THE UNIVERSITY OF QUEENSLAND
AUSTRALIA

QAAFI
Queensland Alliance for Agriculture and Food Innovation

QAAFI REPORT 2011

Working together with the Queensland Government

contents

QAAFI REPORT 2011

Director's Report

In its first full year of operations in 2011, the Queensland Alliance for Agriculture and Food Innovation (QAAFI) has evolved beyond the expectations of its founders. With a research cohort of more than 50 scientists leading research projects and an equal number of senior research affiliates at UQ, plus a growing number of adjunct appointments of senior scientists from outside the university, QAAFI offers a powerful intellectual capacity to improve the competitiveness and sustainability of tropical and sub-tropical food, fibre and agribusiness sectors through high-impact science.

Professor Robert Henry

One of QAAFI's additional strengths has been the strong leadership provided by each of the QAAFI centre directors. In 2011, Professor Stephen Moore joined QAAFI as director of the Centre for Animal Science (CAS). Before coming to QAAFI, Professor Moore had been working for the cattle industry in Alberta, Canada. He has more than 20 years' experience in bovine genomics, including his role as Chair in Bovine Genomics at the University of Alberta since 1999. The expertise he brings to QAAFI's Centre for Animal Science reflects the centre's capacity to embark on research to help Australian and international livestock industries flourish now and into the future.

In early 2011, QAAFI became part of a national effort to fast-track development of new 'healthier' varieties of three of the world's most widely cultivated cereal grains. The 'High Fibre Grains Cluster' focuses on wheat, barley and rice. One of the primary research goals is to boost the amount of beneficial compounds, such as beta glucans and arabinoxylans, which are key contributors to the soluble component of dietary fibre in the various grains. A collaboration between QAAFI, CSIRO's Food Futures Flagship, The University of Adelaide and The University of Melbourne, the program brought together Australia's foremost plant and human nutrition researchers with the aim of boosting the healthy fibre content of common grains. The cluster will see more than $7 million invested over three years, with the university partners receiving more than $3.4 million from the Flagship Collaboration Fund.

QAAFI researchers acted swiftly to ensure Australia's next $180 million avocado crop won't be crippled by a fungus. The popular fruit is susceptible to several fungal diseases but a study by QAAFI plant pathologist Dr Liz Dann isolated and identified a potentially devastating new avocado pathogen which causes severe root problems, particularly in young trees. Already known to cause black rot in peanuts and collar rot in papaya, the pathogen *Calonectria ilicicola* had not previously been confirmed as an avocado pathogen. The fungus will now be added to the list of identified avocado root pathogens. This discovery will no doubt be of lasting benefit to the nation's estimated 1000 commercial avocado growers.

Another highlight for 2011 was the high-value research Associate Professor Steve Walker has contributed to weed science and weed management. He confirmed that eight populations of flax-leaf fleabane (*Conyza bonariensis*) are resistant to glyphosate in northern NSW and southern Queensland. This is the fifth weed species to be confirmed resistant to glyphosate in Australia in the past decade, with four being found in the past three years, and is the first glyphosate resistant broadleaf weed found in Australia. These findings were a wakeup call to no-till farmers and roadside maintenance managers who rely heavily on glyphosate as their herbicide-of-choice.

Improving Queensland's northern cattle herd is the subject of continuing scientific investigation at QAAFI. One major cattle project, led by QAAFI's Dr Stu McLennan, is seeking to identify supplements that provide the most cost-effective growth response in northern cattle. Co-funded by Meat and Livestock Australia, DAFF (Qld) and QAAFI, this project is being carried out at the AgForce-owned Brian Pastures Research Station near Gayndah.

QAAFI also announced development of the world's first vaccine against Bovine Viral Diarrhoea Virus (BVDV) using nanotechnology, a technique which stands to save the Australian cattle industry tens of millions in lost revenue each year. The proposed new BVDV vaccine, based upon a protein from the virus loaded on nanoparticles, has been shown to produce an immune response against the industry's most devastating virus. A group of Brisbane scientists has shown that the BVDV nanoformulation can be successfully administered to animals without the need of any additional helping agent, making

a new 'nanovaccine' a real possibility for Australian cattle industries. QAAFI scientists Dr Neena Mitter and Dr Tim Mahony have established a partnership with the Queensland Government, nanotechnology experts Professor Max Lu and Associate Professor Shizang Qiao from the UQ Australian Institute of Bioengineering & Nanotechnology to develop the vaccine further with potential for commercialisation.

Queensland scientists are at the forefront of international efforts to increase crop production by 30 per cent and reduce crop failures for thousands of African farmers. QAAFI and Queensland Government scientists have interacted with their African counterparts to find ways of improving sustainable production of maize and legume crops in both Africa and Australia. The new research alliance funded by GRDC and ACIAR aims to reduce poverty and improve food security for African communities and help Australian growers capitalise on opportunities from current trends in weather and expected changes in climate research. Headed by QAAFI scientist, Dr Daniel Rodriguez, and supported by Queensland Government scientists, the project will design more productive and sustainable cropping systems in five countries of southern and eastern Africa, and in Queensland and New South Wales.

These are only some of QAAFI's many research highlights in 2011. A more complete picture of our achievements is available on our website. Because food security is so important to all our futures, I believe QAAFI will continue to significantly contribute to finding much-needed answers to some of the biggest challenges facing agriculture, food and human nutrition.

Professor Robert Henry
Director

The Alliance

Established in October 2010, the Queensland Alliance for Agriculture and Food Innovation (QAAFI) benefits from the collective strengths of UQ and the Queensland Government. As a research institute, QAAFI brings together high-level expertise in plant, animal and food sciences from UQ and the Queensland Government.

The institute's scientific focus underpins Queensland's collective capacity to deliver high-impact research and development outcomes across the agriculture and food sectors. QAAFI research programs help to consolidate Queensland as a world leader in development of tropical and sub-tropical agriculture and food.

QAAFI researchers work across three main disciplines – animal science, nutrition and food sciences, and plant science. Collectively these groups work closely with industry, government and other stakeholders to address strategic issues.

From a foundation group of 34 senior Qld Government researchers* transitioned to QAAFI in 2010, the institute now includes 48 full-time senior research-only staff, leading more than 100 staff.

Conceived as a strategic joint-initiative, QAAFI's expertise helps Queensland to capitalise on emerging research in areas such as genomics, materials science and advanced systems modelling – scientific disciplines vital to the innovative capacity of Queensland's food and agribusinesses sectors.

In addition, QAAFI research programs offer exciting career opportunities for young Queensland scientists – from the traditional agricultural research programs supporting the beef, dairy, cropping and horticulture industries, through to leading national research efforts in food nutrition and biosecurity.

QAAFI research staff are based at 12 sites distributed across UQ campuses and Queensland Government research stations and centres, allowing continuing opportunities for collaboration and industry involvement.

**Formerly DEEDI, now the Department of Agriculture, Fisheries and Forestry in Queensland (DAFF).*

QAAFI Advisory Board

Mr Robert Antonio
Chief Executive Officer
McLean Farms, Pittsworth, Qld

Professor Kaye Basford
UQ researcher in applied statistics in agricultural science
President, UQ Academic Board

Mr Wayne Carlson
retired NAB national agribusiness manager with 35 years' experience in the agribusiness and finance sector

Mr Rob Clark
Lanoma Estate, Tasmania

Mr Peter Lancaster
Chairman of Food Spectrum Pty Ltd

Mr Wayne Newton
member of the Grains Research Foundation Ltd board of directors and grain and cotton grower in Dalby

Mr Ralph Shannon
Chairman of the North Australian Beef Research Council

Professor Beth Woods
Chief Scientific Officer, Queensland Government

QAAFI Locations

QAAFI scientists conduct research at 12 facilities across Queensland.

