CSIRO PUBLISHING
Crop & Pasture Science, 2012, **63**, 297–301
http://dx.doi.org/10.1071/CP12149

Epilogue – Future challenges for the national climate change research strategy

Richard Eckard[A], *Alison Kelly*[B], *and Snow Barlow*[C]

[A]Primary Industries Climate Challenges Centre, University of Melbourne. Email: rjeckard@unimelb.edu.au
[B]National Program Manager, Climate Change Research Strategy for Primary Industries, University of Melbourne. Email: a.kelly@unimelb.edu.au
[C]Climate Change Research Strategy for Primary Industries, University of Melbourne, Vic., Australia. Email: s.barlow@unimelb.edu.au

Abstract. Australia's primary industries are likely to be uniquely impacted upon by climate change. In February 2011 the inaugural Climate Change Research Strategy for Primary Industries (CCRSPI) conference was held to discuss the current state of climate change research across Australia's primary industries. Never before had policy makers, producers and scientists from all sectors of our primary industries been brought together in one event to focus on the challenges and opportunities of climate change. This conference was a unique forum to address those challenges and opportunities by sharing knowledge across the various sectors, scientific disciplines and the industry-policy-science divide.

While this collection of review papers provides an excellent knowledge base for industry and government to plan and implement policy and make further research investments to address the obvious gaps there is still much to be done in terms of research and the co-ordination of research. The often unrelated research activity in the adaptation and mitigation components of climate change research have the potential to have either synergistic or antagonistic outcomes at several scales and in several sectors ranging from policy to industry and community. The significant injection of research and development funds into this area through the Carbon Farming Futures and other associated programs will provide further impetus to the need for national co-ordination of climate change research in Australia's Primary Industries.

To build on all this knowledge and experience gained at the 2011 CCRSPI Conference, CCRSPI is currently (2012) finalising the national climate change research strategy for the sector, with an associated audit of existing projects and capacity, in order to encourage and advocate the cross-sectoral RDE needs and co-ordination for the future.

Received 9 April 2012, accepted 12 April 2012, published online 28 May 2012

Introduction

Australia's primary industries are likely to be uniquely impacted upon by climate change. On one hand, as a major export exposed industry managing 65% of the driest inhabited continent, spanning a wide range of climates there will be many challenges to adapt to with the progression of climate change. Concurrent with this production and sustainability challenge, primary industries have a central role to play in greenhouse gas mitigation both reducing emissions and sequestering carbon into the landscape. The federal government has recognised the central role that the land-based sector can play in meeting the 2020 national target of a 5% reduction in greenhouse gas emissions through the introduction of the *Carbon Farming Initiative* (CFI) legislation, to create a mechanism to generate tradeable carbon credits. The subsequent *Clean Energy Future* legislation has provided a mechanism to purchase carbon credits from the land sector. This legislation has also recognised the significant research and development needs of the primary industries sector if it is to adequately respond to climate change and government policy.

This collection of review papers from the first Climate Change Research Strategy for Primary Industries (CCRSPI) conference expertly summarises the current state of climate change research across the themes of the conference nationally, with reference to international research. As such it provides an excellent knowledge base for industry and government to plan and implement policy and make further research investments to address the obvious gaps. While many gaps are highlighted in the individual chapters, the four major areas that emerged in the conference presentations and forums were:

- The engagement of farming communities in the face of an increasingly variable and changing climate;
- The contribution of the land-based sector to national mitigation targets;
- The integration and interface of adaptation research and productivity research in the face of mounting threats to global food security; and
- The integration of adaptation and mitigation agendas at a landscape scale for greatest benefit while avoiding perverse outcomes.

