

Progress Report on Strategic Research Programme Delivery




The February 2022 report to the Operational Group of the Strategic Advisory Board for the Scottish Government's Rural Environment Science and Analytical Services (RESAS) funded Strategic Research Programme (SRP), is the final research update prior to the completion of the 2016-2022 and commencement of the new 2022-2027 SRP. The report is written in the aftermath of the UN Climate Change Summit, COP26, and at which SEFARI* Gateway was privileged to work with Stakeholders across Scotland's rural communities, agriculture and food sectors in examining routes for [Just Transition](#) and the [innovations](#) needed to deliver for net zero. We also had the pleasure of working with extremely talented students examining Strategic Portfolio research contributions to combat climate change and nature crisis, including the interplay of climate issues on [younger generations](#) and seeing climate action through the lens of [gender diversity](#).

Following COP26, the latest IPCC report emphasised the limited time available for restricting global temperature rise to 1.5 degrees celsius and of the increasing observance of some climate impacts being irreversible. Although COP26 resulted in progress for international climate commitments, it is widely acknowledged that it did not go far enough and that globally the impetus for change and innovation across society must be delivered at greater scale and pace. The increasingly dramatic evidence of the impact of climate change at home and globally, and its influence on food security and inequalities, is compounded by the economic and social effects from the ongoing global COVID-19 pandemic and crises, such as the War in Ukraine. The need for Scotland's strategic research in environment, land, agriculture, food and rural communities to inform policy and deliver best practice and new innovation has never been more vital.

This report demonstrates strides in our knowledge and its application for climate action, Just Transitions, land use, and agricultural innovations, including for better plant and animal health and welfare and food security. This reaches across Scotland, the UK and internationally. Examples include: new tools to aid woodland expansion; research on the importance of species diversity to the survival of semi-natural woodlands; research to support habitat conservation and biodiversity as part of a green recovery (from the COVID-19 pandemic). For agricultural innovation, a major new investment in barley research is reported; while new imaging techniques will support Scotland's soft fruit breeding and animal welfare assessment tools continue to see commercial uptake. Recognising the connection between the health of humans, animals and the environment (ONE Health), SEFARI research has also examined the impacts of pharmaceuticals in the environment and is examining ways to measure antimicrobial resistance (AMR) accurately in livestock. For human health and wellbeing, the contribution of Strategic Research in supporting core expertise, is emphasised by sustained SEFARI expertise on plans to introduce folic acid fortification of flour; while SEFARI expertise has also been able to rapidly deploy to examine the experiences of rural communities from the Covid-19 pandemic, as part of steps to aid rural social and economic recovery from the pandemic.

Very best wishes,



Director, SEFARI Gateway





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Summary

Theme 1 - Natural Assets

Research into the impacts of pharmaceuticals in the environment informs response to parliamentary questions: Research from SEFARI was used in the response from Scottish Government to questions in the Scottish Parliament on the level of research into the environmental impacts of pharmaceuticals. The response included materials from recent papers in [Journal of Environmental Pollution](#) and [Science of the Total Environment](#), findings of which highlight the occurrence of waterborne pharmaceuticals in Scottish rivers (e.g. River Dee and River Ugie). Trends indicated that human activities and medication use were the primary source of contaminants. The research suggests that additional catchment monitoring (including a wider range of chemicals and different catchments) are warranted to safeguard water quality.

Lack of tree species diversity in semi-natural woodlands leads to lack of resilience: Work in this area by researchers in SEFARI and Forest Research (FR) is being used to advise Defra through its [Tree and Woodland Science Advisory Group](#). A paper recently published in [Journal of Ecology](#) by SEFARI and FR scientists highlighted the importance of diverse tree species composition within woodlands to increase resilience. The work showed that if multiple tree species are lost from UK woodlands (oak and ash), the total number of associated species at risk of extirpation is greater than the sum of the associated species at risk from declines in either host alone. Ash hosts 45 obligate species (species only found on that host) and oak hosts 326. However, a decline in both these trees would impact 512 associated species, across multiple taxon groups, a 38% increase. In addition, many species that are not obligate on ash or oak are also at risk if oak and ash decline, as in many woodlands across the UK the other tree species that are known to support them are not present within the woodlands despite, in many instances, the soils and climate being suitable for such surrogates to grow. Defra Chief Plant Health Officer, Professor Nicola Spence, commented: "This work reiterates the importance of protecting our native trees. It confirms that the value of our interconnected ecosystems is often more than may immediately meet the eye, and the importance of intelligent woodland management plans to support resilience. Such combinatorial analysis is beneficial to our understanding and further development of an available 'toolkit'".

