

Theo Murphy
High Flyers
Think Tank **09**

**Agricultural Productivity
and Climate Change**

Oaks on Collins, Melbourne
22–23 October 2009

program





Foreword

Each year since 2002, the Australian Academy of Science has held a High Flyers Think Tank to bring together around 70 or so of Australia's brightest young minds to consider a topic of national importance.

The 2009 Think Tank on *Agricultural Productivity and Climate Change* will examine contemporary challenges facing Australian agriculture in a global context. Agriculture plays a significant role in Australia's economy, despite the variability that characterises our environment, and the world's food security depends in part on this nation maintaining and enhancing sustainable agricultural productivity. However, as global climate change affects key variables such as temperature, precipitation and the frequency of extreme weather events, uncertainty and unpredictability in productivity will increase. This Think Tank represents an important opportunity for some of Australia's leading early- and mid-career researchers to reach new understandings and identify new approaches that can be applied to respond to this critical issue

As in 2008, the 2009 Think Tank is generously supported by funds from the Theo Murphy (Australia) Fund provided by the UK Royal Society. The Academy is pleased to have this funding available to enable some of Australia's outstanding young scientists to engage in fresh thinking in an area of great importance to the future of the country and to establish networks that will sustain their careers into the future.

This year I am delighted that we are also able to include an international keynote speaker Professor Peter Gregory, Director and Chief Executive of the Scottish Crop Research Institute, on the program through the generous sponsorship of the Selby Scientific Foundation which provided an additional 2009 Selby Fellow to celebrate the 50th anniversary of the establishment of the fellowships.

A handwritten signature in black ink, reading "Kurt Lambeck". The signature is written in a cursive style with a long horizontal line extending from the end of the name.

Kurt Lambeck

AO, PresAA, FRS

Day 1 Thursday 22 October 2009

9.00am **Registration; coffee and tea**

Session 1: Introductory session

Chair: Dr Sue Meek FAICD FTSE

Chief Executive, Australian Academy of Science

9.30am **Welcome**

Professor Kurt Lambeck AO FAA FRS

President, Australian Academy of Science

9.40am **Opening address**

The Hon Joe Helper MP

Victorian Minister for Agriculture

10.00am **Keynote address**

Selby Fellow, Professor Peter Gregory

Director and Chief Executive, Scottish Crop Research Institute

10.30am **Morning tea**

11.00am **Productivity growth**

Promoting productivity in the agriculture and food sector

value chain: Issues for R&D investment

Dr Kate Grenot FAICD

Chair, Rural Research and Development Council

11.30am **Resilience**

Resilience and agriculture: The human dimensions

Professor Lesley Head

School of Earth and Environmental Sciences, University of Wollongong

12.00pm **Sustainability**

Managing our agricultural landscapes sustainably

Dr Michael Robinson

Executive Director, Land and Water Australia

12.30pm **Global climate**

The six-sided problem of climate, carbon, nitrogen, water, food and people

Dr Michael Raupach FAA FTSE

CSIRO Marine and Atmospheric Research

Global Carbon Project

1.00pm **Lunch**

Session 2: Focus breakout groups

2.00pm

Group A – Policy

Chair: Dr Kate Grenot

Rapporteur: Dr Robyn Bartel

Group B – Knowledge management

Chair: Prof Lesley Head

Rapporteur: Dr Georgina Kelley

Group C – Technologies

Chair: Dr Michael Robinson

Rapporteur: Dr Sandra Eady

Group D – Planning

Chair: Dr Michael Raupach

Rapporteur: Dr Caroline Ummenhofer

3.30pm

Afternoon tea

Rapporteurs prepare reports

4.00pm

Return to focus breakout groups

[Finalise ideas and develop conclusions]

5.30pm

Close of session

6.30pm

Drinks

7.00pm

Dinner for all participants and Victorian Fellows of the Australian Academy of Science

Day 2 Friday 23 October 2009

9.00am **Tea and coffee**

Session 3: Reporting back and final discussion

Chair: Professor Kurt Lambeck

Reports from groups

Each rapporteur has 15 minutes, plus 5 minutes discussion

9.10am **Group A – Policy**
Rapporteur: Dr Robyn Bartel

9.30am **Group B – Knowledge management**
Rapporteur: Dr Georgina Kelley

9.50am **Group C – Technologies**
Rapporteur: Dr Sandra Eady

4.20pm **Group D – Planning**
Rapporteur: Dr Caroline Ummenhofer

10.30am **Morning tea**

10.50am **General discussion**
Chair: Professor Kurt Lambeck

11.20am **Summing up**
Chair: Professor Kurt Lambeck
Speakers: Dr Michael Raupach, Professor Peter Gregory

11.45am **Lunch**

12.30pm **Open lecture by Selby Fellow, Professor Peter Gregory**
Food security in a changing climate
Introduction: Professor Kurt Lambeck

1.45pm **Close of public session**

2.00pm **Closed session: Outcomes and recommendations**
Chairs, speakers, rapporteurs, Academy secretariat

4.00pm **End of Think Tank program**

Introduction

Purpose of Think Tanks

The purpose of the Academy's High Flyers Think Tank series is to bring together early- and mid-career researchers from a broad range of relevant disciplines to engage in thinking about novel applications of existing science (including social science) and technology to issues of national significance, and to identify gaps in knowledge that should be addressed. The High Flyers Think Tanks are a unique opportunity for career development and network creation amongst the nation's next generation of research leaders and their institutions.

Think Tanks are one of the premier events of the Academy's calendar and this year's, the eighth that the Academy has held since 2002, is generously supported by the Theo Murphy (Australia) Fund, which is administered by the UK Royal Society, and the Selby Scientific Foundation.

Previous Think Tanks

Previous Think Tanks have culminated in reports to government that have been timely, well received and instrumental in influencing policy development. Past Think Tank topics (found at www.science.org.au/events/thinktanks.htm) have been:

2002 – Australia's national research priorities

2003 – Safeguarding the nation

2004 – Emerging diseases – ready and waiting?

2005 – Biotechnology and the future of Australian agriculture

2006 – Innovative technical solutions for water management in Australia

2007 – Extreme natural hazards in Australia

2008 – Preventative health: Science and technology in the prevention and early detection of disease

2009 Think Tank: *Agricultural Productivity and Climate Change*

There is wide agreement among the international scientific community that the global climate has not only been changing, but will continue to change, and that human induced increases in concentrations of greenhouse gases will continue to drive climatic changes across the globe. These changes are likely to be associated with a range of biophysical, environmental, social and economic impacts across many sectors throughout the world. Agriculture is one such sector and vital not only for Australia but for the world.

Rather than focussing on climate change science itself, this year's topic will use the insight and expertise of participants to identify and examine potential adaptation and mitigation strategies, in the context of other environmental, social and development pressures. Participants are well placed to tackle this problem, having been chosen from a diverse range of disciplines to include geographers, economists, and other social scientists, soil ecologists, environmental scientists, agronomists, aquaculture specialists, geneticists, modellers and systems analysts, engineers, entomologists and many others.

Think Tanks are primarily about applying science and technology to problems, identifying gaps in knowledge and proposing novel solutions. They also involve thinking strategically with respect to Australia's role and place within such fields of research.

The proceedings begin with presentations by the theme speakers who then lead interdisciplinary breakout discussion groups. We have found it helpful to structure these discussions using an outcomes matrix (see below) which comprises four outcome areas and four ‘tool boxes’ or strategic response areas that are underpinned by research to address challenges in the outcome areas. Each tool box will be examined for potential applications in each of the four outcome areas.

Outcomes matrix for the topic Agricultural Productivity and Climate Change

Tools to address challenges and achieve outcomes Outcomes	Breakout Group 1 Policy Examples <ul style="list-style-type: none"> • governance • emissions trading • policy obstacles • complementary measures • adaptive capacity • regulation 	Breakout Group 2 Knowledge management Examples <ul style="list-style-type: none"> • cross disciplinary participation • ICT • science value chain • change/adoption & adaptation 	Breakout Group 3 Technologies Examples <ul style="list-style-type: none"> • emissions/mitigation management • crop/stock/farm/social technologies • spatial science technologies • abatement technologies 	Breakout Group 4 Planning Examples <ul style="list-style-type: none"> • meteorology/climatology forecasting • market projections • risk management • cost benefit analysis • preparedness
A. Productivity growth Innovation; efficiency, business (farm to corporation); competitive advantage Speaker A – Kate Grenot				
B. Resilience Flexibility; adaptability; population; regional; community, family; individual; preparedness Speaker B – Lesley Head				
C. Sustainability Natural resources & landscape management, water; energy; carbon; materials; soils; river health; erosion; catchment management; biodiversity Speaker C – Michael Robinson				
D. Global climate Avoid dangerous climate change; extreme events; global implications Speaker D – Michael Raupach				

Outputs

The two days’ proceedings will be taped, transcribed and made available on the Academy’s website. This includes all presentations (verbal and PowerPoint slides), breakout group reports, general discussions, and the final report. The final report will summarise the major outcomes and provide contextual information. Generally, major issues and gaps in knowledge will be identified, and recommendations or a ‘way forward’ provided. These outcomes form vital and current information that can be used to underpin policy development and research prioritisation processes. The final report will also be available in printed form.

Instructions for breakout groups

The chair of each session has been requested to give a keynote address of 20 minutes (followed by 10 minutes of questions) that provides a perspective on an outcome area from their field of expertise. The speakers will then chair a breakout group comprising participants with expertise in one or more tools assisted by a rapporteur.

As each breakout group is asked to consider all the outcomes areas, it is not possible for the chair, the rapporteur or any of the participants to have expertise in all outcomes areas. While this will place all participants beyond their direct area of expertise and outside their comfort zone at times, this should not preclude participation and some very interesting discussions are anticipated.

Each group is made up of 16 researchers from across Australia with a variety of research interests, and includes scientists, technologists and social scientists. The breakout sessions will provide an opportunity for detailed discussion of important scientific directions and developments and exploration of their possible applications. Participants are encouraged to think broadly on how to use their toolbox of policy, knowledge management, technologies or planning to address challenges and achieve the following outcomes:

- productivity growth
- resilience
- sustainability
- global climate.

To assist the discussion, there are five generic questions for all participants to respond to:

1. What tools do you have to offer?
2. How can your tools address challenges in the outcome areas?
3. How do your tools interact with the other tools?
4. What are the impediments to effectively employing your tools?
5. What are risks of unintended or undesired consequences of the use of the suite of tools under consideration and how do you manage those risks?

The role of each rapporteur will be to capture the outcomes of their group's discussions. It is also useful to record any further related issues that are considered by the group to be relevant or any problems, gaps, strengths, past lessons and priorities. With the chair's guidance, each rapporteur will prepare a PowerPoint presentation for the combined meeting on Day 2. The presentation will be for 15 minutes, with 5 minutes for discussion.

Please note that rapporteurs will join Think Tank chairs, speakers and Academy secretariat for the closed session at 2.00pm on the second day to discuss the outcomes and recommendations and to progress a final report on the Think Tank.

A list of the participants by breakout group allocation is shown below.

