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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)

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Royal Botanic Garden Edinburgh
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Environmental Change; Food, Land and People

Spotlight on the Scottish Government Strategic Research Programme 2013-2014

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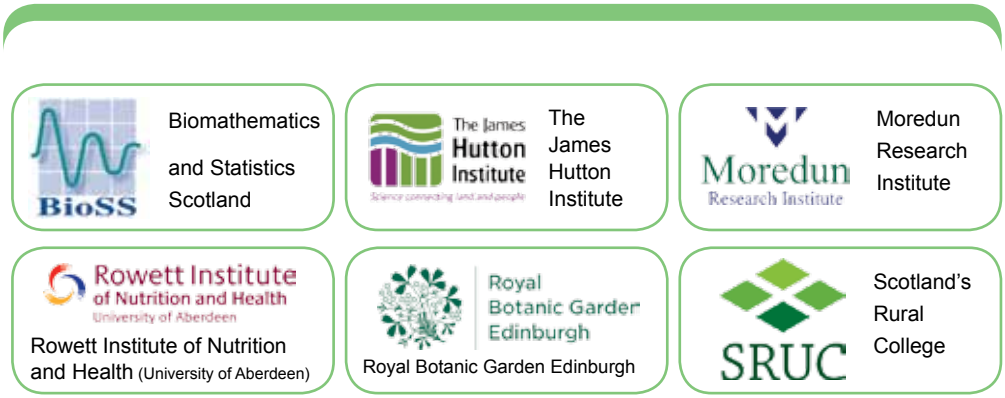
Scottish Government Strategic Research Programme

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 2013-14/15 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

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; providing inputs to the Scottish Government consultation on the SRDP and to the Rural Affairs, Climate Change and Environment Committee evidence sessions. The SRP has 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 Green House Gas Emissions (GHGE) 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 reduce GHGE. 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 in1916. It is potentially damaging to a wide range of soft and stone fruit; damage caused by the larvae renders the fruit unmarketable. Assessments of crop losses are relatively scarce but can range from 20-40% in blueberries and up to 100% in cherries. 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, in Scotland in 2014.

In response to stakeholder concerns, a collaborative UK-wide research project including an MRP, 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 and the Horticultural Marketing Inspectorate and the Project Steering Group. This has enabled a 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 for the pest, reducing the threat of any economic losses which could undermine the profitability and viability of the industry.

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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 Nation 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, research has been presented which encourages farmers to consider and implement improvements to practices encompassing alternative crops (e.g.rye and triticale as well as bird and bee friendly options). They have also promoted the use of alternatives to pesticides such as the planting of less disease susceptible varieties; the use of biological controls and also 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 21 communities to develop community action plans in 3 former 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.

In assessing CAP, while the move from payments per business based on historic entitlements was mandatory, the basis and rates for area-based and other payment (such as production coupled support) left considerable autonomy to Member States. Research (2009-12) in the previous Strategic Programme and elsewhere highlighted the potential for substantial redistribution within sectors and regions with net gains by less intensive production systems.

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. MRP researchers identified and classified such areas using land use data from SG, MRPs, Forestry Commission and Centre for Ecology and Hydrology. The potential additional area was indeed substantial and 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.

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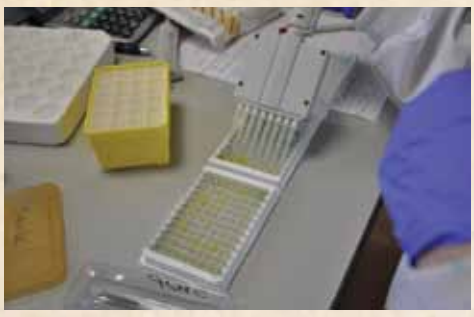
BioX Diagnostics Liver Fluke test

Liver fluke is a highly pathogenic flatworm parasite of sheep and cattle that causes significant economic losses to the Scottish livestock industry. SRP researchers are evaluating diagnostics to help tackle this important threat to the livestock industry.



Diagnosis of fluke infection in the live animal is challenging, with the few available tests having significant limitations and very poor end-user uptake. A recent development, the coproantigen ELISA (or cELISA), commercialised by BioX Diagnostics from Belgium showed significant potential in this respect. The SRP researchers set out to evaluate its performance under Scottish field/farm conditions, concluding that, though with limitations, cELISA is a useful addition to fluke testing capabilities, especially as the test was demonstrated to be liver fluke-specific. cELISA also has potential as a rapid indicator of flukicide treatment outcome. In the form of a coproantigen reduction test, cELISA can give a clear indication of outcome within 7 days of treatment, compared to the 21 days currently advocated for faecal egg counting. 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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Barbervax - a vaccine for Barbers Pole worm

Developed through long-term reserach 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 registered for use in Australia in 2014.The first batch of vaccine, consisting of 300,000 doses, was sold within 10 days just by word of mouth. Barbervax was trialled extensively in Australian Merinos over the last three summers indicating that the degree by which the vaccine reduces worm egg output and hence pasture contamination offers a level of control superior to a conventional anthelmintic.

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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 as 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 immune response 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 periparturient 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 periparturient ewe. This work has now also attracted industry-funding through sponsorship from a UK-based commercial vaccine production company.

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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 and 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

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4 Scientific excellence

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 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 and 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 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 post meal glycaemia and insulin 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 treatment in 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 continental researchers that has recommended a new framework for ensuring a coordinated, EU Wide approach to the identification and assessment of High Natural 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. High Nature Value farmlands (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 asses then vary across each Member State. As a result there is often a lack of accurate data and it is difficult to gain an EU-wide perspective on the extent and condition of HNVf.

In Scotland work by an MRP and others has helped Scottish Government establish that over 2,200 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.The 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 EU countries, including Scotland.

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5 Scientific resilience

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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NERC Resource Recovery from Wastes Programme

This project aims to produce a sustainable, environmentally-friendlier source of soil conditioner and crop fertiliser

Almost all existing fertilisers are produced using energy intensive methods and/or finite and unsustainable resources such as mined phosphate and toxic production process chemicals. This £856K, Natural Environment Research Council-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 areas have been 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 commenced in November 2013 (valued €5.36M; £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 within the consortium on exploiting potato for development of new sources of bioactives and sustainable ingredients.

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