[Read Theme 1 achievements in full](#)

Theme 2 - Productive and Sustainable Land Management and Rural Economies

Commercial roll-out of QBA as an indicator of animal emotional well-being: The on-farm roll-out of Qualitative Behaviour Assessment (QBA) across 12 'own brand' supply chains of UK retailer Waitrose was consolidated through an intensive collaborative programme of training and on-farm data collection, facilitated by the new [QBA mobile app](#). The app was perfected with an in-built algorithm for data normalisation, and with a range of functional adjustments and additions based on feedback from participating supply chain assessors. Supply chain teams all developed their own lists of QBA descriptors and were given training in the use of the app to apply these descriptors to scoring emotional well-being in the different farm animal species (pigs, cows, sheep, goats, chickens, ducks, turkeys and salmon). Data collection for these species was initiated on over 1,500 farms, and evaluation of interim outcomes with



participating assessors indicated the app to be effective in identifying outlying farms showing either excellent or reduced animal emotional well-being relative to the sampled pool of farms. Outcomes also indicated a degree of clustering of assessor farm scores, instigating additional training sessions focused on aligning the way assessors use the app to score QBA descriptors. Following on from the extensive [media coverage](#) generated by a press-release in the previous year, Waitrose submitted the QBA project to the 2021 BBC Food and Farming Awards, which led to an episode of BBC4 radio's 'Farming Today' programme showcasing the project, and to the selection of the project as winner in the '[Farming for the Future](#)' category. The work led to both the retailer and SEFARI researchers participating in a project on consumer trust in the food chain at the European Institute of Innovation and Technology (EIT), led by the University of Reading.

Support for SRP research in barley: Underpinned by research and expertise gained through the SRP, the next generation of barley researchers have received a multi-million investment (£9m) through the Barley Industrial Training Network (BARIToNE) programme, a Collaborative Training Partnership (CTP) led by the Scotch Whisky Research Institute, the International Barley Hub at the James Hutton Institute and the University of Dundee, with support from the Biotechnology and Biological Sciences Research Council and industry partners. The programme will see a cohort of 30 postgraduate researchers.

[Read Theme 2 achievements in full](#)

Theme 3 - Food, Health and Wellbeing

COP26-related activities: SEFARI scientists contributed to high profile events related to climate change and major food issues prior to, during, and following COP26 in Glasgow. Stalls at the 43rd TB Macaulay Lecture on 2nd November, where the guest speakers were Christiana Figueres and Scotland's First Minister, Nicola Sturgeon, featured SEFARI research on sustainable diets, food security and crop diversification and tools to support better diet choices. SEFARI researchers were also panel members in a [session at COP26](#) organised by SEFARI for the Scottish Government entitled "Achieving a Just Transition for Rural Scotland". COP events hosted by Royal Botanic Gardens Edinburgh (6 November), Scotland Food & Drink (9 November), and Food Standards Scotland (10 November) featured SEFARI scientists discussing hemp as a nutritious and environmentally sustainable food, food and drink innovation and alternative proteins, and sustainable diets, respectively. Hemp as a new sustainable crop ([Hemp Futures](#)) also featured at the 'Sustainability in the Creative and Cultural Industries Symposium' (4-8th Oct) held as a run-up discussion forum for COP26.

The topic of sustainable diets and the importance of understanding factors related to nutrition and international impacts of our current food system were also represented at the Festival of the Future (Dundee, October 2021), in the lead up to COP26, together with work on the food security of Scotland and development of novel production systems. SRP science and that of the Tay Cities Deal Advanced Plant Growth Centre (APGC) was represented in the UK Research and Innovation [presentation](#), where the science behind controlled environment agriculture, and the way forward for the production of sustainable food, pharma and chemicals was discussed. The role of SRP research in helping reduce food waste through improved and sustainable production was discussed at Scotland's Climate Ambition Zone - "Is cheap food costing the earth?" - hosted by Zero Waste Scotland.