Breakout groups

Breakout Group 1:	Name	Discipline/background
Policy	Douglas Bardsley	Geography/environmental studies
Chair	Robyn Bartel	Regulator/social science
Kate Grenot	Sarah Bruce	Productivity/sustainable farming systems
Rapporteur	Timothy Cavagnaro	Soil ecology/plant biology
Robyn Bartel	John Davis	PhD studies on coastal/marine stewardship
	Nadine Marshall	Social scientist
	Andrew Moore	Decision making tools for grassland agriculture
	Saffron O'Neill	Social scientist
	Dean Revell	Interactions between livestock/land management
	Katinka Ruthrof	Climate change/forest woodland health

Breakout Group 1: Policy (continued)	Name	Discipline/background	
	Sandra Savocchia	Plant pathology/viticulture	
	Ronald Smernik	Soil organic matter	
	Jonathan Sobels	Social scientist	
	Alison Southwell	Agricultural systems & extension	
	Ernesto Valenzuela	Quantitative economics/modelling	
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Breakout Group 2: Knowledge management	Name	Discipline/background	
	Jennifer Atchison	Environmental science & wheat cultural geography	
	Chair Lesley Head	Michael Bange	Cropping systems/agronomic management
	Rapporteur Georgina Kelley	Steven Crimp	Climate variability & cropping systems
		Raphael Didham	Drivers of global change on biodiversity
		Elske van de Fliert	Social scientist/communication specialist
		David Francis	Sustainable aquaculture practices
		Sigfredo Fuentes	Instrumentation/monitor crop performance
		Chris Guppy	Soil fertility/sustainable nutrient management
		Munir Hanjra	Development economist
		Tamara Jackson	Water & energy trade-offs in irrigated agriculture
		Georgina Kelley	Role of vegetation in natural resource management
		Leo Lymburner	Land cover remote sensing
		Sarah Park	Assessment of climate change impact
		Libby Pinkard	Climate change & role of forests
		Susanne Schmidt	Develop management & plant selection tools
Christine Storer		Community responses to climate change	
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Breakout Group 3: Technologies	Name	Discipline/background	
	Alisha Anderson	Biosensor technology for assessing food & grain quality/new pest control strategies	
	Chair Michael Robinson	Craig Birchall	Agronomy of cropping systems
	Rapporteur Sandra Eady	Clayton Butterly	Soil ecology/sustainable use of soils
		Scott Chapman	Productivity & field crop breeding
		Saul Cunningham	Entomology
		Sandra Eady	Livestock geneticist/GHG abatement
		Neil Huth	Development of plant & soil models
		Andrew Jacobs	Plant functional genomics
		Mark P McHenry	Integrating agricultural production systems with climate change mitigation
		Eric Peterson	Engineer/desalination systems
James Petrie		Omega-3 Land Plants project	

Breakout Group 3: Technologies (continued)	Name	Discipline/background
	Randall Robinson	Ecology & environmental management
	Douglas Rowell	GHG emissions from agricultural systems
	Saman Seneweera	Plant responses to climate change
	Hayden Sprigg	Wheat production adaptation
	Todor Vasiljevic	Sustainable utilisation aqua/ agricultural resources
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Breakout Group 4: Planning	Name	Discipline/background
Chair Michael Raupach	Karl Behrendt	Bioeconomic modelling & systems analysis
Rapporteur Caroline Ummenhofer	Yann Chemin	Remote sensing & agricultural modelling
	Mike Furlong	Insect ecology/sustainability of agricultural productivity
	Ros Gleadow	Mitigating effects climate change on productivity
	Christopher Grof	Advancing biotechnological tools
	Matthew Hipsey	Hydrological interactions with biogeochemistry
	Evelyn Krull	Carbon & nutrient cycling
	Rick Llewellyn	Socio-economic tools for sustainable farming
	Darryn McEvoy	Geographer/climate risk assessment
	Simon Reid	Control infectious/zoonoses of stock
	Michael Renton	Modelling agro-ecological systems
	Carol Richards	Sociology of agriculture and natural resource management
	Chris Stokes	Systems ecology
	Kirrilly Thompson	Applied cultural anthropology/risk & safety
	Caroline Ummenhofer	Climate variability & change
	Michelle Watt	Genetic improvement of wheat
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Free-roaming group	Name	
	Kurt Lambeck – President, AAS	
	Sue Meek – Chief Executive, AAS	
	Michael Agostino – Secretariat, AAS	
	Fiona Leves – Secretariat, AAS	

Speakers and Chairs



Professor Kurt Lambeck AO FAA FRS

President, Australian Academy of Science

Kurt is a distinguished Professor of Geophysics at the Australian National University and President of the Australian Academy of Science. His research interests cover the disciplines of geophysics, geodesy, geology, climate and environmental science, and space science. He has been at the Australian National University since 1977, including ten years as Director of the Research School of Earth Sciences. Kurt was elected to the Australian Academy of Science in 1984 and to the Royal Society in 1994. He is a foreign member of the Royal Netherlands Academy of Arts and Sciences (1993), Norwegian Academy of Science and Letters (1994), Academia Europaea (1999), the Académie des Sciences, Institut de France (2005), and the US National Academy of Sciences (2009).

Kurt's recent work has focused on aspects of sea level change and the history of the Earth's ice sheets during past glacial cycles, including field and laboratory work and numerical modelling. Past research areas have included determination of the Earth's gravity field from satellite tracking data, examination of tidal deformations and the rotational motion of the Earth, the evolution of the Earth-Moon orbital system, and lithospheric and crustal deformation processes.



The Hon Joe Helper MP

Victorian Minister for Agriculture

Joe Helper was born in Germany in 1959, and moved with his family to Melbourne in 1971. He started his working life as a motor mechanic and also worked for a number of state and federal MPs and the Victorian Public Service. In 1996 Joe returned to his trade when he became the proprietor of Newstead Motors. Having run his own business, Joe understands the important role played by small business in communities throughout Victoria. In October 1999 Joe was elected to the Victorian Parliament as the Member for Ripon. Building on his interest in regional issues, in 2002 Joe was appointed Parliamentary Secretary for Regional Development. Following the state election in 2006, Joe was appointed Minister for Agriculture and appointed Minister for Small Business in 2007.



Dr Sue Meek FAICD FTSE

Chief Executive, Australian Academy of Science

Sue has 25 years experience working in a variety of capacities at the interface of industry, academia and government. Her particular interests are in promoting awareness and understanding of science and technology, and the formulation of policies and programs to stimulate the conduct and application of research and development. Sue held the position as Australia's inaugural Gene Technology Regulator from December 2001. This statutory appointment was established to administer the national regulatory system for the development and use of genetically modified organisms. Immediately prior to that, she was Executive Director, Science and Technology in the Western Australian Department of Commerce and Trade. In this role she was responsible for the development and implementation of state policies on science and technology and public sector intellectual property management, and the administration of grant programs to support innovation and the development of research infrastructure.

Sue has a PhD in marine biology; Masters in oceanography; and an honours degree in microbiology. She is a Fellow of the Australian Institute of Company Directors and of the Australian Academy of Technological Sciences and Engineering. Sue is an inaugural member of the Centre for Environmental Risk Assessment Advisory Council.



Professor Peter Gregory

Director and Chief Executive, Scottish Crop Research Institute

Peter was appointed Director of the Scottish Crop Research Institute at Invergowrie, Dundee Scotland, in 2005. In the decade before that, Peter was leader of a research group at the University of Reading investigating root-soil interactions and the introduction of integrated nutrient management into systems of crop production. The main areas of research were in characterising the physical and chemical environment of the rhizosphere, investigating the appropriate use of fertilisers and manures in Nepal, modelling water and nutrient uptake in agroforestry systems in Kenya, and characterising the movement of the weevil *Sitona lepidus* to roots of white clover.

Peter's current research includes: non-invasive imaging of roots and root-soil interactions with x-ray computed tomography; improving resource use efficiency at the root-soil interface; effects of dwarfing and semi-dwarfing genes on root growth of temperate cereals; root growth in response to soil drying; and global environmental change and food security. His research is conducted at two scales: the rhizosphere, a very active region for physical and chemical changes in soils, where his research is concerned with the quantification of the processes leading to these changes; and the global scale, with interests in global environmental changes and food security. This research is undertaken as part of the activities of Global Environmental Change and Food Systems and with staff at the University of Dundee.

Selby Lecture: Food security in a changing climate

Until recently, there has been a widespread working assumption in many countries that problems of food production have been solved, and that food security is largely a matter of distribution and access to be achieved principally by open markets. The events of 2008 challenged these assumptions. Today, for the first time in almost a quarter of a century, food is back on the political agenda. There are many reasons for this including the increased demand for food, especially meat, in the rapidly growing economies of Asia, the demand for land to grow biofuels, drought and severe flooding in diverse countries, diseases associated with the food consumed in rich countries, and the increasing awareness that changing climate may profoundly affect the zones of major food production globally.

In this lecture, Peter will demonstrate how global environmental and social changes are affecting food systems and suggest some of the likely technological and policy responses that will result.



Dr Kate Grenot FAICD

Chair, Rural Research and Development Council

Kate has a PhD in science, a Masters degree in science and technology policy, and is a Fellow of the Australian Institute of Company Directors. She is currently Chair of the Australian Government's Rural Research and Development Council, established in 2009 by the Minister for Agriculture, Fisheries and Forestry. She is a former Director of the Grape and Wine Research and Development Corporation (Chair, Audit Committee), the Industry Research and Development Board (Biological Committee), the Royal Botanic Gardens and Domain Trust (Chair, Finance Audit and Risk Management Committee) and Wirra Wirra Vineyards. Kate is a former Associate Director of Coopers and Lybrand (Government Services) and has a research background in plant physiology (ion channels, signal transduction), science policy and industry development (Sydney, Harvard, Sussex).

Promoting productivity in the agriculture and food sector value chain: Issues for R&D investment

The Australian Government's first Scientific Advisory Council was established in 1916. 'Industrial science' was required to enable the development of primary and secondary industries that would generate national wealth for a growing population under changing conditions based on the resources that were available at the time. 'Agriculture, fisheries and forestry' (AFF) were at the forefront of nation-building consciousness.

One hundred years later, the range and complexity of matters requiring R&D attention has proliferated and the relative contribution of AFF to the national economy has diminished. Farm sector-driven R&D now comprises only two to three per cent of Australia's total R&D expenditure and, while proportional to the sector's contribution to GDP, arguably no longer reflects national need. Meanwhile, the inactivity risk associated with rural R&D is rapidly expanding, as the portfolio is now capable of providing food outcomes, land management outcomes, energy outcomes, health outcomes, security outcomes, social cohesion, and climate change solutions.

In 2009, the Australian Government established a Rural Research and Development Council to guide more effective multi-sector cooperation and prioritisation of investment in R&D for Australia's rural industries, including through the development of a National Australian Strategic Rural R&D Investment Plan.

Kate will, from the Council's perspective, explore the relationship between rural R&D investment and productivity growth before considering the role of 'elite science' in optimising Australia's response to the agriculture and climate change challenge.



Professor Lesley Head FAAH

School of Earth and Environmental Sciences, University of Wollongong

Lesley is a Professor of Geography at the University of Wollongong, with a research specialisation in Australian human-environment interactions over both prehistoric and contemporary timescales. At the University of Wollongong, Lesley is head of the School of Earth and Environmental Sciences, and Director of the Australian Centre for Cultural Research. She will shortly take up an Australian Laureate Fellowship to expand her work on the cultural dimensions of sustainability – agriculture and food production will be one aspect of this. Lesley is a Fellow of the Australian Academy of Humanities and current President of the Institute of Australian Geographers.

Resilience and agriculture: The human dimensions

Australian farmers have always had to deal with significant climatic variability, and presumably have many of the necessary skills and capacities to cope with the uncertainties of climate change. Or do they? In this presentation Lesley will focus on the set of risks that farmers manage, at scales varying from the global to the household. She will consider where 'climate change' might sit in that constellation of risks, and how it might take expression in everyday lives and week-to-week decision-making. Examples come from current research into Australian wheat farming. The failed harvests of 2006–07 and 2007–08, unusual within living memory, provided a research opportunity to examine the social dimensions of adaptation to more frequent droughts, as are projected for parts of the wheat belt under climate change. The findings will be connected back to their broader context in order to provoke discussion by Think Tank participant groups.



