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Assessing the capacity of Australian broadacre mixed farmers to adapt to climate change: Identifying constraints and opportunities

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ABSTRACT

Farmers are continually striving to adapt to Australia's highly variable climate. As a function of global warming, future climatic conditions will present further challenges, but may also present many new opportunities for farmers. We involved a range of rural communities via 14 workshops across a range of Australia's large-scale broadacre cropping regions employing a rural livelihoods framework to elicit and interpret community responses. Farmers identified indicators and rated them on the extent to which they might constrain or enable adaption to increased climate variability or climate change. Financial issues, such as low equity or limited capital were considered to be most constraining, and natural capital assets, such as high soil productivity and low rainfall variability were considered to be most enabling. Most indicators were of broad-scale significance, affecting broadacre mixed farmers across a range of locations, and were not necessarily specific to climate change only. Broad-scale constraints identified were isolation/rural decline, limited access to services, poor regional infrastructure, equity/debt, and the high cost of production. Conversely, enabling factors identified were farmer education/experience, sense of community, and off-farm income. Actions to address these perceived constraints related to farm management practices, training, community, technology/research, communication, funding and institutional arrangements. In the Australian context, adapting to climate variability and change is more than just implementing a new technology, but is also about enhancing the broader resilience of the community in ways that will ensure its long term viability. To achieve this it will be necessary for different components of government and other institutional actors to work together to improve the adaptation capacity of farmers in the future.

1. Introduction

Australia will be subjected to a range of climate change impacts including higher temperatures and shifting regional rainfall patterns (Hennessy et al., 2010). Water availability is likely to be more important than temperature given crops can be grown under thermal stress if sufficient water is provided to the crop (Lizumi and Ramankutty, 2015; Thornton et al., 2014). Resultant impacts on agricultural production as simulated by a range of biophysical models suggest that adaptation will be required for farmers to maintain or increase production (Dai, 2012; Easterling et al., 2007; Howden et al., 2007; Howden and Crimp, 2011; Laing et al., 2009; Lobell et al., 2011). Despite these negative production implications, surveys reveal that less than half of the farmers in Western Australia (Evans et al., 2011) and in Victoria (Schwarz et al., 2012) stated that they agreed that climate change was occurring or that it was a threat to their farm business, however, Steffen et al. (2011) argues that producers and industry themselves can best define significant climate risks. Australian farmers are experienced in dealing with highly variable climatic conditions, and are relatively well supported by industry and research to maximise production/profit under such conditions (Kingwell et al., 2013). Despite this preparedness ongoing changes in extremes will severely test existing coping strategies, raising the question: do producers think that current management strategies be sufficient in the future? Marshall et al. (2013) noted that primary producers that have a greater awareness of the potential impacts of climate change also have a greater capacity to adapt.

At a global scale food security and food production are issues of increasing concern in response to both a rapidly growing population driving demand and a series of climatic extremes that have served to interrupt supply (Nelson et al., 2009; Schmidhuber and Tubiello, 2007). Australian farmers produce almost 93% of Australia's daily domestic food supply and export 60% (in volume) of total agricultural production (PMSEIC, 2010). Australian food production represents 1% of all food consumed in the world feeding some 40 million people each day

Abbreviations: CMA, Catchment Management Authority; DAFWA, Department of Agriculture and Food Western Australia; DPI, Department of Primary Industries; GRDC, Grains Research and Development Corporation; I&I, New South Wales department of Industry and Investment; LHPA, Livestock Health and Pest Authority; NRM, Natural Resource Management (agency); QMDC, Queensland Murray-Darling Committee; SEQ, South East Queensland; WUE, water use efficiency.

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outside Australia (PMSEIC, 2010). While Australia is well placed to continue to be a major producer, consumer and exporter of agricultural products into the future, the next 40 years will see new challenges which will need to be considered and addressed, including: (1) maintaining the quality of land, water and biological resources whilst enhancing productivity; (2) adapting to climate change and its related impacts and legislative responses; and (3) dealing with declining terms of trade. If Australian farmers wish to continue farming, and to run profitable enterprises in the future, then they will need to be able to respond to a range of these challenges. Identifying existing and future challenges and opportunities and exploring appropriate responses should enable farmers to increase their capacity to adapt, particularly if they are involved in identifying the solutions (Adger et al., 2009; Engle, 2011).

In an agricultural context, adaptation can be interpreted as 'the decision-making process and the set of actions undertaken to maintain the capacity to deal with current or future predicted change' (Nelson et al., 2007, p. 396). Adaptation can also be viewed as adjustments in ecological, social and economic systems in response to observed or expected changes in climate stimuli under which change in farm management will occur in response to perceived future constraints or benefits (Adger et al., 2005; Stokes and Howden, 2010). These adaptation responses can occur on a range of spatial and temporal scales and various models have been developed to describe potential responses including incremental to transformational adaptation (Howden et al., 2010; Nelson et al., 2007) and transitional to transformational change (Brown et al., 2015, Pelling, 2011). These adaptive or anticipatory responses may be supported by policy initiatives across a range of scales from local to national governance levels (Adger et al., 2005). For example, the Tasmanian Government, with funding from the Commonwealth, has instigated the development of irrigation infrastructure across the State in an effort to reduce the impact of drought on agricultural production. Farmers needed to commit to a regional irrigation scheme before infrastructure was provided. Support during the process of adapting from dryland to irrigated agriculture was provided by a State Government organisation, Tasmanian Irrigation (http://www.tasmanianirrigation.com.au/).