[Read Theme 3 achievements in full](#)

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Theme 1 - Natural Assets

Work Package 1.1: Soils

Major Achievements

- **Funding successes:** SEFARI peatland researchers, in collaboration with University partners, have been awarded a Large NERC grant (£891k) on "Improving modelling and approaches to assess climate change-related thresholds and ecological shifts in the Earth's peatland ecosystems ([MOTHERSHIP](#))", providing 5-years funding, expanding capability in this research area. A new SEFARI researcher-led [project](#) has also been secured (total value 1.4 million Euros) on "Synergies in integrated systems: Improving resource use efficiency while mitigating GHG emissions through well-informed decisions about Circularity", involving partners from 10 institutions in 7 countries.
- **Presentations to Scottish Policy and International Stakeholders:** RESAS-funded soils research was recently presented at three events: i) A seminar entitled 'Soil Awareness-Introduction to soils' (17 November 2021) covering the fundamentals of soil and providing an introduction for future seminars, given to a wide range of staff in Scottish Government's Environment and Forestry agriculture Policy Divisions amongst others (→50 attending). ii) The "Genome enabled biology and contemporary agriculture" session of the [Lower Saxony-Scotland Joint Forum](#) (22-23 November 2021), iii) RESAS greenhouse gas modelling research showcased at the [DASIM Modeler Workshop](#), Garmisch-Partenkirchen, 9th November 2021.
- **Baseline soils data for Glensaugh Climate Positive Farming Initiative:** The first systematic soil profile collection covering all of James Hutton Institute Glensaugh Research Farm has been completed, with over 100 soil profiles described and sampled. Samples taken from each soil layer will be used to set a baseline for soil carbon stocks to monitor changes as the farm transitions under the [Glensaugh Climate Positive Farming Initiative](#).
- **Mountain heights, hidden depths – biodiversity**

and carbon in Scotland's alpine soils: Research recently highlighted as a [SEFARI case study](#) provides the first large scale assessment of the biodiversity and carbon stocks associated with Scotland's alpine soils. The general public were engaged with this research through a Citizen Science initiative in collaboration with [Plantlife](#), which has raised awareness of soil biodiversity across the Cairngorms National Park. Volunteers from the mountain-going community were recruited and trained to collect soil samples for DNA analysis. This has resulted in the submission of 220 soil samples from 55 out of the 58 Munros (mountains over 3,000ft) within the National Park.

Work Package 1.2: Water

Major Achievements

- **Effective nutrient pollution mitigation measures require an understanding of spatiotemporal controls on water quality:** This research published in [Water Resources Research](#), proposed a new, reproducible, classification of concentration-discharge (c-Q) relationships, that adds value to the regulatory water quality monitoring data. The approaches enable the characterization of processes and best management for a broader range of catchments subject to regulatory surveillance.
- **Stakeholder participation in river restoration explored:** Stakeholder participation is increasingly aspired to in environmental management, but what it means and how to achieve it are not often discussed in the context of river restoration. SEFARI researchers contributed a [chapter](#) on Participatory Approaches: Principles and Practices for River Restoration Projects to the book River Restoration: Political, Social and

Economic Perspectives, discussing the rationales for adopting participatory approaches and identifying general principles for promoting stakeholder inclusion in river restoration projects.

Work Package 1.3: Biodiversity

Major Achievements

- **Realising sustainable and resilient food- and feed-systems demands diversification of crops and downstream value chains:** A recent publication in [Frontiers of Agricultural Science and Engineering](#) from leaders of six EU projects, including SEFARI researchers, highlights that there are significant technological and institutional barriers to diversification in crops and downstream value chains. They point to an urgent need to establish multi-actor networks to facilitate diversification and help ensure the necessary cooperation among all agrifood system stakeholders.
- **Increased grazing drives homogenisation but reduced grazing increases turnover in upland habitat mosaics:** A new paper in [Biodiversity and Conservation](#) by SEFARI scientists reports that increased grazing led to more homogenous vegetation across an upland mosaic of different vegetation types. The increased grazing led to an increase of grazing tolerant species in the vegetation types less preferred by the sheep. In contrast, removing the grazing resulted in a greater turnover of species, particularly in the less preferred vegetation where species capable of responding to the removal of grazing had persisted. Decisions about grazing management of the uplands involve many trade-offs; this study

at Glen Finglas identified potential trade-offs between stability and homogenisation to add to existing ones on the biodiversity of different groups of species and on ecosystem services.

