

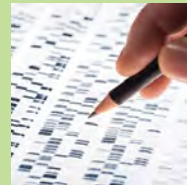
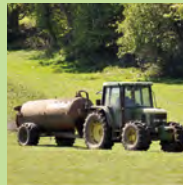


Environmental Change; Food, Land and People



Spotlight 2013-2014

Scottish Government
Strategic Research Programme



Funded by the Scottish Government's
Rural and Environment Science and
Analytical Services Division (RESAS)



Environmental Change; Food, Land and People

Spotlight on the Scottish Government Strategic Research Programme 2013-2014



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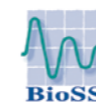
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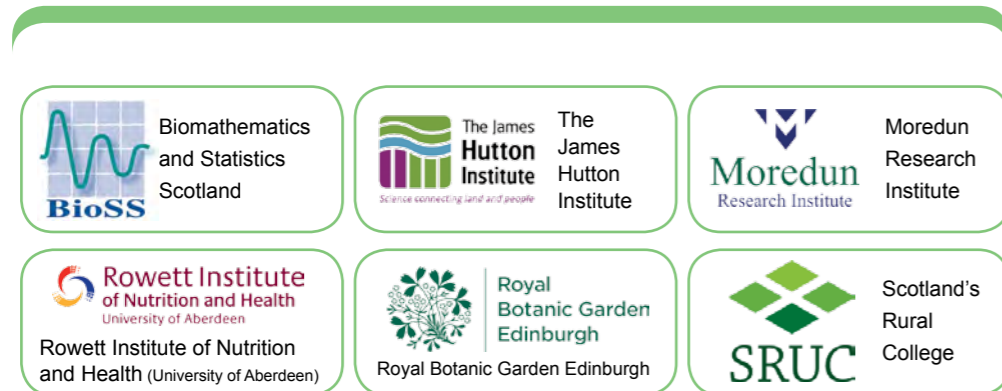
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Scottish Government Strategic Research Programme

The Environmental Change Programme and the Food, Land & People Programme form an interlinked, multidisciplinary strategic research programme (2011-2016), commissioned by the Scottish Government's Rural and Environment Science and Analytical Services Division (RESAS).

The Strategic Research Programme (SRP) is being delivered through integrated research across six Main Research Providers (MRPs):



The main aims of the Strategic Programme are:

- To address major policy issues of climate change, land use and food security
- To develop responses to anticipated issues of global change
- To work with stakeholders, including Policy Makers and Industry

This document showcases examples of the outcomes (and aligned activities) from the 2013-14 annual report.

The research delivers to five strategic priorities:

1. Policy and practice

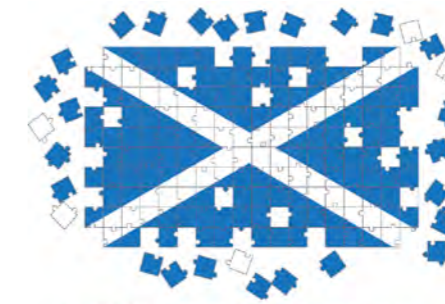
2. Economic growth and innovation

3. Collaboration and multidisciplinary working

4. Scientific excellence

5. Growing scientific resilience

1 Policy and practice



179 reports and briefs produced that are relevant to Scottish Government policy

81 scientists active on 123 advisory groups



Scottish Biodiversity Strategy

The Strategic Research Programme (SRP) has contributed substantial support to the refresh of the Scottish Biodiversity Strategy.

In 2010, in response to continued widespread and global losses of biodiversity, the UN Convention on Biological Diversity set new targets for 2020, the so-called 'Aichi Targets'. New 2020 targets were also set for the EU. The 2020 Challenge, published in 2013, a supplement to the Scottish Biodiversity Strategy, focused on these new desired outcomes for 2020.

The SRP has provided advice on the role of biodiversity in underpinning the delivery of

ecosystem functions and ecosystem services cited in the 2020 Challenge document; provided development and testing of a new framework for a co-ordinated EU-wide approach to identification and assessment of High Nature Value farmland; advised on Common Agricultural Policy reform, particularly through membership of the Scottish Rural Development Programme (SRDP) technical working groups; liaising directly with Natural Resources Division policy leads and providing inputs to the Rural Affairs, Climate Change and Environment Committee evidence sessions. Our researchers have also applied methods and analyses to target resources to maximise the impact of SRDP spend on conserving biodiversity, improving water quality and reducing greenhouse gas emissions.

