

Environmental Change; Food, Land and People

Spotlight 2012-2013

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 2012-2013



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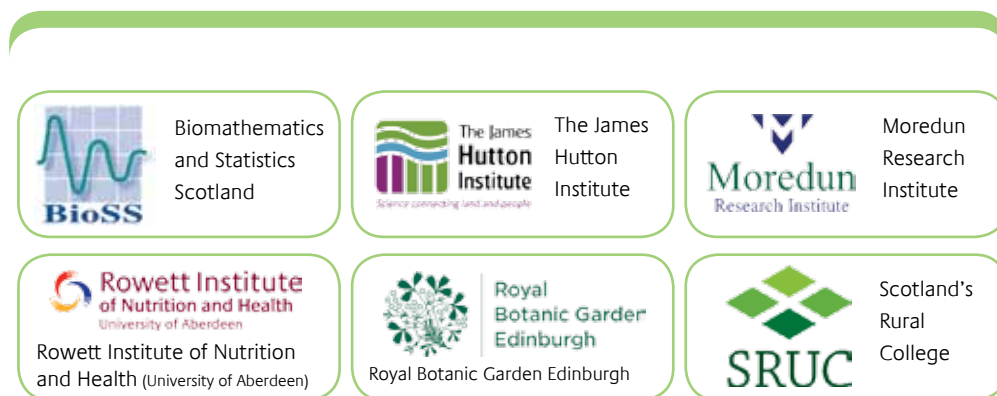
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Spotlight on the Scottish Government Strategic Research Programme

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 Programme is being delivered through collaboration between scientists 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 2012-13 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

- ▶ 136 reports and briefings for policy audiences
- ▶ 108 influences on policy through scientists' membership of advisory groups
- ▶ 34 specific examples where research outputs were of confirmed value to Scottish Government policy
- ▶ Policy output and impact at Scottish, UK, European and local government levels

1.1 BVD Eradication



Bovine viral diarrhoea (BVD) is a contagious disease of cattle occurring worldwide and many livestock farms have the disease among their highest economic and welfare concerns. Infection with the virus can lead to infertility and reproductive problems, respiratory and gut disease and in some cases fatal mucosal disease. The virus is very contagious and can be spread by persistently infected cattle that continuously excrete the virus. The Scottish Government (SG) is supporting an ambitious industry-led scheme to eradicate BVD from Scotland. Eradication is taking place in stages, with initial subsidised screening now being followed by mandatory screening. Evidence accumulated through sustained long term SG-funding of MRPs' work on BVD has informed the development of this policy. SG-funded scientists within MRPs have conducted research to help understand the epidemiology, transmission and host response to the virus and have provided socio-economic as well as scientific evidence on how the virus can be prevented and controlled.

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1.2 Water Resources (Scotland) Bill



Strategic Programme Researchers have provided detailed responses to consultation stages in the development of the Water Resources (Scotland) Bill: during the early written evidence stage; as invited oral evidence to the Infrastructure and Capital Committee at Holyrood, and in a report: 'The Value of Scotland's Water Resources'. This summarised current academic thinking and the evidence on the value of water resources. It considers the Scottish context and examines how the value of water resources might be developed. The Value of Water Resources paper resulted in a recorded motion signed by over 30 MSPs and was published in the Official Report of the Scottish Parliament. The resulting Water Resources (Scotland) Act 2013 was passed by the Scottish Parliament in February 2013, receiving Royal Assent in April 2013.

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1.3 CAP Reform

The European Union's Common Agricultural Policy (CAP) and associated agri-environment schemes provide financial support to farmers and therefore have a major influence on how Scottish farmland is used. In 2012, Scottish receipts from the CAP, at just under £600 million, were almost the same as net income from farming. This demonstrates that the majority of Scottish farmers would be generating negative farm business incomes were it not for support payments.

It is, therefore, not surprising that for the majority of Scottish farmers (as for many others across the 28 EU Member States), the forthcoming 2015 reform of the CAP is uppermost in terms of concerns about the future of their businesses. The Scottish Government recognises that a fundamental re-think is required to ensure not only that future CAP support helps Scottish farmers maintain food production but also that the support received helps achieve environmental targets, such as reducing greenhouse gas emissions, tackling diffuse pollution and halting biodiversity loss. The latter is of particular concern given that over 40% of Scotland's farmland is estimated to be under High Nature Value Farming systems of importance for maintaining a range of habitats and species of high Scottish and European nature conservation importance.