Work Package 1.4: Integrated Land Use Systems

Major Achievements

- **Woodland expansion:** A comprehensive analysis was carried out to highlight areas that could provide multiple benefits from woodland expansion, while (as far as possible) avoiding major trade-offs. This analysis and tool provides enabling capabilities for the [Riverwoods Initiative](#) initiated by the Scottish Wildlife Trust.
- **Bioregional Mapper Project:** A prototype Bioregional/Public Participatory mapping tool has been created that integrates data from multiple scientific sources as a basis for informing mapping from stakeholder citizen science has been built. A [video](#) explaining the prototype was used, on the stand hosted by EU SHERPA project and SEFARI Gateway in the COP26 Green Zone with visitors from policy, practice and civil society. Live demonstrations were given to: (i) NatureScot, the UK Bioregional Group of Practice, Bioregioning Tayside, and the University of Dundee; and (ii) international practitioners including SustainaMetrix and The Stockholm Resilience Centre. Both demonstrations led to talks on possible collaborations and future funding to extend the project.
- **Green recovery:** An analysis of baselines and trends for actions recommended in 'A Nature Recovery Plan' has been completed. This covers a range of habitats and land uses including native woodland, agriculture, peatlands, and marine protected areas; and

other areas including deer management and biodiversity net gain. A spreadsheet model has been developed to allow scenario analysis using NatureScot's Natural Capital Asset Index. This enables exploration of changes in habitat extent and condition through to 2030.

- **Cultural Ecosystem Services:** [Storymaps](#) developed to map various cultural ecosystem services have been included in the Natural Assets Register as an example of how to collect and spatially represent cultural ecosystem services. Within the scope of mapping the CICES (Common International Classification of Ecosystem Services) Aesthetics across the whole of Scotland, a bio-physical methodology was tested and reported upon. This includes a spatial combination of 10 metrics based on the physical characteristics of the landscape and on landscape ecology. Following feedback from stakeholders,

the report draws in a wider literature review and provides a critique of the methodology which addresses only a subset of the much wider and complex research area of landscape aesthetics. Podcast monologues focusing on cultural ecosystem services of the outdoors during the 2021 COVID-19 pandemic are being developed into a 2-part series focusing on 'noticing' nature and becoming 'embedded' in nature.

- **The potential of local Payment for Ecosystem Services (PES) schemes for the delivery of multiple benefits at the landscape scale:** A [research brief](#) highlighting the key results from the [PESLES](#) project for the SRP 2016-2022 on the Lunan and Loch Leven catchments has been published. A final workshop presenting these results was attended by 11 key stakeholders.



Theme 2 - Productive and Sustainable Land Management and Rural Economies

Work Package 2.1: Crop and Grassland Production and Disease Control

Major Achievements

- **Funding for the next generation of SRP researchers:** Based on SRP-research and expertise, an industry-wide programme for Sustainable Agricultural Innovation (CTP-SAI) has won a UKRI-BBSRC collaborative training partnership award (CTP) to provide a £3.6 million postgraduate training programme in sustainable agricultural innovation. The programme was co-developed by the James Hutton Institute as part of its collaboration with the University of Cambridge, the Crop Science Centre, NIAB and leading UK universities.
- **Understanding how Potato Cyst Nematode (PCN) manipulates its host:** SEFARI researchers have identified a protein produced by the potato cyst nematode that targets a key plant growth regulator of the cell cycle during infection. This [published research](#) provides information on the mechanisms by which PCN manipulates its host for its own benefit. This information could contribute to the development of new control strategies based on disruption of essential processes in the pathogen.
- **New imaging techniques to advance soft fruit breeding:** Hyperspectral imaging is a new approach to assess breeding populations that enables high throughput field measurements. A SEFARI institute has developed a hyperspectral imaging platform devised for plantations of the perennial crop raspberry. The [study](#) indicates that hyperspectral imaging can be used as an innovative approach for high throughput field phenotyping of raspberry and could be transferred readily to other perennial crops. The approach provides a pipeline for automated field

data collection and analysis that can be used as a new breeding tool.

