Australian Government
Rural Industries Research and Development Corporation

Decisions Made by Farmers that Relate to Climate Change

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February 2011

RIRDC Publication No. 10/208
RIRDC Project No. PRJ-004546

ISBN 978-1-74254-173-0
ISSN 1440-6845

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Electronically published by RIRDC in February
Print-on-demand by Union Offset Printing, Canberra at www.rirdc.gov.au
or phone 1300 634 313

Foreword

Climate variability is one of many risks managed by Australian farmers. Policy making will be enhanced by policy makers having insight into how farmers perceive climate change in relation to their farming practices. This report fills a critical gap in our understanding of farmers' decision making in the face of climate change.

The report reveals that a majority of farmers are struggling financially in the short term in the face of a myriad of challenges which go beyond longer term trends in climate. Adaptive responses to climate change will present challenges to individual farmers and has the potential to lead to social change in some parts of rural Australia through changing farming practices, income levels and employment opportunities.

The report highlights the need for policy makers to understand the dynamics of farm decision making. Not all farmers will respond to climate change challenges in the same way, and policies that enable structured adjustment need the flexibility to cope with this.

This report is an addition to RIRDC's diverse range of over 2000 research publications and it forms part of our Global Challenges R&D program, which aims to address emerging and current issues through R&D, including global competitiveness, market access and trade barriers, productivity and climate change, that will lead to a globally competitive Australian agricultural sector.

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Acknowledgments

This study was funded by the Rural Industries Research and Development Corporation (RIRDC), and the research team would especially like to thank Margie Thomson and Simon Winter from RIRDC for their support.

The study would not have been possible without the support of the Department of Agriculture, Fisheries and Forestry and the Bureau of Rural Sciences who enabled us to access the Climate Risk and Adaptation dataset. We would particularly like to thank the staff in the Department of Agriculture, Fisheries and Forestry Climate Change section (Lee Nelson & Nadia Bouhafs) and the Bureau of Rural Sciences Social Science Program (Quentin Hart and Rob Kancans).

Abbreviations

Bureau of Rural Sciences	BRS
Department of Agriculture, Fisheries and Forestry	DAFF
Department of Families, Housing, Community Services & Indigenous Affairs	FaHCSIA
Greenhouse gas emissions	GHGEs
Household Income Labour Dynamics of Australia Survey	HILDA
Natural resource management	NRM
Rural Industries Research and Development Corporation	RIRDC

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Executive Summary

What the report is about

This paper reports on a study of 4,000 Australian farmers. It examines factors that are associated with decisions they may or may not make to adapt to risks posed by climate change.

Who is the report targeted at?

The material reported in this paper will be of relevance to policy makers, social researchers, industry groups and farmers, as they address the many adaptive challenges posed to agriculture by climate change.

Where are the relevant industries located in Australia?

This paper is based on an analysis of a dataset provided by the Department of Agriculture, Fisheries and Forestry. It covers farmers from across Australia working in horticulture and broad-acre farming.

Background

In 2008, the Bureau of Rural Sciences (BRS) conducted a national study of farmers' attitudes to climate risk and on farm adaptation (Hogan et al. 2008) with a view to quantifying insights developed in a qualitative study of a smaller group of farmers in the Murray-Darling Basin (Milne et al. 2008). At the time, much of farming Australia was in the grip of a long drought, the severity of which many scientists linked to climate change (Milne et al, 2008: iv). The Milne study (2008: iv) opened up the possibility that a link existed 'between peoples' perceptions of climate variability, climate change and [farmer] preparedness and management of climate risks'.

Aims/objectives

This study examines the above questions using the Department of Agriculture, Fisheries and Forestry's Climate Risk and Adaptation Dataset. This dataset, collected in 2008, contains a sample of 3,993 Australian farmers. The study addressed three research questions:

1. Which factors pertain to farmers' decisions about whether and, if so, how to adapt to climate change challenges?
2. Which of these factors are the most and least important?
3. Are there different types of farmers and, if so, do they differ with respect to factors related to their climate change adaptation behaviour?

Methods used

The analysis was conducted in three stages: data preparation (including derivation and testing of concepts and measures) and descriptive statistics; correlational and hierarchical linear regression modelling; and cluster analytic modelling. Correlational and hierarchical linear regression modelling were used to address questions one and two and cluster analysis was used to answer question three (see Methods chapter).

Results/key findings

Which factors pertain to farmers' decisions about adapting to climate change and how relatively important are these factors? (Research questions 1 & 2)

In order of importance, the following factors each independently helped explain farmers' climate change adaption: farmers who want to produce *green power*, who are strongly supportive of using *planned approaches to managing the pressures they face* and *sustainable practices*, who have a sense of *moral responsibility* to act to address the causes of climate change and who use *on-line weather and climate information* in the context of managing farm pressures showed greater intention to take action to adapt to climate change than did their peers. Two factors were not related to farmers' adaption intentions: seeking advice from rural organisations and observing environmental manifestations of climate change.

Intention to leave farming

This dataset offered limited insight into why some farmers intended to leave farming while others planned to continue. However, those with poorer health and higher levels of perceived on-farm risks were more likely to intend to leave than were their peers.

Health

Health played a substantial role in explaining farmers' adaptation to climate change, both as a contributor to practice and as an outcome of climate change-related circumstances. As a contributor to practice, farmers with poorer health were more likely than were their peers to report that their health was a barrier to sustaining work on the farm. This was significant particularly because, as the farming population ages, (old) age itself might be a barrier to remaining in the business and to adapting to climate change. We found this to be the case, *but only for those reporting poorer health*. For older farmers with good health, age did not contribute to their adaption decisions. Turning to health as an outcome of climate change-related circumstances, in order of the importance of farming business-related factors, farmers who reported *fewer debt pressures*, knowledge of their *financial viability*, were *younger* and *wished to continue farming* reported better health than did other farmers. Further, farmers with greater *social support*, sense of *belonging*, *trust* and *reciprocity* also reported better health than their less-connected peers.

Are there different types of farmers and, if so, do they differ with respect to factors related to their adaptation to climate change? (Research question 3)

Our analyses indicated that there are different types of farmers and that they differ systematically with respect to factors related to the climate change adaptation. We identified three types of farmers: 'Cash poor long-term adaptors' (55% of our sample), 'Comfortable non-adaptors' (26%) and 'Transitioners' (19%).

At more than one-half of the sample, **CASH POOR LONG-TERM ADAPTORS** formed the largest group in this study. These farmers actively sought to adapt their farming practices to manage climate change-related risk and to be sustainable into the long term. They were younger than other farmers, healthy, socially well-connected, information-seeking and believed in climate change. They were also resilient: though affected by climate change-related threats, they were actively responding to these challenges by implementing longer-term adaptive strategies and participating in government assistance programs. Despite their resilience, they were resource-poor, with fewer than one-quarter having the resources to make the necessary adaptations and only one-third with annual incomes over $40,000. Thus, many were interested in accessing government support for their adaptation activities. Though they faced many difficulties, they had strong social support and sufficient income to persist with farming; only a minority (fewer than 30%) were contemplating leaving farming. Overall, c*ash*

poor long-term adaptors reported the highest level of personal adaptive capacity of the three groups identified in this study.

COMFORTABLE NON-ADAPTORS formed the second largest group in this study, representing about one-quarter of respondents. They were a group of older, socially well-connected farmers enjoying comparatively good farming conditions and income. These farmers were well resourced financially and in other ways. They also enjoyed ample social support, good physical health and confidence that they could continue to cope with change. They did not tend to use government support. Given the farming and lifestyle conditions they enjoyed, they felt little pressure to seriously consider climate change or the adaptive practices that adverse climate change will demand. Overall, c*omfortable non-adaptors* were asset-rich with few farm-related pressures. In reviewing farmers' values and aspirations around climate, adaptation and farming, c*omfortable non-adaptors* were mostly interested in continuing with their existing lifestyles and farming methods. They did not believe in climate change and did not perceive any immediate pressure for change. Consequently, they did not consider it necessary to seek information about alternative practices nor to consider leaving the industry. Overall, therefore, this group was low on our measure of human adaptive capacity. This was not so much because they lacked the means to adapt, but because they were not oriented to the need to adapt, nor were they engaged with the organisations and processes which could facilitate such adaptation.

TRANSITIONERS formed the smallest group, representing about one-fifth of respondents. *Transitioners* were farmers under considerable pressure and thus reported low adaptive capacity. This group had the largest proportion of women farmers. They reported the greatest levels of farm-related pressures, the lowest incomes and the fewest resources with which to adapt to the demands of climate change. They also reported the worst health. They were generally isolated from information services and reported the most problems accessing support services. Compared with the sample as a whole, they were over-represented among those using government programs, though their levels of program take-up were much lower than those of the *cash poor long-term adaptors*. This group had the largest proportion of respondents considering leaving farming. Though many displayed high levels of confidence that they could continue to cope with change, *Transitioners* had poor overall adaptive capacity: their farming conditions were poor, most were in drought, they had high levels of debt and lacked access to professional and social support. *Transitioners* were less certain about climate change and what they should do about it than were *cash poor long-term adaptors*. Nonetheless, they were seeking to adapt their farming practices to manage the pressures they faced and to be sustainable. In contrast to comfortable non-adaptors, *Transitioners* faced major barriers to adaptation. These included not just their compromised financial ability to cover the costs of change, but the fact that they had low social capital, and that they were isolated from support and social systems that could help them to make the changes required.

Implications for relevant stakeholders

Despite widespread potential interest in becoming more sustainable, a majority of Australian farmers in this study reported that they were focused on shorter-term strategies for managing their immediate pressures rather than longer-term, climate change-oriented adaptations. Farmers had certainly identified strategies which may enable them to transition to a more sustainable farming platform, but policy mechanisms are required to enable this to occur. Almost one-half of the many farmers identified in this study were not engaged with key mechanisms and institutional processes which facilitate the translation of research and technology into practice. There is an apparent need for a regeneration of non-government and industry support groups in relation to the role they play in facilitating on-farm attitudinal and practice change.

We found that belief in climate change in itself did not significantly influence farmers' decision to take up more sustainable practices. Farmers were interested in sustainability, not climate change, though they were concerned about the community's moral perspective and its views as to how farmers ought to act in relation to climate change. Policy-makers may enhance their traction with producers in

terms of climate change adaptation by focusing on farmers' sense of social or moral responsibility to achieve long-term sustainable practices, rather than necessarily addressing climate change more directly.

Conclusions

This study found that the human aspects of adaptive capacity, based on the capacity to cope with change, social connectedness, and the ability and readiness to use information uniquely differentiated types of farmers from one another. Cash poor long-term adaptors, the main group of farmers focused on and able to engage with longer-term adaptation, were notable for their high ratings on these characteristics. Policy strategies that are intended to encourage farmers' capacity to adapt to climate change may be more successful by responding to the contribution that farmer wellbeing and social connectedness can contribute to supporting the change process. This would complement existing policies that have succeeded in encouraging farmers to take increasing care of their natural resources.

This study found that health and social factors were key attributes of farmers who were seeking to move towards more sustainable farming practices. It also identified that a sense of moral responsibility was at work in farmers' attitudes to sustainability. These were intriguing and powerful findings which, given the little attention they have so far received, would merit further research. That is, consideration of these aspects of adaptive practices is new and requires further development. The insights offered in this study were constrained by the limited number of health, social capital and wellbeing items provided in the DAFF dataset.