One location in the Townsville region

Charters Towers, Qld

One location in the Rockhampton region

25 Yeppoon Road, Parkhurst, Rockhampton, Qld

Two locations in Queensland's Wide Bay Burnett region

KINGAROY
J. Bjelke-Petersen Research Station, Kingaroy, Qld

NAMBOUR
Maroochy Research Station, Nambour, Qld

Four locations in Queensland's South West and Darling Downs region

GATTON
UQ Gatton, Gatton Research Station, Gatton, Qld

TOOWOOMBA
203 Tor St, Toowoomba, Qld

Leslie Research Centre, Toowoomba, Qld

WARWICK
Hermitage Research Station, Warwick, Qld

Four locations in the heart of Brisbane

The University of Queensland – St Lucia Campus (QAAFI Headquarters)

Ecosciences Precinct – Boggo Road, Dutton Park

Health and Food Sciences Precinct – Coopers Plains

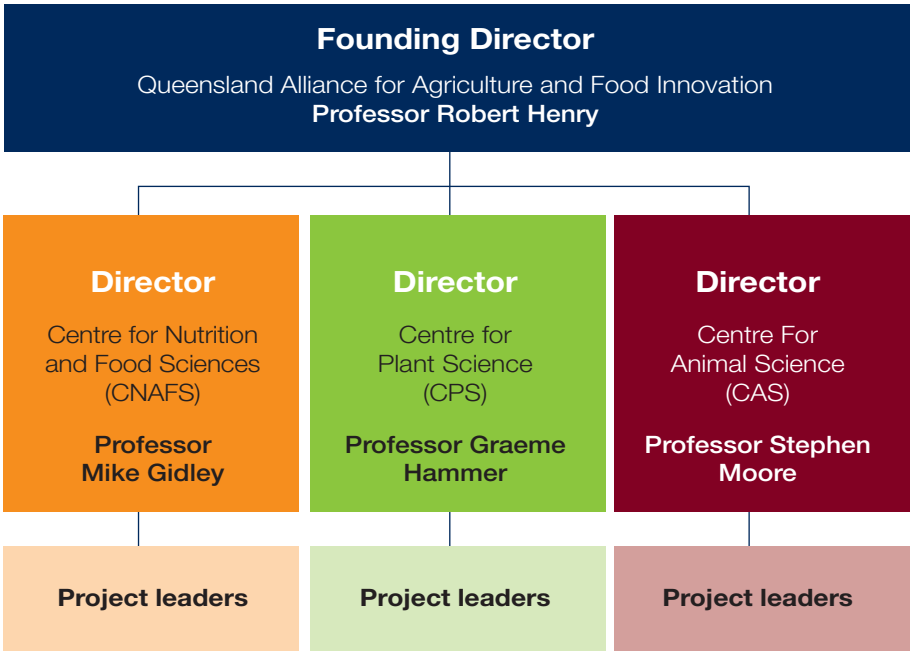
Queensland Bioscience Precinct, UQ, St Lucia

QAAFI Structure

QAAFI is one of eight UQ research institutes. While QAAFI's administrative headquarters are at UQ's St Lucia campus, QAAFI scientists work from twelve strategically located centres throughout the state.

With a director appointed by the Queensland Government and The University of Queensland, QAAFI is closely linked with many of Queensland's and Australia's major food and technology groups.

The institute's research portfolio is managed by QAAFI's director and three supporting centre directors (see table right). The QAAFI Advisory Board, which is comprised of representatives from industry, government and The University of Queensland, regularly reviews QAAFI's progress.



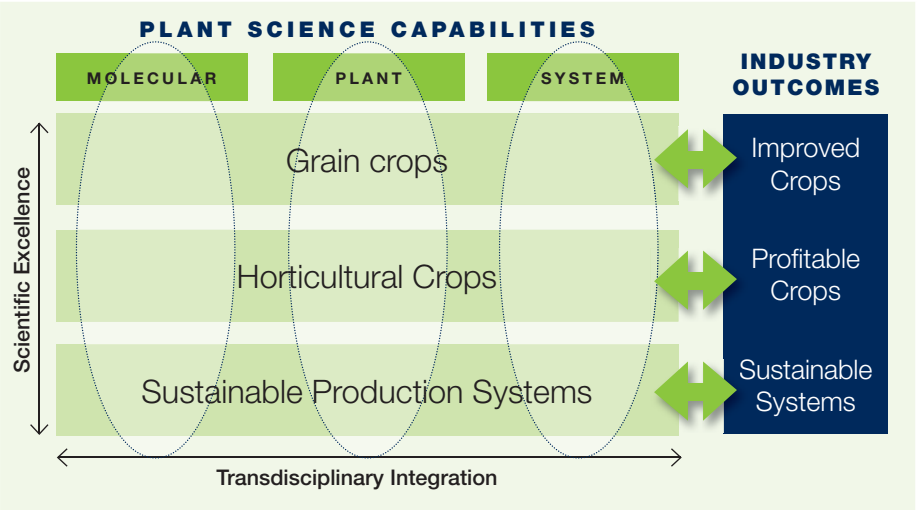
Centre for Plant Science (CPS)

There is a national and international need for enhanced effort in outcome-focussed plant science. Well-adapted plants and production systems are required to deliver the higher levels of profitable, sustainable, and secure production now required to meet the challenges of this century on food supply, production risks, resource use, and soil health.

This environment provides a major opportunity for the strategic advancement of the Centre for Plant Science within QAAFI. CPS provides the vehicle to integrate the significant plant science R&D capabilities in UQ and DAFF to help address these needs.

Aims of the Centre:

- To pursue excellence in plant science at molecular, whole plant, and production system levels for the benefit of plant industries
- To integrate disciplinary capabilities in developing improved grain and horticultural crops, and resilient, sustainable, and profitable production systems
- To develop and maintain strong linkages with industry
- To enhance efficiency in research investment and improve opportunities to obtain major grant funding from government and industry



Research Programs:

CPS links excellence in the plant science capabilities of UQ and DAFF to deliver outcomes for plant industries and associated community benefits via improved crops and production systems. The intent is to maintain scientific excellence at scales ranging from molecular to ecosystem levels while seeking transdisciplinary integration that fosters association between discovery and development science.

CPS consists of 24 scientists operating across these programs in more than 50 R&D projects that involve more than $8 million of grant funding. The QAAFI Biological Information Technology group (see box 4) and the ACIAR–PARDI project collaboration form part of CPS, and the centre manages the Agricultural Production Systems Simulator (APSIM) collaborative initiative with CSIRO and DAFF for UQ.

1. Grain Crops

This program targets improved crops and management systems with research teams focussed on sorghum [see e.g. box 1], wheat, and legume (e.g. peanut) crops. Research teams focus on crop productivity via attention to issues such as tolerance to abiotic [see e.g. box 1] stresses. The teams bring together cutting-edge scientific expertise in plant biology (molecular physiology, ecophysiology, modelling, agronomy), plant genetics (molecular genetics, gene silencing, genomics, breeding technologies), and crop improvement (molecular and bio-technologies, plant breeding, crop management).

This program delivers novel, innovative or improved varieties and breeds to industry that are commercially attractive as well as science-based information products and underpinning knowledge and scientific outputs. These activities are aligned with animal production and product quality aspects residing in QAAFI sister centres (Centre for Animal Science and Centre for Nutrition and Food Sciences). New developments in exploring the potential of crops as cellulose sources for biofuel are planned.

2. Horticultural Crops

This program targets improved quality, productivity, and production efficiency in key horticultural crops (banana [see e.g. box 2], macadamia, avocado, mango, vegetables). The teams bring together cutting-edge scientific expertise in breeding, quantitative genetics and genomics as well as disease biology and management (plant pathology, virology, integrated pest management), and host plant resistance.

This program delivers improved varieties, diagnoses of crop pest and diseases for industry biosecurity threats, disease management systems that reduce losses from pests, and underpinning knowledge and scientific outputs. Delivery is informed by consumer demands for improved product quality and shelf life, so that these activities are also closely aligned with product quality aspects residing in CNAFS.

3. Sustainable Production Systems

This program targets improved resilience, sustainability, and profitability of broad acre dryland and irrigated farming systems. The research teams are focussed on weed management, soil health (see e.g. box 3), resource use efficiency, climate risk management, and farming systems design and analysis. The teams bring together cutting edge scientific expertise in weed ecology, herbicide resistance, soil science, crop nutrition, and resource use efficiency and farming systems modelling.

