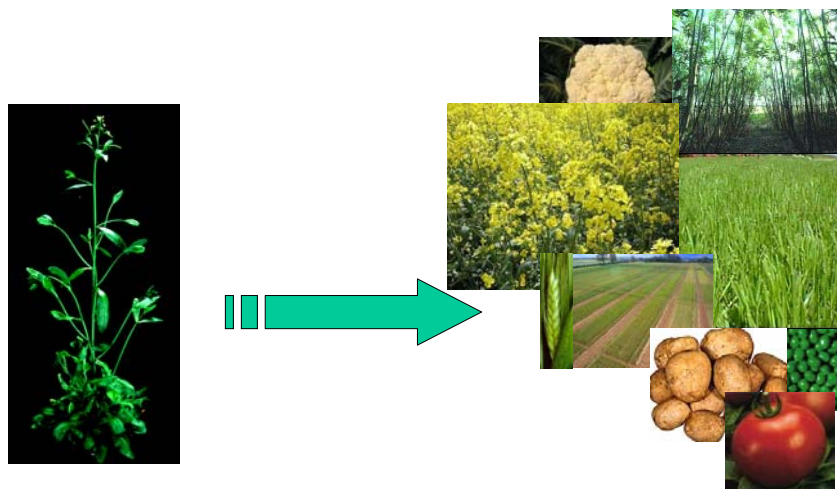


# ARABIDOPSIS AND BEYOND: TO CROPS ! ?



## ARABIDOPSIS AND BEYOND: TO CROPS ! ?

The first gathering of the 'ABC' Forum took place at the GARNet 2005 meeting in Norwich, which was held in association with the UK *Brassica* and Cereal research communities. The ongoing aim of the Forum is to focus discussion on some of the key issues that were raised by the BBSRC Review of Crop Science (Gilligan et al., 2004). This highlighted the perception that the BBSRC and UK crop science portfolio lacked co-ordination, focus and strategic direction. It was recognised that there was a need for a cultural shift that raised the awareness of the strategic importance of crop science. There are now compelling arguments to identify and highlight the opportunities for establishing a **pipeline** between the high quality UK underpinning plant science research base and practical applications. In particular, there is a need to translate basic plant science to improved varieties and other benefits. In order to improve the effectiveness of the process, and create a 'joined-up' delivery pipeline, it is essential that we have a clear understanding of the specific opportunities within the UK research and development communities.

A comprehensive **Model Plant to Crop** transition first requires collation, discussion and prioritisation of the relevant crop traits, and a matching of these to underlying expertise and interests in relevant basic plant science. At one level of abstraction a common approach may be developed by identifying gene functions associated with crop traits. However, for more productive inter-relationships to develop there will be a need for continuing dialogue across a range of disciplines.

In order to help develop a feasible UK and BBSRC strategy, it will be useful to identify clear targets that relate to high quality, safe and sustainable crops. In addition, there is a need to build on the existing investment in plant science and genomics, and place new work in the context of international science. There has been effort in the last couple of years to address end-use and crop stakeholder components of the delivery pipeline, catalysed by the establishment of the Defra Genetic Improvement Networks for different crops (wheat, oilseed rape, legumes, bioenergy). These have provided a focus for crop researchers and stakeholders such as breeders, farmers and agricultural advisors to discuss and prioritise trait targets. They have also assisted in delivery to end-users by establishing key resources and information flow.

The relative effort that is assigned to work on different crop traits varies over time, depending upon changes in environmental, market, economic and regulatory circumstances. Some of the major drivers at present include climate change, economic and environmental sustainability, market diversification and technical innovation. Each of these may have an impact throughout the production, processing and product consumption cycle. We present (Table 1) a preliminary indicative alignment of traits matched against current **strategic requirements** such as reducing inputs, climate change and enhancing product quality. Exercises such as this are an inexact science, but hopefully will provide a useful framework for further discussion. In particular, by providing an overview of UK research capability it should help to indicate where any strategic strengths and weaknesses may lie.