Emerging trends noted in this paper also point towards farmers' life goals and identity as playing an important part in the ways in which farmers make decisions about their farming practice and, indeed, in the viability of farms and farmers themselves. It was also noted that, where farmers see their decisions as impacting on the local community as much as on themselves, they may approach adaptive decisions quite differently from those they perceive as impacting exclusively on their own needs. Further work in these areas may help to shed light, for example, on the factors that influence farmers to leave the industry. Similarly, it may in fact be moral and social identity perspectives which, compared to environmental and economic factors, more strongly influence farmer decision-making with respect to adaptation.

This study represents just one of a handful of projects that has been initiated in Australia in recent years to examine health and social aspects of farmer adaptation to climate change. There is a need to consolidate data and findings from these separate studies in an integrating meta-study that can revise and expand on current knowledge. It would also be appropriate, at this stage, to develop consistent terminology and methodologies for addressing key concepts relating to farmer adaptation to climate change. These would be able to be shared among researchers in this emerging field and would also be available to other participants across the sector. From this baseline, consideration could then be given to monitoring adaptation over time and the social factors which influence it.

A majority of Australian farmers are yet to adapt their farming practices to a future which is increasingly being shaped by a rapidly (and, mostly, adversely) changing climate. While evidence is reported in this study which suggests that there is a small group of early adaptors, the majority of farmers have not oriented their practice to a scenario which encompasses a distinctly new form of sustainable farming. The solution moving forward is not just concerned with the flow of information to farmers. Information is just part of the challenge. Other, perhaps more significant, considerations highlight the need for transitional mechanisms which will enable farmers to shift gears from existing to sustainable practices. While as few as one-third of farmers may be currently engaged in sustainable practices, almost all of them (80%) are interested in making this transition. Against this background, policy may need to focus more strongly on developing the kinds of strategies that will assist farmers to make the transition, a transition which, for some, may mean a facilitated exit from the industry. For others, it may mean significant support for social and health and related wellbeing.

Our analyses of our latent concept of sustainability, a key factor in our regression analyses, provides three critical insights here. One is that, certainly, policy-makers will need to consider how they might improve how they translate emerging knowledge on adaptive practices into user-friendly strategies, tools and practices that farmers can adopt. Second, it will be important to work out how to enable farmers to access and master these strategies, tools and practices. Finally, there is a need to recognise that 'big-step' change in farming practice entails 'retooling' and that the industry will require practical assistance and financial incentives to retool. Structural adjustment has widely been considered as part of a practical, environmentally-centred strategy in managing the transitional needs of the Murray-Darling Basin Water Plan; such strategies may also be required to secure Australia's farming future in the face of climate change.

Introduction

Over the last decade, attention has increasingly focused on identifying the social factors which facilitate the decision to adopt sustainable farming practices in the face of climate change. This work began in earnest with the development of social as well as economic indicators that could be used to monitor natural resource management (Fenton, 2004). In particular, this work saw the development of indicators centred on 'community and social processes relevant to or affected by natural resource management programs, with a particular focus on the capacity of land managers and farmers to change and to adopt sustainable management practices' (National Land and Water Resources Audit, 2008a, b). Implicit in this work was the perspective that social factors were central to sustainability in landholder decision-making (National Land and Water Resources Audit, 2008b:55).

In turn, the need to effectively engage farmers and landholders in sustainable practices emerged as a key performance indicator for institutions involved in promoting such practices (Fenton & Rickert, 2006). While this initial body of work was focused on strengthening the capacity of institutions to assist farmers and landholders in adaptation, the logical extension of this work was to focus on the adaptive capacity of farmers and landholders themselves (Nelson, Brown, Darbas, Kokic, & Cody, 2007). This work built on Ellis' (2000) rural livelihoods approach and placed the issue of adaptive capacity at the centre of the policy agenda. This work was based on the idea that the capacity to adapt pivoted on the various assets that farmers' had to draw on in the face of continued challenges to farming (Nelson et al., 2007: iv). A key outcome of this work (building on Ellis, 2000) was the development of a focus on the 'capitals' as a cornerstone for understanding adaptive capacity (Nelson et al., 2007). Nelson et al. (2007 #6072: iv) observe that Ellis' (2000) framework viewed livelihood strategies 'as comprised of activities that are continuously invented, adapted and adopted in response to changing access to five broadly defined types of capital including human, social, natural, physical and financial capitals' (Box 1).

Box 1 The five capitals

Human capital – the skills, health and education of individuals that contribute to the productivity of labour and capacity to manage land.

Social capital – reciprocal claims on others by virtue of social relationships, the close social bonds that facilitate cooperative action and the social bridging and linking via which ideas and resources are accessed.

Natural capital – the productivity of land, and actions to sustain productivity, as well as the water and biological resources from which rural livelihoods are derived.

Physical capital – capital items produced by economic activity from other types of capital that can include infrastructure, equipment and improvements in genetic resources (crops, livestock).

Financial capital – the level, variability and diversity of income sources, and access to other financial resources (credit and savings) that together contribute to wealth.

(Nelson et al. 2007: iv)

Understanding the factors that underpin adaptive capacity and, therefore, farmer decision-making is critical, then, particularly in contexts such as climate change, where farmers and landholders face unique pressures. In 2008, the Bureau of Rural Sciences reported on a qualitative study which was concerned with these questions (Milne, Stenekes, & Russell., 2008). They considered the ways in which farmers (and others associated with rural Australia) were adapting in the context of climate change and variability. The study was particularly concerned with the relationship between perceptions of climate change and adaptive practices, seeking especially to identify 'pathways to change by exploring climate change perceptions, motivations, adaptive capacity and their relationship with climate risk management strategies and intended actions' (Milne et al.; 2008: iv).

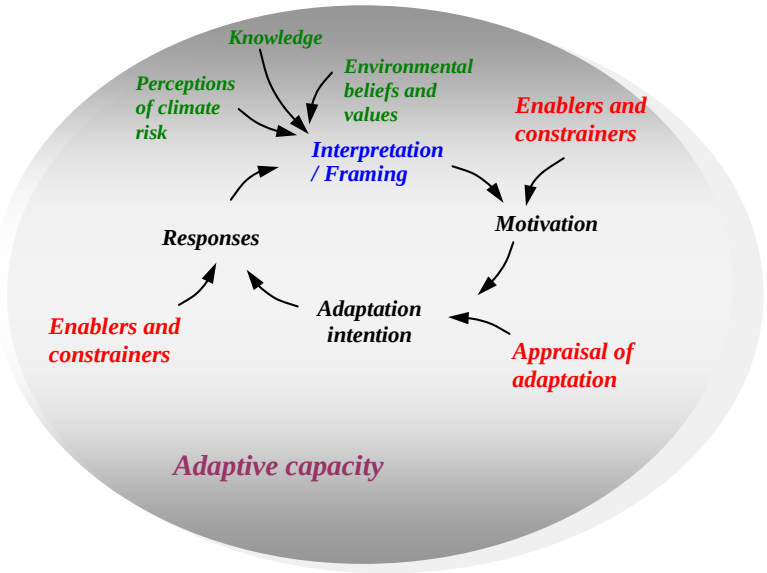

Figure 1 Milne's (2008) adaptive learning cycle.

Specifically, Milne et al reported that peoples' motivations to respond to climate change may be underpinned by three factors:

1. An immediate sense of threat to one's livelihood;

2. Rising to the challenge; and

3. A sense of moral responsibility.

Other work that has contributed to the development of analytic frameworks (see, for example, Allan, Curtis, Grant, & Eliis, 2001; Eggins, Reynolds, Cressell, & Reid, 2004) had demonstrated that the 'five capitals' are not equally salient in their impact on decision-making but that some are more influential than are others. In sum, this body of work illustrates that farmer decision-making in natural resource management, while certainly underpinned by economic factors, is embedded within a broader and dynamic social context (Granovetter, 1985).

Allan et al. (2001) have observed that landholders' (including farmers') decision-making in the context of natural resource management centres on local knowledge and values and is not necessarily driven by scientific information. Eggins et al. (2004: 6) concur, adding that such attitudes and values 'are shaped by their individual and group-based interests, concerns and aspirations'. These needs include such factors as attitudes about what is in individuals' short and long-term financial interests, a desire to have sustainable farming activities for future generations and beliefs about what they and others value about the environment. Eggins et al. (2004: 17ff) also observe that, when people are thinking in terms of their group memberships (such as being a landholder, farmer, or resident of the Murray Darling Basin), they tend to see other people in that group as a part of who they are. When this happens, people are motivated to act in terms of the best interests of the group as a whole, and not just in their own interests. This is called a 'social identity' perspective, one that also emerged clearly in the recent Kenny Report (Drought Policy Review Expert Social Panel, 2008) on the impacts on rural communities of long-term drying in Australia (*It's About People: Changing Perspectives on*

Dryness. A report to Government by an Expert Social Panel). The views of those interviewed for the report indicated a considerable concern among individuals about the broader impacts of drought and drying on whole rural communities.

Understanding landholder perspectives about what they value began at that point to emerge as an important aspect contributing to farmer decision-making. This perspective has been evident in a number of landholder surveys conducted by the Bureau of Rural Sciences (see, for example, Byron, Curtis, & MacKay, 2004). These studies reported on economic factors impinging on-farmer decision-making *within a broader context of* the social, environmental and policy issues impacting on landholders. They noted, for example, that being part of a rural community was what they valued most and that the decline of small towns and local employment were of concern to them, as were their rural businesses and related lifestyles (Byron et al.; 2004: iv). These are all issues echoed in the Kenny Report.

In bringing this body of work together in review, Landscape Logic (2008) observe that the 'livelihoods frameworks' have become the theoretical underpinning of subsequent studies of adaptive capacity in the rural sector. Their summary of this work within a conceptual framework (based on the work of Cary, Webb, & Barr, 2002; Nelson et al., 2007; Pannell, Marshall, Barr, Curtis, Vanclay, & Wilkinson, 2006; Pickworth, Casey, Maller, & Stenekes, 2007) is represented in Figure 2 below.

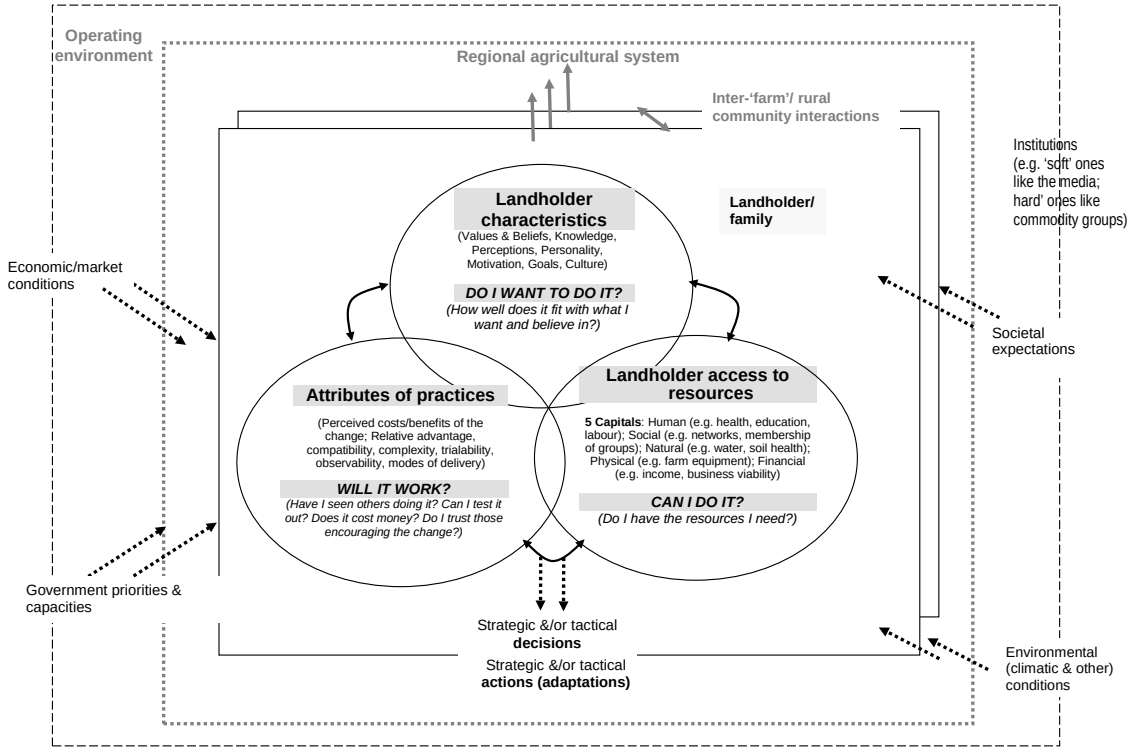

Figure 2 Landscape Logic's depiction of factors influencing adaptation.

