CONTENTS

4 Vision & Mission
5 Introduction
6 Centre Highlights 2003 to 2008
8 CILR Organisation Chart
9 Centre Governance
12 Director's Report
15 Year in Brief
19 CILR Research Branches Out
22 Research Programs
26 Research Reports
48 Education and Outreach Report
52 Intellectual Property and Commercialisation
54 External Collaborations and Linkages
59 Research Publications 2008
70 Media Attention in 2008
72 Financial Report
74 Major Conference Presentations
79 Key Performance Indicators
86 Staff, Students & Associates
89 Acknowledgements
INTRODUCTION

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 (UQ), the Australian National University (ANU), the University of Melbourne (UM) and the University of Newcastle (UN). The director of the Centre is Professor Peter Gresshoff, who is also Professor of Botany in the School of Biological Sciences at the University of Queensland.

The Centre was established in 2003 with an AU$ 10 million Australian Research Council (ARC) grant over five years. The Centre was awarded a further three-year extension for the period from 2008 to 2010 and received a grant for AU$ 6.9 million over the three years. Cash contributions from partner universities and State Governments, combined with in-kind contributions of staff and facilities, have generated a major AU$ 18 million research effort over eight years.

CILR’S VISION

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

CILR’S MISSION

The CILR is committed to:

Being the leading legume research centre in the world,
Creating an integrated research environment,
Developing and applying cutting-edge molecular genetic tools for research into legume genome-phenome relationships,
Applying new and ethno-botanical knowledge of legumes for the benefit of the environment, health and agriculture,
High quality and specialised education of undergraduate and post-graduate students,
Developing products which have tangible benefits for human health and the environment, and
Providing international leadership and capacity in the study of plant development.

The CILR aims to drive further development of the genomics and phenomics of legumes using cutting-edge molecular biology tools, and to provide a critical mass of human, intellectual and infrastructure resources to function as a world-class research centre.

Research in the Centre is providing critical insights into mechanisms of both meristem and organ differentiation and intercellular communication, by 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 (*Pisum sativum*) and soybean (*Glycine max*). Since 2007, a major research effort has developed into the benefits of the legume tree *Pongamia pinnata* (also known as *Millettia pinnata*) for biodiesel production. This research has already generated significant industrial and commercial interest.

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 a direct impact on agricultural sustainability, environmental quality and potential value-added products for human health. The Centre’s research initiatives have significant intellectual property and commercialisation potential, which will augment Australia’s international standing in scientific discovery, directly benefiting the Australian economy.
Activities conducted by the CILR during its first six years has firmly established the Centre as one of the leading legume research centre in the world. It has increased Australian awareness of legumes for agriculture, environment and health.

The CILR has significantly enhanced the knowledge base relating to legumes in particular and plants in general, through the publication of 327 scientific, peer-reviewed articles, 154 international conference presentations, and 75 international poster presentations. In addition, CILR staff have made 103 presentations and shown 24 posters at Australian conferences.

The Centre has also made a significant contribution to the growth of human capital and the future of Plant Science by graduating 45 PhD and Masters students and 34 Honours students. Graduate outcomes are excellent.

CILR Chief Investigators were active on the editorial boards of 30 different journals, such as Molecular Plant, Biotechniques, Functional Plant Biology, Plant Cell Reports, and Immunology and Cell Biology, and represented plant science of several national and state governmental committees.

Research conducted at all four nodes contributed to a deeper understanding of plant development by elucidation of the genetic and chemical bases of tissue-specific gene expression and signalling molecules. The application of mutants to analyse both nodulation and lateral branching control allowed breakthrough discoveries in genome-phenome research. New signalling molecules (such as strigolactones, CLE peptides, flavones, and Nod factors) joined classical hormones, such as auxin, cytokinins, ethylene and abscisic acid to explain complex regulatory circuits. Functional genomics allowed the discovery of coordinated gene networks in shoot and root apical meristems, roots, leaves and nodules. User-friendly bioinformatic packages were developed to analyse complex data sets. Model legumes extended our ability to transfer technology to crop legumes such as soybean and pea.

The Centre developed and applied reverse genetic approaches to test functionality of newly discovered DNA sequences. Together this body of research has helped to understand plant development, environmental adaption and plant productivity to aid plant improvement and end-user application.

The Centre has expanded its involvement with industry in the last few years, particularly with regards to the research being conducted on the legume tree *Pongamia pinnata*. This tree may have a significantly important role to play in the biodiesel industry. The Centre is currently communicating with as many as 13 companies and organisations in this context. To date, the Centre has accrued $1.9 million in funding from industry sources and is actively involved in a ‘start-up’ company with strong ties to the nursery and biofuel industry.

The work being conducted by Centre staff on aspects relating to the hormone strigolactone also has significant potential for the forestry and horticultural industries and commercial interests will be explored. A provisional patent in this area has been filed. In total 12 patent applications were filed.

The Centre has actively sought to carry out its mandate to provide tangible benefits for human health and the environment. In this context, the Centre is involved in a research program involving indigenous communities in the Northern Territory where data are being collected to understand Indigenous Ecological Knowledge and where several species of legumes are important case studies.

This document presents the Centre’s achievements of 2008. The Annual Reports from the years 2003 to 2007 can be viewed on the CILR website www.cilr.uq.edu.au.
Apart from its renowned researchers, the CILR is privileged to engage with many highly respected government, industry, scientific and university leaders who have made a significant contribution to the development of the Centre by agreeing to serve on the Centre Advisory Board (CAB) and the Scientific Expert Advisory Committee (SEAC).
Centre Advisory Board

The CAB provides advice on the development of strategies and vision for the future of the Centre, and its direction in finance, scientific management, commercialisation, and Intellectual Property management.

The members of the Centre Advisory Board are:

Professor Jenni Brand-Miller
School of Molecular and Microbial Biosciences
University of Sydney
SYDNEY

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

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

Professor Barney Glover
Deputy Vice Chancellor (Research)
University of Newcastle
NEWCASTLE

Scientific Expert Advisory Committee

The SEAC advises the Centre Director on the direction of research and educational programs undertaken within the Centre, and provides leadership at the Centre’s annual research symposium.

The members of the Scientific Expert Advisory Committee are:

Professor Doug Cook
Department of Plant Pathology
UC Davis
USA

Dr Noel Ellis
Department of Crop Genetics
John Innes Centre
UK

Professor Ueli Grossniklaus
Institute of Plant Biology
University of Zurich
SWITZERLAND

Professor Erwin Heberle-Bors
Institute of Microbiology & Genetics
University of Vienna
AUSTRIA

Professor Georgina Hernandez
Centro de Investigacion Sobre Fijacion de Nitrogeno
MEXICO

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

Professor Minoru Kanehisa
Bioinformatics Centre
Institute for Chemical Research
Kyoto University
JAPAN

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

Professor John Mattick
Institute of Molecular Biosciences
University of Queensland
AUSTRALIA

Dr Satoshi Tabata
Kazusa DNA Research Centre
JAPAN

Professor Carroll Vance
Plant Science Research Centre
University of Minnesota
USA

The following table lists formal meetings within the Centre for 2008:

<table>
<thead>
<tr>
<th>Meeting Name</th>
<th>Dates</th>
<th>Venue</th>
<th>Attended by</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual Symposium</td>
<td>17-19 April</td>
<td>Thredbo, NSW</td>
<td>CILR staff and students, members from SEAC and CAB</td>
</tr>
<tr>
<td>CILR Chief Investigators Meeting</td>
<td>18-20 September</td>
<td>Canberra</td>
<td>CILR staff</td>
</tr>
<tr>
<td>CILR Node Leaders Meeting</td>
<td>18-20 September</td>
<td>Canberra</td>
<td>Node Leaders and CDO</td>
</tr>
<tr>
<td>Scientific Expert Advisory Committee (SEAC) Meeting</td>
<td>9 December</td>
<td>Puerto Vallarta, Mexico</td>
<td>SEAC Members</td>
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New plant hormone class discovered

Outstanding discoveries were made. Most significant was the discovery, as featured on the cover of the journal ‘NATURE’, of strigolactones as a new type of plant hormone(s) that inhibits shoot branching in plants. These substances were discovered in partnership with European laboratories by analysing the branching behaviour of garden peas. Associate Professor Beveridge’s group, long a ‘player’ in the field of ‘branching biology’, utilised a combination of genetics, genomics and ‘old-fashioned’ chemistry to discover the plant development controlling role of this new type of compound. The Centre obtained intellectual property protection and now seeks opportunities to extend this finding of this new type of compound.

A new emerging theme in Centre research: the identification of new bioactive small molecules

The discovery of strigolactones reflects a strengthening theme that permeates across the entire Centre: the identification of new bioactive small molecules. This includes work on inhibitory RNAs, secondary plant metabolites, oligosaccharides with inter-kingdom activity and peptides. An example of this is our recent advances in the understanding of complex developmental switching circuits in legume plants through the combination of genetics and biochemical research. Centre scientists discovered the genetic requirements underlying long distance gene expression regulation by inhibitory RNAs (published in the Proceedings of the National Academy of Sciences, USA).

Other new signal molecules were discovered. For example, common plant chemicals called flavones were shown to influence plant development. In addition, preliminary genetic and molecular evidence was obtained regarding the signal substances involved in nodulation control through collaborative initiatives at the UQ and ANLI Nodes. The involvement of peptides belonging to the CLE family in this process provides a significant clue towards universal plant developmental pathways involving peptide hormones. Finally, external support was won at the ANLI Node to engage in proof-of-concept experiments involving derivatives of Nod factors. Nod factors are bioactive in legumes but were controlled by root inoculation with nitrogen-fixing rhizobia. Research in this area was aided by a demonstration of site-directed mutagenesis of the NARK gene controlling AON. In the process, we discovered a key interactor, namely a kinase-associated protein phosphatase, thought to be critical for further signal transduction. The recent development and functional demonstration of reverse genetic tools such as VIGS (Virus Induced Gene Silencing) and TILLING (Targeting Induced Local Lesions in Genomes) now add to our toolbox of RNA interference and gene over-expression for the understanding and prediction of genome- to-phenome linkages.

The Centre’s aim is to understand the genetic and molecular mechanisms of plant stem cell development using legume plants as a convenient and economically and environmentally relevant plant group. This last year marked the sixth year of the Centre’s existence. We have continued to demonstrate that genome-phenome analysis using the legume system as a model for all plant biology is a valuable approach.

Significantly, it was discovered within the UIN Node, that the shoot apical meristem undergoes critical gene expression changes during floral transition. Flowering of a legume is a pivotal process as the resultant fruit (i.e., the seed) is the major economic output. Parallel research was conducted with Affymetrix gene chips on soybean pollen, leaf, root and developing nodules.

Research done at the UIN and ANLI Nodes increased our knowledge of legume differentiation and embryonic formation substantially. The role of several transcription factors was verified and the importance of plant stress in the control of stem cell differentiation was delineated, particularly due to the discovery of the novel transcription factor MsSERF1. Other meristem-specific transcription factors and regulatory molecules were identified.
Addressing fuel security and climate change issues through a new legume system: Pongamia

The Centre, primarily through work at the UQ Node, also achieved a number of successes in its biofuel program focussing on the legume tree Pongamia pinnata. Significant industry interest stimulated funding and there has been strong student interest in the linkage between environmental and molecular science that this new initiative offers. A major plantation was planted in central Queensland with a commercial partner. Most pleasing was the ability of the Pongamia plants to survive the harsh winter conditions. A small but pivotal experimental trial was established in the top plant research groups in the world including at the John Innes Centre, INRA, Strasburg and CNRS.

Training the next generation of plant scientists in Australia

Above all, we had rewarding developments in our human capital. The Centre continued to graduate significant numbers of Honours and PhD students. Furthermore, graduating students won placements in the top plant research groups in the world including at the John Innes Centre, INRA, Strasburg and CNRS.

The importance of the Centre to the future Australian agriculture in the face of rapid climate change

The CILR is well-placed to continue its role in modern analysis of plant biology at both a national and international level. The significance of legumes for human health, environmental quality, sustainability, protein and food security and biofuel production has expanded since the inception of the Centre. The Centre has been quick to identify and seize new initiatives and resources and develop new opportunities. Our predictions in 2002 of increased food and fuel demand, the need to understand plant growth beyond Arabidopsis and widely grown cereal grains remain even more relevant today in a world on economic and environmental sensitivities. I strongly believe that legume research, at a concentrated and synergistic level, is essential for Australia’s future as an agriculturally significant nation.

I thank all members, fund providers and friends of the Centre for their past and ongoing support.

Peter M. Gresshoff
Director
March 2009

Breakthrough discovery

CILR researchers have been part of a major discovery in plant science in 2008 viz. the discovery that strigolactones control shoot branching. Chief Investigator Christine Beveridge collaborated with scientists at INRA, Versailles and the University of Toulouse on this project. Their work was published in Nature, with a prominent display on the cover of the September edition. Since then, national and international media have published numerous articles and radio interviews on the branching hormone strigolactone. See page 19 for more information.

Fueling up for the future

As part of the ‘Natural Science – Social Science Linkage Program’, the CILR is researching the potential use of the legume tree Pongamia pinnata as a source of biodiesel. In the past two years this program has become an essential element of the Centre’s research. In 2008, the UQ Node established field trials in central Queensland and at the University of Queensland’s research farm at Gatton. Major research achievements for 2008 were the development of protocols for Pongamia clonal propagation and the demonstration of the salt-tolerant nature of Pongamia. Prof. Peter Gresshoff and Dr Paul Scott obtained a five-year ARC Linkage grant to develop genetic transformation protocols for Pongamia, as well as funding from the federal government-funded ‘Caring For Our Country’ scheme for a field trial on former canefields of the Sunshine Coast. With regards to the biodiesel research, the Centre has regularly been contacted by industry and government bodies, media and the general public.

CILR enhances its international reputation

The CILR lived up to its reputation as a world-class research facility by presenting achievements in the form of seminars and posters at a large number of national and international conferences. CILR staff and students presented a total of 26 papers and seminars and 15 posters at international conferences, and a total of 14 papers and seminars and 4 posters at conferences in Australia. CILR researchers also visited colleagues all over the world to discuss current and future research collaborations. The nodes were visited by renowned researchers, as well as industry and government representatives from Australia and overseas.
CILR attracts industry funding

In 2007, the CILR concluded its first official commercial research contract involving Pongamia. Several other commercial research programs involving Pongamia for biodiesel are currently being undertaken by the Centre. The CILR has clearly demonstrated its ability to work with industry partners and to further engage with industry to perform cutting-edge research into an area of significant importance to society.

Expanded industry initiatives

The CILR made significant strides in 2008 in expanding its ties with industry and in particular, with the biofuels industry, with a considerable amount of interest being shown in the Pongamia tree for biodiesel production. The success of a pilot project, an initiative between the CILR and an industry partner, which looked at the development of basic biological and biotechnological methods for Pongamia jannata for the purpose of fatty acid and triglyceride production for biodiesel, has resulted in a substantial collaborative research project with the same industry partners. The project will run over three years.

Several other collaborative programs are also currently under way with two City Councils in Queensland, a major national energy/gas producer and supplier, several other energy-related companies and two investment corporations. The CILR has also had several enquiries from major companies in the aviation industry which sees significant benefits to using biodiesel as an aviation fuel.

The CILR was successful in obtaining an ARC Linkage Grant to further the research initiative into the legume tree Pongamia jannata for the biodiesel industry. This grant application was supported by a significant role player in the Pongamia plantation/nursery industry.

