The challenge of engaging with farmers about the impacts of, and their adaptation to, climate change

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Abstract
Some recent funding programs on climate adaptation have expected active engagement with farmers in research projects. Based on our direct experience we list ten reasons why it is difficult to gain traction with farmers in discussing the likely impacts of climate change on their farms and the possible adaptation options they should be considering in preparation for a future changed climate. The ten reasons concern the slow and uncertain trajectory for changes in climate relative to the time horizon for farm decision making, when set against short term fluctuations in weather, prices, costs and government policy and on-going optimism for technological progress. We propose there is a role for agricultural science and economics to contribute to meaningful analysis of impacts and adaptation to climate change by farmers. This will involve emphasising the principles of farm management rather than defining optimal farm plans; the use of scenario planning to explore possible futures in a turbulent environment for farming, and understanding the linkages between adaptation options and enabling factors and technologies.

Key Words
Climate change, grain growers, rainfall, global warming, economics, farm management

Introduction
One of the policy responses to the projected impacts of global warming on Australian agriculture has been the funding of research, development and extension programs with the aim to quantify the impacts of climate change on agriculture, identify and develop adaptation responses, and to provide climate information in a form that is useful to decision makers (Stokes and Howden 2010). In some of these programs the funding bodies expect the involvement of farmers as project participants to critique results, with the rationale that a participatory approach will add credibility amongst the wider farming community for the research results and will expedite informed action by farmers. Through our involvement in a national program of such projects we encountered widespread scepticism about climate change, particularly around the urgency for the need to change. This scepticism has led us to reflect on why it is difficult to gain traction with farmers in discussing the likely impacts of climate change on their farms and the possible adaptation options they should be considering in preparation for a future changed climate. Our motivation for this paper is to clearly define for us the opportunities for agricultural science and economics to contribute to meaningful analysis of impacts and adaptation to climate change by farmers. Our views are couched in terms of ten reasons why we believe discussions and analysis on climate change is difficult with farmers, and informed by our involvement with farmer participants in one project, as well as more general interactions with wheat-sheep farmers in Western Australia (WA). WA is one of the regions in Australia that has experienced climate drying in the last 30 years and one of the highest projected reductions in rainfall for any broadacre cropping region in Australia. Our starting assumption is that farmers' views are not motivated solely by scepticism about anthropogenic climate change or antagonism towards the recent policy responses from the Australian Government.

Ten reasons
Reason 1: Climate change is a slow-moving variable.
Current projections indicate that changes in carbon dioxide and temperature are gradual, at least in terms of the urgency of response required by farmers. The IPCC defines a range of future trends of atmospheric carbon dioxide concentrations that depend on rate of emissions, the degree of economic development and the scale of potential mitigation by the international community (IPCC 2007). Current atmospheric levels are around 380 ppm and the range of predicted concentrations for 2030 are 450-460 ppm and by 2050 are 450-560 ppm. Global carbon dioxide concentrations are currently tracking at the upper end of these scenarios. The associated temperature rises and rainfall reductions predicted by general circulation models (GCMs) project that for WA by 2030, a 0.5-1.2^{o}C increase is associated with around a 10-20% fall in annual rainfall and by 2050 a 2-2.5^{o}C increase is associated with around a 40% fall in annual rainfall. This corresponds to a 1-6% fall in simulated average wheat yield in 2030 and 4-20% fall by 2050 (with one outlier of 28%

reduction) (Figure 1). CVs for annual rainfall and yield increased from 30 to 40% over the range of future climate scenarios.