Figure 2 indicates that landholder decision-making is situated within the context in which farmers live and work. It takes into account the following factors:

1. Social dynamics (values, aspirations, beliefs, knowledge and social identity);

2. The condition of their natural resources;

3. The environmental and climatic conditions impacting on the land;

4. Economic and market forces;

5. Government policy processes; and

6. The way they work the land.

Vulnerability to the impacts of adverse climate change, they argue, arises when risks are high and the capacity to adapt is low. Brookes (2003) defines adaptive capacity in terms of a community's ability 'to modify or change its characteristics of behaviour to cope better with actual or anticipated stresses'. Alternatively, 'social resilience', another term for adaptive capacity (Maguire & Cartwright, 2008: 8), is concerned with a community's ability to make use of their resources to 'transform and respond to change in an adaptive way'. They note that communities can be vulnerable and resilient at the same time. Resilience, they argue, must involve transformation, which embraces learning, innovating, reorganising and attaining a state that they can sustain in the current social, political and biophysical (and, we would add, economic) environment (Maguire & Cartwright, 2008: 9). We would add two further psychological aspects to resilience. The first is that reservoir of personal psychological coping assets and social capital that provide people with the will *and* the mental toughness to make necessary changes in the face of severe and continuing adversity. The second is the farmers' sense of identity and life purpose, particularly social identity. A person's social identity in particular provides them with meaning and life orientation, factors which orient their behaviours to specific ends which again provide them with the will *and* determination not just to make necessary changes but in fact serve to underpin decision to persist with current behaviours despite their consequences.

Since the completion of this foundational work, research efforts have shifted to investigating these capitals (as they have come to be known), to the extent that this is possible, using existing, publicly available datasets (see, for example, Nelson, Kokic, Crimp, Martin, Meinke, Howden et al., 2010; Nelson, Kokic, Crimp, Meinke, & Howden, 2009).

Building on this movement, in 2008, the Bureau of Rural Sciences developed the Milne project into a large quantitative study on Climate Risk and Adaptation, which involved surveying approximately 3,993 Australian farmers (Hogan, Maguire, Russell, & Stakelum, 2008). The Bureau survey contained 126 items addressing nine themes (condition of farm, on-farm adaptation, interest in alternative energy forms, attitudes to climate change, perceptions of climate impact, aspects of social capital, program participation, information usage and aspirations for future programs). These themes were supplemented with demographic items. In April 2009, the Rural Industries Research and Development Corporation (RIRDC) provided funds to Associate Professor Helen Berry et al., leader of the Social Capital and Health Group at the National Centre for Epidemiology and Population Health, The Australian National University, to undertake advanced analysis of the Climate Risk and Adaptation Survey dataset. The Bureau provided Berry and colleagues with access to the dataset for the purposes of these analyses. This research project centred on three research questions:

1. Which factors pertain to farmers' decisions about whether and, if so, how to adapt to climate change challenges?

2. Which of these factors are the most and least important?

3. Are there different types of farmers and if so, do they differ with respect to factors that related to their climate change adaptation behaviour?

As Berry and colleagues have particular expertise in community functioning and health, we posed an additional question: taking into account factors impacting on livelihood, to what extent was adaptation related to farmers' health? This report presents the results of this research.

Methodology

Following the approach taken by the Bureau of Rural Sciences (Milne et al., 2008), we conceptualised adaptation to climate change as the *utilisation of planned risk management* strategies put in place with the intention of responding to the shorter and longer-term impacts of climate change. These strategies encompassed activities such as: diversification of production and income earning; taking up training; implementing a variety of risk management programs (e.g. with respect to business, hazards and operational considerations); and downsizing strategies such as selling or leasing property, or leaving the industry. The first phase of the Bureau's study involved qualitative research to scope and understand these risk management strategies. This was followed by a quantitative phase which included a second dimension to adaptation: engaging in *sustainable practices* (e.g. avoiding tillage, reducing emissions and building carbon credits). While the concepts or risk management and sustainable practices are closely related, they tap into quite different issues. One could, for example, implement quite effective risk management strategies to maintain a viable farming business but use practices that may be widely considered unsustainable in the longer term. We have thus chosen to examine both risk management and intention to adapt through utilising sustainable practices as dependent variables in the present study. In addition, we have considered health as a contributor to adaptive practice *and* as an outcome (because of the general relationship between health and capacity to adapt).

Twenty key concepts

The questionnaire designed to collect the data for this study was intended to capture information around a number of themes, or concepts, derived from antecedent qualitative studies. In recognition that these concepts were likely to be multifaceted, the questionnaire contained multiple items (questions) for many of these concepts. Our first task was to examine whether the data provided empirical support for these concepts and, if so, to develop and refine composite measures for each of them.

We thus began with analyses to examine the concepts contained in the dataset. Our intentions in doing so were to:

1. reduce the N=126 items in the dataset to a manageable number of composite variables that would be informative and meaningful (this also reduces error in the later analyses);

2. test the concepts to ensure that we were measuring what we intended to measure;

3. create accurate, weighted composite variables for each concept that included all and only statistically valid items; and

4. produce concise, accurate definitions of these concepts measured in a way that would reflect their multi-faceted nature.

To do this, we adopted a three-phase approach. First, we undertook exploratory factor analyses (see Box 2) of groups of items that had been included in the survey to tap the nine separate themes identified in the BRS project. Exploratory factor analyses help identify the structure of complex underlying or 'latent' concepts, thereby indicating how many concepts there are, which items 'belong' in the concept and to what extent they are representative of that concept (that is, how heavily they load statistically on the factor). For example, there were 13 items in the survey that were intended to measure short and longer-term approaches to risk management, and we conducted an exploratory factor analysis on these items. Our exploratory factor analyses suggested the presence of not eleven but twenty underlying (latent) concepts.

The next step was to test, or confirm, the validity and reliability of these twenty concepts. We did this by conducting twenty one-factor congeneric modelling analyses, that is, one for each latent concept. These models test, remove error from and refine the underlying structures (latent concepts) suggested by the exploratory factor analyses.

Box 2 Explanatory factor analysis: background information and particulars of the present study

The purpose of exploratory factor analysis is to explore the underlying structure of a large quantity of data where these data are intuitively related. The data for the present study met the conditions for exploratory factor analysis: the study was originally designed in such a way as to be suitable for exploratory factor analysis (multiple items tapping each concept); the variables were intuitively related; the dataset was factorable (the majority of correlations were >.30); the sample size was "excellent" (more than 10 respondents per item to be factor analysed in the dataset). The principle criteria for evaluating the factor solutions were (i) meaningfulness and interpretability (factors that made sense and were consistent with the literature), (ii) scientific usefulness, (iii) parsimony, and (iv) fewer than 5% non-redundant residuals. Exploratory factor analysis was performed on the data to examine the factor structure underlying the items. The sampling statistics: Kaiser-Meyer-Olkin statistics (KMO = 0.921) and Barlett's test of sphericity ($p < 0.001$) indicated that the dataset was appropriate for factor analysis. This was further indicated by the adequate sample size (n=3,993, or >the number of variables to be factor analysed times ten) and factorable data (a large proportion of correlations >.30). Maximum likelihood factoring with oblimin rotation were used in the analysis as they are designed, respectively, to allow for non-normally distributed data and correlated factors.

Of particular note, the one-factor congeneric modelling analyses permit the accurate definition and naming of each concept, so that each concept may be clearly understood. In our third and final step, we used weightings derived from the one-factor congeneric models to create valid and accurately weighted composite scores for each concept in our study.

We were able to confirm the presence of the twenty latent concepts that we identified in step one and to refine their structure and measurement. This gave us a set of twenty accurately named and measured concepts on which to perform the substantive analyses for this study. These concepts are summarised in Table 1. Further information about these analytic techniques may be found in Berry and colleagues (Berry, Rodgers, & Dear, 2007; Berry & Shipley, 2009). We included in our analyses all twenty of the weighted latent constructs that we derived from exploratory factor analysis (see Box 3) and one-factor congeneric modelling.

Other measures

The Kenny Report (Drought Policy Review Expert Social Panel, 2008) concluded that, in the context of the multiple pressures farmers were facing, drought was 'the last straw' for farmers. Consistent with this concept, we computed a mean index that was based on farmers' responses to 16 items listing the pressures they were facing and which were potentially problems in managing their properties. These pressures are listed below in Table 1 (items one through four) and take into account a variety of factors such as input costs and commodity prices, debt, interest rates, cash flow, farm income, debt levels, labour, access to services and training, resource condition and personal health). Note that 'my health and fitness' was one item on this list. We did not include this item in the index because we analysed it separately as a health-related item (see 'health' section below).

Five overarching concepts

The twenty weighted composite measures for the latent concepts identified and refined through the exploratory factor analysis and one-factor congeneric modelling were then subjected to a second-

order exploratory factor analysis (Box 3). That is, a second exploratory factor analysis was performed on the twenty composites developed from the initial factor analysis and subsequent one-factor congeneric modelling.

The purpose of this analysis was to reduce (summarise) the twenty concepts to a more manageable number for use in the cluster analysis. This is not an essential step, but cluster analyses produce more accurate, meaningful and interpretable results with fewer (higher order) input variables. As there was considerable overlap between the twenty concepts, it was appropriate to summarise these in this way for this purpose. This second order factor analysis produced the following five factors, in this case, overarching concepts:

1. Belief in climate change (comprising notice evidence of climate change; believes climate change is real; moral responsibility to reduce GHGEs; Concern about financial viability in the face of CC).

2. Desire for financial assistance and advice (comprising Financial help and advice; Offering direct financial assistance; Debt pressures).

3. Social connectedness (comprising People help each other out; I feel part of my local community; I have people to assist with problems; Confidence about coping; Trust).

4. Information-seeking (comprising On-line sources of weather/climate; Non-electronic information sources about weather/climate).

5. Adverse farm conditions (comprising Condition of on-farm resources; barriers to accessing support services; market pressures on farm viability).

These factors were saved as weighted standardised composite scores and used in the cluster analysis. The respective loadings for each of the factors can be seen in Table 2. Details on the specific sources of information used by farmers can be found in Table A6 in the appendices.

