scri
living technology

SCRI GROUP SCIENCE and OPERATIONAL STRATEGY
2006 – 2011

Director's Introduction

Peter Gregory

Chief Executive

The SCRI Group includes SCRI, Mylnefield Research Services (MRS) Ltd and Biomathematics and Statistics Scotland (BioSS) and is located on a 172 hectare site at Invergowrie, Dundee. The University of Dundee Plant Research Unit is also located at Invergowrie. BioSS operates across multiple sites.

As Scotland's leading institute for research on plants and their interactions with the environment, particularly in managed ecosystems, SCRI's research forms a bridge between rural production and urban wellbeing. We have an excellent track record of delivering innovative knowledge, products and services that enrich the UK economy and promote sustainability and healthy food. SCRI intends to maintain its position as a key source of science-based evidence for policy makers and will continue to focus its research activities on practices in crop-based agriculture, developing new crop products and sustainable land management to address evolving societal requirements.

This Science Strategy clearly sets out our research aims and objectives over the next five year period, 2006 – 2011, in response to the expectations of our diverse stakeholders and funders. I commend the plan to you and, should you require further information about SCRI, I invite you to visit our website www.scri.ac.uk.

SCRI GROUP SCIENCE and OPERATIONAL STRATEGY 2006 – 2011

SCRI Group Strategic and Operational Plan 2006-2011

SCRI Mission and Vision

We are Scotland's leading institute for research on plants and their interactions with the environment, particularly in managed ecosystems. Our research and products are internationally recognised.

Our mission is to conduct excellent research in plant and environmental sciences.

Our vision is to deliver innovative products, knowledge and services that enrich the life of the community and address the public goods of sustainability and high quality and healthy food.

We will achieve our vision by developing a culture that promotes and supports scientific curiosity and celebrates the contribution of all staff and students.

High-level Aims

In the context of our mission to conduct excellent research in plant and environmental sciences, we aim to:

- Identify potential customers for our research and focus on and strengthen areas of established and emerging research excellence for which there are realistic opportunities to receive funding
- Work with universities, business and other institutions to develop partnerships that allow SCRI to become the acknowledged centre for plant and environment based research in Scotland
- Redirect our resources to achieve these ends
- Provide a stimulating, challenging and exciting atmosphere in which to undertake plant and environmental science

SCRI Strategic Drivers

Over the period of this plan, significant changes will occur in both the managerial relationship between the Institute and its principal customer, SEERAD, and the research portfolio supported by SEERAD and other customers. From 1 April 2006, the previous system of a block grant to the Institute from SEERAD was replaced by a contract for commissioned research in support of policy objectives and, over the course of this plan, more responsibility for the long-term sustainability of the Institute will pass to the Governing Body. Throughout Europe, there is a move away from rewarding landholders for the production that they achieve towards rewards for stewardship of the land for multiple purposes including tourism, wildlife, biodiversity, and landscape in addition to the need to grow nutritious and healthy products. This change in policy towards sustainable land management for multiple purposes is reflected in the changing funding priorities of many research funders, and will inevitably affect the direction of the Institute's research. The Institute's current research strengths in plant genetics and genomics, plant/pathogen interactions and plant/environment interactions will evolve to meet the challenges of the societal and policy concerns of sustainable land management, healthy and nutritious foods, plant products for non-food industries, biodiversity, and climate and other environmental changes.

The international drive for bio-based economies gives SCRI a major role in the development of the knowledge-based economy of Scotland. The Institute's geographical location in close proximity to the expanding life science businesses and research base of the City of Dundee provides an internationally recognised basis for developments in agbiotech and related businesses.

Over the last 10 – 15 years, there has been a move among research funders to encourage cross-disciplinary approaches to tackling problems and to encourage cross-institutional approaches to research. Funding has shifted significantly away from the "lone scholar" approach towards larger consortium studies with multiple partners. This is evident in research council funding, LINK schemes and in contracts awarded by government departments. The previous funding regime offered by SEERAD may have made these types of connections less important in the past, but over the period of this plan, SCRI will need to ensure that its scientists forge appropriate links with others elsewhere, so that they become preferred partners in future consortium bids. This trend, together with the perceived lack of critical mass in many of the individual institutions comprising the Scottish science base, will also require SCRI to re-examine the synergies that are possible with other research providers and to evaluate the optimal means of exploiting them. This may involve strategic and opportunistic association, pooling or merger.

The financial sustainability of the UK science base is an issue that has attracted considerable attention over the last 5 – 8 years, and the move towards calculating the full economic cost of research will undoubtedly affect SCRI during this planning period. Investment in the SCRI estate will be required if it is to be an establishment fit for modern research purposes rather than a historical legacy of a crop research station, as will investment in the resources needed for systems approaches to sustainable land use. Again, partnerships with other institutions and with land owners will be needed to ensure the cost-effective provision of such facilities. With the greater transparency of costing and the accompanying demands for value for money, SCRI will need to ensure that its administrative costs are competitive and to actively seek opportunities to gain economies of scale.

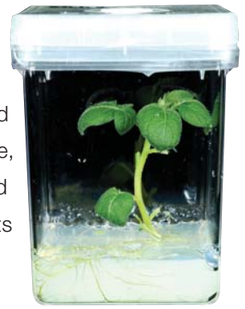
A considerable strength of SCRI relative to many other research providers is that it has a "pipeline" of technology transfer that ensures that research innovation and intellectual property is translated into commercial products. The ongoing vertical integration of the food chain and the changing terms of trade that favour retailers and processors over producers mean that the focus of SCRI's technology transfer efforts (via Mylnefield Research Services Ltd) will continue to be through contracts with industrial partners that facilitate the development of commercial products from SCRI research, rather than with individual producers. Over the course of this plan, greater priority will need to be given to developing new partnerships with businesses beyond SCRI's traditional strengths in the food chain.

