We have spent considerable effort this year strengthening our links with our grower group partners. It is essential that we identify the key problems facing the industry so that our research is focussed and the new knowledge is generated with growers where appropriate, to address the challenges facing industry (i.e. risks of frost and a dry finish, animal health issues).

Our livestock forums held in July and August focussed on efficiency of production and looked at how producers could maximise efficiency within their own livestock businesses.

Our new format with two concurrent Q & A style forums on ‘Stubble Farming’ and ‘Ruminating over the feedbase’ at our Crop and Pasture Systems field day proved very popular with growers and researchers, with over 100 people in attendance.

Over the past few months the Centre has been successful in securing four new projects. These include:

• Pasture legumes in the mixed farming zones of WA and NSW: Shifting the baseline (MLA funded) - Dr Belinda Hackney
• Soil carbon matrix and mapping project in the Hawkesbury Nepean (HN) CMA (HN CMA funded) - Drs Alison Southwell and Peter Orchard
• A therapeutic intervention to alleviate clinical signs of perennial ryegrass toxicosis in sheep (MLA funded) - Dr Jane Quinn
• Australian Herbicide Resistance Initiative - Phase 4 (GRDC funded) - Mr John Broster

Our research income and publication of scientific papers continues to rise showing a steady growth in measures of our research activity.

International research activities are important especially in South East Asia, and we are planning to develop stronger links with institutions in Europe and north America.

Congratulations to Emeritus Professor Ted Wolfe, on his Howard Oration at the recent 22nd International Grasslands Congress in Sydney.

This edition updates some of our research on current projects, news from recent Centre events, travel reports, staff profiles and upcoming events.

Enjoy reading this edition of the Innovator.

Professor Deirdre Lemerle
Forum provides opportunity to discuss revitalising grasslands to sustain our communities

One of many key messages coming from the world’s farmers to grassland researchers at the recent International Grasslands Congress was that we need to revitalise our communities to sustain our grasslands. Other recognised priorities included the need for researchers and farmer groups, and the international research community to work more closely together to do more with less with shrinking research budgets, and to prevent reinvention of research.

In many circumstances the RD&E link is still limiting the adoption of new technologies and practices. Other research needs likely to improve livelihoods at the farm level include responding to the cost-price squeeze, animal health, nutrient management, genetics of livestock and pasture species, water use efficiency, weed control, mechanisation on steep land, extension services and management to improve the environment.

Progressive farmers from eleven countries around the world were interviewed and filmed on their farms about their farm systems, the challenges they faced and the opportunities they saw for the future. Importantly, farmers were asked what they needed from research. A compilation of these films were played for the 800 delegates from 52 countries at the International Grasslands Congress in Sydney. The films formed a starting point for discussion around how research can better meet global farming system needs and better influence the sustainability and vitality of grassland farming communities.

Chair of the Australian Wool Innovation sponsored Farmers’ Forum Tim Reeves, Future Farm Industries CRC, said in his final address, “The huge enthusiasm from everyone on the last day of the conference emphasises how much value we put into trying to help the farmers of the world deliver the food and other products we need... thank you.”

This new way to get farmers and their opinions into the room on discussions around the direction of research was a fitting end to the International Grasslands Congress, which was themed around revitalising grasslands to sustain our communities.

Contact: Dr Alison Southwell
T: 02 6933 2636, E: asouthwell@csu.edu.au

Delegates at the 22nd International Grasslands Congress were told of the need for researchers, farmer groups and the international research community to work closely together to revitalise communities to sustain our grasslands, and they must do this with shrinking research budgets and prevent the reinvention of research. Delegates included (from left): Warwick Badgery (NSW DPI), Ralph Van Gelder (private consultant) and Michael Friend, Deputy Director Graham Centre & Associate Professor CSU. Photo: IGC2013 Ltd.

A future vision for the Australian sheep-wheat belt

According to the scientist selected for the AW Howard Medal for 2013, Emeritus Professor Ted Wolfe of the Graham Centre for Agricultural Innovation at Wagga Wagga, all specialists in agricultural science should have a broad understanding of the agricultural systems in which they work.

Speaking at the 22nd International Grassland Congress in Sydney on September 17, Professor Wolfe emphasised the importance of scientists facing up to the issues-based context of Australian agricultural industries.

“Scientists expect to be understood by farmers, and it is important for them to provide a reciprocal understanding of the current circumstances of farmers”, he said.

Professor Wolfe pointed towards five properties of farming...
systems—any farming system—that need to be considered to gain an industry-wide understanding of the ‘big picture’. These properties, or dimensions, include the productivity, sustainability, economic performance, social well-being and political acceptability of agricultural industries, systems and regions.

He stressed that it does not take long for a professional agriculturalist to gather and summarise information (both descriptive and quantitative) on key performance indicators of these five properties. He gave as examples the water use and energy efficiency of the production system (Australian and international on-line journals), current and future threats to environmental sustainability (journals, reviews), better business performance (ABARES), the health and stress of farm families (rural counselling services), and the inequities and imbalances in farming systems that may require political intervention (Australian Farm Institute, professional societies, international journals).

Professor Wolfe went on to describe four big problems that undermine the current performance of the famous Australian sheep-wheat belt, a mixed farming system which produces an important range of crop and livestock products for domestic consumption and export.

The first problem is a plateau in the production of Australian crops, particularly wheat (kg/ha of grain). This problem appears to be due to limitations in the supply of nitrogen in crops, a consequence of insufficient areas and quality of N-fixing legumes in the mixed farming system.

A second issue is the need to reconcile agricultural objectives with natural resource management (NRM) goals, such as the need to conserve significant areas of remnant vegetation, provide habitat for migrating birds, protect soils from erosion, reduce air pollution and decrease the pollution of waterways.

Professor Wolfe continued, “Too often, there are groups of agricultural and environmental scientists working in isolation, with each group rejecting the approaches of the other. There is a need for these groups to work collaboratively with each other and with farmers to produce healthy landscapes and provide ecosystem services, some of which may be crucial for the survival of the planet.”

“Farmers need a range of incentives to contribute towards carbon sequestration, biodiversity and other environmental stewardship objectives, which otherwise may produce long-term ecological gains for society but at an economic cost (short- to medium-term pain) for the landholder”, he added.

Professor Wolfe warmed up when he came to a third issue affecting the sheep-wheat belt—most mixed farms are making a business loss each year. Declining terms of trade, highly variable incomes due to rainfall and market fluctuations, the rigidity of farm costs (they are more rigid than in urban businesses) and unfair local and global competition have contributed to the financial predicament of farm businesses, a predicament that has to some extent been masked by an upward trend in land values. In short, Australian farmers are inadequately rewarded for the production and marketing risks they endure. The current business models of most mixed farms in Australia are not viable and they need to be overhauled for family farms and rural communities to survive. Traditional agribusiness practices and a lack of trained agribusiness professionals are holding agriculture back.

