THE UNIVERSITY OF WESTERN AUSTRALIA | A CENTURY OF ACHIEVEMENT 1913 - 2013
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The UWA Institute of Agriculture

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(LtoR): Hackett Professor Kadambot Siddique (UWA), Dr Majd Jamal (Assistant Director General, ICARDA), Professor Paul Johnson (Vice Chancellor, UWA), Professor Zhou Xuhong (President, LZU), Professor Jing Tao (Vice President, LZU), Professor Fengmin Li (LZU).

Joint Centre for Dryland Agricultural Ecosystems latest highlight in Australia – China collaboration

Ms Ully Fritsch
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A joint Centre for Dryland Agricultural Ecosystems (CDAE) is testimony both to the important role of drylands in ensuring (future) food security and to the high priority placed by leading agricultural research organisations on pooling their expertise and know-how to advance sustainable dryland agricultural production.

The Centre is based at Lanzhou University (LZU) and represents a joint endeavour between LZU, The University of Western Australia (UWA) and the International Center for Agricultural Research in the Dry Areas (ICARDA); dignitaries from the three institutions travelled to China for the official launch on 23 May 2013.

UWA was represented by Vice-Chancellor Professor Paul Johnson, Pro Vice-Chancellor International Iain Watt, advisor Eva Chye and Hackett Professor Kadambot Siddique. ICARDA was represented by Dr Majd Jamal, Assistant Director General; dignitaries from LZU included Professor Zhou Xuhong, President LZU, and Professor Jing Tao, Vice President LZU and Professor Femgmin Li.

The celebrations reflected on the challenges faced by all, on the successes of previous collaborations and on the shared vision regarding the joint centre

UWA Vice Chancellor Professor Johnson emphasised the urgency for improved adaptation and resilience in dryland agricultural production: "Drylands make up forty per cent of the world's land area and are home to one in three people worldwide," he said. "Australia's agricultural system is largely based on drylands, and like China, it faces the challenges of climate change, especially frequent droughts, high temperatures, nutrient poor soils and dryland salinity."

He remarked on the effective collaboration between UWA and ICARDA spanning two decades and reflected on the highly productive collaborations between UWA and LZU: "Our partnership with LZU dates back to 2006 and has led to numerous exchanges of academic staff and students, many joint international workshops and industry exchanges, joint research projects and publications and two national awards," said Professor Johnson, "and this joint Centre for Dryland Agricultural Ecosystems represents another milestone towards sustainable food production in dryland areas to meet the needs of a growing population."

The overall objective of the Centre is to provide expertise and research groups to act as a knowledge hub to form new research relationships with a view to collectively supporting high impact research, postgraduate training and development activities focused on sustainable dryland agricultural ecosystems.

On a practical level, research at the Centre will bring together scientists across a wide range of disciplines, to optimise the development of integrated cropping/animal production and agro-systems management approaches with a focus on long term sustainability. "We look forward to be working together with LZU and ICARDA on dryland agricultural systems through crop simulation models, smart genetics, agronomic and animal production packages, eco-system management and decision support systems which will assist farmers in adapting their (dryland) food production systems to a changing climate and other challenging conditions now and in the future."

IOA Director Kadambot Siddique summed up the sentiments of the UWA contingent: "We are proud to be part of this important endeavour and confident that it will deliver not only practical benefits for (dryland) farmers around the world, but will also strengthen further the collaboration between UWA, LZU and ICARDA for the benefit of all."

Director's column

Hackett Professor Kadambot Siddique AM FTSE (kadambot.siddique@uwa.edu.au)

Australia is a 'net food surplus' producing country. However our agricultural sector is currently facing a number of challenges. Australia's public research and development expenditure has been decreasing and hence research intensity has been lagging in recent years. Agricultural total factor productivity (TFP) has reached its peak and has been declining in the period 2000 – 2012.

Governments, universities and private sectors must ensure significant new investments in agriculture and food industry in order to make Australia an internationally competitive and high quality food producer and supplier. Continued interaction and partnership between farmers, industry, researchers and policy makers are essential for improving TFP of Australian agricultural sector. UWA's Institute of Agriculture has benefitted greatly from the strong support of its Industry Advisory Board (IAB) under the able leadership of outgoing Chair Mr Bruce Piper, to whom I would like to express my heartfelt thanks. I am privileged to welcome Dr Terry Enright as his successor to the IAB and look forward to his Chairmanship based on his wide-ranging industry experience (cf page 2).

Our international collaborations have received a boost with the signing of an academic partnership known as the Three Brothers Project, between UWA, Zhejiang University (China) and Tarim University (China) in April at Zheijiang University (cf page 4), was the first of two milestones in UWA-China collaborations in agriculture.

The second highlight was the launch of the Centre for Dryland Agricultural Ecosystems (CDAE) at Lanzhou University (LZU) which is a partnership between LZU, UWA and the International Center for Agricultural Research in the Dry Areas (ICARDA) (cf cover story).

Innovation in our agricultural research and development has been highlighted in novel approaches to long-standing global challenges: Assistant Professor Amin Mugera used economical approaches and models to outline ways for improvement in the agricultural sector in selected African countries (cf page 10). Other projects have employed cutting edge technology and modern media to push beyond the boundaries of traditional methods and set the stage for more sophisticated research – and adoption of research outcomes. Examples includes: projects in soil biology (cf pages 7 and 12), herbicide resistance (page 13), water and micronutrient status in plants (cf pages 4 and 9) and farm management tools (cf pages 8 and 14). Applications of existing and new technologies are required for improving Australia's agriculture TFP and our contribution to sustainable global food security.

The high calibre of our scientists is reflected in the significant number of scientific publications (cf pages 19/20), the prizes and awards they have received (cf page 15) and the number of new research grants (cf page 18). This year's IOA Postgraduate Showcase drew a record audience and highlighted the multi-disciplinary nature of agricultural research and teaching at UWA (cf page 5).

With the year already past half way mark, we look towards another exciting field day at the UWA Future Farm on 6 September where we are showcasing the current research and development activities at the farm.

For more information on the UWA Institute of Agriculture (IOA) and its activities go to: www.ioa.uwa.edu.au

New Chair at IOA's Industry Advisory Board

WA grain and livestock producer Dr Terry Enright has been appointed chairman of the Industry Advisory Board of the UWA Institute of Agriculture (IOA)

The former Chairman of the Grains Research and Development Corporation (GRDC) takes over from Mr Bruce Piper who stepped down in May after more than five years as the inaugural chair since the institute's re-establishment in 2007.

UWA Vice-Chancellor Professor Paul Johnson welcomed Enright to this position which plays a critical role in the Institute's strategic direction and interaction with industry. Enright has served in key agricultural appointments, including a commissioner of the Export Wheat Commission, a member of the standing committee on national research priorities and member of the panel to conduct an independent review of the Australian Centre for International Agricultural Research (ACIAR) in 2012.

He is an Independent Director of the Australian Livestock Export Corporation (Livecorp), Director of Grain Producers Australia, Chair of the Western Australian Crawford Fund Committee and a member of the Board of Directors.

Johnson said that on under Enright's leadership, the Board would continue to enhance the value of the Institute and the University to the rural and regional industries through Institute policy and direction.

Johnson also acknowledged outgoing chair Piper and his guidance of the Board which helped build the University's reputation agriculture and related areas.

Incoming chairman Terry Enright.

Outgoing chairman Bruce Piper.

What's new at the UWA Future Farm 2050

www.ioa.edu.au/future-farm-2050

Photo courtesy Econnect Communication.

Phil Vercoe speaking to the Climate Champion farmers about UWA's Future Farm work during their national workshop.

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2013 has seen an increase in outreach activities, commencing with a visit to UWA Future Farm by about 30 Climate Champions from across Australia (www.managingclimate.gov.au/climate-champion-program). The Climate Champions program is an initiative of the Managing Climate Variability program, Meat and Livestock Australia and the Grains Research and Development Corporation, looking at climate risk management. Through this program these farmers work with scientists and industry to provide relevant tailored information, feedback on research results and adaptation options for agriculture. The farmers, who are at the forefront of their industries, commit their own time and networks to contribute to managing climate risk and formed part of the influencer group for the Department of Agriculture, Fisheries and Forestry Climate Change Research Program.

In April, at the annual UWA Institute of Agriculture Industry Forum, the UWA Future Farm 2050 Project contributed to a forum on 'Food 2050' with 16 presenters.

To complement the above event, and as part of community outreach, a series of public lectures on 'Food 2050' will be held between August and October. Topics include:

- 6 August: *'Australian agriculture and global food security'* (W/Prof Kadambot Siddique, The UWA Institute of Agriculture);
- 4 September: *'Is 'more efficient' food production in conflict with animal welfare?'* (Prof Marian Stamp Dawkins, University of Oxford); and
- 10 October: *'Do genetic effects threaten the sustainability of marine fisheries?'* (Prof Fred Allendorf, Fulbright Senior Specialist to UWA).

In addition, the UWA Future Farm will hold its next Field Day on 6 September 2013 (see also back page of this newsletter). For further details visit www.ioa.edu.au/future-farm-2050

In May, a group of about 60 students from six agricultural colleges across the southwest of WA visited UWA Future Farm as part of their education program. The visit was organized by the WA Department of Education.

In July, the farm hosted an international group of visitors: Kansas State University Professor Ron Madl visited the farm with seven of his students to view sustainable agriculture practices, projects and technologies on-site.

The 'City Kids Come to the Country' High School Science Project, whereby students participate in the ecosystem restoration program on the farm, has also expanded: seven groups of up to 50 students are set to visit the farm in July and August, planting trees they have nurtured in their own schools.

International visits planned for 2013 also include students from the North West Agriculture and Forestry University (China) and the South China Agricultural University.

UWA student wins prestigious CSIRO Scholarship

Bidhut Banik.

Interdisciplinary research at UWA's School of Plant Biology and School of Animal Biology has paid off for PhD Student Bidhut Banik, who won the CSIRO Sustainable Agriculture Flagship Scholarship awarded in the research priority area 'Plants, ruminants and methane: it's pure chemistry'. Only one scholarship is awarded per priority research area.

Banik's research focuses on rumen fermentability and methane production and its relation with plant secondary compounds (PSCs) of different cultivars of Biserrula (*Biserrula pelecinus* L.). He first developed an interest in the fermentability of pasture legumes in the rumen while studying for his Masters degree in Genetics and Breeding at UWA.

"I became more and more curious about the mechanism of pasture selection and about the genetics of the plants, so when the opportunity arose to do my PhD with Professor William Erskine (CLIMA), Asst/Prof Zoey Durmic (Animal Biology) and Dr Clinton Revell (DAFWA) as my supervisors, I jumped at it."