Programme researchers have continued to contribute to the development of future CAP policy in partnership with colleagues in Scottish Government. Most effort has been devoted to developing and assessing regionalisation options for the Single Farm Payment Scheme but has also contributed to Scottish Government working groups developing the next Scottish Rural Development Programme. In particular, researchers are contributing to working groups assessing how and where best to target agri-environment measures to address biodiversity, climate change and water quality concerns.

The Scottish farming industry will need to evolve with the changing climate while also protecting ecosystems and biodiversity. Addressing environmental concerns is therefore an essential investment to ensure future sustainable food production. Although the detail of the reformed CAP is not yet finalised, programme researchers are working closely with Scottish Government to help inform decision making by policy makers and land use decisions by the farming industry.




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1.4 Dairy Sector Development

The Strategic Research Programme has made significant input into understanding and developing the competitiveness of Scotland's dairy sector, providing targeted and requested information relevant for policy and practice and developing innovative approaches to dairy production and management. A key report, produced for James Withers (Scotland Food and Drink for the Scottish Dairy Sector Review consultation), provided technical, cost efficiency and enterprise performance analysis for the sector. The report also considered UK consumer trend and demand elasticities for specific dairy products. With growing public and industry concern over the milk price received by dairy farmers during 2012,



researchers, in response to a request by the UK Department of Environment, Food & Rural Affairs and Scottish Government policy analysts, briefed on the impact of the liquid-milk price to the structure and competitiveness of dairy production. Research has also contributed to the sector's efficiency through involvement in the implementation of genomic estimated breeding values within the UK industry.


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1.5 Scientific Advisory Committee on Nutrition (SACN)

Published research has highlighted the importance of sunlight in determining vitamin D status in pregnancy, even in the north of Scotland (P. Haggarty *et al.* Br J Nutr (2013), 109, 898-905). The Scottish Government Public Health Directorates asked that this research be included in the Scientific Advisory Committee on Nutrition (SACN) review of the dietary reference value (DRV) for vitamin D.



Researchers funded by the Scottish Government RESAS programme also make a significant contribution to the work of SACN and its subgroups including: contributing to position statements and papers on selenium and iodine, provision of advice on the regulations for bread fortification and recommendations on methods for riboflavin measurement, and sitting on the Advisory Committee on Novel Foods and Processes.

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2 Economic growth and innovation

- ▶ £9.9 million external income secured to support industry-relevant research
- ▶ 92 publications for industry and trade audiences
- ▶ 75 consultancies with industry in a wide range of areas: including livestock vaccine development, natural product analysis in primary produce and food products, soil analysis tools, assessing influences on strategies for phosphorus uptake by crops
- ▶ Production of tools for the livestock and arable industries to improve animal breeding, farm welfare and control disease
- ▶ Development of new and improved varieties of soft fruit, potato and barley
- ▶ Supporting innovation for small businesses within food production and processing