**Table 1.** Indicative (not-exhaustive) associations between underlying Plant Processes, Genes and Crop Traits.

<b>Climate change</b>			
<b>Strategic Driver</b>	<b>Crop</b>	<b>Crop Trait</b>	<b>Underlying Process/Genes</b>
Drought	All	Water use efficiency	Photosynthesis, ABA regulation, stomatal conductance, leaf development
Seasonal shifts	All	Flowering time	Flowering and developmental regulators
Warmer winters	All	Vernalisation	Vernalisation regulators, epigenetics
Invasive pests	All	Pests	Pest resistance, chemo-signalling
Wetter seasons	All	Diseases	Disease resistance

<b>Energy, Waste and Water</b>			
<b>Strategic Driver</b>	<b>Crop</b>	<b>Crop Trait</b>	<b>Underlying Process/Genes</b>
Reduced pesticides		Disease resistance	Resistance genes and signal transduction, host-parasite interactions
Water tax	All	Water use efficiency	
Renewable fuels	Willow et al.	Biomass	Cell development, partitioning
Renewable fuels	Oilseed rape	Bio-diesel	Fatty acid synthesis, nitrogen uptake
Energy balance		Nutrient Use efficiency	Transporters, uptake, partitioning

<b>Environment</b>			
<b>Strategic Driver</b>	<b>Crop</b>	<b>Crop Trait</b>	<b>Underlying Process/Genes</b>
Reduced diffuse pollution	All	Nutrient Use efficiency	Transporters, uptake, partitioning

**Table 1.** Indicative (not-exhaustive) associations between underlying Plant Processes, Genes and Crop Traits.

<b>Economic sustainability</b>			
<b>Strategic Driver</b>	<b>Crop</b>	<b>Crop Trait</b>	<b>Underlying Process/Genes</b>
Profitability	All	Yield, harvest index	Multiple, partitioning, developmental regulation, inflorescence architecture
Profitability	Wheat	Grain yield	Endosperm development, nitrogen uptake and metabolism, assimilate partitioning, hormonal regulation
Market niche	Wheat	Grain and bread quality	Protein and starch synthesis, structure, endosperm and aleurone development
Market niche	Wheat	Bread quality	Sulphur assimilation
Profitability	Oilseed rape	Crop establishment	Germination, seedling vigour, uniformity, embryo development
Profitability	Oilseed rape	Pod shatter	Fruit (silique) development
Profitability	Oilseed rape	Canopy structure	Stem height, branching
Profitability	Oilseed rape	Oil yield	Embryo development
Market niche	Oilseed rape	Oil quality	Fatty acid synthesis and modification

<b>Human Nutrition</b>			
<b>Strategic Driver</b>	<b>Crop</b>	<b>Crop Trait</b>	<b>Underlying Process/Genes</b>
Functional foods	Wheat	Vitamins	Vitamin synthesis
Functional foods	Oilseed rape	Oil quality, PUFAs, vitamins	Fatty acid and vitamin synthesis and modification pathways
Anti-cancer	Brassicas	Isothiocyanates	Glucosinolate pathways
Food	Vegetables	Shelf life, product quality	Senescence

It is now timely to address the earlier stages of the 'pipeline', where basic plant science could be translated into useful outcomes. The initial task of the ABC Forum is therefore to identify common themes and areas of mutual interest where synergy can develop within the UK research communities. It is anticipated that the Forum will become the focus for ongoing dialogue between basic plant and crop researchers, together with the relevant funding and stakeholder bodies.

In order to facilitate this process, we have been carrying out co-ordinated **surveys of research interests** and activities within the respective Arabidopsis, *Brassica* (UK-BRC) and Cereal communities, and this will be extended to the other UK crop research communities over the coming months. This information includes general research areas, specific research topics, collaborations and use of resources. The data are currently being collated and should provide an integrated overview of research interests, priorities and areas where the UK could excel in translating basic science into practical outcomes. The GARNet survey has now generated 100 responses, a summary of which is provided below (Table 2).