In response to these drivers, SCRI has set four high-level strategic aims for the planning period. These aims have been broken down into a series of objectives, which are detailed below together with plans for their implementation.

Science Achievements 2001-2005

- The entire Commonwealth Potato Collection has been genetically fingerprinted with molecular markers. The resulting data is providing a major insight into the evolution of cultivated potato and its wild relatives and guiding exploitation of genetic diversity in several areas of the work programme.

- Single Nucleotide Polymorphisms (SNPs) are the most common form of variation in plant and animal genomes. We have discovered and genetically located a comprehensive set of SNPs in cultivated barley, allowing development of the most advanced gene map of a small grain temperate cereal. The gene map is providing insight into the comparative relationship between barley and related cereals, especially with rice, and is currently being used in applied research projects worth over $8M in the UK and USA.



- The nucleolus is a sensor of cellular stress, regulates the cell cycle, and in plants is involved in small RNA production and the infection cycle of some plant viruses. We have completed an extensive proteomic analysis of the nucleolus in plants, identifying 217 different proteins. We identified significant compositional difference compared to the mammalian nucleolar proteome, suggesting important and potentially unique functions in plant gene expression control. This proteomic analysis provides a unique and novel basis for investigating sensors of plant stress responses at the molecular and cellular level.

- We have proposed a novel concept of the structural organisation of filamentous plant viruses. Using atomic force microscopy and immunogold labelling techniques we have discovered a novel and unusual structure at one end of the particles of filamentous viruses such as closteroviruses and potato potyviruses. Such structures are associated with the 5'-end of RNA and play key roles in different virus-encoded functions such as directional intercellular virus transport, virus assembly/disassembly and vector transmission.

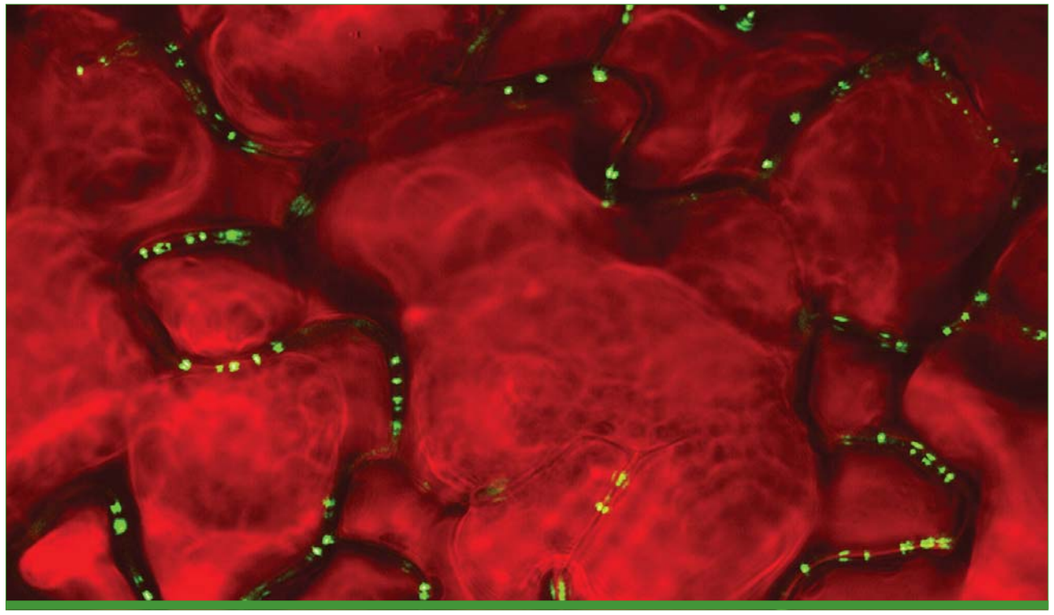
- As part of an international collaboration, scientists at SCRI have isolated the first avirulence gene, *Avr3a*, from the late blight pathogen, *Phytophthora infestans,* which encodes a protein that is recognised by the potato resistance protein R3a. This presents the first opportunity to study gene-for-gene recognition and resistance mechanisms in the late blight pathosystem. Studies of allelic diversity in *Avr3a* are stimulating the development of novel disease resistance strategies.

- We successfully implemented virus-induced gene silencing (VIGS) in barley for the functional characterisation of genes required for *Mla13*-mediated resistance towards the biotrophic barley pathogen *Blumeria graminis* f. sp. *hordei*. BSMV-VIGS-based functional characterisation of *Rar1*, *Sgt1* and *Hsp90* was demonstrated in the *Mla13*-mediated resistance towards powdery mildew. BSMV-induced gene silencing of these candidate genes proved to be robust, and systemic, and could be detected at both mRNA and protein levels.

- In partnership with the Sanger Centre, we sequenced and annotated the complete genome of the potato pathogen *Erwinia carotovora* subsp. *atroseptica (Eca).* This was the first bacterial pathogen to be sequenced in the UK. *Eca* is a close relative of human pathogens such as *Escherichia coli, Salmonella, Shigella* and *Yersinia*. Novel software for comparative genomics developed at SCRI has been used to identify components of the *Eca* genome that: are required for pathogenicity; contribute to alternative lifestyles on hosts other than potato; allow *Eca* to fix nitrogen; and distinguish this plant pathogen from its animal-pathogenic relatives.