The engagement of farming communities in the face of an increasingly variable and changing climate

Future climate projections for Australia indicate generally warmer and drier conditions, moderated more in coastal regions than inland. In the short to medium term, incremental and systems adaptations may allow agriculture to adapt to the biophysical impacts (Rickards and Howden 2012). However, towards the latter half of the 21st century the biophysical impacts of climate change are likely to require more radical transformational adaptations in some areas (Rickards and Howden 2012). Overall, transformational adaptation offers great potential to manage the impacts of significant climate change but also brings risks, particularly in social and economic change. It reinforces the realisation that agricultural research can no longer remain insulated from off-farm, community and social knowledge or processes. Support and guidance of transformational adaptation requires that we understand how Australian agriculture is, and could be, positioned within landscapes, rural communities, and broader social, political and cultural environments (Rickards and Howden 2012).

Much of the agricultural research on climate change has focussed on the biophysical aspects, with little attention paid to the social and community impacts – despite the fact that over 90% of farms in Australia are still run by families. Some rural communities have already been significantly destabilised by climate variability and extreme events over the past decade (Alston 2012), eroding their financial and social capital. It is clear that the social implications of climate change require significant consideration in adaptation and mitigation strategies, as it is these farming families that will make the critical decisions. One contributing factor to the lack of engagement to date with rural communities has been their general mistrust in the science of climate change, with only 28% of primary producers agreeing that human activity is the cause of climate change (Donnelly *et al*. 2009). Further compounding this disengagement is the negative bias in much of the media coverage of climate change – between February and July 2011, 82% of articles published by one media outlet provided negative coverage on the issues around climate change policy, demonstrating a lack of balanced reporting (Bacon 2011). While some of these reports reflect genuine concern within the community, much of the negative reporting of climate science is not balanced.

Alongside the climate change related shifts in policy and community dynamics, the farming sector has witnessed substantial changes in economic conditions over the past few decades. However, productivity growth as a percentage of agricultural gross domestic product has been in steady decline since 1987 (Mullen and Crean 2007), with farmers' terms of trade following the same trend (ABARE 2009). A key driver of agricultural productivity growth is agricultural research and development (R&D) and education investment, but trends over recent decades indicate that public agricultural R&D investment levels are declining in real terms, as are enrolments in tertiary education in agriculture. This will eventually erode the skills-base and capacity to meet these challenges. Addressing the multiple challenges of productivity and profitability, coupled with environmental sustainability and restoration of a degraded resource base, will require a significant increase in investment. There has been some suggestion that the private sector should increase agricultural R&D investment and become more important as a driver of agricultural productivity; however, this may require strategic partnership with government.

The contribution of the land-based sector to national mitigation targets

Despite a lack of engagement at the community level around impacts of future climate change, much has happened in the agricultural sector in 2011 with regard to climate change policy. As outlined above, the passage of the *Clean Energy Future* legislation including the *Land Sector Package* (*Carbon tax*) (DCCEE 2011) and *Carbon Farming Initiative* (CFI) legislation (DCCEE 2010) has brought more certainty to the policy implications of climate change but also signalled the start of a carbon-constrained future. While agriculture is not a covered sector under the carbon pricing mechanism, farmers can expect to pay more for purchased electricity and for long haul transport (from 1 July 2014) as the carbon price is passed through. The scale of the price impact will depend on producers' dependence on fossil fuels.

The CFI is an incentive based mechanism for land holders to generate income for actions that result in real reductions in methane and nitrous oxide emissions, plus increasing the amount of carbon in soils and vegetation in the land based sector (Cowie *et al*. 2012). While there are many possibilities in these areas to reduce emissions (Henry *et al*. 2012) and/or increase carbon sequestration into the landscape (Baldock *et al*. 2012), these activities need to be integrated into the farm system in a balanced manner to ensure continued farm productivity and profitability. There is currently a lack of tools to assess options and assist landholders make informed decisions about how best to integrate possible carbon farming projects with their existing production systems.

