WE HAVE SHARED VALUES
AND CULTURE IN RESEARCH,
EDUCATION AND THE
PUBLIC GOOD

© The University of Queensland operating through the ARC Centre of Excellence for Integrative Legume Research.
INTRODUCTION TO CILR

The ARC Centre of Excellence for Integrative Legume Research (CILR) is a partnership that brings together leading plant research scientists located at the University of Queensland, the Australian National University, the University of Melbourne and the University of Newcastle. The director of the Centre is Professor Peter Gresshoff (who is also Professor of Botany in the School of Integrative Biology at UQ). The Centre aims to drive further development of the genomics and phenomics of legumes, providing the critical mass of human, intellectual and infrastructure resources to function as a world-class research centre.

The Centre was established with a A$10 million Australian Research Council grant over five years from 2003. Cash contributions from partner universities and state governments matching the ARC funding, combined with in-kind contributions of staff and facilities has generated a major A$28 million five-year biological science research effort.

Research in the Centre will provide critical insights into mechanisms of meristem and organ differentiation and intercellular communication, utilising comparative genomics on the internationally recognised model legumes *Lotus japonicus* (Lj) and *Medicago truncatula* (Mt). Studies also focus on two major crop legumes – pea and soybean. New knowledge of plant growth processes through mechanistic analysis of organ induction provides the tools to optimise legumes’ productivity, quality, and environmental adaptation. This in turn will have direct impact on agricultural sustainability, environmental quality and potential value-added products for human health.

The Centre’s research initiatives have significant intellectual property commercialisation potential, and this will augment Australia’s international standing in scientific discovery and directly benefit the Australian economy.

The Centre’s internal organisational linkages are outlined in the chart in Figure 1.
Figure 1: CILR Organisation Chart
As we near completion of its second year, the CILR continues to develop its position as one of the world leaders in the field of plant developmental biology, using a combination of genome–phenome linking technologies and research approaches to understand the functioning of pluripotent stem cells during the development of plant organs. The mission of the CILR continued through the integration of results gained in legume systems with other plant species such as sugarcane, Arabidopsis, oil palm and tomato. Within Australia the CILR consolidated its recognised position as a leader in legume biotechnology.

The past year was characterised by further growth, consolidation of infrastructure, and the ability to attract high quality researchers (as postdoctoral researchers or graduate students), often with significant international research records. New research and office facilities were constructed in Newcastle and Brisbane. The opening of the Queensland office and core research facilities in November 2004 was combined with the official launch of the CILR, highlighted by the representation of the Queensland Government through Ms Linda Lavage (Parliamentary Secretary to the Minister of State Development and Innovation) and members of the CILR’s Advisory Board and Scientific Expert Advisory Committee, Chief Investigators, members of the Queensland research community, and legume researchers from the different nodes.

In 2004 the CILR achieved outcomes beyond its targeted output in publications, graduate student education, and educational outreach. Highlights included the successful bid of the CILR to host the Third International Conference on Legume Genomics and Genetics in April 2006; the activities of CILR members on editorial boards and governing bodies of conferences; and the inclusion of CILR members in parliamentary activities involving biotechnology. For example, as director I accompanied Premier Peter Beattie to the BIO2004 conference in San Francisco. The visit led to successful negotiations with an American biotechnology firm to develop transgenic legumes in Australia.

We are especially proud of the CILR’s achievements in linking natural science to social science. In part this is accomplished through a functional outreach program in which high school teachers (and their students) have access to educational resources from the CILR. Collaborative projects on legume technology and utility were established with the Aboriginal community at Weipa (QLD) and the agricultural campus at Dookie (Victoria). Non-GMO soybean seeds were made available to schools together with educational packages allowing young scientists in the community to experience the phenomenon of germination, flower and nodule development. “Info Sheets” have been produced which provide succinct facts on topics related to legumes, such as human health, cooking, dietary aspects, crop and model legumes as well as native legumes such as acacia and Sturt Desert Pea. Our website is functional and user-friendly, being visited frequently as a resource for colleagues and the public at large.

Normal electronic communication within the Centre is extended by quarterly Chief Investigators’ meetings, rotating between the four nodes. These allow students and postdoctoral staff at the nodes
to meet other members of the team. Research staff from individual groups now regularly conduct research in laboratories at other nodes. Plant material isolated in Brisbane is routinely analysed in Canberra or Melbourne, taking advantage of synergy in equipment, climate and research skills. As an example of synergy, two UQ students spent two weeks at the ANU to acquire new proteomic technologies.

We were able to attract Mr Miles Holmes from the Central Land Council (Alice Springs) as a PhD scholar to investigate Aboriginal uses of Australian native legumes. His cultural and linguistic skills, and familiarity with the region are a great asset. In parallel, researchers (three doctoral students and Assoc Prof. William Grey) from the social sciences are investigating the social and ethical issues relating to the use of genetically manipulated crops, globalisation of food supply, and the precautionary principle.

Research discoveries have moved forward towards real world application through the filing of a provisional patent on the discovery of a legume derived compound with very special properties (details are encumbered because of commercial sensitivity). The CILR is in the process of establishing its commercial arm through a company called “Meristomics” (registered through UniQuest, Brisbane), which reflects in its name our interests in the clusters of growing stem cells in meristems and the integrative technologies underlying our research approach. The CILR is in discussions with several health food manufacturers concerning the development of new legume varieties that have increased health and quality traits. Highlights include the first transcriptional profiling of the entire isoflavone pathway in soybean (leading to the synthesis of phytoestrogens and anti-oxidants), and linkage research with CSIRO (GRDC funded) on soybean 11S and 7S storage proteins.

CILR researchers continued to characterise the role of ‘gate keeper’ (or ‘dimmer switch’) genes that control the key avenues of organ development in plants. The Melbourne node (in collaboration with Queensland and the AGRF) is looking at meristem and pollen development. Genome–wide microarray (soybean gene chip) experiments have been initiated to discover the regulation of genes during this important phase of the life cycle. The Newcastle and Canberra nodes discovered the important ‘baby boom’ gene critical in legume embryo development, while the Brisbane node focused on the interaction of a defective embryo gene (dem) with nuclear trafficking molecules. Epigenetic changes during embryo formation are being investigated by both Newcastle and Brisbane researchers. The Canberra and Brisbane nodes achieved significant advances in the analysis of nodule initiation, root development and lateral branching. Computer simulation models were developed connecting bench-based biology with in silico science. New approaches in bioinformatics and systems biology are starting to reveal complexities not recognised by linear analysis.

We see as part of our mission the need to demonstrate the importance of plants, and especially legumes, to the well-being of our planet, as well as the economic and cultural wealth of Australia. Through our efforts to build an internationally competitive capacity for research, education and training of the next generation of researchers, and the associated advances in the understanding of gene networks controlling plant architecture and development, we hope to advance the application of plant biotechnology and legume research for the benefit of human health, environment and plant productivity.

Peter M. Gresshoff
Director, CILR
March 2005
THE CILR VISION

A. To pioneer knowledge of the biology of legumes.
B. To develop the knowledge of plants and their products for the benefit of health and the environment.
C. To enhance recognition of the value of plant science to the Australian community.
D. To mentor the next generation of plant scientists.

CILR’S MISSION

CILR is committed to:

1. Being the leading legume research centre in the world.
2. Creating an integrated research environment.
3. Developing and applying cutting edge molecular genetic tools for research into legume genome-phenome relationships.
4. Applying new and ethno botanical knowledge of legumes for the benefit of the environment, health and agriculture.
5. High quality and specialised education of undergraduate and post-graduate students.
6. Developing products which have tangible benefits for human health and the environment.
7. Providing international leadership and capacity in the study of plant development.
Having formally established the Centre with the signing of contracts with the ARC in July 2003, there was considerable effort in recruiting staff and ramping up the Centre’s activities for the remainder of 2003 and through 2004. By the end of the year, we had grown to 93 staff and students.

CILR also wishes to recognise researchers and others who work closely with the Centre by offering the status of Centre Associates. We are very pleased that the following individuals have accepted nomination as Associates:

- Prof Craig Atkin (University of Western Australia)
- Prof David Bird (North Carolina State University)
- Dr Jim Hanan (University of Queensland)
- Prof Jim Reid (University of Tasmania)
- Dr Peer Schenk (University of Queensland)
- Dr Ted Steele (Australian National University)

Staff and Students

**University of Queensland**

Prof Peter Gresshoff  Director
Melisa Lewins  Personal Assistant
Ian Harris  Chief Operating Officer
Dr Christine Beveridge  Chief Investigator
A/Prof Bernie Carroll  Chief Investigator
A/Prof William Grey  Ethics Advisor
Dr Sandy Zicus  Education & Outreach Manager
Mr Quyni Jiang  Lab Manager
Dr Pick Kuen Chan  Post Doctoral Fellow
Dr Marjolein Cox  Post Doctoral Fellow
Dr Fiona Filardo  Post Doctoral Fellow
Dr Gustavo Gualtieri  Post Doctoral Fellow
Dr Tripty Hirani  Post Doctoral Fellow
Dr Mark Kinkema  Post Doctoral Fellow
Dr Theirry Lonheinne  Post Doctoral Fellow
Dr Neena Mitter  Post Doctoral Fellow
Dr Trish Murray  Post Doctoral Fellow
Dr Paul Scott  Post Doctoral Fellow
Dr Jiri Stiller  Post Doctoral Fellow
Dr Claudia Vickers  Post Doctoral Fellow
Dr Cheol Ho Hwang  Visiting Scientist
Dr Haohua He  Visiting Scientist
Dana Hoffman  Visiting Scholar
Bandana Biswas  PhD Student
Tanya Brich  PhD Student
Chris Brosnan  PhD Student
Diana Buzas  PhD Student
Lucy Carter  PhD Student
Elizabeth Dunn  PhD Student
Steve Fletcher  PhD Student
Alice Hayward  PhD Student
Arief Indrasumunar  PhD Student
Sandra Laniya  PhD Student
Akira Miyahara  PhD Student
Sureeporn Nontachaiyapoom  PhD Student
Kathy Parmenter  PhD Student
Katie Steele  PhD Student
Alice Yuniaty  PhD Student
Michael Lees  Honours Student
Lisette Pregelj  Honours Student
Hang-Fai So  Honours Student
Tim Wells  Honours Student
Alice Yunainty  Honours Student
Olga Berkin  Research Assistant
Lindsay Carrigan  Research Assistant
Rakesh David  Research Assistant
Dongxue Li  Research Assistant
Mikiko Miyagi  Research Assistant
Johanna Hadler  Occupational Trainee