Table 1 Summary of twenty latent factors and the variables that loaded on them

Factor	Items contributing to factor
1. Barriers to accessing support services	Not enough access to community services
	Lack of access to training or professional services
	Cost of training or professional services
2. Debt pressures	Interest rates, cash flow, debt levels
3. Condition of on-farm resources	Water quality, soil quality, pest and diseases
4. Market pressures on farm viability	Low commodity prices
	Input costs (fuel, energy and fertiliser costs)
5. Adapt through planning and managing property (risk management)	Diversify into other forms of production
	Improve financial situation (improve cash flow, restructure debt)
	Develop risk management strategies for natural hazards
	Develop a business management plan
	Undertake training to improve on farm income
	Use operational management plan (crop rotation, plan stock numbers)
	Succession planning
6. Intention to withdraw from farming	Sale back operations
	Sell or lease part of the property
	Exit the industry
7. Intention to adapt practices	Interest in using property for earning carbon credits
	Interest in using new technologies to reduce emissions from livestock/fertiliser use
	Interest in adopting more sustainable land management practices
8. Desire to produce greenpower	Interest in having wind turbines on property for energy production
	Interest in having hydro power on property for energy production
	Interest in having solar panels on property for energy production
9. Sense of moral responsibility to act to reduce greenhouse gas emissions	Some farming practices generate greenhouse gas emissions (GHE)
	The community has a moral responsibility to reduce GHEs
	It's the government's responsibility to legislate to reduce GHEs
	I have a responsibility to reduce GHEs
10. Belief in climate change	There is no such thing as climate change
	GHEs cause climate change
	Climate patterns are really changing
	The increased intensity of droughts, storms and floss is a result of climate change
11. Financial viability of the property	Not enough farm income to support the family
	Changes in weather patterns are hurting my business
	Climate change is threatening the viability of my property
12. Physical evidence of climate change	Local changes in weather (e.g. less rain, more dust storms, warmer temperatures)
	Shift in seasons (e.g. earlier/later frosts)
	Reduced availability of water on my property
	The melting of ice bergs
13. Confidence in coping ability	Thanks to my resourcefulness, I can handle unforseen situations

Factor	Items contributing to factor
	I can remain calm when facing difficulties because I can rely on my coping abilities
	If I am in trouble, I can think of a good solution
	I can cope with more change
14. Trust	Most people can be counted on to do what they say they will
	Most independent experts can be relied upon to tell the truth about the limits of their knowledge
	I can trust people in government to look after my interests
15. Receiving direct government financial support	Exceptional Circumstance Interest Rate Subsidy
	Exceptional Circumstance (EC) Relief payment
	Professional advice and planning through EC
	Rural financial counselling program
16. Advice from rural organisations	Agricultural extension programs or advisors
	Landcare/Caring for country programs
	Non government groups
	Regional natural resource or catchment management groups
17. Desire for government initiatives to promote adaption to sustainable farming	Enable me to develop more sustainable practices
	Enable me to access advice and support for farm and natural resource management
	Provide me with information on water allocation and availability
18. Desire for direct government financial assistance	Provide me with direct financial assistance to manage current problems
	Provide me with direct financial assistance to enable me to invest in the property's long-term future
19. Access to on-line information (sources used)	Bureau of Meteorology
	Weather forecasting services
	Internet (e.g. Google)
20. Access to information via non-on-line sources (sources used)	Media (TV, Radio, Print)
	Industry associations and groups
	Farm journals and rural press
	Word of mouth

Box 3 Second-order exploratory factor analysis.

Inspection of the correlation matrix revealed many coefficients of .30 or above. The Kaiser-Meyer-Oklin value was .765, exceeding the minimum recommended value of .6 (Kaiser, 1970, 1974) and Bartlett's test of sphericity (Bartlett, 1954) reached statistical significance (p<.001) indicating that the twenty latent constructs were appropriate for exploratory factor analysis. The results revealed the presence of five factors with eigenvalues exceeding 1, which explained 53.33 percent of the total variance. The sixth factor had an eigenvalue of 0.938. Examination of the screeplot identified a clear break after the fifth factor.

Health

According to our conceptual model, health could be a precipitating factor, i.e., contribute to decision-making (for example, poor health could make it more likely that a farmer might withdraw from farming) *and* it could also be an outcome resulting from the pressures associated with coping with climate-related adversities. We therefore included variables tapping health in relevant analyses. There were two such items: 'my health and fitness' (are a barrier to running the property; one of the items included in the list of pressures farmers may be facing); and 'my health is good'.

Table 2 Results of the second-order factor analysis: five overarching factors.

Concept	Belief in climate change	Desire for financial assistance and advice	Social Connected-ness	Information seeking	Adverse farm conditions
Notice evidence of climate change	.872				
Believe climate change is real	.871				
Moral responsibility to reduce GHGEs	.715				
Concern about financial viability in the face of CC	.583				
Financial help and advice		-.804			
Offering direct financial assistance		.685			
Debt pressures		.523			
People help each other out (reciprocity)			.829		
I feel part of my local community			.790		
I have people to assist with problems			.653		
Confidence about coping			.429		
Trust			.366		
Online sources of weather/climate					
Non-electronic information sources about weather/climate				-.754	
Risk Management (actively managing multiple pressures)				-.981	
Seeking advice from rural organisations				-.669	
Help make my farming practices more sustainable				.565	
Condition of on-farm resources					.749
Barriers to accessing support services					.745
Market pressures on farm viability					.440

Other measures used in the study

In addition to creating weighted composite scores and second-order factors for use in our analyses, we also included data on *socio-demographic characteristics* (sex, years of education post year 10, on-farm and off-farm income, self-assessed financial viability and age) and *farming-related variables* (including landsize, irrigation status and main area of primary production).

Adaptive capacity

Central to this study is the linked role that human adaptive capacity (e.g. social connectivity, trust, values, aspirations, social identity etc) play in the context of on-farm decision-making, and our approach merits some discussion. We took an existing theoretical definition for assessing adaptive capacity[1] and reframed it into a form that could be assessed within the range of data options at our disposal, particularly the latent variables developed within this study. The approach adopted in the present study was to assess which tangible and non-tangible resources farmers had in terms of adaptive capacity (that is, 'assets'), in the context of the background pressures they faced and the social dynamics within which they lived. The personal assets we were able to identify within the present dataset were:

1. Reporting sufficient financial resources to cover the costs of on-farm adaptation.
2. Self-reported health.
3. Confidence in coping ability.
4. Trust.
5. Access to support services, such as training, professional support and community services.
6. Access to information.
7. Desire for advice and assistance.
8. Preparedness to manage risk.
9. Desire to adopt adaptive practices.

We note that this description of personal assets does not encompass consideration of physical assets, such as landsize, precipitation and the like. In our view, such assets are fixed; there is little farmers can do about whether the property will receive rain or not or whether the soil is suitable for agriculture. Instead, we consider that indicators of human adaptive capacity, from the perspectives of health and social wellbeing, must meet at least three criteria: people are ready for change (or, at least, open to the need for change); they are willing to change; and they have the resources to change (resources may be financial, psychological or social). Our view is that farmers have to make decisions about adaptive practices in the face of considerable market as well as climate uncertainty, frequently using borrowed money. Decision making in this context demands the mental wellbeing to be able to engage in positive stress, to take risks, to be able to access the advice one requires, to be able to trust such advice, and to have the skills and attributes necessary to implement the changes and engage in risk management.

[1] According to Nelson et al. (2009b: 3) adaptive capacity comprises 'forms of human, social, natural, physical and financial capital from which rural livelihoods are derived (and assessed in the context of farmers) flexibility to substitute between them in response to external pressures'.

To this end we used the above items to compute a human adaptive capacity scale using respondents' means scores on these items. With a Cronbach's alpha of .57, the scale showed a modest level of internal consistency, indicating its suitability for the present preliminary analyses as well as a need to refine the conceptualisation and measurement of this important emerging concept. As with the primary indicator variables, we re-coded this scale to create three groups of farmers with low, medium and high levels of overall adaptive capacity.

Analytic approach

Having produced valid, reliable and accurate measures for our study, we undertook two analytic approaches to respond to our research questions: multiple hierarchical linear regression modelling; and cluster analysis. The purpose of the former was to test the plausibility of our conceptual models; the latter was designed to explore whether our sample of 3,993 farmers was homogeneous in terms of climate change-related factors, or whether it was heterogeneous and could be reduced to a number of more homogeneous sub-groupings. We overview these approaches below.

Hierarchical linear regression models

We tested seven hierarchical models for this study. In each of these models, we entered variables in blocks according to our hypotheses. We derived these hypotheses from the findings put forward by Milne et al. (2008) on which we based our conceptual model (Figure 1).

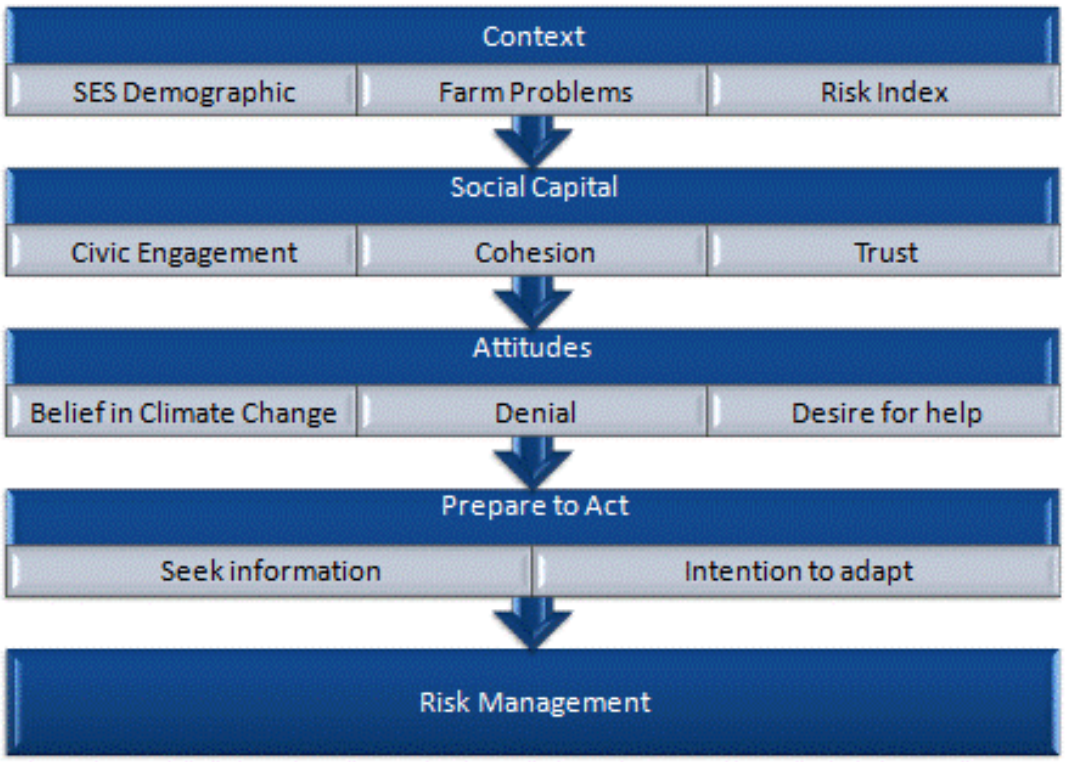

Figure 3 Hierarchical approach to modelling planned approaches to risk management (active planning of how to manage multiple pressures).

Planned approaches to risk management model (Model 1)

The first of these hypotheses, which we refer to as the *planned approaches to risk management model*, is depicted in Figure 3. Recalling Figure 1, Milne et al. (2008) proposed that farmers adapted their farming practices depending on the levels of and interactions among their five capitals. We defined the dependent variable as *planned approaches risk management* because the variables which make it up (see Table 1) are concerned with a variety of plans (business, risk management, operational) and strategies (scale back operations, diversify). We entered contextual variables in blocks (see Table 3). Blocks 1-3 included socio-demographic variables, followed by variables tapping different farm problems and finishing with our index of pressures. Blocks 4-6 included three components of social capital (civic engagement, social cohesion and trust), each added in turn in that order. Blocks 7-9 were variables tapping three sets of attitudes (belief in climate change, denial of climate change and desire for help). Finally, preparing to act-related variables were included in Blocks 10-11, represented by seeking information and forming the intention to adapt.