Dr Michael Robinson

Executive Director, Land and Water Australia

Michael has been the Executive Director of Land and Water Australia since 2006. He has worked in research, communication, business development and policy, in Australia and New Zealand, and is passionate about good quality research informing sustainable and productive landscape management. He currently leads the National Climate Change Research Strategy for Primary Industries and is a member of the Primary Industries Standing Committee Research and Development Subcommittee.

Prior to joining Land and Water Australia Michael was Chief Executive Officer with the Cooperative Research Centre for Greenhouse Accounting. He has also worked with CSIRO in business development, management and communication roles, focusing on environmentally sustainable forestry and landscape scale management issues. Trained as a scientist, his PhD examined the sustainability of using wastes to fertilise plantation forests, and was completed in 1999 with CSIRO and the University of Melbourne.

Managing our agricultural landscapes sustainably

Our agricultural landscapes must continue to feed and clothe the world's growing population in an increasingly variable and changing climate. This production is based on our natural resource base (our soil, water, flora and fauna ecosystems) which must be maintained, even enhanced, from the paddock to the catchment scale. The challenge for our innovation system is to ensure that our natural resource base is sustained by understanding and proactively managing the complex systems in an integrated and holistic fashion.



Dr Michael Raupach FAA FTSE

CSIRO Marine and Atmospheric Research

Michael is a research scientist in CSIRO Marine and Atmospheric Research. He is a Fellow of the Australian Academy of Science and a Fellow of the Australian Academy of Technological Sciences and Engineering. From 2000 to 2008 he was an inaugural co-chair of the Global Carbon Project of the Earth System Science Partnership. He contributed to the IPCC 2007 Fourth Assessment. His research encompasses global and continental carbon and water cycles, carbon-climate-human interactions, land-air interactions, fluid mechanics and particle transport. He is a frequent contributor to the policy and public debate on climate change.

The six-sided problem of climate, carbon, nitrogen, water, food and people

Climate change is now widely perceived as the most pressing environmental problem facing humankind at global scale. This perception is accurate as far as it goes, but conceals a series of connections between climate change and other 'finite-Earth' challenges arising from the collision between the growing influence of humanity on the Earth system and the fact that our home planet has a finite capacity to provide inputs and metabolise outputs from human activities. This talk will examine and broadly quantify some finite-Earth challenges stemming from connections between climate change, trends in major Earth-system cycles (carbon, water and nitrogen) and trends in human societies (population, aspiration and requirements for food and water). Mike will focus on the challenges of (1) capping future cumulative CO₂ emissions at about 500 petagrams (similar to cumulative emissions since 1750) in order to avoid warming greater than two degrees; and (2) supplying energy, food and water for human populations which are increasing in both numbers and levels of affluence. Resolving the tension between these challenges and other finite-Earth challenges requires forward thinking on generational time scales, a skill at which humanity has not often excelled.

Rapporteurs



Dr Robyn Bartel

**School of Behavioural Cognitive and Social Sciences,
University of New England**

Robyn has science and law degrees, a Master of Higher Education from the Australian National University and a PhD in environmental regulation from the University of Melbourne (2003). She is an active contributor to public inquiries and a founding member of the Australian Environmental Law Enforcement and Regulators Network. Her empirical research evaluating the implementation of environmental law and models of regulatory efficacy in agriculture has made a significant contribution. Robyn's research encompasses regulation and regulatory agencies, as well as the social, institutional and natural landscape in which all are situated. Her most recent research has been aimed at understanding farmer attitudes, behaviours, practices and responses to environmental regulation.

Agriculture must meet some key challenges in order to maintain productivity and food security in the face of forecast climate and attendant environmental change. These will need to be met in a policy context which is extending the reach of formal regulation ever further into on-farm environmental management, through legal instrumentation and in concert with market-based initiatives. Robyn's research background in this area would provide a valuable contribution to the Think Tank.



Dr Sandra Eady

Principal Research Scientist, CSIRO Livestock Industries

Sandra is a geneticist with expertise in developing national breeding programs and implementing them on-farm. Her current activities, in CSIRO's Sustainable Agriculture Flagship, expand her expertise in farming systems to the area of life cycle assessment, determining the carbon and water footprint for agricultural products, on-farm greenhouse gas (GHG) emissions profiles and opportunities for biosequestration of carbon. Sandra is also a member of the Technical Options Development Group, established by the Department of Climate Change, to explore policy options for emissions abatement in agriculture.

Australia has the opportunity to offset a significant proportion of our GHG emissions by storing carbon in the landscape, an opportunity that has both benefits and trade-offs, issues that need to be given consideration in the design of policy instruments. Sandra's work focuses on the impact that GHG abatement will have on agriculture, both through the direct effect of an emissions trading scheme on farm profitability and the imperative for land-use change that a strong market for carbon will trigger. She can contribute a broad systems perspective of how varying GHG abatement options will intersect to influence rural land-use, and can bring an individual enterprise perspective on carbon intensity of agricultural production and possible on-farm options for abatement.



Dr Georgina Kelley

**Vegetation Scientist, Bureau of Rural Sciences (BRS)
Department of Agriculture, Fisheries and Forestry**

Georgina has extensive expertise in the role of vegetation in natural resource management, and her current research interest is in how vegetation contributes to the delivery of sustainable ecosystem services in a production landscape. This research interest is being explored through a range of projects including the Australian Vegetation Assessment, status of revegetation in Australia and assessment of resource access under the Environment Protection and Biodiversity Conservation Act. She is also contributing to the development of tools to assist decision makers and land managers to address the challenges of achieving sustainable production under changing and uncertain conditions. Prior to joining BRS, Georgina spent 10 years as a researcher and lecturer in plant ecophysiology at Charles Darwin University and the University of Western Sydney.

Georgina has an extensive knowledge value and importance of vegetation in agricultural landscapes and natural resource management issues, and a strong understanding of the broad range of issues facing land managers, including climate change. As a research scientist with wide experience in Australia's production landscapes, she will bring to the workshop a background in research, a strong understanding of the needs of land managers, a collaborative and creative approach to problem solving as well as sound experience in the importance of data and information to support evidence-based decision making.



Dr Caroline Ummenhofer

Climate Change Research Centre, University of New South Wales

Caroline received a joint honours degree in marine biology and physical oceanography from the University of Wales in Bangor, UK, and in 2008 completed a PhD in climate science at the University of New South Wales (UNSW). She was an ARC Postdoctoral Fellow at the ARC Centre of Excellence for Mathematics and Statistics of Complex Systems at UNSW and now holds a UNSW Vice-Chancellor Postdoctoral Fellowship, as well as a CSIRO Visiting Fellowship with the Centre for Marine and Atmospheric Research in Hobart. Her research focuses on climate variability and change across the Indian Ocean and Australasian region and links to large-scale ocean and atmospheric modes of variability.

Caroline's work exploits connections between Indian Ocean temperatures and regional rainfall variability, how this advances seasonal rainfall forecasting and ultimately improves agricultural management. Interdisciplinary research involving agricultural modelling to assess effects of climate on major wheat-cropping areas in south eastern Australia provided vital insights into key challenges faced in agriculture. This was further compounded during recent engagement with stakeholders in the agricultural sector. Combining collaborative research with real-world applications is an inspiring and rewarding experience for Caroline.

Early-mid career participants

Dr Alisha Anderson

CSIRO Food Futures Flagship and Division of Entomology

Alisha completed her PhD in the Climatic Adaptation group at the Centre for Environmental Stress and Adaptation Research, Monash University in 2005. Her thesis topic was the fitness trade-offs involved in genetic adaptation to environmental stresses, and used *Drosophila melanogaster* as the model organism. Alisha moved into the field of insect olfaction in 2005 when she was awarded a highly competitive CSIRO 'Emerging Science' Postdoctoral Fellowship. She currently leads CSIRO's Cybernose® Project in the Food Futures Flagship which is developing biosensor technology for measuring quality in the agricultural and food and beverage industries. Recently, CSIRO awarded her a highly prestigious travel and development grant Julius Career Award, which recognises a small number of the organisation's top young scientists.

Alisha's scientific background working on climatic adaptation and insect olfaction coupled with her current position leading the Cybernose® Project, gives her the necessary foundations to contribute to ideas to enhance Australia's agricultural productivity under a changing climate. Her contribution will be especially relevant to the area of developing new technology for assessing food and grain quality and also in the area of new pest control strategies to reduce the loss of crops and the cost of pest control in changing climates.

Dr Jennifer Atchison

Lecturer, School of Earth and Environmental Sciences, University of Wollongong

Jennifer is an environmental scientist whose recent postdoctoral research examined the cultural geography of wheat in Australia, focusing on the transformation and mobility of wheat as a food and industrial substance, and on the experience of climate change in the everyday lives of wheat farmers in NSW. Her research interests include the geography and sustainability of food production, and the ethno and archaeobotany of Australian plants. Her PhD work examined the late Holocene and post contact vegetation history of the Keep River region in the Northern Territory.

Jennifer's most recent research on wheat contributes to a larger research project on the cultural ecology of Australian plants, whose aims are to provide more integrative and cross-cutting thinking on the complex issues of food provision and environmental sustainability. In this research, a wide range of geographical methods including historical analysis, ethnography, and empirical and spatial techniques are utilised. Jennifer can contribute to the Think Tank by providing perspectives on the social and cultural dimensions of change, adaptation and risk management amongst Australian wheat farmers.

Dr Michael Bange

Principal Research Scientist, CSIRO Plant Industry

Michael investigates approaches to improve yield, quality and resource use efficiency of cropping systems. He has significant hands-on and leadership experience in cropping systems, agronomic management, plant and crop physiology, simulation modelling, systems, and post-harvest research. Achievements include: development of technologies to manage climate variability through delivery of decision support tools; integrating research approaches to improve resilience of existing cropping systems; and investigating opportunities for cropping in new regions (eg northern Australia). Michael's abilities undertaking, leading and applying research have been recognised with significant leadership roles within CSIRO, the Australian Cotton CRC, a Fulbright scholarship, adjunct associate professorship with the University of Sydney, and numerous industry awards. He has attracted \$9 million competitive funding, and published extensively in industry publications and journals.

Michael has a keen interest in ensuring sustainability and as a researcher passionately seeks to develop science and understanding of the impacts of climate on crop productivity and resource use to develop resilient systems. He currently leads a team of researchers that are specifically investigating mitigation and adaptation strategies in cropping systems. His understanding of issues in rural Australia, impacts of climate variability and strategies for coping, along with a genuine interest in the workshop theme means that he would contribute significantly.

Dr Douglas Bardsley

Senior Lecturer, Geographical and Environmental Studies, School of Social Sciences, University of Adelaide

Douglas trained as an agricultural scientist, a social geographer and an educator. His research interests over the last 15 years have focused on agro-ecological risk management, links between conservation and development, and education for sustainable development. His research has been undertaken both in Australia and the UK, and has involved fieldwork in different contexts in Australia, Thailand, Nepal, Egypt, Turkey, Switzerland and the European Union. He has completed a review of vulnerabilities of natural resources in the Adelaide and Mt Lofty Ranges to projected climate change, and has worked with regional stakeholders to help develop adaptation policy. More recently he has been working on a review of the implications of climate change for migration in the Asia-Pacific region.

Douglas has been researching issues of risk management for agriculture for the last 15 years. More recently his work has focused on climate change adaptation, particularly the roles of vulnerability analyses, participatory approaches to develop adaptation policy, and futuring science to guide decision-making. This work has been published widely and would be able to draw from this professional background to discuss the future of climate change adaptation for agriculture in Australia in the context of environmental and socio-economic change.