CILR protects its intellectual assets

The Centre has continued to identify and exploit commercial opportunities emanating from research across all four nodes. This aspect of the Centre’s activities is seen as very important in ensuring that the Centre maintains its status as a world-class, plant research institute.

The work on the ‘Soybean Nodulation Factor Receptor Proteins’, which shows that there are two copies of the soybean Nod factor receptor gene GmNFR1, and when over-expressed in transgenic roots results in increased nodulation and nitrogen fixation, is now at National Phase and has been registered in the major soybean-producing countries in the world. There has already been some interest in this program and discussions are currently under way with a major, international, plant biotechnology company to commercialise this research.

The ‘Modulators of Angiogenesis’, research program which has shown that compounds derived from the early Rhizobium legume signalling interaction for the onset of nodulation and their derivatives have the ability to influence angiogenesis in mammalian systems (humans and rats), has received ‘proof of concept’ funding which will allow the research to progress to a stage which should attract commercial interest.

Strigolactone

The discovery of a new plant hormone by researchers at the CILR, in collaboration with other international scientists, has gained much attention and has been registered in the major soybean-producing countries in the world. The finding has significant implications for the forestry and horticultural industries. A provisional patent was filed in France protecting this IP in 2008.

The CILR’s involvement with industry partners in the biodiesel arena, has led to the formation of a ‘start-up’ company called Bio Energy Solutions Pty Limited (BES). BES will contract the CILR to carry out all biotechnology-related research related to Pongamia. BES will act as the IP holding company for Pongamia research.

Reaching out

In 2008, the Education and Outreach strategy was extended to include more programs for high school students and the general public. The nodes opened their laboratories to talented high school students to let them gain work experience over a period of one to six months. Information stalls at public events enabled direct communication between

Research strength continues to gain momentum

In 2008, a total of 43 papers were published by CILR researchers, with 20.9% (9) in journals with an impact factor greater than or equal to 5 (according to ISI Web of Knowledge Journal Citation Reports).

The CILR’s research programs have gained significant momentum during the last five years and have enhanced the Centre’s international profile. Through programs focused on differential shoot and root apical meristem gene expression, auxin movements and pools during nodulation and the CILR’s research programs are unravelling the secrets of plant development and control (for more detail see ‘Research Reports’).
The CILR’s newsletter ‘ePOD’ was circulated widely in 2008 to inform Centre researchers and other stakeholders about recent research achievements, publications and other Centre related news. The Centre website continued to be an accessible information tool, used by internal and external researchers, high school students and teachers, and the general public. The media recognised the CILR’s research achievements in 2008 with 16 observed articles in newspapers and magazines, 6 web-articles, 5 radio interviews and 1 appearance on national TV.

CILR RESEARCH BRANCHES OUT

About the discovery of the latest plant hormone: Strigolactone

Plant and animal hormones were first discovered early last century. Hormonal signals were discovered because the loss or damage to an organ could cause changes in the organism, plant or animal, in another location. Particularly for animals, the hormones could be observed as being produced in one place, being active in another, being highly specific and many acting in a dose-dependent way. In plants, the hormone auxin was discovered along these same principles. Removal of the shoot tip caused branching at nodes below and this could be suppressed by adding auxin back to the decapitated stump. Whereas hundreds of hormonal type signals have been identified in animals, only 10 or so are reported so far for plants. But these complex organisms probably require many more hormonal type signals.

Being sessile organisms, plants need to communicate between the shoot and root, and among all plant parts within, to respond to rapidly fluctuating factors such as light, temperature and water availability, and to more stable environmental cues such as photoperiod. Differing from animals, plants have pluripotent meristems that, once initiated, may remain suspended from growth or division. These include axillary meristems that can form additional shoots. The decision to retain these meristematic cells in suspension, or to allow them to divide, relates to the outcome of the interplay of environmental and internal cues. In some cases many different conflicting scenarios must be balanced in order to maintain plant growth and development at its optimum. Plants have a plethora of secondary metabolites. Whilst the factorial combination of a handful of hormones and variable hormone responses may be technically adequate to achieve the complexity required, the question begs to be asked if evolution led to many hormones that are yet to be discovered.

Coming back to the example above, auxin application to decapitated stumps can inhibit branching at nodes below. Yet, soon after this discovery, scientists working on legumes were already realising that another signal that acted as a second messenger for auxin was involved (Robin Snow, 1929). Whereas auxin could only move down the stem, an inhibitory influence had to move up into axillary buds. It wasn’t for seven decades that a branching mutant blocked in such a specific signal that moved upwards in shoots was identified by Centre Chief Investigator Christine Beveridge and colleagues. This mutant was rms1 in the legume garden pea (Beveridge and colleagues, 1997, 2001). The researchers used this mutant to show that RMS1 dependent signalling was required for auxin action (2000).
Thanks to another model plant, Arabidopsis, the mutated gene responsible was identified in collaboration with Ottoline Leyser in York, and Catherine Rameau in Versailles (2003). It was an enzyme, supporting the idea that RS1 acts on a biosynthetic pathway. Beveridge and fellow researchers showed it was auxin responsive, particularly in relation to decapitation studies (2003, 2005), supporting their previous physiological data that it may control the biosynthesis of a second messenger for auxin.

Over the last five years, researchers in another field were escalating research on a little known plant-derived signal that promotes seed germination of parasitic weeds and stimulates plant symbiosis with mycorrhizae. The compound was named strigolactone after the devastating weed Striga and because it is a terpenoid lactone. Matusova and Bouwmeester from Wageningen suggested that strigolactones were carotenoid derived (2005). This was the starting point for a flurry of activity across the globe, with the team in Versailles collaborating with Wageningen, Soizic Rochange in Toulouse and Christine Beveridge’s group at the CILR in Brisbane.

The ms1 mutant was unable to effectively stimulate seed germination of the parasitic weeds or mycorrhizal symbiosis. Moreover, the mutant was deficient in strigolactones. Finally, the scientists were able to show that exogenous synthetic strigolactone inhibited bud outgrowth in ms1 plants whether applied directly to the buds or supplied in the vascular stream well below them. The strigolactone response was also dose-dependent. In order to show this effect was not specific to legumes, they showed that the equivalent mutants in Arabidopsis could also respond to strigolactone. Importantly, CILR researchers and collaborators were able to show that the effect of strigolactone is specific to the branching pathway by showing that in both species it had no effect on branching mutants previously thought to be blocked in response to the novel hormone.

Having discovered the hormonal role of strigolactones in shoot branching, various hypotheses for its action can now be tested. At the start of 2009, Christine Beveridge and other CILR researchers showed that strigolactones likely function as a second messenger for auxin action, more or less according to their model proposed in 2000 based on physiological studies. Some of the key questions that remain include: narrowing down the bioactive strigolactone. For example, is the bioactive compound derived from strigolactones or are strigolactones themselves the active compound? How do auxin, strigolactones, and cytokinin (known to promote shoot branching) interact? Back to the original question, rephrased more specifically, is strigolactone the last plant hormone to be discovered, or do master regulators like auxin mask the work of other unknown hormones?
CILR RESEARCH PROGRAMS
IN RELATION TO THE NATIONAL RESEARCH OBJECTIVES

National Benefit
The CILR, through its individual research programs is maintaining and developing Australia’s international standing in research areas of national priority. The CILR is committed to scientific research and discovery which is both relevant and beneficial to production, health and the environment.

In order to place Australia at the forefront of world research, the CILR is conducting high quality research in all of the Australian government’s four research priorities: An Environmentally Sustainable Australia, Promoting and Maintaining Good Health, Frontier Technologies for Building Sustainable Australia, Promoting and Developing Australia’s National Benefit.

An Environmentally Sustainable Australia
Through its research programs and education and outreach program, the CILR is increasing the awareness and knowledge of the value of legumes for Australian agricultural sustainability.

Water is a critical resource, not just to Australia but to the entire world. Research currently underway at both the ANU and Melbourne Nodes is unravelling knowledge about how root meristems function, develop, and react to hormonal changes. The identification of meristem-specific proteins may enable us to elucidate how plant shape is controlled, particularly with respect to bioactive peptides which have been shown to control the activity of cells in plant meristems.

Advancing our knowledge of the relationship of pluripotent cells and their commitment along a pathway to differentiation and root formation, along with understanding how both nitrogen and phosphorus can affect this development, is vital. Integrated with research emerging from the Newcastle Node showing in vivo root organogenesis, there is the potential to control root initiation, growth and architecture. This has associated agronomic and environmental significance in relation to nutrient uptake, improvement of soil structure, and drought resistance.

An understanding of nodulation, and how to manipulate it through genetic transformation, is proving useful in developing plants that can withstand high acid soils. Research at the UQ Node is elucidating the regulation of auxin transport are directed towards being able to manipulate auxin transport in the plant, to control the formation of cell divisions and organs.

With an increase in oil prices and the threat of reduced fossil fuel availability, Australia is looking towards developing new and improved energy sources, and capturing carbon dioxide. Plants have a unique ability to capture sunlight and carbon dioxide and convert them into a usable form of energy via photosynthesis. This ability is being harvested by the CILR’s UQ Node through its new research program investigating the potential of legumes as sources of alternative energy. The little known legume, *Pongamia pinnata*, can grow on agriculturally marginal land and produces seeds with large oil content. The oil can be converted into biodiesel via a simple chemical process. Most diesel engines currently in use can run on biodiesel with no, or only minor modifications. The creation of a new sustainable and environmentally friendly biodiesel industry will not only create new jobs for Australians, but decrease greenhouse gas emissions while capturing carbon dioxide.

Promoting and Maintaining Good Health
Stem cell research has the potential to gain a greater understanding of human health, growth, disease and genetic inheritance, thus leading to an overall increase in Australia’s social, medical and population health. However stem cell research is not limited to animals. Research into plant stem cells, such as that being conducted within the Melbourne and UQ Nodes, has led to discoveries regarding cell differentiation and growth. As plant and animal systems are not very different, advances made in the field of plant stem cell research may be applied to animal stem cells.

Major breakthroughs in human health have been made at the ANU Node, with the discovery that Nod factors have activity within mammalian systems. Nod factors are compounds released by *Rhizobium* bacteria prior to the establishment of a symbiotic relationship with leguminous plants. Through a collaboration within the ANU Node, it has been found that certain nod factors can positively or negatively regulate angiogenesis, the formation of new blood vessels. Pro-angiogenic compounds, those that promote the formation of...
Legumes provide a superior system for studying the mechanisms of gene regulation, in which small RNA genes play a central role.

new blood vessels, have potential application in wound healing and other associated therapies. Anti-angiogenic compounds can be used to treat cancers, as a key step in metastasis as tumours developing their own blood supply.

Recent results emerging from the ANU Node are clearly showing that microRNAs are responsible for the regulation of tumour growth. Legumes provide a superior system for studying the mechanism of gene regulation, in which small RNA genes play a central role. Small RNA genes are very similar to microRNAs. The understanding and subsequent possibility of manipulation of gene expression will not only have profound consequences in agriculture and nutrition, but because of the similarity to animal systems, also in health and medicine.

Through the Education and Outreach program, the CILR promotes consumption of legumes as a healthy diet constituent.

The ANU Node has developed a number of smart information systems for data management and web-based bioinformatics research. Mclip and MIRAT, both web-based services, were created to detect unknown motifs in protein sequences and analyse putative non-coding RNA genes in legumes. In addition, MapMan, a software tool developed to visualise gene expression data, has been improved to increase its use and efficiency. These advances will help strengthen both the CILR’s and ANL’s research capacity and international scientific reputation.

Leguminous seeds such as soybeans, chickpeas, peas and peanuts, as well as sprouts such as mung beans and alfalfa provide huge nutritional benefits, due to their high protein content, healthy oil balance, and presence of phytoestrogens.

Frontier Technologies for Building and Transforming Australian Industries

Knowledge and new innovation drive economies. However innovation requires basic research in order to increase our understanding of the underlying concepts and theories. The CILR, as a basic research institute, is augmenting Australia’s knowledge economy via the creation of knowledge regarding plant architecture, growth, nodulation and hormonal control. Biotechnology, as a frontier industry, is one of Australia’s key strengths, and the CILR is Australia’s premier legume biotechnology research institute.

The CILR’s education and training scheme, aimed at mentoring the next generation of scientists, is helping Australia build a critical mass of researchers in the area of plant science. A total of 13 CILR students have graduated in 2008, with many going on to new positions within the Australian and international plant science industry.

Through its Natural Science – Social Science Linkage program, the CILR is investigating GM technology, ethical, social, economic and political issues, as well as the scientific ones. A key role of this program is to penetrate the rhetorical fog surrounding these issues, and dispassionately examine the value assumptions which underlie these concerns.

Also through the Natural Science–Social Science Linkage program, CILR and EMSAH (English, Media, Studies and Art History) PhD student Miles Holmes has aided the women of the Warlpiri community of Lajamanu, Northern Territory, to become involved in the ‘wild harvest’ enterprise. This tribe is now utilising its rich store of plant knowledge to harvest, clean and sell seeds of the legume species Acacia coriacea, Acacia cole and Acacia venosa. Although this industry is not new, Miles has enabled this particular tribe to become involved by establishing contacts with industry, and demonstrating the correct cleaning technique required by the buyers of the seed.

The CILR is a part of GTTAC, the gene technology regulator of Australia. Finally, the CILR is involved in a large number of collaborative research projects with research institutes throughout Asia, Europe and the United States.

Legumes provide a superior system for studying the mechanisms of gene regulation, in which small RNA genes play a central role.

Through its Natural Science – Social Science Linkage program, the CILR is investigating GM technology, ethical, social, economic and political issues, as well as the scientific ones.

Safeguarding Australia

Australia is currently free of many of the diseases affecting primary production around the world. In order to maintain this status, research is required into disease resistance and reaction to new diseases. The CILR is contributing to this area by investigating how plants react in defence, and how these defence pathways can be manipulated.

Australian security and safety can be enhanced and strengthened through greater collaboration within the research community and international collaborative approaches to new science and technologies. The CILR is highly collaborative research network. We are governed by an international Scientific Expert Advisory Committee. Staff and students attend and contribute at international conferences and symposia. The Centre regularly receives international visitors for seminars and potential research collaborations. The Centre Director is part of GTTAC, the gene technology regulator of Australia.

Finally, the CILR is involved in a large number of collaborative research projects with research institutes throughout Asia, Europe and the United States.
The new branching hormone

The last 12 months have seen a great breakthrough, namely the discovery that strigolactones control shoot branching. This work, published in Nature, stemmed from a long collaboration with Catherine Rameau at INRA, Versailles on branching in *Arabidopsis* mutants and with colleagues working on strigolactones, particularly, Soizic Roche at the University of Toulouse. Strigolactones were previously known as signals that are associated with mycorrhizae, indicating they may be strigolactone deficient. Indeed this turned out to be the case. Finally, synthetic strigolactone application to the synthesis mutants restored branching inhibition, whereas this was not the case for the response mutants. This story held true for *Arabidopsis* and pea in our hands, and for rice and *Arabidopsis* in a paper published in the same issue of *Nature*.

With the discovery of strigolactone as the novel branch-inhibiting hormone, we are now able to address many questions. From a microarray study in collaboration with Georg Wellmer’s group, we have isolated new branching mutants in *Arabidopsis*. One of these mutants may have a defect in the strigolactone biosynthesis pathway, it shows a response to strigolactone application and the mutation has disrupted an enzymatic gene. Testing the response to strigolactone of these and other already described different classes of branching mutants is allowing us to place different genes up- or down-stream of strigolactone action. Moreover, we are directly testing hypotheses for strigolactone-auxin-cytokinin interactions. For example, in a manuscript recently accepted, we have shown that strigolactone can repress branching even in auxin-depleted decapitated plants and that the best hypothesis for strigolactone action is that it acts as the long sought after second messenger for auxin in apical dominance (Snow, 1929).

