)). The report featured in interviews for Good Morning Scotland and Out of Doors.

Theme 3 - Food, Health and Wellbeing



Work Package 3.1 - Improved Food & Drink Production

Major Achievements

- **Scotland's Dinner plate 2050:** A Gateway sponsored event (May-19) attracted 80 delegates from across the agri-food chain and highlighted the issues around Scotland's possible future food choices with respect to climate change challenges on food security and environmental and economic sustainability. Highlighting WP3.1 research, it also included speakers from National Farmers Union Scotland, Quality Meat Scotland, Scotland Food and Drink, New Nutrition and a food innovation SME. The report and presentations will soon be on the SEFARI website. This topic was echoed in an [exhibit for school children](#) at the Royal Highland Show (Jun-19), which was visited by the First Minister (see image above).
- **On Target for 2030:** A SEFARI scientist authored a section of the UWS-Oxfam Partnership Collaborative Research Reports Series 'On Target for 2030? An independent snapshot review of Scotland's progress against the United Nations Sustainable

Development Goals' entitled '[Ensure sustainable consumption and production patterns](#)' under SDG 12 (Responsible Consumption and Production). The section highlighted SRP research on sustainable production and consumption, including [a case study](#) on food waste in a circular economy.

- **Food Waste highlights:** (i) a workshop '[Food waste – too many definitions](#)' was run at the Agricultural Economics Society (Apr-19) and presented work entitled "[Stakeholders and systems dynamics](#)". Invited talks on this topic were also given at Nanjing Agricultural University, China (Jun-19); (ii) an invited talk "Sustainable agriculture, ecosystem services and environment — data & analytical complexities" was delivered at the EU-China expert seminar 'Identifying Potential Joint Priorities for Research and Innovation in Food, Agriculture and Biotechnology', European Commission, DG Agriculture & Rural Development, Brussels, Mar-19; (iii) new funding has been secured to study (a) new routes to controlling food waste due to acrylamide formation during cooking (Genomia, £50k), (b) the valorisation of crop wastes into high value chemicals and feed stocks (ZWS, £50k) and (c) using new and waste fruit as a route to biostimulation and pest and disease control (EU LIFE, Plants4Plants, €2.9M); (iv) an industrial biotechnology route to waste valorisation was identified in [a paper](#) exploiting engineered bacteria for the production of unusual anthocyanins from crop wastes.

- **Scottish Anti-Microbial Resistance research on an International Platform:** Work on the influence of selective pressure on the spread of antimicrobial resistance (AMR) ('Impact of antimicrobials on gut bacteria') was presented at the Annual Microbiology Society [meeting](#) (Apr-19) and will contribute to a meeting linking to WPs 2.3 and 2.2. AMR is one of the principle drivers in microbiology bioscience, worldwide. Cross-RD coordination will support a Scottish perspective, which can then be used on an international platform, e.g. for the [2020 One Health Congress](#).
- **FAO-WHO contribution to the UN Decade of Action on Nutrition:** A Theme scientist is an invited member of the UN FAO-WHO International consultation on sustainable and healthy diets and an author of their report on sustainable and healthy diets. The committee will provide a set of guiding principles for the UN on sustainable and healthy diets as part of the FAO-WHO contribution to the UN Decade of Action on Nutrition. A meeting (Jul-19) discussed the drafted papers for the report and developed guidance on sustainable, healthy diets. Work is ongoing.

Work Package 3.2 - Healthy Diets and Dietary Choice

Major Achievements

- **High-level parliamentary roundtable:** A roundtable meeting (Jul-19) of the London International Development Centre and the All-Party Parliamentary Group for Africa examining solutions to childhood stunting brought together parliamentarians, researchers and policy makers working on child undernutrition. The meeting heard an overview from the deputy lead on the hub, a SEFARI researcher, on the recently launched UKRI GCRF Action against Stunting Hub - a £19.76M investment by the UK government to alleviate child stunting, globally.
- **Early-life nutrition in adolescent mothers and their offspring:** A [review on adolescent pregnancy](#) was commissioned for a Special Issue of Journal of Endocrinology, and the topic formed the basis of an invited talk at a conference in the USA, which brought together experts and researchers on nutritional needs before and during pregnancy, and how this impacts the lifelong health of mother and offspring. The speakers are developing a consensus statement of recommendations, which will be available to inform policy nationally and internationally.