He describes the advantages of working across disciplines: "My involvement in research that is relevant for the environment, plant biology and animal biology, has made me eligible to apply for quite a few top-up scholarships."

He also appreciates the collective knowledge and experience from the different disciplines: "Working with two different schools is really interesting and allows you to gain a vast amount of experience and knowledge – provided everyone is clear and in agreement about the main focus and the boundaries of the research."

The 'CSIRO Sustainable Agriculture Flagship' is one of CSIRO's 11 national research flagships which were formed to develop scientific solutions through multi-disciplinary research partnerships to meet Australia's most significant challenges and opportunities.

Banik's research is also supported by an Australian Postgraduate Award.

Three Brothers Project boosts UWA – China relation in Agriculture

The signing ceremony of the Three Brothers initiative was hosted by Zhejiang University: (LtoR) Robyn Owens (Deputy Vice Chancellor Research, UWA), Wu Zhaohui (Executive Vice President, Zhejiang University) and Wang Heli (President, Tarim University).

Dr Anke van Eekelen
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A new academic partnership between UWA and two Chinese universities has officially been launched at a signing ceremony at Zhejiang University in China in April.

This new international collaboration is the result of tripartite discussions held late last year. The initiative is referred to as the Three Brothers Project between UWA, Zhejiang University in Hangzhou on the east coast of China and Tarim University in the West Chinese province of Xinjiang.

The visit by Deputy Vice Chancellor Research, Winthrop Professor Robyn Owens, to Hangzhou to finalize the agreement of cooperation with her counterparts at the two Chinese partner institutions, was soon followed by a visit to Tarim, where Hackett Prof Kadambot Siddique, Associate Professor Guijun Yan and Assistant Professor Michael Considine attended a symposium at Tarim University to identify the most suitable areas of collaboration under the Three Brothers Project.

The Three Brothers framework was founded in 2005 by the Ministry of Education in China to support relationships between high-performing universities abroad and elite and emerging universities in China. Previous tripartite agreements have been formed with New Zealand's Massey and Lincoln Universities.

Closer ties between UWA, Tarim University and Zhejiang University are of most interest in the research area of arid horticulture. It is envisaged that a focus on key topics like the endemic Poplar trees in the Tarim Basin, water saving irrigation technologies and the safe and efficient production of crops, can further develop research capacity and training at Tarim University in the remote desert region of West China.

An academic exchange of scholars and students is recognized as being integral to the success of the program. Visiting scholars and students from Tarim University will receive English language and research training at Zhejiang University before they will come to UWA to engage in collaborative research projects.

The first early career researcher to visit UWA has already been selected. Dr Peipei Jiao is an Assistant Professor in biodiversity and conservation, who has recently been awarded a fellowship through the China Scholarship Council (CSC) and is preparing to come to UWA in 2014 to participate in phenology research on the well known Tarim Basin Poplar trees with Michael Considine.

Combined efforts in the next three years will see joint funding applications to Chinese and Australian institutions, shared publications in relevant journals and the organization of workshops and symposia in China as well as at UWA.

Remote control: Probing the water use of crop plants

The ZIM-Plant Technology team in Hennigsdorf, Germany, during a rare sunny moment in May, with Ulrich Zimmermann, Head of the group (far back left) and Helen Bramley, IOA (front centre).

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A group of researchers at the UWA institute of Agriculture (IOA), University of Adelaide and ZIM-Plant Technology (Hennigsdorf, Germany) are able to visit each other through the Group of Eight – German DAAD Research Cooperation Scheme. Their project, 'A novel non-invasive method to monitor water status of crop plants', is adapting German technology in the form of magnetic pressure sensing probes to help solve agricultural problems in Australia. IOA's Dr Helen Bramley visited Germany in May to discuss advances made with the project and plan the upcoming research activities.

"We have been able to show that these novel probes can monitor the water status of wheat plants and indicate when the plants are water stressed," Bramley said. "The innovation is that these probes monitor remotely, so we can view the data over the internet without visiting the field". An Honours student, and GRDC and Eric Smart scholarship recipient, Mr Liam Ryan is now using the probes on a range of wheat genotypes in the glasshouse to show that the technology can indicate those genotypes with greater drought tolerance. "We expect that this technology will help wheat breeders identify drought tolerant germplasm more easily."

The group's German colleagues, headed by Professor Ulrich Zimmermann, have made modifications to the probes making them easier to adapt to wheat, and during Bramley's visit they started the development of a new application that could possibly identify when the plant is flowering. "We're excited by the new possibilities this technology opens up, as we are getting new insights into the behaviour of wheat plants at the fundamental level. Remote monitoring will benefit the wheat industry in their development of new varieties and monitoring of field sites," Bramley said.

Other collaborators include Hackett Professor Kadambot Siddique (UWA), Adjunct Asscociate Professor Jairo Palta (CSIRO/UWA), Professor Steve Tyerman (University of Adelaide) and Professor Erik Veneklaas (UWA).

IOA postgraduate showcase impresses with diverse presentations

(LtoR) Presenters Monica Kehoe, Madeleine Hartley, Cesar Rosales, Kelsie Moore, Renu Saradadevi with Tony O'Donnell (Dean, Faculty of Science), Peter Davies (Pro Vice-Chancellor Research) and presenter Alex Liu.

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Six UWA PhD students from the disciplines of medicine, law, animal biology and plant biology made this year's Postgraduate Showcase: Frontiers in Agriculture a smorgasboard that had something for everyone. An audience over 100 packed out the auditorium to listen and engage with the students.

Monica Kehoe (Plant Biology) talked about the cause of black pod syndrome (BPS) in narrow-leafed lupin; her research established that BPS is caused by the Bean Yellow Mosaic Virus (BYMV) and by using genetic sequencing she identified a particular gene in the virus, which may be responsible. As BPS is the main cause for reduced yield in this crop and Australia produces 85% of the global crop, Ms Kehoe's findings represent a major step forward in solving BPS.

Ms Kehoe's supervisors are Professor Roger Jones (UWA/DAFWA), Adjunct Associate Professor Bevan Buirchell (DAFWA), and her research is supported by UWA, DAFWA and GRDC.

Renu Saradadevi (Plant Biology) compared the stomatal conductance – a water conservation strategy by plants – of several wheat cultivars under terminal drought, and the role of Abscisic acid in this process. Her findings will help identify and develop wheat varieties best adapted to a drying climate. Renu's supervisors are Hackett Professor Kadambot Siddique (UWA), Adjunct Associate Professor Jairo Palta (CSIRO/UWA), Dr Helen Bramley (UWA), and her research is funded by an Australian Endeavour Postgraduate Research Award and UWA.

Alex Liu (Medicine and Pharmacology) presented the benefits of a rich green-leafy vegetable diet on arterial stiffness and blood pressure. He showed that a high dietary nitrate intake from eating spinach mediates vasodilation and reduces blood pressure. He is sponsored through the China Scholarship Council and UWA, and his supervisors are Professors Jonathan Hodgson and Kevin Croft (both from UWA).

Madeleine Hartley (Law) provided great insights regarding the governance and the reality of groundwater use efficiency in Western Australia on the Gnangara Mound, advocating an integrative approach of improved stakeholder awareness re policies, metering, and enforcement of sanctions to achieve water use efficiency for sustainable development. Her research is supported by the National Centre for Groundwater Research and Training, Cotton Research & Development Corporation. Her supervisors are Associate Professor Alex Gardner (UWA); Professor Simon Young (UWA); Professor Tom I Romero II (SCOL, Colorado).

Kelsie Moore's (Animal Biology) findings on alpaca fleece characteristics and vitamin D synthesis indicated that Vitamin D levels in alpacas are highly influenced by shearing, season, skin colour and fleece distribution around the face.

Kelsie is supervised by Associate Professor Dominique Blache, Professor Shane Maloney and Associate Professor John Milton (all from UWA).

Cesar Rosales (Animal Biology) showed that mating of Merino ewes can be brought forward from 18-24 months old to 8-10 months old without affecting the animal's reproductive ability in the long term, and that the pregnancy rate (for early mating) is strongly correlated to live weight gain during that mating period: a gain of about 200g per day could result in a 75% pregnancy rate. Cesar's supervisors are Winthrop Professor Graeme Martin (UWA), Dr Mark Ferguson (NZ Merino) and Associate Professor Andrew Thompson (Murdoch University and DAFWA).

IOA Director, Siddique summed up the significance of the event:

"The IOA Postgraduate Showcase has again highlighted the outstanding research undertaken by UWA students in agriculture and related areas; and perhaps more importantly and befittingly for UWA's 100 year anniversary, the Showcase has delivered a clear message that agriculture is a truly diverse and multidisciplinary field, which continues to attract some of our brightest students."

The presentations can be accessed at www.ioa.uwa.edu.au/publications/showcase

Champion for soil health visits UWA

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(Lto R) Matthias Leopold (UWA) , Chris Gazey (DAFWA), Lyn Abbott (UWA), Tony O'Donnell (UWA), Hon. Michael Jeffery, Fran Hoyle (DAFWA), Daniel Murphy (UWA) and Gavan McGraw (UWA).

Former Governor-General, Major General the Hon. Michael Jeffery visited Western Australia in March this year to open the 'Talkin' Soil Health' conference in York. It created the opportunity for Major General Jeffrey to hear from local growers and researchers what challenges in agriculture are faced in our State.

His attendance at the meeting was initially followed by a busy schedule of regional visits to WA farmer's organization and groups of growers in the Central WA grain tbelt. Here, the topic of conversation was soil acidity management and related issues that impact on a grower's capacity to manage soil health, like live animal transport and seasonal conditions

Hackett Professor Kadambot Siddique, Director of the UWA Institute of Agriculture (IOA), and Winthrop Professor Tony O'Donnell, Dean of the Faculty of Science, hosted a UWA event for Major General Jeffrey to discuss current research projects at IOA and its collaborators. Major General Jeffrey met with several agricultural experts at UWA and was presented with UWA's future directions of agricultural research and teaching.

He was keen about the Future Farm 2050 project. "I look forward following the progress of the project and hope other universities and agricultural colleges across Australia will follow your example," Major General Jeffrey said.

Professor Daniel Murphy offered Major General Jeffrey a look at soil health from an unconventional view point. He illustrated how NanoSIMS (Nanoscale Secondary Ion Mass Spectrometry) technology can help understand soil-plant interactions at a subcellular level and discussed the value of knowledge of our ecosystem to improve the health of our landscape. How it complements applied research and development in the field was covered in further conversations around this sophisticated research approach.

A final meeting with soil scientists and microbiologist to hear about other fundamental soil focused research at UWA and some large collaborative soil microbiology and soil organic matter projects between IOA and DAFWA, concluded the Major General's visit to WA.