Molecular physiology of shoot branching

We have provided new evidence through stem girdling that auxin depletion is not enough to promote branching, even where buds can be induced to grow out by decapitation or cytokinin application. Auxin treatments affect the expression of strigolactone biosynthesis genes, whereby auxin depletion leads to depleted gene expression. Usually this depletion in expression of strigolactone biosynthesis genes leads to branching. However, we argue in *Plant Physiology* that if cytokinin gene expression is not activated, branching will not follow, even if the plants are both auxin and strigolactone depleted. We also show that apical dominance and correlative inhibition can still operate in *rms* mutant plants. As in our previous work, we are able to highlight the progression of buds through different control points from dormancy to sustained growth.

Two students in their PhD studies, Alice Hayward and Tanya Brech, have shown that auxin regulation of strigolactone biosynthesis genes, a major influence in pea, is conserved in *Arabidopsis*. At least for pea, in addition to transcription, a substantial effect of auxin is mediated through transcript degradation, which is an exciting and relatively uncharted mechanism for hormonal regulation of gene expression in plants.

Molecular characterisation of legume crop shoot apical meristems

Legumes are the second most important family of crop plants – they are widely used as a food and feed source. In addition, legumes are particularly important for sustainable agriculture because of their ability to fix atmospheric nitrogen. We are particularly interested in exploring the molecular basis of meristem functionality in legumes, which diverged from *Arabidopsis* approximately 92 million years ago. We focused on the garden pea (*Pisum sativum*), a classic model species for crop and plant development studies. To this end, 10,346 EST sequences representing 7,611 unique genes were generated from pea SAM cDNA libraries. These sequences, together with previously reported ESTs, were used to construct a 12K oligonucleotide array used to identify genes exhibiting differential shoot apical meristem (SAM) expression, as compared to the auxillary meristem, root apical meristem, and non-meristematic tissues. We identified a number of genes that are predominantly expressed in specific cell layers or domains of the SAM, and thus are likely components of the gene networks involved in stem cell maintenance and initiation of lateral organ primordial cells. In situ hybridisation confirmed the spatial localisation of some of these key genes within the SAM. Our data also indicate the diversification of some gene expression patterns and functions in legume crop plants.
Flowering is central to crop yield hence the continuity of our food supply. However, molecular control of flowering in important legume crops, such as soybean, is largely unknown.

Gene expression profiling of mature soybean pollen

The current knowledge of the pollen transcriptome is limited to the model plant systems Arabidopsis thaliana and Oryza sativa, which have tri-cellular pollen grains at maturity. Soybean pollen are however bicellular at maturity. In collaboration with the UQ Node, we have addressed a transcriptional profile of mature bi-cellular soybean pollen. Compared to the sporophytic transcriptome, the soybean pollen transcriptome revealed a restricted and unique repertoire of genes, with a significantly greater proportion of specifically expressed genes and unique repertoire of genes, with unknown and novel genes.

Soybean floral transition and hormonal pathways in shoot apical meristem

Flowering is central to crop yield hence the continuity of our food supply. However, molecular control of flowering in important legume crops, such as soybean, is largely unknown. The focus of our work is to study molecular events underlying the conversion of the SAM into a floral meristem. Our data highlighted an increase in ABA levels in the shoot apical meristem during this developmental change. In addition, the striking occurrence of abiotic stress-related transcription factors but also genes of these genes, many new mutants have been identified that are defective in systemic spreading of gene silencing. One of these is unique in that it is required for transmission of a mobile silencing signal from the root. We have mapped the location of the mutation in the genome and are in the process of cloning the affected gene.

We have discovered seven genes involved in the reception of an RNA silencing signal in newly formed shoot apices of plants.
Defective embryo and meristems (dem) and plant development

We have shown that dem proteins are required for both cell division and cell differentiation in plants. Consistent with this fundamental role at the cellular level, these proteins are also required for formation of all tissues affecting plant architecture, i.e. shoot and root meristems, leaves for capturing solar energy, and roots for absorbing water and nutrients from the soil. Through genetic and biochemical analysis, we discovered that dem proteins exert their fundamental effects on cellular processes via interaction with Ran proteins involved in nucleocytoplasmic transport of proteins and RNA and the export of microRNAs from the nucleus to the cytoplasm. MicroRNAs control the expression of many, if not all, development genes in both plants and animals. MicroRNAs have therefore played a fundamental role in the evolution of kingdoms (e.g. plants), phyla (e.g. legumes) and individual species (e.g. soybean). The aims of this project are to discover: i) microRNAs that have remained conserved in the evolution of higher plants (by comparison of soybean to other higher plants species), ii) microRNAs that are specific to plant meristems (stem cells) and mature leaf cells (that capture solar energy via photosynthesis), and iii) microRNAs that contributed to the evolution of legumes, and more specifically, to the evolution of soybean. Hundreds of thousands of microRNAs have been sequenced from soybean meristems and leaves, and many of these have been characterised for expression by microarray analysis. The majority of microRNAs are more abundant in leaves than meristems. However, we have identified small number of microRNAs that are enriched in meristems, and some of these are conserved between soybean and distantly related plant species.

Dr Michael Djordjevic – Node Leader and Chief Investigator – Australian National University

The group led by Chief Investigator Djordjevic has had a highly productive year publishing five research papers in high citation impact journals and three conference papers. The highlights follow.

Bioactive molecule discovery and analysis

A key theme of our research is the discovery of low molecular weight bioactive compounds. Our research continued along four lines: the bioactivity of flavonoids in plants, our continued work on Nod factors and their role in modulating angiogenesis, the discovery of new bioactive plant molecules that also regulate angiogenesis, and the bioactivity of peptides in plants systems.

The bioactivity of flavonoids in plants

Flavonoids are low molecular weight secondary metabolites that play important roles in plant biology. A long-held belief is that flavonoids influence plant architecture. However, the best supporting evidence was recently refuted when an architectural phenotype of a well characterised flavonoid-deficient mutant, tt4, was found to be due to another background mutation and not defective flavonoid synthesis. We recently undertook a systematic phenotypic study and showed that flavonoid-defective Arabidopsis mutants display a wide range of alterations to root and shoot development. Our study reaffirmed the link between flavonoid alterations and plant architecture. It showed that flavonoid mutants affected at different steps in the flavonoid pathway are affected to varying degrees in a myriad of developmental processes. The traits affected include alterations to root growth, lateral root density, root hair development and length, shoot/lower organ number, overall architecture and stature and seed organ density. Importantly, normal root architecture can be restored for some mutants by direct flavonoid supplementation which enables molecular complementation rather than genetic complementation.

Nod factor control of angiogenesis

In collaboration with Professor Chris Parish at the John Curtin School of Medical Research we have investigated whether Nod factors (potent plant active signal molecules required for root nodule formation) are biologically active in mammalian systems. We have shown that Nod factors and structural variants can inhibit or enhance in vitro angiogenesis in rodent and human model systems in a concentration-dependent fashion. Angiogenesis is a very tightly controlled process where new blood capillaries grow from existing blood vessels. In adult humans, almost every tissue lacks substantial angiogenesis due to a fine balancing of endogenous pro- and anti-angiogenic factors. One exception is the cyclical events associated with menstruation. Aberrant angiogenesis underpins many disease symptoms in humans. Excessive angiogenesis may contribute to disease states such as rheumatoid arthritis, psoriasis, blindness and cancer. Conversely, insufficient angiogenesis can contribute to infertility, ulcers, etc.
stroke and heart disease. Therefore, the development of potential therapeutics that either stimulate or repress angiogenesis is a significant challenge. We have linked bioactivity to molecular structure, showing that even subtle changes are critical for different types of physiological activity. In generic terms, Nod factors stand apart from other anti-angiogenic drugs. As novel structures, from a novel source, and with a potentially novel mode of action, these molecules may well form a unique new class of both anti-angiogenic and pro-angiogenic drugs with potential therapeutic value. We have recently signed a research agreement with ANU Connect Ventures to synthesise a series of Nod factors, to do proof-of-concept experiments to confirm the mode of action, and to begin to determine their molecular nature.

New angiogenesis modulating factors from plants

Our previous research demonstrated that potent plant bioactive molecules, called Nod factors (bacterial lipo-chitooligosaccharides), can also be active in mammalian systems. We discovered a potentially new class of pro- and anti-angiogenic signalling molecules. From this work we examined fractionated plant material which we hypothesised would be enriched in bioactive signalling molecules. From this we discovered a potentially new class of pro- and anti-angiogenic compounds. The objective of our current experiments is to determine the molecular nature of the new molecules.

Plant CLE peptide hormones and apoplast proteomics

Recently, CLE (CLV3-Endosperm Surrounding Region related) peptides have been shown to control stem cell differentiation in plants in a process that cannot be complemented by metabolite hormones. These peptides seem to act as 12 amino products that are processed from a larger precursor protein. How this processing occurs is unknown. We have examined the biological activity of synthetic CLE peptides in legumes, Arabidopsis and rice and found that CLEs have vastly different biological potency and function in different sizes and potency.

Phosphoproteomics

We have engaged in a fruitful collaboration with the Gresshoff laboratory at the UQ Node as a proof-of-concept experiment to examine our ability to determine the phosphorylation sites on molecules of biological importance to long range signalling in legumes. The nodule autoregulation receptor kinase (NARK) gene regulates the nodulation signals in several legumes via a long range (root-to-shoot and shoot-to-root) signalling system. NARK perceives a long range root-to-shoot signal in young leaves. Our collaborators expressed and purified the putative catalytic domain of wild type and defective NARK in Escherichia coli. Using mass spectrometry we determined the auto-phosphorylation and trans-phosphorylation sites of wild type NARK proteins in vitro.

Professor Peter Gresshoff – Director and Chief Investigator – University of Queensland

Identifying legume autoregulation of nodulation signals

AON Signal Molecules

A soybean-based bioassay was developed to detect the root-to-shoot AON factor, Q, in xylem sap. A number of soybean genes that could encode Q CLE peptides have been identified and candidates have been synthesised in collaboration with Prof. Robert Capon (UQ) and Dr. Ute Roessner (UMelb), and tested using our bioassay. In collaboration with Dr. Mike Djordjevic (ANU) and Dr. Randy Caplan (UQ), HPLC and LC-MS technologies are now being used in conjunction with the petiole-feeding bioassay to help identify the SDI molecule.

Post-NARK Signals

A number of genes acting downstream of NARK were recently identified using transcript profiling (Kinkema and Gresshoff, 2008) and site-directed mutagenesis (Miyahara et al., 2008). Whether these genes function in AON is being evaluated using Virus-Induced Gene Silencing (VIGS) in collaboration with Prof. Said Ghabrial (UKentucky). Additional genes of unknown function are also being tested to identify their role in AON. VIGS, following rhizobia-inoculation are being investigated using Q-TOF technology.

Various properties of the shoot-derived AON factor, SDI, have been further characterised using the novel petiole-feeding bioassay.

Various properties of the shoot-derived AON factor, SDI, have been further characterised using the novel petiole-feeding bioassay (Lin et al., Plant Physiology in review). In collaboration with Prof. Robert Capon (UQ), HPLC and LC-MS technologies are now being used in conjunction with the petiole-feeding bioassay to help identify the SDI molecule.

Our previous research demonstrated that potent plant bioactive molecules, called Nod factors, can also be active in mammalian systems.
As the public’s awareness of biofuels grows, the importance of Pongamia as a sustainable feedstock for biodiesel production continues to emerge.

Pongamia is an out-crossing species and for it to become a feedstock for the Australian biodiesel industry, methods are needed for clonal propagation.

together with soybean TILLING, and RNAi approaches in hairy roots provide useful reverse genetic tools.

Determining early nodule development events in soybean

Early Nodulation Events

Using Real Time PCR, deep sequencing, reporter gene fusions, and Laser Capture Microdissection technologies, together with the soybean genome database, we are profiling the spatial and temporal regulation of gene expression within soybean roots following rhizobia-inoculation. This approach will also enable us to identify novel genetic pathways required for nodulation.

Acidity and Nodulation

Overexpression of the soybean Nod factor receptor gene (GmNFR1a) recently identified and patented, together with improved nodulation events, even in the presence of inhibitory acid soil conditions. This finding is being confirmed by hairy root transformation using the red root vector, doped. In addition, a detailed analysis of the effects of soil acidity on soybean nodulation, including varying the degree of acidity and performing time-course and permissive/restrictive-tests, was undertaken. Findings from these studies have provided the foundation for transcriptome deep sequencing experiments.

Pongamia biotechnology for sustainable biodiesel production

As the public’s awareness of biofuels grows, the importance of Pongamia as a sustainable feedstock for biodiesel production continues to emerge.

Hocart (ANU Node) conducted fatty acid analysis.

Success was seen in new funding, research findings and publications. Professor Greshoff and Dr Paul Scott secured a five year ARC Linkage Grant to develop genetic transformation for Pongamia. Furthermore funding was obtained from the federal government-funded “Caring For Our Country” scheme to determine whether or not Pongamia has the potential to form part of a new, sustainable agricultural industry on the acid sulphate soils of ex-canelands of the Sunshine Coast. The past year saw the research group publish the first comprehensive review of Pongamia in the journal Bioreg Res.

An important milestone was the establishment of two experimental field trials, one at Spring Gally in central Queensland and the second at the UQ Gatton campus. The Spring Gally trial site, planted in May 2008, has been successful in showing that Pongamia can thrive in the harsh climatic conditions encountered in northern inland Australia. Trees at the Gatton trial site are forming part of a long-term life cycle analysis.

Pongamia is an out-crossing species and for it to become a feedstock for the Australian biodiesel industry, methods are needed for clonal propagation. To meet this demand we have successfully developed protocols for the propagation of Pongamia by both multiple bud culture and shoot cuttings. In addition, in support of the cultivation on so-called marginal (LAP) lands of northern Australia we demonstrated the salt-tolerant nature of Pongamia by both multiple bud culture and shoot cuttings. Furthermore, in support of the cultivation on so-called marginal or low agricultural productivity lands of northern Australia we demonstrated the salt-tolerant nature of Pongamia and its symbiosis with rhizobia. Pongamia grows and forms nitrogen fixing nodules at salt levels well beyond the maximum salinity recommended for the irrigation of crops.

Pongamia shows sensitivities to hormones in a mechanistic fashion, we isolated insensitivity mutants of Lotus japonicus MG-20 by EMS mutagenesis using root growth inhibition (for ABA) and the seedling triple response (for ethylene) as screening criteria.

Two ethylene insensitive mutants were characterised. One, the dominant triple response mutant ENIGMA, was mutated in l/en1, part of the ethylene response chain. In contrast to the similar sickle mutant in Medicago truncatula (also mutated in En1), nodule numbers in near-constitutive wilty phenotype associated with its inability to regulate stomatal opening. BEYMA did not show alteration of nodule number control, as in the absence of added ABA the number and patterning (but not size) of nodules formed in the mutant was similar to MG-20.

Transgenic lines containing the Atabi1 gene were created in Lotus japonicus. The lines generated showed ABA insensitive phenotypes, such as defective stomatal opening leading to wilty and frequent drying of branches and leaves. However, like Beyma the transgenic lines did not show alteration in nodule number control but did show an alteration in nodule size.