The data from all the surveys will be collated in autumn 2005, and made available via the GARNet, UK-BRC and the various genetic improvement network websites. It will also be made available to BBSRC and Defra. It is hoped that we will be able to update the information periodically, and that the Forum will become a useful means for communication that can lead to a more integrated plant and crop science community.

In order to initiate the discussion on how these respective areas could interact, we presented examples from these surveys, of where areas of basic plant science carried out in model species may correspond and deliver to specific crop trait areas, at GARNet 2005. To date this has provoked a variety of useful discussions, and will hopefully raise awareness within the respective model and crop areas of the need to understand the different drivers and constraints, as well as the complexity involved in mapping information about specific gene functions onto a range of different crop traits.

Among the issues that have been raised so far are:

- It is not possible at this stage to develop a classification system that fits everything, and so the headings provided in the tables below should be taken as indicative. They are designed to generate discussion rather than provide 'pigeon-holes'.
- Trait areas such as crop yield are multi-factorial, with many (most) component traits contributing to overall yield. This includes disease and pest resistance and most physiological traits. The *relative* contribution of a trait to yield is subject to much discussion and requires various modelling approaches to quantify
- Some traits studied in model and crop plants map onto several areas. For example, plant architecture and stature are major contributors to yield, resource allocation, nutrient use efficiency, biomass generation, as well as responses to various abiotic stresses.
- One of the major challenges in making underlying science on model plants such as Arabidopsis relevant to crop performance in field situations is the context of the respective environmental conditions under which experiments take place. This can vary according to trait.

For example modelling a clear developmental change like flower colour or branch/no branch may be rather more obvious phenocopy than many others. With diseases, field resistance is a far more complex phenomenon than observed in Arabidopsis or even crop glasshouse assays. This is an important area for discussion in order to raise awareness, and refine the roles for Arabidopsis research in the context of crop science.

- One view would be that the model merely provides a source of initial genes that may have an impact on, or provide insights into the crop trait. This can help focus the crop science questions onto specific candidates as a point of departure. With the advent of systems approaches in model plants, it will be interesting to compare the specific properties of crop plant behaviour in production situations with model plants in controlled experimental situations.

If you wish to discuss any of these topics raised in this document please contact either

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For additional information relating to crop research in the UK

<b>Defra Genetic Improvement Networks</b>	WGIN (Wheat)	<a href="http://www.wgin.org.uk">www.wgin.org.uk</a>
	OREGIN (Oilseed RapE)	<a href="http://www.oregin.info">www.oregin.info</a>
	BEGIN (Biomass for energy)	<a href="http://www.biomass4energy.org">www.biomass4energy.org</a>
	PCGIN (Pulse crop)	<a href="http://www.jic.ac.uk/staff/noel-ellis/PCGIN/">www.jic.ac.uk/staff/noel-ellis/PCGIN/</a>
	UK- <i>Brassica</i> Research Community	<a href="http://www.brassica.info/ukbrc/index.htm">www.brassica.info/ukbrc/index.htm</a>
	HGCA (HomeGrown Cereals Association)	<a href="http://www.hgca.com">www.hgca.com</a>