- The search for major determinants of potato flavour has yielded novel data on new sesquiterpenes in the headspace of cooked potato. Moreover, metabolite profiling has also revealed that levels of specific amino acids are associated with the enhanced flavour of *S. phureja* tubers compared with *S. tuberosum.* The increased levels of the branched amino acids and methionine in phureja raw material is pertinent since these are precursors of methional and branched aldehydes, alcohols and esters, thought to be key contributors to the characteristic aroma of cooked potato via thermally-induced reactions such as the Strecker degradation.

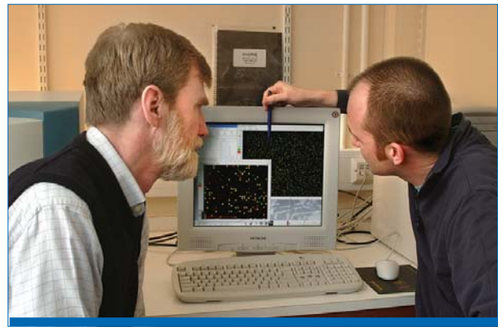
- In collaboration with scientists in the USA, we have downregulated specific steroidal glucosyl transferases (SGTs) in potato tubers with the aim of minimising the synthesis of potentially toxic glycoalkaloids. One gene knockout severely reduces solanine content but induces an almost stoichiometric increase in chaconine. Downregulating a related, but different, SGT impairs the synthesis of both major glycoalkaloids. This approach shows promise in reducing the levels of antinutritional compounds which can also contribute to environmental problems (e.g. presence of glycoalkaloid toxins in waste from potato processing plants). The transgenics also provide the tools to investigate the role of glycoalkaloids in pest and disease resistance.



- Collaborative studies into atherosclerosis with the University of Glasgow, employing model arterial systems, have shown that a phenol-rich, vitamin C-free, raspberry extract exerted a significant ability to scavenge superoxide (0_2), a major destructive chemical *in vivo*. Additionally, raspberry phytochemicals exhibited beneficial effects with respect to nitric oxide bioavailability, a compound associated with beneficial blood vessel relaxation and vascular tone regulation.

- SCRI played a major role in the farm-scale evaluation for winter oilseed rape, as part of a consortium with CEH and Rothamsted Research. The work showed that GM herbicide tolerant winter rape gave no advantage to energy interception by the crop, yet reduced surface- and above-ground food webs and would increase the grass weed problem later in the rotation by selectively targeting broadleaf weeds. The results influenced government policy on the adoption of GM herbicide tolerant winter rape.

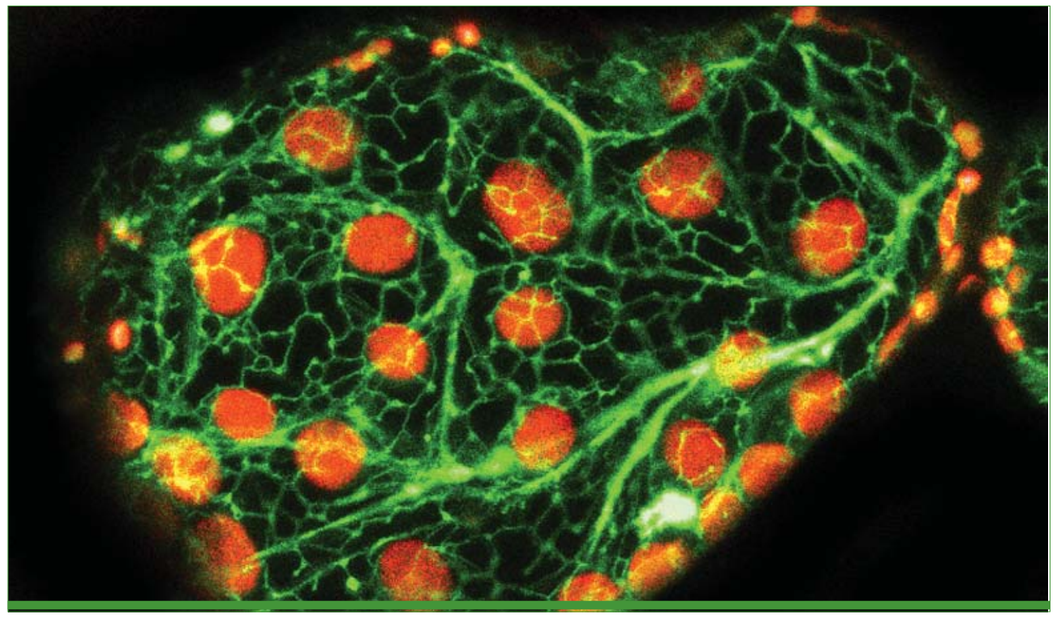
- Dynamics of key soil functional groups have been investigated using novel combinations of functional and molecular methods. Contrary to conventional wisdom, it was shown for the first time that the nitrifying community in soils is dominated by *Nitrosospira* sp. rather than *Nitrosomonas* sp., and that they are present at several orders of magnitude greater than previously thought. Linkage between denitrifying bacterial diversity and plant species has been demonstrated, indicating that niches supplied by plants are variable and affect bacterial community structure. This work clearly supports the premise



that these groups are good indicators for the effects of agronomic practices on soil ecosystem dynamics and resilience.

- BioSS, in collaboration with SCRI, developed new statistical methods for the analysis of DNA multiple sequence alignments and incorporated these along with a sophisticated user interface into a single program, TOPALi. This program, freely available from the BioSS web site and already cited in several high quality papers, has made it possible for biologists to access state-of-the-art methods for detecting recombinant sequences and producing fast approximate phylogenetic analyses of very large numbers of sequences.