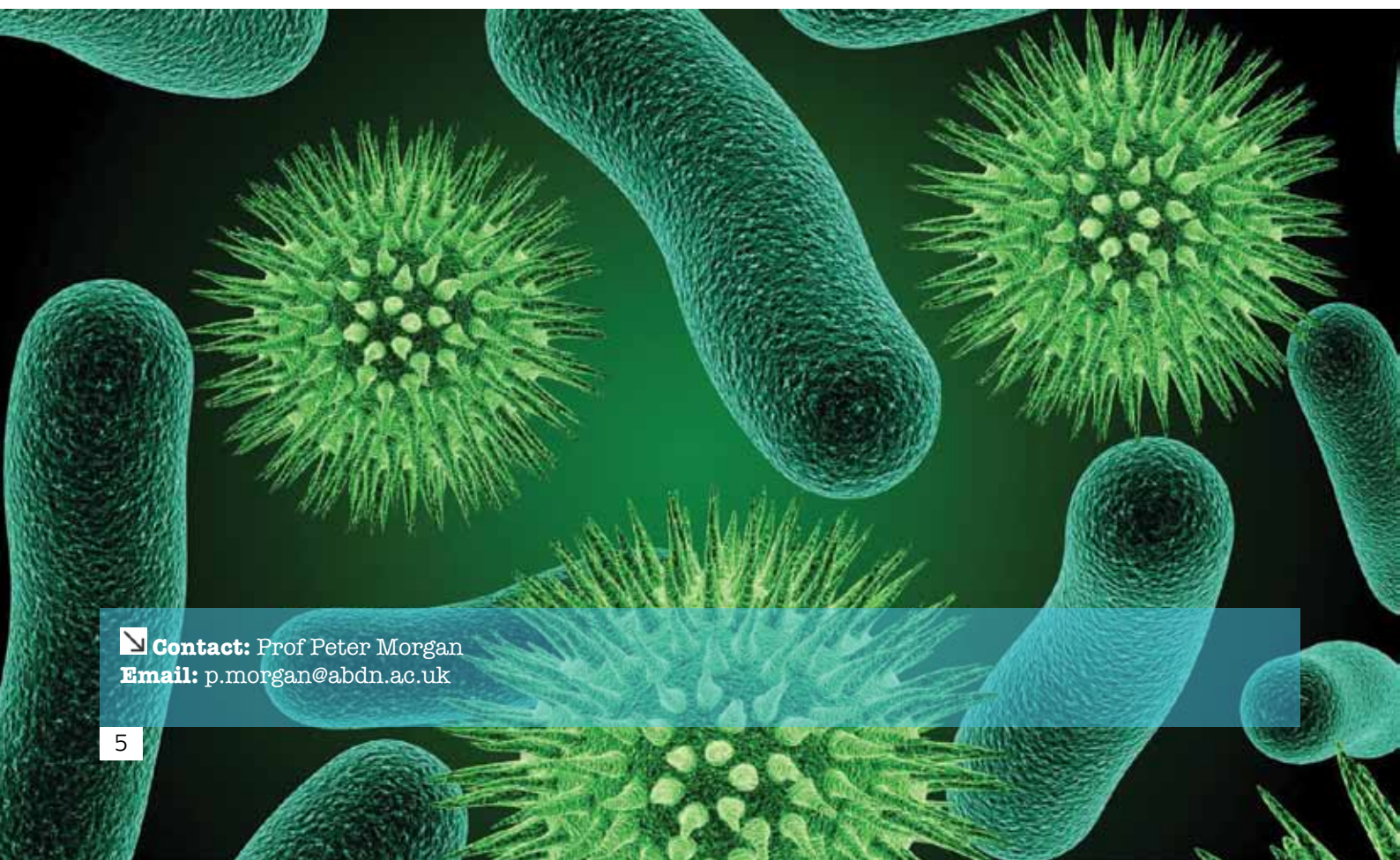
2.1 GT Biologics Limited - Gut Immunology

GT Biologics Ltd is a spin-out company based on outputs from research into gut immunology funded in the previous Strategic Programme. The company has secured significant multi-million pound funding from Aquarius Equity Partners which will allow it to

develop and commercialise an oral-based probiotic product for the treatment of mild to moderate Crohn's disease and ulcerative colitis, and a novel family of protein/peptide therapeutics for the treatment of moderate to severe inflammatory bowel diseases.

These novel compounds have been derived from bacteria that naturally colonise the gut of healthy individuals and have been demonstrated to exhibit potent anti-infectious and anti-inflammatory properties.

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2.2 Future-proofing the Blackcurrant Industry

The effects of a changing and less predictable climate are starting to pose serious challenges for growers and producers within the horticultural supply chain. For many woody crop species, where a specific level of winter chilling is usually required during dormancy, the inconsistent levels of chilling experienced in recent winters has led to variations in crop performance in the subsequent growing season. In blackcurrant these effects have already been seen by some UK growers and juice processors and so SG-funded researchers have been selecting future varieties based on their ability to crop at a high level across a range of winter conditions. Understanding the response of woody plants, including blackcurrant, to warmer winter conditions is the subject of ongoing research within the Strategic Programme. Various long-term strategies are being developed to ensure that the future blackcurrant industry has access to varieties that are resilient to emerging climate patterns.

As a first step in this process, a new blackcurrant variety from the breeding programme has been approved for release by commercial sponsors, LR Suntory. The release, provisionally named 'Ben Lawers', is the latest in a series of varieties that underpin the UK industry, and has a fairly low chilling requirement, thereby making it better adapted to warmer winter conditions. Additionally, 'Ben Lawers' has excellent fruit quality, in terms of phytochemical content and flavour-related properties. Although more work is required to fully understand the chilling process, it represents the future direction of blackcurrant breeding, where environmental factors are among the main objectives of the programme. Winter chilling aspects are also under consideration in the wider context of other woody crop and landscape species.