Dr Karl Behrendt

Lecturer in agribusiness, School of Agricultural and Wine Science, Charles Sturt University (CSU)

Karl started as a lecturer in agribusiness with CSU in 2008 and this year became a Research Centre Fellow with the EH Graham Centre. His PhD (2008) is based on research on the bioeconomic modelling of pasture resource management and development. Prior to joining CSU, Karl operated an agricultural research and consulting firm, which serviced rural clients throughout the central west of NSW. He has also worked as a rural financial counsellor, farm management advisory officer at Tocal Agricultural College, and as an economist with NSW Agriculture. His current research interests include the bioeconomic modelling and analysis of agricultural and ecological systems, agribusiness planning and risk management, and the development and use of decision support tools in agriculture.

Karl believes he would bring to the workshop both industry experience and a developing background in agricultural and ecosystems research. Working as a private consultant to primary producers over the past 12 years has provided him with an insight into how producers may adapt to climate adversity while concurrently aiming to enhance their productivity. His more recent research has enhanced his knowledge about the broader societal issues of food security, regional stability and wealth.

Mr Craig Birchall

Lecturer, Sustainable Grains Production, Agronomy and Soil Science, University of New England (UNE)

Craig's career has included extensive experience in the grain industry of eastern Australia, including:

- seven years with NSW Department of Primary Industries involving cropping systems research and extension in northern and southern farming systems;
- five years as a commercial agronomist involved in on-farm decision making and grower education; and
- six years with UNE running a graduate certificate course for agronomists and others in grains industry, focusing on sustainable grain production and the application of best management practice and the latest research results.

Research interests include the agronomy of cropping systems, particularly crop nutrition and physiology and water management.

Craig has broad experience in addressing issues in applied farming systems agronomy in the northern and southern grain growing regions of eastern Australia. In addition, he has experience in agricultural extension, and working with farmers and their agronomists. Craig also has familiarity with a significant proportion of the agricultural research that is being conducted in the northern region.

Dr Sarah Bruce

Senior Scientist, Climate Change and Water Sciences Program, Bureau of Rural Sciences, Department of Agriculture, Fisheries and Forestry

Sarah's research background is in the improvement of productivity and sustainability of farming systems. Projects included factors limiting canola productivity in conservation farming systems; factors influencing the productivity and sustainability of intercropping crops with perennial pastures; and the application of Agricultural Production Systems Simulator (APSIM), a

farming simulation model, to a novel intercropping system. Currently she is working at the science–policy interface in the development and management of techniques and approaches to improve the adaptability of farming systems to climate change and variability. She represented the Department of Agriculture, Fisheries and Forestry in the USA in 2008 to build on linkages with the USA where drought and climate variability are part of the operational environment, and to facilitate an exchange of information on drought preparedness, climate change and variability.

Sarah can contribute her understanding and experience in communicating the uncertainties of the science of climate variability and climate change to government policy-makers and farmers. A challenge to maintain and increase agricultural productivity under climate change partly lies in the effective communication of the uncertainty of science to policy-makers and industry; and the recognition that science is only one of the factors used by decision-makers.

Dr Clayton Butterly

Postdoctoral Fellow, Department of Agricultural Sciences, La Trobe University

Clayton joined the Department of Agricultural Sciences at La Trobe University in 2008 after completing his PhD in soil science at the University of Adelaide. Prior to this he was involved in research projects of the CRC for Plant-Based Management of Dryland Salinity at the University of Adelaide, and the Department of Agriculture and Food in Western Australia. Clayton's current research examines the role of organic matter in soil pH change in agro-ecosystems. He is particularly interested in the sustainable use of soil and land systems, and is an active member of the Australian Society of Soil Science.

Clayton has research experience in soil biology and nutrient cycling as well as the major issues facing productivity and sustainability of land such as drought, dryland salinity and acidification. In addition, he has worked in a number of states (WA, SA and VIC) and comes from a farming background which brings a unique understanding of Australian agricultural production systems and fundamental scientific processes. He is interested in understanding the wider issues of climate change and would like to participate in identifying future challenges to agricultural productivity and strategies pending a change in climate.

Dr Timothy Cavagnaro

Lecturer, School of Biological Sciences and Australian Centre for Biodiversity, Monash University

Timothy's teaching and research interests are in soil ecology and plant biology. In particular, his research focuses on climate change impacts on agricultural and natural ecosystems. Members of his research group investigate the role of soil microbial communities in the cycling of nutrients, and the consequences for plant growth, food security and soil health. His research seeks to inform debate on how best to adapt to and/or mitigate climate change, especially in agricultural ecosystems. Prior to moving to Monash in late 2006, Timothy was a research scientist at the University of California Davis, and before that, a postdoctoral researcher at the University of Adelaide, where he also completed a PhD.

Timothy's research focuses primarily on climate change impacts on agricultural ecosystems. He has several research projects investigating the impacts of climate change on agriculture, including soil carbon sequestration and crop responses to climate change. Timothy actively contributes to both national and international climate change policy development. He is lead author of an invited, peer reviewed report identifying climate change impacts on California agriculture for Governor Schwarzenegger, helping shape legislation (Assembly Bill 32), and has co-authored a report to the Australian Government *Garnaut Climate Change Review*.

Dr Scott Chapman

CSIRO Plant Industry

Scott has a PhD (1990) from the University of Queensland, and was a Research Fellow at there from 1994 to 1996. He has been with CSIRO since 1996 and currently Principal Research Scientist (Crop Adaptation). Scott has broad training in the areas of crop and plant physiology, crop simulation modelling, plant breeding, quantitative genetics and crop–climate interactions. Most of his research has been directly engaging with field crop breeding programs (public and private) to improve the yield of crops, particularly under conditions of drought and heat stress. His research has been directly supported by more than \$7 million from international and national grant and research agencies.

All of Scott's research has been in the area of improving productivity of crops in the face of abiotic stresses like drought and heat. He works with international and national research agencies in a range of crops (wheat, sorghum, maize, rice, sugarcane and sunflower) and sees climate change as requiring urgent application of this research and the increased

training of new scientists in Australia and elsewhere. He currently leads a new project of Climate Ready that aims to identify new traits and options to improve productivity of wheat and sorghum under increased heat and increased CO₂ conditions.

Dr Yann Chemin

Senior Spatial Hydrologist, International Centre of Water for Food Security, Charles Sturt University

Yann gained a degree in international agricultural development from the ISTOM/International Agri Development Institute (France, 1995), and Masters in land and water resources management from Cranfield University (UK, 1996) and DTSc on remote sensing and GIS applications from the Asian Institute of Technology (Thailand, 2003). In 2003 there followed a short course on supercomputer programming (Kasetsart University, Thailand), which became a fundamental tool for his doctorate on evolutionary algorithms applied to remote sensing and agricultural modelling. Scientific interests include evapotranspiration mapping by remote sensing, supercomputing for agricultural science, evolutionary algorithms and data assimilation.

Adaptation to climate change requires serious effort on the agricultural and geographical sciences to meet variations of soil moisture and air humidity within the next human population generation so as to cope with the seed responses and farming practices optimisation along the years of changing conditions. While this is a multi-disciplinary effort, a meeting point for decision-making is often in the shape of a well informed map, so as to provide arguments for discussion and argumentation on path identification.

Mr Steven Crimp

CSIRO Sustainable Ecosystems

With a background in climatology and environmental science, Steven is evaluating options to increase resilience of Australian cropping systems to climate variability and change. He joined CSIRO in 2006 as a climate applications scientist tasked with assisting farmers and farmer groups to improve on-farm climate risk management. During this time he has led a range of research projects working with farmers to enhance current management practices to cope with the challenges of climate variability and change. Current research activities centre on evaluating options to increase resilience of Australian cropping systems to climate variability and change, and include:

- examination of the vulnerability of Australian cropping and grazing industries to climate change;
- identification of feasible adaptation options for case study farms across both summer and winter cropping areas of Australia; and
- quantitative assessment of the benefits of using seasonal climate forecasts and climate trend information to enhance on-farm management.

Steven can contribute to the workshop in a number of ways, including developing and implementing practical concepts of vulnerability, resilience and adaptive capacity from the farm to policy scales, in order to increase the societal value of climate impacts science.

Dr Saul Cunningham

CSIRO Entomology

Saul's research for his honours degree (1989) and PhD (1995) focused on animal pollination in undisturbed forests, first in south-eastern Australia and then in the Costa Rican rainforest. Since returning to Australia his focus has shifted to the mixed landscapes of agriculture and other vegetation that dominate so much of the Earth's surface. In this context he has been interested in understanding how we can manage landscapes for good conservation outcomes while still supporting productive agriculture. These questions have been his pre-occupation for the past 10 years he has been with CSIRO. In particular, his research has examined the way that good land management can support the public benefit of biodiversity conservation and, at the same time, provide private benefits to farmers through ecosystem services like crop pollination and pest control by natural enemies.

Saul would be keen to contribute either through discussion in a workshop environment, or by presenting some of his relevant research (especially around biodiversity and ecosystem services to agriculture). Climate change has not been the focus of his published research, but he is involved in a nascent project examining the expected impacts of a shift towards more cropping in Australia's high rainfall zone.

Mr John Davis

Lecturer, School of Sustainability, Murdoch University

John is currently completing his PhD in policy research on coastal and marine stewardship. Since obtaining his degree in agriculture he has had extensive experience in rural community development in south Asia and Africa, Landcare in Western Australia and taught in a university in Indonesia. His experience has given him an appreciation of the need for holistic approaches to challenges faced by communities. He is the social scientist in a multidisciplinary research project funded by ACIAR which is investigating the potential for pasture legumes to contribute to livelihoods of people on communal lands in the Eastern Cape of South Africa, and how to do this with active stakeholder engagement.

John brings to the Think Tank interdisciplinary perspectives, gained by immersion in a variety of cultures: perspectives which are important for 'wicked problems' like mitigation of greenhouse gas emissions and adaptation to climate change. His PhD research explores the linkages between place, persons, community and policy and how policy works to enable local initiative. He has experience working with other partners from scientific, economic, social and cultural disciplines. He is interested in how meeting the challenge of changing climate not only safeguards agricultural productivity but also the natural heritage.

Professor Raphael Didham

Professor of Ecology, School of Animal Biology, University of Western Australia

Raphael was recently appointed to the School of Animal Biology at the University of Western Australia, with a joint research position at CSIRO Entomology. He received his PhD from Imperial College London in 1997 and completed a postdoctoral fellowship at the University of Delaware, before holding a faculty position at the University of Canterbury. The goal of his research is to quantify the synergistic effects of multiple drivers of global change on biodiversity and ecological resilience of remnant natural ecosystems within production landscapes, with a particular focus on conserving invertebrate biodiversity and maintaining natural pest control services.

Raphael can bring to the workshop a wealth of ecological research experience and conceptual synthesis of the science underpinning the interactive effects of multiple drivers of global change on biodiversity and ecological resilience. The major thesis of his work is that addressing individual components of global change separately, such as water shortage or climate change, will not lead to better prediction and management of human impacts on biodiversity or productivity. Complex effects occur frequently and to meet the future challenges we need to take a quantum leap beyond the current focus on independent drivers of global change.

Associate Professor Elske van de Fliert

Principal Research Fellow and Deputy Director

Centre for Communication and Social Change, School of Journalism and Communication, University of Queensland (UQ)

Elske is a communication specialist and ecologist with a doctorate from Wageningen University, The Netherlands. She worked for two decades on participatory research, learning, and communication in agricultural development, mainly in Asia, for a range of international organisations, including UNFAO and CGIAR. She joined the UQ in 2006, and currently leads two ACIAR-funded multidisciplinary research projects in Vietnam and Indonesia. The main research interests include communication for development and social change, collaborative inter-stakeholder RfD models, and multi-focal impact assessment for sustainable rural development.