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Environmental sustainability of school menus



Strategic Programme scientists responded to a request by the Scottish Government to examine the environmental sustainability of school meals.

This work considered where the greatest contribution of greenhouse gas (GHG) emissions was likely to come from within the school meals service. It provided an overview of current meal provision and worked examples of how meals could be revised to help reduce GHG emissions. The research helped inform current policy work on sustainable school meals.

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Tackling the threat of Spotted Winged Drosophila

In 2014, SRP researchers provided the first identification of Spotted Wing Drosophila within Scotland. Working with stakeholders, SRP researchers are helping to ensure effective preparedness and control measures for this pest.



Spotted Wing Drosophila (SWD), a vinegar fly native to Asia, was first described in Japan in 1916. It is potentially damaging to a wide range of soft and stone fruit; damage caused by the larvae may render the fruit unmarketable. Assessments of crop losses

are not well documented but have been estimated to range from 20-40% in blueberries and up to 100% in cherries in other countries. Unlike native species that are only attracted to overripe fruit, SWD are attracted to early ripening, ripe and overripe fruit, making it more difficult to control and prevent damage. SWD was first reported in the USA and Europe in 2008, in the UK in 2012 and, as part of our strategic research, first noted in Scotland in 2014.

In response to stakeholder concerns, a collaborative UK-wide research project including our researchers, industry and external funders was initiated. An SRP scientist sits on the SWD Working Group whose members include SG, DEFRA Plant Health, Chemical Regulations Directorate, National Farmers Union, the Horticultural Marketing Inspectorate and the Project Steering Group. This has enabled sharing of new information, early awareness of future problems arising as a result of spread and infestation, and the identification of solutions that meet the needs of industry. The project is influencing practice, management and targeted control measures, reducing the threat of economic losses from this pest.

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Integrated Pest Management

The Strategic Programme is at the forefront of Integrated Pest Management (IPM) development and engagement with the agri-sector. Developing IPM approaches are a high priority with key roles to play in the 'greening' of the Common Agricultural Policy (CAP) and the need for National Action Plans (NAP) under the EU Sustainable Use Directive.

NAPs oblige EU Member States to promote integrated management practices which reduce reliance on pesticides. Through a series of open days and farmer workshops, information generated from our strategic research has been presented which encourages farmers to consider and implement improvements to practices. These have encompassed alternative crops and have included demonstrations of rye and triticale as well as bird and bee friendly options. These events have also been used to promote the use of alternatives to pesticides such as the planting of less disease susceptible varieties; the use of biological controls and also improved monitoring and surveillance to better target inputs. SRP research has linked this to the monitoring and surveillance work carried out under the Veterinary and Advisory Service (VAS) Crop Health Activity, which includes a fortnightly report to growers of the disease risks and actions needed, targeting best practice.

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Supporting rural community resilience and development

The SRP is delivering vital research to understand the basis and drivers for community empowerment, work which links directly to the Programme for Government: passing power to people and communities.

As a component of their Rural Communities research, SRP experts work extensively in support of LEADER (Links Between Activities Developing the Rural Economy). For example, researchers have examined rural community development planning in Ayrshire, evaluating LEADER "Rural 21", which supported

communities to develop action plans in 3 Ayrshire Local Authority areas (East, South, and North). The research identified ingredients of success in how "three Ayrshires" worked in bottom-up ways with their communities, and with each other; what could have worked better, e.g. specific support, timeframes, training and guidance; a regional network. The findings contributed to 21 community plans through LEADER.

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Reform of CAP direct payments post 2015



Strategic Programme expertise has played a long term and significant role in the development of Common Agricultural Policy (CAP) options, working closely with RESAS analysts, Rural Payments and Inspections Division and Scottish Government (SG) policy teams.

Member States were given considerable discretion in shaping the 2015 CAP reforms. In moving from historic to area based payments this discretion applied to both the basis on which regions were defined and how shares of budgets were allocated between them. There were also several optional measures that could be used and the most significant of which for Scotland was the use of voluntary coupled support, linking payments to numbers of livestock per business. Research in the previous and current research programmes supported the evaluation of a wide range of policy options and, in particular, highlighted that within-sector redistribution from more intensive to less intensive business was a key outcome regardless of the area-based payment system used.