- **Blue light inhibits immune response of potato to late blight:** SEFARI researchers and collaborators [published results](#) showing that a pathogen protein delivered into plants manipulates blue light signalling to promote infection. Blue light treatment was found to suppress the usual immune response and make the host plant more susceptible to late blight. Such light treatments offer the prospects of an alternative to pesticides for the sustainable management of pests and diseases.
- **Advances in barley breeding:** SEFARI scientists have identified a gene in barley that doubles the rate of recombination (the rate at which genetic material is mixed up during crossing). This research, published in the journal [Frontiers in Plant Science](#), has the potential to speed up plant breeding and help address economic and environmental concerns through the provision of new adapted plant varieties.
- **New solution to crop protection:** Funding has been secured by SEFARI researchers (£546k over 2 years) in a second Innovate UK project to investigate the biocontrol properties of bacteriophages against the potato blackleg pathogen *Pectobacterium*.

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

Major Achievements

- **One Health benefits of measuring antimicrobial resistance (AMR) accurately in livestock:** Accurate measures of AMR should help identify opportunities for reductions in the use of antimicrobials in livestock. Previously we showed that the measure

of AMR used greatly affects estimates of prevalence. We have now tested a new method (Quantitative Estimation of Population AMR; QEPA) which provides extensive information about a sample, namely estimates of total bacterial density and proportion of resistant bacteria along with associated estimates of uncertainty. QEPA was successfully validated using trials in which artificial samples were constructed with known proportions of resistant bacteria. The results will be presented at the conference of the Society for Veterinary Epidemiology and Veterinary Medicine in early 2022 and will be published thereafter. Prospectively, by reducing antimicrobial usage in livestock, the prevalence of livestock AMR can be reduced with concomitant reductions for AMR in humans.

- **Genetic differences in rumen volumes of sheep, as a methane predictor:** Earlier work confirmed that increased volume of the reticulum and rumen (RRvol) is associated with increased methane emissions. Differences in RRvol between breeds, at a fixed live weight, have been identified in lambs reared together. RRvol appears to be heritable within breed (45% in Texel lambs), suggesting

potential to alter RRvol, and potentially methane emissions, by breeding. Results also suggest that breeding for the lower RRvol would not be at the expense of desirable production traits. Results of this work will be published in *Animal Production Science* and have been disseminated widely to stakeholders.

- **Do hens value pecking enrichments provided in free-range systems?** Laying hens are typically provided with destructible enrichments to redirect pecking behaviour away from one another. UK egg producers often provide alfalfa hay to hens for this purpose, but its benefits are little understood. We compared alfalfa hay bales, pecking blocks (made of compressed grains, calcium carbonate molasses and cereals), pelleted feed, scattered twice a day, and jute ropes for their influence on hen behaviour. Pecking blocks and bales provided consistent interest to hens in terms of interaction, more so than pelleted feed, with ropes being the least attractive. Whilst ropes were by far the cheapest enrichment to provide, behaviour at ropes was indistinguishable from behaviour away from any enrichments.



A balance between encouraging positive hen behaviour and cost to the producer needs to be considered in the practical use of any enrichment.