Clearly it is too early to evaluate the impact of the CFI to farming operations and the measurement, auditing and marketing of carbon credits, with much research to be done to identify productive mitigation technologies and practices and cost effective carbon credit measurement and marketing systems. The research and demonstration challenge going forward is to develop a range of activities and technologies that act synergistically rather than antagonistically with productive and profitable farming, while delivering significant mitigation into the national accounts. A key imperative in this area is the development of appropriate measurement and abatement methodologies utilising the outcomes of the current research programs. It is only with the availability of methodologies approved by the *Domestic Offsets Integrity Committee* that landholders and managers can begin to develop appropriate projects at a farm scale.

The integration and interface of adaptation research and productivity research in the face of looming threats to global food security

Globally the pendulum has begun to swing, with the issues of land degradation, food scarcity, climate change, greenhouse

gas emissions and water all raising the profile of food production and the imminent need to invest in sustainable food production. Increase in demand for food has resulted in higher global food prices that are likely to be sustained into the foreseeable future, providing an optimistic medium term outlook for agricultural production. There is still, however, a lag between this increasing awareness and government investment in agricultural development. The recent *Land Sector Package* announcement in Australia (DCCEE 2011) represents initial recognition that some of these issues need addressing by government.

A suite of new terminology is emerging as scientists and leaders attempt to point the way forward for agriculture to meet these multiple challenges. Some of these concepts include:

- *Conservation Agriculture* – a concept for resource-saving agricultural crop production that strives to achieve acceptable profits together with high and sustained production levels while concurrently conserving the environment (http://www.fao.org/ag/ca/);
- *Climate-Smart Agriculture* – adapting to climate change while producing more food to feed the world's growing population (http://www.fao.org/climatechange/climatesmart/en/); and
- *Sustainable Intensification* – incorporating a range of concepts, including Conservation Agriculture and Climate-Smart Agriculture, Sustainable Intensification is simply described as producing more food from the same area of land while reducing the environmental impacts (Pretty *et al*. 2011).

Nationally the *Land Sector Package* incorporating a substantial *Carbon Farming Futures* research, demonstration and extension package worth $429 million over six years, provides a significant research investment to begin to address the multiple challenges associated with a changing climate, addressing both the mitigation and adaptation challenges in an integrated way. The challenge for policy makers and research managers alike will be to ensure that these research investments embrace productivity as well as mitigation without developing systems that deliver potentially perverse outcomes in adaptation and /or mitigation or both.

While there is a need to increase productivity and profitability in agriculture, it is also increasingly clear that this can no longer be achieved by merely further increasing inputs, particularly of water and nitrogen, and/or simply cultivating more land. Synthetic fertilisers are increasingly part of the environmental problem and applying more of the same cannot be the solution. Research will require clear focus on improving the efficiency of conversion of energy (fossil fuels and sunlight), carbon (including soil carbon and animal methane), water and nitrogen into agricultural product. Our cropping systems still only convert around half of the nitrogen into food products, and in grazing systems two-thirds of the nitrogen is commonly lost to the environment (de Klein and Eckard 2008). Clearly there is room for improved nitrogen use efficiency and focus on technologies that decouple this input to output ratio. Genetic advances through a range of technologies will continue to make contributions to productivity improvements, but they must also be applied to the efficiency of input use, such as nitrogen, including raising atmospheric carbon dioxide levels (Chapman *et al*. 2012).

Ultimately a substantial part of the required productivity gains will have to come from new systems incorporating improved technology but also managed in different ways that are allowed by greater access to 'real-time information'. For example the resilience of modern agriculture mono culture production systems that emerged in the Green Revolution to future climate extremes has been questioned (Hayman *et al*. 2012). Future farming systems that incorporate broader biodiversity in soil, plant and animal species are likely to be more resilient, with mixed cropping systems providing farmers with more options to respond to an emerging season and market prices than a monoculture crop system (Hayman *et al*. 2012). A broader definition of sustainability is also needed that includes consideration of the resilience of the resource base in future climates, the profitability and socioeconomic capacity of rural communities.