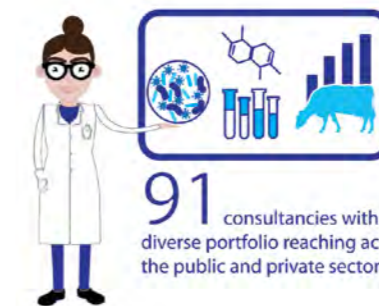
Phase 1 of the CAP analysis, which synthesised the outcomes of 30 combinations of regions and budgets for an area-based basic payment scheme, was presented at the CAP Moving Forward Conference (17 April 2013), attended by the Cabinet Secretary for Rural Affairs, Food & Environment with over 100 delegates from government, agencies, industry and the wider public. The outputs from the analysis were extensively discussed within the CAP stakeholders group (the principal standing forum for CAP discussions) and within SG working groups. The utility of the analysis in informing the choice of land type as the basis for

payment regions was publicly acknowledged by the SG policy lead. From May 2013, Phase 2 of the analysis included voluntary coupled support (for the beef sector) and the redistributive (or 'French') payment. These gave policy makers and stakeholders an early view of the balance of outcomes from such options and informed modelling by RESAS analysts. Since eligibility for support would not be tied only to historic receipt of payments, there was potential for new areas to become eligible for CAP support. Strategic Programme researchers identified and classified such areas using land use data from SG, MRPs, Forestry Commission Scotland and Centre for Ecology and Hydrology. The potential additional area was indeed substantial. This was mainly rough grazings where minimum stocking rate was proposed as a criterion for eligibility. There was intense debate on the appropriate level for such minimum stocking rates and MRP staff undertook analyses for SG to address stakeholder concerns. This new area and stocking rate data was used within the Government's December 2014 CAP Direct Payments Consultation.

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2

Economic growth and innovation



Supporting smaller businesses in Scotland to innovate

Strategic Programme researchers have contributed to workshops, conferences, field and site visits and featured in a series of short industry-facing videos focussing on research relevant to support the work of The Food and Health Innovation Service within the agri-food Small and Medium Enterprise (SME) sector.

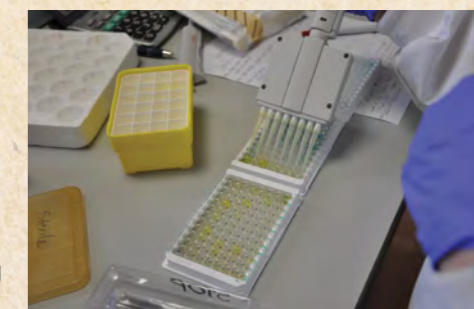
The Food and Health Innovation Service (FHIS), supported by Scottish Enterprise and Highlands and Islands Enterprise, helps food and drink companies exploit the commercial opportunities from healthier eating. More than 400 SMEs have interacted with FHIS and over 250 have had direct structured support, including scientific support from SRP researchers on food, nutrition and health. This support has been delivered through master classes with companies to explore options and solutions, or by providing tailored reports. SRP researchers have produced a wide range of briefing papers both direct to companies and to build a library of information that will form part of the project's legacy. This will provide a valuable resource to businesses looking to enhance their opportunities to innovate.

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BioX Diagnostics liver fluke test

Liver fluke is a highly pathogenic flatworm parasite of sheep and cattle that causes significant economic losses to the Scottish livestock industry, estimated to be in the region of £25-30 per infected sheep and around £60 per head for infected beef cattle. SRP researchers are evaluating diagnostics to help tackle this important threat to the livestock industry.

Diagnosis of fluke infection in live animals is challenging, with the few available tests having significant limitations and consequently very poor end-user uptake. SRP researchers set out to evaluate the performance of a new test, the coproantigen ELISA (or cELISA; BioX Diagnostics, Belgium), based on the detection of fluke secretions in host faecal samples. Although the test had some limitations under field/farm conditions, cELISA represents a useful addition to our fluke testing capabilities. The test proved to be liver fluke-specific, not cross-reacting with other infections such as rumen fluke, a common co-infection in sheep and cattle. This test also has potential for use as a rapid indicator of flukicide treatment success, giving a clear indication of outcome within 7 days, compared to the 21 days required by currently available methods. cELISA testing is now being offered commercially by the SAC Veterinary Investigation Service and several commercial veterinary testing laboratories.



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Working with Interface Food and Drink

Programme scientists are working with Interface Food and Drink to help develop and successfully roll out their Common Interest Group (CIG) initiative. CIGs promote knowledge exchange and collaborative working between groups of SMEs and researchers.