Australian National University
Prof Barry Rolfe  Deputy Director
Dr Georg Weiller  Chief Investigator
Dr Michael Djordjevic  Chief Investigator
Prof Chris Parish  Chief Investigator
Dr Ulrike Mathesius  Chief Investigator
Dr Nijit Iman  Post Doctoral Fellow
Dr Tursun Kerim  Post Doctoral Fellow
Dr Flavia Pellorone  Post Doctoral Fellow
Dr Jeremy Weinman  Research Officer
Dr Prudy Hall  Visiting Scientist
Dr Hiroto Naora  Visiting Scientist
Dr Mary Skotnicki  Senior Tech Officer
Charles Hocart  Senior Tech Officer
Marie Oakes  Tech Officer
Hancai Chen  Tech Officer
Elena Gartner  Tech Officer
Kerong Zhang  PhD Student
Anne Mackenzie  PhD Student
Femke De Jong  PhD Student
Angela Morris  PhD Student
Giel Van Noorden  PhD Student
Joko Praytno  PhD Student
Jean Wen  PhD Student
Anton Wasson  Honours Student
### University of Melbourne
- **A/Prof Mohan Singh** Node Leader
- **A/Prof Prem Bhalla** Chief Investigator
- **Dr Mokoto Endo** Post Doctoral Fellow
- **Dr Harald Ottenhof** Post Doctoral Fellow
- **Dr Takashi Okada** Post Doctoral Fellow
- **Hai-Shan Chi** PhD Student
- **Sakesan Chinwang** PhD Student
- **Farzad Haerizadeh** PhD Student
- **Ruby Tiwari** PhD Student
- **Yu-Hua Wang** M.Hort.Sci Student
- **Cathy Jensen** Research Assistant
- **Andrea Merrall** Research Assistant
- **Anzu Okada** Research Assistant

### University of Newcastle
- **A/Prof Ray Rose** Node Leader
- **Dr Sergey Kurdyukov** Post Doctoral Fellow
- **Kim Nolan** Research Officer
- **Dr Xin-Ding Wang** Senior Research Assistant
- **Sonya Hubbard** Research Assistant
- **Nikki Legge** Research Assistant
- **Yoko Nitani** Research Assistant
- **Shih Chen** PhD Student
- **Rina Irwanto** PhD Student
- **Feky Mantiri** PhD Student
- **Nasir Saeed** PhD Student
- **Michael Sheahan** PhD Student
- **Daniel Daniher** Honours student
GOVERNANCE

The Centre is privileged to have so many highly respected government, industry, scientific and university leaders who have made a significant commitment to the development of the Centre by agreeing to serve on the Centre Advisory Board and the Scientific Expert Advisory Committee. We appreciate their valuable contribution and guidance as the Centre works to achieve its research goals.

1. The Centre Advisory Board provides advice on the development of strategies and vision for the future of the Centre, and its direction in finance and scientific management, commercialisation and IP management.

The members of the Centre Advisory Board are:

**Ms Paula Fitzgerald (Chair)**  
Executive Manager  
Agrifood Awareness Australia  
CANBERRA

**Professor David Siddle**  
Deputy Vice Chancellor (Research)  
University of Queensland  
BRISBANE

**Professor Frank Larkins**  
Deputy Vice Chancellor (Research)  
University of Melbourne  
MELBOURNE

**Professor Ron McDonald**  
Deputy Vice Chancellor (Research)  
University of Newcastle  
NEWCASTLE

**Professor Vicki Sara**  
Chancellor  
University of Technology, Sydney  
SYDNEY

**Professor Lawrence Cram**  
Deputy Vice Chancellor (Research)  
Australian National University  
CANBERRA

**Professor Peter Langridge**  
Director  
Australian Centre for Plant Functional Genomics  
University of Adelaide  
ADELAIDE

**Professor Dick Wettenhall**  
Director, BIO21  
University of Melbourne  
MELBOURNE

**Dr Jaydeep Biswas**  
School of Engineering  
University of Queensland  
BRISBANE

**Dr John Manners**  
Program Leader  
CSIRO Plant Industry  
BRISBANE

**Dr Bruce Wicking**  
Consultant  
MELBOURNE

**Dr Bill Silvey**  
Director, Competitive R&D Investment Programs  
Qld Dept of State Development and Innovation  
BRISBANE
2. The Scientific Expert Advisory Committee advises the Centre Director on the direction of research and educational programs undertaken within the Centre, and provides leadership in the Centre’s annual research conference.

The members of the Scientific Expert Advisory Committee are:

**Professor John Irwin (Chair)**  
CRC for Tropical Plant Protection  
University of Queensland  
AUSTRALIA

**Professor Doug Cook**  
Department of Plant Pathology  
University of California at Davis  
USA

**Professor Ueli Grossniklaus**  
Institute of Plant Biology  
University of Zurich  
SWITZERLAND

**Professor Minoru Kanehisa**  
Bionformatics Centre  
Institute for Chemical Research  
Kyoto University  
JAPAN

**Professor Adam Kondorosi**  
Institute des Sciences Du Vegetal  
Gif-Sur-Yvette  
FRANCE

**Dr Satoshi Tabata**  
Kazusa DNA Research Centre  
JAPAN

**Professor John Mattick**  
Institute of Molecular Bioscience  
University of Queensland  
AUSTRALIA

3. The Centre Management Committee is responsible for the provision of advice on the research strategies and progress towards research objectives; general operating of the Centre and the protection of IP generated by the Centre.

The members of the Centre Management Committee are:

**Professor Peter Gresshoff (Chair)**  
Director and UQ Node Leader

**Professor John de Jersey (from October 2004)**  
Deputy Executive Dean  
Faculty of Biological and Chemical Sciences  
University of Queensland

**Associate Professor Ray Rose**  
University of Newcastle Node Leader

**Associate Professor Mohan Singh**  
University of Melbourne Node Leader

**Professor Al McEwan**  
(to October 2004)  
Director of Research  
Faculty of Biological and Chemical Sciences  
University of Queensland

**Professor Barry Rolfe**  
Deputy Director and ANU Node Leader

**Mr Ian Harris**  
Chief Operating Officer
4. The Chief Investigators meet on a quarterly basis, with meetings rotating around each node to maintain full communication on research programs and developments in individual laboratories.

The Node Leaders and the Chief Operating Officer also meet on a regular basis as required for effective operation of the Centre.

The Centre’s annual symposium brings together all staff and students for several days for the exchange of research reports and to discuss collaborative projects.

The following table lists formal meetings within the Centre for 2004:

<table>
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<th>MEETING NAME</th>
<th>DATES</th>
<th>VENUE</th>
<th>ATTENDED BY</th>
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| Annual Symposium                    | 15-17 April 2004    | Novotel Twin Waters, Sunshine Coast | - CILR Staff & Students  
                                                                                     | Sunshine Coast Queensland                                                 |
|                                     |                     | - SEAC Board Members                |                                                                             |
|                                     |                     | - CAB Board Members                 |                                                                             |
|                                     |                     | - Centre Associates                 |                                                                             |
| Centre Advisory Board               | 19 April 2004       | University of Queensland            | CAB Board Members                                                           |
|                                     | 24 November 2004    | University of Queensland            |                                                                             |
| Scientific Expert Advisory Committee (SEAC) | 19 April 2004     | University of Queensland            | SEAC Members                                                                |
| Centre Management Committee (CMC)   | 13 May 2004         | University of Newcastle             | CMC members                                                                 |
|                                     | 20 August 2004      | University of Queensland            |                                                                             |
| Node Leaders                        | 13-14 May 2004      | University of Newcastle             | CILR Node Leaders and Chief Operating Officer                               |
|                                     | 26 November 2004    | University of Queensland            |                                                                             |
| Chief Investigators                 | 26-27 February 2004 | University of Melbourne             | CILR Chief Investigators and Chief Operating Officer                         |
|                                     | 1-2 July 2004       | Australian National University      |                                                                             |
|                                     | 27 November 2004    | University of Queensland            |                                                                             |
The past year was an exciting and fruitful time for the CILR. Some highlights:

Centre officially launched at the University of Queensland.

The Centre had its official launch on 25 November 2004, which included the opening of newly refurbished and extended offices and laboratories for the University of Queensland node. More than 75 people attended the ceremonies, which were followed by tours of the new facilities. Guests of honour included The Hon Linda Lavarch MP, Parliamentary Secretary for State Development & Innovation, Queensland; Prof David Siddle, UQ Deputy Vice Chancellor (Research); Prof Mick McManus, Executive Dean, UQ Faculty of Biological & Chemical Sciences; Prof Dick Wettenhall, Director of Bio 21, University of Melbourne; Paula Fitzgerald, Executive Director, Agrifood Awareness Australia; Dr Bill Silvey, QLD Department of State Development & Innovation, Queensland; Prof James Dale, QUT Director of Science Research; Prof John Irwin, Director, CRC for Tropical Plant Protection; Prof Peter Koopman, UQ Institute for Molecular Bioscience; and Prof Peter Langridge, Director, Australian Centre for Plant Functional Genomics, University of Adelaide.

The annual symposium provided opportunities for development of collaborative projects between the nodes.

In April, more than 70 people, including several international members of the Centre’s Scientific Expert Advisory Committee, attended the CILR’s annual symposium at the Novotel Twin Waters Resort on Queensland’s Sunshine Coast. The symposium brought together chief investigators, postdoctoral researchers, postgraduate students, Centre staff, invited guests, and members of the Centre Advisory Board and the Scientific Expert Advisory Committee for three days of quality science, information exchange and collaborative learning.

A combination of oral presentations, high-quality postgraduate poster sessions and social time provided great opportunities for the development of joint research projects among the various nodes of the Centre. Time was also spent discussing the social science aspects of the Centre’s program and formulating ideas for the education and outreach program.

Guest speakers included Dr Noel Ellis from the John Innes Centre in the UK, who gave an update on the European Union Grain Legumes Project, and Professor Doug Cook, whose keynote address outlined recent developments from his group at the University of California at Davis.
A comprehensive Education and Outreach Program was launched.

Also in April, Dr Sandra Zicus began work as the Education and Outreach Manager. Initial brainstorming at the annual symposium was followed by individual and group meetings at each of the nodes. An education and outreach strategy was developed to promote the Centre's research and increase public awareness of the importance of legumes to human health and environmental protection. The strategy is being implemented through conference exhibits and presentations, development of information sheets on legumes, education programs for Centre students and researchers, professional development for teachers, and work with a rural community in Cape York.