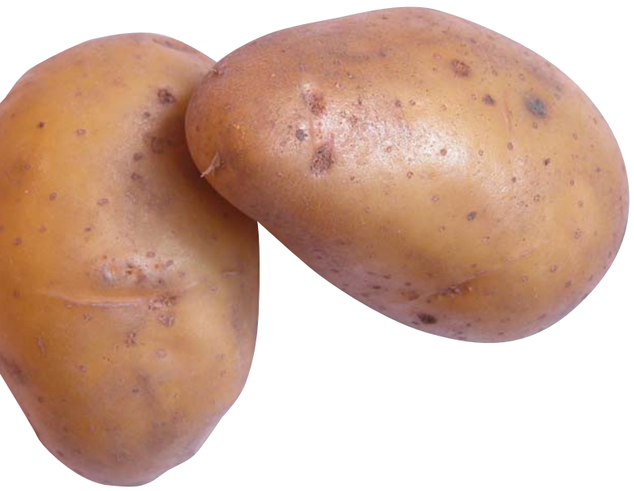
- BioSS and SCRI collaborated to develop and establish statistical methods for linkage mapping in autotetraploid species such as potato. QTL interval mapping theory has also been developed. These methods have been implemented in a Windows based program, Tetraploidmap, available from the BioSS website.



Examples of Outputs Bringing Practical Benefits

- A range of molecular markers has been developed that are being used for marker assisted selection of important barley breeding targets by commercial breeders across the EU. A marker for Barley Yellow Mosaic Virus Resistance is now being used by Crop Evaluation Limited (CEL) to identify winter barley lines for promotion to recommended list trials and an Epiheterodendrin (EPH) marker has been instrumental in the policy decision by the Scotch Whisky Association to use non-EPH-producing lines in future.

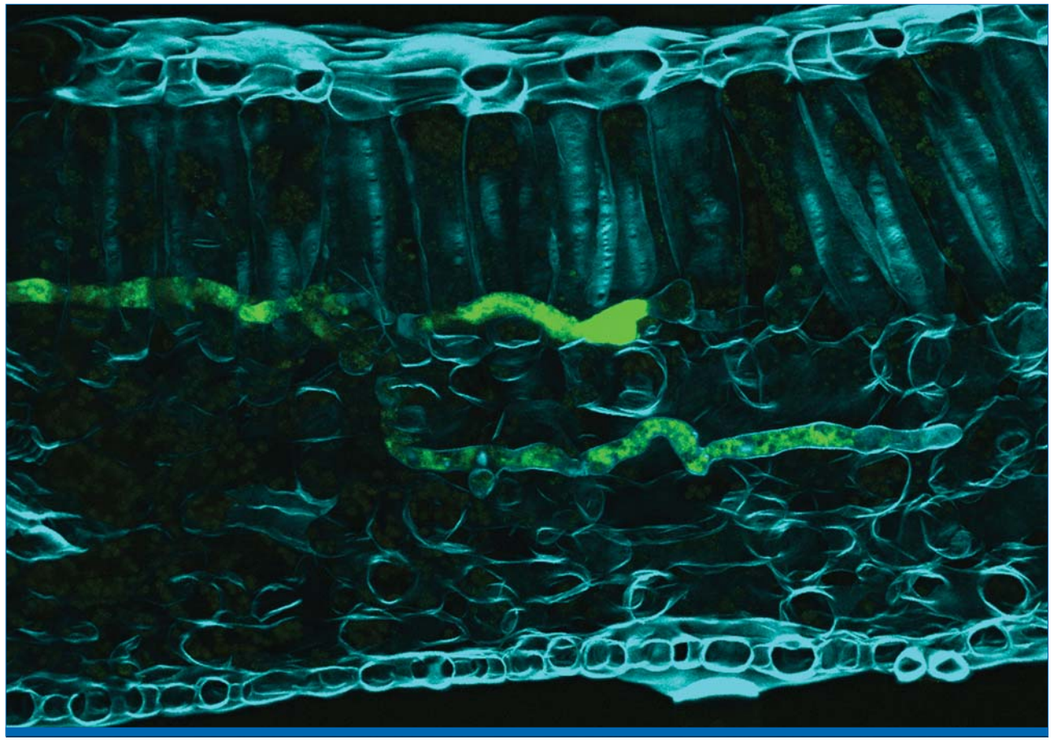
- Genome-wide, high throughput genotyping arrays for barley are being used in collaboration with all UK barley breeders, and a novel DNA marker system for characterising biodiverse germplasm collections and genetic variation in natural plant species has been developed and used in conservation studies with the Royal Botanic Garden Edinburgh, the Macaulay Institute and Scottish Natural Heritage.



- Since 2001 nine varieties of potato, five varieties of blackcurrant, one variety of blackberry and one variety of kale were granted plant variety rights and successfully commercialised. The blackcurrant varieties are all licensed to GlaxoSmithKline and, together with some older SCRI varieties, account for an estimated 50% of the global blackcurrant crop. The potato varieties include Lady Balfour, the number one organic variety in the UK, and Mayan Gold, the first phureja variety to be commercialised in the UK and recently introduced to Tesco and Sainsburys; both are licensed to Greenvale AP, the UK's largest supplier of fresh potatoes.

- Studies of the novel plant functional analogue of animal caspases, the main elements of programmed cell death, have led to the development of a new platform technology of genetic transformation that allows *Agrobacterium*-mediated gene transfer to a virtually unlimited range of recipient species including animal cells.