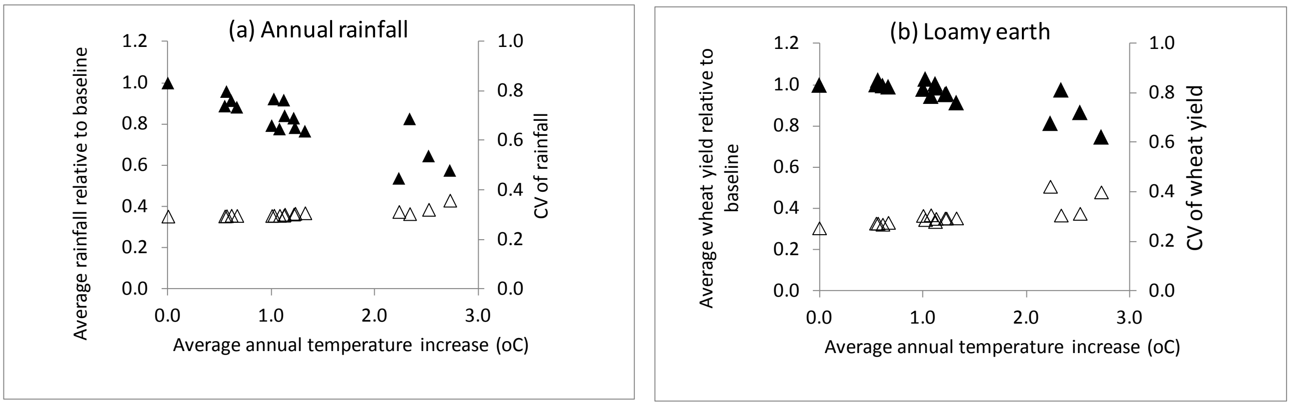

Figure 1: Scatter plot of projected change in rainfall from 16 GCM runs (4 models x 2 emission scenarios x 2 time frames of 2030 and 2050) and change in mean (filled triangle) and CV (hollow triangle) of annual rainfall and wheat yield simulated by the crop growth model APSIM, where the x-axis is the change in mean annual temperature under each scenario. Climate is for Mullewa Western Australia and APSIM-simulated wheat yields are for a loamy earth soil type. Results are presented relative to an historical baseline of 1961-2010.

Reason 2: Climate change projections are uncertain

Climate change projections are subject to uncertainty as a result of model limitations (GCM output) and variation in the emissions scenarios due to political and economic uncertainty, and errors when incorporated in applications models. Outcomes from possible scenarios widen with time. In Figure 1 with a combination of four contrasting GCMs and low and high emissions scenarios, the range of projected increases by 2030 in carbon dioxide (450-460 ppm), temperature (0.5-1.2^{o}C), reduction in rainfall (5-21%) and reduction in wheat yield (1-6%) is quite small. At 2050, this range widens considerably to 450-560 ppm for carbon dioxide, 2-2.5^{o}C for temperature, 20-54% for rainfall and 4-28% for wheat yield. Herein lies the paradox with uncertainty around climate projections. In the short term, where impacts are likely to be small, the uncertainty is small; whereas further into the future where potential impacts could be substantial, the range of possible outcomes are much wider, spanning from a situation similar to the short term through to large negative effects.

Reason 3: Time horizons for farm planning are relatively short

Farmer decision making can be classified as operational, sequential and strategic, with an increasing time horizon of the decision at stake. In our conversations with farmers, advisors and consultants strategic decision making rarely goes beyond the time frame of 10 years, and if it does, it is to address human issues of succession planning and retirement. When seen against the relatively slow-moving changes associated with climate change it is not surprising that there is little appetite for pre-emptive changes to farm operations, tactics or strategy.

Reason 4: Managing the "here and now" of climate, price and cost variability takes precedence

Australian agriculture typically has a high degree of intra- and inter-annual variability in climate. Seasonal variability is exacerbated by variability in commodity prices and input costs to create volatility in farm income. By way of example, Kingwell (2011) has shown that recent (last 10 years) movements in yields and prices experienced by Australian wheat growers have led to enhanced volatility in income. In an ironical twist, the enhanced income volatility has reinforced the view amongst the farming community to concentrate on managing short-term variability rather than longer-term climate change, even though climate scientists postulate that the recent enhanced variability in seasonal conditions is one of the symptoms of climate change.

Reason 5: Confidence in technological progress keeping pace with negative impacts of climate change

Australian broadacre agriculture has an impressive record of progress in production and total factor productivity (production expressed as a ratio of inputs used). For example, Robertson (2010) cites 20 year rates of increase in yields of broadacre crops per hectare and meat, wool, and milk per head that vary between 1 and 2% when expressed at 2010 as the baseline. WA wheat yields have increased by around 100%

over the last 30 years (Turner and Asseng 2005). Estimates based on cautious assumptions about technology innovation and adoption suggest that production increases ought to be able to be maintained at those levels (Robertson 2010).