Table 3 Order of entry of blocks of variables for the *planned approach to risk management* model.

Block	Concept	Variables
1	Socio-demographic characteristics	Sex, age, education, on-property and off-property income
2	Problems on the farm	Barriers, debt pressures, condition of on-farm resources, market pressures on-farm viability, crude risk index
3	Social capital (civic engagement)	Member of a community group, volunteered in the last 12 months
4	Social capital (social cohesion)	Support in problems, sense of belonging and reciprocity
5	Social capital (social trust)	People can be counted on to do what they say they will, experts can be relied on, government can be trusted
6	Belief in climate change. Evidence of climate change	Belief that climate change is real, moral responsibilities, notice evidences of climate change
7	Denial of climate change	Belief that normal weather patterns will return
8	Desire for help	Financial help, advice from rural organisation, direct financial assistance
9	Adaptive intentions	Adopt sustainable practices; produce green power
10	Seeking information	Use of online and non-electronic information sources about weather/climate
11	Financial viability	Have enough money to adapt to climate change

At each step, variables that did not make a significant independent contribution to explaining variance in risk management behaviours were removed one-by-one. As each item was removed, the entire model (that is, the present block and all previous blocks) was comprehensively re-evaluated to ensure that only statistically significant variables remained in each block. This is a conservative approach that ensures that only the strongest variables remain in the model. We repeated this approach for all the models reported in this study. In each case, we included the same socio-demographic variables (sex, age, education and income), but changed the dependent variable in accordance with the question of interest.

Intention to adapt model. (Model 2)

Terry Hillman of La Trobe University (pers.com) observed that general risk management activities, such as most of those described above, are pursued when a farmer does not believe in climate change, noting that climate change demands a fundamental shift in approach and practice rather than the

pursuit of adaptation approaches generally. We thus examined the intention to adapt to climate change as a second (alternative) way of considering adaptation (Figure 4).

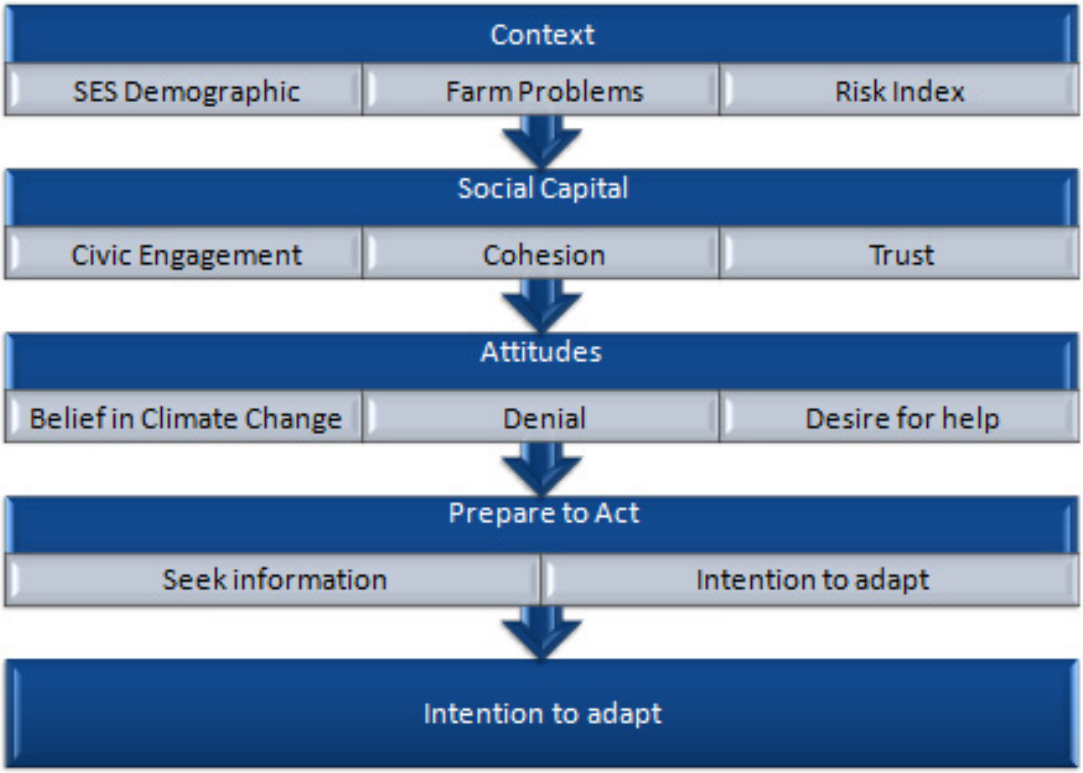

Figure 4 Hierarchical approach to modelling planned approaches to intention to adapt.

The analysis for the two preceding models were subsequently repeated (regression analyses three and four), with the inclusion of the variable *my health and fitness* (as a barrier to running the property, i.e., a pressure that the farmer has to manage).

Health impact model (Models 5 and 6)

In the health impact model (Figure 5), the health variable (*my health is good*) became the dependent variable and intention to adapt and planned approaches to risk management subsequently became independent variables in the model. During preparatory work for these analyses, a correlation was observed between self-rated health and intention to remain or exit the industry. To assist in explaining this relationship statistically, an additional step (adapt or withdraw) was included in this model. The health impact model was considered in two ways, with and without the inclusion of the variable *my health and fitness* (as a barrier to operating the property). This was undertaken to test two distinct hypotheses; the first examined the extent to which, in a multivariate analysis, the intention to adapt together with planned approaches to risk management were predictively associated with self assessed health; The second analysis examined the extent to which the intention to adapt and planned approaches to risk management were predictively associated with self assessed health, taking into account the farmer's rating of whether their health was a barrier to undertaking farm work.

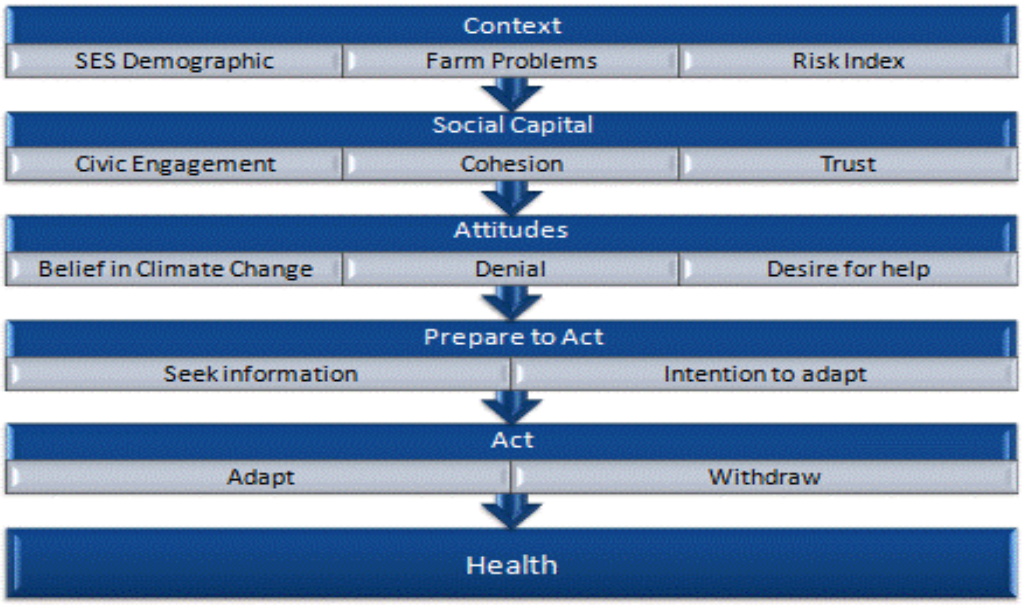

Figure 5 Hierarchical approach to modelling planned approaches to predicting farmer health.

Decision to exit (Model 7)

One option facing farmers in the face of climate change is to decide to leave the industry. The seventh and final regression analysis examined the decision to exit taking into account the factors underpinning other aspects of adaptation considered in the analyses described above.

Cluster Analysis: Investigating types of farmers

We used two-step cluster analysis to group respondents according to factors associated with farmers' preparedness for and capacity to adapt to climate change. Cluster analysis refers to a group of exploratory statistical techniques which identify homogeneous subgroups of respondents within a larger, more heterogeneous population. Cluster analytic techniques are conceptually similar to other techniques which involve grouping variables or participants, such as factor analysis, multidimensional scaling and latent class analysis. Cluster analysis can assist in the development of hypotheses concerning the causal influence of complex and multifaceted concepts (Adlaf & Zdanowicz, 1999) and identify factors influencing problematic psychosocial outcomes (Rubin & Panzano, 2002), both of which goals are appropriate to the present study. (For detailed technical information about two-step cluster analysis, see Berry, Butterworth, Caldwell, & Rodgers, 2008, downloadable from the FaHCSIA website.)

To test different approaches to conducting the cluster analysis, we included in our first attempt all twenty of the weighted latent constructs that we derived from exploratory factor analysis and one-factor congeneric modelling (see Table 1). Because of the large number of variables, as we expected, the cluster analysis using these twenty variables did not generate an appropriate or interpretable cluster solution (for details about how to evaluate cluster solutions, see Berry et al., 2008). Consequently, we conducted a second cluster analysis, as described above, using the five higher-order factors previously described: (i) belief in climate change, (ii) desire for financial assistance and advice, (iii) social connectedness, (iv) information-seeking and (v) adverse farm conditions. Log-likelihood distances were used to measure distance between clusters.

We obtained a three-cluster solution indicating that there were three types of respondents; the solution fitted the data well (see chapter 4). In order to describe and compare these clusters, we undertook one-way analyses of variance (ANOVAs), with *post-hoc* comparisons, for continuous variables and chi-squared analyses for categorical variables. To simplify reporting, respondents' scores on the five higher-order factors (belief in climate change, desire for financial assistance and advice, social connectedness, information-seeking and adverse farm conditions) were recoded into three groups by recoding the data to 'low' (lowest to up to 30 per cent of respondents), 'medium' (over 30% to 60% of respondents) and 'high' (over 60% to highest percentile respondents). This meant that we could describe types of farmers in terms of being low, medium or high scorers on our five key clustering variables. For example, a type of farmer could have 'low (levels of) belief in climate change' or 'high (levels of) social connectedness'.

How are concepts in the model related? Results from regression models

Overview

In this section we report the results of our hierarchical linear regression modelling. The chapter commences with a report on the results of the seven regression analyses (discussed in the previous chapter and reported in that order) and is followed by a report on the results of the cluster analysis. The tables presented in this chapter are the summary tables for five of the seven final fitted models. Two models did not produce statistically significant results and these are not reported here. The tables present unstandardised and standardised beta values derived from each of the hierarchical regression analyses showing all (and only) the variables that made a significant independent contribution to explaining variance in the outcome variable for each model. As noted in the methods chapter, each regression analysis controlled for socio-demographic factors (sex, age, education and income). Included in every model (and in this order) were factors concerned with social capital, climate change (belief in, evidence of, denial of) desire for government help, adaptive intentions, information-seeking behaviours and financial viability. The items making up these factors can be found in Table 1 in the previous chapter. Full details of each of these models, including variables that did not contribute significantly to explaining variance in the final models, are shown, step-by-step, in Appendix A.