- Five hundred copies of the potato cyst nematode (PCN) management model developed at SCRI were released by the British Potato Council to growers and agronomists. The management model allows users to understand the principles governing yield loss and nematode population dynamics. By altering potato cultivar characteristics and cultural practices such as rotation, nematicide treatment etc., future trends in both yields and PCN population levels can be explored.



- Research on regional geneflow and persistence was used by several high-level governmental commissions in the UK (including Scotland), Denmark, Sweden and France in their deliberations on GM policy and co-existence, and had a major impact on GM policy in Belgium. This research is now Europe-wide. A large international consortium, funded by the EU and coordinated by SCRI, is quantifying all potential sources of gene-flow and persistence.

- Collaborative research with the Universities of Dundee (Divisions of Civil Engineering and Applied Computing) and Cambridge (Plant Science Department) has developed new methods for quantifying the mechanical interactions between roots and the soil at micro- and macro-scales, and genetic factors controlling cellular growth in roots at the micro-scale. The results are being used to inform management policies for the maintenance of vegetation and slope stabilisation along transport corridors, and to develop generic tools for image tracking in biology.

Science Drivers

SCRI is committed to conducting excellent research in plant and environmental sciences. We shall integrate our strategic plant science, much of which is underpinned by the exploitation of genetic biodiversity, with environmental science to deliver innovative knowledge, products and services of value to government, business and the public. The past emphasis on crop improvement as the practical embodiment of SCRI's efforts will be complemented by more emphasis on other plant-based products and on outputs leading to sustainable land and resource management.

Intensification of land use has been a dominant global driver of land use practices in recent decades and, while parts of Europe may be less intensively managed for food production in the future (though intensively managed for other purposes e.g. recreation, non-food crops), there is a clear need for new technologies to sustain intensive use with more efficient use of inputs. Agricultural biotechnologies that integrate better crop improvement with management will be a major source of new ideas to improve the efficiency of land use while providing economic sustainability for land owners.

Two important drivers affect the direction of scientific research at SCRI. The first is that our largest customers require that our research should make clear contributions to economic well-being (e.g. a Smart, Successful Scotland), quality of life and implementation of policy objectives in both the public and business sectors. The second driver, implicit in most research contracts but explicit in the case of research supported by Research Councils, is that of excellence; namely that the outcomes of our research should have impact on, and be recognised by, the global scientific community. These twin drivers are important to SCRI's employees and our customers, and are key determinants of SCRI's research activities; they ensure a dynamic equilibrium between problem/project orientation on the one hand and science/hypothesis drive on the other. SCRI recognises that innovation and originality in all its activities is essential for scientific excellence and for opening up opportunities for product development and exploitation.

Research funders are increasingly looking for the integration of biophysical research with that of social scientists, so that issues of economic well-being and quality of life can be more directly addressed. SCRI will establish appropriate partnerships to enable such research.

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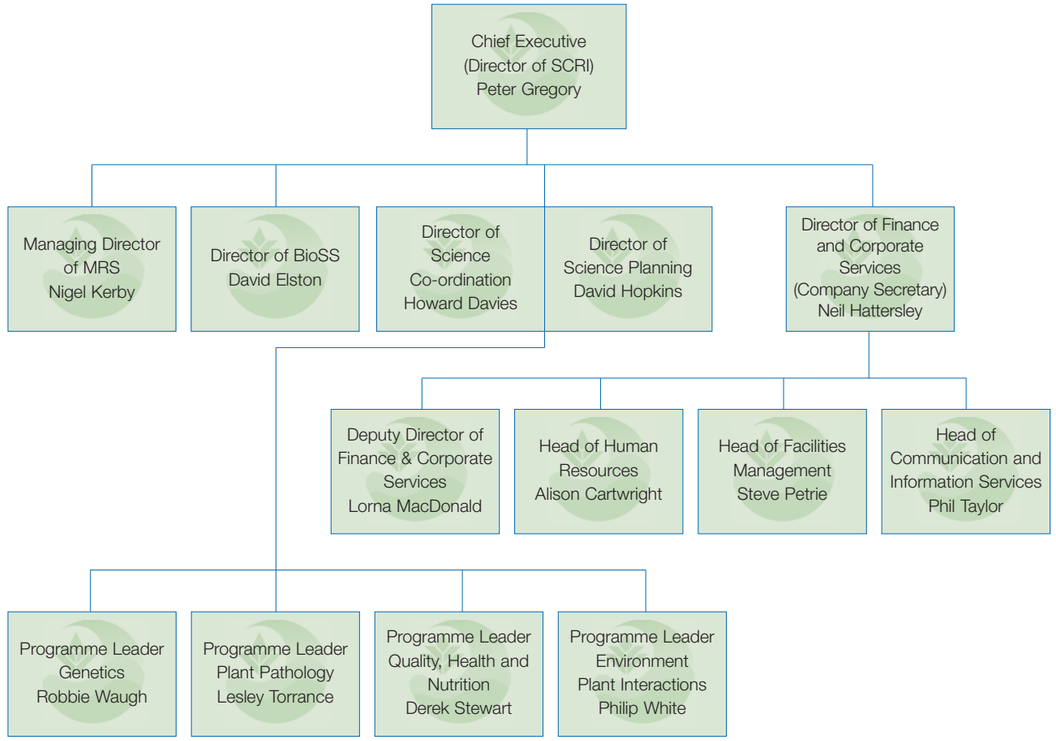
Management of the SCRI Group



Science at SCRI is conducted through four science programmes with specific research contracts (such as the SEERAD workpackages) delivered by appropriate groups of scientists from across different programmes. Cross-programme working is expected to increase during the planning period as the funding of multi-disciplinary and inter-disciplinary research increases. In addition to the four science programmes located at Dundee, BioSS operates as a multi-site programme providing statistical consultancy and research. Additionally, there is close collaboration with the University of Dundee Plant Research Unit (part of the Division of Environmental and Applied Biology at the School of Life Sciences in the University of Dundee) who are co-located and contribute to several of the science programmes through joint research initiatives and student supervision.