**Table 2.** Results from the GARNet Arabidopsis Survey of Research

<b>Disease &amp; Pest Resistance (Responses to Biotic Environment)</b>		
<b>Research Group</b>	<b>Organisation</b>	<b>Research Area(s)</b>
Anna Amtmann	University of Glasgow	Interaction between mineral nutrition and susceptibility to pathogens
David Baulcombe	Sainsbury Laboratory	RNA Silencing and disease resistance in plants
Mike Beale	Rothamsted Research	Engineering terpenoid biosynthesis for insect, pathogen and parasitic weed resistance
John Carr	University of Cambridge	Induced resistance to viruses and non-viral pathogens. Viral counter-defence proteins. Salicylic acid and signalling
Paul Devlin	Royal Holloway	Plant/microbe signalling in the phyllosphere
Murray Grant	Imperial College London	Molecular plant pathology. Pseudomonas. Systemic immunity. Natural variation in plant defence responses
Kim Hammond-Kosack	Rothamsted Research	Fungal - Arabidopsis Interactions
Eric Holub	Warwick HRI	Genetics of host-parasite interactions. Population biology of disease in wild plant species
Jonathan Jones	John Innes Centre	Plant disease resistance and pathogen compatibility factors or effectors
Paula Kover	University of Manchester	Host-pathogen interactions
Richard Leegood	University of Sheffield	Trichome Formation
Gary Loake	University of Edinburgh	Plant Disease resistance.
Andy Maule	John Innes Centre	Plant-virus interactions
Joel Milner	Glasgow University	Plant Virology. Plant Pathology
Peter Morris	Heriott Watt University	MAP kinase signal transduction pathways in biotic stress
Jonathan Napier	Rothamsted Research	The role of sphingolipids in plant signalling. The role of volatile signalling in plant defence & communication
Anne Osbourne	John Innes Centre	Plant-microbe interactions and disease resistance
Mike Roberts	Lancaster University	Defence against invertebrate herbivores
Steve Roberts	Lancaster University	Calcium channel activity and calcium signalling in filamentous fungi
Lorraine Williams	University of Southampton	Transporters involved in responses to abiotic and biotic stress

**Table 2.** Results from the GARNet Arabidopsis Survey of Research

<b>Responses to Abiotic Environment</b>		
<b>Research Group</b>	<b>Organisation</b>	<b>Research Area(s)</b>
Anna Amtmann	University of Glasgow	Molecular mechanisms of salt and drought tolerance
Martin Broadley	University of Nottingham	Management of contaminated soils, phytoremediation
Neil Baker	University of Essex	Photosynthesis and environmental stress physiology
Mike Blatt	University of Glasgow	Cell signalling and ion transport
Cliff Bray	University of Manchester	Proteomic analysis of DNA ligase interacting proteins
Jonathan Clarke	John Innes Genome Lab	Functional Genomics. Epigenomics.
Peter Dominy	University of Glasgow	Control of Salt tolerance. Heavy Metal tolerance mechanisms.
Justin Goodrich	University of Edinburgh	Plant epigenetics. Histone Methylation
Nick Harberd	John Innes	Role of DELLAs in environmental response
Bill Finch-Savage	Warwick-HRI	Seed Dormancy and Dormancy Cycling
Tim Flowers	University of Sussex	Effects of salinity on plants
Christine Foyer	Rothamsted Research	Ascorbate regulation of growth and defence. Glutathione signalling, cell death and senescence. Antioxidant regulation of photosynthesis
Patrick Gallois	University of Manchester	Programmed Cell Death
Anthony Hall	University of Liverpool	Response to ambient temperature change.
Gareth Jenkins	University of Glasgow	UV-B perception and signalling. Abiotic signal transduction
Marc Knight	University of Oxford	Signalling in response to biotic and abiotic stress
Martin McAnish	University of Lancaster	Plant cell signalling and environmental stress responses
Peter Meyer	University of Essex	Epigenetics
Peter Morris	Heriott Watt University	MAP kinase signal transduction pathways in abiotic stress
Phil Mullineaux	University of Essex	Responses of plants to abiotic stress
John Newbury	University of Birmingham	Functional genomics of sodium transporters
Mike Roberts	University of Lancaster	Physiological and molecular responses to abiotic stress
Steve Roberts	University of Lancaster	Organic acid efflux and anion channel function in roots
Tony Stead	Royal Holloway	Plant senescence
Lee Sweetlove	University of Oxford	Response of plant metabolism to abiotic stress
Lorraine Williams	University of Southampton	Transporters involved in responses to abiotic and biotic stress