Two ethylene insensitive mutants were characterised. One, the dominant triple response mutant ENIGMA, was mutated in l/en1, part of the ethylene response chain. In contrast to the similar sickle mutant in Medicago truncatula (also mutated in En1), nodule numbers in
Auxin is a central regulator of lateral root development.

1. Auxin is a central regulator of lateral root development. Because of the similarities between lateral root and nodule development we hypothesised that auxin transport and signalling are important for nodule development and that the regulation of auxin is distinct during both organogenesis programs (Mathesius, 2008). We found previously that local auxin transport inhibition in the root is required for nodulation initiation. To test whether auxin signalling is differentially required for nodule and lateral root initiation, we have silenced various auxin response genes in *Medicago truncatula*. This has resulted in the generation of plants with increased auxin response, but normal auxin transport. These transgenic roots show decreased nodule numbers but normal lateral root formation, suggesting that auxin signalling is a negative regulator of nodulation. In contrast, auxin signalling has been shown to be a positive regulator of lateral root initiation in many studies. It is possible that the early auxin transport inhibition during nodule formation leads to reduced auxin signalling which then facilitates nodule initiation.

A second hypothesis is that shoot-to-root, or long distance, auxin transport inhibition is linked to the regulation of nodule numbers in *Medicago truncatula*. We have demonstrated that long distance auxin transport is reduced by inoculation with rhizobia. In collaboration with Dr Julia Frugoli (Clemson University, USA) we have examined long distance auxin transport in the autoregulation mutants *saw* (super nernerary nodules) and *ls* (like *sun* supernodulation). Both mutants have defective long distance auxin transport which does not respond to inoculation with rhizobia, confirming that long distance auxin transport regulation is correlated with nodule numbers.

2. Because of the known roles of flavonoids as auxin transport regulators, we have investigated the interactions between flavonoids and auxin transport during nodulation. Our hypothesis is that flavonoids are required for auxin transport regulation during nodulation. We have shown before that flavonoid-deficient plants are unable to regulate auxin transport when inoculated with rhizobia. However, these flavonoid-deficient plants are still able to develop normal lateral roots and root galls formed by root knot nematodes, indicating that the requirement for flavonoids is specific to nodulation (Wasson et al., 2009). We are currently investigating whether the reason for this specificity is because auxin transport inhibition is only required for nodulation but not lateral root and root gall initiation.

Another hypothesis we are testing is whether cytokinin signalling is required for the induction of flavonoids that regulate auxin transport. Cytokinin is a crucial early regulator of nodulation and lateral root formation, respectively positive or negative. In collaboration with Dr Florian Frager (CNRS, Cal-ain Yeete, France) we used a cytokinin-insensitive mutant (with reduced nodulation) to determine whether it displays normal flavonoid accumulation and auxin transport regulation. Our current results suggest that auxin transport regulation is defective in the cytokinin-insensitive mutant. Whether the autoregulation gene, *SUNN*, mediates the changes in root architecture to altered C/N ratio via regulation of shoot-to-root auxin transport. We found that the C/N ratio significantly alters the shoot-to-root auxin transport and that this is dependent on *SUNN*. However, total shoot-to-root auxin transport was not correlated with lateral root or nodule numbers. Instead, the relative change in auxin transport after inoculation was linked to nodule numbers, and was dependent on the C/N ratio and the *SUNN* gene. We conclude that *SUNN* is required for sensing of the C/N ratio in the shoot, and that this leads to changes in long distance auxin transport. However, our results also suggest a parallel, *SUNN*- independent and auxin transport independent effect of the C/N ratio on root architecture.

4. A fourth hypothesis is that auxin transport inhibition is only required for nodulation but not lateral root and root gall initiation.

Auxin transport inhibition is only required for nodulation but not lateral root and root gall initiation.
CLE peptides interact with leucine-rich repeat receptor-like kinases and regulate meristem activity in plants.

When body cells become abnormal and divide without control or order, a cancer may result because there has been a general loss of genome integrity that alters the structure, function and/or abundance of gene products.
mutation has to arise in a cell that is appropriately placed and to confer complex new properties on that cell. The evidence suggests that a single mutation in general is not enough; most cancers develop only after multiple mutations have occurred in a single cell lineage. Thus, the body of an adult vertebrate exists in a state of dynamic equilibrium, equipped with homeostatic controls on cell proliferation and various mechanisms to keep cells from straying from their proper places – cancers are relatively rare but may be very difficult to treat once spread from site of origin.

**CILR program on “bioactive molecules that bridge between plant and animal systems”**

Epidemiology studies have led scientists to suspect that diets rich in soybean products are associated with lower cancer mortality rates, particularly for cancers of the colon, breast, ovary and prostate, in countries such as China and Japan. These particular malignancies increased in incidence as consumers were shifted onto Western diets. Colon cancer is one of the most frequent malignancies.

The average human intestine absorbs nutrients and defends against would-be pathogens. The gut constitutes a two-dimensional structure folded into the proliferative crypts and the differentiated villi of the small intestine and crypts only in the colon – large intestine. There are four different cell types in the intestinal epithelium, which arise from the stem cells at the base of the crypts. The gut’s topology of villi and crypts, combined with its amazing rate of unprecedented self-renewal, makes it particularly vulnerable to malignant transformation. Several models of the genetic origin of colon cancer exist, but the situation is not clearly resolved. Currently, there are many representative cell lines of colon cancer cells available, which result from mutations at different stages of cell development. To examine the possible relationship between human diet and protection against cancer, we have developed a rapid bioassay of the growth of a chosen colon cancer cell line, LIM1863, which forms organoid structures in culture. Our first bioassay is to take advantage of the Epithelial-Mesenchymal Transition (EMT) shifts observed with the LIM1863 cell line where its three-dimensional structured organoid architecture can be converted into a migratory two-dimensional cell type (monolayer) in response to added cytokine TGF-beta. In a series of reconstruction experiments we have grown LIM1863 cells in 24-well plates with a combination of adding cytokine factors, either tumour necrosis factor-alpha (TNF-alpha) or transforming growth factor-beta1 (TGF beta1) or a combination of both. Morphological changes in the organoid phenotype have been assessed by light microscopy. Inhibition control assays use cells pre-treated with the MEK inhibitor PD98059 and then the cytokines added.

We have started to try to interfere with this growth shift by adding various legume compounds isolated during our CILR program, such as the isolated flavonoids.

**Plant stem cell research**

We have made several advances in the understanding of plant stem cell biology. We have used an in vitro system for generating roots or somatic embryos and applied proteomic, transcriptomic and quantitative real time PCR approaches to the generation of these developmental processes. We have identified key genes (transcription factors, microRNAs and signalling molecules) that are involved in the induction of in vitro somatic embryogenesis and root formation in Medicago truncatula. Now we are elucidating the roles of these genes in root formation and under stress conditions using functional genetics and other molecular and cellular techniques.

**The molecular mechanism of the induction of somatic embryogenesis**

In addition to gaining insight into the ability to produce embryos and then plants from cultured cells, necessary for genetic modification, this work increases understanding of plant development, stem cells and apomixis.

Signalling in the induction of embryo formation from somatic cells in Medicago truncatula Medicago truncatula (genotype 2HA) can produce numerous somatic embryos (SEs) when leaf explants are cultured on a basal nutrient medium containing the plant hormones auxin and cytokinin. We have obtained evidence for a series of key signalling steps in the induction and development of somatic embryos. The first signals perceived by the explant on excision are reactive oxygen species (ROS), which are essential for the first cell divisions. Secondly, the stress hormone ethylene is synthesised. The auxin and cytokinin in the culture medium, together with the newly synthesized ethylene, have specific roles in SE induction. SEs are derived from two types of stem cell – firstly, vein procambial cells and secondly, stem cells derived from dedifferentiated mesophyll cells. These stem cells become
committed ‘embryo’ stem cells, in part due to the action of the WUSCHEL homeotic transcription factor, whose expression is cytokinin dependent. Transcription of the SERK1 (Somatocyte Embryo Receptor Kinase) gene follows and marks cells that will differentiate into SEs. We have detailed evidence that ethylene, auxin and cytokinin are necessary for the induction of the transcription factor MtSERF1 (SOMATIC EMBRYO RELATED FACTOR1) which signals embryo development after about two weeks in culture.

Expression of the SOMATIC EMBRYOGENESIS RECEPTOR-LIKE KINASE (SERK1) gene is associated with developmental change in the life cycle of Medicago truncatula. SERK genes were initially demonstrated to play a role in somatic embryogenesis, but the view of their role in plant development has broadened. The Medicago truncatula MtSERK1 gene has been associated with somatic embryogenesis and in vitro root formation. In order to further study the role of MtSERK1 in development, SERK1 promoter-driven GLU expression was studied in A. tumefaciens-transformed cultures and regenerated plants, in A. rhizogenes-transformed root clones and in nodulation. MtSERK1 expression is associated with new cell formation. When somatic embryos form, GLU staining occurs throughout embryo development. Zygotic embryos show expression until the heart stage. The MtSERK1 in planta studies reveal a number of interesting expression patterns. There appear to be three types: 1. Expression associated with the primary meristems of the root and shoot and the newly formed meristems of the lateral roots and nodule. 2. Expression at the junction between one type of tissue or organ and another. 3. Expression associated with the vascular tissue procambial cells. MtSERK1 expression is associated with developmental change, possibly reflecting cellular reprogramming.

The nature of the super-embryogenic Jemalong 2HA mutant

It has been known for some time that 2HA can produce many embryos in culture and that in Medicago truncatula a cycle of tissue culture and regeneration from a wild type (which is rare) will always enhance regeneration. More recent work on MtSERF1, flower development, nodulation (with Uli Marheus) and methylation (with Bernie Carroll) has lead to a focus on ethylene signalling and epigenetics.

Transcription factors and the development of zygotic embryos

This research is particularly aimed at understanding early embryo development as well as protein and oil accumulation, and partitioning between the two. Legume embryos develop into the major part of the seed. The developmental cell biology of zygotic embryogenesis in Medicago truncatula provides insights into dedifferentiation and the biology of DNA containing organelles (chloroplasts, mitochondria) as well as non-DNA containing organelles such as peroxisomes. Also performed vital functions. Using cultured mesophyll protoplasts expressing organelle-targeted fluorescent protein, changes in organelle dynamics have been visualised and potential inheritance strategies for non-DNA containing organelles were evaluated before the protoplasts first divide. Changes in ER and vacuole morphology were both actin and
myosin dependent, whereas those of peroxisomes and lysosomes appeared independent of either. In all cases, organelle redistribution was actin-dependent. It appears that actin-dependent mechanisms exist to ensure unbiased inheritance of the non-DNA containing organelles.

Reactive oxygen species initiate plant cell regeneration in *Medicago truncatula*

One of the earliest responses to stress is increased production of reactive oxygen species (ROS) at the site of stress. Interestingly, H2O2 production occurred only in proliferating callus explants. These data are being linked to the development and proliferation of peroxisomes as modulators of ROS.

**Dr Georg Weiller – Chief Investigator – Australian National University**

In the bioinformatics laboratory, we have developed a number of software programs and web servers that aid the analysis of large sets of expressed sequences and other gene-expression data. These software solutions have been made available to researchers in the CILR and the wider scientific community and publicised through journal publications. We have also supported the analysis of data obtained from labs associated with the CILR. While all our work focuses on improving our understanding of gene regulation, it encompasses the following distinct projects, all of which have either resulted in publications during 2008 or are currently submitted to peer-reviewed journals.

**Prediction of non-coding RNA genes**

Perhaps the most intriguing biological insight from recent years is that many important genes do not code for a protein but work directly at the RNA level.

**Enzyme neighbourhood**

Metabolic pathways are typically represented as cycles where most metabolites are reused. However, real biological systems depend on a complex network of metabolic functions where metabolites enter and leave the classic cycles on numerous locations. In order to overcome the ‘pathway centric’ view in favour of a ‘network’ view, we had developed the PathExpress databases and web server. The system has been further developed with the inclusion of our new Enzyme-Neighbourhood method, which can detect the coordinated expression of interacting genes, even if these are not part of the same classical pathway. The method was instrumental in the analysis of meristematic root cells in *Medicago truncatula*.

**Mclip**

Mclip was originally developed to provide a straightforward way of identifying regulatory motifs in large sets of DNA/RNA sequences using a profile-profile alignment approach. Profile-profile comparison methods have proven to be highly sensitive and useful in the areas of homology modelling and protein structure prediction. We have further developed Mclip to be used on protein sequences as well as to provide an automated means of identifying all different domains and sequence motifs present in sets of protein sequences.

**AffyTrees**

Although model plants like *Medicago truncatula* have many advantages in studying gene networks, we are often interested in crop plants that are harder to study. In order to extend our findings to these plants, we need to know which of their genes are orthologous and whether orthologs are similarly expressed. We have developed the AffyTrees method and web server to infer the phylogeny of microarray sequences to better distinguish between orthologous and paralogous genes. The sensitive high specificity of this method has enabled us to contribute to the development of a gene expression atlas for *Medicago truncatula*. In addition, we have extended the server beyond the original set of seven representative plant species to include all plant species for which Affymetrix chips are available.
CLE-related genes produce signal peptides which are involved in meristem regulation in plants.

CLE proteins

CLE-related genes produce signal peptides which are involved in meristem regulation in plants. The computational identification of CLE-specific peptides has enabled us, in collaboration with colleagues in the Mathesius and Gresshoff labs, to identify all CLE family peptides present in the public databases at the time. This has become a landmark paper for research in this area.

Dr Jim Hanan – Centre Associate – University of Queensland

Computational biology of nodulation:

The Centre investigates complex interaction during nodulation by computational modelling. This work is done by Liqi Han (PhD student) and Dr Jim Hanan (Centre Associate) who developed a virtual-experiment approach, Computational Complementation, to help in investigating unknown AON signalling mechanisms.

This form of virtual experiment is based on computer modelling techniques, the Computational Complementation enables biologists to complement the deficiency of a non-AON mutant plant with totally hypothetical or concept-derived physiological components. If the experimental result demonstrates a nodulation phenotype similar to the wild type, the hypotheses could be suggested as reasonable, otherwise the hypotheses would likely be incorrect. These functionalities not only allow AON researchers to test their hypotheses and make predictions by time- and resource-saving virtual experiments, but also bring out possible underlying details that are unobservable through real-plant experiments.

Miles Holmes – PhD Student – University of Queensland

Natural Science – Social Science Linkage Programs

As part of the CILR’s Natural Science – Social Science linkage program, PhD student Miles Holmes is investigating Warlpiri ecological knowledge. Miles Holmes is an anthropologist who has been working in the Northern Territory for the last eight years. He conducts his PhD research on Indigenous Ecological Knowledge to answer the question “What is the structure of Warlpiri Plant Knowledge?”. Miles Holmes is co-supervised by Professor Peter Gresshoff and Dr Mary Laughren (UQ Faculty of Arts).

Significant research findings for 2008 included the articulation of a Warlpiri system of ecological knowledge through a concept called Njura-kulru which means ‘from country’ or ‘with country’ and is a template for the interrelationships between the five key elements of Warlpiri culture. Ecological knowledge about any given plant or animal is a function of these elements which are; Country, Skin (kinship), Law, Language and Ceremony. In 2008 Miles published a monograph about Njura-kulru in conjunction with a Warlpiri man named Wanta Pawu-kurpu-lunu Jampijinpa. The paper achieved high readership and continues to deliver significant benefits to Warlpiri people which is an important ethical component of Miles’ research. The monograph is now compulsory reading for new teachers at the Lajamanu Community Education Centre and Wanta and the other authors have been invited to present at several conferences. Joint publications between anthropologists and indigenous people are rare due to many cultural and organisational difficulties. These were overcome extremely well and therefore the process of publishing the Njura-kulru paper is now the subject of a case study in a Northern Territory National Resource Management Board of Inquiry which looks at best practice protocols for IEK research. In addition, community development projects started in 2006 and 2007, such as the Acacia seed collecting bush food enterprise and IEK revitalisation project, are now likely to be formally included in the plan of management for the Tanami (Warlpiri) Protect Area.