Within each science programme scientists are grouped into sub-programmes to promote the advancement of science and to aid management. The composition of each programme is:

Genetics: Leader Robbie Waugh (Associate Leader John Brown)

Sub-programmes:	Genome biology	Glen Bryan
	Applied genetics	John Bradshaw
	Genes and development	John Brown
	Biodiversity	Joanne Russell
	Bioinformatics	Dave Marshall

Plant Pathology: Leader Lesley Torrance (Associate Leader Paul Birch)

Sub-programmes:	Pathogen genomics	Paul Birch
	Plant-pathogen interactions	Michael Taliansky
	Pest and disease management	Adrian Newton
	Cell biology and imaging	Alison Roberts
	Environmental pathology	Ian Toth

Quality, Health and Nutrition: Leader Derek Stewart (Associate Leader Howard Davies)

Sub-programmes:	Phytochemicals and health	Derek Stewart
	Metabolic regulation	Howard Davies
	Molecular physiology	Mark Taylor

Environment Plant Interactions: Leader Philip White (Associate Leader Bryan Griffiths)

Sub-programmes:	Plant and plant-soil interactions	Glyn Bengough and Paul Hallett
	Functional ecology	Cathy Hawes and Ron Wheatley
	Ecosystem upscaling	Geoff Squire

BioSS: Director David Elston

BioSS is a unit that serves several research organisations in Scotland and specialises in the development and application of the quantitative methodologies that underpin research in plant science, animal health and welfare, ecology and environmental science, and human health and nutrition.

Sub-programmes:	Mathematical and statistical models for process and system models	Glenn Marion
	Statistical methodology	Chris Glasbey
	Statistical bioinformatics	Dirk Husmeier
	Statistical consultancy	Jim McNicol

University of Dundee Plant Research Unit:
The research of this Unit interacts closely with several sub-programmes of SCRI, emphasising issues of major public concern such as biodiversity, the impact of climate change on plant productivity, and the benefits and risks of plant biotechnology. The main interests of the five research groups and their primary links are:

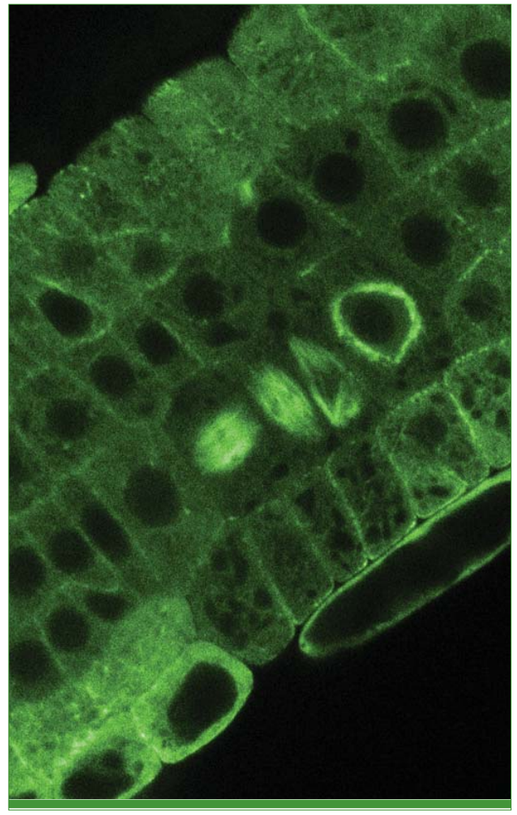
Transposons, genome evolution and biodiversity in plants (Andy Flavell – links with Genetics)

Manipulations of plant metabolism using reverse genetics (Claire Halpin – links with Genetics)

Regulated gene expression controlling floral development (Gordon Simpson [joint appointment] – links with Genetics)

Plant ecophysiology and adaptation to environmental stress (Lyn Jones – links with Genetics and Environment Plant Interactions)

How photosynthetic organisms acquire carbon (John Raven - links with Environment Plant Interactions)



Science Programme Outputs

Each of the science programmes has a clear description of its scientific responsibilities and an understanding of its contribution to the SCRI strategy. Outputs are communicated to end users in a variety of media including publications and oral presentations, but a particular focus of SCRI is to ensure that the outputs of our research are presented through a series of web portals targeted at relevant academic, commercial, public and policy groups. The scientific hypothesis and major objectives of each programme for the planning period are described below:

Genetics

Description:

The programme conducts innovative basic and applied genetic research to identify and associate variation in genes and genomes with variation in phenotypes which are relevant to end user needs.

Hypothesis:

Understanding and utilising genetic biodiversity by exploiting the power of genetics can provide a platform for long-term crop improvement and promote the development of environmentally enhanced and sustainable production systems.

Five year objectives:

- Develop genetically anchored physical maps and provide extensive genome sequence information as a contribution to global genomics initiatives in our target crops.
- Identify the location of genes underlying key traits (e.g. flavour / texture, time to maturity, resistance, nutritional factors), and investigate their regulation and their natural genetic diversity.
- Apply both established and novel genetic strategies for efficient gene identification and validation (e.g. association genetics and targeted mutant identification) and promote marker development for marker assisted breeding.
- Maintain the Commonwealth Potato Collection and key barley and soft fruit germplasm in high health status condition (Statutory objective).
- Develop advanced germplasm and exploit through commercial breeding partnerships.
- Apply advanced molecular systems to measure genetic variation in natural plant species and populations to inform biodiversity and conservation strategies.
- Incorporate sophisticated statistical and mathematical approaches into the analyses of complex biological systems.