Centre researchers and students represented the CILR at a wide variety of regional, national and international conferences, seminars and workshops.

Through a variety of conference presentations, seminars and workshops, Centre researchers and students presented their work in 14 different countries – Australia, Austria, Brunei, China, France, India, Japan, Malaysia, Mexico, New Zealand, Pakistan, Poland, South Africa and the United States.

Several researchers were invited plenary or keynote speakers at international conferences, including Dr Christine Beveridge (combined International Conference on Legume Genetics and Genomics and the European Association for Grain Legume Research, France), Prof Peter Gresshoff (Oils and Fats International Congress, Malaysia; South African Genetics Society Congress; International Congress of Nitrogen Fixation, China) and Assoc Prof Mohan Singh (Botanical Society of America, USA).

The CILR was also appointed to host the Third International Conference on Legume Genomics and Genetics (ICLGG-3) in Brisbane, April 2006.

Centre research programs continue to improve our understanding of plant developmental biology and make major contributions to a growing global knowledge bank.

In collaboration with researchers at the Institut National de la Recherche Agronomique (INRA) in Versailles, France, Chief Investigator Dr Christine Beveridge and her research team discovered that a legume gene, named RAMOSUS1, regulates completely new and unknown plant hormones that control shoot production. Through research with garden peas, they have shown that in addition to the long-distance signals that have already been identified, there must be at least two more unknown signals that play critical roles in plant development. Work is ongoing to identify these hormones, which is a crucial first step in improving our understanding of the molecular processes involved. This knowledge could lead to the development of new techniques that may provide significant benefits to many agricultural and horticultural industries.

More of the Centre's research is outlined in the Research Highlights section.
RESEARCH PROGRAM

Research Overview

The Centre, through its four interacting nodes, conducts research into the nature and mechanisms of plant development by using an integrative ‘Genome to Phenome’ approach.

The underlying working hypothesis is that plants predominantly develop and respond to the environment through the control of cell proliferation and cell development in distinct cell masses called ‘meristems’. These pluripotent plant stem cells possess the ability to develop progeny cell populations that maintain themselves indefinitely, or alternatively differentiate into the diversity of plant organs such as leaves, flowers and roots.

The Centre has developed many genetic and macromolecular building blocks controlling these processes through a combination of classical and modern genetic, physiological and biochemical analyses.

Research programs using related or identical research technologies are focusing on the definition of gene networks and pathways within meristems, the nature of the cell proliferation and differentiation control mechanisms, the signalling between meristems and the definition of signal and receptor molecules.

Strategically the Centre has chosen four legumes to address these research areas; these are the two major legume crops soybean and pea, as well as the two internationally recognized model legumes Medicago truncatula and Lotus japonicus (themselves valuable as forage crops). Meristem research incorporates analysis of cell division and meristem control at different stages of the plant’s life cycle. This starts with the development of the male gamete, the pollen, prior to fertilization, the development of the fertilized zygote and embryo in both seed and in vitro embryogenesis, establishment during germination and seedling growth, development of leaves and branches as well as roots and nitrogen fixing nodules, through to flowering and renewed gamete and seed development.

Centre research has already defined several critical genes at all these developmental phases. The present and future aims are to discover further genetic components, define their biochemical manifestations in terms of plant growth and yield (including special chemicals involved in signalling in animal and human systems), recognise the applicability to other cropping plants, and to develop real world outcomes through linkages to end users. This will be carried out through the Centre’s commercialisation arm Meristomics, communication through the international science community and links to social sciences and the broader community.
Research Highlights in 2004

Dr Christine Beveridge – Chief Investigator UQ

New gene, new role
CILR researchers, in collaboration with researchers at the Institut National de la Recherche Agronomique (INRA) in Versailles, France, have used a legume gene, named RAMOSUS1, to show that two completely new and unknown plant hormones control shoot production. The number of shoots produced by a plant is tightly regulated through a system of interacting long-distance signals. In a paper appearing in *The Plant Cell* February 2005, we have proposed that RAMOSUS1 acts like a dimmer switch, perceiving and integrating a range of different messages before modulating levels of a novel long-distance signal that inhibits bud outgrowth.

Microarray approach
UQ researchers are working closely with the University of Melbourne node to establish a microarray approach to identify genes involved in axillary meristem initiation. This involves dissection of thousands of shoot apical meristems, too small for observation with the naked eye, from wild-type and budless mutant plants. In 2005 we will generate considerable new knowledge from this unique and invaluable resource.

Associate Professor Prem Bhalla – Chief Investigator UM
Associate Professor Mohan Singh – Chief Investigator UM

High resolution transcriptomics
Researchers in the Melbourne node are applying high-resolution transcriptomics to unravel complex gene regulatory mechanisms that control dynamic cell organization and architecture of shoot apical meristems in legumes. Normalized and subtractive pea shoot apical meristem cDNA libraries were prepared and nucleotide sequences of more than 5000 expressed sequence tags have been obtained. The subtracted cDNA library has allowed the identification of several novel transcripts that show meristem specific developmental regulation. A 12,000 elements “meristem” spotted cDNA microarray has been completed recently, and will be utilised as a unique tool to analyse genes that are developmentally regulated in plant stem cells.

Meristems and MicroRNAs
The Melbourne node is also investigating role of miRNAs in shoot apical meristem development and differentiation. MicroRNAs are ~22 nucleotides long non-coding RNAs that regulate gene expression at post-transcriptional level. This study will provide novel entry point for understanding gene networks that orchestrate meristem specific developmental pathways.

High density gene chip analysis
The Melbourne group has also used Affymetrix high-density synthetic oligonucleotide soybean gene chips to obtain a unique tissue-specific transcript profile of soybean shoot apical meristem. The analysis has revealed several genes encoding cell signalling related pathways as well as a number of transcription factors that are developmentally regulated in shoot apical meristem cells. In collaboration with the University of Queensland node they have also used gene chips to explore soybean pollen transcriptome. Comparison between the transcriptome of the vegetative tissues and pollen showed that the pollen transcriptome has a reduced complexity and a unique composition.

Associate Professor Bernie Carroll – Chief Investigator UQ

RNA interference
Bernie Carroll’s laboratory has extended research into RNA interference (RNAi), a recently discovered phenomenon of immense relevance to both plant and animal development. In collaboration with colleagues at Plant Industry, CSIRO, Canberra, they have discovered genes directing the systemic transmission of RNAi from the roots to leaves of plants. Another important epigenetic mechanism regulating
gene expression and development involves DNA methylation. The group has continued to use their novel protocol called Amplified Methylation Polymorphism (AMP) to define the importance of DNA methylation in key developmental processes. While the protocol was initially developed to study plants, in collaboration with scientists at the Walter and Eliza Hall Institute of Medical Research, Melbourne, they have shown that DNA methylation is required for chromosome pairing during meiosis and the formation of sperm in the mouse.

Dr Michael Djordjevic – Chief Investigator ANU

Search for novel signalling peptides.

Methods have been established for the effective fractionation and characterisation of small proteins and peptides from legumes. Protein and peptide fractions have been tested for biological activity with suspension culture cells that we have established (tobacco and Medicago varia). We have found that seed storage and other proteins are present in seedling root tips although they appear to be not derived from transcription and translation. Before a tobacco line died we had reproducible biological activity in select fractions containing peptides that led to altered culture pH.

Root shoot signalling

In collaboration with the University of Queensland node, we have established ways of effectively isolating xylem sap from inoculated and non-inoculated soybeans and determining the metabolite and protein content of the material. A protein with potential long range signalling ability has been identified (KTI) but is not differentially accumulated in inoculated and un-inoculated plants. N and C terminal specific antibodies to KTI are being prepared to test the hypothesis that differential degradation of KTI might be a player in root shoot signalling.

Patent application

In a very interesting development which has involved working closely with Professor Chris Parish (Chief Investigator – ANU), plant based biologically active molecules of potential therapeutic value in mammals have been identified and the Centre has filed a provisional patent covering this work.

Professor Peter Gresshoff - Chief Investigator UQ

First cloning and characterisation of duplicate nod factor receptor genes (NFR1) in soybean.

Soybean like other legumes respond to lipo-oligosaccharide nodulation factor through a receptor. We characterised two soybean non-nodulation mutants, namely nod49 (made by Carroll and Gresshoff) and rj1 (found naturally). Both mutants fail to nodulate but form effective symbioses with mycorrhizal fungi. Both mutants were found to be altered in the same gene, namely GmNFR1a (nod factor receptor 1a). This gene encodes a LysM type receptor kinase. Of special interest is the fact that soybean contains a second, highly similar gene (GmNFR1b) that fails to complement the mutation in GmNFR1a (despite being 90% identical). We have discovered a GmNFR1b mutation in variety PI476.543, which does not show a phenotype. The biology of infection in the mutant suggests that GmNFR1a is needed for early infection events (suggesting a high affinity receptor) as well as induction of cell divisions leading to nodulation. In contrast, GmNFR1b, a putative low affinity receptor will only trigger cortical cell divisions but not early infection steps. We thus have a powerful tool to distinguish between these two pathways which in other legumes like Lotus and Medicago are controlled by a single NFR1 receptor.

Kinase associated protein phosphatase (KAPP) genes cloned from both soybean and Lotus japonicus.

Many receptors are protein kinases (e.g., genes controlling early nodulation and autoregulation of nodulation (like GmNFR1 and GmNARK). Kinases are negatively regulated by protein phosphatases, especially KAP, as shown in Arabidopsis. With our success in expressing and maintaining kinase activity in E. coli expressed GmNARK kinase domain, and the effective site-directed mutagenesis of this region, we succeeded in cloning two GmKAPP genes from soybean and one from Lotus.
japonicus. These share overall structure with the KAPP of Arabidopsis known to interact with CLAVATA1 and SERK (note the Newcastle node works on MtSERK). We also discovered that both LjKAPP1 and GmKAPP1 are alternatively spliced, providing mechanisms for increased biochemical diversity of the phosphatase domain.

**Dr Jim Hanan – Centre Associate UQ**
In co-sponsored research with the ARC Centre in Bioinformatics, a prototype system for specifying spatially distributed sub-cellular sources, targets and signals with rule-based parameterisation of message rates and reception thresholds has been implemented as an L-system model. In collaboration with the ARC Centre for Complex Systems, an interface to the Qu-Prolog logic programming language has been programmed for the prototyping.