The effects of climate change on agriculture require the industry to apply adaptive strategies to safeguard sustainable production. For this, strong communication platforms and processes are needed to:

- provide information in appropriate formats on emerging constraint and potential options/solutions to and amongst stakeholder groups;
- facilitate dialogue amongst stakeholder groups to achieve mutual understanding and address conflicting interests; and
- monitor, evaluate and assess impact of policies, interventions and practices in a participatory manner to encourage sustainable and organic adaptation and change.

Contribution to the workshop will be through the identification of needs and opportunities for such communication platforms and processes, and by sharing experiences from similar situations in other countries.

Dr David Francis

Research Fellow, School of Life and Environmental Sciences, Faculty of Science and Technology, Deakin University

Originally from Scotland, David immigrated to Australia in 1982. He went to Deakin University's Warrnambool campus in 1999 and obtained a PhD in aquaculture in 2007. His key research focus is on the development of eco-friendly, sustainable feed ingredients for aquafeed production, that permit the maintenance of the health beneficial qualities associated with fish consumption. As mankind's insatiable appetite for fish as a source of protein and omega-3 fatty acids increases, fisheries are being exploited at an alarmingly increasing level. However, aquaculture, widely regarded as the solution to this problem, is currently an unsustainable practice. In part, this is due to its reliance on the use of fishery products for the production of farmed fish feeds (aquafeed).

Aquaculture is a rapidly growing industry in Australia, representing more than 40 per cent of gross fisheries production. For aquaculture, climate change introduces a multitude of challenges that will ultimately impede productivity and future growth. These are associated with effects on biological processes and food web alterations. David's knowledge and expertise of this rapidly growing, nationally important sector will be of great benefit to the workshop's theme where he will effectively contribute to industry specific mitigation solutions and adaptation measures.

Dr Sigfredo Fuentes

Lecturer, School of Agriculture, Food and Wine, University of Adelaide

Sigfredo studied at the University of Talca in Chile for an honours degree in agriculture specialising in horticulture. He came to Australia in 2001 to work as an irrigation specialist for Darling Irrigation Pty, and in 2005 received his PhD from the University of Western Sydney (UWS). He was also a postdoctoral fellow at UWS and the University of Technology Sydney, before his appointment as lecturer at the University of Adelaide, where he is investigating the effects of elevated CO₂, water supply and temperature on grapevines.

Sigfredo will be able to bring a broad perspective to the workshop, particularly on how major economically important woody crops (such as grapevines and forest trees) will respond to the expected changes in water availability, elevated CO₂, and temperature. His expertise in advanced instrumentation and computing to monitor crop performance in the field is directly relevant to how we can study the consequences of climate change on long-lived plant species using remote sensing and other approaches. He will also contribute an international perspective through his experience in Chile and his still-strong links with the University of Talca.

Dr Mike Furlong

Lecturer, School of Biological Sciences, University of Queensland

Mike is an applied insect ecologist with a PhD from Imperial College, London, and postdoctoral appointments at Rothamsted Research (UK), University of Maine (USA) and the University of Queensland (UQ). He took up his current position at UQ in 2005. His research focuses on the sustainable management of agricultural insect pests in developing countries and Australia, and incorporates fundamental ecological studies for the design and implementation of wide-scale management strategies. Current research examines the effects of temperature on trophic interactions between insect pests, their biological control agents (predators and parasites) and crop plants.

Given the potential impact of climate change, the sustainability of agricultural productivity is central to Mike's research, which is beginning to unravel the likely impacts of climate change on essential ecosystems services. Simulation models provide a mechanism by which these can be predicted and tested. Application of this research in regions of marginal agricultural productivity in Australia (eg canola growing regions) and his considerable overseas experience in related agricultural systems provides him with a unique perspective and a wide range of experiences which will enable Mike to make an important contribution to the workshop.

Dr Ros Gleadow

Senior Lecturer, School of Biological Sciences, Monash University

Ros completed her PhD in botany at the University of Melbourne in 1999. She founded the Monash Cyanogenesis Group in 2005 and has also worked at the Universities of Copenhagen, Arizona and California. She took a break from active research to raise three children and during this time became a pioneer in the use of multimedia in higher education. Her research focuses on the effects of climate change on plant defence. Ros has served as ecophysiology, education and Science Meets Parliament representative for the Australian Society of Plant Sciences and collaborates with Pacific Seeds (drought effects on sorghum toxicity), CassTech (commercialising cassava in northern Australia) and AusAID (food security, Mozambique).

An overlooked consequence of increased atmospheric CO₂, and concomitant changes in climate is the change in plant composition. Typically, concentrations of natural toxins increase and protein decreases when plants are grown in future emission scenarios. This would have serious consequence for human and animal health. This important area has yet to become part of the climate change debate and should be considered when attempting to mitigate the effects of climate change on food production. Ros' links with aid agencies, agricultural companies and international researchers help her to approach the issue from a fresh perspective.

Professor Christopher Grof

Professor of Plant Science, School of Environmental and Life Sciences, University of Newcastle

During his appointment at CSIRO Plant Industry (1993 to 2008) Christopher initiated, developed and supervised a number of innovative research projects in sugarcane physiology, biochemistry and biotechnology. These projects were aimed at addressing key sugarcane industry issues including sucrose accumulation, genetic transformation and raw sugar quality. He was appointed Professor of Plant Science at the University of Newcastle in 2008, and has since secured \$1.8 million in funding through ARC Linkage to establish a research program in conjunction with collaborators at the University of Queensland and industry partner Pacific Seeds. Christopher has a strong interest in advancing Australian agriculture using the entire gamut of biotechnological tools available and founded upon a strong platform of fundamental scientific understanding.

Christopher's extensive experience in key Australian crops, sugarcane and more recently sorghum, coupled with the ongoing application of innovative strategies to maximise the productivity of these crops, ensures that he has the appropriate experience to contribute to future strategies aimed at maximising agricultural productivity in a changing environment. As climate change models foreshadow increases in temperature and drought conditions, understanding of plants possessing C₄ metabolism will maximise our chances of maintaining agriculture productivity and sustainability.

Dr Chris Guppy

School of Environmental and Rural Science, University of New England

Chris completed undergraduate and postgraduate studies in agricultural science and soil fertility at the University of Queensland in 2004, before taking a position in soil fertility at the University of New England. His research interests are in soil fertility and sustainable nutrient management, particularly phosphorus which is one of the key constraints to future agricultural sustainability. He is currently involved in the Nutrient Management Initiative examining sustainable and predictable phosphorus and potassium nutrition of northern farming systems; and Grain and Graze, a project increasing the sustainability and profitability of mixed farming systems.

Chris sees the workshop's theme as directly relevant to his current research interests, as he focuses on nutrient and water use efficiency in agricultural systems under a changing climate. He firmly believes investment in adaptive management of northern farming systems, particularly soil management issues, serves the long-term interests of better food security and a prosperous, sustainable future.

Mr Munir Hanjra

Water and Carbon Policy Analyst, International Centre of Water for Food Security, Charles Sturt University

Munir holds degrees in agricultural economics from Pakistan and a Master of Economics from Australia. He is a development economist with 18 years of work experience in developing countries, particularly in south and south-east Asia. He has worked in multidisciplinary international research teams in the International Water Management Institute to undertake impact evaluation of irrigation infrastructure development and rehabilitation on rural poverty. Under the Challenge Program on Food and Water, he was involved in the development of poverty and vulnerability monitoring indicators in nine river-basins (eg Indo-Gangetic, Mekong and Yellow River). He is currently working on optimisation models for enhancing the productivity of land and water resource management in Australia and internationally, with an emphasis on irrigation infrastructure modernisation.

Munir works on core issues related to rural water management for enhancing the sustainability of agricultural production and livelihoods through water savings and energy savings in major farming systems across Australia. He has developed interests in Australian priority research areas such as water and carbon dynamics, climate change and public policy, and in developing educational and knowledge products for a wide range of stakeholders on issues of environmental sustainability, rural renewal, and social inclusion. This will be the main contribution to the workshop theme.

Dr Richard Harper

Environmental Science, Murdoch University

Richard was recently appointed to the Alcoa Chair in Integrated Water Management at Murdoch University after roles in science and policy for the Western Australian Government for 20 years. He has a PhD in soil science from the University of Western Australia and has published on the potential for carbon sequestration in agriculture and forestry systems. He has also developed a bioenergy production system using short rotation forestry that will increase the sustainability of agriculture and not compete with food production. Richard has participated in several state and federal climate change policy committees and provided an overview of the mitigation potential of agriculture and forestry for the *Garnaut Climate Change Review*.

Richard has a strong understanding of the science and policy related to climate change for both agriculture and forestry and in particular the biophysical and social limitations. He was an early advocate of using investment in carbon mitigation to tackle intractable land management issues such as salinity and erosion, and has more recently attempted to value these multiple benefits. This experience at the interface of science and policy, between climate change adaptation and mitigation, and between agriculture and other land-uses, will allow him to make a worthwhile contribution to this workshop.

Dr Matthew Hipsey

School of Earth and Environment, University of Western Australia

Matthew's research focus is around understanding the hydrological and hydrodynamic interactions with biogeochemical and ecological processing of elements in lakes, rivers, wetlands and estuaries. Interests include assessing impacts of land-use change and hydro-climatological variability on wetland and estuarine biogeochemistry, and using wetlands and lakes as 'barometers of change' by defining quantitative estimates of ecosystem health. Key Australian sites worked on include the lower Murray River (SA), Yarra River (VIC), the Swan River and Peel-Harvey estuaries (WA) and numerous lakes and wetlands. Matthew is also involved in global ecosystem observatory networks for monitoring changes in freshwater systems, and is currently a theme leader in the UWA Terrestrial Ecosystem Research Initiative.

Water quality problems include increases in salinity, turbidity, acidity, in addition to the problems of eutrophication and algal blooms. Such problems have had considerable impact on aquatic ecosystem values such as biodiversity, and in particular to those downstream of agricultural practices. In addition to providing insights into the dynamics of how such systems will respond to land-use changes and shifts in climatic regimes, Matthew also has experience in down-scaling large scale atmospheric circulation models to drive basin-scale ecosystem models for forecasting purposes.

Mr Neil Huth

CSIRO Sustainable Ecosystems

Neil has developed detailed modelling and analytical skills during his career with CSIRO. As a member of the Agricultural Production Systems Research Unit he has provided a lead in the development of detailed plant (phenology, growth, resource use) and soil (water and solute movement, nitrogen and carbon dynamics) models for use within farming systems research. Neil has used these skills in farming systems analysis for dryland agriculture, pastures, horticulture, sugar cane and viticulture. He has also undertaken extension of the modelling frameworks for the simulation of agroforestry systems. Neil's main interest lies in combining detailed experiments, process-based models and farmer knowledge to drive farming systems design.

Neil will bring many insights from his current portfolio of work. He is currently involved in the assessment of climate change impacts on agriculture and forestry in south-east Queensland. This includes engaging with horticultural and pastoral farmer groups, not only to document vulnerability, but to explore and trial adaptive options in the field. His expertise has also been called upon to assist in the choice of best bet management options for long-term studies of carbon, water and greenhouse gas management in northern farming systems.

Dr Tamara Jackson

International Centre of Water for Food Security, Charles Sturt University

Tamara has a background in water and energy trade-offs in the area of irrigated agriculture. She has postgraduate qualifications in applied hydrology, an international internship with UNESCO, and applied research on water and energy management issues in the context of agriculture and food security. Tamara's recently-completed PhD research explored

water use efficiency, energy consumption and greenhouse gas emission relationships for different irrigation systems. It also included stochastic modelling to quantify the potential water and energy consumption and carbon equivalent emissions resulting from changes to irrigation systems in terms of environmental and operating inputs. Her current research interests include water management, food security, agricultural development and adaptation in the face of climate change.