With the support from Interface, SRP scientists are undertaking research on provenance and quality for the 8 companies in the Scottish Rapeseed Oil group, on husbandry and disease prevention for the Scottish Venison Partnership, and on cereals for the 30 industry members of the Craft Distillers Group.

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Non-chemical control of parasitic worms

Fundamental research from the Strategic Programme has now attracted industry-funding through sponsorship from a UK based commercial vaccine production company.

Strategic Programme research has demonstrated, in lambs of 6-7 months-old, vaccine induced protection against the most economically-important parasitic nematode of sheep in temperate regions, *Teladorsagia circumcincta*. However, the protective effects were less pronounced in young lambs (ca. 4 months old) which have less effective immunity and are also most susceptible to the production-limiting effects of *T. circumcincta* infection. It was suggested that the impact of the vaccine in younger lambs may best be achieved by immunisation of pregnant ewes to control the pregnancy-associated relaxation in immunity and associated pasture contamination, which is the principal source of infective larvae to young lambs in late spring/early summer. Research has now validated an experimental model for this approach, the outputs from which have informed the experimental challenge model for the *T. circumcincta* vaccine in the pregnant ewe. This work has now also attracted industry-funding through sponsorship from a UK-based commercial vaccine production company.



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Barbervax - a vaccine for Barbers Pole worm



Developed through long-term research into the sustainable control of parasites, Barbervax[®], is the first vaccine in the world for a worm parasite of sheep and a revolutionary new tool for farmers to combat Barbers Pole worm.

Barbers Pole Worm (*Haemonchus contortus*) is the most important roundworm parasite of sheep and goats in the world. It is a voracious blood sucker causing anaemia which can readily become fatal. Fortunately for UK farmers it prefers warmer conditions and so is only a sporadic problem, but in parts of Australia, South Africa and South America it presents a real difficulty for commercial sheep farmers, compounded by the fact that strains resistant to anthelmintic drugs are common and widespread.

Barbervax contains tiny amounts of protein purified from the lining of Barbers Pole intestines. Like all vaccines, it works by stimulating the natural immune response in the animal after injection. The antibodies produced circulate in the sheep's blood, so that the parasites drink antibodies with their blood meal. These antibodies attach to the lining of the Barbers Pole intestine, blocking digestion and starving the worm so that it produces far fewer eggs and dies.

Barbervax was trialled extensively in hundreds of Merinos in New South Wales over three consecutive seasons. The results indicated that the degree by which the vaccine reduced worm egg output and hence pasture contamination offered a level of control superior to a conventional anthelmintic.

Barbervax[®], was registered for use in Australia in 2014. The first batch of vaccine, consisting of 300,000 doses, was sold out within 10 days just by word of mouth and its users were pleased with its performance. Orders for the entire second batch of 1.6 million doses have also been secured.

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A multidisciplinary approach to Ramularia

The Strategic Research Programme's genomic research, risk warning schemes and collaboration and partnership with Government and Industry are creating a multi-targeted approach to understanding and tackling Ramularia infection in barley.



The genome of the newly important pathogen of barley *Ramularia collo-cygni* has been successfully sequenced, providing a significant opportunity to develop new approaches to its control. The identification of fungal proteins such as small secreted proteins, often involved in host pathogen interactions, will also be a key focus of research to help explain the complex life cycle of Ramularia. PhD funding from industry has added value to this core work.

A further joint industry-funded PhD has identified the adaptability of the pathogen and confirmed the need for careful stewardship to guard against fungicide resistance. This has been highlighted to growers at joint Scottish Government and Agriculture and Horticulture Development Board (AHDB) funded workshops, agrochemical manufacturers and the Chemical Regulations Directorate through direct discussion and dissemination at the Fungicide Resistance Action Group UK. AHDB has agreed to fund a project aimed at extending the Ramularia risk warning scheme to the rest of the UK. The scheme, developed within the Strategic Programme and run in Scotland since 2011, allows growers to tailor fungicide sprays to the predicted risk area.

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3

Collaboration and multidisciplinary working



Livestock with low methane production?



A cross-programme project (the Scottish Methane Consortium) aims to discover to what extent the genetics of cattle controls the rumen microbial community and, in turn, emissions of the greenhouse gas methane. A potential to breed for low greenhouse gas emissions livestock would have significant implications for climate change mitigation strategies.