**Dr Ulrike Mathesius – Chief Investigator ANU**
**Auxin transport**
Researchers in the Mathesius lab have shown that the supernodulating sunn mutant has major defects in auxin transport. We hypothesized that auxin transport is a critical factor in nodule organogenesis and were able to demonstrate that the sunn mutant is unable to regulate auxin transport in response to rhizobia. This links meristem formation to the transport of one of the regulating hormones affecting cell division. One interesting aspect of the finding was that auxin transport is affected not just locally at the infection site, but over a distance of several centimeters, to affect auxin export from the shoot into the root. This is an important observation because autoregulation is regulated by a shoot signal.

**Flavonoids as auxin transport regulators**
We have worked on transformation of Medicago truncatula. We showed that nodulation is inhibited in flavonoid deficient knockout plants. These KO plants also showed increased auxin transport, but were not able to regulate auxin transport in response to rhizobia, in contrast to controls. This is the first genetic evidence that flavonoids are the long hypothesized auxin transport regulators during nodule formation.

**Associate Professor Ray Rose – Chief Investigator UN**
**An ordered mechanism of partitioning in plant cells**
The inheritance of individual nuclear chromosomes during cell division through the mitotic mechanism has been known for more than one hundred years. We have now discovered for the first time that the major cytoplasmic components of the cell (chloroplasts, mitochondria and endoplasmic reticulum) also have an ordered mechanism of partitioning at cell division involving specific interactions with the cytoskeleton. *The Plant Journal* article reporting this discovery (2004) 37, 379 –390 was cited in the Faculty of 1000 Biology Reports, which highlight the world’s most interesting papers in biology.

**Professor Barry Rolfe – Chief Investigator ANU**
**Proteomics and transcription factors**
Barry Rolfe’s group produced the first comprehensive proteomic study of Sinorhizobium using the recently completed genome sequence. This now enables us to predict the overall metabolic framework for Sinorhizobium cells under a range of environmental conditions and involves a number of international collaborations. Their new central interest is in plant cell biology. This has led to the demonstration that the expression of the transcription factor BABY BOOM1 (BBM1) was critical in the conversion of vegetative growing cells into differentiating cells. We have observed that it behaves as a temporal switch at early stages of embryo development. We have also identified six other genes/proteins that are essential for embryo development in legumes.
Dr Georg Weiller – Chief Investigator ANU

Multimodal distribution of isoelectric points
A surprising multimodal distribution of the isoelectric points (pI) of proteins has since long puzzled the proteomic community. We have analysed all fully sequenced genomes and shown that the multimodal distribution does not reflect phylogeny or sequence evolution but rather physiochemical properties of amino acids. We have provided a statistical explanation of why the observed distributions of pI values are multimodal. This work has been published in *Proteomics*.

Computational analysis of putative non coding RNA genes in *Medicago truncatula*
We have developed a computational pipeline that enabled us to use the publicly available EST and genomic sequence data to screen for all transcribed genes that do not encode a protein. Applying this pipeline to the model legume *Medicago truncatula* we have identified 598 novel genes that encode ncRNAs or, in some cases, small peptides. Several characteristics of these non-coding genes were then contrasted with a dataset of protein encoding genes, which we constructed using an analogous approach. We have found significant differences in the utilisation of oligonucleotide patterns and inverted repeats. Sequence comparison with other organisms suggests that in contrast to protein genes, many of the ncRNA genes have homologues only in closely related plants. Analysis of the promoter regions suggests that bidirectional transcription is more prevalent in ncRNA genes, whereby pairs of divergently transcribed genes tend to consist of a coding and a non-coding partner.

Natural Science – Social Science Linkage Program
As an extension of its scientific mission, CILR aims to develop a broader understanding of legumes, and to utilise this knowledge to benefit both agriculture and the natural environment. This raises a range of complex and connected issues – technical, economic, political and ethical – that need to be addressed through an interdisciplinary approach with the social sciences.

For this reason, the centre has incorporated a social science program into its research agenda. Currently five researchers (four doctoral students and Assoc Prof. William Grey) from the social sciences are investigating anthropological, social and ethical aspects of legumes, including Aboriginal knowledge, issues of genetically modified (GM) crops, and globalisation of our food supply.

Consumer understanding and opinions about GM crops
Genetics is a rapidly expanding domain of science that has generated a rich, subtle and varied range of ethical dilemmas. At the University of Queensland node two PhD students are examining GM-related ethical issues under the supervision of the Centre’s ethics advisor, Dr William Grey. Issues being explored include a careful examination of the so-called ‘precautionary principle’ and problems of rational decision-making under uncertainty.

Working under the supervision of Prof Barry Rolfe at the Australian National University, another doctoral student is conducting research on consumer knowledge and opinions about GM crops and food, their perceived benefits and detriments and other factors that have an impact on consumer attitudes. As part of his research, he is also analysing differences in opinions and knowledge at different points in time and between geographical areas.

Aboriginal knowledge and uses of legumes
A PhD student working under the supervision of Dr Mary Laughren (UQ Faculty of Arts) and Prof Peter Gresshoff is examining the social construction of legumes in aboriginal Warlpiri society in terms of their classification, use, politics and metaphysical properties. The material generated by his research will contribute to our understanding of how people relate to their environment and, more specifically, to the plants in that environment, in a cultural and practical sense. As the project is interdisciplinary, it will also contribute to the interface between conventional western scientific thought and indigenous knowledge. Such findings are increasingly becoming important to natural resource managers, scientists and planners who seek to utilise indigenous knowledge in their work.
During the past year an education and outreach strategy was developed to promote the centre’s research and increase public awareness of the importance of legumes to human health and environmental protection. This program has three main target audiences:

- Centre researchers and students
- Middle and high school teachers and students
- General public

Centre researchers and students:
The Centre continues to provide educational opportunities and support for university students. During 2004, seven Honours students did their research through the Centre. Another seven students commenced work on PhD degrees. In addition, in association with the Centre, three students completed Master’s degrees and eleven completed their PhD theses.

A quarterly electronic newsletter, the e-pod, was created to help maintain contact among the researchers and students from the various nodes. It includes information about research being conducted, listing of upcoming events and opportunities, profiles of Centre people and general information of interest about legumes.

A series of contemporary technology workshops have been planned to enhance the ability of Centre researchers and students to conduct world-class research. Three workshops have been scheduled for 2005, and more will be scheduled in 2006:

- RNAi and methods for transgene detection, University of Queensland, February
- Cell biology and cell culture, University of Newcastle, September
- Plant development and modelling, University of Queensland, November

Middle and high school teachers and students:
During 2004, we had exhibits at two major science teacher conferences – the Australian Science Teachers’ Association (CONASTA) in Canberra and the Science Teachers’ Association of New South Wales (STANSW) in Sydney. During the two conferences, more than 350 teachers visited our booth. Twelve Centre researchers and students helped staff the exhibit and spoke with the teachers about the Centre’s work.

We are developing standards-based curriculum resources on food and plant biology that will help middle school and high school teachers gain awareness of the role of legumes in health and environment, and their potential as a tool in plant research. After field-testing and revision, the resources will be posted on our website.

In 2004, we conducted three workshops that involved a total of 74 teachers:

- Investigating Food: the science behind your meals introduced the basics of nutrition and healthy eating, aimed primarily at middle school level.
- Plants, Genes & Environmental Responses: Exploring variability was a workshop for high school teachers that looked at the nitrogen cycle and nodulation in soybeans and clover.
• Investigating Ecosystems: An action research approach to environmental investigations focused on practical approaches to conducting environmental studies in a school setting and included discussion about the importance of native legumes in Australian ecosystems. This workshop was based on a resource that was created by the Bright Minds science education project of the University of Queensland.

General public:
To increase the visibility of the Centre and make information about legumes accessible to the public, we have prepared a series of 20 two-page information sheets covering topics as diverse as ‘What are legumes?’; ‘Legumes & health’; ‘Sturt’s desert pea’; ‘Lentil’ and ‘Clover’. The information sheets will be made available in both printed and electronic form.

Talks & seminars
In August, more than 50 people attended a CILR-sponsored lunchtime symposium with renowned author Professor Jennie Brand-Miller, who spoke on the benefits of low Glycemic Index diets, which heavily involve legumes.

Peter Gresshoff was a featured speaker at the University of Queensland Bright Minds ‘Frontiers in Science’ lecture series. His lecture on biotechnology and sustainability was attended by approximately 180 people.

Community involvement
We are working with the Western Cape Training Centre (WCTC) in Weipa, Queensland to provide assistance with their horticulture and nutrition programs, for Weipa and the surrounding aboriginal communities of Mapoon and Napranum.

Additional meetings were held with nutrition health workers from Queensland Health to discuss plans for a professional development workshop based on the Investigating Food resource for regional teachers and health workers.
RESEARCH PUBLICATIONS

Core publications


*Foo E., Bullier E., Goussot M., Fouquer F., Rameau C., and Beveridge C.A.* “The branching gene RAMOSUS1 mediates interactions among two novel signals and auxin in pea.” *Plant Cell* 17: 464–474. Accepted


* Impact Factor ≥ 5

*Morris S., Cox M., Ross J.J., Krisanti S. and Beveridge C.A. “Auxin dynamics after decapitation are not correlated with the initial outgrowth of axillary buds.” Plant Physiology, accepted.


Other publications by CILR staff that have benefited from the technologies of the Centre, and applied in associated programs


Bhalla P.L. and Singh M. “Future directions for allergen immunotherapy.” Current Drug Targets; Allergy and Inflammation (in press).


* Impact Factor ≥ 5


Singh M. and Bhalla P.L. “Recombinant expression systems for allergen vaccines.” Current Drug Targets; Allergy and Inflammation, in press.