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2.3 ArxBio to Exploit Platform Technology for Bacterial Vaccines

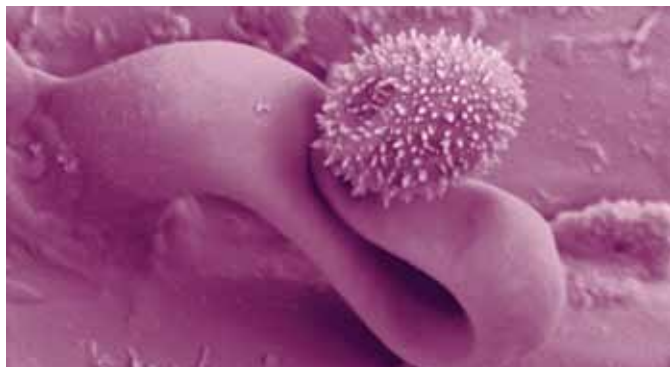
A new company, ArxBio has been established to exploit an innovative vaccine platform technology developed by scientists at an MRP, targeting important bacterial diseases of livestock. The animal health market is a global multi-million dollar industry and this new technology is well placed to make a strong impact to generate novel products to prevent and control animal disease. ArxBio and the research scientists involved from the MRP won the prestigious 2012 Heriot-Watt Converge Challenge and the 2012 Converge European Open Innovation competition. The novel technology seeks to improve the immunogenicity of vaccine preparations thus improving their efficacy to protect against infectious pathogens.

ArxBio is seeking to tap into a market that requires innovative solutions to tackle the significant impact of infectious diseases on livestock production. Using its patent-pending platform technology, ArxBio intends to implement a vaccine development pipeline which is being used to create vaccine products for a number of specific applications; initially against two distinct bacterial diseases of sheep and pigs, with plans to further extend the product pipeline to other veterinary applications and also to human use. It is expected that ArxBio's lead product for sheep will be submitted for regulatory appraisal within 18 months.

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2.4 Protecting Scottish Crops from a Growing Disease Threat

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Ramularia leaf spot (RLS) – a fungal disease that affects barley throughout the world – first emerged in the 1990s. Strategic Programme scientists have studied the biology and epidemiology of this pathogen over many years and developed crop protection programmes to reduce its prevalence. The researchers also developed a risk warning system which is now published at critical points in the year to warn growers of the need to treat crops.

In the UK, economic losses due to RLS have been estimated at £38 million per annum. With good quality barley production vital to the growing Scottish brewing and distilling industry, Ramularia was tackled first by industry and then through programme-funded research. Researchers developed a diagnostic test which detected the disease in leaves two to four weeks before symptoms appeared and proved it was present in the seed. Both findings helped immensely in developing protection measures.

Later research produced a forecasting scheme which is publicised through Crop Protection Reports, open days and events. The scheme offers farmers the option of adjusting fungicide programmes if they are located in a high risk region.

Scottish Government-funded research has therefore taken the disease full circle - from industry, into science programmes and then back out to industry. Research into Ramularia has now moved on with scientists studying how best to control the disease in the face of a changing climate.



2.5 Industry-based Surveillance Schemes

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An MRP has established and subsequently provided technical support for industry-based endemic disease surveillance schemes, mainly British Pig Health Scheme (BPHS funded by BPEX) and Wholesome Pigs Scotland (WPS funded by QMS). Disease estimates are provided through trained operators on the killing lines using advanced IT methods.

The scientists provide participating pig farmers (for BPHS and WPS) with disease prevalence estimates derived from quarterly abattoir screenings of slaughter weight pigs. In Scotland the majority of producers are involved and results are summarised to provide benchmarks used by pig veterinarians to motivate/drive health improvements.

3 Collaboration and multidisciplinary working

- ▶ Over 70% of peer-reviewed publications co-authored with non-programme scientists
- ▶ Cross-MRP collaboration and interlinking of natural and social science disciplines
- ▶ Active collaboration with other non-programme research institutions and with the agriculture and agri-food sectors

3.1 Welfare Indicators for Sheep

Society is increasingly expressing concern about animal welfare and a desire to know more about the conditions under which food is produced. In response, programme scientists have been working on establishing methods of assessing welfare on farm, in transit and at slaughter.