Methane is a greenhouse gas (GHG), 25 times as potent as carbon dioxide. Ruminants are major methane emitters, contributing 3-4% of global GHG emissions. The methane is derived from microbial fermentation in the rumen, being produced by microbes known as archaea. Measuring methane emissions can be difficult and expensive, so it was a breakthrough when Strategic Programme scientists discovered that the microbial community in ruminal digesta samples collected at slaughter corresponded to that found in live animals a few weeks previously. By taking post-mortem samples of ruminal digesta at slaughter and analysing these samples by molecular microbial ecology methods available within the SRP, it should be possible to identify the genetic background to methane emissions.

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Woodland chemical ecology, plant pests and pathogens

Strategic Programme researchers are forging partnerships to exploit the benefit of the chemical ecology approach to understanding ecological processes that underpin forest management and resilience.

A Natural Environment Research Council project with Royal Holloway, University of London, is measuring the relative importance of species and genotypic diversity, two key facets of biodiversity, as determinants of forest ecosystem processes. The diversity-function relationship is crucial to sustainable forest management and involves significant international collaboration with scientists from Germany, Finland and Estonia. In addition, a Biotechnology and Biological Sciences Research Council grant in collaboration with three MRPs, Centre for Ecology and Hydrology, Forest Research, University of Edinburgh and University of Aberdeen, will devise ecological and evolutionary solutions to novel pests and pathogens in order to promote forest resilience (PROTREE), providing a significant critical mass of Scotland-based collaborative expertise in forest resilience and management. The SRP partners support logistics, provide public engagement and key expertise on resistance to pests and pathogens in crops and Scots pines.

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4

Scientific excellence



Potato Cyst Nematode genome sequence

Publication of the *Globodera pallida* genome sequence is a major advance for developing control strategies and breeding resistance to this important pathogen. This places SRP work on *G. pallida* in a world-leading position.

Nematodes cause damage to crops valued at over 100 billion US dollars each year and are a major constraint to achieving global food security. Withdrawal of most currently effective nematicides on environmental grounds means that problems caused by plant nematodes are increasing. The most damaging species are the root-knot and cyst nematodes, with the potato cyst nematode *G. pallida* prominent in the latter group. Co-led by SRP researchers, the sequencing of the *G. pallida* genome is the culmination of almost 10 years collaborative effort, funded, in part, through the previous and current SG programme and involves 21 researchers, from 9 international research institutes. The researchers describe the identification of gene families, likely to be critical for the interactions of the nematode with its host. The availability of the genome sequence and a full life stage transcriptome dataset will underpin future research on *G. pallida*.



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Berry extract in diabetes management?

Strategic Programme research has demonstrated that ingestion of a concentrated berry extract significantly reduces postprandial plasma glucose in volunteers with type 2 diabetes.

Type 2 diabetes is an increasingly prevalent chronic condition, affecting 2.5 million people in the UK (about 5% of the population), made worse by the continuing rise in obesity. Type 2 diabetes is expected to double in incidence over the next 20 years, substantially increasing the financial burden on health care. While weight loss is an effective strategy to reduce the risk, many find weight loss difficult to achieve and maintain. Thus additional effective management and early prevention strategies are required.

Berries such as bilberries, native to Scotland, are rich in polyphenols and may influence carbohydrate digestion and absorption and thus the body's ability to manage

glucose. SRP research has demonstrated for the first time that the human-ingestion of a concentrated bilberry extract reduces glycaemia and insulin levels after eating in type 2 diabetics. SRP research is now investigating if the extracts exert a longer term effect in lowering blood glucose. This might offer a route for the prevention and management of the disease.

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High Nature Value farming

An SRP lead investigator has been part of an expert consortium of international researchers that has recommended a new framework for ensuring a coordinated, EU wide approach to the identification and assessment of High Nature Value farmland (HNVf).

The research, published in "Journal of Environmental Management, was highlighted in November 2014 within "Science for Environmental Policy", a European Commission news and information service which provides policy makers with the latest environmental research needed to design, implement and regulate effective policies.



With over half of Europe's species dependent on agricultural habitats, protecting 'high nature value' farmland is vital to biodiversity conservation. However, the identification and assessment of such farmland requires careful co-ordination. HNVf can either have a high proportion of semi-natural vegetation, involve low-intensity farming with mosaics of semi-natural and cultivated land, including hedgerows, ponds and trees, or support rare species. The EU requires that all Member States monitor their HNVf, as part of their assessment of Rural Development Programmes. However, decisions about how to assess then vary across each Member State. As a result there is often a lack of comparable data and it is difficult to gain an EU-wide perspective on the extent and condition of HNVf both within and between Member States.