- **New information on tick-borne pathogens:** Ticks and tick-borne disease incidence have been increasing in many parts of Europe, including Scotland, over the last few decades. Despite this, there is a major knowledge gap of the prevalence, or even existence, of some tick-borne pathogens across large areas. In collaboration with scientists in Switzerland and the Netherlands, SEFARI researchers [compared](#) the prevalence of several tick-borne pathogens between different regions of the UK (including NW Scotland) and the Netherlands. *Borrelia burgdorferi* (the Lyme disease pathogens) and *Anaplasma phagocytophilum*, the cause of tick-borne fever in sheep, were the most prevalent in all regions and Scottish ticks generally had lower pathogen prevalences than those in the Netherlands. Unlike all other regions, in Wester Ross *Anaplasma* was more prevalent than *Borrelia*, and detection of *Spiroplasma ixodetis* in Wester Ross was a first in the UK, the significance of which is not yet known. This type of information is crucial for aiding region-specific diagnostics and awareness strategies.
- **Improving awareness of ovine pulmonary adenocarcinoma (OPA) and disease control strategies:** OPA is a viral lung disease of sheep and is not easy to diagnose. There is no cure, and disease control measures take time to have an effect, so awareness is essential to early detection of problems in a flock. We have gone back to Scottish sheep farmers who had participated in a survey in 2006-2008 and found that while their knowledge and awareness of OPA had improved, there were still some misconceptions. An inter-disciplinary team has secured funding (from the Universities Innovation Fund) to extend knowledge exchange and dissemination activities. The OPTimisation of industry Awareness and Networks to improve uptake of disease control strategies OPA-NET: Scotland team is holding two webinars for sheep farmers in February 2022, updating the related technical note and producing pod-casts. Improved awareness of clinical signs, diagnosis and available methods for disease control should provide Scottish sheep farmers with more confidence to address this endemic disease problem.

Work Package 2.3: Productive and Sustainable Land Management

Major Achievements

- **Manmade soils using waste products:** Results from a four-year trial looking at whether mixtures of construction waste and compost could act as an alternative plant growing medium to soil showed positive results with two grass species (reed canary grass and rye grass). A mineralogical analysis of the construction waste revealed it contained several minerals in common with soil, and when mixed with municipal green waste compost, provided a medium with sufficient capacity to supply the nutritional requirements of the plants for two full growing seasons in large pots. Studies with both grasses plus pea and barley plants demonstrated that it is possible to engineer a mixture in which the plants germinate and produce shoots as well as in real soil, without any adverse biotic effects. Leaching of harmful chemicals from the mixtures was low, so it is likely that these materials could be used for urban greening close to the source of their generation, reducing the need for soil import and the associated CO2 emissions from transport.

Work Package 2.4: Rural Industries

Major Achievements

- **Contributing to deliberations on future agricultural policy:** WP expertise was embedded in the recent [Farming for 1.5: From here to 2045](#) and The Transition to Future (Conditional) Agricultural Support – NFU Scotland’s Approach [eports](#) – with SEFARI scientists presenting the latter at the Autumn NFUS, and at the Defra/AES [one day conference](#) on The Future of Farming

Across the UK. Knowledge Exchange engagement on policy and research evidence has been undertaken by SEFARI researchers to farmers (c. 400 farmers over 8 presentations), local authorities, academic groups, Scotland's Farm Advisory Service consultants, veterinary profession, etc. as well as supporting the new [Rural Affairs, Islands and Natural Environment Committee](#) of the Scottish Parliament in their business planning session. The Scottish Government have recently published earlier SEFARI outputs on agricultural emissions in the national greenhouse gas inventory – [headline disaggregated figures](#), arable, [sheep](#) and [dairy](#) sectors. SEFARI researchers were also awarded a contract from the Scottish Government for 'The provision of economic advice and related services to support development of a new rural support scheme for Scotland' that utilises the knowledge embedded in the SEFARI research base (over multiple programmes). SEFARI researchers presented novel methodological approaches to RESAS on 'Building an integrated spatial microsimulation for Scotland: Farm-level simulation of post-Brexit FTA scenarios'.