A €4.5 million programme - AWIN (an EC funded, international project led by an MRP: www.animal-welfare-indicators.net) - has been funded to allow the development of animal welfare assessment protocols for a number of species.

Strategic Programme researchers are working together to develop novel methods to assess the welfare of sheep and to validate how good these methods are at identifying welfare problems when animals are unwell. The collaboration combines immunological and disease expertise with behavioural and physiological science to develop new tests to assess proteins called cytokines in ovine blood samples. Cytokines act as biomarkers for inflammation and may be a useful addition to the animal welfare assessment toolbox.

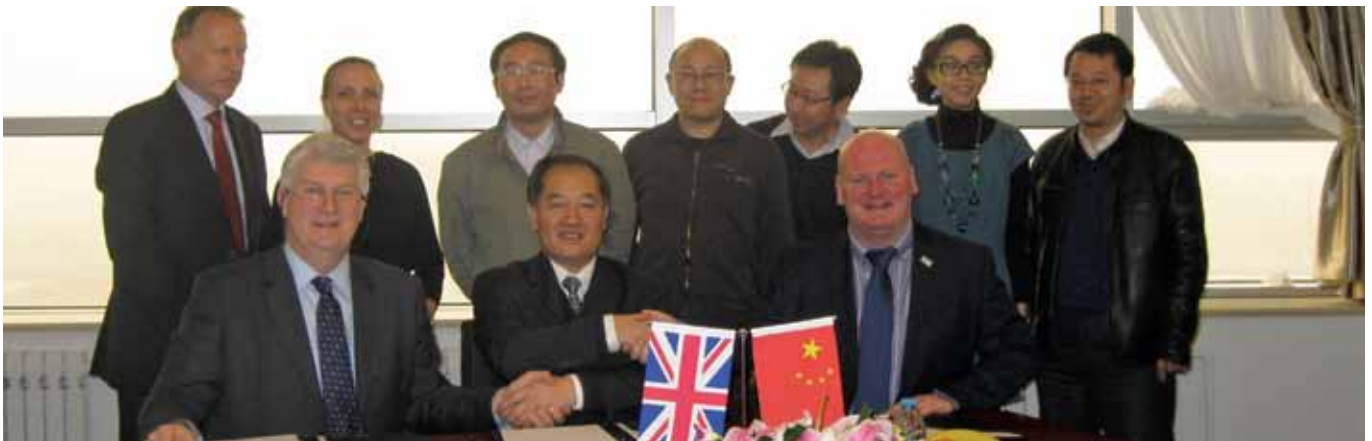
In addition, the sharing of knowledge about disease conditions achieved through this collaboration has allowed the welfare indicators to be tested in controlled disease conditions. This is to ensure they are valid measures of the welfare impact of disease in sheep. Using the research currently conducted on sheep scab, welfare indicators and biomarkers are measured in sheep before infestation, during a sheep scab outbreak and following treatment. This data will allow greater insight into the impact on the sheep of this unpleasant condition and will help to support the further development of welfare indicators.



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3.2 China Collaboration to Address Food, Water and Energy Security

An MRP and the Centre for Ecology and Hydrology, the Chinese Academy of Sciences and China Agricultural University have formed a new Centre-Centre research collaboration developed to tackle some of the global challenges of food, water and energy security. This will provide knowledge and understanding to support long-term economic growth along with environmental protection. Initially, this collaboration will target research on the remediation and recovery of polluted environments, water and food security and watershed management, soil contamination, and the development of eco-toxicology tools for environmental monitoring.



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3.3 Understanding Food Choices of Vulnerable Young People

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This project is studying the food choices of vulnerable young people in Scotland (including those at risk of becoming homeless and/or who are unemployed, or in very low income occupations). These groups are at risk of making poor food choices which may compromise their present and future physical and mental health and well-being. Cross-disciplinary input is provided by public




health and nutrition scientists, together with education and community development expertise and the social sciences. The research is undertaken in collaboration with 'The Foyer', a charitable organisation and social enterprise company in Aberdeen. 'The Foyer' is an essential partner in this study as it will facilitate extensive access to this otherwise hard-to-reach group of young people.