Adaptation through a planned approach to risk management

Table 4 provides the final unstandardised and standardised beta values derived from the first hierarchical regression analysis showing all (and only) the variables that made a significant independent contribution to explaining variance in adaptation through a *planned risk management approach*. We controlled in this analysis for pressures arising from the farming context, social capital, attitudes of farmers and desire to be more sustainable, but we did not take account of health problems. In the final model, in order of the size of the standardised beta values, greater risk management was primarily explained by: using adaptive practices; *not* seeking advice from rural organisations, such as Landcare; having larger rather than smaller debt pressures; using online sources of weather and climate information; and *not* noticing evidence of climate change. Significant but much smaller contributions to explaining variance in risk management were made by a number of additional variables. In order of magnitude, these were: using sustainable practices; younger age; having on-property income (income generated by the farming activities); having more rather than fewer barriers to accessing support services; having a sense of having a moral responsibility to address climate change; producing green power; *not* seeking financial help and advice; using non-electronic sources of information; greater education; and greater financial viability.

This model explained 40% of variance (at $p<.001$) in risk management behaviour in the present sample of Australian farmers. This model was run a second time, but with the variable of farmer self-assessed fitness for farming (*my health/fitness as a problem in managing the property*) included. The item, introduced in the second step of model, did not make a statistically significant contribution to explaining variance in risk management behaviour and was removed from further analysis. This analysis (which was consequently identical to the one just described) is therefore not presented here.

Table 4 Independent predictors of planned risk management.

Final model	B	Std Err B	β	R^2
Age	-.01	.00	-.07***	.40***
Years of Education after Year 10	.02	.01	.04**	
On-property income	.03	.01	.06***	
Barriers	.06	.01	.06***	
Debt pressures	.13	.01	.15***	
Member of a community group	.03	.01	0.05**	
Moral responsibility	.07	.02	.06***	
Notice evidence of climate change	-.09	.01	-.10***	
Financial help & advice	-.05	.01	-.06***	
Advice from rural organization	-.17	.01	-.20***	
Sustainability	.08	.01	.08***	
Adaptive practices	.23	.02	.23***	
Production of green-power	.07	.01	.06***	
Non-electronic information sources	.09	.02	.06***	
Online sources of weather/climate	.14	.02	.12***	
Financial viability	.02	.01	0.03*	

Farmer intention to adapt through adopting more sustainable practices

Table 5 provides the overall results of the second hierarchical regression analysis and provides estimates for the prediction of variance in farmer *intention to adapt* to more sustainable farming practices. The model (which is statistically significant at $p < .001$) explained 40% of variance in intention to adapt. The desire to produce green power was most strongly independently associated with the intention to adapt, followed closely by avoiding seeking assistance from non-government organisations, the use of planned on-farm risk management practices, a sense of moral responsibility to act to address climate change and a desire for support to adopt sustainable practices.

In order of magnitude, variance in intention to adapt scores was predicted by: the desire to produce green power, use of planned on-farm risk management practices, a sense of moral responsibility to act to address climate change and a desire for government support to adopt sustainable practices. Small but significant contributions intention to adapt were contributed by market pressures, having volunteered in the past 12 months and the non-use of agricultural extension officers.

This model was also run a second time, again with the variable of farmer self-reported fitness for farming (*my health/fitness is a problem in managing the property*) included. The item, introduced in the second step of model, remained in the model until on-farm resources variables were considered. At that point, it no longer made a significant independent contribution to explaining variance in intention to adapt and was removed from the model. That it remained in the model to this point indicates that it is related to intention to adapt but that this relationship is best accounted for by the nature and extent of on-farm resources. That is, health was not a barrier to intent to adapt given sufficient (other) resources.

Table 5 Independent predictors of intention to adapt.

Final model	B	Std Err B	β	R^2
Age	-.00	.00	-.03*	.40***
Years of Education after Year 10	.02	.01	.04**	
Market pressures	.05	.02	.04**	
Volunteered in the last 12 months	.02	.01	.03*	
Moral responsibility	.22	.02	.19***	
Agriculture extension advisers	-.11	.03	-.05*	
Non-government organisations	-.41	.08	-.07***	
Sustainability	.16	.04	.15*	
Risk management	.21	.02	.21*	
Green power	.25	.01	.23**	
Online sources of information	.05	.02	.04**	

Farmer health controlling for risk management and adaptation practices

Table 6 provides the final unstandardised and standardised beta values derived from the fifth hierarchical regression analysis showing all (and only) the variables that made a significant independent contribution to explaining variance in farmer self-rated health (*my health is good*). Again, we controlled for socio-demographic factors and took account of planned approaches to risk management and the intention to adapt. The model (which is statistically significant at $p<.001$) explained 21% of variance in farmer self-rated health. In the final model, better health was most strongly predicted by: an absence of on-farm risk, greater financial viability, greater debt pressures, younger age and a desire to continue farming (rather than to withdraw). Greater sense of belonging, higher levels of reciprocity and trust, taking up adaptive practices and the absence of feelings of moral responsibility for climate change also made very small but nonetheless significant independent contributions to explaining variance in farmer health.

Table 6 Predictors of farmer self reported health.

Final model	B	Std Err B	β	R^2
Age	-.01	.00	-.11***	0.21***
Years of Education after Year 10	.02	.01	.04*	
Barriers	.04	.02	.04*	
Debt pressures	.17	.02	.18***	
Market pressures	.08	.03	.05**	
Crude risk index	-.40	.04	-.26***	
Support in problem	.22	.02	.19***	
Sense of belonging	.06	.02	.06**	
Reciprocity	.05	.02	.05**	
Trust	.04	.02	.03*	
Moral responsibilities	-.04	.02	-.04*	
Adaptive practices	.06	.02	.05**	
Financially viable	.19	.01	.20***	
Adapt	.04	.02	.04*	
Withdrawing	-.12	.02	-.11***	

Table 7 provides the final unstandardised and standardised beta values derived from the sixth hierarchical regression analysis showing all (and only) the variables that made a significant independent contribution to explaining variance in farmer self-rated health (*my health is good*). In this analysis, we re-ran exactly the model described immediately above, but this time added the farmer's assessment of their health and fitness to work. The model (which is statistically significant at p<.001) explained 43% of variance in farmer health. Variance in farmer self-rated health was most strongly explained, in order of magnitude, by: health and fitness not being a barrier to farming, greater access to sufficient social support, greater financial viability, greater debt pressures, and a desire to continue farming (rather than to withdraw). In order of magnitude, factors that made a small but significant contribution to explaining variance in farmer self-rated health included two social factors, sense of belonging and reciprocity.

Table 7 Predictors of farmer self reported health controlling for current health and fitness

Final model	**B**	**Std Err B**	***β***	***R*²**
My health/fitness	.47	.01	-.55***	.43***
Debt pressures	.10	.01	.11***	
Resources	.06	.01	.06***	
Support with problems	.20	.02	.17***	
Sense of belonging	.06	.02	.05**	
Reciprocity	.06	.02	.05***	
Adaptive practices	.05	.01	.05***	
Financially viable	.14	.01	.15***	
Withdraw	-.04	.01	-.04**	

Intention to withdraw from farming

Table 8 provides the final unstandardised and standardised beta values derived from the seventh hierarchical regression analysis showing all (and only) the variables that made a significant independent contribution to explaining variance in farmer decision to withdraw from farming and exit the industry. The model (which is statistically significant at p<.001) explains just 9% of variance in intention to withdraw. Variables that made a significant independent contribution to explaining variance in the decision to withdraw were, in order of magnitude: poor self-rated health; greater farm-related pressures; greater debt pressures; belief in the moral responsibility to address GHGEs; noticing evidence of climate change; a lack of desire to seek help to become more sustainable; an absence of a sense of generalised reciprocity; and seeking advice from non-government organisations.

Table 8 Predictors in intention to withdraw from farming.

	B	Std Err B	β	R^2
Age	.01	.00	.14***	.09***
On-property income	-.03	.01	-.07***	
My health/fitness	.13	.01	.16***	
Debt pressure	.04	.02	.05*	
Crude risk index of pressures	.09	.03	.06**	
Reciprocity	-.04	.02	-.04**	
Moral responsibility	.05	.02	.04*	
Notice evidence of climate change	.05	.02	.05**	
Advice from rural organization	.05	.01	.06***	
Sustainability	-.05	.02	-.05**	
Production of green-power	.06	.02	.06***	
Online weather/climate information	.04	.02	.03*	

All farmers are not the same: Results from the cluster analysis

This chapter presents the results of our cluster analysis in response research question 3 about whether there are different types of farmers and, if so, what their defining characteristics may be. This analysis produced three sub-groups of farmers which (as per the discussion below) we labelled *cash poor long-term adaptors, comfortable non-adaptors*, and t*ransitioners*. *Cash poor long-term adaptors* were the largest group, representing some 55% of respondents. Comfortable non-adaptors were the second largest, representing 26% of respondents, while *transitioners* made up the remaining 19% of respondents. The following sections describe the cluster analysis that generated these sub-groups and the subsequent between-group analyses that we performed to describe the differences between the groups. We finish the chapter by integrating and interpreting the results of these analyses and evaluating the cluster solution.

A three-cluster solution

Details of how to evaluate a cluster solution may be found in Berry et al. (2008). In summary, because cluster analysis is an exploratory technique, the most important evaluation criteria are substantive: the cluster solution must be (i) meaningful, (ii) scientifically useful and (iii) parsimonious (the fewest number of clusters are used to produce a meaningful and statistically acceptable solution). A meaningful and scientifically useful solution is one that is interpretable and that makes sense theoretically, or in terms of what is known or hypothesised (in this case) about farmers' climate change-related decision-making. The first two of these criteria can only be considered following the conduct of all between-cluster comparisons and the integration and production of (in this case) farmer 'profiles'. However, we can comment on the parsimoniousness of the solution, as we have done immediately below.

The substantive evaluation criteria are supplemented by the use of statistical criteria. These include: (i) marked, one-off jumps in the ratios of change calculated from the agglomeration schedules (see Berry et al., 2008) and (ii) statistically significant differences in mean scores (for continuous variables) or distributions (for categorical variables) among the clusters derived from the analysis. We considered two agglomeration schedules: Schwarz's Bayesian Criterion and Akaike's Information Criterion.

The cluster analysis returned a three-cluster solution: examination of the ratios of change for Schwarz's Bayesian Criterion and Akaike's Information Criterion agglomeration schedules revealed a steep jump between three and four clusters. Table 9 presents the criterion statistics and ratios of change for each agglomeration schedule. Table 10 presents mean scores by cluster on each of the twenty climate change-related concepts.

Table 9 Agglomerations schedules, ratios of change and cut-point for three-cluster solution following two-step cluster analysis.

Number of Clusters	Schwarz's Bayesian Criterion (BIC)	BIC Change[a]	Ratio of BIC Changes[b]	Ratio of Distance Measures[c]
1	13919.106			
2	11998.433	-1920.673	1.000	1.668
3	10880.499	-1117.934	.582	1.640
4	10230.971	-649.528	.338	1.235
5	9720.952	-510.019	.266	1.062
6	9245.639	-475.314	.247	1.401
7	8930.234	-315.405	.164	1.303
8	8707.359	-222.875	.116	1.004
9	8485.603	-221.755	.115	1.111
10	8294.409	-191.195	.100	1.214
11	8151.516	-142.893	.074	1.097
12	8028.680	-122.835	.064	1.277
13	7950.458	-78.222	.041	1.104
14	7887.425	-63.033	.033	1.031
15	7828.816	-58.609	.031	1.068

a. The changes are from the previous number of clusters in the table

b. The ratios of changes are relative to the change for the two cluster solution

c. The ratios of distance measures are based on the current number of clusters against the previous number of clusters.

Note. Line in table represents cut-point.

Table10 Mean scores for between-groups comparisons of types of farmer for twenty climate change-related latent concepts.