The program delivers new or improved production systems that improve business profitability and sustainability, reduced losses from weeds, reduced chemical use, and underpinning knowledge and scientific outputs.

Keeping Bananas Healthy

Bananas are Australia's most consumed fresh fruit with an annual production of 274,000 tonnes and a farm gate value of $450 million.

The banana industry is a vital part of the domestic food industry and plays an important economic role in regional areas of NSW, WA and Queensland. The supply of this popular fresh fruit is under threat from adverse weather conditions, such as cyclones, and the occurrence of pests and diseases. Pests and diseases can have a significant impact on the cost of production, quantity and quality of supply and access to markets.

Australia is in a unique position in the global banana production system in that we have managed to keep a large number of pests and diseases out of Australia. The most recent banana industry biosecurity plan lists 13 fungal pathogens, 3 viruses, 4 bacteria, 6 nematodes and 182 insects which occur in other banana production areas elsewhere in the world. The main current disease threats are banana bunchy top (NSW border region endemic), Fusarium wilt 'Tropical Race 4' (responsible for contraction of the Darwin NT industry), Fusarium wilt Race 1 (affects Ladyfingers and Ducasse and present in NSW, south-east Qld and the Atherton Tablelands), Fusarium wilt 'Sub-tropical Race 4' (affects Cavendish) and potential recurrence of black Sigatoka diseases (appeared and eradicated in 2001). The benefits of not having these exotic diseases, so called exclusion benefits, are large and fall into four different categories: 1) exclusion is by far the cheapest option of control and it keeps the cost base of production low (e.g. black Sigatoka control in Costa Rica is currently via 70 chemical spray applications per annum while Fusarium 'Tropical Race 4' makes land unsuitable for Cavendish production); 2) lower environmental footprint of our production system due to not having to control a range of pests and diseases; 3) market access with regards to export and import of plant material and fruit and 4) consumer confidence in the final product which is of higher quality and has less risk of residue in the fruit.

Banana freckle disease (Malaysia)

Five year plan

To safeguard the banana industry from the impact of serious endemic and exotic diseases and pests in a world of increasing international travel and trade, a combined team of QAAFI, DAFF and UQ scientists led by Associate Professor André Drenth (QAAFI) was recently awarded a five-year grant with a value of more than $6 million from Horticulture Australia Limited. A comprehensive approach has been developed to safeguard the industry from exotic pests and diseases, and reduce the impact of endemic pests and diseases, while at the same time increasing consumer choice through the availability of more varieties.

Australia is in a unique position in the global banana production system in that we have managed to keep a large number of pests and diseases out of Australia.

The Banana Plant Protection Program can be seen as a framework in which the key core activities required for banana plant health in the short and long term are aligned and streamlined to ensure economical delivery of effective outcomes for the industry as a whole and on a national basis. The program consists of four strategic areas:

1. Resistant Varieties and Consumer Choice, led by Dr Mike Smith (DAFF) aimed at facilitating the evaluation of pathogen-tested planting material of consumer accepted varieties with specific disease and pest resistance for security of the Australian Banana Industry;
2. Safeguarding Production and Markets, led by Dr Sharon Hamill (DAFF) aimed at reducing the risk from incursions of emergency and endemic plant pests through improved capacity for prevention, detection, identification and an effective, coordinated, early response. This subprogram also involves the maintenance and safe access to banana germplasm and facilitate safe access to new varieties into Australia for sustained production and development of new markets;
3. Sustainable Production Systems, led by a field pathologist to be appointed at DAFF, aimed at improving productivity through provision of cost-effective and sustainable management options for priority pests and diseases in the banana industry;
4. Building Science and Communication, led by A/Professor Andre Drenth (QAAFI) aimed at building a networked industry-science capacity. The program will be managed by a leadership team consisting of Dr Drenth from QAAFI (program leader), private consultant David Peasley (NSW, sub-tropical) and private consultant Richard Piper (north Qld, tropical).

Flexibility the key

Dealing with the biotic nature of pests and diseases, the QAAFI developed plant protection program is flexible to continually adjust and improve the best-practice guidelines as soon as new and relevant information comes to hand. At the same time flexibility is needed to deal with emergency pest and disease issues. The plant protection program is designed in such a way that both short and long-term disease and pests issues are addressed in consultation with industry.

QAAFI, being a close collaboration between DAFF and UQ, is ideally placed to develop and manage large programs like these and bring together teams of scientists from different organisations in different parts of Queensland and the nation with strong scientific international links to turn scientific research into benefits for our local industries. Undergraduate and graduate scholarships are also incorporated into the program to attract bright and young students to work on important areas of research.

Sustainable soil management to support northern cropping systems

A series of collaborative projects between the major soil and farming systems research groups in Qld and northern NSW is trying to devise cropping practices and soil management strategies that improve the sustainability of our grains and cotton cropping systems.

Dr Mike Bell (QAAFI) leads a series of projects under this broad work area, with strong financial support from the Grains and Cotton Research and Development Corporations, the Australian Government's Department of Agriculture, Food and Forestry, regional natural resource management groups and the international fertilizer industry. The collaborative effort is supported by scientific groups in DAFF (led by Dr David Lawrence), EHP (led by Dr Phil Moody), QUT (Prof. Peter Grace), UNE (Dr Chris Guppy) and NSW DPI (Mr Guy McMullen). Over the past decade, the research program has explored the interaction between farming systems and chemical, physical and biological components of soil health, with the current foci on soil organic matter/soil C, managing declining soil nutrient reserves and developing measures to improve Nitrogen (N) use efficiency to minimise nitrous oxide generation.

Soil health is a nebulous term that invokes both robustness (an ability to resist change) and resilience (an ability to bounce back after a stress event). Both these properties are keys to soils that can support profitable and sustainable farming systems – especially when those farming systems are operating under financial pressure and a variable climate. Unfortunately, there has been a marked decline in soil health of the

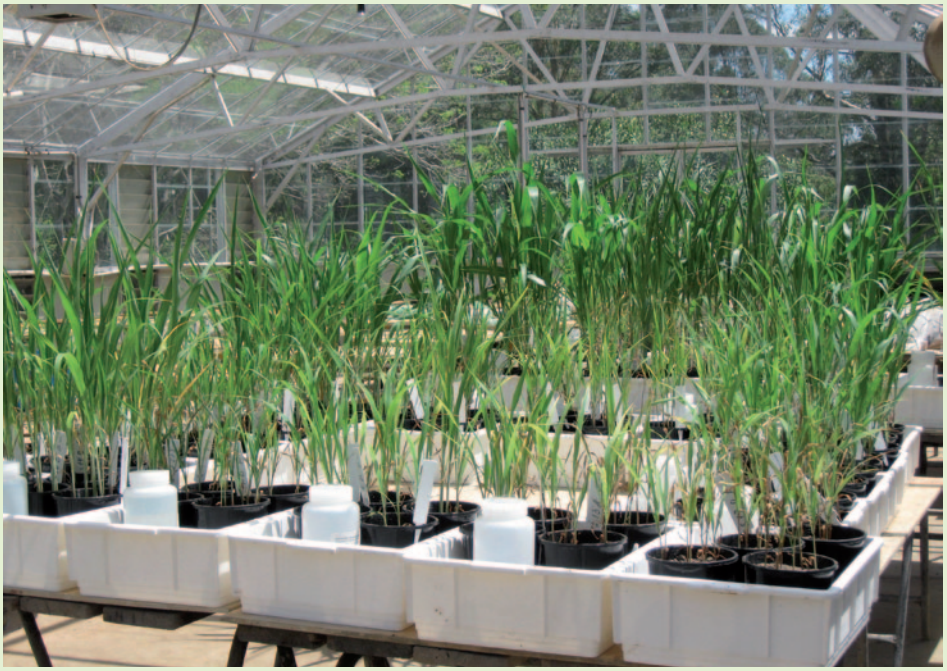
soils supporting the broad acre grains, sugar and cotton crop industries across northern Australia. This decline can be measured in terms of lower soil organic matter and C stocks, much diminished native nutrient reserves (both organic and inorganic) and less diverse and vigorous soil microbial communities. Management strategies to address these changes are being devised as new problems emerge, but adoption by industry is often slowed by both a cost:price squeeze on producers and the increasing complexity of the interacting issues.