In Scotland, research by an MRP and others has helped Scottish Government establish that over 2.2 million ha (equivalent to 40%) of Scotland's Utilised Agricultural Area is estimated to be under HNVf systems.

The research from the consortium proposes a framework together with a set of key recommendations that allows local data to be combined to give a cohesive assessment at the Member State, and ultimately EU, level. It uses contributions from local organisations such as farmers' organisations, NGOs and local authorities. SRP researchers are continuing to work with a consortium of continental researchers, including the Centre for Biodiversity and Genetic Resources in Portugal, to test the new framework on case study data from across the EU, including areas of Scotland.

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5 Scientific resilience

£30m
additional income earned
40% - industry funding (contracts, intellectual property, grants and other commercial sources)
60% - research funding (European, UK and Scottish councils and governmental bodies)


268 MSc Students
308 PhD Students

Towards European Societal Sustainability

SRP expertise is collaborating within a major EU programme to investigate the factors contributing to the success of community-based initiatives and to assess their carbon-saving potential.

Small-scale, grassroots initiatives towards sustainability have been increasing over recent years, yet little is known about how they emerge or scale-up, or how much they contribute to the transition to a low-carbon society.

Towards European Societal Sustainability (TESS) is an EU FP7 project being led by the Potsdam Institute of Climate Impact Research, to investigate the factors contributing to the success of community-based initiatives and to assess their carbon-saving potential. The project runs from December 2013 until December 2016 and includes eight partners from six countries across Europe.

Anticipated impacts of TESS include enhanced understanding of the factors that encourage the emergence and growth of community initiatives in different regions across Europe, a clearer picture of which activities are best suited to a community-led approach, and how policy makers can best encourage community-led action toward sustainability. Outcomes for community initiatives will include a toolkit to assess their carbon-saving potential, training in using assessment methodologies, enhanced interaction with other groups across Europe and greater connection to researchers, and policy makers. The total value of the project to the MRP partner is £750k.

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Developing sustainable soil conditioners and plant fertilisers

Strategic Programme researchers have helped develop and are working on a University of Lancaster led, Natural Environment Research Council (NERC) "Resource Recovery from Wastes Programme"-funded project which aims to produce a sustainable, environmentally-friendlier source of soil conditioner and crop fertiliser.



Almost all existing inorganic fertilisers are produced using energy intensive methods and/or finite and unsustainable resources such as mined phosphate and toxic production process chemicals. This £856K, NERC-funded project will use a mixture of digestates, derived from anaerobic digestion, and ash, from burnt biomass, as an alternative to existing

crop fertilisers. A successful digestate-ash fertiliser would also reduce costs and provide additional income to biomass and anaerobic digestion operators, since ash is currently expensively dumped at landfill.

MRP expertise will provide two crucial development areas; on managing any risks from transfer of pathogens from digestate to soils and in understanding the crop availability of phosphorus forms from the new replacement fertiliser. Both of these build on research developed within the Strategic Research Programme. Bringing together academics with industry partners the project will ensure the resulting product meets the requirements of farmers and bio-energy producers.

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EU FP7 Cooperation Grant on generation of high value plant products

Strategic Programme scientists have joined a consortium, working in the Food, Agriculture and Fisheries and Biotechnology theme of the EU FP7 Cooperation Programme, to sustainably generate high value plant natural products for pharmaceutical and industrial use.

The project 'From DISCOvery to products: A next generation pipeline for the sustainable generation of high-value plant products' is a four year programme (valued €6.5M; £436k to the MRP). It consists of eight research organizations, seven Small and Medium Enterprises and a large industry partner from across seven countries. Building on the 'Land Use', 'Food' and 'Diet & Health' Themes of the SRP and the allied SG-funded Strategic Partnership-'Sustainable Food', an MRP leads the work of the consortium on exploiting potato for development of new sources of bioactives and sustainable ingredients.



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Strategic Research is addressing the major issues of Climate Change, Land Use and Food Security.



Conducted by leading teams of scientists from the Main Research Providers.



Delivering to Policy & Practice and Economic Growth and Innovation.



Funded by the Scottish Government's Rural and Environment Science and Analytical Services Division (RESAS)



Notes