1The Warlpiri are Indigenous Australians who reside in the Tanami Desert in the Northern Territory
EDUCATION AND OUTREACH REPORT

Besides conducting cutting-edge research, the CILR is committed to seeding and growing the next generation of plant scientists. With a comprehensive Education and Outreach strategy for 2008 the CILR addressed a wide range of target audiences. Throughout the year numerous undergraduate and postgraduate students worked in the laboratories of the four nodes. Workshops and internships gave high school teachers and students an insight into the world of science and research. With information stands and displays at community events the Centre reached out to the general public.

Training tomorrow’s scientists

In 2008, 8 Honours, 2 Masters and 25 PhD students were supervised at the four nodes of the CILR. Of these students five graduated with an Honours degree and seven with PhDs. One student graduated with a Masters degree. Many of the graduates continue to work at the CILR as PhD students or Post Doctoral Fellows. All nodes also had undergraduate students working in their laboratories on different research projects.

Science Immersion Program

In a new outreach approach, the CILR gives outstanding science students from grade 10—12 the chance to gain work experience in its state-of-the-art labs and to interact with renowned researchers.

A year 10 student conducted research at the ANU Node from February to April and the University of Newcastle took on two students from August to November. In September two high school students worked at UQ on nodulation and tissue culture and in December three high achieving students from the Brisbane Boys’ College started their long term work experience at UQ. The grade 11 students will be working on their projects until mid 2009.

All nodes are going to continue the Science Immersion Program in 2009.

Experience Science program – July

In July, the CILR and the CRC for Sugar Industry Innovation through Biotechnology (SiIB), hosted a “Plant biotechnology for Beginners’ workshop as part of UQ’s Experience Science program. More than 100 year 11 and 12 students participated in six workshops over three days. The students extracted DNA, learnt the basics of tissue culture and conducted two nodulation experiments.

STEP IN LABS – October

In 2008, the CILR’s professional development program for high school teachers was held from October 8-10. The ongoing support from Education Queensland provided funds for teacher relief as well as two Rural Scholarships, which enabled teachers to travel to the ANU Node. During the three-day workshop, ten teachers participated in hands-on workshops on tissue culture, nodulation and apical dominance. In seminars, the enthusiastic participants also learned about molecular biology techniques and the CILR’s Pongamia biodiesel research. Both scientists and teachers were inspired by the interaction. The teachers will return to the CILR in March 2009 for a Reunion Day to discuss the influence of the STEP IN LABS experience on their coursework.

Seeds for Schools

In addition to the Centre’s nodulation workshops for teachers and students, the CILR has developed the ‘Seeds for Schools’ program, which enables teachers to conduct this exciting experiment at school. Interested teachers can order a nodulation experiment kit, including a detailed description of the experiment, as well as different soybean seeds (wild type and two different mutants) and Bradyrhizobium peat inoculum to induce nodulation. Teachers that participated in the STEP IN LABS, are automatically supplied with the experiment kit, but the Seeds for Schools order form is also available on the CILR’s website.

The experiment kit is free of charge.

Advanced Analytical Techniques for Biologists Workshops

In July a three-day workshop on “Advanced Analytical Techniques for Biologists” was hosted by Dr Charles Hocart at ANU. Together with thirty other participants, CILR researchers and students from the UQ and ANU Node learned about the chemistry, the new developments and the uses of Mass Spectrometry for biologists.

Seminars

CILR Chief Investigators of all nodes hosted a series of seminars with national and international speakers. CIs also visited other universities and institutions to give seminars on their research.

Among others the CILR hosted seminars included a presentation at UQ on “Ecology, Practical Application and Molecular Biology of the Rhizobia-Legume Symbiosis” by Prof Dietrich Werner from the Phillips University in Marburg (Germany), as well as the seminar “Azurin – At the root of nodules development?” by Dr Ulrike Mathesius at ANU. Dr Michael Djordjevic from the ANU Node was the presenter of a CILR seminar at UQ on “CLE peptides in legumes”.

Just a few of the many seminars of CILR researchers worldwide
can be mentioned here. Prof Peter Gresshoff gave a number of talks on his Pongamia biodiesel research on and off the UQ campus. Prof Mohan Singh travelled to the Indian Agricultural Research Institute in New Delhi where he gave two seminars on “Transcriptional regulation of male germ line development in flowering plants” and the “Transcriptional repertoire of legume meristems”. Dr Bernie Carroll spoke about “Potential applications of RNA interference to crop improvement” at the India-Australia Transgenic Crops Workshop in New Delhi.

Events
At several events the CILR promoted its different research projects to a variety of target audiences. In February the Melbourne Node showcased a Plant Biotechnology display during the “Victorian Cabinet Biotech & Medical Research Forum” at the Bio21 Institute. The ANU Node represented the CILR as part of the ARC Centre of Excellence booth at the ‘Canberra Careers Market’ in August, answering the many questions from students. The UQ Node also spoke to students during the BioCareers Night in September, where the CILR represented the University of Queensland.

At Brisbane’s first environmental festival Greenfest, the CILR showcased the Centre’s Pongamia biodiesel research. From Oct 10-12 hundreds of people visited the UQ stand at South Bank and spoke to researchers and students to learn more about the environmental and economic advantages of Pongamia biodiesel.

Website
The CILR website is not only a platform for exchange of information between all four nodes, but also an important Education & Outreach tool to the Centre. The ‘Education’ section is targeted at teachers as well as school and university students. The website offers legume factsheets, research posters, lecture notes, workshops, legume recipes and much more for download. The updated image gallery shows the diversity of legume plants and gives some insight into the Centre’s research.

ePOD
With an ever-growing audience, the CILR newsletter ePOD informed more than a hundred researchers, teachers and other stakeholders about the Centre’s research. Throughout the year the ePOD featured articles on current research achievements, such as the discovery of the shoot inhibiting hormone strigolactone and new field trials for the Pongamia project. The newsletter also included abstracts from recently published papers, outcomes from conferences, and acknowledgments of awards and successful grant applications. The new design of the Centre’s December newsletter was well received by both internal and external ePOD readers.

CILR in the News
The CILR’s remarkable research projects and findings of 2008 received a wide range of media attention. In July Prem Bhalla and Mohan Singh gained international media interest with their publication on allergen free GM plants. In mid year, Christine Beveridge’s discovery of the branching hormone strigolactone put the CILR into the international spotlight with articles and radio interviews in the Australian and European media. Peter Gresshoff’s Pongamia biodiesel research was the focus of interest throughout the year with 13 appearances in national newspapers, on radio and TV.
The CILR has given priority to best practice management of intellectual property, generated by its research activities. Protection of IP generated by the Centre is decided upon by the Centre Management Committee. UniQuest Pty Ltd, a recognised leader in university commercialisation, commercialises Centre IP.

**Patent applications**

Two patent applications were filed in 2008. The first relates to Soybean Nodulation Factor Receptor Proteins and the second relates to the research done on the Strigolactone hormone in collaboration with French colleagues.

The Soybean patent was registered at a National phase in the US, Argentina, Brazil and China. Some commercial interest has already been shown in this work and discussions are currently being conducted with a large multi-national organisation to commercialise this work.

This patent describes the sequence of the soybean (Glycine max) Nod Factor Receptor gene. The researchers have found that, in soybean, two copies of the Nod Factor Receptor gene, GmNFR1, exist. This gene is mutated in the soybean mutant nod49, and when overexpressed in transgenic roots results in both an increase in nodule numbers (nodulation) and nitrogen assimilation (nitrogen fixation). This discovery could potentially provide the means of increasing soybean nitrogen fixation, increasing seed and oil production, and enhancing establishment in low 

Bradyrhizobium soils.

A provisional patent on the strigolactone work was filed by the Institut National de la Recherche Agronomique (“INRA”) in France on behalf of all the collaborators in this project. Negotiations aimed at commercialising this research were initiated during 2007 and remain ongoing.

This project has recently received an additional $80,000 in funding from the commercialisation company at the Australian National University (ANU Connect Ventures) to further progress this work.

A provisional patent has been filed that describes technology indicating that a homologous transgene that produces single-stranded RNA, in addition to a homologous transgene producing double-stranded RNA or another homologous RNAi-inducing molecule, enhances induction of RNAi-based virus resistance in plants, and induction of RNAi against endogenous genes. The patent also describes identification of several genes that play a key role in long-distance transmission of RNA silencing to newly-formed shoot apices of plants.

**Disclosures**

The following disclosures were made through UniQuest Pty Limited

- Assay to test a pro-angiogenic disaccharide to induce serum-starved cells to proliferate;
- Hormones to control plant branching;
- Plant hormone biosynthetic inhibitors as promoters of plant rooting, and
- Partial sequencing of genes involved in fatty acid metabolism in Pongamia pinnata

**Start-up Company**

A start-up company called Bio Energy Solutions (BES) Pty Ltd was initiated through UniQuest Pty Ltd. BES has received substantial financial backing from an industrial partner. Most of the cash injection into BES has been earmarked for research and development in the CILR. The major research thrust is around the legume tree Pongamia pinnata which appears to be highly suitable as a feedstock for the biodiesel industry. At present, BES is the IP holding company for Pongamia with various licenses in place to ensure that the industry benefits from the research at the CILR. There has been some interest from other industrial partners to invest in BES. It is therefore hoped that BES will grow with increasing amounts of revenue being made available to the CILR for research purposes.
EXTERNAL COLLABORATIONS AND LINKAGES

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 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.

The collaborations and linkages reported below were active in 2008.

International Collaborations

Research Institutes

Dr C. Turnbull, Imperial College, UK (Beveridge, UQ)

Dr Xiujie Wang, Institute of Genetics and Developmental Biology, Chinese Academy of Sciences, China (Carroll, UQ; Singh and Bhalla, UQ)

Dr Janine Sherrier, University of Delaware, USA (Djordjevic, ANU)

Dr Gloria Muday, Wake Forest University, USA (Djordjevic, ANU)

Dr Elmar Kannenberg, Complex Carbohydrate Research Center, University of Georgia, USA (Frickey, ANU)

Dr Fabiola León-Galvan and Noel Carbajal, Institute for Scientific and Technological Research of San Luis Potosi, Mexico (Frickey, ANU)

Dr Sofia Costa, University of Coimbra, Portugal visited the ANU Node

Dr Jin Jian, Chinese Academy of Science, China visited the ANU Node

Professor Hamide Gubbuk and Professor Lani Kaynak, Akdeniz University, Turkey visited the Melbourne Node

Professor Allen Good, University of Alberta, Canada visited the UQ Node

Dr Marcus Heisler, California Institute of Technology, USA visited the UQ Node

Professor Pat Heslop-Harrison, University of Leicester, UK visited the UQ Node

Professor David Lim, UTAR University, Malaysia visited the UQ Node

Industry

Dr Richard Furneaux, GlycoSyn (Industrial Research Limited), New Zealand (Gresshoff, UQ)

Dr Helen Becker, Monsanto, USA (UQ)

International Visitors

Professor Sofie Goormachtig, Plant Microbe Division VIB Department of Plant Genomics, Ghent University, Belgium (Mathesius, ANU)

Professor Marcus Heisler, California Institute of Technology, USA visited the UQ Node
Dr Kerstin Nagel, Forschungszentrum Jülich, Germany visited the UQ Node

Dr Catherine Rameau, INRA Versailles, France worked for two months at the UQ Node

Prof Dietrich Werner, Phillips University, Germany visited the UQ Node

International Visits

A number of CILR staff and students also visited international research institutions to discuss their research goals and outcomes. This highlights the internationality of the CILRs network.

Dr Christine Beveridge visited Dr Catherine Rameau and Frederique Gayma at INRA Versailles, France

Dr Michael Djordjevic visited the University of Malaysia, Kuala Lumpur, Malaysia

Dr Brett Ferguson visited Dr Krzysztof Szczypkowski at the University of Western Ontario, Canada

Professor Peter Gresshoff visited the Gaizinger Botanical Gardens Institute for Genetics and the Canton Academy of Agricultural Sciences Institute in Gaizinger, China

Professor Peter Gresshoff visited researchers Dr Bettina Haase and Dr Sara Schaarschmidt at the Lebnisz Institute for Plant Biochemistry in Halle, Germany

Professor Mohan Singh visited the Indian Agricultural Research Institute and the National Research Centre on Plant Biotechnology in New Delhi, India

Dr Georg Weiller visited the Institut des Sciences Végétales, Centre National de la Recherche Scientifique, Gif sur Yvette, France

Dr Steven Djordjevic and Dr Stuart Cordwell, University of Sydney (Djordjevic, ANU)

Australian Collaborations

Research Institutes

Dr Rosanne Casu, CSIRO (Beveridge, UQ; Weiller and Frickey, ANU)

Dr J. Ross, University of Tasmania (Beveridge, UQ)

Professor John Mattick, University of Queensland (Carroll, UQ)

Professor John Bowman, Monash University (Carroll, UQ)

Professor Peter Waterhouse, University of Sydney (Carroll, UQ)

Professor Robert Capon, University of Queensland (Gresshoff, UQ)

Professor Geoff MacFarlane and A/Prof David McCurdy, University of Newcastle (Rose, UN)

Professor Jenny Graves and Hardip Patel, Australian National University (Weiller and Frickey, ANU)

Dr Penny Smith, University of Sydney (Weiller and Wen, ANU)

Industry

ANU Connect Ventures Pty Ltd (ANU)

Bioenergy Research Pty Ltd (UQ)

Bio Energy Solutions Pty Ltd (UQ)

Mitsui & Co. (Australia) Ltd (UQ)

Monsanto (UQ)

ORIGIN Energy CSG Ltd (UQ)

Pacific Renewable Research (UQ)

Origo Resource Partners (UQ)

Primary Holdings (UQ)

Qantas (UQ)

Tarong Energy (UQ)

Virgin Airlines (UQ)

Government

Brisbane City Council (UQ)

NSW Department of State and Regional Development (UN)

SEQ Catchments (UQ)

Sunshine Coast Regional Council (UQ)

National (Australia) Visitors

Dr Stuart Cordwell and Dr Steven Djordjevic visited the ANU Node
Dr Michael Djordjevic and Professor Barry Rolfe visited the Australian Proteomic Computational Facility at the Ludwig Institute for the official opening of the facility by Minister Lindsay Tanner.

Dr Michael Djordjevic visited A/Professor Paul Haynes at the Australian Proteomic Analysis Facility.

Dr Michael Djordjevic gave a talk at the STAQ Senior Sciences Conference at UQ.

Professor Peter Gresshoff held three seminars at the University of Melbourne.

Professor Peter Gresshoff held a seminar at the Southern Cross University in Lismore.

Professor Peter Gresshoff gave a seminar at the 1st Australian Biofuels for Transport Conference in Melbourne.

Professor Peter Gresshoff gave a talk at the Sunfix Meeting 2008 at the University of Sydney.

Professor Peter Gresshoff gave a seminar at the STAQ Seminar Series.

Dr Michael Djordjevic gave a seminar at the University of Adelaide.