**Table 2.** Results from the GARNet Arabidopsis Survey of Research

<b>Flowering Time</b>		
<b>Research Group</b>	<b>Organisation</b>	<b>Research Area(s)</b>
Isabelle Carre	University of Warwick	Circadian rhythms, photoperiodic regulation of flowering
Caroline Dean	John Innes Centre	Molecular control of flowering time. Control of vernalization requirement
Paul Devlin	Royal Holloway	Circadian rhythms
Justin Goodrich	University of Edinburgh	Role of Pc-G in flowering time control and response to vernalization
Anthony Hall	University of Liverpool	Circadian regulation and temperature buffering
Karen Halliday	University of Edinburgh	Role of phytochrome B in Flowering
Paula Kover	University of Manchester	Genetic basis of adaptation in flowering time and vernalization
Stephen Jackson	Warwick-HRI	Control of Flowering
Alex Webb	University of Cambridge	Circadian regulation of signalling

<b>Water use efficiency</b>		
<b>Principal Investigator</b>	<b>Organisation</b>	<b>Research Area(s)</b>
Mike Blatt	University of Glasgow	Guard cell signalling. Ion transport and membrane traffic.
Liam Dolan	John Innes Centre	Root epidermal development and evolution
Alaistair Hetherington	University of Lancaster	Signal transduction in stomatal function and development
Julie Gray	University of Sheffield	Guard cell signalling
Claire Grierson	University of Bristol	Mechanisms of root hair growth
James Hartwell	University of Liverpool	Crassulacean acid metabolism
Paul Knox	University of Leeds	Mechanisms of root growth
Andrew Thompson	University of Warwick	Water use efficiency. Abscisic acid
Ian Woodward	University of Sheffield	Stomatal development

<b>Nutrient Use Efficiency</b>		
<b>Research Group</b>	<b>Organisation</b>	<b>Research Area(s)</b>
Anna Amtmann	University of Glasgow	Molecular mechanisms of plant adaptation to nutrient stress. Interaction of K with N and C metabolism.
Martin Broadley	University of Nottingham	Plant responses to mineral stresses
Juliet Coates	University of Birmingham	Lateral root development
Liam Dolan	John Innes Centre	Root epidermal development and evolution
Brian Forde	University of Lancaster	Genetic control of root architecture. Plant-nutrient interactions
Christine Foyer	Rothamsted Research	Carbon-nitrogen interactions.
Claire Grierson	University of Bristol	Mechanisms of root hair growth
Nigel Halford	Rothamsted Research	GCN2, amino acid sensing and signalling
Paul Knox	University of Leeds	Mechanisms of root growth
Keith Lindsey	University of Durham	Root development
Steve Roberts	University of Lancaster	Organic acid efflux and anion channel function in roots

**Table 2.** Results from the GARNet Arabidopsis Survey of Research

<b>Resource Allocation</b>		
<b>Research Group</b>	<b>Organisation</b>	<b>Research Area(s)</b>
Anna Amtmann	University of Glasgow	Interaction of K with N and C metabolism. Ion transport
Mike Bevan	John Innes Centre	Analysis of molecular mechanisms controlling growth in response to carbohydrates
Cliff Bray	Manchester University	Peptide transport during seed germination and development
Nigel Halford	Rothamsted Research	SnRK1, metabolite signalling.
Christine Foyer	Rothamsted Research	Carbon-nitrogen interactions.
Nigel Halford	Rothamsted Research	GCN2, amino acid sensing and signalling
James Hartwell	University of Liverpool	Molecular basis for the circadian control of primary metabolic pathways in plants
Nick Kruger	University of Oxford	Regulation of Plant Metabolism
Carol Mackintosh	University of Dundee	Regulation of nitrate and sugar metabolism by a plant LKB1/AMPK-like signalling pathway
Anne Osbourne	John Innes Centre	Natural products in plants - function, synthesis and basis of metabolic diversity
Matthew Paul	Rothamsted Research	Trehalose metabolism
Christine Raines	University of Essex	Regulation of carbon metabolism. Protein complexes in carbon metabolism
Alison M Smith	John Innes Centre	Primary carbohydrate metabolism - starch and sucrose
Alison G Smith	University of Cambridge	Metabolites as regulators of gene expression
Alex Webb	University of Cambridge	Circadian regulation of metabolism and physiology
Astrid Wingler	University College London	Plant metabolism and development. Stress and Senescence