- **Changes in farm payments 2014-2019:** Analysis of the changes in [farm payments between 2014 and 2019](#) was developed with RESAS analysts and RPID officials. In response to requests from stakeholders the scope of the analysis was extended to cover Pillar 2 payments in greater detail (including the first mapping of these payments). The materials were used in several discussions with SG policy leads and published through the ARD Stakeholders meeting with 40+ groups present.
- **Farmer Intentions Survey (FIS) on achieving net zero carbon:** A research [briefing](#) on new entrants from FIS analysis was included in briefing [notes](#) of the Cabinet Secretary for Rural Affairs and Islands for the Scottish Parliament's Rural Affairs and Islands Portfolio Questions on 2 September 2021. Two papers were published, one analysing [Farmer intentional pathways for net zero carbon: Exploring the lock-in effects of forestry and renewables](#) with a second on [Farmer past and intended investment behaviours](#).
- **Knowledge exchange on iconic value chains within Scotland:** In conjunction with the [H2020 MOVING project](#), a policy brief and [short film](#) were produced on 'why mountains' matter, highlighting the contributions that mountains make within Scotland's rural industries and environment. Working with stakeholders, a report was produced highlighting how the Speyside malt whisky value chain draws on natural capitals and the risks from climate change and other drivers. The Speyside whisky value chain case was presented in a webinar for the [EU level multi-actor platform](#).
- **Enabling farmers to adopt Climate smart behaviours:** An extensive [review](#) of enabling behaviour change in farmers was conducted to understand the ways in which interventions can support adoption of climate smart technologies. In conjunction with the H2020 LIFT project, SEFARI staff have produced three briefings on ecological practices within Scotland. This work examined how farmers [perceive ecological practices](#), how we can develop a [typology of practices](#) and the [economic effects](#) of ecological practices. These were taken up by several national newspapers and trade press.
- **Climate change and food security:** SEFARI researchers were called on to contribute to a [brief on climate change](#) led by the Royal Society with [teaching materials](#) developed for schools facilitated by the Royal Geographical Society.
- **Novel visual representations of climate change projections:** SEFARI researchers developed novel visual representations of observed and projected temperature and precipitation for Glasgow 1960 to 2080. These were used with public and policy audiences at the COP26 Green Zone stand of SEFARI and EU SHERPA, and at the SEFARI stand at the [43rd TB Macaulay Lecture](#).

Theme 3 - Food, Health and Wellbeing

Work Package 3.1: Improved Food & Drink Production

Major Achievements

- **Circular Bioeconomy Research and Analysis Service:** Funding has been secured (maximum £800k, on a call off basis) by SEFARI researchers, in collaboration with Zero Waste Scotland, and academic and commercial partners, to develop a systems model that will deliver evidence led, actionable, high-impact recommendations to guide policy and activity and contribute to sustainable change and a thriving Scottish bioeconomy. The framework grant funding will run from 2022 to 2026.
- **Vertical and controlled environment agriculture:** Funding has been secured from Innovate UK project (value £487k) by SEFARI researchers on System Sensing in Vertical Farming and Controlled Environment Agriculture ([Sys-Sens](#)). The project will develop sensors in vertical and controlled environment agriculture aims to design a product for the accurate and non-invasive measurement of crop stresses and their relationship to food nutritional content/

maturity and production optimisation. The consortium brings together sensor experts, Gardin Ltd., and Intelligent Growth Solutions and SEFARI researchers.

- **Arable mycotoxin stakeholder forum:** Recognising that mycotoxin contamination of cereals grown in the UK is a major concern for growers, processors and regulators, a UK forum was organised by the UK flour millers' association, hosting 30 representatives from cereal growers and processors' associations, research institutions and regulators (FSA and FSS). A SEFARI researcher presented SRP research on mycotoxins and masked mycotoxins in human nutrition, highlighting work spanning RD 3.1.3 and 3.2.2. Future research priorities for regulators and industry were discussed and align with the SRP 2022-27, hence demonstrating continuous stakeholder relevance of RESAS funded research activities.
- **Modelling food waste and food security:** A SEFARI researcher presented SRP research findings on the behavioural modelling of food waste and food security linkages using Scottish household survey data at a RESAS seminar (September 2021), with more than 50 policy makers in attendance.