Finally, Professor Wolfe drew attention to the ‘specialise or diversify’ conflict that is at the heart of the decline since 1975 of the sheep enterprise on Australian mixed farms. Most farmers enjoy sowing and harvesting crops but they must also sow pastures and graze livestock to gain the synergies from the mixed farming system (ensuring nitrogen supply for crops, controlling weeds, coping with drought).

Wolfe supported the findings from the ‘Crops, rumps and woolly jumpers Forum’ conducted by the Graham Centre and Sheep Connect in 2012, which indicated that solutions
could come from the complementary skills of the business partners who operate each farm or group of farms. The complexity of multiple farm enterprises can be addressed by at least two individuals specialising within the farm business, to ensure that each enterprise receives the attention to detail that is required to maximise business success. It is not even necessary for sheep specialists to own the land on which they graze their sheep, Professor Wolfe emphasised. Successful farm families or partnerships occur when producers share an absolute commitment to seeking out and evaluating information, enterprise by enterprise and for the farm business as a whole. The top farmers are not necessarily early adopters but they plan carefully and control costs tightly.

In short, generational change is happening in the sheep-wheat belt.

Professor Wolfe concluded, “The benefits that may come from innovation in the economic, financial and social aspects of agriculture are as important as refining the technology of production. We must turn around the situation where more than 50% of farm families are experiencing financial (partly documented) and emotional (largely undocumented) stress. In the Australian sheep-wheat belt, policies at the R&D, industry and political levels must take into account agricultural stability and community well-being. There is a need for a nation-building approach to land management, much as New Zealand does with its dairy, sheep, horticultural and wine industries.”

Contact: Professor Ted Wolfe, E: twolfe@csu.edu.au

Sharing knowledge with those who need it most

Australian Volunteer, Ms Jessica Armstrong, says she has found her niche working on an agricultural research project in southern Laos.

Jessica said she has always wanted to volunteer in South East Asia. Her mother is Thai, and Laos and Thailand share a lot of similarities - culture, language and food, so Jessica says she feels ‘right at home’.

Jessica is a wetland ecologist by profession, so working in agricultural farming systems is new to her.

“But a wise man once told me that a rice paddy is just another wetland. I can certainly say that I have learnt as much as I have given,” Jessica said.

Jessica is volunteering through the Australian Volunteers for International Development (AVID) Program, an Australian Government, AusAID initiative.

The AVID Program aims to strengthen mutual understanding between Australia and the countries of Asia, the Pacific and Africa and make a positive contribution to development.

Jessica is volunteering with the National Agriculture and Forestry Research Institute (NAFRI) on an Australian Centre for International Agriculture Research (ACIAR) funded research project titled, ‘Developing improved farming and marketing systems in rainfed regions of southern Laos PDR’, or the South Laos Project for short.

Its main aim is to improve the quality and quantity of agricultural production, and improve food security in southern Laos PDR. Charles Sturt University (CSU) is administering the project, so Jessica is working with local and international researchers from several institutions around the world.

The NAFRI head office is located in the capital of Laos, Vientiane. Regional centres have been established to coordinate and implement research to solve specific regional problems. In southern Laos, NAFRI has established the Southern Agriculture and Forestry Research Centre (SAFReC). The Phone Ngam Research Station, where Jessica is based, is part of SAFReC and is located in Pakse.

The AVID volunteer says there is a real sense of community in Pakse, which is home to around 87 000 people. Jessica believes sending volunteers into the provinces is a real strength of the AVID program.

“The more time I spend with my colleagues, the more I...
learn about them and the issues they face. This puts me in a better position to help solve their problems in a regionally appropriate way.

“Being on ground has deepened my understanding immensely - I simply don’t think I would be as effective if I were based in Vientiane,” said Jessica.

As a Project Assistant in the knowledge sharing team, Jessica is building the skills of local district and provincial staff by providing training in experimental design, data collection and analysis, project planning and management, as well as developing and promoting communication and extension materials from project research outputs.

Some of the simplest experiences, such as ‘cross site visits’, where farmers are supported to travel to different sites to demonstrate a new technology or farming method, have been the most rewarding for Jessica.

During August, the team organised around 30 farmers from eight districts to get together in Savannakhet to demonstrate a drill seeder in a rice field.

“When using a drill seeder reduces labour time significantly, which is a huge bonus when a) household labour is scarce, and b) hired labour is expensive (it has doubled to around 50 000 kip per day, which is around AUS7 in the last three years!).

It was great to see the farmers picking up the equipment themselves and talking about their experiences with each other,” Jessica said.

When the farmers go back to their villages, the team knows they try out what they have demonstrated on their own properties, and they then educate their neighbours about what they have learnt too. Jessica believes this is true knowledge sharing and you cannot put a price on it.

“To be able to give back to the community in a meaningful way is the best situation I could possibly have hoped for. I love working in southern Laos. Putting my hand up to volunteer was the best decision of my life, I’ve met so many inspiring people and I’ve witnessed real change. I wouldn’t take back this experience for the world,” Jessica said.

Contact: Professor Len Wade
T: 02 6933 2523, E: lwade@csu.edu.au

Foxes found to spread tapeworm parasites

Thomas Williams, an Animal Science student at Charles Sturt University (CSU) recently won the Best Student Poster at the School of Animal and Veterinary Sciences (SAVS) 2013 Research Symposium. Thomas is completing his Honours year working on the tapeworm parasites of foxes. His research is funded through a Graham Centre New Initiative Grant and a CSU Faculty of Science Honours Project Operating Grant. He has undertaken his study through SAVS, CSU supervised jointly by Drs David Jenkins and Nigel Urwin. Thomas’ work has made a major contribution to a two year study, funded by Meat and Livestock Australia (MLA), run by Dr Jenkins, investigating the transmission of sheep measles (Taenia ovis).

Sheep measles is a parasite infection of sheep caused by larval stages of a tapeworm transmitted to sheep from dogs via tapeworm eggs passed in dog faeces. The reason why this parasite is of interest to MLA is because the larval stage of the parasite forms small cysts in the muscles of sheep, with each cyst containing a tapeworm head. Initially, the cysts are infective to dogs if eaten, however over a few months the immune system of the sheep attacks the cyst, kills the parasite that develops into a pus-filled abscess in the muscle. Over the next few months these abscesses mineralise transforming first into gritty masses, then into hard nodules that remain in the muscle for the life of the sheep.

From a consumer’s perspective none of these cystic manifestations is acceptable in sheep meat for human consumption. Processors have also been complaining that sheep measles is costing them major financial losses in condemned whole or part carcasses and extra time for inspection and carcass trimming.