* Impact Factor ≥ 5
### INTERNATIONAL – PRESENTATIONS, SEMINARS & WORKSHOPS

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<td>Beveridge, C.</td>
<td>Plenary speaker: Molecular physiology of bud outgrowth in pea.</td>
<td>Combined International Conference on Legume Genetics and Genomics (ICCGG) and the European Association for Grain Legume Research (AEP), Dijon, France</td>
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<td>Carroll, B.</td>
<td>Molecular basis of mantled fruit in cloned oil palm.</td>
<td>Oils And Fats International Congress 2004, Kuala Lumpur, Malaysia</td>
<td>Sept. 2004</td>
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<td>Carroll, B.</td>
<td>A protocol for arbitrarily detecting DNA methylation polymorphisms between genomes.</td>
<td>Whitehead Institute, MIT, Boston, Massachusetts, USA</td>
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<td>Carroll, B.</td>
<td>Short and long distance signalling in plant development.</td>
<td>National Centre of Excellence in Molecular Biology, University of Punjab, Lahore-53700, Pakistan</td>
<td>Sept. 2004</td>
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<tr>
<td>Carroll, B.</td>
<td>Short and long distance signalling in plant development.</td>
<td>Jawaharlal Nehru University Nov. 2004 UNU and International Institute for Genetic Engineering and Biotechnology, New Delhi, India</td>
<td>Nov. 2004</td>
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<td>Djordjevic, M.A.</td>
<td>Sequences of small proteins to help annotate the genome of Sinorhizobium meliloti.</td>
<td>Genomics of Nitrogen Fixing Organisms workshop, Toulouse, France</td>
<td>July 2004</td>
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<td>Djordjevic, M.A.</td>
<td>A proteomic analysis of nodule bacteria.</td>
<td>6th European Nitrogen Fixation Congress, Toulouse, France</td>
<td>July 2004</td>
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<td>Djordjevic, M.A.</td>
<td>Life in the root nodule: a proteomic perspective of Sinorhizobium meliloti 1021 nodule bacteria.</td>
<td>Centre for the Investigation of Nitrogen Fixation, UNAM, Cuernavaca, Moroles, Mexico</td>
<td>July 2004</td>
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<td>Gresshoff, P.M.</td>
<td>Post-genomic analysis of nodulation: In vitro kinase activity of a receptor kinase controlling long distance cell proliferation.</td>
<td>Plant and Animal Genome Conference XII, San Diego, California, USA</td>
<td>Jan. 2004</td>
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<tr>
<td>Gresshoff, P.M.</td>
<td>Systemic regulation of cell proliferation in legumes requires an LRR plant receptor kinase.</td>
<td>South African Genetics Society Congress, Stellenbosch, South Africa</td>
<td>April 2004</td>
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<td>Gresshoff, P.M.</td>
<td>Post-genomic analysis of soybean autoregulation.</td>
<td>Second International Conference for Legume Genomics and Genetics, Dijon, France</td>
<td>June 2004</td>
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<td>Gresshoff, P.M</td>
<td>Functional genomics of the regulation of nodule number in legumes.</td>
<td>12th International Congress of Nitrogen Fixation, Beijing, China</td>
<td>Oct. 2004</td>
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<td>Gresshoff, P.M.</td>
<td>Gene discovery for cell proliferation control.</td>
<td>National University of Brunei, Brunei</td>
<td>March 2004</td>
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<td>Gresshoff, P.M.</td>
<td>Functional genomic analysis of nodule development.</td>
<td>Danforth Center, St. Louis, Missouri, USA</td>
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<td>Gresshoff, P.M.</td>
<td>Systemic regulation of cell proliferation in legumes requires a LRR plant receptor kinase.</td>
<td>South African Sugar Association, Mount Edgecombe, South Africa</td>
<td>April 2004</td>
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<td>Gresshoff, P.M.</td>
<td>Functional genomic analysis of nodule development.</td>
<td>National Center for Soybean Biotechnology, University of Missouri, Columbia, Missouri USA</td>
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<td>Gresshoff, P.M.</td>
<td>Functional genomic analysis of nodule development.</td>
<td>Southern Illinois University, Carbondale, Illinois, USA</td>
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<td>Gresshoff, P.M.</td>
<td>Functional genomic analysis of systemic control of nodulation in legumes.</td>
<td>Agricultural University, Vienna, Austria</td>
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<td>Mendel Biotechnologies, Hayward, California USA</td>
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<td>Gresshoff, P.M.</td>
<td>Functional genomics of the regulation of nodule number in legumes.</td>
<td>Matsuda University, Japan</td>
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<td>Gresshoff, P.M.</td>
<td>Functional genomics of the regulation of nodule number in legumes.</td>
<td>National Institute of Agricultural Sciences, Tsukuba, Japan</td>
<td>Nov. 2004</td>
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<td>Imin, N.</td>
<td>Proteomic analysis of male gametophyte development and its response to low temperature stress in rice.</td>
<td>Plant and Animal Genome Conference XII, San Diego, California, USA</td>
<td>Jan. 2004</td>
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<td>Imin, N.</td>
<td>Proteomic analysis of male gametophyte development and its response to low temperature stress in rice.</td>
<td>2nd International Symposium on Rice Functional Genomics, Tucson, Arizona, USA</td>
<td>Nov. 2004</td>
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<td>Imin, N.</td>
<td>Low temperature changes proteome of male gametophyte development in rice.</td>
<td>International Rice Cold Tolerance workshop, Canberra, CSIRO</td>
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<td>Kerim, T.</td>
<td>Proteome analysis of male gametophyte development in rice anthers.</td>
<td>International Rice Cold Tolerance workshop, Canberra, CSIRO</td>
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<td>Morris, A.C. &amp; Djordjevic, M.A.</td>
<td>Strain ANU794 induces novel developmental responses on subterranean clover cultivar Woogenellup that suggest common links between nodule and lateral root initiation.</td>
<td>6th European Nitrogen Fixation Conference, Toulouse, France</td>
<td>July 2004</td>
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<td>Rolfe, B.G.</td>
<td>Proteomic analysis of Plant-Microbe Interactions – Workshops.</td>
<td>Plant and Animal Genome Conference XII, San Diego, California, USA</td>
<td>Jan. 2004</td>
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<td>Rolfe, B.G.</td>
<td>Proteomic analysis of somatic embryogenesis in Medicago truncatula.</td>
<td>Combined International Conference on Legume Genetics and Genomics (ICCGG) and the European Association for Grain Legume Research (AEP), Dijon, France</td>
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<td>Singh, M.</td>
<td>Unique transcriptional profile of flowering plant male gametes.</td>
<td>Department of Biology, Colorado State University, Fort Collins, USA</td>
<td>Aug. 2004</td>
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**INTERNATIONAL - POSTERS**

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<td>Simons, J., Templeton, K., Plummer, K., Beveridge, C., &amp; Snowden, K.</td>
<td>Characterisation of the genetic and hormonal control of plant branching.</td>
<td>18th International Conference on Plant Growth Substances, Canberra</td>
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<td>Morris, S., Ross, J.J., Cox, M., Renton, M., Hanan, J., &amp; Beveridge, C.</td>
<td>Auxin comes too little too late.</td>
<td>18th International Conference on Plant Growth Substances, Canberra</td>
<td>Sept. 2004</td>
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<td>Parmenter, K., Rameau, C., Turnbull, C., Murfet, I., &amp; Beveridge C.</td>
<td>Regulation of shoot meristem identity prior to flowering.</td>
<td>18th International Conference on Plant Growth Substances, Canberra</td>
<td>Sept. 2004</td>
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<td>Krisantini, K., Johnston, M., Williams, R., &amp; Beveridge, C.A.</td>
<td>Uptake and transport of indole-3-butyric acid in cuttings of Grevillea, and Australian native species.</td>
<td>18th International Conference on Plant Growth Substances, Canberra</td>
<td>Sept. 2004</td>
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**AUSTRALIA – PRESENTATIONS**

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<td>Carroll, B.</td>
<td>Short and long distance signalling in plant development.</td>
<td>Plant Genomics Centre, The University of Adelaide</td>
<td>Sept. 2004</td>
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<td>Gresshoff, P.M.</td>
<td>Genome-Phenome Analysis of Legumes.</td>
<td>Institute for Molecular Biosciences, The University of Queensland, Brisbane</td>
<td>May 2004</td>
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<td>Gresshoff, P.M.</td>
<td>Functional genomic analysis of nodule development.</td>
<td>The University of Tasmania, Hobart</td>
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<td>Gresshoff, P.M.</td>
<td>Functional genomic analysis of nodule development in soybean and Lotus japonicus.</td>
<td>COMBIO, Perth</td>
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<td>Imin, N.</td>
<td>Proteomic Analysis of Medicago truncatula Explant Cultures Grown Under Plant Hormone Treatments.</td>
<td>The 2nd Australian Health and Medical Congress, Sydney</td>
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<td>Karno, C.A., Beveridge, C., Lakshmanan, P. &amp; Bonnett, G.D.</td>
<td>Bud outgrowth of different sugarcane genotypes.</td>
<td>Australian Society of Sugar Cane Technologists (ASSCT), Brisbane</td>
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<td>Rolfe, B.G.</td>
<td>ARC Centre of Excellence for Integrative Legume Research slowly takes off</td>
<td>The SUNFix Centre Annual Meeting, University of Sydney</td>
<td>June 2004</td>
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<td>Sheahan, M., McCurdy, D.W. &amp; Rose, R.J.</td>
<td>Maintaining Mitochondrial and Mitochondrial genome continuity</td>
<td>COMBIO, Perth</td>
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<td>Weiller, G.</td>
<td>Analysis of the Sinorhizobium meliloti proteome.</td>
<td>Lorne Genome Conference, Lorne, Australia</td>
<td>Feb 2004</td>
<td>150</td>
</tr>
</tbody>
</table>

**CILR-SPONSORED GUEST SPEAKERS**

<table>
<thead>
<tr>
<th>Presenter</th>
<th>Title</th>
<th>Venue</th>
<th>Date</th>
<th>Approx.# Attend.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prof Jenny</td>
<td>Dietary carbohydrates, glycemic load and disease risk</td>
<td>University of Queensland, St. Lucia</td>
<td>Aug. 2004</td>
<td>75</td>
</tr>
<tr>
<td>Brand-Miller, University of Sydney</td>
<td>Polarity and meristems in land plants</td>
<td>University of Queensland, St. Lucia</td>
<td>Sept. 2004</td>
<td>60</td>
</tr>
</tbody>
</table>

**Judgment on gene technology possible only with facts**

While Bob Bridges (ICT Letter, February 15) may think it is a waste of money to fund the research on Sinorhizobium meliloti, it is an important discovery. Sinorhizobium meliloti is the bacterium that forms nodules on the roots of legumes and is critical for the nitrogen fixation process, which is essential for plant growth and development. By understanding the molecular mechanisms involved in the nodulation process, scientists can develop more efficient and sustainable crop varieties, which can help meet the growing demand for food and fuel. The research on Sinorhizobium meliloti has the potential to revolutionize the field of agriculture and contribute significantly to global food security. The investment in such research is a wise one, as it can lead to the development of new and improved crops, which can help sustain the planet's food supply for generations to come. The benefits of investing in gene technology research are numerous, and it is essential that we continue to support such research to ensure a sustainable future for our planet.
The Centre recognises that with the rapid rise of the genomics and phenomics revolution, and dramatically improved communication systems, good science depends on effective collaboration and effective linkages with potential end-users. As a Centre with a primary objective to keep at the forefront of discovery in plant development, we have applied resources from day one to initiating and growing tangible and successful collaborations with other top quality institutions and research groups both in Australia and overseas.