Beijing Youth Science success for Shenton College – UWA partnership

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A group of Shenton College girls blitzed international contestants at this year's Beijing Youth Science Competition to become the latest ambassadors of the highly successful 'UWA Learning Links' outreach program, in which Shenton College students are mentored by UWA scientists in conducting a research project of their own.

14 year-old Shenton College student Eemali McDonald took out the gold medal this year for her poster presentation on identifying the gene which controls flower colour in narrow-leafed lupin.

The poster was based on molecular genetics research she conducted at UWA with mentors Assoc/Prof Matthew Nelson (School of Plant Biology and IOA) and Ms Naghmeh Besharat (visiting scholar), who commended Eemali on her ability to grasp advanced genetic concepts and quickly learn laboratory skills.

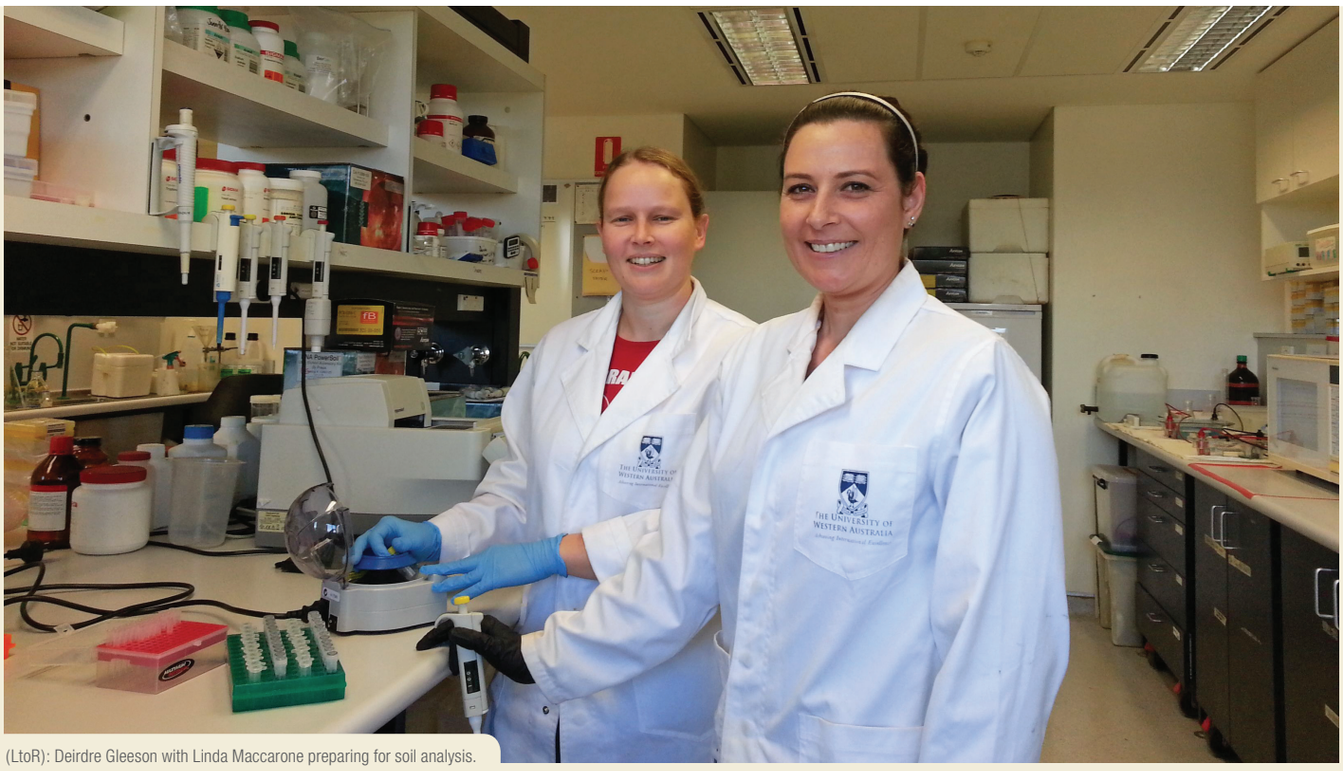
Another project put fellow student Ellie-Rose Rogers in the spotlight at Beijing: Ellie-Rose shared her research of the effects of sulphur dioxide on grapes, which she conducted with her mentor Assist/Prof Michael Considine (School of Plant Biology and IOA). Together with Sarah Barnes, Daisy Evan and Sarah Effler, the girls were judged the most successful international team at the world's largest youth science competition, in which students from Denmark, Korea, the US, Singapore, Hong Kong, Germany, Italy, South Africa and Australia competed along with 200 finalists (selected from 350,00 applicants) from the Beijing area.

"It was a fantastic feeling and a big confidence boost to be up there with students from all these other countries and to get official recognition that the work we have produced is up there with the best, "says Eemali. "We had such great support from our mentors at UWA and from our Science teacher at Shenton College – they were a real inspiration and kept us motivated and I want to say thank you to all of them."

Learning Links Coordinator, Warwick Mathews, returned the compliment "Eemali and the other members of the Shenton College team were great ambassadors for UWA at the Beijing Competition and for the Learning Links program." For more information on this program visit www.shenton.wa.edu.au/college/uwa

Eemali (centre) with mentors Matt Nelson and Naghmeh Besharat, showing her 'spoils' from Beijing's Youth Science competition.

Microbes – understanding their secret life in soils



(LtoR): Deirdre Gleeson with Linda Maccarone preparing for soil analysis.

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Researchers from IOA and School of Earth and Environment are breaking new ground in the study of microbes in semi-arid soils. Associate Professor Deirdre Gleeson and Dr Linda Maccarone, from the Soil Biology and Molecular Ecology Group, are studying the groups of microbes called nitrifiers.

The nitrifiers investigated in this study belong to two different domains of life, bacteria and archaea; they have different evolutionary histories, with archaea considered one of the earliest life forms on earth. These microbes can affect crop production by converting ammonia into nitrate, in a process called nitrification. Nitrate can be leached out of the soil and can contribute to soil emissions of nitrous oxide, a potent greenhouse gas. Until now, most of the research on nitrifiers has been conducted in temperate regions, such as North America and Europe.

The research by Gleeson and Maccarone was undertaken in the wheat belt region of Western Australia, with soils collected from DAFWA research station at Wongan Hills, from Cunderdin Agricultural College and the Liebe Group's long term trial site at Buntine.

Gleeson explains the importance of studying nitrifiers in local soils, "Microbes are affected by climatic conditions and there's been little research on nitrifiers in semi-arid regions, particularly in South-West Australia. These regions are very important to agriculture in Australia – they're responsible for 40% of Australia's grain production."

Nitrifiers are still largely a 'black box' for soil scientists. For many years it was thought that all nitrifiers were bacteria. However, recent research in temperate regions shows that nitrifying archaea are not only present in most soils, but can be more abundant than nitrifying bacteria.

Gleeson and Maccarone have shown that the relative importance of different nitrifiers in semi-arid soils in Western Australia seems to be different to what has been reported previously in temperate regions. Gleeson says, "Compared to temperate soils, we found that in semi-arid soils nitrifying bacteria were more abundant than nitrifying archaea. Now that we know which microbial populations dominate these soils we can investigate how best to manage this biological process."

Maccarone compared the abundance of nitrifying bacteria and archaea down the soil profile. She found that nitrifying bacteria inhabit the top-soil whilst nitrifying archaea inhabit the sub-soil. She says, "Understanding how nitrifiers are distributed at different soil depths may provide farmers with alternative management strategies such as altering the depth placement of fertiliser to improve nitrogen use efficiency."

Maccarone also found that as soil got deeper, both the abundance of nitrifying bacteria and nitrification rates decreased. "We think it's likely that it's bacteria that are responsible for most of the nitrification in these semi-arid soils, rather than archaea. It's important we know which microbes are performing these processes in soil so that we can understand how to manage the processes to benefit crop production, greenhouse gas emissions and sustainability," says Maccarone.

The researchers also found that nitrifiers in semi-arid regions responded differently to water than they do in temperate regions. Gleeson says, "Unlike in temperate regions, we found that in semi-arid soils, nitrifying bacteria were more affected by soil water content than nitrifying archaea, particularly in the top ten centimeters of soil."

"This is important as climate change is projected to make rainfall more variable, which has implications for these key microbial populations in soil."

Gleeson adds, "Our understanding of these microorganisms in semi-arid soils may become relevant to other agricultural regions across the planet if climate change causes them to shift towards aridity."

This research was supported by GRDC's Soil Biology Initiative II and an ARC Discovery Project.

Livestock forage-gap filled with green feed

The Tedera and Cullen trial site at Buntine before grazing.

ScienceNetwork
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Min Song
www.sciencewa.net.au

IDEAL conditions for producing perennial legumes – that could be used to relieve the shortage of forage during dry periods – have been identified by agricultural researchers.

The results will interest early adopting farmers and crop breeders working toward commercial release of perennial legumes and could assist during the annual feed-gap period when stocks of green feed for livestock run low, according to study co-author and UWA School of Plant Biology and IOA's Assiciate Professor Megan Ryan.

"The feed-gap occurs in the late summer-autumn period prior to the first autumn-winter rains, and reflects the fact that WA farming systems are mostly based on annual crops and pastures which grow only over the winter-spring period," says Ryan.

Over two years, the team of researchers observed the survival and production of tedera (Bituminaria bituminosa var. albomarginata) and Cullen species in Buntine and Newdegate, two low-rainfall sites in WA, under different growing conditions.

They found that in these areas, which receive less than 350mm of average rainfall annually, tedera generally survived better, with survival rates of approximately 70 to 80 per cent as opposed to Cullen australasicum's rate of 18 to 45 per cent.

They also discovered that cutting tedera three times a year – twice during summer-autumn but not in early summer – would be optimal for maximising shoot dry weight for use during the feed-gap.

The researchers suggest that a favourable plant density to aim for is about eight to 16 plants per square metre, slightly less than that recommended for a place of higher rainfall, though growers should use their own knowledge of local growing conditions before consulting any findings from the study.

Ryan says these results support findings from other recent studies that show the economic significance of green feed in the autumn feed-gap.

"Many farmers have to purchase feed once their animals have eaten all dry feed available," she says.

"This is expensive and can reduce farm profits and animal health, and product quality may also suffer.

"The ability of perennials to provide green feed during this time will be a major driver of adoption."

Tedera and Cullen species have not yet been commercially released, but the researchers are optimistic.

"The team is working towards commercial release of tedera by working on other aspects of its biology, especially seed production, and agronomy, and through selection of superior germplasm," says Ryan.

"We are continuing to work on the ecology, physiology and agronomy of other native species with pasture potential, including other Cullen species."

This was first published online by ScienceNetwork WA.