Latent concept	Comfortable non-adaptors	Cash poor longer term adaptors	Transitioners	Std error
Barriers accessing support services	2.63	2.41	2.68	.02
Debt pressures	2.19	3.54	3.53	.02
Conditions of on farm resources	1.88	2.62	2.59	.02
Market pressures on viability	4.19	4.74	4.74	.01
Risk management	2.35	3.15	2.63	.02
Withdrawing from the industry	1.82	1.92	2.09	.02
Intention to adapt practices	2.55	3.19	2.77	.02
Desire to produce green power	1.97	2.33	2.16	.02
Moral responsibility to reduce GHGEs	3.87	4.04	3.79	.02
Believe climate change is real	3.39	3.43	3.51	.02
Concerned about financial viability in the face of CC	2.95	3.91	3.95	.02
Notice evidence of CC	3.15	3.35	3.47	.02
Confident about coping	3.89	3.77	3.24	.01
Trust	2.66	2.62	2.56	.01
Financial help and advice	4.78	3.80	4.23	.02
Advice from rural organizations	4.10	3.39	4.16	.02
Help make my farming practices more sustainable	2.94	4.12	3.65	.02
Offering direct financial assistance	2.54	4.46	4.03	.02
Non-electronic information source	3.79	4.19	3.16	.01
Online information sources	3.66	4.13	3.63	.01

Note: all p-values significant at $p<.001$.

The characteristics of the three types of farmers

In this section, we describe the three types of farmers identified in the cluster analysis, starting with the largest group. The description of each cluster is structured in two parts. The first part presents a description of the cluster group based on the 'primary variables', that is, the variables used in the cluster analysis and noted immediately above. Because these are the variables that were used to define the groups, they are essential to understanding the differentiating characteristics of each group. The secondary characteristics of each group are discussed in the second part of each cluster description. These are variables that were not used in the cluster analysis itself but which are related to farmer decision-making with respect to climate change. In this study, these characteristics are farm attributes (size, use, condition), adaptive practices, financial position, use of government programs and personal characteristics (age, health, and so on).

Table 11 provides an overview of cluster members' scores with respect to the five cluster analysis variables: (i) belief in climate change, (ii) desire for advice and assistance, (iii) social connectedness, (iv) information seeking and (v) adverse farm conditions. For ease of interpretation (see methods section), these scores have been recoded to three categories: low, medium and high.

Cash poor long-term adaptors

Primary characteristics of cash poor long-term adaptors

Struggling long term adaptors were the largest cluster group, made up 55% of respondents. Most reported either a high (42%) or medium (31%) level of belief in climate change. Almost two-thirds (60%) of *cash poor long-term adaptors* reported a strong desire for financial help from government, with only 6% reporting low levels of desire for such assistance. *Cash poor long-term adaptors* tended to report high levels of social connectedness (52%), with most of the rest reporting medium levels of connectedness (37%). They were not inclined to use information sources, with 57% reporting being lower level users. *Cash poor long-term adaptors'* farm conditions tended to be poor, with 49% falling in the group reporting high levels of adverse farm conditions. Only 15% were in the bottom group, in which farm conditions are likely to be good.

Table 11 Comparison of clusters by key cluster variables

Indicator	Comfortable non-adaptors (%)			Cash poor longer term adaptors (%)			Transitioners (%)			$\chi^{2(4)}$	*P*-value
	L	M	H	L	M	H	L	M	H		
Belief in climate change	38.6	27.2	34.1	26.9	31.0	42.1	28.6	32.1	39.2	48.4	*P*<.001
Desire for government financial help	84.3	15.1	0.6	5.5	34.3	60.3	26.2	38.0	35.8	2200.1	*P*<.001
Social connectedness	21.7	33.9	44.5	10.5	37.4	52.1	95.9	41.1	0.0	2038.4	*P*<.001
Use of information sources	46.6	29.0	24.4	56.7	29.8	13.5	56.7	29.8	13.5	855.4	*P*<.001
Adverse farm conditions	78.8	18.1	3.1	14.7	36.7	48.6	7.6	27.1	65.3	1728.3	*P*<.001

L= Low; M= Medium; H=High

Secondary characteristics of Cash poor long-term adaptors

Cash poor long-term adaptors were 54 years of age on average. Three-quarters (75%) reported that their health was good and 85% reported that they could cope with more change. Fifteen per cent of this group were women farmers. *Cash poor long-term adaptors* reported having large farms with an average lot size of 5,137 hectares. Most (62%) *cash poor long-term adaptors* reported that the primary purpose of their farms was for business rather than for lifestyle purposes. A large proportion (79%) of this group was involved in livestock production and 44% were involved in dry land cropping. Some 17% were also involved in irrigated crops. As a group, *cash poor long-term adaptors* were strongly drought-affected (83%). Almost one-half of these farmers (45%) reported debt and market pressures impacting on their financial viability. Approximately one-third of *cash poor long-term adaptors* (32%) reported high to very high levels of cumulative on-farm risk, while one-in-four (26%) reported difficulties accessing farm support services. Nearly 30% reported that their health or fitness was a barrier to continuing to run the farm. At the same time, a large minority of members of this group showed signs of thinking about contracting their farming efforts. Almost one-third (30%) of this group was considering the possibility of leaving the industry, while one-quarter (24%) reported presently considering selling off or leasing out part of their property.

Cash poor long-term adaptors agreed (83%) that there was a moral responsibility for the community to reduce Green House Gas Emissions (GHGEs) and that climate change was real (55%). They were

inclined to acknowledge (45%) changes in the physical environment (such as more frequent extreme weather events) as evidence of climate change. More than one-half (58%) of the *cash poor long-term adaptors* reported an intention to adopt sustainable practices and three-quarters (75%) desired further government support to help make them sustainable. The variables which make up the latent factor *planned approaches to risk management* were scored on a four point scale ('not doing', 'not doing now but considering', 'doing now as part of seasonal risk management' and 'doing now as part of long-term risk management'). A majority of this group (57%) was already undertaking a planned approach to risk management activities, at least as part of seasonal risk management, with a substantial minority (23%) of these respondents having been engaged in activities as part of long-term risk management. Overall, while agreeing that there was a community responsibility to act on GHGEs, they did not agree that it was their responsibility to act on GHGEs. They reported, instead, not being very interested (58%) in producing green power.

More than one-half of this group (60%) regarded themselves as breaking even or being financially viable based on the last five years. One third (33%) of these farmers also reported on-farm income exceeding $40,000 but fewer (27%) reported off-farm income of more than $40,000 per annum. A large majority of *cash poor long-term adaptors* reported being under financial pressure in the face of adaptations demanded by climate change; fewer than one-quarter (23%) reported having had sufficient funds to make adaptations which they considered necessary. Significant proportions used government support programs. Approximately one-third (36%) received the government's exceptional circumstances (EC) interest rate subsidy, another one-third (35%) received EC support payments, one-quarter (24%) utilised the EC advice and planning program and a small portion (12%) received irrigation management grants. Sixteen percent of these farmers had used the rural financial counselling service.

Cash poor long-term adaptors reported being well-connected people who sought out information and support. They were strong users of both on-line (62%) and non-electronic information sources (58%).

Comfortable non-adaptors

Primary characteristics of comfortable non-adaptors

Comfortable non-adaptors were the second largest group identified in the cluster analysis, making up just over one-quarter (26%) of respondents. They tended towards not believing in climate change, with nearly two-in-five (39%) reporting low levels of belief. A large majority (84%) of *comfortable non-adaptors* reported a low desire for financial help from government with less than 1% reporting high levels of desire for such assistance. *Comfortable non-adaptors* showed evidence of strong social connectedness with nearly one-half (45%) reporting high levels of connectedness and one-third (34%) reporting medium levels of connectedness. *Comfortable non-adaptors* were also strong users of on-line information sources (84%). *Comfortable non-adaptors*' farm conditions also tended to be very good, with nearly four-fifths (79%) falling in the low group for adverse farm conditions. Only 3% were in the top group in which farm conditions were poor.

Secondary characteristics of comfortable non-adaptors

Comfortable non-adaptors reported having farms with an average lot size of size of 1,639 hectares and reported a mixed response with regards the primary purpose of their farm: 40% reported that the purpose of their farm was equally for business and lifestyle with a small majority (56%) reporting lifestyle as an important component of operating their farm. More than three-quarters of this group (77%) were involved in livestock production and one-quarter in dry land cropping. About one-in-six (16%) identified themselves as irrigators. At the time of the survey, more than one-half (55%) of comfortable non-adaptors were in drought. Comfortable non-adaptors were an older group of farmers with two-in-five (39%) aged 64 years or older. A small proportion (13%) of comfortable non-adaptors

was female. Three-quarters of comfortable non-adaptors (74%) reported that their health was good and nearly all (87%) reported that they could cope with more change.

With the exception of facing market pressure (92%), members of this group did not report problems with on-farm conditions. Fewer than one-in-ten (9%) reported significant debt pressures or difficulties accessing support services. In terms of cumulative on-farm risk factors (e.g. poor soil, low water, high debt levels, labour problems), these farmers reported a low number of total risk problems: only 3% reported high to very high levels of on-farm risks. As a group, they were not concerned about their financial viability in the face of climate change. A small minority (17%) reported that their health or fitness was a barrier to continuing to run the farm. Few members of this group (7%) reported difficulties accessing farm support services and only 6% used the rural financial counselling service. Similarly, comfortable non-adaptors usage of use government assistance programs was low, with 6% utilising interest rate subsidies, 9% utilising EC relief payments and 5% utilising EC assistance and related planning services. More of these farmers had taken up irrigation management grants, but they were still in the minority (45%). A majority (56%) reported themselves as breaking even or being financially viable based on the last five years. Approximately one-third (32%) of these farmers reported on-farm incomes of over $40,000 per annum and 35% reported off-farm income over $40,000 per annum.

Across the range of possible planned approaches to risk management three-quarters (75%) of *comfortable non-adaptors* consistently reported that they were only considering undertaking risk management activities with 11% doing so only as part of a short-term response. Although one-half of this group (51%) reported having had sufficient funds to make adaptations which they considered necessary, few were interested in making climate change-related adaptations. They reported that they were not very interested (71%) in producing green power. As a group they were also not interested in learning about sustainable practices (67%). While a large minority (25%) of this group was considering the possibility of leaving the industry, only a small proportion (14%) of *comfortable non-adaptors* reported considering selling off or leasing out part of their property.

Comfortable non-adaptors reported being socially well-connected and were high users of both on-line (84%) and non-electronic information sources (93%). They tended to agree that there was a moral responsibility in the community to reduce GHGEs (77%). As a group, they leaned towards agreeing that climate change existed (56%), although they did not readily acknowledge physical changes in the environment (such as more frequent extreme weather events) as evidence of climate change (64%).

Transitioners

Primary characteristics of transitioners

Transitioners made up the smallest cluster grouping representing 19% of respondents. Most *transitioners* believed in climate change with nearly two-in-five (39%) scoring in the 'high belief' group on this factor. *Transitioners* were mixed in their desire for financial help from government. While approximately one-quarter (26%) reported low levels of desire for such assistance, another one-third (36%) reported high levels in desire for assistance. *Transitioners* reported the lowest levels of social connectedness with almost all (96%) respondents falling in the low grouping. *Transitioners* were also less inclined to use information sources, with more than one-half (57%) reporting being low level users. *Transitioners*' farm conditions also tended to be poor, with two-thirds (65%) falling in the group with high levels of adverse farm conditions.