The integration of adaptation and mitigation agendas at a landscape scale for greatest benefit while avoiding perverse outcomes

One of the strongest messages delivered to the 2011 CCRSPI Conference, delivered by both Jason Alexandra and Andrew Campbell, was the potential of climate change to shape future Australian landscapes through both the direct impacts of climate and policy. As landscape management results from the dynamic interplay between knowledge, governance, and the specific policy settings at any instant in time, capacity to adapt depends on the functionalities of the governance arrangements and their ability to respond to new circumstances, new knowledge and new evidence and the new values and beliefs of the people. Given that global climate change demands new rules and new relationships with the earth (Alexandra 2012) this is even more the case in Australia.

Since the 2011 CCRSPI Conference this has been further emphasised by the establishment of the *Biodiversity Fund* within the *Land Sector Package*, which will inject $960 million into the Australian landscape in the next 6 years to preserve biodiversity and increase carbon storage in the landscape. The *Biodiversity Fund* is likely to make a substantial investment in biodiversity corridors to aid landscape adaptation to future climates and the likelihood of increasing frequency of extreme events. Resources are also available for Australia's 56 Natural Resource Management (NRM) regions to develop and/or refine their regional management plans in the light of downscaled regional climate change projections.

These initiatives together with the carbon plantings available under the CFI have great potential for stimulating change and reshaping the Australian landscape of which primary industries are the major custodians. Primary industries nationally and within the regions must be aware of these reshaping forces and participate strongly in the ongoing planning processes. The pricing of water and now carbon could have transformative influences on the land use across Australia. The Climate

Change Research Strategy for Primary Industries (CCRSPI) must be cognisant of these potentially powerful drivers for land use change in the landscape the across nation. Appropriate research and extension is required to evaluate the potential outcomes of land use changes and strive for a balance between planting vegetation for carbon and biodiversity and retaining productive agricultural land in order to ensure that the eventual outcomes are synergistic rather than perverse.

Road forward for CCRSPI

The inaugural 2011 CCRSPI Conference was held over three days in Melbourne (15–17 February, 2011) at the Melbourne Cricket Ground (MCG) and surrounding venues. The conference was an opportunity to share knowledge and information and ensure the best available science in the agricultural sector is understood and interrogated for relevance by other sectors. It aimed to facilitate quality communication between all primary industry sectors – and in doing so bring together a strategic combination of farmers, scientists and policy makers. The directive from the conference Chair (Dr Michael Robinson) was to make sure people felt the event was a success – measured by level of participation and contribution to sessions, level of interaction and participation between sessions. The objective of CCRSPI is to achieve cross sectoral collaboration across primary industries – the 2011 CCRSPI Conference was a primary tool in achieving that.

Never before had policy makers, producers and scientists from all sectors of our primary industries been brought together in one event to focus on the challenges and opportunities of climate change. This conference was a unique forum to address those challenges and opportunities by sharing knowledge across the various sectors, scientific disciplines and the industry-policy-science divide.

Many respondents had constructive feedback regarding the format of both this event and subsequent CCRSPI Conferences. Particularly common was the suggestion to get more 'industry' people involved in the conference (as both speakers and delegates) – farmers, consultants, advisors etc – and to do more to 'bridge the gaps' between research, policy and industry. Respondents also provided a wide range of suggestions of topics that were under-represented, or that should be included in future events. However, there was significant interest from all participants in the synthesis keynote presentations and their associated papers, represented within this Special Issue.

The suite of synthesis papers have provided an overview of key climate change relevant topics, and especially highlighting their specific nuances related to:

- Climate change impacts – at multiple levels including general community, sector, and/or region;
- Options for adaptation to new climate;
- Options for mitigation in response to policy settings (assumed driver), for example water use efficiency and/or carbon sequestration;
- Assessment of current knowledge and activity;
- Assessment of current gaps in activity;
- Identification of priorities (by region, sector, general community); and
- Identification of grower adoption.