Using available moisture

The problems are hugely significant for the sustainability of the northern cropping region, with nutrient management in the grains and cotton industries being a classic example. These farming systems occupy the predominantly heavy clay soils of inland Qld and northern NSW, and with a few exceptions, are dominated by rainfed cropping using conservation tillage or no tillage management. The key to the success of these systems has so far been the effective capture, storage and subsequent utilisation of available moisture. As organic matter has declined, the requirement for artificial N fertilizers has increased, with this input dominating fertilizer programs and a major component of crop growing costs. However, these systems have been exploiting native reserves of other nutrients in the interim (organic and inorganic sulfur reserves, and inorganic reserves of phosphorus and potassium), and those reserves have reached critical levels in a number of regions. Yield responses of 50–70% have been recorded by addressing these limitations in some seasons.

The solution may appear simple – apply more fertilizer, or more appropriate fertilizer combinations. However, there are serious limitations in the diagnostic tools to determine the levels of plant available P, K and S in soils (and hence the need for fertilizer), the relative importance of subsoil and topsoil nutrient reserves and the most appropriate application strategies to ensure efficient use of those nutrients across a farming system exposed to variable climatic conditions. There are also issues associated with the cost of nutrient inputs and whether investments in N fertilizer can be reduced to cater for these emerging constraints – perhaps by increasing the use of legumes in the crop rotation.

Responses to differing soil potassium (K) concentrations in field research on barley crop to quantify soil test – crop response relationships.



Detailed laboratory and glasshouse studies to determine the fate of applied fertilizers in soil support the field research.

The implications of this work are significant. World agriculture is under pressure to meet the demands for food and fiber from an increasing population, so maintenance of productive farming systems is globally important. However, global reserves of fertilizer nutrients (e.g. P and to a lesser extent K) or the industries that support their production (i.e. N from the petrochemical industry) are also challenged by finite reserves. The development of viable and efficient use practices in the short term and more sustainable reuse/recycling of nutrients in the long term will be essential to continue to meet global food needs.

Identifying Candidate Genes for Stay-Green in Sorghum

Sorghum genotypes with the staygreen trait (right) retain stature and yield under drought

An international project involving Australian (UQ/DAFF) and US (TAMU) scientists aims to identify and understand the function of gene networks that contribute to improved plant drought adaptation and productivity in water-limited environments.

Dr Andrew Borrell (QAAFI) leads the overall project, with significant input from Dr David Jordan (QAAFI). Professor John Mullet from Texas A&M University leads the US end of the project. Sorghum, one of the most drought resistant cereal species, is being used as a model crop to study drought adaptation mechanisms. Breeding, physiology, molecular biology and simulation modelling are integrated using a 'phenotype-to-gene' approach. This decade-long study has been funded by GRDC, DAFF, TAMU and NSF, with more recent funding from QAAFI.

Post-flowering water stress is common in Australia's cropping zones. Sorghum plants with the stay-green trait maintain green leaves and stems when water is limiting during the grain-filling period resulting in higher grain yield, larger grain size and increased lodging resistance. Unlike many drought adaptation traits, stay-green has limited (or no) cost in favorable environments. A large amount of data is available from multi-environment breeding trials over many seasons, indicating the value of the trait. Stay-green has been a target of sorghum breeders for more than 30 years and is widely deployed in commercial hybrids in Australia. The trait remains a major focus of the QAAFI/DAFF sorghum breeding program.

Stay-green is a multi-genic trait with major gene effects. In the current project, a map-based gene cloning approach has identified candidate genes for the two most important loci controlling the trait. Stay-green is much more than green leaves. DAFF/UQ scientists, including Drs Borrell, George-Jaeggli, Van Oosterom, Hammer, Mace and Jordan have developed a strong understanding of the causal mechanisms of stay-green gained from genetic analysis, gene expression studies and detailed physiological dissection of the trait. The stay-green genes have been shown to modify a range of physiological processes affecting the canopy, roots, N uptake and water dynamics, leading to enhanced yield under drought. This understanding leads the team to believe that the stay-green mechanism will enhance drought adaptation in other major cereal species (wheat, barley, maize and rice) in environments where water limits crop growth post-flowering. Transformation studies are planned to assess the candidate genes in a range of crop species. Patents have been filed on the use of key genes controlling the trait for the improvement of drought tolerance in crops. It is the intention of the inventors that the technology will be freely available to poor farmers in drought-prone areas of the world. Commercial partners will be sought to roll-out the technology.

This project has global implications, particularly in Africa and India. Sorghum is the dietary staple of more than 500 million people across 30 countries. Drought-adapted sorghum germplasm containing stay-green QTL is currently being developed for sub-Saharan Africa in a project funded by the CGIAR's Generation Challenge Program, co-led by Drs Jordan and Borrell (QAAFI, Australia), in collaboration with Drs Teme and Coulibaly (IER, Mali). In another project funded by ACIAR, Drs Hammer and Borrell (QAAFI) are working with Drs Vadez (ICRISAT) and Talwar (DSR) to evaluate sorghum germplasm containing stay-green QTL for both grain and fodder at the CGIAR'S ICRISAT centre in Hyderabad, as well as field sites in the Indian states of Andhra Pradesh, Maharashtra and Karnataka.

Studying the physiological mechanisms underpinning the staygreen trait in sorghum

QAAFI Biological Information Technology

The QAAFI Biological Information Technology (QBIT) group, located in the Centre for Plant Science, develops innovative software tools and products for use in research, training and decision support. The group's R&D activity focuses on identification software, scenario-based learning software, and computational modelling. The group also provides related support, training services, software development and multimedia services to QAAFI, UQ and outside agencies.

Identification Tools

QBIT's world-leading digital identification and diagnostic platform (Lucid®) for developing and deploying online, multimedia identification aids, is currently used in more than 170 countries. Many Lucid tools have been developed for pest management and biosecurity: particularly by the US quarantine service (APHIS) as their standard tool for deploying identification aids and resources.

QBIT is currently working with national and international collaborators in developing the next generation of identification software for handling descriptive data on a global scale to provide a new model for online, interactive identification. For more information on these projects, visit www.identifylife.org and www.lucidcentral.org.

Scenario based learning

Scenario Based Learning Interactive (SBLi) is a software suite designed to enable teachers, lecturers and others working in training or education to create and deliver scenarios to provide problem-based learning experiences. Originally developed as a means of simulating a plant diagnostic experience, SBLi is now being used nationally and internationally across most disciplines by school, university and professional learners. Recently SBLi scenarios have been developed for quarantine, horticulture, vertebrate pests and veterinary problems as well for plant development, genetics and statistics. For more information on SBLi, visit www.sblinteractive.org.

Computational Biological Modelling

Biological modelling research, headed by Dr Jim Hanan, develops mathematical and computational approaches and techniques for simulation and visualisation, facilitating the study of biological systems. The models incorporate genetics, physiology, ecology and environmental effects. Current research includes studies of macadamia tree vegetative growth and flowering funded through DAFF and HAL, modelling of the effects of plant cell-wall fibre in the digestive system with the Centre for Nutrition and Food Science, and development of a virtual wetland, integrating hydrology models with developmental models of wetland plants.