During the last six years sheep measles infection data generated through the National Sheep Health Monitoring Survey (coordinated by Animal Health Australia), has shown that sheep measles is common in slaughtered sheep meat. A previous 1400 rural dog intestinal worm study, as well as data from over 200 additional rural dogs in this study, has only revealed one dog infected with the sheep measles tapeworm. These results are probably largely due to the wide availability of highly efficient all-wormers for dogs and the development of palatable, convenient-to-use dry dog food. Therefore all the sheep measles-infected sheep, seen from all sheep rearing areas of Australia, must be exposed to the parasite in something other than domestic dogs. The

Degenerate heart cysts (tapeworm), left, compared to viable cysts in heart. Photo: David Jenkins.
obvious alternative potential parasite hosts are foxes and/or wild dogs.

Since foxes are far more numerous and widespread than wild dogs, the study initially concentrated on foxes, with the fox study constituting Thomas’ research project. A wild dog study is currently under way. Five hundred foxes have been examined, collected in a number of areas in NSW and WA. The project team have relied on obtaining carcasses from vertebrate pest control programs and recreational shooters.

Thomas’ results have shown, for the first time, foxes are a host for the sheep measles tapeworm. The number of infected animals in a given population seems to be low, about one percent, but nevertheless, one percent of foxes spread over the sheep rearing areas of Australia is a lot of animals. Given, that once spread on to pasture, the eggs of sheep measles tapeworms can remain infective to sheep for almost a year, foxes appear to be the hitherto unidentified link in the transmission pathway causing the high prevalence of infection seen in slaughtered sheep.

Clearly, if there is wildlife transmission of sheep measles to sheep, the currently recommended control strategy of regularly de-worming farm dogs and feeding them safe food (dry rations or cooked or pre-frozen meat) can, at best, only be partially helpful, there needs to be protection for the sheep.

In 1989, results on the use of a highly effective, experimental vaccine for sheep against sheep measles were published. The vaccine was registered for use in New Zealand, but due to a marketing issue, nothing to do with the efficacy of the vaccine, the vaccine was not taken up by producers. So far the vaccine has never been registered for use in Australia, however if used widely by producers, this vaccine has the potential to greatly reduce the impact of sheep measles on the Australian sheep meat industry, saving several million dollars per year, possibly even completely eliminating sheep measles in Australia.

Contact: Dr David Jenkins
T: 02 6933 4179, E: djenkins@csu.edu.au

Debate nuts out food security

Food security is shaping as a critical issue for all Australians, especially those in the Murray Darling Basin. In the lead-up to the federal election, Charles Sturt University (CSU) and its Institute for Land Water and Society (ILWS) hosted a public debate that explored the views of candidates standing for the election, as well as CSU experts, on important aspects around food security at CSU in Albury-Wodonga.

Using a question-and-answer format, three CSU experts outlined the importance of food security and its implications for all Australians as well as the Basin.

Professor Deirdre Lemerle, Director of the Graham Centre for Agricultural Innovation formed part of the panel, focusing on agricultural production, outlining the importance of food security and its implications for all Australians as well as the Basin.

Associate Professor Sue McAlpin focused on the diet and health implications, and ILWS researcher Professor Allan Curtis addressed the environmental and social implication for food security.

They were followed by four election candidates from the electorates of Farrer and Indi who outlined their policies to the audience:

• The current federal Member for Farrer, the Hon. Sussan Ley
• Country Labor Party candidate for Farrer, Mr Gavin Hickey
• Australian Greens candidate for Indi, Ms Jenny O’Connor
• Independent candidate for Indi, Ms Cathy McGowan.

All panellists were then open to questions from the floor, with the evening moderated by ABC Goulburn Murray station manager Ms Gaye Pattison.

Event coordinator and ILWS deputy director Associate Professor Vaughan Higgins said food security is often seen as
a problem mainly for developing countries.

“Yet Australia faces significant challenges, including the rising cost of healthy food, the economic and social burden of diet-related disease, and the increasing vulnerability of food production as a consequence of climate change, less water availability and rising energy costs,” Professor Higgins said.

“These factors pose serious questions about the sustainability and equitability of food production and supply systems in Australia.”


Contact: Professor Deirdre Lemerle
T: 02 6933 4398, E: dlemerle@csu.edu.au

### Sorting the chaff from the wheat

Charles Sturt University (CSU) Bachelor of Agricultural Science students demonstrated their grain industry knowledge gaining second place in the team category of the Australian Universities Crop Competition.

The three day event held in Temora from 18-20 September saw students from six universities tested on everything from grain grading and yield potential through to weed identification, business skills and farm management software.

Coach and Graham Centre member, Dr Sergio Moroni, lecturer in crop agronomy from the School of Agricultural and Wine Sciences, said the team performed well. “It takes a great effort and independent training for this competition as students volunteered to represent the University and their preparation was done outside of their current study obligations.”

CSU was represented by Mr Cameron Prien, Mr Nathanael Liersch, Ms Georgia Branson, Mr Lachlan Vogan and Mr Jamie Thornberry. The annual competition is hosted by Grain Growers.

Contact: Dr Sergio Moroni
T: 02 6933 2914, E: smoroni@csu.edu.au

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### Maximising efficiency of production in your beef herd

The Graham Centre Beef Forum was held on 9 August with over 65 producers in attendance. Industry experts from Charles Sturt University, NSW Department of Primary Industries, BC agriculture and CSIRO provided the latest research and tools to maximise animal health, production and profits.

Producers heard about drench resistance including liver fluke - the current status and increase in anthelmintic resistance in beef herds, E.coli shedding in beef cattle, Hormonal Growth Promotant use in steers, reducing methane output in beef cattle, breeding for net feed efficiency and successful pasture establishment in cropping rotations.

Participating in afternoon workshops, producers looked at the profitability of increasing efficiency in their herd, and using decision support tools to determine whether to undersow crops with pasture species.

The field day was run in conjunction with the Hume Livestock Health and Pest Authority, with sponsorship contributed from Novartis Animal Health, Animal Health Australia, Coopers Animal Health, Ancare, Riverina Cooperative, Teys Australia and National Australia Bank.


Contact: Ms Toni Nugent
T: 02 6933 4402, E: tnugent@csu.edu.au

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Beef producers from across the Riverina heard the latest research findings, techniques and tools to maximise production efficiency in their beef herds at the Graham Centre’s Beef Forum in August. Photo: Toni Nugent.
**Crop & Pasture Field Forum a success**

The vibe was positive, with more than 100 people attending the Graham Centre’s Crop and Pasture Systems Field Forum on Wednesday 4 September. The field day was held at the Centre’s field site, showcasing the latest research and providing a platform for farmers, researchers and industry to network, sharing ideas and information, and identifying issues and research gaps.