<b>Yield</b>		
<b>Research Group</b>	<b>Organisation</b>	<b>Research Area(s)</b>
Anna Amtmann	University of Glasgow	Interaction of K with N and C metabolism. Ion transport
Ian Bancroft	John Innes Centre	Regulation of seed storage lipid biosynthesis
Mike Bevan	John Innes Centre	Analysis of molecular mechanisms controlling growth in response to carbohydrates
Mike Blatt	University of Glasgow	Membrane protein traffic
Sue Bourgoud	University of York	Role and coordination of cell division during plant growth and development
Mary Byrne	John Innes Centre	Meristem function, inflorescence architecture
Enrico Coen	John Innes Centre	Evolution and modelling of organ size, quantification of plant growth dynamics
John Doonan	John Innes Centre	Regulation of cell proliferation. Spatial control of gene expression in meristems and seeds
Andrew Flemming	University of Sheffield	Leaf Morphogenesis
Justin Goodrich	University of Edinburgh	Plant Development. Flower development. Flowering Time. Epigenetics. Histone Methylation

**Table 2.** Results from the GARNet Arabidopsis Survey of Research

<b>Yield</b>		
Karen Halliday	University of Edinburgh	Light Signal Transduction
Nick Harberd	John Innes Centre	Regulation of plant growth by DELLA proteins
Jim Haseloff	University of Cambridge	Plant morphogenesis: 3D microscopy, gene misexpression, computer modelling
Julian Hibberd	University of Cambridge	Photosynthesis
Richard Hooley	University of Bath	G protein signalling, Plant hormone signalling
Andrew Hudson	University of Edinburgh	Molecular genetics of leaf and meristem development, natural variation in organ shape and size
Paul Jarvis	University of Leicester	Protein targeting; Chloroplast biogenesis; Chloroplast protein import
Smita Kurup	Rothamsted Research	Embryogenesis
Richard Leegood	University of Sheffield	Seed development in Arabidopsis
Richard Leegood	University of Sheffield	Roles and regulation of PEP carboxykinase
Keith Lindsey	University of Durham	Embryogenesis
Enrique Lopez-Joez	Royal Holloway	Light control of plastid and leaf development
Simon McQueen-Mason	CNAP University of York	Expansins. Cell Expansion and development. Cell wall biosynthesis
Christine Raines	University of Essex	Photosynthetic carbon metabolism
Jerry Roberts	University of Nottingham	Cell separation processes in plants
Steve Roberts	University of Lancaster	Protein targeting; Chloroplast biogenesis; Chloroplast protein import
Robert Sablowski	John Innes Centre	Meristem development, floral development
Alison M Smith	John Innes Centre	Primary carbohydrate metabolism - starch and sucrose
Matthew Terry	University of Southampton	Regulation of chloroplast development. Role of tetrapyrroles in chloroplast development and signalling
Miltos Tsiantis	University of Oxford	Genetics of shoot development and leaf shape, Natural variation in leaf shape
Alex Webb	University of Cambridge	Circadian regulation of metabolism and physiology

<b>Biomass</b>		
<b>Research Group</b>	<b>Organisation</b>	<b>Research Area(s)</b>
John Doonan	John Innes Centre	Regulation of cell proliferation
Andrew Flemming	University of Sheffield	Leaf Morphogenesis
Simon McQueen-Mason	CNAP University of York	Lignocellulose mobilisation
Gail Taylor	University of Southampton	Leaf development, abiotic stress response and response to elevated CO <sub>2</sub>
Miltos Tsiantis	University of Oxford	Genetics of shoot development and leaf shape, Natural variation in leaf shape
Richard Waites	University of York	Leaf development