Do-it-yourself soil monitoring trialled for on-farm use

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A recent workshop on Garry Page's farm in Pingelly saw landowners learn how they can assess some of the components of soil biology on their properties with simple equipment.

They were guided by Professor Lyn Abbott from IOA and UWA's School of Earth and Environment on how to use a newly developed toolkit to quantify soil fauna on their farms and to determine the amount of mycorrhizal fungi present in roots of their crops and pastures. The soil fauna assessed are mites and springtails. The toolkit is based on resources developed in collaboration with SPICE at UWA, which is a collaboration with the Department of Education WA to expand teaching resources for science teachers.

According to Abbott, more and more farmers are looking for alternative ways to improve productivity and this on-farm toolkit can help them monitor the impact of poor seasons and agricultural practices on their soil.

"In sustainable farming systems, we want soil biological processes to complement management practices as much as possible."

The easy to use toolkit, developed by Abbott in collaboration with the Wheatbelt Natural Resource Managment Inc and the South-West Catchment Council, provides farmers with the means to sample and monitor aspects of soil health without having to call on experts.

The workshop in Pingelly was one of a series recently conducted in south-western Australia. Other workshops were held in York, Northam, Boyup Brook, Dalwallinu and Dumbleyung. They have come at a time when farmers are becoming increasingly aware of the importance of soil health and biological fertility.

Biofortification to meet the demand for micronutrient-rich food

Winthrop Professor Zed Rengel
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(Front row right): Zed Rengel, UWA, with fellow delegates in Norway, at the 4th annual conference of the European Cooperation in Science and Technology.

The European Cooperation in Science and Technology (COST) held its 4th annual conference in Ås, Norway, last June, and focussed on the theme of "Essential and Detrimental Trace Elements Entering the Food Chain via Plants". Winthrop Professor Zed Rengel of UWA's School of Earth and Environment and IOA was invited to give a keynote presentation on availability of micronutrients and undesirable trace elements in the soil-plant-microbe continuum.

COST puts a strong emphasis on quality of agricultural produce, particularly from the standpoint of increasing micronutrient content of grains and vegetables. The micronutrient initiative was started in the early 1990s as an Australian-US collaboration between the University of Adelaide and Cornell University. It has since blossomed into a huge world-wide research effort administered by Consultative Group on International Agricultural Research (CGIAR) under the banner of HarvestPlus, funded by philanthropists (e.g. The Bill and Melinda Gates Foundation) and various governments.

The reason why the world is interested in producing food with increased micronutrient content is that 4 to 5 billion people worldwide are deficient in the micronutrients iron and zinc, particularly in developing countries, with zinc and iron deficiencies being, respectively, the 5th and 6th leading causes of disease. The most effective solution to the micronutrient malnutrition problem in these countries is increasing micronutrient content in staple cereals.

But if you think that solutions to micronutrient deficiencies are only implemented in developing countries, check your packet of breakfast cereals next time you eat them. There is a fair chance your cereal is fortified with Fe, potentially Zn, vitamin C and folic acid among many others. And switching to a 'ham and eggs' breakfast may not help you avoid micronutrient-containing chemicals added to your food – in developed countries many other grain-based products, like flour and pasta, are also fortified with micronutrients.

Rengel's research interest is in developing an alternative way of producing micronutrient-enriched grains without adding chemicals during food processing. He investigates biofortification in the field during crop growth. Biofortification can increase micronutrient content in grains via targeted fertilisation and/or selecting varieties with enhanced capacity to take up micronutrients from the soil.

Rengel's group works on wheat and barley (the latter not a staple crop but is becoming an increasingly important food component in Western countries). His group characterises physiological mechanisms and genetic factors responsible for a high capacity to take up micronutrients by the roots and load them into the grains.

Crop sequence and fallow treatment effects in a changing climate

Dr Anke van Eekelen
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Under the umbrella of the National Adaptation and Mitigation Initiative, a recent 2-year research trial by Dr Ken Flower and Dr Sudheesh Manalil from the UWA Institute of Agriculture and School of Plant Biology has focussed on the effects of different crop sequence and fallow treatment regimes on greenhouse gas emission and soil water conservation in Western Australia.

The study aimed to demonstrate what impact different farming systems in the WA grain belt have on mitigation of agricultural greenhouse gas emissions and adaptation to climate change.

Crop sequences with either wheat or canola preceeding the final year wheat crop, and weedy versus chemical fallow treatments were tested at the UWA Future Farm near Pingelly as well as at the DAFWA Merredin Research Station. The UWA researchers collaborated with Mr Glen Riethmuller and Dr Geraldine Pasqual, both from the Department of Agriculture and Food WA (DAFWA).

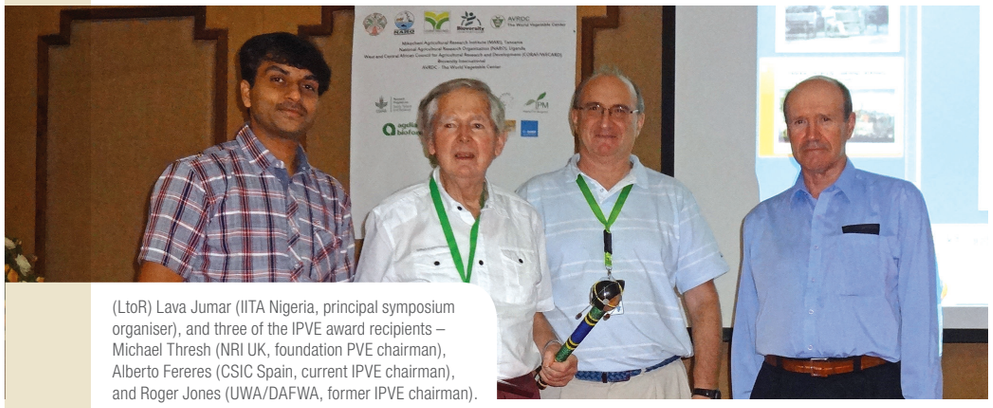
Fallow management in the first year of the trial did not increase the soil nitrous oxide emissions measured in the wheat crop of the following year, compared with growing crops the previous year. Emissions in the second year of the study increased slightly after seeding and more noticeably when urea was applied at the tillering stage of the wheat crop.

The chemical fallow with no weeds present was able to conserve the most soil water, followed by the cultivated fallow and a fallow with weeds killed in August. The weedy fallow – wheat sequence conserved the least water.

Funding for this project was received from DAFWA, the Australian Government Department of Agriculture, Fisheries and Forestry (DAFF) and the Grains Research & Development Corporation (GRDC).

Ken Flower and Sudheesh Manalil with a manual chamber that allows monitoring of green house gas emission from crops in the field.

Africa Symposium addresses plant virus disease threat to world food security



(LtoR) Lava Jumar (IITA Nigeria, principal symposium organiser), and three of the IPVE award recipients – Michael Thresh (NRI UK, foundation PVE chairman), Alberto Fereres (CSIC Spain, current IPVE chairman), and Roger Jones (UWA/DAFWA, former IPVE chairman).

Professor Roger Jones
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As part of a series of International Symposia organized every three years by the International Committee on Plant Virus Epidemiology of the International Plant Pathology Society, this year's Symposium on 'evolution, ecology and control of plant viruses' was held in Arusha, Tanzania. It was an international gathering of plant virologists, where Professor Roger Jones of the School of Plant Biology at UWA was honoured for his achievements in plant virus epidemiology and invited to present keynote addresses to an audience of more than 150 fellow researchers from across the world.

Jones presented one lecture on the opportunities in plant virus epidemiology, which considered recent advancements, trends and new technologies applied to plant virus epidemiology, including knowledge enhancement, data collection and processing. His view on the provision of more effective prediction and decision support systems to optimize virus control measures complemented the focus of the meeting on how best to address the threat to world food security posed by losses due to viral infections of staple crops and the devastating virus pandemics now occurring in crops in Africa and other parts of the globe.

Jones and six other distinguished plant virology researchers received awards for their outstanding contributions to the field of plant virus epidemiology. Among them, Professor Karl Maramorosch, who had even more reason to celebrate. He turned 97 years of age at the meeting and took the opportunity to talk about his meeting with the late Professor Nathan Salaman, the first professor of plant virology world wide. Most attendees belonged to generations that were born well after Salaman's lifetime.

The Symposium was also attended by UWA PhD student Eviness Nyalugwe from Malawi, who presented her work on oilseed brassica germpasm for resistance to the Turnip mosaic virus.

The symposium was organized by the International Plant Virus Epidemiology (IPVE) committee and the International Institute of Tropical Agriculture (IITA) in partnership with the Mikocheni Agricultural Research Institute (MARI, Tanzania), the National Agricultural Research Organization (NARO, Uganda), the West and Central African Council for Agricultural Research and Development (CORAF/WECARD), Biodiversity International and the Asian Vegetable Research and Development Center (AVRDC-The World Vegetable Center). It was sponsored by many institutions and private companies.

(RtoL): Australia's Prime Minister Kevin Rudd shows new sweet potato variety with high beta-carotene content to Rob Williams (Seeds of Life) and former President of Timor-Leste HE José Ramos-Horta.

New sweet potatoes h security and nutrition i

Ms Ully Fritsch
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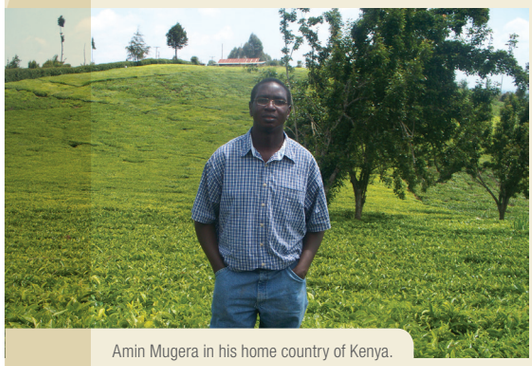
New sweet potato varieties are producing more reliable crops of superior quality than local varieties in poverty-stricken Timor-Leste, a country with one of the highest percentage of chronically malnourished children in the world.

Professor William Erskine, from UWA's Centre for Legumes in Mediterranean Agriculture (CLIMA) and Institute of Agriculture (IOA), is co-author of a study which shows how the new varieties help to improve life for Timor-Leste's 1.1 million people, of whom more than 80 per cent are subsistence farmers.

CLIMA; IOA; the Ministry of Agriculture, Forestry and Fisheries in Timor-Leste; and the Seeds of Life Program collaborated on 198 farmer-managed trials over the 2006 – 2007 and 2007 – 2008 growing seasons. The Project is supported by AusAID and Australian Centre for International Agricultural Research (ACIAR).

Economic viability of African Agriculture assessed



Amin Mugera in his home country of Kenya.