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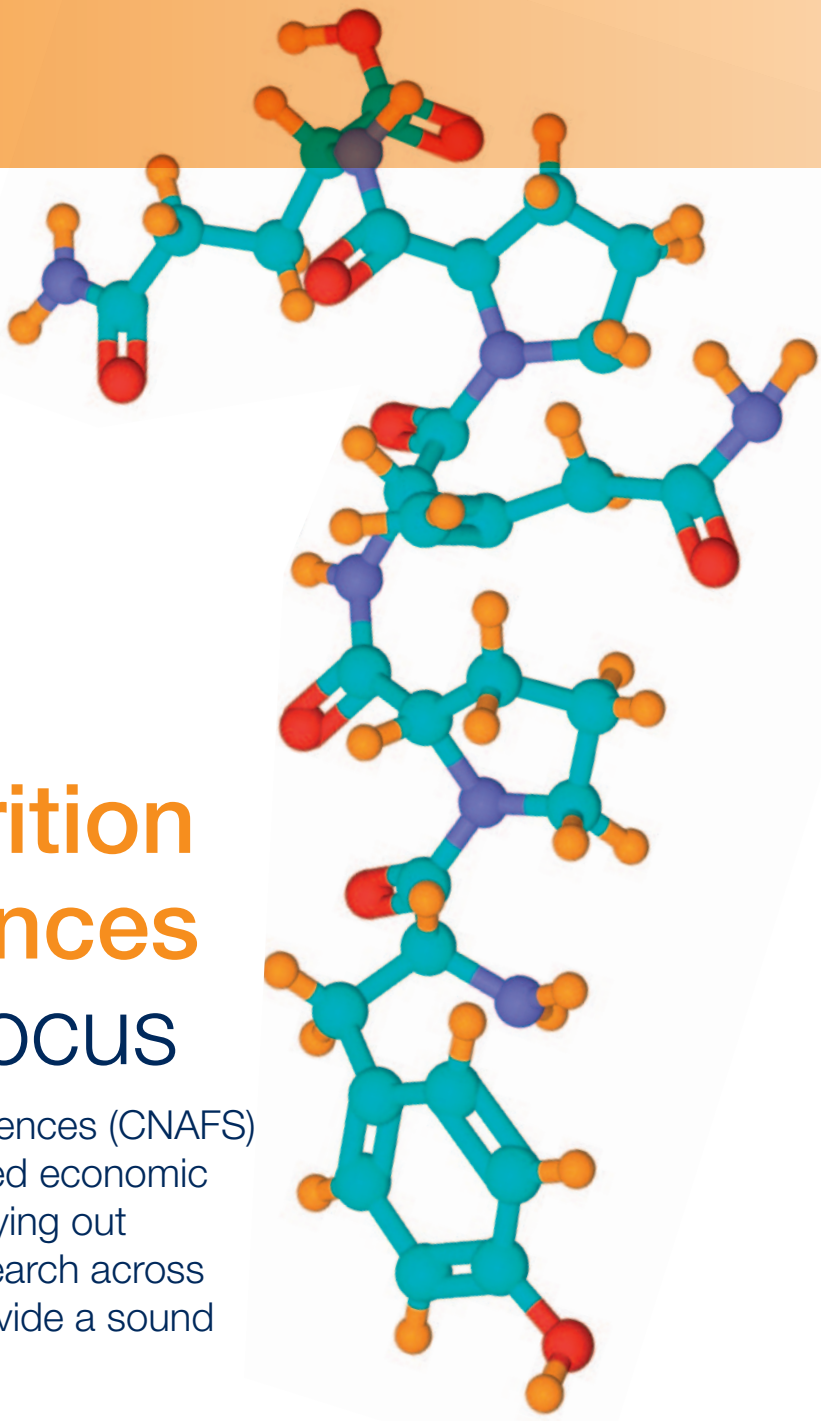


Centre for Nutrition and Food Sciences – Scope and Focus

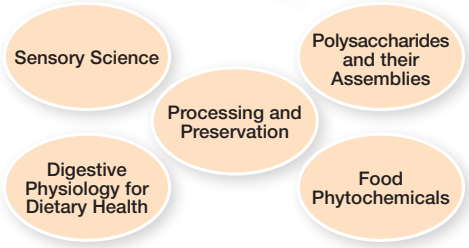
The Centre for Nutrition and Food Sciences (CNAFS) supports the development of enhanced economic benefits and health outcomes by carrying out relevant fundamental and applied research across the nutrition and food sciences to provide a sound basis for subsequent exploitation.

The science of food and nutrition involves the integration of approaches drawing from physical, chemical and biological disciplines. CNAFS uses a range of cross-disciplinary approaches, modern analytical techniques and understanding developed through study of model systems, to identify the fundamental mechanisms responsible for important food and nutrition properties. This involves extensive collaboration with research groups within The University of Queensland, the Queensland Government's Department of Agriculture, Fisheries and Forestry (DAFF), as well as Australian and international partners.

Current research within CNAFS addresses the topic of naturally-functional foods through study of:

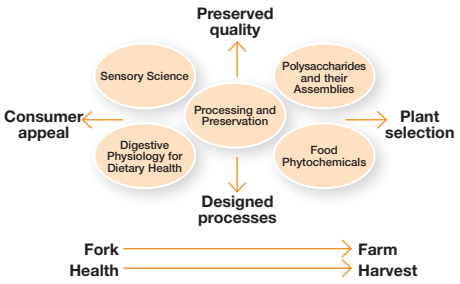
- Molecular basis for food quality
- Food bio-materials and processing
- Health and nutrition properties

These broad science capabilities are focused on five areas of strength that link key food raw materials (polysaccharides; phytochemicals) to consumer and health properties (sensory science; digestive physiology) through processing and preservation:



Skills and projects

Projects aimed at developing the knowledge necessary for enhanced health and/or economic benefits recognise that it is only purchased (and consumed) food that lead to economic (and health) benefits. Many take a 'Fork to Farm' / 'Health to Harvest' approach to define and design technical opportunities through, for example, enhanced consumer appeal (sensory, nutrition, convenience), raw materials selected for end-product quality, and/or processes designed for efficiency and effectiveness:



The skills within each of the five focus areas are used to pursue specific project opportunities, but it is the combination of skill bases within CNAFS and the opportunity to collaborate with the QAAFI centres of Plant Science and Animal Science, together with colleagues within UQ and DAFF, that leads to the unique ability to tackle broad-ranging questions that span the agri-food supply chain and address consumer needs.

Focus Areas

1. Polysaccharides and their assemblies

- biosynthesis-structure-property relationships of polysacharrides
- molecular assembly of plant cell walls and starch granules
- controlled breakdown during processing and in the digestive tract

2. Food phytochemicals

- composition in raw materials (including biofortification)
- sensory properties
- nutritional bioactivities

3. Processing and preservation

- preserved fresh quality and nutrition
- machine-materials interactions
- extraction, protection and delivery of nutrients

4. Sensory sciences

- flavour/texture perception
- receptor biology, appetite, satiety, and food intake
- cognitive and consumer responses

5. Digestive physiology and dietary health

- physical, biochemical, microbiological and physiological effects
- nutrition/sensory interactions
- health consequences (metabolic syndrome, GI tract health…)

While focus areas 1 and 2 are material-specific, areas 3 – 5 can be applied to all food materials.

Pan-disciplinary opportunities

The integration of approaches from many disciplines is often needed to tackle the big questions facing the agri-food supply chain and to derive consumer- and health-relevant innovation. CNAFS will contribute by developing specific pan-disciplinary approaches of general relevance, such as (but not limited to):

Food/feed in the digestive tract

- integration of interactions involved in digestion of food components
- laboratory and pig models for prediction of food/feed digestion

Raw materials selected/designed for optimal function

- 'Fork to Farm' selection for food product quality / nutrition
- molecular breeding opportunities

Processing for quality/nutrition

- enhancing/creating desired properties by processing
- foods/ingredients with designed flavour/nutrient release profiles

Control of food/feed intake

- integration of sensory and hormonal responses
- design of food/feed to limit or enhance intake

Shelf-life extension of kangaroo meat using natural antimicrobials – Dr Yasmina Sultanbawa

The objective of this work is to assess the potential of using natural antimicrobials such as plant extracts and organic acids in extending the storage life of chilled kangaroo meat and as an alternative to sulphites as a chemical preservative.

QAAFI and Queensland Government scientists have discovered promising new anti-microbial properties in a combination of natural-plant ingredients, including two common native Australian plums.

A research team led by QAAFI food scientist Dr Yasmina Sultanbawa has discovered that when small amounts of the kakadu and Queensland Davidson plum are combined with organic acids they display promising new anti-microbial properties.

Dr Sultanbawa's research team has been looking at how native plants might be used to extend the shelf-life of processed kangaroo meat in pet food, which would help to reduce the industry's reliance on preservatives such as sulphides.