Two concurrent forums addressed ‘Farming with stubble’ and ‘Ruminating over the feedbase’, and provided an opportunity for farmers to hear from researchers who are at the cutting edge of technology development, while also learning from key farmers across the region who told their story as part of the panel sessions.

Key issues raised in the forums included:

**Ruminating over the feedbase**
- How to measure whole farm production?
- Designing production systems to effectively utilise the feedbase (particularly during spring)
- The need for a common language for measuring animal production (e.g. kg lamb/mm rainfall)
- Establishment and persistence of perennial grasses
- Grazing cereals - how much to sow?
- Options for selling lambs - whether to sell at weaning or finish lambs?
- Genetics and double joining

**Farming with stubble**
- Interference/emergence
- Inter row sowing RTK
- Harvest management
- Wide rows
- Weed management
- Sow by the date
- Herbicide resistance - good rotations; mix chemical groups; application technology

Copies of the Field Site Book containing information on the trials and demonstrations at the Centre’s Field Site in 2013 are available by contacting the Centre’s Public Relations Manager Toni Nugent.

Contact: Ms Toni Nugent
T: 02 6933 4402, E: tnugent@csu.edu.au

**School science awards**

School students put their research skills to the test at the Graham Centre Science Investigation Awards at Charles Sturt University (CSU) in Wagga Wagga on Wednesday 14 August. More than 50 Year 6 and Year 10 students from Ladysmith, Griffith and Wagga Wagga designed and completed a science investigation or experiment and presented their project to a panel of judges.

They explained their hypothesis, the experiment used to test it and the findings of the research. The budding scientists also participated in practical laboratory classes and met with CSU and NSW Department of Primary Industries (DPI) researchers.

The event aims to promote science education and encourage students to consider research careers. Robust research is needed for Australian industries like agriculture to continue to be profitable and sustainable into the future. Events like...
this will ensure a new generation of scientists will be ready to meet this challenge.

Contact: Ms Toni Nugent
T: 02 6933 4402, E: tnugent@csu.edu.au

New techniques and recent findings in rhizosphere research

A workshop held on 16 August at the Graham Centre presented the latest research findings and new techniques for studying the rhizosphere from a select group of visiting international and Australian rhizosphere biologists, including Charles Sturt University and NSW Department of Primary Industries staff whose focus is on rhizosphere interactions.

Topics discussed included the measurement of microbial ecology and diversity in the rhizosphere, root exudation and the role of root exudates in plant and microbial interactions, bioactive secondary products their role in chemical signalling in the rhizosphere, and detection of bioactive secondary metabolites and root exudates in the rhizosphere.

The workshop also summarised potential research opportunities for global research collaboration.

Many of the participants also presented at the International Society of Chemical Ecology session on Rhizosphere Chemical Ecology organised by Leslie Weston and Ulrike Mathesius of Australian National University, held in Melbourne 19-23 August.

Contact: Professor Leslie Weston
T: 02 6933 2429, E: leweston@csu.edu.au

Meating and measuring meat quality

As a Graham Centre Member and PhD student with the School of Animal and Veterinary Sciences at Charles Sturt University (CSU), Steph Fowler describes the day to day activities involved with her PhD as ‘playing laser tag with lamb’, so a conference titled ‘The Power of Meat in 21st Century’ seemed very fitting. This was the theme of the 59th International Congress of Meat Science and Technology, held in Izmir, Turkey in mid-August 2013.

With just over 18 months of her PhD under her belt, Steph had enough data on the innovative, non-destructive technique which she is investigating to better determine meat quality, to make both an oral and poster presentation. Her oral presentation was titled ‘Predicting tenderness of ovine semimembranosus using Raman spectroscopy’, while her poster was titled ‘Predicting tenderness of ovine longissimus thoracis using Raman spectroscopy.’

Steph said she enjoyed ‘meating other researchers in the field.’ Following her time at the congress, Steph had the opportunity to visit Universität Bayreuth, das Max Rubner-Institut, where she worked in the laboratory where the Raman spectroscopy probe that she uses in her project was developed and is undergoing continuing refinement.

Under the supervision of Professor Peter Wynn (CSU) and Dr David Hopkins (NSW Department of Primary Industries), and funded by Australian Meat Processors Corporation, Steph’s PhD project is aiming to develop and validate a probe to measure meat quality.

Contact: Ms Steph Fowler
T: 0428 552 879, E: sfowler@csu.edu.au

Steph Fowler on tour at Ephesus during the 9th International Congress of Meat Science and Technology. Photo: Pedro Imazaki.
Initial seedlot infection by seedborne bacterial pathogens affects rice germination and yield

PhD student Danta Adorada attended the 10th International Congress of Plant Pathology, in Beijing China from 25-30 August 2013 as part of the Graham Centre Conference Support Scheme. The congress was organised by the Chinese Society for Plant Pathology on behalf of the International Society for Plant Pathology and had the theme, 'Bio-Security, Food Safety and Plant Pathology: The Role of Plant Pathology in a Globalised Economy.'

Danta presented a poster titled ‘Initial seedlot infection by seedborne bacterial pathogens affects germination and yield of rice’. His poster attracted interest from plant pathologists from the academic, scientific and private institutions. Danta had the opportunity to meet well known plant pathologists from across the world. These interactions with international plant pathologists resulted in exchanges of ideas and established contacts, and could potentially lead to research collaboration in the future.

While in China, Dante visited the State Key Laboratory for Biology and Plant Diseases and Insect Pests at the Chinese Academy of Agricultural Sciences, and met with their scientists - Drs Chen Huanin, Zhao Tingchang, Li Bin and Xu Lixui, together with Dr Xie Guanlin from Zhejiang University. This was the first step towards establishing partnerships with these experts. Incidentally, Dr Xie Guanlin was the author of the published paper on genome sequence of the rice bacterial pathogen Pseudomonas fuscovaginae which was the subject of Dante’s PhD research at Charles Sturt University. Talks are on-going looking at possible scientific visits and exchange student programs.

Dante also had the once in a lifetime opportunity to visit the Great Wall of China and Ming’s Tomb, two of the world famous heritages.

Attendance at the congress and consequent meetings has provided Dante with a better understanding of the magnitude of the roles plant pathologists have in solving world hunger problems.

Contact: Mr Dante Adorada
T: 02 6933 2749, E: dadorada@csu.edu.au

Travel explores international research collaboration

In early July Graham Centre Deputy Director Associate Professor Michael Friend travelled to the United States for two weeks to complete a manuscript, explore future research collaboration and attend the 2013 American Society of Animal Science.

The first week of Michael’s visit saw him work with Juan Villalba to complete and submit a manuscript based on work undertaken during his last visit to Utah State University in 2010. He also explored future collaboration with the US, including joint PhD supervision, and for Juan to spend two weeks at the Graham Centre in 2014.