Dr Anke van Eekelen
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The dependence of rural welfare and economic growth on productivity within the agricultural sector is particularly evident in Africa. Across this continent it is vital that countries embrace opportunities to remain technically efficient, yet new studies by a Kenyan born researcher at UWA show that the ability to do so varied considerably between African regions with dire outcomes for some.

Assistant Professor Amin Mugera, of UWA's School of Agricultural and Resource Economics and IOA, collaborated with colleagues from California State University in the US and Konkuk University in Korea to analyse data from 33 African countries using new economical approaches and models.

They were able to outline ways for improvement in the agricultural sector across Africa, recently described and published in two relevant journals in the field of agricultural science and technology and resource economics, the Journal of International Development and Contemporary Economic Policy.

s help achieve food
n in Timor-Leste

Erskine describes some of the benefits: "The new varieties produce larger sweet potatoes that are more marketable because of their smooth skin and flesh and regular shape." But this is not the only area in which the study has proved a big success; the new varieties are now being widely adopted across Timor-Leste, which Erskine attributes to the study's unique nature: "We involved farmers in the trials and also interviewed them after harvest to find out how they viewed characteristics in the local and test varieties and whether they would re-plant and why."

The improved yield and ready adoption of the new sweet potato varieties mean that Timor-Leste now has a much better chance to achieve food security. Sweet potato stores well and one of the varieties, which is high in calories and has good levels of beta-carotene (a source of vitamin A), is likely to help prevent vitamin A deficiency, which can cause cancer, birth defects, impaired immune function and night blindness as well as calorie malnutrition. Sweet potato maintains its beta-carotene for at least 50 days and retains it during cooking.

Gabon looking to UWA for agricultural development expertise

Ms Ully Fritsch
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In April this year, a representative of Gabon's Ministry of Agriculture, Ms Jocelyne Awandong, visited IOA to identify potential opportunities to provide direction in how UWA and the Gabonese government can collaborate on agricultural development and training in Gabon.

Situated on the west coast of Africa across the equator, Gabon's economy relies on mining and oil production and export. "Gabon's agricultural sector is relatively underdeveloped with only about 10% of the total land area under cultivation," explained Ms Awandong. "Agricultural production is dominated by food crops, and the lack of infrastructure means, they are consumed in the regions where they are produced, while the rest of the country depends on massive food imports."

At the invitation of IOA Director Hackett Professor Kadambot Siddique, Awandong met with senior staff at the Institute over five days and exchanged information about Gabon's needs and expectations for agriculture versus IOA's (training) programs, expertise and facilities.

Professor William Erskine discussed the Seeds of Life project in Timor-Leste and how such an approach can be useful for Gabon.

Associate Professor Christian Nansen shared his experience on running short courses in Africa and outlined the benefits of working in both countries in terms of assessing the real needs and adapting the training programs to local needs.

Awandong showed keen interest in Dr Ken Flower's views on the importance of conversation agriculture and the need to develop farming systems that are productive, but also avoid erosion and environmental degradation.

She was inspired by her meeting with Ms Susan Hall, Project Manager, Grower Group Alliance (GGA) with whom she discussed what Gabon can do to develop effective farmer groups in Gabon.

Jocelyn Awandong on the UWA campus with (LtoR) Wallace Cowling, Michael Perry and Kadambot Siddique.

The meeting with Winthrop Professor Tim Colmer she found equally valuable: "He has worked with the International Rice Research Institute (IRRI) on rice projects and has run short courses in Thailand, Vietnam and the Philippines – and this could be of interest because rice is a staple food crop in Gabon."

Awandong was also very interested in the expertise and short courses offered under IOA's Animal Production Systems Program, as Gabon is a net importer of meat.

"The discussions and meetings have given me valuable ideas for our collaboration, as well as an understanding of the difficulties and constraints," she said. "Currently, there are no real farmers in Gabon, so the first thing we need to do is to train people to become farmers, to give them the basic knowledge they need and to help them get organized in cooperatives."

"UWA has all the expertise needed to help Gabon develop efficient agricultural systems, and I hope that jointly we can secure funding from the Australian Center for International Agricultural Research (ACIAR) and AusAID to support agricultural development projects in Gabon. I will be reporting findings from my visit to UWA to the Minister for Agriculture Gabon."

The initial focus was on whether African agriculture was lagging behind in technical efficiency by examining statistics from 1966 to 2001. Further research examined whether or not poverty-reducing, low-interest loans from organisations such as the International Monetary Fund (IMF) and the World Bank had an impact on productivity by examining available statistics from 1981 to 2001.

In both research projects the effects of globalisation, civil violence, levels of development of physical and financial infrastructure and the influence of natural resource factors on agricultural productivity were considered.

The authors found that efficiency differed greatly across African regions and countries with evidence of "catching up" to the latest technology primarily within the East African countries. "Our analyses point to the need for policies that improve technological uptake in African agriculture," they write.

The authors also found that macroeconomic policy reforms instituted by groups such as the IMF and World Bank improved agricultural productivity in the 33 countries they sampled. "This is important because many countries rejected the IMF and World Bank requirements in the initial stages," they argue.

"It was not until the IMF and World Bank turned the requirements for policy reforms into conditions for receiving financial aid that countries slowly started to adjust to the new macroeconomic environment."

Australia and Japan target key Australian pasture

(LtoR): Rudi Appels (Murdoch University), Parwinder Kaur (UWA), Phil Nichols (DAFWA), William Erskine (UWA) and Sachiko Isobe (KDRI, Japan).

Dr Parwinder Kaur
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Climate-smart clovers/crops ... it sounds like the stuff of science fiction but it is one possible outcome of Sub-clover Genomics Research project at UWA's Centre for Legumes in Mediterranean Agriculture (CLIMA) and School of Animal Biology. This project's focus is not so much on the cows and sheep themselves, but rather, on their fuel. This multi-disciplinary team of researchers is developing methodologies to enable breeders to identify environmentally-friendly subterranean clover and discover the genes controlling economically important traits in this pasture.

Subterranean clover is the most widely sown pasture legume species in Australia. Covering about 29 million hectares nation-wide, subterranean clover is valued by sheep and cattle producers because it is highly nutritious. Its nitrogen-fixing qualities also improve the soil, leading to better yields when cereal crops are grown on clover paddocks on alternate years.

This collaborative research project funded by the Australian Research Council (ARC) and the Department of Agriculture and Food (DAFWA) through a linkage grant is on its way to uncover genes controlling important traits in this species by sequencing the complete genome.

"The sequence will dramatically accelerate research on molecular markers," says Dr Parwinder Kaur. "These markers will help us discover the genes in the clover that control complex traits such as methane release potential."

Collaboration with Kazusa DNA Research Institute in Japan has brought access to their expertise in legume genomics and to state-of-the-art equipment to achieve the goals of the research program.

The team is very excited about the opportunity that this collaborative arrangement brings. "This research is a world-first effort and will change the way grazing is practiced," says Kaur. "The results could help address a range of emerging issues such as climate change and ruminant health."

With this multi-disciplinary team work, climate-smart clovers/crops could become a science fact.

Future of soil carbon storage is below 10cm

Dr Jennifer Carson
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The future of carbon storage in Western Australian soils is in deeper soil layers, according to researchers at IOA and UWA's School of Earth and Environment working in collaboration with DAFWA and grower groups.

A key finding of the Soil Carbon Research Program was that in many agricultural regions in the Southwest, the 0-10cm layer of soil is storing as much organic carbon as it can under the current climate and management practices.

This is because many farmers use annual legumes in rotation with cereals and employ minimal tillage. These management practices cause most inputs of organic carbon to be in the surface soil layers. Over time, organic carbon accumulates there rather than deeper in the soil.

However, there may be other ways to increase the amount of organic carbon stored in soil. Soils between 10 and 30 cm below the surface were found to have the potential to store twice as much carbon as they are currently storing. The next step in this research will be to identify practical ways for farmers to increase the carbon stored in these deeper soil layers.

One approach may be to improve soil properties in the 10-30cm layer that constrain plant growth, such as subsoil acidity, compaction or waterlogging. This would allow greater plant root growth in these soil layers and therefore greater inputs of organic carbon. Another option may be inverting soil, using mould-board ploughing and spading, to bring the 10-30cm layer to the surface where most inputs of organic carbon occur.

The Soil Carbon Research Program also demonstrated that it is most realistic to expect small annual changes in organic carbon in soil over long periods of time. Some examples of the annual increases in soil organic carbon found by the researchers are 0.1 t/C ha for stubble retention compared to burning in a low rainfall environment, 0.2 t C/ha for clay addition to sandy soil and 0.4 t C/ha under perennial pasture (> 500 mm rainfall).

The program was funded by the Australian Government's Climate Change Research Program and GRDC.

Further information:

- Fact sheet "Organic Carbon Storage in Western Australian Soils" on www.soilsquality.org.au;
- Professor Daniel Murphy Email: daniel.murphy@uwa.edu.au

Andrew Wheret touching base with a local farmer while collecting soil samples.

Victory over black spot key to success for field pea production

Ms Ully Fritsch
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Field peas have often been referred to as a poor man's meat: high in protein and allergen-free, they are little powerhouses of nutrition and were a staple in the Middle Ages. They can be grown on different soil types and environments. One major obstacle to field pea production is black spot fungus, which is endemic to most field pea growing areas in Australia.

Research Professor Tanveer Khan from the UWA Institute of Agriculture (IOA) has just led a review of international methods trialled to combat the disease which appeared in the recent issue of the journal *Field Crops Research* (www.sciencedirect.com/science/article/pii/S0378429013001202).

"Black spot is a difficult disease to control, primarily due to the absence of robust host plant resistance, and a lack of cost-effective fungicides," he says. "The fungus survives on pea stubble, releasing spores into the air with the first winter rains, so in Australia the best management option is to delay sowing until after the first winter rains, when there are fewer spores left to threaten the plant." He is quick to point out, however, that this method comes at a heavy yield loss (up to 25%) due to the shortened growing season.

The review found that traditional breeding methods to develop black spot resistant cultivars have produced only partially-resistant varieties and it is yet to be determined whether they perform better with a single application of fungicide and/or when sowing is not delayed.

Traditional breeding methods have been complemented by research to develop molecular marker technology, and although there have not been any major breakthroughs as yet, Khan believes it is well worth investing in novel molecular and genomic technologies and to explore whether it is possible to transfer resistance from another species into field pea: "Our findings suggest that it is unlikely that conventional breeding, even if aided by marker-assisted selection, will succeed in developing very high levels of black spot resistance. As field pea remains the most produced grain legume in Europe and the second-most in the world (after common bean), it will become a very large crop in Australia – if we are able to control black spot."

Black spot infection at an early stage.

Section of a field pea crop at an advanced stage of black spot infection.

Qin Yu examining seeds.