Dr Michael Djordjevic gave a talk at the CSIRO RSBS Plant Biology seminar.

Dr Michael Djordjevic gave a seminar as part of the Advanced Analytical Techniques for Biologists” workshop at the ANLI.

Dr Michael Djordjevic held a seminar at the Sunfix Meeting 2008 in Sydney.

Dr Michael Djordjevic held a seminar at the University of Queensland.

Dr Michael Djordjevic held a seminar as part of the SIB Seminar Series at UQ.

A/Professor Bernie Carroll held a seminar as part of the SIB Seminar Series at UQ.

A/Professor Bernie Carroll held a seminar as part of the Advanced Study Program in Science at UQ.

A/Professor Bernie Carroll gave a talk at the University of Newcastle.

A/Professor Bernie Carroll held a seminar for the Queensland Area RNA Club.

A/Professor Bernie Carroll held a seminar as part of the SIB Seminar Series at UQ.

Annual Report 2008

Series at UQ.

Professor A/Professor Bernie Carroll held a seminar as part of the SIB Seminar Series at UQ.

Dr Christine Beveridge held a seminar for the Queensland Area RNA Club.

CSIRO Plant Industry, Canberra visited the UQ Node.

Professor Peter Waterhouse from the University of Adelaide visited the UQ Node.

Professor Peter Gresshoff gave a seminar at the University of Melbourne.

Professor Peter Gresshoff gave a talk at the STAQ Senior Sciences Conference at UQ.

Professor Peter Gresshoff held a seminar as part of the Plant Biology Seminar Series at ANU.

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CSIRO Plant Industry, Canberra visited the UQ Node.

Professor Ian Small, Centre for Plant Energy Biology in Perth visited the UQ Node.

Dr Vera Ignjatovic, Royal Children’s Hospital and University of Melbourne visited the ANU Node.

MP David Gibson, Member for Gympie visited the UQ Node.

National (Australia) Visits

Dr Christine Beveridge held a seminar as part of the SIB Seminar Series at UQ.

A/Professor Bernie Carroll gave a talk at the University of Newcastle.

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Research Publications 2008

Publications funded by, or related to the core activities of the Centre

Publications in journals with impact factor greater than or equal to 5 (according to ISI Web of Science Journal Citation Reports)


Publications in journals with impact factor less than 5


Proceedings and Monographs (Book Chapters)


39. Seminar on Strigolactones and Shoot Branching presented by Catherine Rameau (INRA, Versailles) and Christine Beveridge, (CILR, UQ) at the Jacques Monod Conference on Fine tuning of plant signalling pathways, Roscoff (Brittany), France, June 4-10, 2008.


and Genetics, Puerto Vallarta, Mexico, Dec. 7-12, 2008.


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


Software products and Web servers


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


Software products and Web servers

Honours:
1) Stephen Kazakoff (UQ): Cloning and Characterising Lipoygenase and Seed Storage Protein Encoding from *Pongamia pinnata*.
2) John O’Toole (UQ): Induction of Hairy Root Tumours in *Pongamia pinnata* (Linn) Pierre Through Co-Cultivation with *Agrobacterium rhizogenes*.
4) Terence Tiew (UN): The Role of Peroxisomes and Peroxisome Dynamics in ROS Homeostasis in Plant Cell Regeneration.

CILR staff involvement on editorial boards of refereed journals or international advisory committees:
- Dr Christine Beveridge
  - Editorial Board Member of *Plant Growth Regulation*
- Prof. Prem Bhalla
  - Associate Editor of *Plant Cell Tissue and Organ Culture*
  - Editorial Board Member of *Recent Patents on Anti-Infective Drug Discovery*
  - International Editorial Board Member of *Propagation of Ornamental Plants*
  - Editorial Board Member of *Recent Patents on Biotechnology*
  - Editorial Board Member of *Molecular Plant*
  - Editorial Board Member of *The Journal of Plant Physiology*
  - Member of the RIRDC Granting Committee (Biofuel & Bioenergy)
- Dr Michael Djordjevic
  - Editorial Board Member of *Genomic Insights*
  - Managerial Board Member of the *Australian Proteomics Computational Facility*
- Prof. Barry Rolfe
  - Managerial Board Member of the *Australian Proteomics Computational Facility*
- Prof. Ray Rose
  - Editor of *Plant Cell Reports*
  - Advisory Board for Protoplasts
- Prof. Mohan Singh
  - Editorial Board Member of *International Journal Of Food Agriculture and Environment*
  - Editorial Board Member of *Indian Journal of Aerobiology*
- Dr Georg Weiller
  - Chair of the Scientific Advisory Committee of the Australian Proteomics Computational Facility
- Dr Ulrike Mathesius
  - Editorial Board Member of *Plant Physiology and Biochemistry*
  - Reviewer for *Plant Genome Biology*
  - Reviewer for *ARC College of Experts*
  - Reviewer for *BBSRC Research Grants*
MEDIA ATTENTION IN 2008

The following table includes recorded articles and segments from newspapers, magazines, radio and TV about the CILR's research and Centre researchers.

<table>
<thead>
<tr>
<th>Media Attention</th>
<th>What</th>
<th>Where</th>
<th>Who</th>
<th>Node</th>
</tr>
</thead>
<tbody>
<tr>
<td>14/01/2008</td>
<td>Article: “This tree may turn the leaf for a brighter environment”</td>
<td>Courier Mail</td>
<td>Prof Peter Gresshoff</td>
<td>UQ</td>
</tr>
<tr>
<td>14/01/2008</td>
<td>Web-article: “Pongamia biodiesel research starts in Queensland”</td>
<td>Entomologia</td>
<td>Prof Peter Gresshoff</td>
<td>UQ</td>
</tr>
<tr>
<td>29/01/2008</td>
<td>Announcement: “Energy Crops Australia are chasing biodiesel”</td>
<td>ABC Radio</td>
<td>Prof Peter Gresshoff</td>
<td>UQ</td>
</tr>
<tr>
<td>1/02/2008</td>
<td>Article: “Tree of Life”</td>
<td>Ethical Investor</td>
<td>Prof Peter Gresshoff</td>
<td>UQ</td>
</tr>
<tr>
<td>12/02/2008</td>
<td>Article: “The etiquette of authorship”</td>
<td>General News,</td>
<td>Prof Christine Beveridge</td>
<td>UQ</td>
</tr>
<tr>
<td>25/03/2008</td>
<td>TV: “Tree could provide 20% of Australia’s diesel needs”</td>
<td>Channel 7</td>
<td>Prof P. Gresshoff, Dr P. Scott</td>
<td>UQ</td>
</tr>
<tr>
<td>11/05/2008</td>
<td>Article: “The good oil on canelands”</td>
<td>Sunshine Coast Daily</td>
<td>Prof Peter Gresshoff</td>
<td>UQ</td>
</tr>
<tr>
<td>11/07/2008</td>
<td>Web-article: “Allergen free GM plants may boost food safety”</td>
<td>Food Navigator</td>
<td>Prof M. Singh, Prof P. Bhalla</td>
<td>UM</td>
</tr>
<tr>
<td>22/07/2008</td>
<td>Web-article: “Allergen-free GM plants may boost food safety”</td>
<td>Aglia World</td>
<td>Prof M. Singh, Prof P. Bhalla</td>
<td>UM</td>
</tr>
<tr>
<td>24/07/2008</td>
<td>Article: “Biotechnology offers limited hope for removing allergens from plants”</td>
<td>Food Chemical News</td>
<td>Prof M. Singh, Prof P. Bhalla</td>
<td>UM</td>
</tr>
<tr>
<td>10/08/2008</td>
<td>Article: “Oil will grow on trees in future”</td>
<td>Sunday Mail</td>
<td>Prof Peter Gresshoff</td>
<td>UQ</td>
</tr>
<tr>
<td>11/08/2008</td>
<td>News announcement &amp; discussion: “Singelactions”</td>
<td>AM Radio</td>
<td>Prof Christine Beveridge</td>
<td>UQ</td>
</tr>
<tr>
<td>12/08/2008</td>
<td>Radio: “Research into tree hormone manipulation”</td>
<td>ABC Radio</td>
<td>Prof Christine Beveridge</td>
<td>UQ</td>
</tr>
<tr>
<td>14/08/2008</td>
<td>Article and announcement: “Branch control”</td>
<td>Courier Mail, ABC Radio</td>
<td>Prof Christine Beveridge</td>
<td>UQ</td>
</tr>
<tr>
<td>18/08/2008</td>
<td>Article: “Plant hormone involved in regulating branch information”</td>
<td>Canberra Times</td>
<td>Prof Christine Beveridge</td>
<td>UQ</td>
</tr>
<tr>
<td>1/09/2008</td>
<td>Article: “Natural pruning”</td>
<td>Australian R&amp;D Review</td>
<td>Prof Christine Beveridge</td>
<td>UQ</td>
</tr>
<tr>
<td>10/09/2008</td>
<td>Article: “Hormones for your plants”</td>
<td>Glasshouse Country News</td>
<td>Prof Christine Beveridge</td>
<td>UQ</td>
</tr>
<tr>
<td>1/10/2008</td>
<td>Article: “Plant research branches out”</td>
<td>Good Fruit &amp; Vegetables</td>
<td>Prof Christine Beveridge</td>
<td>UQ</td>
</tr>
<tr>
<td>1/12/2008</td>
<td>Radio: “Could common tree be used as an alternative fuel?”</td>
<td>ABC Radio</td>
<td>Prof Peter Gresshoff</td>
<td>UQ</td>
</tr>
<tr>
<td>10/12/2008</td>
<td>Web-article: “Trees play a role”</td>
<td>Sunshine Chronicle</td>
<td>Prof Peter Gresshoff</td>
<td>UQ</td>
</tr>
<tr>
<td>12/12/2008</td>
<td>Article: “Is council barking up the wrong trees?”</td>
<td>MX Brisbane</td>
<td>Prof Peter Gresshoff</td>
<td>UQ</td>
</tr>
<tr>
<td>16/12/2008</td>
<td>Web-article: “Trees new power sources”</td>
<td>Wymman Herald</td>
<td>Prof Peter Gresshoff</td>
<td>UQ</td>
</tr>
<tr>
<td>17/12/2008</td>
<td>Articles: “Powered by trees”</td>
<td>Southern Star</td>
<td>Prof Peter Gresshoff</td>
<td>UQ</td>
</tr>
<tr>
<td>17/12/2008</td>
<td>Article: “Tree could hold trees to run buses”</td>
<td>Westside News</td>
<td>Prof Peter Gresshoff</td>
<td>UQ</td>
</tr>
</tbody>
</table>
## FINANCIAL REPORT

### INCOME (to 31 December 2008)

<table>
<thead>
<tr>
<th></th>
<th>2007</th>
<th>2008</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>$ per Node</strong></td>
<td><strong>$ Centre Total</strong></td>
<td><strong>$ Centre Total</strong></td>
</tr>
<tr>
<td><strong>ARC Centre Grant</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>University of Queensland</td>
<td>1,033,161</td>
<td>931,500</td>
</tr>
<tr>
<td>University of Melbourne</td>
<td>370,293</td>
<td>425,500</td>
</tr>
<tr>
<td>Australian National University</td>
<td>610,484</td>
<td>795,500</td>
</tr>
<tr>
<td>University of Newcastle</td>
<td>210,166</td>
<td>241,500</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>2,224,104</strong></td>
<td><strong>2,300,000</strong></td>
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<tr>
<td><strong>State Government Funds</strong></td>
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</tr>
<tr>
<td>Queensland</td>
<td>675,000</td>
<td>0</td>
</tr>
<tr>
<td>ACT</td>
<td>120,000</td>
<td>0</td>
</tr>
<tr>
<td>NSW</td>
<td>27,252</td>
<td>45,000</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>822,252</strong></td>
<td><strong>45,000</strong></td>
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<tr>
<td><strong>Host Institution Support</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>University of Queensland</td>
<td>675,000</td>
<td>750,000</td>
</tr>
<tr>
<td>University of Melbourne</td>
<td>100,000</td>
<td>100,000</td>
</tr>
<tr>
<td>Australian National University</td>
<td>225,000</td>
<td>63,235</td>
</tr>
<tr>
<td>University of Newcastle</td>
<td>40,000</td>
<td>70,000</td>
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<tr>
<td><strong>Total</strong></td>
<td><strong>1,040,000</strong></td>
<td><strong>983,135</strong></td>
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<tr>
<td><strong>Headquarters Strategic Funds</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Centre Activities – carried forward</td>
<td>249,078</td>
<td>282,587</td>
</tr>
<tr>
<td><strong>CENTRE TOTAL INCOME</strong></td>
<td><strong>4,335,434</strong></td>
<td><strong>1,610,722</strong></td>
</tr>
</tbody>
</table>

### EXPENDITURE (to 31 December 2008)

<table>
<thead>
<tr>
<th></th>
<th>2007</th>
<th>2008</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>$ per Node</strong></td>
<td><strong>$ Centre Total</strong></td>
<td><strong>$ Centre Total</strong></td>
</tr>
<tr>
<td><strong>Salaries</strong></td>
<td></td>
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<tr>
<td>University of Queensland</td>
<td>1,675,640</td>
<td>1,475,017</td>
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<tr>
<td>University of Melbourne</td>
<td>149,172</td>
<td>273,555</td>
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<tr>
<td>Australian National University</td>
<td>365,265</td>
<td>495,242</td>
</tr>
<tr>
<td>University of Newcastle</td>
<td>220,332</td>
<td>269,608</td>
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<tr>
<td>Centre Wide Activities</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>2,810,349</strong></td>
<td><strong>2,513,422</strong></td>
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<tr>
<td><strong>Equipment</strong></td>
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<tr>
<td>University of Queensland</td>
<td>10,103</td>
<td>11,130</td>
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<tr>
<td>University of Melbourne</td>
<td>123,125</td>
<td>6,384</td>
</tr>
<tr>
<td>Australian National University</td>
<td>27,000</td>
<td>133,598</td>
</tr>
<tr>
<td>University of Newcastle</td>
<td>0</td>
<td>2,681</td>
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<tr>
<td>Centre Wide Activities</td>
<td>0</td>
<td>0</td>
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<tr>
<td><strong>Total</strong></td>
<td><strong>160,228</strong></td>
<td><strong>153,613</strong></td>
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<tr>
<td><strong>Travel</strong></td>
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<tr>
<td>University of Queensland</td>
<td>99,111</td>
<td>64,025</td>
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<td>University of Melbourne</td>
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<td>76,484</td>
<td>55,397</td>
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<td>University of Newcastle</td>
<td>2,627</td>
<td>1,460</td>
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<td>Centre Wide Activities</td>
<td>10,253</td>
<td>12,344</td>
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<tr>
<td><strong>Total</strong></td>
<td><strong>221,018</strong></td>
<td><strong>151,194</strong></td>
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<tr>
<td><strong>Maintenance/Consumables</strong></td>
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<tr>
<td>University of Queensland</td>
<td>473,521</td>
<td>511,218</td>
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<tr>
<td>University of Melbourne</td>
<td>151,819</td>
<td>32,775</td>
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<tr>
<td>Australian National University</td>
<td>146,918</td>
<td>133,198</td>
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<tr>
<td>University of Newcastle</td>
<td>43,668</td>
<td>37,380</td>
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<tr>
<td>Centre Wide Activities</td>
<td>121,364</td>
<td>109,482</td>
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<tr>
<td><strong>Total</strong></td>
<td><strong>937,490</strong></td>
<td><strong>824,771</strong></td>
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<td><strong>Scholarships</strong></td>
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<td>University of Queensland</td>
<td>145,308</td>
<td>35,021</td>
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<tr>
<td>University of Melbourne</td>
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<tr>
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<td>University of Newcastle</td>
<td>30,091</td>
<td>8,471</td>
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<td><strong>Total</strong></td>
<td><strong>229,020</strong></td>
<td><strong>80,086</strong></td>
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<td><strong>Outstanding Commitments</strong></td>
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<tr>
<td>University of Queensland</td>
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<tr>
<td>University of Melbourne</td>
<td>124,553</td>
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<td>Australian National University</td>
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<td>0</td>
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<td>University of Newcastle</td>
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</tr>
<tr>
<td>Centre Wide Activities</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>124,553</strong></td>
<td><strong>0</strong></td>
</tr>
<tr>
<td><strong>Total Expenditure</strong></td>
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<tr>
<td>University of Queensland</td>
<td>2,403,683</td>
<td>2,097,051</td>
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<td>University of Melbourne</td>
<td>786,512</td>
<td>890,620</td>
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<td>Australian National University</td>
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<td>834,491</td>
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<td>University of Newcastle</td>
<td>296,918</td>
<td>320,100</td>
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<tr>
<td>Centre Wide Activities</td>
<td>151,617</td>
<td>121,826</td>
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<tr>
<td><strong>CENTRE TOTAL EXPENDITURE</strong></td>
<td><strong>4,482,858</strong></td>
<td><strong>3,723,488</strong></td>
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<tr>
<td><strong>CENTRE TOTAL CARRY FORWARD</strong></td>
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</tr>
<tr>
<td></td>
<td>- 148,424</td>
<td>- 112,766</td>
</tr>
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</table>
# Major Conference Presentations, Seminars and Workshops