**Table 2.** Results from the GARNet Arabidopsis Survey of Research

<b>Landscape &amp; Plant Architecture</b>		
<b>Research Group</b>	<b>Organisation</b>	<b>Research Area(s)</b>
Enrico Coen	John Innes Centre	Modelling plant development, molecular and genetic mechanism of flower asymmetry
Paul Devlin	Royal Holloway	Photomorphogenesis. Shade avoidance
John Doonan	John Innes Centre	Spatial control of gene expression in meristems and seeds
Nick Harberd	John Innes Centre	Regulation of plant growth by DELLA proteins
Stephen Jackson	Warwick-HRI	Control of Plant Stature
Simon McQueen-Mason	CNAP University of York	Expansins. Cell Expansion and development. Cell wall biosynthesis
Andy Philips	Rothamsted Research	Gibberellin biosynthesis and signalling
Colin Turnbull	Imperial College	Shoot architecture - branching
Neil Taylor	CNAP University of York	Cellulose synthesis. Secondary cell wall synthesis.
Simon Turner	University of Manchester	Plant secondary cell walls biosynthesis and plant vascular development

<b>Environment (containment)</b>		
<b>Research Group</b>	<b>Organisation</b>	<b>Research Area(s)</b>
James Cole	University of Bath	Pollen stigma recognition - self incompatibility and interspecific incompatibility. Sperm biology - sperm proteome, blocks to polyspermy
Claire Grierson	University of Bristol	Control of polar growth in root hairs and pollen tubes
David Twell	University of Leicester	Plant reproductive cell development, pollen development and function
Zoe Wilson	University of Nottingham	Pollen and anther development

<b>Breeding, control of recombination</b>		
<b>Research Group</b>	<b>Organisation</b>	<b>Research Area(s)</b>
Peter Shaw	John Innes Centre	Nuclear organization, chromosomes, meiosis
Chris Frankin	University of Birmingham	Meiosis, Cell -cell signalling

<b>Harvestable Product quality &amp; Processing</b>		
<b>Research Group</b>	<b>Organisation</b>	<b>Research Area(s)</b>
Alison M Smith	John Innes Centre	Starch synthesis and degradation
Stephen Fry	University of Edinburgh	Cell wall biochemistry. Cell expansion
Paul Knox	University of Leeds	Plant cell walls. Cell expansion and cell separation.
Simon McQueen-Mason	CNAP University of York	Expansins. Cell Expansion and development. Cell wall biosynthesis
Tony Stead	Royal Holloway	Plant senescence
Neil Taylor	CNAP University of York	Cellulose synthesis. Secondary cell wall synthesis.

**Table 2.** Results from the GARNet Arabidopsis Survey of Research

<b>Harvestable Product quality &amp; Processing</b>		
Miltos Tsiantis	University of Oxford	Genetics of shoot development and leaf shape. Natural variation in leaf shape
Simon Turner	University of Manchester	Plant secondary cell walls biosynthesis and plant vascular development

<b>Human Nutrition</b>		
<b>Research Group</b>	<b>Organisation</b>	<b>Research Area(s)</b>
Diana Bowles	University of York	Glycosyltransferases (GTs):Production of glycosides with utility as anti-oxidants, health-care products or pharmaceuticals
Martin Broadley	University of Nottingham	Heavy metal hyper accumulation -nutritional diagnostics
Martin Broadley	University of Nottingham	Variation in mineral composition of plants
Stephen Fry	University of Edinburgh	Cell wall phenolics (ferulic acid etc.)
Jonathan Napier	Rothamsted Research	Reverse-engineering of polyunsaturated fatty acids into transgenic plants
Alison G. Smith	University of Cambridge	Pantothenate (vitamin B5) biosynthesis. Vitamin B12 synthesis, and its role in algal metabolism.