Ongoing adaptation to changing physical and socio-economic conditions will require continued building of adaptive capacity. To do this within the context of Australian large-scale broadacre agriculture will require ongoing dialogue with farmers and rural communities in order to identify perceived current barriers and potential synergies to improve adaptive capacity and to develop well-targeted adaptation policies (Adger and Vincent, 2005; Below et al., 2012, Smit and Wandel, 2006). Uptake of adaptation policies, particularly top-down initiatives, will result in change on the ground only where they are perceived to be of benefit, thus an understanding of local context is important (Morse et al., 2009). Marshall et al. (2010, p. 251) concluded that 'the impact of climate change on agriculture will only be moderated if adaptation options are effectively implemented on the ground by individual managers'. Understanding farmers' perceptions is necessary to develop appropriate policy options, building on strengths and reducing the influence of weaknesses. Given the variation in potential climate impacts and the variable nature of farming across Australia, it is necessary to understand the extent of similarity or differences in issues being faced to better understand and ultimately facilitate adaptation.

The aim of our work was to better understand and assess rural community perspectives on adaptive capacity to climate change and to identify commonalities among perceived barriers to adaptation for a range of communities across Australia. We achieved this through a series of structured workshops with rural landholders involved in mixed cropping/grazing agricultural enterprises across six states of Australia. In order to provide a common framing for the responses from disparate rural communities, a five capitals approach was employed (Chambers and Conway, 1992; Ellis, 2000; Scoones, 1998). An important advantage of this actor-oriented perspective (De Haan, 2012) or 'bottom-up' approach was the commonality with other top-down studies using national-level data to develop and map adaptive capacity of broadacre farming communities (Crimp et al., 2010; Nelson et al., 2010a, 2010b). This bottom-up participatory approach lends itself to the development of a better understanding of farmers' perceptions of the relative strengths of their asset base i.e. the five capitals; human, social, natural, physical and financial, and combined with the targeted involvement of local community leaders, i.e. those who facilitate change at the local level (Morse et al., 2009), the approach allows for more informed policy development, and potential for on-ground change around climate adaptation strategies. Such an approach has not been undertaken before across multiple locations across Australia. We asked: (1) What are the perceived national and regional constraints and opportunities that face broadacre farmers in Australia under climate change? (2) What do farmers suggest needs to be done to build adaptive capacity in the rural communities? (3) What institutional arrangements are likely to facilitate adaptation to climate change?

2. Methods

2.1. Adaptive capacity workshops

Fourteen workshops were conducted across rural communities reliant on large-scale mixed cropping/grazing enterprises in the six Australian states of Western Australia, South Australia, Victoria, Tasmania, New South Wales and Queensland (Fig. 1). In this context, mixed broadacre farming refers to large-scale production of grains, oilseeds and other crops and grazing of livestock for meat or wool on large parcels of land (>1000 ha). These enterprises are important to Australia's export economy and the rural communities examined in this study formed part of a broader study where farmers and researchers worked together to identify and examine a range of adaptation options to manage for increased climate variability and climate change (Crimp et al., 2013; Rodriguez et al., 2014). Local coordinators involved in the broader study were utilised to ensure the inclusion of community members who had wider land management or natural resource management interests in order to capture perspectives of participants broader than just as farmers. These community leaders were potentially important due to their influence in implementing on-ground change with respect to developing and implementing adaptation options (Morse et al., 2009). The workshops were conducted from April 2010 to July 2011, and involved 115 participants (Table 1), excluding researchers and state-based local coordinators. As is common in rural communities, many participants had multiple roles, for example, most government staff were also farmers.

At the beginning of each workshop, a local coordinator provided background information regarding the likely regional implications of projected climate change for the near-term period 2030. The projection information was derived from four General Circulation Models (GCMs) used in the Inter-governmental Panel on Climate Change Fourth Assessment Report (AR4). The GCMs were selected based on formal evaluation of performance over Australia and represented four of the top eight performing models in terms of simulating Australian climatologies (Moise et al., 2015). This selection of models resulted in a range of climate future states all clustered around warmer and drier future conditions. The participants were then asked to describe their farming system (mix of cropping/grazing, farm size, etc.) and to draw an area on a map that they felt best represented the area they had knowledge of and therefore felt comfortable representing in response to the workshop questions (shown in Fig. 1). There are weaknesses to this approach (farmer's perceptions of spatial expertise, who was present on the day, less local specificity, etc.), however the areas reflected the diversity of landuse and community resilience. Some participants (e.g. rural finance councillor or government agents) had a good understanding of issues over a broader region. This was followed by a facilitated discussion around the implications these changes may have