Tamar's research carried out as part of her PhD studies regarding the water–energy nexus in irrigated agriculture is pertinent to the theme of this workshop. The opportunity to participate would allow her to both contribute her ideas and learn from others regarding the issues facing irrigated agriculture in Australia, and to explore the potential impacts of climate change on this vital section of the agricultural industry. Ultimately, it would be beneficial if these discussions could lead to options for the continued development of sustainable, vibrant agricultural communities.

Dr Andrew Jacobs

Group Leader, Technology Platforms, Australian Centre for Plant Functional Genomics, University of Adelaide

Andrew's research has focused on the development of grain crops tolerant to environmental stresses through the application of genetic technologies. His group has been responsible for the development of targeted and high throughput gene analysis systems and the isolation of a number of genes and transcription factors important in stress tolerance. Abiotic stresses currently under investigation include salinity, drought and cold/frost. His research perspective is broad, ranging from gene discovery to testing of genetically modified cereals in the field. Andrew works on a range of collaborative academic and commercial projects, has published in various peer reviewed journals and holds a number of patents related to his work.

In addition to presenting research findings as an invited speaker at international conferences, Andrew is engaged in the communication with and education of farmers and the wider community through Grains Research and Development Council research updates and road shows. This gives him insight into the issues and problems farmers face in Australia and has provided opportunities for dialogue regarding technologies which may address these issues. He will be able to use his knowledge to contribute insights into how modern genetic technologies can provide solutions to overcome the challenges grain growers will face as a result of climate change.

Dr Evelyn Krull

Senior Research Scientist, CSIRO Land and Water

Evelyn's expertise lies in the application of stable and radiogenic isotopic analyses to determine organic matter sources and degradation processes that occur in soils and sediments, as well as the effect of vegetation change on soil organic carbon stores. Her approach of combining isotopic and ¹³C-NMR analyses has enabled us to better determine organic matter sources and transport processes. Her current research is focusing on the degree of urbanisation on carbon cycling in the Logan estuary (south-east QLD), the impact on increased salinisation on the Coorong and Lower Lakes ecosystems (SA), and on the potential of biochar as an agricultural amendment and as a carbon sequestration tool.

Evelyn's expertise relating to the Think Tank theme includes:

- assessment of the effects of land management (fire suppression, grazing pressure) on vegetation change and C stocks;
- evaluation of fire-derived charcoal as a highly stable organic carbon pool in soils as well as estuarine sediments; and
- development and leadership of a national biochar initiative.

Her contribution will draw on her scientific skills, ability to think laterally and endeavour to learn and contribute to society.

Dr Rick Llewellyn

Farming Systems Scientist, CSIRO Sustainable Ecosystems

Rick gained a PhD from the School of Agricultural and Resource Economics at the University of Western Australia for his research into weed management decisions by grain growers. His research bridges farming systems field research and developing research, development and extension strategies for improved technology adoption. He currently leads national projects including the development of the role for perennials in future farming systems, predicting adoptability of new agricultural technologies and a national study of the adoption of conservation tillage practices in Australia. Before joining CSIRO, he spent four years as lecturer in agricultural systems and extension at the University of Western Australia. He has also worked closely with farmer groups.

Rick has a breadth of experience working with farmers and integrates biophysical and socio-economic disciplinary approaches to tackle a range of environmental, production and social pressures facing agriculture. As well as researching and developing new technologies for Australian agriculture, he applies socio-economic research to address the farmer perspective to adaptation and practice change. His research identifying constraints to adoption of complex, information-intensive innovations has led to a keen interest in the development of novel approaches to increasing specialised adoption capacity of farms while still maintaining the opportunity for farm business diversity.

Dr Leo Lymburner

Remote Sensing Applications Specialist, Geoscience Australia

Leo graduated from Macquarie University in 1998 with an honours degree. He worked at CSIRO Land and Water in the Environmental Remote Sensing Group from 1998 to 2001. He completed his PhD on remote sensing of riparian zones through the University of Melbourne in 2005, and from 2006 to 2008 worked for the Australian Centre for Tropical Freshwater Research at James Cook University in Townsville. At the beginning of 2008 Leo returned to Canberra to form part of a new land cover remote sensing team at Geoscience Australia. His main interests are object-oriented image processing and multi-temporal land-cover/land-use mapping techniques with a particular interest in developing tailored image processing techniques to identify cropping and land management practices.

For the past year Leo has been working on a project that characterises the cropping and food production areas of Australia at both national and regional scales. The map products that he has developed in conjunction with the land cover team at Geoscience Australia could form a fundamental talking point for the dialogue around adapting food and fibre production systems to a changing climate.

Dr Nadine Marshall

Social Scientist, CSIRO Sustainable Ecosystems

Nadine has worked within the commercial fishing industry in Queensland for over eight years and with Australian cattle graziers and farmers for over three years. Most of her work focuses on issues pertaining to climate adaptation and vulnerability with particular emphasis on recognising the need for, and influences on, transformative change. Nadine has two degrees in the biophysical sciences; an honours degree and Masters from the Universities of Melbourne and Monash respectively, and completed her PhD in the social and environmental sciences at James Cook University in 2006, and has since been with the Climate Adaptation Flagship and CSIRO Sustainable Ecosystems, based in Townsville.

Nadine's interdisciplinary background equips her with a systems approach to examining natural resource problems. Her research currently addresses how resource users are vulnerable to climate change and how their vulnerability can be minimised. She has seen the variety in the circumstances of resources users, and their dependency on the resource, and has correlated these with the strategies they have chosen to manage their enterprises. Nadine believes that agricultural Australians are generally not sufficiently equipped with the necessary skills to meet the challenges of climate change. The Think Tank would provide the opportunity to discuss potential adaptation strategies.

Dr Darryn McEvoy

Principal Researcher, Climate Change Adaptation, RMIT University

Darryn is a geographer with an interest in interdisciplinary solutions-oriented action research. His most recent research activity has focused on issues relating to climate change impacts and adaptation, with consideration of the implications for sustainable development. This has included managing two large scale projects in the UK (2002 to 2006), and post 2006 he was based in the Netherlands acting as a senior researcher on the EU consortium project Adaptation and Mitigation Strategies: Supporting European Climate Policy (ADAM). His research expertise covers climate risk assessment and adaptation, innovative adaptation practice in different contextual settings (eg climate change and cities; land and water management under a changing climate).

Darryn has analysed adaptation to climate change across a wide range of hazards, sectors, landscape types, and issues for the ADAM project, of particular relevance to this workshop being: Guadiana, Spain and Portugal (drought); the Tisza river basin, Hungary (flooding); and Inner Mongolia, China (desertification and sustainable livelihoods). In addition to this international experience, he is also leader of the climate change adaptation programme for the Global Cities Institute, RMIT University, and the Deputy Director of the newly-established Victorian Institute for Climate Change Adaptation Research.

Mr Mark P McHenry

School of Engineering and Energy, Murdoch University

Mark's research is focused on integrating agricultural production systems with climate change mitigation, adaptation, renewable energy and biosequestration options. He has authored several peer reviewed journal articles, conference proceedings and a book chapter. Mark is due to finish his PhD in February 2010. He has research and consulting experience with Main Roads WA, Brierty Ltd, Maunsell AECOM, the Department of Defence, Transfield Services, WA Department of Fisheries, the Research Institute for Sustainable Energy, and the WA Legislative Assembly. Mark is also a member of the Department of Agriculture, Forestry and Fisheries' Rural Research and Development Council (RRDC).

As Mark's research is focused directly on the contemporary challenges facing Australian agriculture, and his RRDC work on agricultural technology, productivity and food security, he is particularly suited to contribute to this workshop. Mark's PhD research specialises on the integration of mitigation and adaptation technological options for agricultural production systems, and particularly on cost-effective opportunities deriving from climate change projections and competitive advantages of Australia's landscape. As a fourth generation farmer he appreciates the social, cultural, environmental and institutional components of rural Australia and hopes he can make more of his work accessible through this opportunity.

Dr Andrew Moore

Principal Research Scientist, CSIRO Plant Industry

After training as a vegetation ecologist at the University of Adelaide and the Australian National University, Andrew joined CSIRO in 1989 where he works on predictive modelling of pasture growth and quality, the management of grazing systems and the application of agricultural simulation models in decision making. Recently he extended his scientific interests to the linking of crop and livestock simulation models, using them to study risk and integration in mixed farming systems. He currently leads a project studying adaptation to climate change by the southern Australian livestock industries.

Andrew will be able to contribute to the workshop's theme in a number of ways. As an agro-ecosystem ecologist and modeller, he integrates a broad understanding of how weather and climate drive processes in agriculture at scales from the plant to the whole farm. Through conducting his research within a number of programs of participatory research, development and extension he has developed a broad view of the economic, environmental and social drivers of changes in practice on Australian broadacre farms. He has a particular appreciation of the role of climatic variability as a factor that constrains farming practice, including adaptation to climate change.

Dr Saffron O'Neill

Research Fellow, Department of Resource Management and Geography, University of Melbourne

Saffron is a Research Fellow at the University of Melbourne and a Visiting Fellow at the Tyndall Centre for Climate Change Research, UK. Her research interests focus on the interactions between society, policy and climate science. She is particularly interested in the roles of cognition, affect and behaviour in individuals' engagement with climate change adaptation and mitigation. Her ongoing projects include a co-edited book (Engaging communities with climate change and energy demand reduction: Earthscan), exploring the role of the arts in climate change, and investigating how carbon off-setting behaviours may act to promote green identity and behaviour spillover.

Compared to research on the reduction of greenhouse gas emissions and climate change impacts, there has been relatively little research on social responses to climate change. Identifying mitigation and adaptation strategies that acknowledge and address the psychological and sociological aspects of climate change in future agricultural productivity and consumption is a challenge. Saffron can contribute expertise in the social science aspects of the workshop theme. Indeed, she has been interested in developing research to address this challenge for some time, and the workshop would provide an ideal opportunity to develop this further.

Dr Sarah Park

CSIRO Sustainable Ecosystems

Sarah's work draws on an extensive background in development studies and agricultural sciences. She has approached the assessment of climate change impact, adaptive capacity and development of response strategies in crop production using both quantitative biophysical modelling and qualitative stakeholder engagement methodologies. The systems approach

she has used recognises the need for effective and appropriate response strategies to be developed in collaboration with decision makers throughout the value chain and at all levels of governance. More recently, Sarah has applied theoretical and applied science in crop production and climate change adaptation applied in Australia, to the issue of climate change adaptation and food security in the Pacific and south-east Asia.

In addition to a systems perspective and innovative approach to problem solving, Sarah will contribute knowledge and skills on:

- engagement of both stakeholders and policy makers to promote evidence-based decision making at all levels;
- multifunctional agricultural landscapes with the potential to support agricultural production and biodiversity conservation;
- crop physiology, agronomic production practices and industry institutional operations; and
- quantification of the impact of climate change on crop yield and the potential of adaptation response strategies under scenarios of future climate change.

Dr Eric Peterson

Lecturer, Architectural Engineering, School of Engineering and Science Faculty of Health, Engineering and Science, Victoria University

Eric's expertise includes solar desalination systems, building services design, as well as modelling dynamic of coral reefs. He is a licensed professional engineer, having ten years industry experience in modelling thermal dynamics of the built environment, followed by ten years of water engineering. He has a PhD from James Cook University for modelling marine pond dynamics and the impacts of aquaculture effluent, with three years of postdoctoral work on the topic. He now balances his time between research and training architects and engineers in ecologically sustainable development and ocean engineering.