<table>
<thead>
<tr>
<th>Presenter/s</th>
<th>Title</th>
<th>Venue</th>
<th>Date</th>
<th>Approx. Attendance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beveridge, CA, Rameau, C</td>
<td>Seminar on Strigolactones and Shoot Branching</td>
<td>Jacques Monod Conference on Fine tuning of plant signalling pathways, Rouscoff, France</td>
<td>4-10/06/2008</td>
<td>100</td>
</tr>
<tr>
<td>Bhalla, PL</td>
<td>Shoot apical meristem development in PsaVm sativum as revealed by transcriptions analysis</td>
<td>IV International Conference on Legume Genomics and Genetics, Puerto Vallarta, Mexico</td>
<td>07-12/12/2008</td>
<td>300</td>
</tr>
<tr>
<td>Bhalla, PL</td>
<td>Legume Shoot Development – Transcriptional Features</td>
<td>IV International Conference on Legume Genomics and Genetics, Puerto Vallarta, Mexico</td>
<td>07-12/12/2008</td>
<td>300</td>
</tr>
<tr>
<td>Brewer, P</td>
<td>Hormonal Repression of Shoot Branching by Strigolactones</td>
<td>Annu. 2008, Marrakesh, Morocco</td>
<td>4-10/06/2008</td>
<td>100</td>
</tr>
<tr>
<td>Carroll, B</td>
<td>Potential applications of RNA interference to crop improvement</td>
<td>India-Australia Transgenic Crops Workshop, New Delhi, India</td>
<td>21-22/04/2008</td>
<td>150</td>
</tr>
<tr>
<td>Carroll, B</td>
<td>Genetic and Molecular Analysis of Long-distance miRNA Silencing in Arabidopsis</td>
<td>Plant Biology 2008, Mexico, Mexico</td>
<td>26-06-07/2008</td>
<td>100</td>
</tr>
<tr>
<td>Dymokevic, MA</td>
<td>Biacidity and processing of CLE peptides in legumes</td>
<td>IV International Conference on Legume Genomics and Genetics, Puerto Vallarta, Mexico</td>
<td>07-12/12/2008</td>
<td>100</td>
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<tr>
<td>Don, EA</td>
<td>Deciphering shoot branching control with the aid of computational modeling</td>
<td>FASEB Summer Research Conference: Mechanisms in Plant Development, Vermont, USA</td>
<td>10-14/06/2008</td>
<td>100</td>
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<tr>
<td>Don, EA</td>
<td>A branching story from a humble legume</td>
<td>IV International Conference on Legume Genomics and Genetics, Puerto Vallarta, Mexico</td>
<td>07-12/12/2008</td>
<td>100</td>
</tr>
<tr>
<td>Gresshoff, PM</td>
<td>Functional Genomics of Soybean Nodulation Control</td>
<td>Plant &amp; Animal Genome Conference, San Diego, USA</td>
<td>12-16/01/2008</td>
<td>2000</td>
</tr>
<tr>
<td>Gresshoff, PM</td>
<td>Systemic regulation of legume stem cell proliferation in soybean nodulation</td>
<td>Plant Genomics in China IX, Guangzhou, China</td>
<td>18-20/07/2008</td>
<td>700</td>
</tr>
<tr>
<td>Gresshoff, PM</td>
<td>Mutational and Functional Genomic Analysis of Systemic and Local Regulation of Legume Nodulation</td>
<td>FAO/IAEA International Symposium on Induced Mutation, Vienna, Austria</td>
<td>12-15/08/2008</td>
<td>500</td>
</tr>
<tr>
<td>Gresshoff, PM</td>
<td>Perspectives on European Nitrogen Fixation: Closing Remarks</td>
<td>8th Nitrogen Fixation Conference, Ghent, Belgium</td>
<td>10/08-03/09/2008</td>
<td>100</td>
</tr>
<tr>
<td>Gresshoff, PM</td>
<td>Systemic and Local Regulation of Legume Nodulation</td>
<td>8th Nitrogen Fixation Conference, Ghent, Belgium</td>
<td>10/08-03/09/2008</td>
<td>100</td>
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<tr>
<td>Gresshoff, PM</td>
<td>Regulation of Nodulation: Soybean Lessons for Beans (Workshop)</td>
<td>IV International Conference on Legume Genomics and Genetics, Puerto Vallarta, Mexico</td>
<td>07-12/12/2008</td>
<td>100</td>
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<tr>
<td>Gresshoff, PM</td>
<td>Signals, Targets and Activated Statii in Systemic and Local Regulation of Legume Nodulation</td>
<td>IV International Conference on Legume Genomics and Genetics, Puerto Vallarta, Mexico</td>
<td>07-12/12/2008</td>
<td>100</td>
</tr>
<tr>
<td>Gresshoff, PM</td>
<td>Regulation of Plant Stem Cell Proliferation during Legume Nodulation (Workshop)</td>
<td>Monsanto, St Louis, USA</td>
<td>13/12/2008</td>
<td>5</td>
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<tr>
<td>Gresshoff, PM</td>
<td>Pongamia pinnata: A Legume for Sustainable Biofuels</td>
<td>Guangzhou Botanical Gardens Institute for Genetics and Canton Academy of Agricultural Sciences Institute, Guangzhou, China</td>
<td>22/07/2008</td>
<td>200</td>
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<tr>
<td>Russell, SD</td>
<td>Profiling of the male gametophyte of rice and other flowering plants</td>
<td>XX International Congress of Sexual Plant Reproduction, Brasilia, Brazil</td>
<td>04-08/08/2008</td>
<td>250</td>
</tr>
<tr>
<td>Scott, P</td>
<td>The significance of legumes and nitrogen fixation in the current biofuel debate: Solution provided by Pongamia pinnata, a tropical and subtropical legume tree</td>
<td>IV International Conference on Legume Genomics and Genetics, Puerto Vallarta, Mexico</td>
<td>07-12/12/2008</td>
<td>100</td>
</tr>
<tr>
<td>Singh, MB</td>
<td>Drought tolerance genes – An overview</td>
<td>India-Australia Transgenic Crops Workshop, New Delhi, India</td>
<td>20-22/04/2008</td>
<td>150</td>
</tr>
<tr>
<td>Singh, MB</td>
<td>Transcriptional regulation of male germ-line development in flowering plants</td>
<td>XX International Congress of Sexual Plant Reproduction, Brasilia, Brazil</td>
<td>04-08/08/2008</td>
<td>250</td>
</tr>
<tr>
<td>Weiller, G</td>
<td>Analysis of structural strand asymmetry in non-coding RNAs</td>
<td>Sixth Asia-Pacific Bioinformatics Conference (APBC 2008), Kyoto, Japan</td>
<td>14/17/01/2008</td>
<td>400</td>
</tr>
</tbody>
</table>
Weiller, G  Exploring the metabolic network to interpret post-genomic data
Sixth Asia-Pacific Bioinformatics Conference (APBC 2008), Kyoto, Japan
14/17/01/2008  300

Weiller, G  Exploring the metabolic network to interpret post-genomic data
Sixth Asia-Pacific Bioinformatics Conference (APBC 2008), Kyoto, Japan
14/17/01/2008  300

Australia – Presentations, Seminars and Workshops
Brewer, PB Hormonal expression of shoot branching by singlontakas
ComBio 2008, Canberra
21-25/09/2008  800

Buer, CS Architectural phenotypes in the transparent testa mutants of Arabidopsis thaliana
ComBio 2008, Canberra
21-25/09/2008  800

Carroll, B Long distance intercellular transmission of gene silencing in plants
ARC/NHRC Research Network in Genes and Environment in Development Forum, Palm Cove
16-18/06/2008  100

Carroll, B Long distance transmission of gene silencing in Arabidipso
Epigenome Conference, Blackheath, Blue Mountains
25-29/09/2008  80

Djuricovic, MA Using biostat and mass spectrometry to assess extracellular CLE peptides cleavage in legumes
Advanced Analytical Workshop, ANL
1-3/07/2008  50

Djuricovic, MA Reactivity and processing of CLE peptides in legume
ComBio 2008, Canberra
21-25/09/2008  80

Gresshoff, PM Viable Crop Alternatives for Biofuels
Scientists and the Media Advanced Studies Program in Science, UQ August 2008  50

Gresshoff, PM Oil crops Biofuels Conference, Ballina 22-23/08/2008  50

Gresshoff, PM The Biotechnology of Biofuels 'A case for legumes'
1st Biofuels in Australia’s Transport Future Conference, Melbourne
09-11/11/2008  200

Gresshoff, PM The Biotechnology of Biofuels 'A case for legumes'
STAQ Senior Sciences Conference, UQ
28/11/2008  200

Gresshoff, PM Scientists and the Media Advanced Studies Program in Science, UQ August 2008  50

Gresshoff, PM Oil crops Biofuels Conference, Ballina 22-23/08/2008  50
### Presenter/ Title  
**Academic Life**  
ComBio 2008, Canberra  
21-25/09/2009  
800

**Inductive signals driving embryo formation from somatic cells in the model legume Medicago truncatula**  
ComBio 2008, Canberra  
21-25/09/2009  
800

### Australia - Posters  
**Kudyukov, S**  
Stem cells and ethylene: The link between embryogenesis and modulation  
ComBio 2008, Canberra  
21-25/09/2009  
800

**Nolan, KE**  
SERK1 expression is associated with developmental change in the life cycle of the model legume Medicago truncatula  
ComBio 2008, Canberra  
21-25/09/2009  
800

**Peters, J**  
Defective embryo and meristems (Dem) directs plant development and interacts with conserved Ras-like nuclear protein (Ran)  
ARC/NHMRC Research Network in Genes and Environment in Development Forum, Palm Cove  
16-18/06/2008  
100

**Sheahan, MB**  
Distinct inheritance mechanisms for non-DNA containing organelles in plant cells initiating cell division  
ComBio 2008, Canberra  
21-25/09/2009  
800

### Australia - Attendance  
**Grenfell, PM**  
Germany Sweden Science Forum, Canberra  
14/03/2008  
120

**Mathesius, U**  
Australian Society for Parasitology Annual Conference, Adelaide  
06-09/07/2008  
100

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### Key Performance Indicators

<table>
<thead>
<tr>
<th>Performance Measure</th>
<th>Target</th>
<th>Progress to 31 December 2008</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Research findings and competitiveness</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quality of Publications</td>
<td>Peer reviewed journals, invited reviews, monographs and publications with broad readership for public education. The goal is to achieve 6 publications per annum in journals with impact factor 5.</td>
<td>9 publications (CLR researchers) in journals with an impact factor greater or equal to 5.</td>
</tr>
<tr>
<td>Number of Patents</td>
<td>Filing an average of two provisional patent applications per annum. Target of one PCT level patent per annum.</td>
<td>Two (one at the National phase and one provisional with INRA – France)</td>
</tr>
<tr>
<td>Invitations to address and participate in international conferences</td>
<td>Members will address the international meetings of the International Society of Plant Molecular Biology (ISPMB), Plant and Animal Genome Conference, International Society of Molecular Plant Microbe Interactions (ISMPMI) and the national meetings of the Combined Biological and Biochemistry Societies of Australia (COMBIO), and the Australian Society of Plant Scientists. Target: five per annum.</td>
<td>CILR researchers were invited to a total of 24 international and national conferences. Attended conferences include the 8th European Nitrogen Fixation Conference in Ghent, Belgium, IV International Conference on Legume Genomics and Genetics in Puerto Vallarta, Mexico, Plant Genomics IX Conference in China, Sixth Asia-Pacific Bioinformatics Conference (APBC 2008), Kyoto, Japan, COMBIO 2008 in Canberra.</td>
</tr>
<tr>
<td>Invitations to visit leading international laboratories</td>
<td>Members of the centre will visit international laboratories to conduct research and learn technologies. Target: six per annum.</td>
<td>In 2008, CILR researchers visited a total of 17 international laboratories, such as the Institut des Sciences Végétales, Centre National de la Recherche Scientifique, Céret, France, Department of Plant &amp; Microbial Biology, University of California, Berkeley, USA, Institut für Tierzucht und Genetik, Veterinärmedizinische Universität, Vienna, Austria.</td>
</tr>
<tr>
<td>Additional competitive grant income</td>
<td>ARC Linkage Grant application. Smart State Grant application. REDI Grant application (depending on success rate may be sufficient to carry through to 2010. Total: $6 to $8 million. ARC Discovery Grant application and ARC Early Career Grant applications.</td>
<td>ARC Linkage Grant successful (Total: $670,000). Smart State application unsuccessful.</td>
</tr>
</tbody>
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### Performance Measure: Target Progress to 31 December 2008

<table>
<thead>
<tr>
<th><strong>Number and nature of commentaries about the Centre's achievements</strong></th>
<th><strong>Target</strong></th>
<th><strong>Progress to 31 December 2008</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td></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>26 media reports on Centre activities were recorded in 2008. Articles in newspapers (e.g. The Courier Mail, The Canberra Times) and in special interest magazines (e.g. Australian R&amp;D Review), radio (ABC Radio) and TV (Channel 7) interviews, and online publications (e.g. Food Navigator, AgBio World) recognised the CLR's research achievements.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Research training and professional education</strong></th>
<th><strong>Target</strong></th>
<th><strong>Progress to 31 December 2008</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Number of postgraduates recruited</strong></td>
<td>4 per annum</td>
<td>A total of 35 postgraduate students worked at the CLR during 2008. Of these, 8 were Honours students, 2 Masters students and 25 PhD students.</td>
</tr>
<tr>
<td><strong>Number of postgraduate completions</strong></td>
<td>4 per annum</td>
<td>In 2008, seven PhD students and one Masters student graduated from the CLR. (45 since Centre was established)</td>
</tr>
<tr>
<td><strong>Number of honours students</strong></td>
<td>4 per annum</td>
<td>Five Honours students graduated during 2008. (34 since Centre was established)</td>
</tr>
<tr>
<td><strong>Number of professional courses</strong></td>
<td>1 per annum</td>
<td>Advanced Analytical Techniques for Biologists Workshop, July, ANU.</td>
</tr>
<tr>
<td><strong>Participation in professional courses</strong></td>
<td>2 per annum</td>
<td>CILR Chief Investigators and students participated in the &quot;Advanced Analytical Techniques for Biologists Workshop&quot; at ANU and in the workshop &quot;Computational analysis of biological networks: fundamentals, theoretical studies, and real applications&quot; in Kyoto, Japan.</td>
</tr>
<tr>
<td><strong>Number and level of undergraduate and high school courses in the priority area(s)</strong></td>
<td>Host 2 per annum (high school courses):</td>
<td>The CLR offered a total of 6 undergraduate and high school courses in 2008 (see Education and Outreach Report for detailed information): 1) Lab Experience, Feb-Apr, ANU 2) Experience Science Workshops, July, UQ 3) Lab Experience, Aug-Nov, UoN 4) Science Immersion, September, UQ 5) STEP IN LABS, October, UQ 6) Lab Experience, Dec, UQ 7) Extensive contribution to undergraduate biology courses in all four nodes.</td>
</tr>
</tbody>
</table>