Plant Pathology

Description:

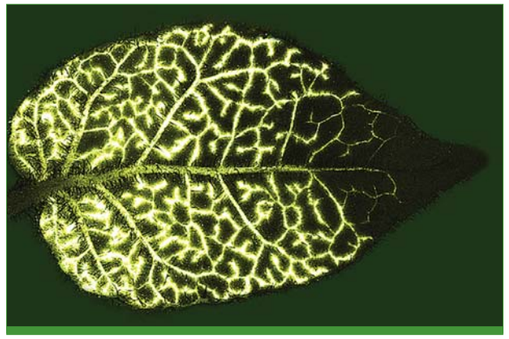
The programme conducts research on economically important pathogens and pests of potato, barley and soft fruit to understand pathogenicity and disease processes. Studies are conducted over a range of scales from plant–pathogen interactions at the level of cells and molecules to the dynamics of pest and pathogen populations in the field. The discoveries and innovations are used to deliver crop improvement through durable host resistance and sustainable disease control strategies.

Hypothesis:

Sustainable pest and disease management can be achieved through a detailed understanding of pest and pathogen biology, pathogen variation and plant defence mechanisms.

Five year objectives:

- Contribute to the sequencing, annotation, comparative sequence analysis and exploitation of the genomes of the potato pathogens *Erwinia carotovora* ssp. *atroseptica*, *Phytophthora infestans* and *Globodera pallida*.
- Advance understanding of cellular and molecular mechanisms of disease resistance and susceptibility through studies of plant and pathogen gene function.
- Characterise pathogenicity factors in economically important pathogens leading to a better understanding of mechanisms underlying pathogenicity, horizontal gene transfer, (a)virulence and intraspecific variation.



- Integrate genetic, biochemical and functional data in order to achieve a better understanding of disease mechanisms and resistance durability.
- Understand the mechanisms of pest and pathogen spread, disease development and factors driving evolution and population change, particularly with regard to changing climate and management practices.
- Combine knowledge of disease epidemiology and pest and pathogen biology with rapid diagnostic techniques to develop effective control strategies for integrated pest and disease management systems.
- Investigate the population dynamics of and interactions between plant pathogens, plants and other microbial communities in managed systems.

Quality, Health and Nutrition

Description:

The programme conducts research into the chemical, biochemical and genetic bases of nutritional quality in plant-derived foods and products. It aims to enhance the health benefits of foods to the public by improving the nutritional and organoleptic properties of both raw and processed products.

Hypothesis:

Understanding the key biological factors and mechanisms during plant development will allow the quality and nutritive values for the end user to be tailored and optimised in biodiverse and sustainable production systems.

Five year objectives:

- Characterise the life cycle of the potato tuber using metabolomics, biochemical and molecular biological methods to understand key factors affecting crop utilisation by the potato industries.
- Develop biochemical and molecular methods to understand and characterise the key metabolic drivers of nutrition and organolepsis in potato.
- Determine the major bioactive compounds in crops with emphasis on soft fruit.
- Increase the level of interaction with biomedical research specialisms to establish key factors affecting human health, including the retardation and/or amelioration of pathologies through plant based dietary intervention.

Environment Plant Interactions

Description:

The central theme of the programme is the efficient use of resources in resilient and sustainable managed systems. The resources are energy, carbon, nitrogen, phosphorus and water. Sustainability involves a healthy environment and economic viability.

Hypothesis:

Economically viable cropping systems can be developed that sustain a greater functional diversity of vegetation and food-webs and result in more resilient and efficient systems.

Five year objectives:

- Identify and develop a suite of critical biological and physical indicators of resilience for sustainable managed systems.
- Determine plant genetic and environmental factors, and their interactions, that enhance resource-use efficiency in cropping systems.
- Develop molecular and physiological methods to identify plant and agronomic drivers of the soil biological community and its function.
- Establish genetic and phenotypic metrics of arable plant diversity and characterise the role of plant diversity in sustaining essential invertebrate food webs.
- Establish models and methods for predicting plant types and management that enhance productivity, resilience and biodiversity at field and landscape scales.

BioSS

BioSS undertakes research, consultancy and training in mathematics and statistics as applied to agriculture, the environment, food and health. Research is partitioned into three themes: statistical genomics and bioinformatics; spatial and temporal models; and process and systems modelling. Scientific areas of particular expertise include: plant science; animal health and welfare; ecology and environmental science; and human health and nutrition. BioSS bridges the gap between the development and application of biomathematics and statistics. BioSS consultants add quantitative expertise to research throughout Scotland. Key aspects of the programme of knowledge transfer include: development of software products; delivery of training courses for scientists; and supervision of PhD students.

Five year objectives:

- Improve performance methods for detecting mosaic structures in multiple sequence alignments, incorporate these in the BioSS-produced TOPALi package and adapt the package to exploit the accessibility and computing power of emerging GRID technologies.
- Develop methods to integrate different types of postgenomic data including gene expression profiles, promoter sequences and protein interaction data via Bayesian Networks to improve our ability to learn about molecular signalling pathways and regulatory networks.
- Develop methods to model complex interactions in epidemic processes in plants and animals, such as *in vivo* models of *E. coli* O157 population dynamics incorporating multiple, spatially-structured, colonisation sites.
- Develop improved models for spatio-temporal analysis of water quality data, and identify effects at different spatial and temporal scales.
- Ensure statistical methods are used where appropriate to improve the efficiency of research in the SEERAD-funded work packages, strengthening the conclusions and giving due weight to the evidence base supporting the conclusions.