Michael said they will apply for Fulbright funding to facilitate Juan visiting in 2014, and they have an agreement to undertake joint PhD supervision activities, with students from both Universities undertaking some of their experimental work abroad.

During the second week Michael attended the 2013 American Society of Animal Science annual conference in Indianapolis. This is the largest animal science conference in the world.
with 3200 delegates registered. Michael’s oral presentation of his teams work on novel endophytes for tall fescue enabled the Graham Centre’s profile to be raised at a major international conference.

Attending the conference also provided the opportunity for Michael to network with researchers from different countries and explore potential collaboration opportunities. The most likely future collaboration (apart from existing collaboration with US colleagues) will be with researchers from Argentina.

Contact: Associate Professor Michael Friend
T: 02 6933 2285, E: mfriend@csu.edu.au

Biosecurity, food security and plant pathology in a globalised economy

Plant pathologists must consider the potential of their research to offer solutions in a changing world where global warming, environmental degradation, reduced land available to food production, and diminishing fossil reserves challenge the agricultural status quo. Added to these issues is the expected increase in the world’s population, which is predicted to double the demand for agricultural products by 2050.

The United Nations Millennium Development Goals include a challenge to eradicate extreme poverty and hunger, a condition affecting over 1.1 billion people, by the year 2015. Because the majority of these people rely on agriculture for their livelihood, the opportunity for scientific advances that improve crop productivity to improve their well-being are substantial.

Though the challenges for agriculture are serious and imminent, advances in plant pathology and collaborations across all science disciplines can lead to their resolution and are now available or emerging at a rapid rate.

Recent travel to Beijing, China to attend The 10th International Congress of Plant Pathology provided Mohd Mostofa Kamal with a snapshot of opportunities for plant pathologists that have the potential to improve crops to meet the demands of tomorrow’s global economy. Mohd presented a paper titled ‘Microbial biocontrol of sclerotinia stem rot of canola’ at the congress. The abstract has recently been published in “Acta hytopathologica Sinica”, one of the most highly rated academic journals in China and the world.

Meeting the demands of growing global population and reducing loss of crop productivity is essential for long-term food security. Plant diseases reduce the production and quality of food, fibre and biofuel crops. Plant pathology...
Topoisomerase-1 inhibition activity of canola meal extracts

Topoisomerase-1 is an important enzyme for DNA replication and transcription, and so far has a major effect on cellular processes. Higher than normal levels of Topoisomerase-1 are often found in human cancer cells. Canola meal extracts, obtained using solvents such as ethanol and acetone, have been shown to have both poisoning and suppression activity against topoisomerase-1, suggesting that canola meal may contain compounds that have anti-cancer properties.

Since canola meal is produced in large quantities in Australia and worldwide, the discovery of compounds with health benefits which can be readily extracted from the meal, is an attractive proposition.

PhD student Saira Hussain recently attended the International Cereal Chemistry Conference (ICC) 2013, in Perth to present her poster ‘Topoisomerase-1 inhibition activity of canola meal extracts.’

Researchers at the conference introduced Saira to different molecular, tissue culture and chemistry based techniques.

Saira commented that a major focus of the conference was related to the protein chemistry capacity building programme, which focuses on understanding the functional proteins of grains with health benefits and high-value uses.

Discussion with other students and researchers has given Saira a better understanding of cereal grain research for health and food product innovation.

Contact: Ms Saira Hussain
T: 02 6938 1631, E: shussain@csu.edu.au

Parasites cause a major stir

Two Graham Centre summer scholarship recipients, Leah Brunt third year Charles Sturt University (CSU) Veterinary Science student and Thomas O’Brien second year CSU Veterinary Science student, received travel grants from Australian Society for Parasitology to present the results of their 10 week research projects (summer 2012-2013), at the World Association for Advancements in Veterinary Parasitology conference.

Leah worked under the supervision of Dr Shokoofeh Shamsi (School of Animal and Veterinary Sciences) and Dr John
Harper (School of Agriculture and Wine Science) looking at the characterisation of three possibly new species of acanthocephalan parasites.

Thomas investigated parasites of cormorants and their impacts on the development of aquaculture in regional Australia, under the supervision of Drs Shokoofeh Shamsi, Nigel Urwin and Rob Woodgate (SAVS).

They presented their research as a poster and a two minutes oral presentation. Both presentations and posters were well received at the conference and attracted the attention of many conference participants. There is the potential to develop initial collaboration with researchers from Brazil on Cormorants' parasites, and with the South Australian Museum and researchers in South Africa on Acanthocephalans. A great achievement for our undergraduate students.

Contact: Dr Shokoofeh Shamsi
T: 02 6933 4887, E: sshamsi@csu.edu.au

Internationally recognised leader visits CSU Wagga

Professor Gordon Howarth is recognised as an international leader in Nutraceutical treatments for intestinal diseases. He leads the University of Adelaide's Digestive Health Research Group at the School of Animal and Veterinary Science. Professor Howarth is also an Affiliate Associate Professor at the Gastroenterology Department of the Women's and Children's Hospital.

Professor Howarth was an invited speaker at Charles Sturt University's School of Animal and Veterinary Science Research Week in September. As part of his visit to Wagga he gave a seminar titled ‘Nutraceutical treatments for intestinal disease: the importance of animal models.’

Pictured from left, PhD student Marefa Jahan, Bangladesh met with Professor's Howarth and Lemerle and Dr Bing Wang at the Graham Centre during the SAVS Research Week. Marefa was awarded a CSU International Postgraduate Scholarship in July. Her research will focus on early nutrition and its importance in animal growth and development. Photo: Toni Nugent
International rice-based farming systems research

In the previous edition of the Innovator, we published an introductory article on the Rice-based Systems Research (RSR) Program: Food Security in Lao PDR, Cambodia and Bangladesh. The program is managed by the Australian Centre for International Agricultural Research (ACIAR), and aims to improve rainfed and irrigated rice-based farming systems in the three target countries. A summary report on program progress 2013 is now available for download at www.aciar.gov.au/rsr

Mr Geoff Beecher, NSW Department of Primary Industries, leads one of the program’s five large-scale bio-physical and socio-economic projects. His project, ‘Improved rice establishment and productivity in Cambodia and Australia’, focuses on enhancing rice system productivity in rainfed and irrigated lowland systems in Cambodia, especially through developing efficient direct seeding technology.

The work is framed within the context of three major changes reshaping agriculture in Cambodia: the uptake of direct seeding, the replacement of draught animals with mechanised forms of field preparation, and a significant increase in the proportion of irrigated rice.

In Cambodia, the project team are working collaboratively with the Cambodian Agricultural Research and Development Institute (CARDI), the General Directorate of Agriculture (GDA) and Royal University of Agriculture (RUA) to conduct a farming systems integrated cropping experiment. This experiment examines the impact of cropping season and cropping intensity on the performance of rice crops and monitors the effect of weed competition.