"The pet food industry has traditionally used sulphites to extend the shelf-life of meat products, however extended high exposure to sulphites can lead to thiamine deficiencies in small animals including cats and dogs," Dr Sultanbawa said.

"Consumers are trending towards fresh, natural produce across-the-board – and that includes food choices for their beloved pets.

"The kakadu and Queensland Davidson plums both have tremendous potential as anti-microbial agents and we have only just begun to explore the protective properties of these native fruits.

"Although this is new work, our preliminary studies suggest it might be possible to improve the shelf-life of kangaroo meat by adding native plum anti-microbial agents and using existing processing such as vacuum packaging for best results."

Potential for other mince meats

Department of Agriculture, Fisheries and Forestry (DAFF) scientist Andrew Cusack said this research could be applied to other minced meat products such as sausages where sulphite is used as a preservative.

"Additionally plant extracts have other benefits such as antioxidant properties which could contribute to better health," Mr Cusack said.

Dr Yasmina Sultanbawa's research "Shelf-life extension of kangaroo meat using natural anti-microbials" is a collaboration between scientists from QAAFI and DAFF's Innovative Food Solutions and Technologies.

Liver structure could hold the key to battling diabetes — Professor Robert Gilbert

The Gilbert research group has developed new experimental and theoretical methods for the characterisation of starch, glycogen and other branched polymers. These new methods open doors for understanding of starch and glycogen biosynthesis-structure-property relations, especially with regard to human health.

"This discovery has utilised new technology and a unique partnership to identify how to manage what is fast becoming an international epidemic."
Professor Robert Gilbert

Our liver could be a major springboard for determining life-changing diabetes diagnosis and treatment thanks to a world-first discovery by an Australian-Chinese research team.

QAAFI scientists, working with a team from Wuhan University in China, have identified a link between the structure of the glucose-storage molecule (known as glycogen) in our liver cells and diabetes.

The project's lead scientist, Professor Robert Gilbert, said the latest findings were the result of world-class research in molecular science.

"This discovery has utilised new technology and a unique partnership to identify how to manage what is fast becoming an international epidemic," Professor Gilbert said.

"This discovery sheds new light on diabetes: it suggests that there is a molecular mechanism involved in the lack of control of blood sugar which characterises diabetes.

"Type-2 diabetes is growing at epidemic rates: it is estimated that by 2025, three million Australians will suffer from this disease.

"This new insight opens the way to potential new means of diagnosis and clinical intervention," he said.

One of the project's key researchers is UQ PhD student, Mitch Sullivan, while mouse-model studies were done in collaboration with Professor Ling Zheng from Wuhan University.

Glycogen in liver comprises two sorts of molecules: smaller ones known as beta particles, and dozens of these joined together, known as alpha particles.

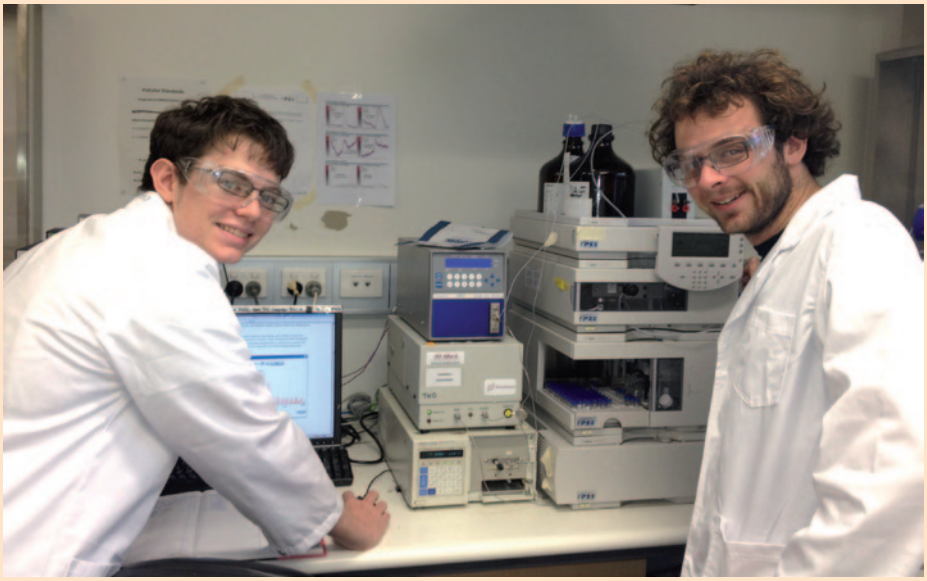
Through extensive laboratory studies (including size-exclusion chromatography equipment in Professor Gilbert's lab, which has world-leading capability for characterisation of this type of molecule), the research partnership has shown diabetic mice have lower levels of alpha particles compared to healthy mice.

Having fewer alpha particles would impair the body's means of gently regulating blood sugar levels against glucose spikes.

The research partnership will extend their findings to larger-scale tests with a view to establishing sought-after DNA testing and targeted liver treatment drugs.

Details of this work, including additional aspects involving researchers at Melbourne and Monash Universities, has been published in MA Sullivan, J Li, C Li, F Vilaplana, D Stapleton, AA Gray-Weale, S Bowen, L Zheng, RG Gilbert. *Biomacromolecules* 12 1983-6 (2011).

The size-exclusion chromatography equipment, with Mitch O'Connor (a UQ undergraduate researcher) and Mitch Sullivan



Centre for Animal Science

The Centre for Animal Science (CAS) works to improve health, welfare and productivity outcomes in the animal industries, while seeking to build leadership in development of Australia's tropical livestock research programs. CAS undertakes major research, teaching, consultancy and community-based service programs.

The CAS research portfolio includes:

- An animal health program focused on pest and disease control through improved detection, monitoring and vaccine technologies plus application of integrated pest management; systems. Public health, food safety and biosecurity are major components of this program.
- Animal behaviour, welfare and ethics;
- Animal improvement, focused on genetics, breeding and reproduction as well as animal nutrition, metabolism and growth.

CAS enjoyed both growth and consolidation in 2011. After guiding the centre through its embryonic development (when more than a dozen Queensland Government animal scientists joined QAAFI), interim director Dr Wayne Jorgensen was succeeded by Principal Research Fellow, Dr Stuart McLennan (Feb–Aug) and Senior Research Fellow, Dr Mary Fletcher (Aug–Sep). Professor Stephen Moore assumed his appointment as CAS director in September 2011. Before coming to QAAFI, Professor Moore had been working for the cattle industry in Alberta, Canada. He has more than 20 years' experience in bovine genomics, including his role as Chair in Bovine Genomics at the University of Alberta since 1999.

Diverse industry benefits

CAS continued to perform strongly in all areas of activity throughout the year, including research in genetics/genomics, nutrition, reproduction, animal health and welfare. CAS scientists delivered consultancy services across a wide range of industry sectors, nationally and internationally. For example, Dr Pat Blackall gathered *in vitro* data to support the registration of new generation antibiotics for intensive animal production systems (pigs and cattle). Meanwhile, Dr Peter James worked closely with Australian Wool Innovation (AWI), developing strategies for strike resistance and parasite control.

Animal welfare remains one of the centre's many strengths. Dr Jess Morgan designed and delivered training in animal welfare and animal ethics to staff at Charles Darwin University, and Dr Carol Petherick's expertise formed part of a RSPCA report to the Australian Senate about welfare standards in Australia's live export markets. Meanwhile Dr Eugeni Roura worked closely with the pork industry, delivering technical papers and training courses to producers and industry leaders.

Another important role for CAS is its provision of policy reports to industry and government. For example, Dr Pat Blackall, presented two briefings to government food safety regulators (one in NSW and one in Qld) on the Food Safety Research program within the Poultry CRC.

Several CAS researchers are working closely with the northern Australian cattle industry in on-going efforts to improve nutrition and reproduction/genetics/health in this vital industry.

Better nutrition for improvements in beef quality

The Centre for Animal Science includes programs that focus on genetics, breeding and reproduction as well as animal nutrition, metabolism and growth. Because demand for higher quality beef is increasing across both the domestic and export markets, scientists are looking at several ways to improve the tenderness and eating quality of beef once it reaches the table.