4 Scientific excellence

- ▶ 645 peer-reviewed publications
- ▶ New scientific discoveries that significantly advance their field, with applications across the environment, the food chain and including examples relevant to human health benefit

4.1 A Major Breakthrough in Cereal Genomics

An international consortium of scientists has published a high resolution draft of the barley genome. The research, published in the high impact journal Nature, will help to produce new and better barley varieties that are vital for the beer and whisky industries. The UK team behind the research was led by a Strategic Programme investigator. Barley is the second most important crop in UK agriculture and malting barley underpins brewing and pub industries worth some £20 billion to the UK economy. The breakthrough is a critical step towards barley varieties able to cope with the demands of climate change. It should also help in the fight against cereal crop diseases that cause millions of pounds of losses annually.



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4.2 Host Systemic Inflammatory Response to Sheep Scab Mites

Sheep scab is a widespread problem in the UK, characterised by a yellow scab on the skin surface, accompanied by restlessness, scratching, wool-loss, bleeding wounds and loss of condition. In particular, the disease appears to cause considerable distress, irritation and/or pain to the sheep and is, therefore, of major welfare concern. Current disease control strategies are heavily reliant upon chemotherapy; however concerns over residues, eco-toxicity and the development of parasite resistance have led to questions being raised regarding the sustainability of current strategies and an interest in the development of alternatives. Mite survival is dependent on the successful initiation of the lesion, indicating that the mites may prompt


the host inflammatory response for their own benefit, i.e. production of a food source and a suitable microclimate. Programme Scientists are working to identify the key host factors involved in the development of the sheep scab lesion which are critical for the establishment of the mite. Recent studies looking at the transcriptome of circulating sheep leucocytes during a mite infestation have revealed distinct local and systemic host responses. This approach is being combined with efforts to characterise the mite factors responsible for instigating the lesion in order to identify potential vaccine and diagnostic candidates, and further studies will evaluate whether these can be used in a vaccine strategy to control sheep scab.

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4.3 Maternal BMI, Placental Weight and Pregnancy Outcome

Both underweight and obese women are at risk of complications during pregnancy that can impact mother and baby. A retrospective cohort study investigated the role of the placenta in mediating these complications. Placental weight increased with increasing body mass index (BMI). Having a small placenta was a risk factor for pre-eclampsia, premature delivery, stillbirth and low birthweight, while having a large placenta predicted a greater risk of caesarean section and high birthweight. It is recommended that mid-gestation placental screening by ultrasound may help early identification and appropriate management of those at risk.

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5 Scientific resilience

- ▶ £18.4m of additional research funding from external funders (and further to the income secured for industry-relevant research)
- ▶ SG-funded scientists provide training for over 450 postgraduate (PhD and MSc) students within the Main Research Providers

5.1 Evaluation of Environmental Impacts of Rural Development Programmes in the EU

The EU collaborative project, ENVIEVAL, will develop and integrate advanced evaluation tools into new methodological frameworks for the evaluation of environmental impacts of rural development programmes at micro- and macro-levels, and produce a methodological handbook for the evaluation of environmental impacts of rural development programmes. The project is funded under the EU Knowledge-Based Bio-Economy (KBBE), and is led by an MRP with six other partners, coordinated by Johann Heinrich von Thunen Institute, Germany. This project runs from 2013-2106. The total value (obtained from EU) is €1.74 million with a value to the MRP of €309,000.

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5.2 Aquavalens

A €8.5 million EU-funded research project to improve the safety of European drinking water has just been launched and involves scientists working across the Strategic Programme from two MRPs. Scientists, engineers, policy makers and public health practitioners from 39 organisations in 13 countries across Europe are involved in the project which aims to develop rapid methods to diagnose pathogens such as *Cryptosporidium*, *Toxoplasma gondii*, *Campylobacter* and *E. coli* in water supplies and for the food industry. Around 330,000 cases of water-related diseases are reported yearly in Europe according to the World Health Organization. Globally, diarrhoea accounts for 10.5% of the 8 million deaths of children under 5 and the protozoan parasite *Cryptosporidium* is one of the major pathogens involved in causing diarrhoeal illness.

Cryptosporidium parasites are particularly problematic to control as the oocyst stage of the parasite can persist in the environment for 12 -18 months and is resistant to normal water disinfection treatments such as chlorine. The Aquavalens project seeks to develop suitable platforms that harness the advances in new molecular techniques to enable the rapid detection of water-borne pathogens that is appropriate for both large and small systems throughout Europe. The value of the project to MRPs is €205,825. Links with national and international government agencies such as the European Commission and the World Health Organization will ensure that the project's findings will influence European policy.

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