Work Package 3.2: Healthy Diets and Dietary Choice

Major Achievements

- **Folic acid fortification policy:** Drawing on expertise developed over several Scottish Government funded SRPs, and where collaboration with Food Standards Scotland has been active in the present programme, a SEFARI researcher wrote an invited [commentary](#) for the Lancet (September 21) on plans for the UK to introduce folic acid fortification of flour to prevent neural tube defects. This is one of the most important nutritional interventions in the UK in recent decades, with the potential to affect generations of mothers and babies and has important implications for the food industry in Scotland and the UK.
- **Early Years policy:** A SEFARI researcher updated Scottish Government Health policy teams on the relevance of SRP research to policy on Early Years. Policy teams from "Improving Health and Wellbeing Children and Families Directorate Division", policy leads on 'Diet and Obesity' and 'Scottish Milk and Healthy Snack' initiatives, and Maternal and Infant Nutrition leads in NHS Boards were invited to the briefing in November 2021.
- **Proof of concept in prenatal flavour programming:** SEFARI researchers have shown that inclusion of bitter vegetables in the maternal diet during late pregnancy increases infant exposure to these flavours in utero and subsequent liking of a bitter vegetable, namely spinach, at weaning. This was the case for mothers who regularly included bitter vegetables in their diet naturally, and those who were low consumers but were exposed to a predominantly bitter vegetable-based intervention in late pregnancy. This work points to ways in which the diet of future generations could be sustainably improved.

- **BBSRC food and health initiative:** A SEFARI researcher co-chaired a joint meeting of the UKRI-BBSRC Strategic Advisory Panel on Bioscience for an Integrated Understanding of Health and the Strategic Advisory Panel on Food (September 2021). This is a new initiative by BBSRC, designed to promote holistic approaches and solutions in the areas of food and health. It was attended by a wide range of policy colleagues across the UK (including RESAS), scientific advisors, researchers, and industry.

Work Package 3.3: Food Security

Major Achievements

- **Digital agriculture:** A SEFARI researcher contributed to the publication 'What are the priority research questions for digital agriculture?' ([Land Use Policy](#)), prioritising research questions for UK agriculture and constructing a research framework to steer policy, both in UK and beyond.
- **Publication output:** SEFARI researchers published articles, conference papers and blogs on: 1. "[Trend analysis of sustainability claims: the European fisheries and aquaculture markets case](#)"; 2. "[The market for organic food in the UK](#)"; 3. "[Estimation of a hedonic price equation with instruments for chicken meat in the UK: does the organic attribute matter?](#)"; 4. "[Industry levy versus banning promotion on soft drinks in Scotland: a distributional analysis](#)"; 5. "[Ready meals in the UK: an analysis based on their nutritional and sustainable claims](#)"; 6. "[The road to recovery for the food and drink sector](#)"; 7. "[The British are eating less red meat and consuming more processed food](#)"; 8. "[How to delink the UK's soybean imports and livestock supply chains from deforestation in the Amazon](#)".



Work Package 3.4: Communities and Wellbeing

Major Achievements

- **Rural communities and Covid-19:** SEFARI researchers published a [report](#) on the experiences of rural communities of the Covid-19 pandemic, the third phase of a research project conducted on the impacts of, and responses to, the Covid-19 pandemic on rural Scotland and the prospects for a rural recovery, and delivered a [keynote presentation](#) entitled 'Researching digitalisation in remote rural regions during Covid-19: the case of the Scottish Crofters' to the online workshop 'COVID and what next? Methodological Implications for Digitalization Research in Rural-Peripheral Areas' in November 2021. The presentation featured WP3.4 work on understanding the response to Covid-19 in rural and island communities across Scotland (see also this [report](#) on understanding the response to Covid-19 in Scotland's rural and island communities).
- **Rural Affairs, Islands and Natural Environment committee:** SEFARI researchers gave evidence on The National Islands Plan Survey to the Scottish Parliament Rural Affairs, Islands and Natural Environment Committee (Oct 2021). The session can be viewed [here](#).
- **Youth in rural areas:** A report from a SEFARI researcher has informed a resolution and recommendation to be formally adopted by the Council of Europe in Spring 2022. The report was on 'The future of youth in rural areas: responsibilities of local and regional authorities' presented to the Council of Europe Congress of Local and Regional Authorities ([Current Affairs Committee](#)) in November 2021.
- **Place-based policy: SEFARI researchers published two reports on place-based policy in rural Scotland:** One summarises the findings of [case study work](#) in rural communities across Scotland, and the other discusses the [future for rural policy in Scotland](#) in the context of place-based policy and place-based working, alongside other drivers such as climate change and net zero and EU exit.



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