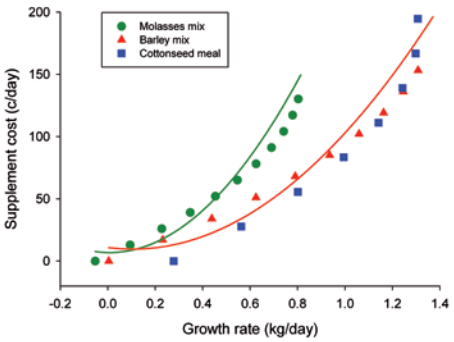
In northern Australia the most practical way of achieving this is by reducing the age of cattle sent to market while maintaining or increasing carcass weights. However, unfavourable grazing conditions encountered over much of the northern region, including the low quality of native pastures coupled with extended dry periods (when cattle lose weight), mitigate against achieving the high growth rates required to attain higher quality targets. One possible strategy is to feed targeted supplements during the one or two dry seasons that typically occur between weaning calves and marketing them.

This feeding regimen has raised several practical questions. For example, what supplement type provides the most cost-effective growth response?; at what stage in the growth path of cattle should they be fed?; and do different age groups respond similarly to the supplements? As part of a major project co-funded by Meat and Livestock Australia, DAFF (Qld) and QAAFI, led by Dr Stu McLennan (QAAFI), experiments are being carried out in the pen feeding complex at the AgForce-owned Brian Pastures Research Station near Gayndah to provide answers to these questions. Recent trials have compared the performance of cattle from two age groups (but the same genetic background). These were weaner steers aged about 10 months and mature steers of about 34 months. The cattle were fed a low-quality speargrass hay, mimicking dry-season pasture, and increasing amounts of either a barley/urea-based mix, a protein meal (cottonseed meal) or a combined molasses/urea/protein meal mix which is commonly used in northern Australia.

The younger steers were expected to outperform their older counterparts because at that age they tend, in contrast to the older animals, to gain weight more efficiently. But the results surprisingly indicated similar growth responses by the two age groups. In practical terms this means that cattle at different stages in their growth path will respond similarly when fed a set amount of supplement. Furthermore, the results suggest delaying [supplementary] feeding as long as possible in the growth path to reduce the impact of compensatory growth, a phenomenon whereby the response to nutritional treatments is partly eroded by faster growth by unsupplemented animals when conditions are good, for instance during the wet seasons in northern Australia.

The other practical finding was that for both age groups the responses increased in order of the molasses mix, barley mix and cottonseed meal which, significantly, followed the same ranking as the cost of the supplement mixes per tonne. However, when the cost and response information were combined, the barley mix and cottonseed meal provided a lower cost option for increasing gains compared with the molasses mix despite their higher cost per tonne (see figure). The growth response data is being incorporated into decision-support systems for use by cattle producers and their advisors so that they can compare options for increasing growth rates using their own costs for supplements landed on-property. Because molasses remains the preferred energy source for cattle in northern Australia, research efforts are continuing into increasing the cost efficacy of the molasses-based mix.

The results of these intensive pen studies are being “road-tested” in a grazing trial at Swans Lagoon Research Station near Ayr. Additional investigation of cattle growth rates under different nutritional regimes, including both supplements and leucaena-improved pasture (and the associated economic analysis), is being undertaken under commercial grazing conditions. The final assessment includes assessing carcasses for Meat Standards Australia grades as a tangible measure of meat quality. Ultimately, this type of research helps the beef industry to develop the cost-effective strategies it needs to produce the higher-valued high quality beef the consumer demands.



Cost response curves for various supplement types

Steers being fed hay and supplement in pens at Brian Pastures.

Steers eating a molasses-based mix in the grazing study at Swans Lagoon.

PARDI Annual Report 2011

PARDI — 'Pacific Agribusiness Research for Development Initiative' — commenced in February 2010. The project is coordinated by The University of Queensland (UQ) and funded by the Australian Centre for International Agricultural Research (ACIAR).

PARDI **seeks to create sustainable livelihood development outcomes for the South Pacific forestry, fisheries and crop-based sectors**. Scientists undertake supply-chain and market-driven research to identify constraints that impede local economic development. Research is aimed at achieving tangible solutions, such as new skills for locals, new technologies and product options.

PARDI is a partnership that involves UQ under the Queensland Alliance for Agriculture and Food Innovation (QAAFI), The University of the South Pacific, the Secretariat of the Pacific Community, University of Adelaide, James Cook University, The University of the Sunshine Coast, the Queensland Government's Department of Agriculture, Fisheries and Forestry (DAFF) and Southern Cross University.

The PARDI project is part of the portfolio that makes up QAAFI Centre for Plant Science. PARDI is headed by Project Leader, Stephen Underhill, who works with a qualified team of scientists from several of PARDI's partner organisations. The **PARDI project portfolio** includes a significant number of projects, each of which falls under **Crops, Fisheries, or Forestry**.

Canarium nut harvest: edible kernels (forefront) and canarium nut shells behind.

A scene from Sigatoka Valley, Fiji. A new PARDI project in Sigatoka Valley will support the sustainable production of high-value vegetable crops.

2011 Highlights

Impressive progress was reported across the PARDI project portfolio during the 2011 calendar year. Following are a selection of highlights during the reporting period.

Pacific pearl project off to a strong start

The PARDI pearl project, *'Supporting development of the cultured pearl industries in Fiji and Tonga'*, made good progress towards the project's aim to empower local communities and power business investment. The Fijian and Tongan pearl industries have significant potential to expand and evolve their production and sale of raw cultured pearls and a wide range of cultured pearls and pearl-shell products. During 2011, PARDI researchers undertook a broad and comprehensive review of the Fijian and Tongan industries to benchmark current and future performance.

A brighter future for Pacific cocoa

'Facilitating improved livelihoods for Pacific cocoa producer networks' is a project that aims to facilitate the entry of Pacific Islands cocoa farmers into higher-value markets. Based in Vanuatu and the Solomon Islands, the PARDI project has identified that Pacific Islands cocoa farmers have a number of distinct advantages that will assist them to tap into premium markets. Some of these advantages include fine flavour and high cocoa content. Research is now under way to help enable farmers to tap into and benefit from these opportunities.

Pacific canarium – poised to be more than just nuts

'Developing markets and products for Pacific Islands and PNG nut industries' was established in July 2011 to build on Vanuatu and Solomon Islands canarium domestic and export markets, and to investigate how communities in these countries can value-add one of their most important commodities. Since the project's establishment, PARDI researchers have conducted consumer and customer research to understand canarium markets according to market segments.

PARDI Research – Looking Ahead

This summary provides brief insight into the PARDI project and some of the research that has progressed during 2011. The year ahead for PARDI encapsulates a broad project portfolio covering new work on teak, vegetables, tamarind, capacity building, and extensive consumer and market surveys across the South Pacific. For a full list of PARDI's project portfolio or to gain more in-depth insight into PARDI's work, contact Project Leader, Steven Underhill (mobile: 0412 140 032) or PARDI communications, Julie Lloyd (mobile: 0415 799 890). More information also available at www.qaafi.uq.edu.au/pardi