### Performance Measure: Target Progress to 31 December 2008

<table>
<thead>
<tr>
<th><strong>International and regional links and networks</strong></th>
<th><strong>Target</strong></th>
<th><strong>Progress to 31 December 2008</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Number of papers published with international co-authors/ reports for international bodies</strong></td>
<td>8 per annum</td>
<td>11 publications, 12 conference abstracts, 4 other publications with international co-authors.</td>
</tr>
<tr>
<td><strong>Number of international visitors</strong></td>
<td>10 per annum</td>
<td>17 international visitors across all nodes. See External Collaborations and Linkages for detailed information.</td>
</tr>
<tr>
<td><strong>Number of national and international workshops</strong></td>
<td>Around 6 per annum, provide 6 per annum</td>
<td>Attended: &quot;Advanced Analytical Techniques for Biologists Workshop&quot; at ANU and in the workshop &quot;Computational analysis of biological networks: fundamentals, theoretical studies, and real applications&quot; in Kyoto, Japan. Provided: Three workshops at international conferences (see Major Conference Presentations); &quot;Advanced Analytical Techniques for Biologists Workshop&quot; at ANU, STEP IN LABS professional development workshop for high school teachers at UQ.</td>
</tr>
<tr>
<td><strong>Number of memberships of national and international professional committees</strong></td>
<td>20 per annum</td>
<td>Target exceeded.</td>
</tr>
<tr>
<td><strong>Examples of relevant Social Science and Humanities research supported by the Centre</strong></td>
<td></td>
<td>PhD student Miles Holmes researches the knowledge transfer amongst Aboriginal communities (Walpiri tribe) in central Australia. The Pongamia research program at UQ has significant social (job creation) and environmental benefits (carbon sequestration, reduced nitrogenous fertilizer, high saline tolerance, drought resistance) which the biodiesel industry has already noted.</td>
</tr>
</tbody>
</table>
### Performance Measure: Number and nature of commercialisation activities

**End-user links**

<table>
<thead>
<tr>
<th>Linkages will be established through:</th>
<th>Target</th>
<th>Progress to 31 December 2008</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) A trading name established for the commercialisation activities of the Centre and a commercialisation contract nominated; 2) Interaction with relevant industry organisations and commercial entities; 3) Interaction and contract research with Australian and overseas plant science or biotechnology companies. Target: 2 interactions started per annum.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1) Meristemix is registered nationally as a trading name for the commercialisation activities of the Centre; 2) The four partner universities of the Centre have approved the formation of a virtual company through UniQuest Pty Ltd (the main commercialisation company of the University of Queensland) to commercialise plant research discoveries; 3) Research contract continued with CNRS France for the synthesis of derivatives of anti-angiogenic compounds; 4) Research contract (pilot project) negotiated and completed with Pacific Renewables Energy Pty Ltd for research into Pongamia pinnata; 5) New research contract negotiated and finalised with Bioenergy Research for one million dollars, which has led to a start-up company together with UniQuest Pty Ltd; 6) Cooperative Pongamia research program initiated with large oil/gas company in central Queensland; 7) Discussion with potential industry partners for commercial development of each of the Centre’s provisional patents, ongoing; 8) Negotiations ongoing with large biotech company regarding cooperative research relating to the patent on Soybean nodulation factor receptor proteins; 9) 5 CDAs; 10) 8 MTAs;</td>
<td></td>
<td></td>
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**Number of government, industry and business briefings.**

<table>
<thead>
<tr>
<th>Target</th>
<th>Progress to 31 December 2008</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 per annum</td>
<td></td>
</tr>
<tr>
<td>Throughout the year the Centre Director, Chief Operating Officer and certain CIs had numerous meetings and discussions with the Brisbane City Council, SEQ Catchments, Origo Sino-India Plc, Minnis &amp; Co, Primary Holdings and other institutions with regards to the Pongamia biodiesel research.</td>
<td></td>
</tr>
</tbody>
</table>

**Number of Centre associates trained in technology transfer and commercialisation.**

<p>| The Centre will facilitate training through third parties in technology transfer. Target: 2 per annum and maintaining | | |
| The COO and Education and Outreach Manager, as well as Postdoctoral Fellows and PhD students participate regularly in UniQuest training sessions on the commercialisation of university research. The COO also runs a seminar on commercialisation at the Centre Symposium each year for Centre staff. | | |</p>
<table>
<thead>
<tr>
<th>Performance Measure</th>
<th>Target</th>
<th>Progress to 31 December 2008</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level and quality of infrastructure provided to the Centre.</td>
<td>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.</td>
<td>1) The Centre administration is housed in modern offices at UQ; 2) Substantial laboratory facilities are available at all nodes; 3) Equipment and facilities are state-of-the-art and are maintained by trained personnel. New purchase and access for 2008 include: Beckman Coulter Biotek NZ DNA, RNA and protein extraction robot; Beckman Coulter DTX-880 multimode plate-reader; and CorbettRotor-gene 6000 High-resolution melt DNA sequence variant detector. 4) Adequate PC2 greenhouse space for controlled plant growth is available at all nodes; and 5) Scenarios at all nodes have direct access to university library facilities, including electronic and in-print journal publications.</td>
</tr>
</tbody>
</table>

**Governance**

| Breadth and experience of the Advisory Board | The Centre Advisory Board and Scientific Expert Advisory Committee to include individuals with world-class experience and representing a broad spectrum of interests. The Centre will maintain its compliance with OGTR and AQIS regulations. The laboratories at UQ are certified quarantine facilities – maintain this status. Two of the UQ Node personnel are certified QAPs. The Centre Advisory Board (CAB) and Scientific Expert Advisory Committee (SEAC) membership. OGTR and AQIS regulations and standards have been maintained. Laboratory staff regularly attend lab-related courses. | See Centre Advisory Board (CAB) and Scientific Expert Advisory Committee (SEAC). Centre Advisory Board meetings. Yearly for centre CAB, quarterly update from Director and COO to Board and subsequent teleconference. Yearly for Scientific Expert Advisory Committee. The Scientific Expert Advisory Committee met in December 2008 in Puerto Vallarta, Mexico at the fourth International Conference on Legume Genomics and Genomics. Regular Node Leader and CI meetings were held during 2008. The Centre’s Strategic Plan is up-dated annually. |

| Frequency and effectiveness of Advisory Board meetings | The Centre’s Strategic plan was established on the combined knowledge of the applicants and their consultants within the partner universities. | The Centre’s Strategic Plan was established on the combined knowledge of the applicants and their consultants within the partner universities. |

| Quality of the Centre Strategic plan | The Centre will maintain its compliance with OGTR and AQIS regulations. The laboratories at UQ are certified quarantine facilities – maintain this status. Two of the UQ Node personnel are certified QAPs. The Centre Advisory Board (CAB) and Scientific Expert Advisory Committee (SEAC) membership. OGTR and AQIS regulations and standards have been maintained. Laboratory staff regularly attend lab-related courses. | See Centre Advisory Board (CAB) and Scientific Expert Advisory Committee (SEAC). Centre Advisory Board meetings. Yearly for centre CAB, quarterly update from Director and COO to Board and subsequent teleconference. Yearly for Scientific Expert Advisory Committee. The Scientific Expert Advisory Committee met in December 2008 in Puerto Vallarta, Mexico at the fourth International Conference on Legume Genomics and Genomics. Regular Node Leader and CI meetings were held during 2008. The Centre’s Strategic Plan is up-dated annually. |

| Effectiveness of arrangements to manage Centre nodes. | The nodes will communicate through an already established website. Additional interactions to occur through: 1) monthly nodal leader phone conference; 2) Quarterly rotational visits to the nodes; 3) All for 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. | 1) Chief Investigators regularly discuss research and Centre items during phone-conferences; 2) CI’s and the Scientific Expert Advisory Committee meet during the ICLGG-JV conference in Mexico; 3) The Centre’s Annual Symposium was held in Toowoomba (south of Canberra) in April 2008. 4) The electronic newsletter-FCD informed all nodes about current research achievements. |

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<tbody>
<tr>
<td>The adequacy of the Centre’s key performance indicators.</td>
<td>1) International benchmarking to research in top international plant research. Centres such as the MPI, John Innes Centre and the Danforth Centre.</td>
<td>The KPI’s are regarded as an important instrument to gauge the effectiveness and relevance of the Centre as an international Plant Science Centre of Excellence.</td>
</tr>
</tbody>
</table>

| National benefit | Measure 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 (e.g., 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. | Collaboration with industry (e.g. Origin Energy, Pacific Renewable Energy, GlycoSyn), government (e.g. Brisbane City Council, NSW Agriculture) and academia (e.g. Universiti Tenaga Nasional Malaysia, Chinese Academy of Sciences) are constantly being expanded. Especially the biodiesel research project created many new linkages in 2008; 2) Education and Outreach programs such as information stalls at Greenfest; 3) 9 publications in journals of impact factor greater or equal to 4; total of 96 publications directly or indirectly related to Centre activities; 4) Two new patents; 5) New research contracts signed with industrial partners on Pongamia. |

| 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 information on cereal boxes, ‘Sanitarium’ sponsorship); 2) Increased teaching content on Systems Biology and genetics/phenome relations for high-school/ undergraduate/graduate education; 3) Increased awareness and access of Science Teachers to Genomis/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 genome/phenome technology and understanding. | 1) Legumes recipes available for download on the Centre website; 2) Workshops on nodulation, tissue culture and special dominance for high school teachers (STEP IN LABS) and students (Experience Science); 3) Development of new workshops for high school teachers and students (e.g. Tissue Culture Workshop); 4) Involvement in the Bright Minds “Science Immersion” program; 5) Seeds for School Program; 6) Development of new fact sheets on Pongamia and biodiesel; 7) Development of a biodiesel display for public events; 8) Update of the CILR website. |
STAFF, STUDENTS & ASSOCIATES (TO DECEMBER 31, 2008)

CENTRE STAFF
Professor Peter Gresshoff
Director
Dr Alvin van Niekerk
Chief Operating Officer
Amanda Carter
Education and Outreach Manager
(March to August)
Charlotte Camerer
Education and Outreach Manager
(From September)
Melisa Lewins
Personal Assistant to the Director

ANU Node
Chief Investigators
Dr Michael Djordjevic
Node Leader
Dr Uli Mathesius
Prof Chris Parish
Professor Barry Rolfe
Dr Georg Weiller
Postdoctoral & Research Fellows
Dr Charles Buer
Dr Tancred Frickey
Research Officers/Technical Officers
Dr Han Cai Chen
Cassandra Harris (from July)
Marie Oakes
Research Students
Greg Bodulovic (Masters)
Lauren du Fall (Honours)
Choon Hua Goh (Honours, from August)
Samira Hassan (Honours, from August)
Peta Holmes (PhD)
Lucia Kunawatwi (PhD)
Karsten Oelkers (PhD)
Anton Wassen (PhD)

ANU Exchange Students
Felicity Maree Bongi, ANU
Quy Dong Dinh, Hogeschool van Arnhem en Nijmegen, The Netherlands (Honours, to August)
Angela Medelina Hartono,
University of Jogjaakarta, Indonesia
Kathryn Mary Kuran, ANU
Natalia Sampaio,
Murdoch University, Perth

ANU Visiting Scholars
Dr Sofia Costa, Centre for Functional Ecology, University of Coimbra, Portugal (July)

University of Newcastle Node
Chief Investigators
Professor Prem Bhalla
Professor Ray J Rose
Node Leader
Postdoctoral & Research Fellows
Dr Sergey Karyndykov
Dr Kim Nolan
Dr Michael Sheahan
(ARC Postdoctoral Fellow)
Dr Xi Yi Zhang (to April)
Postdoctoral & Research Fellows
Dr Jiangxi Liang
Dr Annie Wong
Dr Wan-Jun Zhang
Research Officers/Technical Officers
Noshan Gao
James Pui
Research Students
Paul Knight (PhD)
Tze-Yu James Pai (PhD)
Centre Associates
Professor Scott Russell
University of Melbourne Node
Chief Investigators
Professor Prem Bhalla
Professor Mohan Singh
Deputy Director and Node Leader
Postdoctoral & Research Fellows
Dr Dibengzhang
Dr Annie Wong
Dr Wan-Jun Zhang
Research Officers/Technical Officers
Mary Lu (to July)
Dr Xin-Ding Wang
Research Students
Shih Chen (PhD)
Feky Mantiri (PhD)
Terence Tiew (Honours)
UQ Node
Chief Investigators
Associate Professor Christine Beveridge
Co-Node Leader
Associate Professor Bernie Carroll
Co-Node Leader
Professor Peter Gresshoff
Director
Postdoctoral & Research Fellows
Dr Jacqui Bailey (with ACPFG)
Dr Phil Brewer
Dr Chris Brown (to September)
Dr Pick Kuen Chan (to May)
Dr Elizabeth Dun
Dr Brett Ferguson
Dr Tripsy Hirani (to October)
Research Officers/Technical Officers
Mary Lu (to July)
Dr Xin-Ding Wang
Research Students
Shih Chen (PhD)
Feky Mantiri (PhD)
Terence Tiew (Honours)
UQ Chief Investigators
Dr Mark Kinkema (to March)
Dr Thierry Lomhienne
Dr Paul Scott
Research Officers/Technical Officers
Olga Berkina
Dr Ning Chen
Kerry Condon
Dr Jessica Dalton-Morgan
(from September)
Dr Uwe Dreschel (from July)
Quynt Jang
Dongue X (Snow) Li (to September)
Sze Ying Lim
Mikiko Miyagi
Research Students
Bandana Biswas (PhD)
Tanya Brech (PhD)
Michael Christie (PhD)
Julia Cremer (PhD, to April)
Nial Cusansky (PhD)
Liqi Han (PhD)
Satomi Hayashi (PhD)
Alice Hayward (PhD)
Miles Holmes (PhD)
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- School of Biological Sciences, University of Queensland
- School of Molecular and Microbial Sciences, University of Queensland
- School of Environmental and Life Sciences, University of Newcastle
- 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 Biochemistry and Molecular Biology, Australian National University
- School of Biochemistry and Molecular Biology, 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
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- The State Government of New South Wales
- Origin Energy CSG Ltd
- Bio Energy Solutions Pty Ltd
- Bioenergy Research Pty Ltd

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Editor:
Dr Alvin van Niekerk and Charlotte Camerer

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