AHRI research expands understanding of metabolic herbicide resistance

Ms Brogan Micallef
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Researchers at the GRDC-funded and UWA-based Australian Herbicide Resistance Initiative (AHRI) have started a battle to crack the mechanisms responsible for causing herbicide resistance.

Most herbicides kill weeds by inhibiting an enzyme that is essential to plant growth. The herbicide binds to the enzyme (target site), rendering it unviable and causing the plant to die. Weeds have now developed resistance to many common herbicides, which can be grouped into two main mechanisms.

AHRI's Research Associate Professor Qin Yu explains: "Herbicide resistance can evolve through either target site resistance, where the herbicide can no longer bind to the target site due to a mutation in the plant; or it can evolve through metabolic resistance (non-target site resistance), where the herbicide does not reach the target site because the plant metabolises, or eats, the herbicide before it can get there."

One type of metabolic resistance involves P450 enzymes, which 'eat' some herbicides, including those not yet marketed.

"There are literally hundreds of P450 enzymes," says Yu, "and there has been a growing interest world-wide to better understand their role in the evolution of metabolic resistance."

In 2005, then AHRI researcher Dr Paul Neve, now Assistant Professor at the University of Warwick, UK, showed that ryegrass could quickly develop resistance after being sprayed with low doses of Hoegrass® (diclofop-methyl). Yu and her team have now confirmed that this was due to enhanced metabolic resistance, likely involving P450 enzymes. The same results were confirmed for a population of wild oats by AHRI former PhD student Dr Ahmad-Hamdani.

"Wheat can tolerate herbicides such as diclofop-methyl due to rapid metabolism. We now know that weeds such as annual ryegrass and wild oats also have the ability to evolve this mechanism of resistance," says Yu.

"It is likely that several P450s and other enzymes may be involved in causing this resistance, but currently there is no simple way of measuring a particular P450 enzyme. Now we are collaborating with scientists at Bayer CropScience Frankfurt to provide more precise answers to these questions."

For further information, visit the AHRI website, www.ahri.uwa.edu.au

UWA scientists pave the way for strawberry renaissance in WA: A story on root rot in strawberry

Typical root rotting symptoms of strawberry plants caused by binucleate *Rhizoctonia* infection in a WA commercial strawberry field.

Ms Ully Fritsch
Email: ully.fritsch@uwa.edu.au

Strawberry root rot may soon become a thing of the past in WA, thanks to groundbreaking research by scientists from UWA's School of Plant Biology and IOA.

The team, comprised of PhD student Ms Xiangling Fang, Winthrop Professor Martin Barbetti and Associate Professor Patrick Finnegan, has identified new genetic groups of soil-borne fungus *Rhizoctonia,* a pathogen that causes serious root rot of strawberries and poses a major threat to commercial production worldwide.

They collected about 100 isolates of *Rhizoctonia* from diseased roots of strawberry plants from commercial strawberry fields across the Perth region. They then characterized the isolates on the basis of their capacity to produce disease and their genetic diversity and two thirds of them were found to cause significant disease on strawberries.

Molecular sequence analysis highlighted that at least six different genetic groups occur across the pathogenic isolates of this fungus, and it also highlighted the existence of new genetic groups not previously reported in Australia or anywhere else in the world. The research was recently published in the journal PLoS One (www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0055877).

Barbetti said they were surprised to discover genetic groups of the disease which had not previously been found anywhere in the world, highlighting the peculiar challenges for Australian strawberry producers.

"Now that we know about these new genetic groups it is possible to develop new strawberry cultivars that have an improved resistance to the fungus and are better suited to WA conditions," Barbetti said. "This will reduce the need for anti-fungal chemicals, reduce input costs and generate improved outcomes in terms of human health and the environment."

The research was funded by the Australian Research Council, the Department of Agriculture and Food WA (DAFWA), the Strawberry Growers Association of Western Australia, the China Scholarship Council and UWA.

Smartphone app to optimize pesticide spray applications

Dr Anke van Eekelen
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A new app may soon help farmers to quantify spray coverages when pesticides are applied to field crops. Low and inconsistent coverages are believed to increase the risk of pest populations developing resistance, so it is very important that pesticides are applied with the highest possible canopy penetration and overall crop coverage. Researchers at IOA and DAFWA are developing a smart phone app in collaboration with the Mingenew-Irwin group to optimize spray applications of pesticides.

Associate Professor Christian Nansen from the IOA and School of Animal Biology at UWA, and Mr Rob Emery from DAFWA, received funding from the Council of Grain Grower Organisations (COGGO) to address the issue of low and inconsistent spray coverages. Nansen's position at UWA is supported by GRDC.

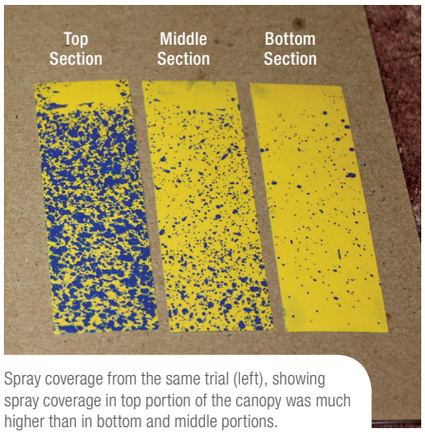
The smart phone app will enable growers to quantify spray coverages after pesticides have been applied. In other words, the app can be used as part of quality control. "If the app indicates you should be achieving 32 per cent coverage and you got 18 per cent on your yellow card, there is something wrong. So you can go back and see if there is a problem with the nozzles or the pressure – it's a form of quality control," says Nansen.

The app will also allow growers to plan how spray coverages can be optimized by spraying with different nozzles and taking weather conditions into account. "A grower may want to spray a paddock of canola for control of a disease, weed or insect pest – he/she can then plug forecasted weather conditions into the app and also select a type of spray nozzle and a target spray volume (liters per ha). With these inputs, the app will calculate a predicted spray coverage, so the grower can select the settings that are practically feasible and give the best spray coverage. This smart phone app will therefore help growers to obtain better spray coverages when applying pesticides, and that will lead to: better pest control and lower risk of pests developing resistance," says Nansen.

The phone app is linked to an internet server, and users of the app will have their own personal website to store all spray application data and therefore be able to easily compare results obtained across different paddocks, for different spray settings and under a range of weather conditions.

The new app will be presented at field days in August and will be free to download.

Three vertically placed spray cards placed in the top, the middle and the bottom section in a crop canopy.



Spray coverage from the same trial (left), showing spray coverage in top portion of the canopy was much higher than in bottom and middle portions.

IOA Director joins CGIAR Grain Legumes Independent Advisory Committee

Kadambot Siddique inspecting grass pea drought experiments at UWA.

Dr Anke van Eekelen
Email: anke.vaneekelen@uwa.edu.au

Recently the Director General of International Crops Research Institute for the Semi-arid Tropics (ICRISAT), Dr William Dar, invited Hackett Professor Kadambot Siddique, Director IOA, to join as an independent advisor on the Consultative Group for International Agricultural Research (CGIAR) Program on Grain Legumes.

The overall aim of CGIAR as a global agricultural research partnership is to bring together a diverse range of research institutions and partner organizations to think in an innovative way about a food secure future.

Siddique will join the advisory panel of one of the 15 Research Programs (CRP) of the influential CGIAR, and will take part in defining a research and developmental strategy to improve grain legume production in developing countries.

Within his CGIAR Centre on Grain Legumes (jointly with ICRISAT, ICARDA, IITA and CIAT), Siddique will contribute to the generation and dissemination of specific knowledge, technologies, and policies for agricultural development through the strategic planning of a research program in the area of sustainable nutrition for the poorest people in the world.

The appointment to become a member of the CGIAR Research Program on Grain Legumes Independent Advisory Committee will allow Siddique to join a world-wide network of agricultural scientists, providing access to the most comprehensive collections of genetic resources and agricultural research infrastructure in the world, among the many other benefits of this prestigious position.

New staff

Dr Yichao Rui

Email: yichao.rui@uwa.edu.au

Dr Yichao Rui has been appointed as a Research Associate within the School of Earth and Environment and IOA.

He holds a joint PhD from the Chinese Academy of Sciences and Griffith University and has been investigating carbon, nitrogen and phosphorus cycling in various ecosystems for the past six years. He currently focuses on the DAFF National Carbon Farming Program and will be investigating the influence of carbon on critical soil functions and long-term viability of sequestering carbon in agricultural systems.

Dr Jeremy Bougoure

Email: jeremy.bougoure@uwa.edu.au

Dr Jeremy Bougoure has been appointed as a Research Assistant Professor within the School of Earth and Environment and IOA.

He completed his PhD at UWA and acquired postdoc experience at the University of British Columbia and the Lawrence Livermore National Laboratory, Canada. He currently works on the CRC Polymers Project, specifically investigating the microscale interactions of soil biota with certain additives to ameliorate reduced water holding capacity and non-wettability.

Research and industry recognition

NAME	AWARD
W/Prof Kadambot Siddique	Ag Institute Australia Fellow Award for his outstanding contribution to the agricultural profession.
Prof Kingsley Dixon	Linnean Medal awarded by The Linnean Society of London for his contribution to research on native plants and the regeneration of ecosystems.
E/Prof Alan Robson	Officer of the Order of Australia (General Division), for distinguished service to tertiary education through governance and administrative roles, to the advancement of scientific and medical research, and to the community.
Asst/Prof Marit Kragt	Essay Prize of the Agricultural Economics Society for the essay 'Comparing stated and inferred attribute attendance models in environmental choice experiments'.
Ms Xixi Li	Best young scientist oral presentation award at the 8th International Meeting on Anaerobic Microbiology for her presentation 'Eremophila glabra reduces methane production and methanogen populations in Rusitec'.

New staff continued

Dr Falko Mathes

Email: falko.mathes@uwa.edu.au

Dr Falko Mathes has been appointed as a Research Associate within the School of Earth and Environment and IOA.

He holds a PhD from Cardiff University, UK, where he studied marine sedimentary microorganisms under stress conditions such as starvation and elevated temperatures. Dr Mathes currently works in the CRC for Polymers which aims to optimize the growing conditions for plants in the soil. He will investigate how soil microbial communities respond to these polymers using next-generation sequencing and other molecular biological techniques.

Dr Jiayin Pang

Email: jiayin.pang@uwa.edu.au

Dr Jiayin Pang has been jointly appointed as a Research Associate within the School of Plant Biology and IOA, to work on the Australia-India Strategic Research Fund (AISRF) Grand Challenge Project "Genomics approaches to drought, salinity and heat stress tolerance in Chickpea".