QAAFI research scientists

Director

Prof. Robert Henry

Centre Directors

CPS – Prof. Graeme Hammer

CNFS – Prof. Mike Gidley

CAS – Prof. Stephen Moore

Research Staff

Dr Michael (Mike) Bell (CPS)
Dr Pat Blackall (CAS)
Dr Andrew K. Borrell (CPS)
Dr Brian M Burns (CAS)
Dr Karine Chenu (CPS)
Dr Jack (John) Christopher (CPS)
Dr Elizabeth Dann (CPS)
Dr Sushil Dhital (CNAFS)
Dr Ralf G. Dietzgen (CPS)
Dr Rob Dixon (CAS)
Dr Andre Drenth (CPS)
Dr Bernadine Flanagan (CNAFS)
Dr Mary Fletcher (CAS)
Dr Geoffry Fordyce (CAS)
Dr Glen Fox (CNAFS)
Dr Andrew Geering (CPS)
Prof. Robert (Bob) Gilbert (CNAFS)
Dr Jim Hanan (CNAFS)
Dr Craig Hardner (CPS)
Dr Jovin Hasjim (CNAFS)
Dr Timothy Holton (CPS)
Dr Peter James (CAS)
Dr David Jordan (CPS)
Dr Athol Klieve (CAS)
Dr Ala Lew-Tabor (CAS)
Dr Patricia Lopez-Sanchez (CNAFS)
Dr Tim Mahony (CAS)
Dr Stuart McLennan (CAS)
Dr Deirdre Mikkelsen (CNAFS)
Dr Neena Mitter (CPS)
Dr Jess A. T. Morgan (CAS)
Dr Tim O'Hare (CPS)
Dr Jose O. Payero (CPS)
Dr Carol Petherick (CAS)
Dr Andries B. Potgieter (CPS)
Dr Rao C.N. Rachaputi (CPS)
Dr Daniel Rodriguez (CPS)
Dr Manuel Rodriguez-Valle (CAS)
Dr Eugeni Roura (CNAFS)
Dr Peter A. Sopade (CNAFS)
Dr Roger Stanley (CNAFS)
Prof. Roger Swift (CPS)
Dr John Thomas (CPS)
Dr Bruce Topp (CPS)
Dr Conny Turni (CAS)
Dr Kinnari Shelat (CNAFS)
Dr Heather Smyth (CNAFS)
Dr Yasmina Sultanbawa (CNAFS)
Dr John Thomas (CPS)
Dr Morgan Tizzotti (CNAFS)
Dr Steven Underhill (CPS)
Dr Steven Walker (CPS)
Dr Barbara Williams (CNAFS)

QAAFI research affiliates

Name	UQ Title	QAAFI Centre
Bernie Carroll	Affiliated Associate Professor	CPS
Bruce D'Arcy	Affiliated Senior Research Fellow	CNAFS
Christine Anne Beveridge	Affiliated Associate Professor	CPS
Christopher Lambrides	Affiliated Senior Research Fellow	CAS & CPS
David Adamson	Affiliated Senior Research Fellow	CAS & CNAFS
David Edwards	Affiliated Associate Professor	CAS & CPS
David McNeill	Affiliated Senior Research Fellow	All 3 Centres
Dennis Poppi	Affiliated Professor	CAS
Dianne Mayberry	Affiliated Research Fellow	CAS
Doug George	Affiliated Senior Research Fellow	CPS
Elizabeth Aitken	Affiliated Associate Professor	CPS
Elizabeth Gillam	Affiliated Professor	CPS
Emily Piper	Affiliated Research Fellow	CAS
Erik van Oosterom	Affiliated Senior Research Fellow	CPS
Gunnar Kirchhof	Affiliated Senior Research Fellow	CPS
Guta Bedane	Affiliated Research Fellow	CPS
Ian Godwin	Affiliated Professor	CNAFS & CPS
Jacqueline Batley	Affiliated Senior Research Fellow	CPS
James De Voss	Affiliated Professor	CAS
Jaquie Mitchell	Affiliated Research Fellow	CPS
Jimmy Bottela	Affiliated Professor	CPS
Joanne Meers	Affiliated Associate Professor	CAS
Johannes Bernhard Wehr	Affiliated Senior Research Fellow	CPS
John Gaughan	Affiliated Senior Research Fellow	CAS
Jonathan Hill	Affiliated Professor	CAS
Judy Cawdell-Smith	Affiliated Research Fellow	CAS & CPS
Kathryn Steadman	Affiliated Associate Professor	CNAFS & CPS

QAAFI adjunct appointments

Name	UQ Title	QAAFI Centre
Kaye Basford	Affiliated Professor	CPS
Madan Gupta	Affiliated Senior Research Fellow	CAS & CPS
Mark Dieters	Affiliated Senior Research Fellow	CNAFS
Mark Turner	Affiliated Senior Research Fellow	All 3 Centres
Max Shelton	Affiliated Associate Professor	All 3 Centres
Melissa Brown	Affiliated Professor	All 3 Centres
Michael D'Occhio	Affiliated Professor	CAS
Michael Furlong	Affiliated Senior Research Fellow	CPS
Michael Holland	Affiliated Professor	CAS
Michael McGowan	Affiliated Professor	CAS
Neal Menzies	Affiliated Professor	CPS
Nick Shaw	Affiliated Professor	CNAFS
Olivia Wright	Affiliated Research Fellow	CNAFS
Paul Dargusch	Affiliated Research Fellow	CPS
Peer Schenk	Affiliated Associate Professor	CNAFS & CPS
Peter Gresshoff	Affiliated Professor	CPS
Ross Barnard	Affiliated Professor	CAS & CPS
Shaniko Shini	Affiliated Senior Research Fellow	CAS & CNAFS
Simon Quigley	Affiliated Research Fellow	CAS
Stephen Anderson	Affiliated Senior Research Fellow	CAS & CNAFS
Stephen Barker	Affiliated Associate Professor	CAS
Steve Adkins	Affiliated Professor	CPS
Susanne Schmidt	Affiliated Associate Professor	CNAFS & CPS
Victor Galea	Affiliated Associate Professor	CPS
Wayne Bryden	Affiliated Professor	All 3 Centres
Xiuhua Li	Affiliated Research Fellow	All 3 Centres

Name	Title
Prof. Colin Wrigley	Adjunct Professor
Dr Diane Ouwerkerk	Adjunct Research Fellow
Dr David Butler	Adjunct Research Fellow
Dr Emma Mace	Adjunct Research Fellow
Prof. John Skerritt	Adjunct Professor
Dr Kevin Thiele	Adjunct Associate Professor
Dr Lisa Gulino	Adjunct Research Fellow
Dr Rosalind Gilbert	Adjunct Research Fellow
Prof. Scott Chapman	Adjunct Professor

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Grants and income

It is not insignificant that, in terms of agriculture research, The University of Queensland is consistently ranked among the top fifty or so institutions around the world. Meanwhile QAAFI continues to build on its capacity to attract competitive grant funding.

In the 2011 calendar year, research funding accounted for some $15.1 million of the institute's total income. Many of QAAFI's funding agreements with external agencies operate on a time-frame of two-to-three years.

To date QAAFI's major external funding agencies include:

- AgForce
- Australian Centre for International Agricultural Research (ACIAR)
- Australian Research Council (ARC)
- Australian Wool Innovation
- Beef Cooperative Research Centre (Beef CRC)
- Centro Internacional de Mejoramiento de Maíz y Trigo (CIMMYT)
- CSIRO
- Department of Agriculture, Fisheries and Forestry (DAFF)
- Department of Employment, Economic Development and Innovation (DEEDI)
- Department of Environment and Resource Management (DERM)
- Fisheries Research and Development Corporation
- Grains Research and Development Corporation (GRDC)
- Horticulture Australia Limited (HAL)
- Meat and Livestock Australia (MLA)
- Pfizer Australia
- Pork Cooperative Research Centre (Pork CRC)
- Poultry Cooperative Research Centre (Poultry CRC)
- Rural Industries Research and Development Corporation (RIRDC)
- Seafood Cooperative Research Centre

Consultancy fees are another growth area for QAAFI. During the reporting period, QAAFI provided some 39 consultancies (i.e. expert scientific advice paid for by private enterprise), attracting $270,000 from industry across the plant, animal, nutrition and food sectors. Projects ranged from industry workshops to large-scale projects with national food security implications. Sectors benefiting directly from QAAFI scientific expertise in 2011 included:

- Cattle industry
- Grain growers (sorghum)
- Horticulture (fruit/vegetable industry)
- Kangaroo meat industry
- Pineapple growers
- Pork industry
- Sheep/wool industry
- Wholesale nurseries

Queensland Alliance For
Agriculture and Food Innovation

Room 523, Level 5
John Hines Building (62)
The University of Queensland

Tel: (07) 3346 0553
Fax: (07) 3346 0555

Email: info@qaafi.uq.edu.au
Website: www.qaafi.uq.edu.au