**International (Collaborations and Visitors)**

**BASF Plant Science** – research and development associated with Assoc Prof Mohan Singh's patents.

**Bayer Crop Science** – research and development associated with Assoc Prof Mohan Singh's patents.

**Prof. David Baulcombe**, The Sainsbury Laboratory, John Innes Centre, Norwich, England – collaboration with Assoc Prof Bernie Carroll re RNAi Signalling.

**Professor Patricia Bedinger** and **Professor ASN Reddy**, Department of Biology, Colorado State University, Fort Collins, CO, USA – visit by Assoc Prof Mohan Singh, August.

**Beijing Genomics Institute**, Beijing, PRC – visit by Prof Peter Gresshoff Nov.

**Dr K. Berlin**, Epigenomics Laboratories, Berlin, Germany – visit by Assoc Prof Bernie Carroll July.

**Prof A. Bhattacharaya**, Jawaharlal Nehru University (JNU) and Dr. S. K. Mukherjee, International Centre for Genetic Engineering and Biotechnology, New Delhi, India – visit by Assoc Prof Bernie Carroll November.

**Dr. John Bowman, UC Davis**, California, USA – collaboration with Assoc Prof Bernie Carroll on signalling in plant development.

**Chinese Academy of Sciences**, Beijing, PRC – visit by Prof Peter Gresshoff November.

**Prof Doug Cook**, Department of Plant Pathology, and **Professor V Sundaresan**, Plant Biology, University of California, Davis, USA – visit by Assoc Prof Mohan Singh, July.

**Dr Claris Coyne**, Department of Plant Introduction and Testing Washington State University – visit to Dr Christine Beveridge June.

**Danforth Centre**, St. Louis, Missouri, USA – visit by Prof Peter Gresshoff April.

**Department of Biology, Colorado State University** Fort Collins, USA, - visit by Assoc Prof Mohan Singh, August.

**Dr Neil Emery**, Biology Department, Trent University, Canada – visit to Dr Christine Beveridge, June.

**Dr Julia Frugoli**, Department of Genetics and Biochemistry, Clemson University, South Carolina USA – collaboration with Dr Uli Mathesius on the sunn mutant in Medicago truncatula.

**Prof David Galbraith**, Department of Plant Sciences, University of Arizona, USA – visited UQ node September.

**Guthrie Biotechnology** Malaysia – contracted research by Assoc Prof Bernie Carroll and Prof Peter Gresshoff.

**Professor Prudence Hall**, Hiram College, Ohio USA – visitor to ANU node January – June.

**Dr Gina Hernandez**, Centro de Investigacion sobre Fijacion de Nitrogeno, Universidad Nacional Autonoma de Mexico, Mexico – visit by Dr Michael Djordjevic July.
Heska Corporation USA – research and development associated with Assoc Prof Mohan Singh’s patents.

Hong Kong Jockey Club – contracted research by Assoc Prof Prem Bhalla.

Dr Cheol Ho Hwang, School of Bioresources Science, Dankook University, Chungnam, Republic of Korea – visiting scientist to UQ node for whole year.

Prof. Jatinder Khurana and Prof Akhilesh Tyagi Department of Plant molecular Biology, University of Delhi, South Campus, New Delhi, India-visit by Assoc Prof Mohan Singh, June.

National Centre for Soybean Biotechnology, Columbia, Missouri, USA – visit by Prof Peter Gresshoff, April and formal MOU being negotiated.

National Institute of Agricultural Research, Tsukuba, Japan – visit by Prof Peter Gresshoff, Nov.

Institute National de la Recherche Agronomique, Versailles France – collaboration between Dr Catherine Rameau and Dr Christine Beveridge, major contribution to the vegetative axillary meristem project. (several exchange visits in 2004)

Institute des Sciences Du Vegetal, Centre National de la Recherche Scientifique, Gif-sur-Yvette France; Prof Adam Kondorosi, Dr Eva Kondorosi, Dr. Martin Crespi – collaboration with Prof Barry Rolfe re detailed transcriptome analysis of Medicago truncatula. Visits by Prof Barry Rolfe, Dr Georg Weiller and Mr Ian Harris in June.

Prof. Jatinder Khurana and Prof Akhilesh Tyagi Department of Plant molecular Biology, University of Delhi, South Campus, New Delhi, India – visit by Assoc Prof Mohan Singh, June.

Dr V. Klimyuk, Icon Genetics Laboratories, Halle, Germany - visit by Assoc Prof Bernie Carroll July; ongoing collaboration in protein expression in plants.

Prof. D Lightfoot and Dr K Meksem Department of Plant, Soil and General Agriculture Southern Illinois University – visit by Prof Peter Gresshoff, April 2004.

Matsuda University, Matsuda, Japan – visit by Prof Peter Gresshoff November.

Mendel Biotechnologies, Hayward, California, USA – development of research plan and contract negotiations with Prof Peter Gresshoff for legume biotechnology.

Dr Akira Orimo, Whitehead Institute, MIT, Boston, USA, – visit by Assoc Prof Bernie Carroll July 2004.

Prof. S. Riazuddin, National Centre of Excellence in Molecular Biology, University of Punjab, Lahore-53700, Pakistan – visit by Assoc Prof Bernie Carroll November.

Professor Scott Russell, Managing Editor, University of Oklahoma, USA – collaboration with Assoc Professor Bhalla and Assoc Professor Singh on functional genomics of male gametes.

Dr. A.B. Singh, Deputy Director, Institute of Genomics and Integrative Biology, Delhi University Campus Mall Road, New Delhi, India – visit by Assoc Prof Mohan Singh, June.

Dr. Anirudh Kumar Singh, Head, Germ Plasm Conservation Division, National Bureau of Plant Genetic Resources (NBPGGR), New Delhi, India – visit by Assoc Prof Mohan Singh, June.

South African Sugar Association Institute, Mount Edgecombe, South Africa – visit by Prof Peter Gresshoff April.

Professor. Anand P. Tyagi, Head, The Department of Biology, University of the South Pacific, Suva, Fiji – visited Melbourne node in December.

Professor Kathryn VandenBosch, and Professor Carroll Vance, Department of Plant Biology, University of Minnesota, USA – collaboration with Assoc Prof Ray Rose and Dr Michael Djordjevic on microarray analysis and high throughput Medicago truncatula transformation.

Prof Brett Tyler, Virginia Bioinformatics Institute, Blacksburg, Virginia, USA – visitor to UQ node July.

Dr Colin Turnbull, Department of Agricultural Science, Imperial College London, UK – visit to Dr Christine Beveridge August.
**Australian Collaborations**

**Dr Jason Able, Plant Genomics Centre, The University of Adelaide** – visit by Assoc Prof Bernie Carroll September.

**Australian Macadamia Society** – contracted research by Assoc Prof Prem Bhalla.

**Access Genetics** – industry partner in ARC Linkage grant awarded to Assoc Prof Prem Bhalla.

**Professor Craig Atkins, Plant Biology (Botany), University of Western Australia** – collaboration with ANU and UQ nodes on screening of regulatory genes in lupins.

Professor Jenni Brand-Miller, School of Molecular and Microbial Biosciences, University of Sydney – strategies to promote the utilisation of legumes in low glycaemic index (GI) diets, promoting better health and improved quality of life in ageing.

**CRC for Sugarcane Industry Innovation Through Biotechnology** – Dr Christine Beveridge and Assoc Prof Bernie Carroll are also Program leaders for this CRC, and accordingly CILR is contributing significant genetic and other in-kind resources.

**CSIRO Plant Industry, Brisbane and GRDC** – collaboration with Prof Peter Gresshoff on soybean storage protein profiling (with Dr Andrew James), supported by one GRDC funded PhD student.

**CSIRO Plant Industry, Brisbane** (Dr Gangping Xue and Dr Ray Shorter)- collaboration with Prof Peter Gresshoff on the characterisation of transcription factors involved in drought tolerance of wheat. Supported by a GRDC funded PhD student.

**CSIRO Canberra** (Dr TJ Higgins) – collaboration with Prof Barry Rolfe on proteomic analysis of transgenic pea plants.

**CSIRO Canberra** (Dr Peter Waterhouse) – collaboration with A/Prof. Bernie Carroll on long distance RNAi signalling.

**Qld DPI Toowoomba** (Dr Malcolm Ryley)- growth of soybean material for UQ node.

**Prof Jim Reid, Dr Jim Weller, Dr John Ross, School of Plant Science University of Tasmania** – A PhD student at UTAS is now jointly funded and supervised by CILR and the collaborations on this and other projects extends across the UQ and ANU nodes.

**S.A. Pristine Forage Technologies** – collaboration with Assoc Prof Ray Rose re complementary breeding strategies.

**Sanitarium Health Foods, Avondale NSW** - strategies to promote the utilisation of legumes in food for better health and improved quality of life in ageing.

**SARDI, Adelaide** – development of commercial cultivars of annual medics with Assoc Prof Ray Rose.

**Other key briefings**

**Mr Glen Hassett**, Manager, Sector Development Unit, BusinessACT, and **Mr Philip Melville** of the ACT Government regarding the work of the CILR and how the acquisition of Q-TOF Mass Spectrometry could enhance strategic research in the ACT. Our subsequent application to the ACT Knowledge Fund Grants Program, Industry Development Grant, was successful.

**Premier Peter Beattie** Queensland trade mission to BIO2004, San Francisco, June – UQ representative Prof Peter Gresshoff.

Prof Peter Gresshoff gave several briefings to Queensland Government seminars re agricultural biotech capabilities.

Prof Peter Gresshoff provided a business briefing to the Peanut Company of Australia (QLD) on peanut biotech opportunities.

Assoc Prof Ray Rose is a member of R&D Roundtable – NSW Dept of State and Regional Development.

Assoc Prof Ray Rose also provided a briefing for the Manager, Newcastle Regional Office of the NSW Dept of State and Regional Development on CILR activities in August.
LOOKING TO THE FUTURE

The original proposal for the Centre was made July 2002; its precise goals of establishing an international plant research centre in genome-phenome analysis were described at this time. Our understanding of and vision for the field of legume biology has since been supported by scientific and organizational developments in the last 33 months.