While this provides a great summary of knowledge within these topics, there is still a need to address the issue of how further cross-sectoral R&D can be implemented more effectively. There were some feelings among conference participants that priorities for action in this space had been identified and it was now time to agree on how and who is most appropriate to get them implemented. There was a need to emphasise the importance of research that:

- Engages with both policy and farming communities;
- Addresses questions to inform future policy decisions;
- Leverages of existing national and international science; and
- Embraces the social elements of adoption of outcomes (such as social and institutional barriers).

Building on all this knowledge and experience gained at the 2011 CCRSPI Conference, CCRSPI is currently (2012) finalising the national climate change research strategy for the sector, with an associated audit of existing projects and capacity, in order to encourage and advocate the cross-sectoral RDE needs for the future.

References

ABARE (2009) Australian Commodity Statistics, 2009.

Alexandra J (2012) Australia's landscapes in a changing climate—caution, hope, inspiration and transformation. *Crop & Pasture Science* **63**, 215–231.

Alston M (2012) Synthesis paper on socioeconomic factors relating to agriculture and community development. *Crop & Pasture Science* **63**, 232–239.

Bacon W (2011) A SCEPTICAL CLIMATE Media coverage of climate change in Australia 2011. Part 1–Climate Change Policy. The Australian Centre for Independent Journalism (ACIJ), The University of Technology, Sydney. p. 70.

Baldock JA, Wheeler I, McKenzie N, McBratney A (2012) Soils and climate change: potential impacts on carbon stocks, greenhouse gas emissions and future research for Australian agriculture. *Crop & Pasture Science* **63**, 269–283.

Chapman SC, Chakraborty S, Fernanda Dreccer M, Howden SM (2012) Plant adaptation to climate change–opportunities and priorities in breeding. *Crop & Pasture Science* **63**, 251–268.

Cowie A, Eckard R, Eady S (2012) Greenhouse gas accounting for inventory, emissions trading and life cycle assessment in the land-based sector: a review. *Crop & Pasture Science* **63**, 284–296.

DCCEE (2010) Design of the Carbon Farming Initiative, Consultation paper. Department of Climate Change and Energy Efficiency, Canberra, ACT.

DCCEE (2011) Securing a clean energy future: The Australian Government's Climate Change Plan. Department of Climate Change and Energy Efficiency, Canberra, ACT. p. 135.

de Klein CAM, Eckard RJ (2008) Targeted technologies for nitrous oxide abatement from animal agriculture. *Australian Journal of Experimental Agriculture* **48**, 14–20. doi:10.1071/EA07217

Donnelly D, Mercer R, Dickson J, Wu E (2009) Understanding behaviours, attitudes and preferences relating to climate change; Australia's Farming Future Final Market Research Report, October 2009. Prepared for Australian Government Department of Agriculture, Fisheries and Forestry. Instinct and Reason, NSW, Australia. p. 92.

Hayman P, Rickards L, Eckard R, Lemerle D (2012) Climate change through the farming systems lens: challenges and opportunities for farming in Australia. *Crop & Pasture Science* **63**, 203–214.

Henry B, Charmley E, Eckard R, Gaughan JB, Hegarty R (2012) Livestock production in a changing climate: adaptation and mitigation research in Australia. *Crop & Pasture Science* **63**, 191–202.

Mullen JD, Crean J (2007) 'Productivity growth in Australian agriculture: trends, sources, performance.' (Australian Farm Institute: Sydney)

Pretty J, Toulmin C, Williams S (2011) Sustainable Intensification – Increasing Productivity in African Food and Agricultural Systems. International Journal of Agricultural Sustainability, February 2011. p. 200.

Rickards L, Howden SM (2012) Transformational adaptation: agriculture and climate change. *Crop & Pasture Science* **63**, 240–250.