Dr Pang completed her PhD at the University of Tasmania, and over the past three years, she has worked on improving nitrogen use efficiency in wheat at CSIRO Plant Industry in Perth and, prior to this, on phosphorus use efficiency in perennial legumes at UWA's School of Plant Biology and IOA. She will be involved in the screening of chickpea genotypes tolerant to salinity and drought stress in the WA grain belt and identifying the key physiological traits encoding the salinity and drought tolerance in chickpea.

Ms Aanandini Ganesalingam

Email: aanandini.ganesalingam@uwa.edu.au

Ms Aanandini Ganesalingam has been appointed as a Research Associate at IOA.

She completed a Bachelor of Science in Agriculture (Hons) and a Bachelor of Economics at UWA in 2009. She then went on to undertake a PhD, researching how the efficiency of plant breeding programs can be improved using information on correlated traits, ancestry and environments and her thesis is currently being examined.

Ms Aanandini is currently working on the Statistics for the Australian Grains Industry (SAGI) Project funded by GRDC.

Alumni

Hani Saoub (centre) with alfalfa farmers south of Amman, during a visit to provide technical advice.

Dr Hani Mahmoud Saoub

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Dr Hani Mahmoud Saoub graduated at UWA in 1994, with a PhD in the area of agronomy/forage crops after completing a Masters degree in Plant Production and a Bachelor of Science (Soil and Irrigation) degree in his home country of Jordan.

Following his return to Jordan, Saoub commenced teaching at the University of Jordan, in agronomy and forage crops. Since then, he has supervised postgraduate research students, served on examination committees, authored numerous scientific papers, participated in national and international research and conferences, and contributed to consultancies at home and overseas.

He is currently the Vice Dean of the Faculty of Agriculture at the University of Jordan and Professor of Field and Forage Crops/Agronomy, at the Department of Horticulture and Crop Science, where he served as the Head of Department from 2009 to 2012.

"During my studies at UWA, I gained significant experience in the field of crop science as well as in my social life. I would like to thank my supervisor Professor Walter Stern, along with all the other dedicated staff at UWA, who helped me achieve my dreams. I look forward to visit UWA in the near future, and to further strengthen links between UWA and the University of Jordan."

New postgraduate students

STUDENT NAME	TOPIC	SCHOOL	SUPERVISOR(S)	FUNDING BODY
Ms Myrtille Lacoste	Understanding the strategies of outstanding performers in dryland farming enterprises	Plant Biology and IOA	Dr Ken Flower W/Prof Stephen Powles	GRDC
Ms Louise Blackmore	Achieving joint carbon and biodiversity outcomes in Australia: social and economic dimensions	Agricultural and Resource Economics and IOA	Assoc/Prof Steven Schilizzi Asst/Prof Marit Kragt Asst/Prof Abbie Rogers	APA National Environmental Research Program – Environmental Decisions (NERP-ED) Top-Up Scholarship
Mr Benjamin Congdon	Unravelling the complex factors that drive pea seed-borne mosaic virus epidemics in peas and development of an innovative predictive model	Plant Biology and IOA	Prof Roger Jones Assoc/Prof Michael Renton	ARC Linkage Project
Ms Suzanne Orchard	Fine endophytic mycorrhizal fungi in pasture plant species	Plant Biology and IOA	Assoc/Prof Megan Ryan Asst/Prof Rachel Standish	APA Henry Schapper Postgraduate Scholarship MLA Scholarship
Ms Asha Gunawardena	Optimal use of policy instruments to control waste water pollution in Kelani River in Sri Lanka	Agricultural and Resource Economics and IOA	Prof Ben White Asst/Prof Ram Pandit Assoc/Prof Hailu Atakelty	Endeavour Postgraduate Award

Current and upcoming visitors to IOA

VISITOR	VISITORS' ORGANISATION, COUNTRY	HOST DETAILS/PURPOSE	DATES
Assoc/Prof Xiaoling Wang	Visiting scholar, Agricultural College of Guizhou University, China	Prof Dan Murphy	Jun 2013 – May 2014
Ms Rebecca Bitter	ZIM-Plant Technology GmbH, Hennigsdorf Germany	Dr Helen Bramley	Aug 2 – 26, 2013
Prof Ylva Hilbur	Deputy Director General for Research, International Institute of Tropical Agriculture, Nigeria	W/Prof Kadambot Siddique	Aug 12, 2013
	Delegation from Huazhong Agricultural University, China	W/Prof Kadambot Siddique	Sep 9 – 10, 2013
Dr B Ashok	Vice Chancellor, Kerala Veterinary & Animal Sciences University, India	W/Prof Kadambot Siddique	Sep 30 – Oct 3, 2013
Ms Solveigh Hennig	Visiting researcher, Kiel University, Germany	Assoc/Prof Stephen Schilizzi	Sep 18 – Nov 2, 2013

Agriculture online and on air

TOPIC	ACCESS FROM
Methane emissions (Prof Phil Vercoe)	http://www.abc.net.au/news/2013-06-09/wa-researchers-measure-gas-from-cattle/4742908
The 'wine dress' (Fermented Fashion) (Mr Gary Cass)	http://on.aol.com/show/hardwired/episode/517800206
Soil quality (radio interview) (Prof Daniel Murphy)	http://www.abc.net.au/news/2013-05-29/soil-quality-website/4721268

New research projects (since April 2013)

TITLE	FUNDING PERIOD	FUNDING BODY	SUPERVISORS
Managing soil-borne root disease in sub-clover pastures	2013 – 2017	MLA	W/Prof Martin Barbetti
Fertility crisis: harnessing the genomic tension behind pollen fertility in sorghum	2013 – 2014	University of Queensland ex ARC Linkage	Assoc/Prof David Jordan Prof Ian Small Dr Emma Mace Prof Robert Klein Dr Diana Dugas
Grazing into the future: building soil health and carbon with pasture management	2012 – 2015	DAFF Carbon Farming Futures Action on the Ground	W/Prof Lyn Abbott, Dr Natasha Pauli
Harnessing soil biological functions to improve grapevine management for a sustainable industry	2013 – 2014	Victoria DPI ex Grape and Wine Research and Development Corporation	Prof Daniel Murphy, Dr Linda Maccarone, Assoc/Prof Deirdre Gleeson
Experientia docet: learning and remembering in plants	2013 – 2015	ECR Fellowship Support Program	Dr Monica Gagliano
Safeguarding honeybees: Understanding host-parasite interactions at the level of proteins	2013 – 2016	Australian Research Council Better Bees of Western Australia Swiss Federal Institute of Technology	Prof Boris Baer Prof Richard Oliver Mr John Davies Prof Paul Schmid-Hempel
Genomic basis of clonal variation in Cabernet Sauvignon wine grapes	2013 – 2016	Australian Research Council DAFWA Western Australian Vine Improvement Association The Yalumba Wine Company Australian Wine Research Institute	Asst Prof Michael Considine Prof James Whelan Prof Ryan Lister Mr Glynn Ward Dr Kristen Brodison Mr James Campbell-Clause Mr Daniel Newson Dr Paul Chambers
The Fourth Australia-China Wheat Genetics and Breeding Workshop	2013	GRDC	Assoc/Prof Guijun Yan
Achieving least cost greenhouse gas abatement – opportunities in Australian grains farms	2013 – 2016	DAFF: Filling the Research Gap	Peter Thornburn (CSIRO) Asst/Prof Marit Kragt
Modifications and update of Dam Design Software Tool – Damcat5	2013	WA Department for Water	Asst/Prof Chun Woo Baek Mr David Stanton Dr Neil Coles
Identifying the biochemical and molecular bases of 2,4D herbicide resistance in the economically important weed *Raphanus raphanistrum* (wild radish)	2013 – 2015	Nufarm	W/Prof Stephen Powles

UWA IOA Publications 2013 (April-July)

Refereed journals

Ahmad R, Hussain S, Farooq M, Rehman A and Jabbar A (2013). Improving the performance of direct seeded system of rice intensification by seed priming. *International Journal of Agriculture and Biology* **15**: 791–794.

Anisa, Chen S, Turner NC and Cowling WA (2013). Genetic variation for heat tolerance during the reproductive phase in Brassica rapa. *Journal of Agronomy and Crop Science* ISSN 0931-2250: 1-12.

Asseng S and Pannell DJ (2013). Adaptating dryland agriculture to climate change: farming implications and research and development needs in Western Australia. *Climatic Change* **118 (2)**: 167-181.

Barton, L, Gleeson DB, Maccarone, LD, Zúñiga, LP, Murphy DV (2013). Is liming soil a strategy for mitigating nitrous oxide emissions from semi-arid soils? *Soil Biology and Biochemistry.* dx.doi.org/10.1016/j.soilbio.2013.02.014.

Barton L, Murphy DV and Butterbach-Bahl K (2013). Influence of crop rotation and liming on greenhouse gas emissions from a semi-arid soil. *Agriculture, Ecosystems and Environment* **167**: 23-32.

Bose J, Babourina O, Shabala S and Rengel Z (2013). Low-pH and aluminium resistance in Arabidopsis correlates with high cytosolic magnesium content and increased magnesium uptake by plant roots. *Plant and Cell Physiology* **54 (7)**: 1093-104.

Chen S, Dunbabin VM, Postma JA, Siddique KHM and Rengel Z (2013). Modelling root plasticity and response of narrow-leafed lupin to heterogeneous phosphorus supply. *Plant and Soil,* DOI 10.1007/s11104-013-1741-x.

Christensen S, Nemchenko A, Borrego E, Murray I, Sobhy I, Bosak L, DeBlasio S, Erb M, Robert C, Vaughn K, Herrfurth C, Tumlinson J, Feussner I, Jackson D, Turlings T, Engelberth J, Nansen C, Meeley R, Kolomiets M (2013). The maize lipoxygenase, ZmLOX10, mediates green leaf volatile, jasmonate, and herbivore-induced plant volatile production for defense against insect attack. *The Plant Journal* **74**: 59-73.

Doole GJ and Pannell DJ (2013). A process for the development and application of simulation models in applied economics. *Australian Journal of Agricultural and Resource Economics* **57 (1)**: 79-103.

Doole GJ, Romera AJ and Pannell DJ (2013). A mathematical optimisation model of a New Zealand dairy farm. *Journal of Dairy Science* **74**: 59-73.

Dunbabin VM, Postma JA, Schnepf A, Pagès L, Javaux M, Wu L, Leitner D, Chen YL, Rengel Z and Diggle AJ (2013). Modelling root-soil interactions using three-dimensional models of root growth, architecture and function. *Plant and Soil* DOI 10.1007/s11104-013-1769-y.

Coutts BA, Kehoe MA and Jones RAC (2013). *Zucchini yellow mosaic virus*: contact transmission, stability on surfaces and inactivation with disinfectants. *Plant Disease* **97**:765-771.