Our primary future goal is to continue the activities of the CILR along the present lines of interaction and partnership. We are committed to the value of legume research because of (a) the suitability of this group of organisms for developmental studies using the genome-phenome analysis approach, (b) the economic importance of legume crops, and (c) the health (via nutrition) and biomedical (via pharmaceuticals) benefits of legumes and their derivatives. Our focus on legumes, their architecture and their value-added product market has been vindicated by equivalent international research efforts. For example, there is increased focus on advanced legume research through multi-million dollar programs at the Danforth Centre (USA), the EU (E25 million) research consortium (John Innes Centre directed), the National Centre for Soybean Biotechnology (USA), and Brazilian and Chinese soybean genomics programs. Additionally there has been a substantial increase of contributions based on legume research in international conferences dealing with plant genetics and genomics.

The legume field is about to receive an overwhelming amount of information in the form of the entire Lotus japonicus and Medicago truncatula genomes. Soybean is not far behind and already has the most legume ESTs available in the electronic databases. Furthermore the Affymetrix chip holding 35,000 Unigenes (plus 15,000 Phytophthora genes and 10,000 soybean cyst nematode genes) are gaining favour in both the USA and with us in Australia. Expression data at the RNA level will increase logarithmically. Hopefully costs will decrease to increase the utility of the Affymetrix approach.

In parallel the high throughput technologies of genomics are aided by reverse genetic approaches such as TILLING and RNAi. Both have advantages. The outcome is clear; more and more functional phenotypes will be recognised. This is of direct relevance to our Centre research. Several of our programs have defined or are close to defining genes involved in pluripotency and organ differentiation. Both gate keeper and dimmer switch genes are being defined. Proteomic and transcriptome profiling are identifying extra molecular components for which function needs to be determined. The Systems Biology network of linking developmental pathways will become clearer in the next 3-5 years.

The availability of two complete legume genomes will permit comparative genomics. Gene discovery in more isolated species such as chickpea, pea or clover will be streamlined from that information. Evolutionary biology will be aided as we gain understanding of gene rearrangements in nature.

At present Australia is restricted in becoming a major player in biotechnology using transgenic plant approaches because all Australian States, except Queensland, have a moratorium in place. This severely undermines investor confidence and is setting Australian Ag-Biotech behind Canadian, and American efforts.

It is a Centre priority to develop to a high level of intellectual maturity in the analysis of perhaps three or four developmental pathways in legumes and recognise the linkages among them. Natural science, computational biology and bioinformatics will interplay to generate the synthesis.

Another priority is to develop ‘windfall’ discoveries. An example is the current filing of a provisional patent relating to biomedically active substances. This needs to be supported at a high level. Industrial partners need to be pursued.

The Centre also needs to evaluate its focus relative to other Australian legume or plant biology research efforts. Equally important is the question of whether and how we will expand our findings to plants other than legumes. Already this occurs but in the reverse direction. We use Arabidopsis and tomato as tools to look at legume issues.
### Key Results Areas and Performance Measures

<table>
<thead>
<tr>
<th>Key Result Area</th>
<th>Performance Measure</th>
<th>Target</th>
<th>Progress to 31 December 2004</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1 RESEARCH FINDINGS</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.1 Quality of publications</td>
<td>Peer reviewed journals, invited reviews, monographs and publications with broad readership for public education. The goal is to achieve 2 publications per annum in journals with impact factor 5 (or above) for the first two years, increasing to 3 per annum for years 3 and 4, and 4 publications in year 5.</td>
<td>Six publications in journals of impact factor ≥ 5.</td>
<td></td>
</tr>
<tr>
<td>1.2 Number of publications</td>
<td>Target: 10 per annum for years 1, 2 and 3; 15 per annum for years 4 and 5.</td>
<td>20 core publications and refereed conference papers, and an additional 18 publications by CILR staff that have benefited from the technologies of the centre, and applied in associated programs. (See page 22)</td>
<td></td>
</tr>
<tr>
<td>1.3 Number of patents</td>
<td>Filing an average of 2 per annum after year 1. Target of two PCT level patents by 2007.</td>
<td>One filed and one being prepared for filing at the end of 2004. United States Patent 6,740,748 Developmental regulation in anther tissue of plants Assignee – The University of Melbourne European Patent 665888 T Cell Epitopes of Rye grass Assignee – The University of Melbourne</td>
<td></td>
</tr>
<tr>
<td>1.4 Invitations to address and participate in international conferences</td>
<td>Members will address the international meetings of the International Society of Plant Molecular Biology, Plant and Animal Genome Conference, International Society of Molecular Plant Microbe Interactions and national meetings of Combined Biological and Biochemistry Societies of Australia (COMBIO) and the Australian Society of Plant Scientists. Target: 5 per annum.</td>
<td>42 international presentations including combined International Conference on Legume Genetics and Genomics (ICCGGG) and the European Association for Grain Legume Research (AEP), 18th International Conference on Plant Growth Substances, Plant and Animal Genome Conference XII, 6th European Nitrogen Fixation Congress, and the 12th International Congress of Nitrogen Fixation. 12 Australian presentations including COMBIO and the 2nd Australian Health and Medical Congress. (See page 25)</td>
<td></td>
</tr>
<tr>
<td>1.5 Invitations to visit leading international laboratories</td>
<td>Members of the centre will visit international laboratories to conduct research and learn technologies. Target: 5 per annum.</td>
<td>CILR staff visited laboratories in key research centres such as the Danforth Centre (St. Louis), UC Davis (USA), the Kazusa Institute (Japan), CNRS (France) and the Max Plank Institute (Germany). Research staff from the centre are engaged in a wide range of collaborations with counterpart staff in these international centres. (See page 32)</td>
<td></td>
</tr>
<tr>
<td>1.6 Number and nature of commentaries about the Centre’s achievements</td>
<td>The activities of the centre will be widely recognised in specialty and general publications. The electronic media will recognise the achievements through interviews and invited commentary to programs such as Landline. Target: 3 per annum.</td>
<td>Centre activities reported in Australian Life Scientist and Queensland regional press; contributions to GMO debate in Canberra Times; Prof Peter Gresshoff interviewed on ABC morning radio.</td>
<td></td>
</tr>
<tr>
<td><strong>2 RESEARCH TRAINING AND PROFESSIONAL EDUCATION</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.1 Number of postgraduates recruited</td>
<td>20 over 5 years</td>
<td>8 in 2004</td>
<td></td>
</tr>
<tr>
<td>2.2 Number of postgraduate completions</td>
<td>20 over 5 years</td>
<td>15 in 2004</td>
<td></td>
</tr>
<tr>
<td>2.3</td>
<td>Number of Honours students</td>
<td>25 over 5 years</td>
<td>7 in 2004</td>
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<tr>
<td>2.4</td>
<td>Number of professional courses</td>
<td>1 per annum</td>
<td>RNAi and Methods for Transgene Detection scheduled for February 2005. Also scheduled for September &amp; November 2005: Cell biology and cell culture, Newcastle Plant development and modelling, Brisbane Planned for 2006: Protein expression in heterologous systems, Melbourne Mass Spectroscopy &amp; proteomics, Canberra Bioinformatics &amp; data mining, Canberra</td>
</tr>
<tr>
<td>2.5</td>
<td>Participation in professional courses</td>
<td>2 per annum</td>
<td>Participation planned in 2005</td>
</tr>
<tr>
<td>2.6</td>
<td>Number and level of undergraduate and high school courses in the priority area(s)</td>
<td>2 per annum</td>
<td>4 workshops for high school teachers, details in 7.2</td>
</tr>
</tbody>
</table>

### 3 INTERNATIONAL, NATIONAL AND REGIONAL LINKS AND NETWORKS

<table>
<thead>
<tr>
<th>3.1</th>
<th>Number of international visitors</th>
<th>4 per annum</th>
<th>Seven visitors across all nodes. (See page 30)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.2</td>
<td>Number of national and international workshops</td>
<td>Attend 2 per annum, provide 4 per annum</td>
<td>Four national workshops attended.</td>
</tr>
<tr>
<td>3.3</td>
<td>Number of visits to overseas laboratories</td>
<td>These visits are mainly for information transfer, collaboration arrangements, centre marketing and research perspectives: 12 per annum</td>
<td>11 visits in this category in 2004 (See page 30)</td>
</tr>
<tr>
<td>3.4</td>
<td>Examples of relevant Social Science &amp; Humanities research supported by the Centre</td>
<td>The Centre will conduct numerous activities related to Social Science and Humanities.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Recruitment of PhD students to research GMO issues involving ethics, public perceptions, intellectual property law, and aboriginal use of legumes.</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>• Preparation of information sheets Legumes &amp; Health and Cooking Legumes. Preparation of resource materials (Investigating Food) for middle and high school teachers; delivery of teacher workshops on this resource at conferences of the science teachers’ associations of Queensland and New South Wales and Geelong District (QLD) Science Symposium (total attendance 82).</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Delivery of teacher workshops on Investigating Ecosystems at Western Cape College, Weipa (QLD) and conference of Science Teachers’ Association of New South Wales</td>
<td></td>
</tr>
</tbody>
</table>

### 4 END-USER LINKS

<table>
<thead>
<tr>
<th>4.1</th>
<th>Number &amp; nature of commercialisation activities</th>
<th>Linkages will be established thorough: 1) A trading name established for the commercialisation activities of the centre and a commercialisation contact nominated; 2) Interaction with relevant industry organisations and commercial entities; 3) Interaction and contract research with Australian and overseas plant science or biotechnology companies</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Target: 2 interactions started per annum.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Meristomics was registered nationally as a trading name for the commercialisation activities of the centre and commercialisation strategy and framework is currently under consideration by the partner universities.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Discussions ongoing with SeedMart, Sanitarium, SARDI and SA Pristine Technologies.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Contract research being planned with Australian food industry and Californian biotech company.</td>
</tr>
<tr>
<td>4.2</td>
<td>Number of government, industry and business briefings</td>
<td>Target: 3 per annum.</td>
</tr>
<tr>
<td>4.3</td>
<td>Number of Centre associates trained in technology transfer and commercialisation</td>
<td>The Centre will facilitate training through third parties in Technology transfer. Target: 2 per annum and maintaining.</td>
</tr>
</tbody>
</table>
4.4 Number and nature of Public Awareness programs

1) significance of legumes in society;
2) significance of legumes to health;
3) Australian Science Teacher Association;
4) Science fairs.
Target: 3 per annum.