Eric believes he can make a contribution to the workshop through his work and experience, such as analysis of meteorological data to determine energy and water efficient building design parameters throughout Australia; using supercomputer facilities to model coral atoll hydrodynamics, validated with fieldwork in the Marshall Islands to inform sustainable resettlement of nuclear weapons testing victims at Rongelap Atoll in the face of sea level rise; evaluation of a pilot 'green powered desalination' solar desalination plant at Mt Coot-tha Botanic Gardens (Brisbane) with marine plants brine treatment; and advising design professionals with location-specific data for rainwater harvesting.

Dr James Petrie

Metabolic Engineering of New Plant Products, CSIRO Plant Industry

James graduated from University of Wollongong with honours, after which he joined the CSIRO Metabolic Engineering team as a PhD student. He is now part of the CSIRO Food Futures Flagship and is working in the Omega-3 Land Plants project, which aims to deliver a sustainable source of long-chain polyunsaturated fatty acids such as eicosapentaenoic acid and docosahexaenoic acid in order to reduce pressure on fish stocks and increase the intake of beneficial omega-3 oils by the Australian population. James is now involved in both the core scientific pursuits and the business development activities in the project.

James believes that the goals of CSIRO's Food Futures Flagship are highly relevant to the Think Tank's theme of agricultural productivity. One of the key aims of the flagship is to develop frontier science and technologies to transform the Australian agrifood sector. A clear example of this is found in the Omega-3 Land Plants project with the aim to add value and increase the productivity of the Australian oilseeds market by making substantial qualitative changes to the product itself, allowing Australian farmers to produce a distinct, high-value oil.

Dr Libby Pinkard

CSIRO Sustainable Ecosystems

Libby has a broad background, encompassing trees in the rural landscape, through her past roles as Greening Australia Tasmania state president and as a farm trees project officer with Forestry Tasmania; trees in the natural environment, as a project officer for the Tasmanian National Parks and Wildlife Service; and through her current role with CSIRO understanding how tree functioning affects forest management. Her involvement in the steering committees of a National Association of Forest Industries project examining industry adaptation to climate change, and a national assessment of forest vulnerability, provide her with a broad perspective of the implications of climate change for Australia and the role of forests in Australia's response to climate change.

Addressing national challenges such as greenhouse gas mitigation, water security or biodiversity conservation will require landscape level solutions that integrate agriculture, production forests and conservation. Forests span these elements. Libby can contribute an understanding and analysis of the contribution of trees within these landscapes and trade-offs with other land-uses, the extent to which forests will be affected by climate change, and how we may build resilience into forest systems to enhance the long-term sustainability of our agricultural environment.

Dr Simon Reid

Veterinary Epidemiologist, School of Veterinary and Biomedical Sciences, Murdoch University

Simon's goal is to make a significant contribution to national and international programs for surveillance and control of major infectious and zoonotic diseases of livestock. He obtained his veterinary degree from Murdoch University in 1989 and PhD from James Cook University in 2000. In 2008 Simon accepted a posting in Indonesia to provide technical support to the Indonesian National Control program for avian influenza (HPAI), and is currently working in Vietnam for the Food and Agriculture Organization of the United Nations providing expertise in a research project to enable the government of Vietnam to modify its HPAI control program in 2011.

Simon has been a willing and articulate participant in many workshops designed to evaluate issues related to livestock diseases and develop strategies to ameliorate their effects. He has a deep understanding of the need to develop multidisciplinary approaches to tackle some of the more complex problems facing the agricultural sector in Australia. Research programs to address the future impact of climate change on the impact of infectious diseases on livestock production and trade will need to be complex and interdisciplinary. He believes that his contribution to the Think Tank will enable informed discussion of these issues.

Dr Michael (Saam) Renton

Assistant Professor and Modeller, School of Plant Biology, Faculty of Natural and Agricultural Science, University of Western Australia (UWA) and Agricultural Landscapes

Michael completed his honours at UWA in maths and his PhD at the University of Queensland, looking at approaches to modelling the interactions between plant form, function and environment. His postdoctoral position in Montpellier, France, married stochastic models with structural models to create virtual apple trees. He returned to Perth to teach applied maths at UWA, before spending a couple of years creating the Weed Seed Wizard (a model of seed bank dynamics) at the Department of Agriculture and Food. In 2007 he took up a lectureship in computational agro-ecology in the School of Plant Biology. His current projects include modelling of weeds, seed bank population dynamics and evolution of resistance to herbicides and pesticides, competition and interaction between plants in natural and managed systems, the role of new options (such as perennial pastures) in farming systems, and optimal land-use in agricultural systems.

Michael will be able to contribute to the workshop's theme based on his work in modelling agro-ecological systems. Of most relevance is his modelling work on optimising land-use in agricultural systems and mixed-use landscapes across time (land-use sequencing) and space (optimal land-use allocation), while taking into account risk due to climate variability and other factors and carbon sequestration possibilities.

Dr Dean Revell

CSIRO Livestock Industries

Dean's research has focused on interactions between livestock and land management. He completed his undergraduate degree and PhD in agricultural science at the University of Western Australia and since then has worked at the Rowett Research Institute in Scotland, the University of Western Australia, Massey University in New Zealand, the University of Adelaide and, for nearly 4 years, CSIRO Livestock Industries in Perth. Dean currently leads a national, multi-disciplinary project, Enrich, which aims to increase options for landholders to develop new, more resilient and sustainable grazing systems by incorporating Australian native shrubs. He leads a research group in CSIRO whose work covers a broad range of issues relating to interactions between plants, animals, people and the environment.

Dean would bring to the Think Tank specific expertise in nutrition and grazing behaviour of herbivores and, importantly, knowledge on how these disciplines relate to land management, farming systems, and emerging market demands and consumer expectations. Current research is exploring multi-purpose grazing systems that consider the imperative of boosting profitability of farming systems whilst simultaneously dealing with a changing climate and emerging market and consumer demands. Multiple benefits are achievable through beneficial interactions between plants, the behaviour of grazing herbivores, and innovative management.

Dr Carol Richards

Sociology Postdoctoral Research Fellow, School of Social Science, University of Queensland

Carol specialises in agriculture and food. She has extensively researched the issue of environmental sustainability of grazing and agriculture within the context of the global political economy, highlighting why in many instances, it is 'unthinkable' for Australian primary producers to alter their land management practices to align with broader sustainability goals. Recently, Carol has shifted focus to the retail end of the supply chain, and is examining the impact that powerful supermarkets have on the food supply chain. This includes an international comparison of agri-environmental labelling, and the quasi-governance of primary production through a market concentrated retail sector. Carol also coordinates and lectures sociology of the environment.

As a social scientist, Carol brings a perspective that analyses the complex relationships between primary production and the global political economy. It is important to understand how current market structures lock Australian producers into a program of productivism and the necessity to constantly increase supply, often from a diminishing resource base. Her comparative work in this area has shown how other production modalities, such as those found in Europe, and broadly described as multifunctional, have been more attuned to the non-tradable concerns of agriculture, such as the environment.

Dr Randall Robinson

Course Coordinator and Lecturer, Ecology and Environmental Management, School of Engineering and Science Faculty of Health, Engineering and Science, Victoria University

Randall teaches botany, fundamentals of ecology, geographic information systems, environmental impacts and monitoring, and conservation genetics at Victoria University. His research interests focus mainly on recruitment and population dynamics of plants, sexual and clonal (asexual) reproduction in plants, introduced pest plant species and overall ecosystem management. He is a member of several committees and panels focusing on environmental management and has published widely on a range of topics including the conservation of orchids, population dynamics of wetland plants, and weeds and restoration of grassy ecosystems.

Randall's work, particularly that relating to plant germination and establishment, introduced pest plants and the use of GIS, allows him to have an understanding of some of the fundamental issues facing agriculture and the management of resources. His work on recruitment and population dynamics in plants, especially those aspects that deal with the effects of climatic variables and how they affect plant growth, place him in a position to understand what is presently happening in the environment and to predict possible impacts of a changing environment on the growth of desired species and also what impacts climate change may have on introduced pest plant species.

Dr Douglas Rowell

Research Fellow, Department of Resource Management and Geography, University of Melbourne

Douglas is a Research Fellow at the University of Melbourne, working in greenhouse gas emissions from agricultural systems. His current research interest is the measurement of greenhouse gases and ammonia from beef cattle feedlots using open-path spectroscopy and micrometeorology.

His future research will explore a number of management strategies for the mitigation of greenhouse gas emissions from beef cattle feedlots, and it is in discussion of this that he believes he can contribute to the Think Tank's theme.

Dr Katinka Ruthrof

Senior Research Fellow, State Centre of Excellence of Climate Change and Forest and Woodland Health, Murdoch University

Katinka has expertise in invasive and native plant ecology, restoration of degraded ecosystems, as well as experience with resource management issues. She has planned and written environmental management plans for major resources, and has significantly contributed to the field of weed ecology and restoration ecology. Katinka has assisted in winning two major research grants: ARC Linkage and State Centre of Excellence of Climate Change, and Forest and Woodland Health (more than \$10 million). As part of the Centre of Excellence, she researches methods of increasing the resilience and success of restoration of declining woodland ecosystems.

Katinka will contribute to the workshop theme through her experience in a broad range of disciplines, including weed ecology, degraded forest and mine site restoration, community engagement and natural resource management. She will add to discussions about the challenges and opportunities Australian agriculture will face to operate in a carbon-constrained economy and in a future of climate change. If climate change adaptation and mitigation strategies become embedded in natural resource management, agricultural techniques and policy, Australia can become resilient and take advantage of global demand for food security and carbon sequestration through productive agriculture, large-scale forestry and diversification.

Dr Saman Seneweera

Research Fellow, Melbourne School of Land and Environment, University of Melbourne

Saman completed his PhD in 1996 at the University of Western Sydney and currently works as a plant physiologist at the University of Melbourne. His research interest is on understanding the mechanisms of how plants respond to global climate change and abiotic stresses like drought and temperature. This will enhance understanding of how climate change impacts on biodiversity, productivity and global food supply. Molecular, biochemical, physiological and ecological tools are used to assess plant performance under manipulative field and controlled environment chamber experiments. Saman's long-term research focus has been on crop plant responses to climate change, particularly how elevated CO₂, temperature and drought modify the various physiological processes, such as growth, respiration, source sink interaction, mineral nutrition and grain quality.

In the workshop, he will discuss how these key individual physiological processes respond to climate change, and then identify possible targets for crop breeding for future climate change which will ensure food security globally. His experience working in free air carbon dioxide enrichment facilities will provide the workshop with a greater insight into plant response to climate change at ecosystem levels.

Dr Sandra Savocchia

National Wine and Grape Industry Centre School of Agricultural and Wine Sciences, Charles Sturt University

In 2002 Sandra was awarded a PhD in plant pathology and fungicide resistance from the University of Adelaide. She is currently employed as a Senior Lecturer at Charles Sturt University in the discipline of viticulture, where she teaches and coordinates various undergraduate subjects. Her research interests are in the area of plant pathology, epidemiology and molecular diversity of plant pathogens, in particular fungal pathogens of grapevine. She also has an interest in how environmental changes will impact on plant diseases of importance to agriculture.

The future of sustainable agriculture is dependent on the management of biotic factors such as pests and diseases. The development of new crop varieties that are tolerant to these biotic factors, high yielding and environmentally adapted will be crucial. Future production of such crops may occur through genetic modification, either via traditional breeding or genetic manipulation. For the latter, the community must be informed of the technology for an acceptance of these crops to occur. Socially, Sandra believes there is an increase in demand for low pesticide use in agriculture and food production. The urban sprawl is also encroaching on farm land and in order to maintain global food security this must be considered.