Baseline survey data has been collected from 450 farmers (in three provinces, three districts, three communes, three villages) on current practices, trends in rice establishment methods, agricultural machinery use, production constraints, cropping systems, rotations, land access and productivity.

‘We have put significant effort into identifying and introducing best-bet technologies,’ Geoff explains. ‘For example, the project has adapted and incorporated best-bet chemical weed management approaches, like the rotary/cono weeder, from elsewhere in Asian rice-growing areas into our field experiments.’

Workshops have been conducted at CARDI on the assembly, calibration and use of seed drills, and on the use of hydrotiller and drum seeders in recession rice areas. Local modifications were made to the hydrotiller to make it more suitable for Cambodian conditions, especially to allow easier transport between locations/fields.

The project has also imported limit plot drills (cone seeders) from India. These will be tested in CARDI’s rice breeding program in the 2013 wet season.

Geoff highlights the importance of information accessibility, and notes that, ‘the project has produced Khmer language publications on rice-growing practices, weed control and machinery applications for use in promoting best-bet technologies to Cambodian farmers.’

One of the project’s significant achievements is the release of the CLEAR (Cambodia Land Environment and Resources) multi-layer spatial database with a broad range of land, environmental and social data from numerous agencies within Cambodia. This database can be interrogated on a geographical basis and now has more than 500 registered users (free access at http://clear.awhere.com/Homepage.aspx until February 2014).

In Australia, project researchers have established ten field trials across southern NSW rice growing region to investigate different seeding methods and zinc fertiliser treatments in farmers’ paddocks with potentially adverse soil conditions.

Replicated glasshouse experiments have investigated the effectiveness of using zinc seed coating and fertilisers and gibberellic acid (GA) treatments. These glasshouse experiments were extended to field trials in the 2012-13 season.

‘Sam North at Deniliquin is assessing fifteen semi-dwarf rice varieties for salinity tolerance at vegetative and reproductive stages’, explains Geoff. The salinity field trials comprise eight current Australian varieties, two unreleased Australian lines, two Cambodian lines (IR 66 and Sen Pidao) and three International Rice Research Institute (IRRI) checks.
Salinity field trials in 2012 were frustrated by abnormally wet seasonal conditions accompanied by vast populations of ducks and other water birds. Those field trials that did survive are showing the effect of salinity on some varieties.

Glasshouse experiments are also demonstrating differential responses from rice varieties to salinity treatments at different growth stages.

Geoff points out that Sam is hoping to use the research data to develop a salinity stress index for the different rice varieties.

Contact: Mr Geoff Beecher  
T: 02 6951 2725, E: geoff.beecher@dpi.nsw.gov.au

Visit: www.grahamcentre.net

Green Eggs and Ham?

Transgenic technology for egg sex determination in chooks?

Researchers at Charles Sturt University, Dr Nigel Urwin (Senior Lecturer in Genetics) and Mr Emmanuel Quansah (PhD candidate) are working towards developing a test to determine the sex of chicks within the egg (in ovo), and very early in development.

Mass euthanasia of male day old layer chicks is a welfare, ethics and economics issue, and for a number of years has been a problem that researchers have tried to solve. Despite many methods being developed to determine the sex of chicks within the egg, most of these are not simple, rapid or low cost and are difficult to fit into hatchery operations. Consequently, feather and vent sexing remain the main methods used.

There are two main approaches being used by researchers around the world to investigate this problem and both rely on the production of genetically modified chickens. The first technique alters the level of gene expression that is involved in the development of the sex, enabling the sex ratio of chicks at hatching to be manipulated and skewed towards females.

The second technique and the one Emmanuel and Nigel are using, is to put a gene in the female specific sex W-chromosome that produces a protein originally from a jelly fish. This gene produces a protein called green fluorescent protein (GFP) that would cause a chick to fluoresce green under a blue or ultraviolet light. It is non-toxic, only visible under blue/ultraviolet light and if the gene were in the female specific chromosome only hens would fluoresce green.

It is hoped the fluorescence could be detected within the embryo in the egg by simply illuminating an egg with a UV light and scoring fluorescent chicks (females) and non-fluorescent ones (males), in a manner similar to candling. This process could be easily automated and do hundreds to thousands of eggs per minute.

It is possible this could be done at a very early stage in development before chicks become sentient, and consequently save on incubation costs of eggs containing male chicks.

Emmanuel recently received a Graham Centre and Australia Egg Corporation Limited (AECL) travel award of $1800 to assist him to attend a conference on Genetic Engineering and Genetically Modified Organisms in Raleigh, United States on 12-14 August. He presented the preliminary results of his research showing the GFP genes being used are expressed in cells in culture, with the next step being to generate genetically modified chicken lines containing the gene. He also met with poultry researchers at the Animal Biosciences and Biotechnology Laboratory of the United States Department of Agriculture (USDA) at Beltsville, Maryland with who he will be collaborating with over the coming months.

It is unlikely that such GM lines of layers will be available within the next 5-10 years. Even if the project is successful in breeding GM chooks, the use of such lines will require public acceptance of the chooks. Public perceptions of GM are however changing, so it is hoped they will be accepted by the public and industry alike.

Contact: Mr Emmanuel Quansah  
T: 02 6933 2959, E: equansah@csu.edu.au or  
Dr Nigel Urwin, T: 02 6933 2450, E: nurwin@csu.edu.au

Emmanuel Quansah received the Best Poster Award at a recent conference in the United States that focussed on genetic engineering and genetically modified organisms.
Lotus shows phosphorus benefits

Farmers at recent field days across New South Wales have heard how research into the perennial legume *Lotus corniculatus*, commonly known as birdsfoot trefoil, is showing that its responsiveness to phosphorus could have benefits for farmers by reducing fertiliser input costs.

While the results are preliminary, they indicate the lotus cultivar is more efficient at using phosphorus than sub clover. *Lotus corniculatus* is a perennial legume native to Europe and relatively new in southern Australia. It has been extensively researched as part of the Future Farm Industries CRC’s EverGraze research program looking at future livestock production, and led by Pasture Ecologist Graeme Sandral, NSW Department of Primary Industries.

Mr Sandral said while the results are preliminary, many farmers were excited by this early finding into phosphorus use.

“Phosphorus is typically 20-30 percent of on-farm costs for grazing enterprises in the high rainfall zone of south-eastern Australia (greater than 600 mm annually), so any savings in this input cost would have large impacts on farm profitability,” Mr Sandral said.

*Lotus corniculatus* has the potential, particularly for land receiving more than 650 mm of rain per year, with acid soils and dry, harsh summers. It could be a good option for farmers to trial where they can’t get species like white clover or lucerne to grow.

Apart from being able to withstand acid soil, *Lotus corniculatus* provides bloat protection due to tannins in its leaves. It is also very tolerant of waterlogging.