Fang X, Jost R, Finnegan PM and Barbetti MJ (2013). Comparative proteome analysis of the strawberry-*Fusarium oxysporum* f. sp. *fragariae* pathosystem reveals early activation of defense responses as a crucial determinant of host resistance. *Proteome Research* **12**: 1772-1788.

Fang X-W, Turner NC, Xu D-H, Jin Y, He J and Li F-M (2013). Limits to the height growth of *Caragana korshinskii* resprouts. *Tree Physiology* **33**: 275-284.

Farrell M, Hill PW, Farrar J, DeLuca TH, Roberts P, Kielland K, Dahlgren R, Murphy DV, Hobbs PJ, Bardgett RD and Jones DL (2013). Oligopeptides represent a preferred source of organic N uptake: a global phenomenon? *Ecosystems* **16**: 133-145.

Foster K, Ryan MH, Real D, Ramankutty and Lambers H (2013). Seasonal and diurnal variation in the stomatal conductance and paraheliotropism of tedera *(Bituminaria bituminosa var. albomarginata*) in the field. *Functional Plant Biology* **40 (7)**: 719-729.

Gaines TA, Wright AA, Molin WT, Lorentz L, Riggings CW, Tranel PJ, Beffa R, Westra P and Powles SB (2013). Identification of genetic elements associated with *EPSPS* gene amplification. *PLOS ONE* June 2013 | Volume 8 | Issue 6 | e65819.

Garg H, Li H, Sivasithamparam K and Barbetti MJ (2013). Differentially expressed proteins and associated histological and disease progression changes in cotyledon tissue of a resistant and susceptible genotype of *Brassica napus* infected with *Sclerotinia sclerotiorum*. *PLOS ONE* 8 (6) e65205 plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0065205

Guo YM, Chen S, Nelson MN, Cowling W and Turner NC (2013). Delayed water loss and temperature rise in floral buds compared with leaves of *Brassica rapa* subjected to a transient water stress during reproductive development. *Functional Plant Biology* dx.doi.org/10.1071/FP12335.

Han H, Yu H, Cawthray GR and Powles SB (2013). Enhanced herbicide metabolism induced by 2,4-D in herbicide susceptible *Lolium rigidum* provides protection against diclofop-methyl. *Pest Management Science* DOI: 10.1002/ps.3552.

Hancock, GR, Murphy, DV and Li Y (2013). Soil properties and environmental tracers: A DEM based assessment in an Australian Mediterranean environment. *Geomorphology* **183**: 45-57.

Inostroza-Blancheteau C, Aquea F, Loyola R, Slovin J, Josway S, Rengel Z, Reyes-Diaz M, Alberdi M and Arce-Johnson P (2013). Molecular characterization of a calmodulin gene, VcCaM1, that is differentially expressed under aluminium stress in highbush blueberry. *Plant Biology* DOI:10.1111/j.1438-8677.2012.00722.x.

Jayakannan M, Bose J, Babourina O, Rengel Z and Shabala S (2013). Salicylic acid improves salinity tolerance in Arabidopsis by restoring membrane potential and preventing salt-induced K+ loss via a GORK channel. *Journal of Experimental Botany* **64 (8)**: 2255-68.

Kamphuis LG, Zulak K, Gao L-L, Anderson J and Singh KB (2013). Plant–aphid interactions with a focus on legumes. *Functional Plant Biology* dx.doi.org/10.1071/FP13090.

Kaur J, Sirari A, Kumar D, Singh Sandhu J, Singh S, Kapoor K, Singh I, Gowda CLL, Pande S, Kaur P, Sharma M, Imtiaz M and Siddique KHM (2013). Combining Ascochyta blight and Botrytis grey mould resistance in chickpea through interspecific hybridization *Phytopathologia Mediterranea* **52 (1)**: 157-165.

Khan TN, Timmerman-Vaughan GM, Rubiales D, Warkentin TD, Siddique KHM, Erskine W and Barbetti MJ (2013). *Didymella pinodes* and its management in field pea: Challenges and opportunities. *Field Crops Research* **148:** 61-77.

Kragt ME (2013). The effects of changing cost vectors on choices and scale heterogeneity. *Environmental and Resource Economics* **54 (2)**: 201-221.

Kragt ME, Robson BJ and Macleod CJA (2013). Modellers' roles in structuring integrative research projects. *Environmental Modelling and Software* **39 (1)**: 322-330.

Li M, Yu Q, Han H, Vila-Aiub MM and Powles SB (2013). ALS herbicide resistance mutations in *Raphanus raphanistrum*: evaluation of pleiotropic effects on vegetative growth and ALS activity. *Pest Management Science* **69 (6)**: 689-95.

Liang B, Yang X, Murphy DV, He X, Zhou J (2013). Fate of 15N-labeled fertilizer in soils under dryland agriculture after 19 years of different fertilizations. *Biology and Fertility of Soils* DOI: 10.1007/s00374-013-0789-3.

Liu CA, Li FR, Zhou LM, Feng QI, Pan CC, Wang LJ, Chen JL, Li XG, Jia Y, Siddique KHM and Li FM (2013). Effect of water management with plastic film in a semi-arid agricultural system on available soil carbon fractions. *European Journal of Soil Biology* **57**: 9-12.

Liu Y, Zang Y, Long X, Shao H, Liu Z, Zhang Z and Rengel Z (2013). High nitrate removal capacity of an aerobic denitrifier *Klebsiella oxytoca* DF-1 isolated from aquaculture ponds in coastal mudflats. *African Journal of Microbiology Research* **7**: 1527-1534.

Long X, Ni N, Wang L, Wang X, Wang J, Zhang Z, Rengel Z, Liu Z and Shao H (2013). Phytoremediation of cadmium-contaminated soil by two Jerusalem artichoke *(Helianthus tuberosus* L.) genotypes. *Clean Soil Air Water* **41**: 202-209.

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Nansen C, Sidumo AJ, Martini X, Stefanova K and Roberts JD (2013). Reflectance-based assessment of spider mite ''bio-response'' to maize leaves and plant potassium content in different irrigation regimess. *Computers and Electronics in Agriculture* **97**: 21-26.

Raman H, Raman R, Kilian A, Detering F, Long Y, Edwards D, Parkin IAP, Sharpe AG , Nelson MN, Larkan N, Zou J, Meng J, Aslam NM, Batley J, Cowling WA and Lydiate D (2013). A consensus map of rapeseed (*Brassica napus* L.) based on diversity array technology markers: applications in genetic dissection of qualitative and quantitative traits. *BMC Genomics* **14**: 277.

Schroeder JI, Delhaize E, Frommer WB, Guerinot ML, Harrison MJ, Herrera-Estrella L, Tomoaki H, Kochian LV, Munns R, Naoko K, Nishizawa NK, Tsay Y-F and Sanders D (2013). Using membrane transporters to improve crops for sustainable food production. *Nature* **497**: 60-66.

St Jack D, Hesterman DC and Guzzomi AL (2013).Precision metering of *Santalum spicatum* (Australian Sandalwood) seeds. *Biosystems Engineering* **115**: 171-183.

Savage D, Barbetti MJ, MacLeod W, Salam MU and Renton M (2013). Temporal patterns of ascospore release in *Leptosphaeria maculans* vary depending on geographic region and time of observation. *Microial Ecology* **65**: 584-592.

Skurray J, Pandit R and Pannell DJ (2013). Institutional impediments to groundwater trading: the case of the Gnangara groundwater system of Western Australia. *Journal of Environmental Planning and Management* **56 (7)**: 1046-1072.

Suriyagoda LDB , Real D, Renton M, Lambers H and Ryan MH. Establishment, survival, and herbage production of novel, summer-active perennial pasture legumes in the low-rainfall cropping zone of Western Australia as affected by plant density and cutting frequency. *Crop and Pasture Science* **64 (1)**:71-85.

Tang K, Shen J, Zhang F and Rengel Z (2013). Interactive effects of phosphorus deficiency and exogenous auxin on root morphological and physiological traits in white lupin *(Lupins albus* L.). *Science China Life Sciences* **56**: 313-323.

Thamo T, Pannell DJ and Kingwell RS (2013). Measurement of greenhouse gas emissions from agriculture: economic implications for policy and agricultural producers. *Australian Journal of Agricultural and Resource Economics* **57 (2)**: 234-252.

Turner NC (2013). Climate change, population and food security. *World Agriculture* **4 (1)**: 25-28.

Zhang Z, Rengel Z, Liaghati T, Torre A and Meney K (2013). Influence of plant species and submerged zone with carbon addition on the removal of metals by stormwater biofilters. *Desalination and Water Treatmen*t DOI: 10.1080/19443994.2013.803709.

Zhang ZH, Solaiman ZM, Meney K, Murphy DV and Rengel Z (2013). Biochars immobilize soil cadmium, but do not improve growth of emergent wetland species *Juncus subsecundus* in cadmium-contaminated soil. *Journal of Soils and Sediments* **13**: 140-151.

Zimmermann U, Bitter R, Schüttler A, Ehrenberger W, Rüger S, Bramley H, Siddique KHM, Arend M and Bader MKF (2013). Advanced plant-based, internet-sensor technology gives new insights into hydraulic plant functioning. *Acta Horticulturae* **991**: 313-320.

Book Chapters

Bramley H, Turner NC and Siddique KHM (2013) Water use efficiency: governed by an interactive network of physical, biochemical and hydraulic processes. In: Kole C (Ed.) *Genomics and Breeding for Climate-Resilient Crops*, Springer-Verlag, Berlin, pp 225-268.

Farooq M, Wahid A and Siddique KHM (2013). Physiology of grain development in cereals. In: Pessarakli M (Ed.) *Handbook of Plant and Crop Physiology*, Third Edition, Taylor and Francis Group, LLC 6000 Broken Sound Parkway, Suite 300, Boca Raton, FL 33487 USA.

Stefanova K (2013). Statistical model for multi-environment trials: accounting for variety by environment interaction. In: Muggeo VMR et al (Eds.) *Proceedings of the 28th International Workshop on Statistical Modelling,* Instituto Polygrafico Europeo, Palermo, Italy. ISBN 978-88-96251-49-2, pp 783-788.

UPCOMING MEETINGS AND EVENTS

International Event
InterDrought-IV Conference
2-6 Sep 2013
Perth, Australia
www.interdrought4.com

4th Australia-China Wheat Genetics and Breeding Workshop
5 Sep 2013
UWA, Perth, Australia
Email: guijun.yan@uwa.edu.au

National event
ComBio 2013 Conference
29 Sept – 3 Oct 2013
Perth, Australia
www.asbmb.org.au/combio2013/

Local Event
UWA Future Farm Field Day
6 Sep 2013
167 Page Rd, West Pingelly, Western Australia
www.ioa.uwa.edu.au/future-farm-2050

HELP US REDUCE WASTE

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