Display booth at CONASTA & STANSW conference (approximate visitation to booth 400).
Seven teacher workshops and one panel discussion conducted (total attendance 200).
Visit with Mapoon (QLD) women’s group and youth and adult aboriginal students at Western Cape Training Centre (focus on legumes in gardening and healthy eating).

5 ORGANISATIONAL SUPPORT

5.1 Annual cash contributions from Collaborating Organisations

<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>UQ</td>
<td>$675,000</td>
<td>$785,000</td>
<td>$785,000</td>
</tr>
<tr>
<td>ANU</td>
<td>$225,000</td>
<td>$289,971</td>
<td>$389,971</td>
</tr>
<tr>
<td>UoN</td>
<td>$40,000</td>
<td>$54,359</td>
<td>$54,359</td>
</tr>
<tr>
<td>UoM</td>
<td>$100,000</td>
<td>$98,197</td>
<td>$98,197</td>
</tr>
</tbody>
</table>

Each partner university has met its promised cash contribution commitments.

5.2 Annual in-kind contributions from Collaborating Organisations

<table>
<thead>
<tr>
<th>University</th>
<th>Amount (2003)</th>
</tr>
</thead>
<tbody>
<tr>
<td>UQ</td>
<td>$649,096</td>
</tr>
<tr>
<td>ANU</td>
<td>$389,971</td>
</tr>
<tr>
<td>UoN</td>
<td>$54,359</td>
</tr>
<tr>
<td>UoM</td>
<td>$98,197</td>
</tr>
</tbody>
</table>

Each partner university has met its promised in-kind contribution commitments through availability of staff, equipment and facilities.

5.3 Number of new Organisations recruited to or involved in the Centre

The centre will initiate new linkages as demanded by research advances both within the Centre and overseas. Target: 4 in 2003/4, increasing by 1 per annum.

The centre has enhanced collaborations with the University of Tasmania, University of Western Australia, CSIRO Plant Industry and INRA (France); new collaborations have been initiated with the National Center for Soybean Technology (USA) and the Sainsbury Laboratory of the John Innes Centre (UK).

5.4 Level and quality of infrastructure provided to the Centre

1) An efficient centre administration at UQ,
2) Provision of quality laboratory space at all nodes.
3) Access to high quality research infrastructure across the nodes
4) Quality greenhouse space for controlled plant growth under PC2 (transgenic) containment
5) Direct access to electronic journals and other library facilities for centre scientists.

- The centre administration has been housed in newly refurbished offices at UQ
- Refurbishment of laboratory space has been completed at UQ, and is under way at Newcastle. Substantial facilities are available at ANU in the Research School of Biological Sciences and the School of Biochemistry and Molecular Biology
- Equipment and facilities are state-of-the-art and are maintained by trained personnel. New purchases include mass spectrometers, AFLP, microplate readers, ultracentrifuges and growth cabinets
- Adequate PC2 Greenhouse space for controlled plant growth is available at ANU, Newcastle and Melbourne, and further space is being developed at UQ.

6 GOVERNANCE

6.1 Breadth and experience of the members of the Advisory Board

The Centre Advisory Board and Scientific Expert Advisory Committee to include individuals with world-class qualifications and representing a broad spectrum of interests.

See Centre Advisory Board and Scientific Expert Advisory Committee membership (page 10).

6.2 Frequency and effectiveness of Advisory Board meetings

Yearly for entire Centre Advisory Board; but quarterly update from Director and COO to board and subsequent tele-conference.
Yearly for Scientific Expert Advisory Committee

The Centre Advisory Board face to face meetings have been increased to two per year.

6.3 Quality of the Centre strategic plan

The Centre's strategic plan was established on the combined knowledge of the applicants and their consultants within the partner universities.

Implementation of the plan is being carried out by the same individuals, now building on the resources provided by the Scientific Expert Advisory Committee and the Centre Advisory Board. Our plan will be reviewed by business, science and university leaders. The plan is flexible and versatile taking into account international developments in the field of Genomics and Phenomics.
### 6.4 Effectiveness of arrangements to manage Centre nodes

The nodes will communicate through an already established website. Additional interactions will occur through:
1. Monthly nodal leader phone-conference;
2. Quarterly rotational visits to the nodes;
3. Ad hoc meetings of CIs and nodal leaders at research conferences;
4. Annual research coordination meetings with CIs, Scientific Expert Advisory Committee, and Advisory Board.
Centre participants and line managers at each node report satisfactory arrangements during ARC reviews. Node research is featured in the Centre’s Annual Report.

- Centre website has been enhanced, and also expanded to incorporate an intranet facility allowing secure transactions and communication between all members of the centre across all nodes.
- CIs meet quarterly, rotating between nodes. Node leaders meet more frequently as required.
- The centre three day Annual Symposium at the Sunshine Coast in April was attended by more than 70 members, including staff, students, and members of the Centre Advisory Board and Scientific Expert Advisory Committee.

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### 6.5 The adequacy of the Centre’s Key Performance Measures

1. International benchmarking to research in top international plant research Centres such as the MPI, John Innes Centre and the Danforth Centre;
2. Hosted an annual review of three year.

- Performance criteria for CNRS (France) and John Innes Centre (UK) assessed and adapted for centre use. The ARC Review is scheduled for 27 April 2005.

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### 7 NATIONAL BENEFIT

#### 7.1 Measures of expansion of Australia’s capability in the priority area(s)

1. Widespread involvement of genomic and phenomic technology in Australian industry and academia as evidenced by linkages and research expansion;
2. Improved dialogue between social and life sciences in areas of overlap (i.e., GMO, health, environmental ethics);
3. Quality publications in world-class journals in the priority area;
4. Development of patents and commercialisation;
5. The functioning of the Centre as a focal point for related commercial development institutions

- Interactions with industry and other institutions constantly being expanded (see page 33).
- Academic supervisors and PhD students in philosophy and science/law (studying GMO issues) and aboriginal use of legumes.
- Active engagement in the GMO debate through articles and letters to the editor in the Canberra Times.
- Substantial progress with publications in quality journals in 2004, but the research data generated by the centre in 2004 will lead to significantly more substantial publications in 2005. (See page 22)
- One provisional patent filed (GmNARK), one being prepared for filing (plant derived compounds with potential therapeutic benefits).
- Contracted research being negotiated with one organisation in Australia and two in the USA.

#### 7.2 Case studies of economic, social, cultural or environmental benefits

1. Increased awareness of biomedical benefits of legumes in diets and impact to human health (preparation of a ‘Legume Cookbook’; possible informationals on cereal boxes; ‘Sanatorium’ sponsorship);
2. Increased teaching content on Systems Biology and genome/phenome relations for high school/undergraduate/graduate education;
3. Increased awareness and access of Science Teachers to Genome/Phenome technology and understanding. Work through existing linkages as well as new programs such as the ‘Bright Minds’ project at UQ;
4. Popularise the history of legumes in Australia; e.g., lupins and the west; clover and the sheep, effects of GMO soybean in Australia.

- Preparation of information sheets: Legumes & Health and Cooking Legumes. Preparation of resource materials (Investigating Food) for middle and high school teachers; delivery of teacher workshops on this resource at conferences of the science teachers’ associations of Queensland and New South Wales and Geebung District (QLD) Science Symposium. Work begun on “Healthy Gardens for Healthy Eating” project with Western Cape Training Centre, Weipa (QLD).
- Resource materials on the nitrogen cycle and nodulation, for high school teacher workshop and centre display presented at Australian Science Teachers’ Association conference (CONASTA) in Canberra and NSW science teachers’ conference Thirty soybean and clover nodulation experiment kits prepared and distributed at CONASTA.
- Fourteen other information sheets on different legumes prepared and to be available for distribution in the first quarter of 2005.
## Centre Summary of operating income and expenditure year ended 31 December 2004

<table>
<thead>
<tr>
<th></th>
<th>2003</th>
<th>2004</th>
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</thead>
<tbody>
<tr>
<td><strong>INCOME</strong></td>
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</tr>
<tr>
<td>ARC Centre Grant</td>
<td>2,047,296</td>
<td>2,095,201</td>
</tr>
<tr>
<td>State Government Funds</td>
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<tr>
<td>Qld Govt (see note below #)</td>
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<td><strong>TOTAL INCOME</strong></td>
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<td><strong>TOTAL EXPENDITURE</strong></td>
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<td><strong>Funds carried forward</strong></td>
<td>1,413,147</td>
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# Note: Queensland State Government funding for 2003 and 2004 totalling $1,350,000 to be paid in the first half of 2005. The University of Queensland has invoiced the State of Queensland for these funds.
## Statement of operating income and expenditure
year ended 31 December 2004 per Node

<table>
<thead>
<tr>
<th></th>
<th>2003 Per Node</th>
<th>2003 Centre Total</th>
<th>2004 Per Node</th>
<th>2004 Centre Total</th>
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<td>3,087,296</td>
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**Note:** Queensland State Government funding for 2003 and 2004 totalling $1,350,000 to be paid in the first half of 2005.

The University of Queensland has invoiced the State of Queensland for these funds.
<table>
<thead>
<tr>
<th></th>
<th>2003 Per Node</th>
<th>2003 Centre Total</th>
<th>2004 Per Node</th>
<th>2004 Centre Total</th>
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<td><strong>TOTAL EXPENDITURE</strong></td>
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<td>4,737,685</td>
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<tr>
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<td>1,413,147</td>
<td></td>
<td>-118,703</td>
<td></td>
</tr>
</tbody>
</table>

**In kind contributions**
The Centre is dependent upon substantial contributions by partner university staff, including Chief Investigators, together with access to equipment and infrastructure which is not directly funded by the Centre. In 2004 the dollar value of this in-kind support was estimated to exceed $1.8m across all nodes.
ACKNOWLEDGEMENTS

The Chief Investigators wish to express their appreciation for the cash and in-kind support provided to the Centre by the following groups:

The Australian Research Council
The Vice-Chancellors and Deputy Vice-Chancellors (Research) of the four partner universities.

Faculty of Biological and Chemical Sciences, University of Queensland
School of Molecular and Microbial Sciences, University of Queensland
School of Integrative Biology, University of Queensland
School of Land and Food Sciences, University of Queensland
Research School of Biological Sciences, Australian National University
School of Biochemistry and Molecular Biology, Australian National University
John Curtin School of Medical Research, Australian National University
School of Agriculture and Food Systems, University of Melbourne
Faculty of Land and Food Resources, University of Melbourne
School of Environmental and Life Sciences, University of Newcastle
The State Government of Queensland
The State Government of New South Wales