Cross Programme objectives

Many of the research contracts undertaken within the SCRI Group require cross-programme working - especially the SEERAD workpackages. During the next planning period particular attention will be directed to:

- Establishing a vigorous element of quantitative biology in all research programmes, drawing on advanced capabilities in bioinformatics, statistics and modelling.
- Ensuring that technology platforms are up-to-date, can be efficiently accessed and utilised, and complement other local infrastructure. We shall exploit our strengths in established and emerging technology platforms (e.g. genetics, genomics and metabolomics) to broaden applications, provide greater depth of knowledge and expand opportunities.
- Building on our status as a LEAF Innovation Centre to demonstrate how our research capacity can be utilised to develop sustainable production systems with environmental and biodiversity benefits.
- Developing a research capacity and coherent programme of research relevant to climate and environmental change.
- Exploring the application of technologies developed in the context of crop plants to wider issues of natural plant biodiversity and conservation.

Partnerships and Collaboration

SCRI is in a strong position to deliver integrated multi-disciplinary research of wide applicability. Moreover, we have developed several long-standing partnerships that have enhanced our basic research capability in plant sciences and enabled product development. In the planning period, it will be essential to sustain these partnerships and build other strategic alliances and formal partnerships in Scotland, the UK and internationally.

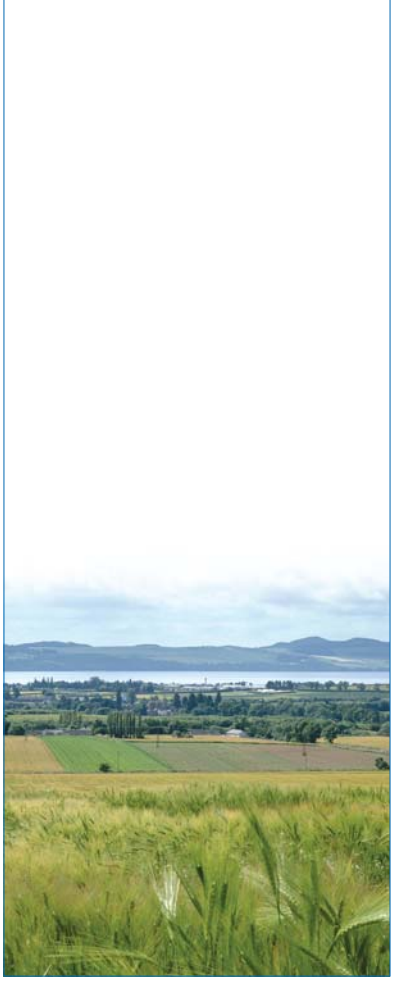
SCRI has a productive and strong partnership with the University of Dundee whose Plant Science staff are housed at SCRI. One joint appointment has been made and we are committed to further such appointments in the planning period. Productive commercial partnerships also exist with companies such as GlaxoSmithKline (blackcurrants), the Raspberry Consortium, and McCain, Greenvale AP and Taypack (potatoes). A wider range of commercial partnerships exploiting innovations in other plants will be developed.

Both the PwC report of 2005 and the Arthur D Little report of 2006 have encouraged the institutes in Scotland to seek such economies of scale as can realistically be realised and to exploit scientific synergies. For SCRI this means particular consideration of our working relationships with both the Scottish Agricultural College (SAC) and the Macaulay Institute. Complementary crop and soil research programmes exist with SAC, and form part of SEERAD's commissioned research Programme 1. Similarly there is potential for scientific collaboration with the Macaulay Institute. The research focus at SCRI is predominantly on managed, arable agroecosystems with outputs at field and farm scales, while that of the Macaulay Institute is on semi-natural systems at landscape and catchment scales. A closer working relationship would allow the two institutes to seize the opportunities for collaborative strategic research in sustainable land management in Scotland and make a significant contribution to UK and European research in this area. There is also scope for further interactions between SCRI, Macaulay and the Royal Botanic Garden Edinburgh in the field of biodiversity and conservation, and smaller scientific interactions also exist with the Moredun and Rowett research institutes that will continue to be fostered as appropriate.

Closer working with institutes in England and Wales is already well-advanced with cross institute programmes (CIP) in soil science, and crop genomics and genetic improvement (MONOGRAM), established. SCRI has been invited to be a founding partner of the MONOGRAM CIP with the John Innes Centre, Rothamsted Research and the Institute for Grassland and Environmental Research (IGER), and will become a member of the soils CIP (with Rothamsted Research and IGER) during 2006 when SEERAD research commissions are agreed. This will demonstrate SCRI's commitment and contribution to the UK research base, and offer new opportunities for coordinated UK-wide research projects.

Internationally we shall explore key partnerships in Europe that will maximise our ability to secure EU Framework 7 funding. Some areas of research already have such links but greater visibility is required in others. International collaborations with institutions in other countries, particularly China, have begun to flourish and a coordinated approach to these will need to be developed during the planning period to ensure that external funding is available to support them. Another priority for the planning period is to reinvigorate SCRI's links with the International Centre for Potato Research in Peru and the International Centre for Agricultural Research in the Dry Areas in Syria.

The pooling arrangements that Scottish universities are developing offer another avenue for SCRI to link its research to that of universities and to gain from facilities, fellowships and studentships. During the planning period we shall develop proposals relating to university pooling bids for environmental sciences (SAGES), and for specific elements of plant sciences and microbiology in the context of a larger life sciences bid. A metabolomics facility in partnership with the universities of Dundee and Glasgow will also be taken forward.



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