Mr Sandral said it had the potential to be used year-round, particularly to extend the green feed period at the start and end of the winter growing season.

It also has the advantage of being able to efficiently convert dry matter to livestock production because the tannin suppresses methane producing organisms in the rumen, leading to improved feed conversion.

Mr Sandral said farmers should aim for 30 percent legumes in their pastures, which can be difficult to obtain in grass/legume mixtures. Grasses are often more competitive than legumes.

The NSW trials have included mixing *Lotus corniculatus* in the same rows as perennial grasses and in separate rows.

Preliminary results show advantages from separating the species at sowing with less lotus plants dying from competition.

Farmers could reduce the amount of lotus seed sown from 8 kg to 6 kg but still get the same number of plants.

Contact: Mr Graeme Sandral
T: 02 6938 1807, E: graeme.sandral@dpi.nsw.gov.au

*Adapted with permission from Future Farm Industries CRC ‘Focus Online’.*
Pakistan village-based forage systems

Pakistan has 163 million livestock, with over 70% of the country’s population relying on livestock as a primary source of either food, income or both. Despite this reliance, productivity is typically low because animals are chronically undernourished and/or have endured periods of severe nutritional stress, resulting in low liveweight gain, low milk production and a reduction in fertility.

The livestock and dairy sector has grown rapidly during the last decade in Pakistan resulting in a high demand for forage crops. Smallholder farmers are often not absorbing new knowledge on production technologies for producing quality forage of high genetic potential. Farmers are heavily dependent on their own-saved seed and local market seed that are impure, costly and unreliable.

A market oriented forage seed production system at the village level offers exciting commercial opportunities, as it could significantly increase forage and livestock productivity and improve rural livelihoods.

New technologies need to be introduced to allow farmers to capacity build, increase forage and livestock productivity, ensure household food security, and produce surplus forage seed for the local market to help with the family budget. The challenge is to find a mechanism that will provide small-scale farmers with affordable quality seed of improved and durable varieties at their doorstep.

As part of the Agriculture Sector Linkage program to assist small-holder dairy farmers in Pakistan, a village-based forage seed enterprise (VBFSE) for organising farmer-managed seed supply is being developed. It will provide high-quality forage seed and develop skills leading to profitable and sustainable farmer-based seed enterprises. It will also improve the project team’s understanding of the livestock and forage supply inter-relationship to further expand the financial resilience of farmers.

Key innovative producers within a community will be selected by the extension team, who will assist them to develop a seed production system. This will help build further research based on farmer needs and facilitate collection of production information including financial records.

The study areas are located in two different regions, Kasur and Okara. The different research components of the project include a baseline survey of farmers, research trials both on-station and in farmer’s fields, and the refinement of least cost quality forage seed production and its marketing through a VBFSE. The project will also investigate the sustainability of such enterprises at the village level.

Berseem clover (Trifolium alexandrinum L.) is being used as the target forage crop as it is the most popular forage grown in Pakistan for winter feed. Berseem seed makes up 73% of the cost of seed imports into Pakistan, worth 401 million rupees (AUS$4.22 m) per year.

The baseline survey showed that all farmers in the districts of Kasur and Okara cultivated berseem clover as a winter forage to feed their livestock. While the seed market farmers access is located only 12-25 kilometres away, this
is a significant distance for them to travel. As a result, 56% percent of farmers produce their own seed and sell it to other farmers.

None of the farmers surveyed perform laboratory analysis to check the quality of seed or the forage grown from the seed, so knowledge of quality seed and forage is negligible.

When asked, 66% of smallholder farmers were willing to work as seed entrepreneurs and believed such an enterprise could be successful in their region.

Data was collected on different agronomic parameters for both forage and seed, which showed significant productivity gains if improved seed was obtained from the Fodder Research Institute in Punjab, in preference to commercial sources normally available to farmers in the region.

In addition the provision of honeybees as pollinators in the research plots resulted in dramatic increases in seed production. Clearly pesticides used in the environment may be limiting the productivity of forage crops across the region.

Contact: Mr Muhammad Shoaib Tufail
T: 02 6933 2959, E: mtufail@csu.edu.au

Acknowledgements: This program is part of the Agriculture Sector Linkage program, funded through the Graham Centre by AusAID.

A new control option for the management of Australia’s most significant biosecurity insect threat, Queensland fruit fly

The Queensland fruit fly ‘Qfly’, Bactrocera tryoni (Froggatt) (Diptera: Tephritidae) is the major insect threat to Australia’s $7 billion-plus per annum horticultural industry. The use of dimethoate has been greatly restricted for Qfly control and the remaining option, fenthion, is soon likely to experience a similar fate. So there has been an urgent need to identify alternative in-field control options, including an efficacious chemical control for Qfly management.

A project commenced last year, funded by Horticulture Australia Ltd, using the Summerfruit industry levy and matched funds from the Australian Government to test alternative in-field chemical controls for Qfly that may offer a viable replacement for dimethoate and fenthion in stonefruit. A series of three laboratory bioassays were conducted to determine which of seventeen selected chemicals were the most efficacious under controlled conditions. A field bioassay was also conducted; the first replicate was completed in 2012, with another two replicates due for completion in November 2013.

Early indications are that Clothianidin is very effective at both suppressing adults and subsequent development of offspring, and could be useful as an alternative to Dimethoate and Fenthion for controlling Qfly. Clothianidin also appears to have some repellency effects.

As a result, a permit for the use of Clothianidin in Nectarines, Peaches, Apricots and Plums against Qfly was submitted by Growcom on behalf of Summerfruit Australia Ltd with the Australian Pesticides and Veterinary Medicines Authority (APVMA) in May this year. The use pattern on the requested permit is identical to the existing label with respect to the number of applications and rates. But a shorter 7 day withholding period has been requested, rather than the current 21 day withholding period on the label. The permit was granted in September this year. A copy of the permit can be found at: http://permits.apvma.gov.au/PER14252.PDF

This is significant for growers, particularly in endemic areas where the pressure from Qfly may warrant the use of a cover spray, in addition to a range of integrated pest management controls used that may include bait sprays, Male Annihilation Technique (MAT) blocks/wicks and sterile flies.

Contact: Dr Olivia Reynolds
T: 02 4640 6426, E: olivia.reynolds@dpi.nsw.gov.au

Orchard nectarines contained in a mesh sleeve awaiting fruit fly release after insecticide application. Photo: Olivia Reynolds.
Graham Centre Honours Roll 2013


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http://dx.doi.org/10.1111/wbm.12015

http://www.springer.com/life+sciences/plant+sciences/journal/11105


Visiting scientist to work in pasture research

Dr Wei Zheng, Northeast Institute of Geography and Agroecology, Chinese Academy of Sciences, Changchun, Jilin Province will work with the Pasture Group at Wagga Wagga for the coming 12 months. Dr Zheng, pictured right with Dr Guangdi Li, will conduct a series of growth chamber and glasshouse experiments to test aluminium and manganese tolerance of a range of perennial grasses and legumes that are potentially adapted to the high rainfall regions of NSW. The visiting scientist will primarily work on research relevant to the EverCrop project, but will also experience the breadth of pasture research currently conducted at Wagga Wagga under a range of other projects including EverCrop Carbon+, Lotus Feedbase, Phosphorus Use Efficiency, Crop Sequencing and Nitrous Oxide Emission.