- **Affordable, healthy and sustainable diets:** A [paper published in Public Health Nutrition](#) ('Healthy and sustainable diets that meet greenhouse gas emission reduction targets and are affordable for different income groups in the UK') (work from the last SRP) was chosen as the Nutrition Society Paper of the Month for April. A [blog post](#) highlighted background and main findings. [Another paper](#) from the last SRP ('Eating like there's no tomorrow: Public awareness of the environmental impact of food and reluctance to eat less meat as part of a sustainable diet') was the second most cited paper since 2016 in the journal Appetite. These measures of esteem recognise SRP expertise and reputation in sustainable diets research and its application.

Work Package 3.3 - Food Security

Major Achievements

- **Research on the effect of prices on nutrient purchases:** Joint WP3.2 and WP3.3 work: 'Trading down in quality and the consumption of minerals and vitamins in the UK', was contributed to the [Family Finance Surveys User Conference](#), Jun-19, with opportunity for policy transfer, and 'Using household demographic data to estimate demand for sustainable diets', was presented at the [Agricultural Economics Society](#) annual conference in Apr-19.

- **Addressing meat consumption:** A [paper](#), stemming from the last SRP's engagement with debate on the economic, social and environmental challenges of livestock consumption, has been accepted for publication in Appetite: 'Nudging, formulating new products, and the life course: A qualitative assessment of the viability of three methods for reducing Scottish meat consumption for health, ethical, and environmental reasons.'
- **Researching food insecurity among children:** As an output from work on societal interaction with research to address social inequalities, a paper was presented to the British Sociological Association: 'Making unheard voices heard: methodological and ethical challenges in designing research with young people aged 12-18 years old about their experiences of food insecurity'.
- **Identifying 'local food' enterprises:** Results from a large survey of Scottish food and drink enterprises was presented to the British Sociological Association: 'Alternative' food networks as a Weberian ideal-type: findings from a survey of food and drink enterprises in Scotland'. This provides important baseline data towards a better understanding of factors influencing how food and drink small and medium-sized enterprises operate and work together to add value to produce and to the local economy.
- **Outputs:** research was presented at (i) the [Congress of Local and Regional Authorities of the Council of Europe](#) (Apr-19) and (ii) the European Society of Rural Sociology Congress (Jun-19) on place-based policy and rural resilience, (iii) the Rural Entrepreneurship Conference, (Inverness, Jun-19) on place based policy making, (iv) a workshop on the Resilience of the UK's Food system (on definitions and conceptualisations of resilience in rural areas; Jun-19), and (v) a workshop defining resilience technology (Oxford, Jul-19). A [blog](#) on everyday and emergency resilience and an [online interactive application](#) mapping local level wellbeing were produced, along with a [report](#) on small area-level evidence for place-based policy in Scotland.
- **Islands Revival:** SEFARI Gateway funding was secured for 'Islands Revival', which will collect stories of green shoots of population growth in the Scottish islands. This includes the [Islands webinar series](#) which has engaged individuals and communities actively with regeneration.
- **Resilience hotspots and notspots:** A completed spin-off project (local assets, local decisions, and community resilience), funded by the National Centre for Resilience, identified places in Scotland where resilience is happening and include interviews and a geo-package database.

Work Package 3.4 -Communities and Wellbeing

Major Achievements

- **Working with policy:** researchers discussed demographic change, place-based policy and resilience at the Rural Community Liaison Group (Jun-19), attended the Sustainable Rural Futures Event in the Scottish Parliament (May-19), the Scottish Land and Estates Conference (May-19), and the LEADER staff group event (Jun-19). Discussions with HIE (Jun-19) addressed work on Sparsely Populated Areas and complementarity with HIE's plans.

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