Associate Professor Susanne Schmidt

School of Biological Sciences, University of Queensland

Susanne graduated in 1992 with a German Masters degree in agricultural biology, and a PhD in 1996 from the University of Queensland. In 2004 she became a Senior Lecturer in Plant Ecology and Ecophysiology, and more recently an Acting Professor. Her research interests are in plants and plant-based systems in the context of genetics, soil, management and climate in the sub/tropics, with a focus on plant-soil-microbe interactions as drivers of nutrient and carbon cycles in natural ecosystems and agricultural systems. Her research aims to develop management and plant selection tools to inform strategies for sustainable production, use of bio-resources and adaptation to change.

Susanne will bring knowledge of plant systems to the Think Tank with a view of natural resources and rural industries, agricultural and sustainability science, and ecology, as well as in-depth knowledge of sustainability issues and advances in the sugarcane industry. Networking with national research leaders would allow sharing this knowledge and contributing to strategies for a national agenda to safeguard agricultural productivity. Such agenda is a high priority and concepts proposed in the Millennium Assessment have to be adapted to Australian bioproduction systems, developed with and communicated to the Australian people.

Dr Ronald Smernik

School of Earth and Environmental Sciences, University of Adelaide

Ron is a recognised leader in the field of soil organic matter research, for which he was awarded the Frederick White Prize by the Australian Academy of Science in 2008. He was a QEII Fellow from 2004 to 2009 in the School of Earth and Environmental Sciences, University of Adelaide, where he is now employed as a Senior Lecturer. His research interests cover several aspects of soil organic matter, including its roles in pollutant fate and transport, soil fertility, and global carbon cycling. He has published widely and is also an associate editor of the *European Journal of Soil Science* and a regular reviewer for numerous journals, the ARC and international research agencies.

Ron's expertise in soil organic carbon (SOC) will be a valuable contribution to the themes of the workshop. SOC plays key roles in both agricultural productivity and climate change mitigation. Enhancing SOC levels in soils through reduced tillage, crop residue retention and the addition of organic amendments (such as biochar) is an important recent advance in agricultural land management that has increased soil fertility, agricultural productivity and resilience to drought. Ron will be able to address important issues on how we can manage soils to mitigate elevated CO₂ levels.

Dr Jonathan Sobels

School of Geography, Population and Environmental Management, Flinders University

From 1981 to 1987 Jonathan developed broadacre markets for Roundup herbicide and conservation farming and was R&D manager for Seedco, managing contracts for international seed production, agronomy and plant breeding and selection of pasture and crop varieties until 1997. From 1998, doctoral studies at Charles Sturt University were interspersed with 18 months consultancy to RMIT University in an attempt to commercialise real-time satellite remote sensing for broad acre crops. Following his PhD in 2007 he completed a number of consultancies in the organisation and role of Landcare. His research interests include:

- social change resulting from land-use changes brought about by drought, climate change and new rules for irrigation water supply; and
- use of GIS and Web 2.0 technologies in a new survey methodology, initially designed around calculating carbon pollution from commuting behaviours.

Jonathan can contribute to the workshop in a variety of ways, such as: extensive geographic and practical knowledge of the innovations and systems that created and drive modern Australian agriculture; and knowledge of social parameters of change that influence rural and regional people, including local organisation, social learning, mobilisation of community assets and adoption and adaptation or risk management and information flows.

Dr Alison Southwell

Lecturer, Agricultural Systems and Extension, School of Agricultural and Wine Sciences, Charles Sturt University

After completing her honours degree in rural science at the University of New England in 2001, Alison began a PhD investigating the hydrology of native pasture communities in the high rainfall zone of south-eastern Australia. Whilst completing her PhD, she began lecturing in agricultural systems and extension, and this new role has moved her away from eco-physiology to a systems level of research. She has since worked on an ACIAR project looking to improve extension practices to increase buffalo milk production in Pakistan, and with Riverina communities looking to improve resilience in farming systems. Her research interests now lie in improving farming systems in southern Australia. She also co-manages the family sheep and wool property near Canberra.

Australian agriculture needs to adopt innovations and management strategies in an environment of increased climatic and economic risk. Increased labour and economic efficiencies are required to cope with the 'knowledge and skills drain' that is occurring as a result of decline in population, government services and interest amongst youth. New ideas for farming systems and land-use choices need to be examined. Alison is in touch with what's happening in agriculture and has good connections with many sectors of the agricultural industry and rural communities.

Dr Chris Stokes

Senior Research Scientist, CSIRO Sustainable Ecosystems

Chris' research in the rangelands of Africa, North America and Australia has looked at how these ecosystems are impacted by human disturbances such as grazing, land fragmentation and climate change. This ecological understanding has been integrated in multidisciplinary teams to better inform decisions about complex long-term natural resource management issues at paddock to regional scales. His work in the OzFACE experiment, the world's first field CO₂ experiment in the

tropics, has demonstrated the importance of tropical grasses (C4 plants) to global ecosystem responses to rising atmospheric CO₂ levels. His current work has involved reviewing climate change impacts and adaptation options in Australian agriculture.

Chris' research has involved assessing climate change impacts and adaptation options in Australian rangelands and developing broad systems approaches that seek to balance policy, social, economic and environmental outcomes in developing adaptation options that will prepare agriculture for future while dealing with the uncertainties in the available science. These approaches draw on simulation models that incorporate process standing of the impacts of climate change on biological systems, integrated with other disciplines to explore adaptation options and the limits of adaptive capacity. This experience should provide a strong basis to contribute to Think Tank discussions.

Mr Hayden Sprigg

Curtin University of Technology

Hayden completed an honours degree in agribusiness in farm management at Curtin University of Technology in 2005, which provided him with a very solid and broad understanding of agriculture. In 2007 Hayden commenced his doctorate titled *Adaptation to wheat production in a drying climate* aimed at increasing wheat yield stability in water scarce environments in light of climate change. In 2008 he was invited to attend the 'Wheat Production in the Western Region in Water Limited (drought-prone) Environments – Where to next?' workshop aimed at shaping the future of wheat research in Western Australia.

Climate change is likely to lead to less rainfall in most dryland agricultural regions and less freshwater allocation to food and fibre production. The reality is we need to produce more food and fibre from less water. Hayden believes he has the necessary skills set to contribute to this forum as his PhD is directly aimed at finding solutions to this problem. Also his rural upbringing provides him with an insight into social aspects of the issue and his background as a producer and broad understanding of agriculture, means he understands practical barriers to adaptation and mitigation strategies.

Dr Christine Storer

Senior Lecturer, Agribusiness, School of Agriculture and Environment, Curtin University of Technology

Christine has been working in her current position since 1991. Previously she worked as an information system analyst and chartered accountant internationally. Her PhD looked at communication between organisations in food chains. Subsequent work has been looking at coordination in the food chain including catalysts, problems and critical success factors. Currently Christine is looking at farmers and rural community responses to climate change and the role of government and scientists. In addition she is developing tracking and tracing systems for small business to address biosecurity issues in food chains.

Research interests include: complex problem solving; information communication systems and management; on-farm quality assurance adoption; traceability systems; use of price risk management tools; and consumer and buyer behaviour and attitudes.

Christine's broad range of research interests and considerable experience in research in rural communities will enable her to engage with a broad range of people at the Think Tank. Much of her work is based on working in multi-discipline teams nationally and internationally. With this background she expects to be able contribute across different topics and consider others points of view.

Dr Kirrilly Thompson

Research Fellow, Human Factors Group, Centre for Sleep Research, University of South Australia

Kirrilly is an applied cultural anthropologist working on mixed-methods research projects at the University of South Australia. Her research interests include: humans, society and the environment; human-animal relations; social and cultural aspects of risk and safety; environmental sustainability; community participation, sports and volunteering; social justice and equity; qualitative and social research techniques; and cross-cultural research. Kirrilly works successfully with industry partners to achieve solutions to multi-faceted problems. She is deputy leader of Operations and Safety in the CRC for Rail Innovation and has won a grant to research the socio-cultural drivers to wasteful food behaviours in Australia.

Kirrilly's anthropological approach equips her with the ability to understand community perspectives and mediate them to a general audience to reconcile difference. She uses ethnographic methods to identify the socio-cultural and psychological drivers that underpin, facilitate and perpetuate behaviours. This understanding is essential for sustainable behaviour change. Her current research portfolio includes an environmental sustainability project to understand and reduce food waste behaviours, and a public service improvement project to understand customer experiences of crowding in the rail industry. Kirrilly can contribute a critical social science understanding of the ways in which climate change is perceived.

Dr Ernesto Valenzuela

Lecturer and Research Fellow, School of Economics, University of Adelaide

Ernesto obtained his PhD from Purdue and was a Fulbright scholar during his Masters studies. His research interests include quantitative economics and economy-wide modelling, and he is currently involved in developing a framework to assess demand and global climate changes in the wine industry. Prior to his current position at the University of Adelaide, Ernesto worked for the World Bank's Development Research Group in Washington DC and was involved as a moderator for WBI courses on trade policy and growth and as consultant for the World Bank's trade policy support program.

Human-induced accelerated climate change poses a great challenge to current agricultural production patterns. It is understood that extreme climate events would exacerbate productivity variations increasing food prices, thus disrupting consumption patterns. Increasing awareness of this substantial risk has not been met with a production-climate adaptation framework of how best to respond. This workshop represents an opportunity to delineate a formulation of climate change agricultural adaptation, which would serve to generate informed policy design and analysis.

Based on his experience in economy-wide modelling, and in particular with his understanding of agricultural markets, Ernesto is able to contribute in devising interlinks between climate change volatility and productivity variation measurement.

Dr Todor Vasiljevic

Senior Lecturer and Postgraduate Program Coordinator, School of Biomedical and Health Sciences, Faculty of Health, Engineering and Science, Victoria University

For the past six years Todor has been associated with Victoria University in the area of nutrition, food and health sciences. His research interests focus on sustainable utilisation of aqua- and agricultural resources and implementation of novel technologies in water and energy recovery. Specifically, he is interested in extending a number of fish species utilised for human food but processed in ways which will improve overall health whilst at the same time enhance the biodiversity of our marine ecosystem by decreasing the economic pressure on existing species. His other focus is on development and implementation of membrane technologies for achieving energy and water savings in major dairy processing, in order to reduce the consumption of potable water in the dairy industry in a carbon neutral way.

Over the next several decades, significant progress can and will be made towards more profitable, resource conserving, and environmentally sound aqua- and agricultural systems. Agriculture could, as a result, become a more rewarding profession, both economically and through stewardship of national land and water resources. With his involvement in this workshop, Todor will try to provide a valuable input to make these changes possible, based on new scientific knowledge, novel agricultural management tools and approaches, and economic necessity.

Dr Michelle Watt

Senior Research Scientist, CSIRO Plant Industry

Since joining CSIRO as a Postdoctoral Fellow in 2001, Michelle has worked on six projects with the Australian Grains Research and Development Corporation to improve wheat roots. Wheat is Australia's most important crop, and the world's most important temperate crop. She and her team apply new molecular and imaging techniques to 'see' how roots function and grow in farmer's fields, and use that information to improve roots with genetics or new land management practices. She has presented widely and has been recognised internationally with six keynote speaker invitations since 2006, and by CSIRO with a Julius Award for leading early- to mid-career researchers. Michelle leads projects with the US Department of Agriculture's Agricultural Research Service and the Indian Centre for Agricultural Research with ACIAR.

Michelle will share her experiences with research to increase agricultural productivity- identifying priorities, linking laboratory to field research and validation, applying new genetic models to crops, working within multidisciplinary teams, and communicating to growers, industry and scientific peers. She will discuss the benefits and challenges of working within large international projects, including with India. Michelle who currently supervises PhD students from Australia, China, Iran and India, is strongly committed to training the next generation of agricultural scientists



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