Photo: Toni Nugent
Dr David Hopkins

Position: Senior Principal Research Scientist
Organisation: NSW Department of Primary Industries

Career Brief
I grew up on a grazing property (sheep and beef) in the South West of Victoria and am married to Kerry a teacher. We have two grown sons, Jonathan a policeman and Simon who works in the advertising and marketing industry. My first appointment as a scientist was for the Tasmanian Department of Agriculture, where I worked for six years before moving into a newly created position with NSW Department of Primary Industries (Centre for Red Meat and Sheep Development, Cowra). My PhD was based on a study of the relationship between actomyosin, proteolysis and tenderisation examined using protease inhibitors. I am the sole meat scientist in NSW DPI.

Research activities
The following areas are currently under study: 1) Factors impacting on the tenderisation of meat; 2) Growth, carcase composition and meat quality in sheep; 3) Application of electrical technologies to the processing industry; 4) Application of Raman spectroscopy to the meat industry; 5) Methods to improve the quality of lamb, beef, goat and alpaca meat; and 5) Assessment of technology for predicting meat yield and quality traits.

Teaching activities

Current students include Steph Fowler (PhD, Charles Sturt University), Melanie Smith (PhD, The University of Sydney), Colin Starkey (Masters, University of New England) and I have recently had a PhD student from Brazil come for 12 months.

Professional Links
- Australian Society of Animal Production
- New Zealand Society of Animal Production
- American Meat Science Association
- Chief Editor Meat Science
- Adjunct Professor at CSU & UNE

A typical day for me include: Checking emails - screening submitted papers and sending them out for reviewing, rejecting them or asking for clarification! Phone calls with students and collaborators, supervising my staff, writing papers and planning new experiments/submissions. Then there is travelling...

My main project at the moment is: We have a number of different projects with collaborators in Germany, New Zealand, The University of Sydney, DEPI Victoria and within NSW DPI. One of the most challenging is Steph Fowlers project on Raman spectroscopy, we have some really interesting data on Alpacas from Melanie’s work and also on feeding an algae supplement to lambs in collaboration with Dr Ed Clayton (NSW DPI) and Dr Eric Ponnampalam (DEPI Victoria).

My favourite part of my job is: The variation from editing papers and book chapters, to designing experiments, analysing data and writing papers, mentoring students and representing Australia internationally. It is a great job!

When I am not in the office I like: In my time outside of work I ride motorcycles, play soccer, follow Carlton, bush walk, read and study the Bible (Hold a Grad Dip in Divinity: 2012).

When I am driving I like to listen to: Actually I ride a 1250 Suzuki Bandit to work so I listen to the exhaust, but it is quieter then my last bike a Triumph Sprint!
Emmanuel Socrates Quansah
PhD Student

**Supervisors:** Dr Nigel Urwin, Dr Padraig Strappe and Dr Shane Raidal

**Thesis title:** Generation of stable transgenic lines of chicken with the Green Fluorescent Protein Gene in the female specific chromosome and its application in sex determination in ovo.

**Funding body**
CSU Research Higher Degree Scholarship

**Career and studies till now**
- Bachelor of Animal Science, University of Ghana, Accra, Ghana
- Masters of Animal Nutrition, University of Maryland, Maryland, USA
- Internship: United Nations Food and Agricultural Organisation, Rome, Italy

**Currently studying**
- PhD, Molecular Genetics

**Research Interests**
- Poultry Nutrition and Genetics

**A typical day for me includes:** A stop at the Equine Centre where I feed chickens and collect eggs. I then shuffle between the Veterinary Diagnostic Laboratory and NaLSH for some lab work. I read at least one journal paper a day and write as much as I can. I usually end Mondays and Fridays with an hour of soccer at the gym.

**My main project at the moment is:** To validate DNA plasmids I constructed in 293T cells and Chick Embryonic Fibroblast cell culture. I am also working on transforming chicken sperm from the roosters I have at the Equine Centre with DNA.

**My favourite part of my studies is:** Lab work involving cell culture.

**When I am not studying I like to:** Skype with my Pamela, watch TV, cook, read, play soccer or see what is happening in politics.

**When I am driving I like to listen to:** music - Ghana Hiplife and Gospel.

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**Summer Edition of the Innovator**
The Summer Edition of the Innovator will be available January 2014. Submission of articles for this edition close on Friday, 13 December 2013. Please email articles to Toni Nugent or Sharon Fuller.
## EVENTS CALENDAR

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<td>12 &amp; 13 Nov</td>
<td><strong>Knowledge to Action Workshop</strong></td>
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<td>13 Feb</td>
<td>Graham Centre Stubble Research Forum</td>
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<td>5-6 March</td>
<td>FarmLink Sheep Handling Days</td>
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<td>12 March</td>
<td>FarmLink GRDC Grower Update</td>
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<td>Science &amp; Agriculture enrichment Day</td>
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<td>Convention Centre Charles Sturt University Wagga Wagga</td>
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<td>15 Aug</td>
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<td>21-22 Aug</td>
<td>National Food &amp; Farming Forum</td>
<td>Convention Centre Charles Sturt University Wagga Wagga</td>
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<td>3 Sept</td>
<td>Graham Centre Cropping &amp; Pasture Systems Field Forum</td>
<td>Graham Centre Field Site Coolamon Road Wagga Wagga</td>
<td>Toni Nugent E: <a href="mailto:tnugent@csu.edu.au">tnugent@csu.edu.au</a></td>
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<tr>
<td>10 Sept</td>
<td>FarmLink Expo</td>
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## INNOVATOR CONTACTS

**Deirdre Lemerle**  
Director  
P (02) 6933 4398  
M 0419 816 267  
E dlemerle@csu.edu.au

**Toni Nugent**  
Editor  
P (02) 6933 4402  
M 0418 974 775  
E tnugent@csu.edu.au

**Sharon Fuller**  
Layout & Production  
P (02) 6933 4401  
E sfuller@csu.edu.au

Our Location:  
Pugsley Place (off Pine Gully Road)  
Wagga Wagga NSW 2650 Australia

Mailing Address:  
Graham Centre for Agricultural Innovation  
Charles Sturt University  
Locked Bag 588  
Wagga Wagga NSW 2678 Australia