Reason 6: Agriculture has been faced with, and adapted to, larger and more sudden shocks.
In the last 50 years, farmers have faced a continuously changing business environment, in part due to the drive for deregulation of the economy. Governments have deregulated the financial sector (in particular interest rates), marketing arrangements (in particular prices and marketing boards), drought policy and research, development and extension services. At the same time, governments have introduced legislation requiring farmers to comply with occupational health and safety, chemical use and environmental requirements. The context for farming businesses is one of an increasing rate of change and increasing complexity. For example, the collapse of the wool reserve price scheme in 1991 lead to a subsequent halving of the price by 1993. Shortages of wool following droughts in the early 1990's then lead to a quadrupling of price in two years. Such fluctuations are sudden, severe and unexpected.

Reason 7: The short-term impacts of climate change policy are more immediate than changes in climate
The public debate about climate change and rural Australia has been dominated by discussion about the impacts of imminent climate change policy rather than climate change itself. This includes higher costs associated with the carbon tax; the opportunities (and potential costs and regulations) associated with the Carbon Farming Initiative; and the threat of restrictions to market access for Australian produce.

Reason 8: Adaptation options do not offer much that is new
Adaptation responses have been classified in terms of their type and extent (Stafford Smith et al. 2010).
• Same type and extent. This includes options currently being used by farmers and the appropriate adaptation response is to use them at a similar scale and extent to the present. These are practices that are adopted, or will be adopted even in the absence of climate change (Asseng and Pannell 2011).
• Same type with different extent. This includes options currently being used by farmers but may increase in scale, intensity or frequency with adaptation to climate change, e.g. fallowing (Oliver and Robertson 2010).
• Different type and extent. These are practices that are not used now or only by the isolated leading innovators. The degree to which a pre-emptive adoption of such new practices will be superior to current practice will depend on observed changes in climate.

The options we elicited from farmers in workshops are either well adopted already, or at least the farming community are aware of them and hence fell into the first two categories. Can science generate genuinely new adaptation options that farmers are not already using or at least aware of?

Reason 9: Science does not have much to offer to support longer-term more transformational decisions
As one moves from incremental to transformational adaptation options, the value of technical options, advice and analysis reduces because decisions become based more on business structure, portfolio management, off-farm investments, and geographical diversification. Consequently, the potential contribution of agronomy and farm management economics diminishes and the importance increases of factors such as preferences, attitudes to risk, skills, values, and identification with farming as a vocation. This relegates the need for technically-based input and accentuates the need for "soft" systems approaches, tailored advice and scenario analysis. The role of individual factors in the adoption of a particular transformative adaptation option becomes greater, and there is less need for generating technology-based options.

Reason 10: Some farmers doubt the purity of intentions of researchers.
Science is a business and this has led some to cynically conclude that it is in the best interests of researchers to paint a grim picture of the negative impacts of climate change, an urgent call for adaptation and more science to underpin the projections and efficacy of various adaptation strategies.

How can research, development and extension contribute?
While we have listed ten reasons why it can be difficult to engage with farmers around the issue of climate change, and questioned the role for research, development and extension, we propose that there is a role, albeit reduced, in contributing to discussion on the issue.

Emphasise farm management rather than farming systems

A number of studies on impacts of, and adaptation to, extended droughts in southern Australia (e.g. Lawes et al. 2012) have highlighted the importance of farm management by farmers that were successful in adapting to and surviving the drought. This suggests that the role of research is less about identifying optimal strategies, farm plans, or enterprise mixes, but rather analysing the principles of farm management to understand past changes and their impacts on agriculture (Asseng and Pannell 2011). This research can provide insights to current and/or future adaptation strategies for farmers, increasing confidence about whether adaptation is currently warranted.

Scenario planning in turbulent environments
Traditionally strategic planning has relied on forecasts of the future to guide planning, either economic forecasts or market research forecasts or a combination of these and other forecasts. However, in a turbulent environment, such as under climate change, where it is impossible to forecast with any degree of reliability, other approaches are required (Grant 2003). One such approach is to use scenario planning, which involves imagining multiple, alternative views of the future, with each scenario having distinct assumptions about the levels for the key variables driving the business. The aim is to develop understanding of the critical uncertainties and relationships in the business environment so that the management will have some understanding of the potential transformations in the environment before they occur.

Understanding the context for single adaptation options
Understanding system interactions and feedback when examining the adaptation options needs to take a "rich picture" approach, rather than examine individual options alone. The aim is to understand the decision-making environment, the role of enabling technologies or practices (current and future), and factors that may enhance or mitigate against the efficacy of the adaptation option under examination.

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