Secondary characteristics of transitioners

Transitioners reported a mean lot size of 2,746 hectares with a majority (59%) reporting that the purpose of their farm was business. Of these farmers, three-quarters (74%) reported being involved in livestock production and one-third (35%) in dry land cropping. Around one-sixth (17%) were also

involved in irrigated crops, with small minorities in dairy (9%) and intensive farming (4%). At the time of the survey, the large majority (82%) of *transitioners* were in drought. Almost one-half of these farmers (44%) reported high to very high levels of cumulative on-farm risk and one-third (35%) reported difficulties accessing farm support services. More than one-half of this group (52%) was aged under 55 years and one-fifth (22%) was aged 45 years or younger; 17% were women farmers. *Transitioners* reported poor health, with fewer than one-half (47%) reporting that their health was good; one-in-three (35%) reported that their health or fitness was a problem in being able to continue to operate the farm. A significant minority of *transitioners* (19%) agreed that they 'could not cope with any more change', with only a minority positively agreeing that they could.

Almost one-half (49%) of these farmers regarded themselves as breaking even or being financially viable based on the last five years. These farmers reported the lowest levels (27%) of on-farm income exceeding $40,000 per annum and a minority (28%) reported off-farm income of more than $40,000 per annum. Almost one-half the farmers in this group (46%) reported debt pressures and market pressures impacting on their viability. Only 10% of this group reported utilising the rural financial counselling service. Nearly one-quarter (23%) of *transitioners* received an interest rate subsidy, one-quarter (25%) received EC payments and around one-in-ten had received EC advice and planning (12%) and irrigation management grants (9%). A small proportion (13%) of *transitioners* reported having sufficient funds to make adaptations which they considered necessary, while a large proportion (41%) were considering leaving the industry. Similarly, almost one-third (31%) of *transitioners* reported considering selling or leasing out part of their property.

As a group, *transitioners* showed interest (56%) in initiatives that would help make them sustainable in the long term and two-thirds (67%) were interested in incentives to take up more fuel-efficient machinery. However, approximately one-half of t*ransitioners* did not use the internet (47%) or consult industry groups (52%) about their on-farm decisions. Only one-quarter utilised the rural farm press and one-third consulted friends and other farmers when making these decisions. *Transitioners* agreed that there was a moral responsibility to reduce GHGEs and acknowledged changes in the physical environment (such as more frequent extreme weather events) as evidence of climate change. However, their attitudes to climate change were varied: more than one-half (53%) believed that climate change was real, while only (21%) did not; the remainder was uncertain

Farmer profiles: Synthesising the results of analyses of primary and secondary variables

In this final section, we synthesise the results of the analyses of the three groups of farmers in terms of primary and secondary variables. This synthesis provides 'profiles', or 'pen portraits' of the three types of farmers. These profiles permit (i) an integrated understanding of primary and secondary descriptors for each group in terms of belief in climate change, desire for advice and assistance, social connectedness, information seeking and adverse farm conditions and (ii) also provide information for evaluating the cluster solution. That is, we can consider whether farmers fall into sub-categories based on systematic differences in adaptive capacity. To illustrate, Table 12 provides a comparative overview of cluster membership by key cluster variables while Table 13 provides a thematic summary.

Table 12 Farmer adaptive capacity based on mean scores for the human and social aspects of adaptive capacity (see Methods Chapter, p.28) by cluster membership.

Indicator	**Comfortable non-adaptors (%)**			**Cash poor longer term adaptors (%)**			**Transitioners (%)**			$\chi^{2(4)}$	***P*-value**
	L	**M**	**H**	**L**	**M**	**H**	**L**	**M**	**H**		
Adaptive capacity	0.1	69.7	30.2	6.0	86.4	7.6	37.2	62.8	0.0	1140.4	*P*<.001

L= Low; M= Medium; H=High; Key differences in bold.

Table 13 Proportion of types of farmers by low, medium and high adaptive capacity (all BG differences significant; major significant differences in bold).

	Comfortable non-adaptors (%)	**Cash poor longer term adaptors (%)**	**Transitioners (%)**
Low adaptive capacity	38.5	19.0	42.5
Medium adaptive capacity	30.1	39.4	30.4
High adaptive capacity	22.2	66.4	11.4

X^2 (4) = 577.1; p<.001

Cash poor long-term adaptors

Cash poor long-term adaptors represent the majority of farmers with, overall, the highest levels of adaptive capacity. They are slightly younger than average, many have above-average incomes, and they are healthy and well-connected socially. They believe that climate change is real and, for the most part, have the financial capacity to adapt, seeking information from a variety of sources to help them do so. Although they are managing multiple on-farm pressures, they are responding comprehensively to the challenges of climate change by implementing short and longer-term adaptive strategies. Despite their resilience, they struggle with adaptation; they have little income and only a minority has the resources to make necessary adaptations. Commensurately, many access government support and most seek help in becoming sustainable longer term.

Comfortable non-adaptors

With an average age of 61 years old, *comfortable non-adaptors* are an older group of famers, socially well-connected and enjoying good farming conditions and income. Few need or desire financial help and only a small proportion of this group participate in government programs. They report a strong lifestyle focus to their farming and a large proportion feel they can cope with further change. Given the current farming and lifestyle conditions they enjoy, they feel little pressure to seriously consider climate change or the adaptive practices that changes in climate will demand. As such, they are less likely than other types of farmers to believe in climate change. Generally speaking, *comfortable non-adaptors* have not taken up even short-term adaptive strategies and are not interested in receiving support to adopt more sustainable practices. While these farmers have sufficient resources to adapt, because of their lack of perceived need for change, they do not have the same (high levels of) adaptive capacity as *cash poor long-term adaptors*.

Transitioners

Farmers who are *transitioners* are under considerable pressure. They report the greatest levels of pressures, the poorest farm conditions, the lowest incomes and the fewest resources with which to adapt to the demands of climate change on their properties. They also have the worst health, despite being (at 55 years old) somewhat younger than *comfortable non-adaptors*. They have little access to information services and have the most problems accessing support services. They tend to see their property as a business rather than a lifestyle. But, uncertain about climate change and how they should adapt to it, this group has the largest proportion of respondents considering exiting the industry. Few are interested in producing green power. Some *transitioners* were considering adopting risk management practices as part of short-term adaptive strategies, while others were already doing so. However, few have the resources to cover the costs of adaptation. With the least capacity to cope with further change, of the three types of farmers, *transitioners* have the lowest levels of adaptive capacity.

Evaluation of the cluster solution

To reiterate, the most important criteria for evaluating the acceptability of this cluster analysis are substantive: the cluster solution must be (i) meaningful, (ii) scientifically useful and (iii) parsimonious. This cluster solution is meaningful in that the analysis of primary and secondary characteristics produced internally coherent results which were able to be integrated into profiles of recognisable types of farmers. Each type of farmer was distinctively different from the other types in ways which could be interpreted in terms of policy and service interventions and used to design new and more insightful research studies (see next chapter). As such, the solution is scientifically useful. The solution is also parsimonious in that it reduces a heterogeneous dataset of 3,993 respondents to three fairly homogeneous sub-groups. In terms of the statistical criteria, the ratios of change calculated from the agglomeration schedules indicated that a three-cluster solution fit the data well. Further, we found statistically significant differences in mean scores (for continuous variables) and distributions (for categorical variables) among the clusters derived from the analysis. Importantly, there were striking and statistically significant differences observed between cluster groupings across all five primary climate change adaptation-related variables.

In summary, the cluster analysis produced three interpretable and recognisable groupings of farmers, generating a meaningful, scientifically useful and parsimonious solution that also met all statistical criteria. It reduced a sample of 3,993 respondents to three distinct, internally coherent and useful groupings consistent with and contributing to knowledge about the characteristics of farmers which influence their preparedness and capacity to adapt to climate change. Consequently, we conclude that the cluster solution satisfied the evaluation criteria.

Discussion and Conclusions

This chapter of the report presents a guide to how to interpret and use the findings of this study and the extent to which these findings can be relied upon for future decision-making. It begins with a summary of our research findings in terms of our research questions. It then orients this study in the context of previous research and knowledge. Limitations of the study are discussed next, followed by an analysis of future research needs. We conclude by considering some of the policy implications of our findings.

Summary of research findings

Summary of aims

Using the BRS' Climate Risk and Adaptation Dataset collected in 2008, a dataset which contained a sample of 3,993 Australian farmers, this study addressed three research questions:

1. Which factors pertain to farmers' decisions about whether and, if so, how to adapt to climate change challenges?

2. Which of these factors are the most and least important?

3. Are there different types of farmers and, if so, do they differ with respect to factors related to their climate change adaptation behaviour?

Which factors pertain to farmers' decisions about adapting to climate change and how relatively important are these factors? (Research questions 1 & 2)

Reviewing the findings of this study it can be seen that factors associated with farmers' who undertook a planned approach to risk management were the farmer's intention to use adaptive practices, the use of on-line weather and climate information, while not taking into account advice from rural organizations and or environmental manifestations of climate change.

Factors associated with farmers' who wished to adopt more sustainable practices included the desire to produce green power, a desire for support to adapt to more sustainable practices, a planned approach to risk management and a sense that there was a moral responsibility to reduce GHGEs.

Farmer health was associated with an absence of stress, the presence of debt pressures in the context of knowledge on financial viability, younger age and a desire to continue farming. A farmer's acknowledgement that their health was a barrier to sustaining work on the farm was associated with self rated health as was social support, belong and social reciprocity.

The intention to leave farming is not well explained by this dataset. A farmer's assessment of their health and fitness was associated with the decision to leave as was the presence of a high level of on-farm risks. However, the explanatory power of this analysis is weak.

Of notable interest in the analysis was that belief in climate change was not a significant factor in the model and noticing physical evidence of climate change only contributed a modest amount to the outcome. Social factors such as moral responsibility concerning climate change initially featured quite strongly in the modelling as being associated with planned risk management but were strongly offset by respondents' genuine interest in using and adopting adaptive and sustainable practice. Similarly, factors such as social cohesion, trust and reciprocity, which initially contributed to models, were also mostly overtaken by factors such as adaptive practices. The interplay of economic factors, situated in the context of social dynamics is evident in decision making.

Are there different types of farmers and, if so, do they differ with respect to factors related to their adaptation to climate change? (Research question 3)

The cluster analysis produced three groups which we identified as *cash poor long term adaptors, comfortable non-adaptors* and *transitioners*. Respectively the groups made up 55%, 26% and 19% of the sample.

Cash poor long-term adaptors formed the largest group in this study, representing 55% of respondents. Cash poor long-term adaptors were younger than average aged farmers. They were well connected farmers who ultiised available information sources and believed in climate change. They were resilient. While they were risk affected they were also responding to the challenges of risk by implementing longer term adaptive strategies. However, given that only a quarter of the members of this group had the resources to make necessary adaptations, many desired government support to be adaptive in the face of climate change. Overall, *cash poor long-term adaptors* had strong assets in the social and health domains and have a reasonable proportion with higher incomes and financial capacity to adapt. One would conclude that they have the capacity to adapt in the face adverse circumstances. Overall, *cash poor long-term adaptors* were seeking to adapt their farming practices to manage risk and to be sustainable. In the context of their adaptive capacity, while things are difficult for them, they have strong support and sufficient income to persist with farming; a proportion though were contemplating leaving.

Comfortable non-adaptors formed the second largest group in this study, representing 26% of respondents. The *Comfortable non-adaptors* were a group of older, socially well connected farmers who enjoyed good farming conditions and income. Of all the farmers in this study *Comfortable non-adaptors* enjoyed the best farm conditions, financial resources, social support and health. Given the current farming and lifestyle conditions they enjoy, there is little felt pressure for them to seriously considering climate change or the adaptive practices that changes in climate will demand. Overall, *Comfortable non-adaptors* rated very highly in the basic context of assets versus risks. However, in reviewing their values and aspirations around climate adaptation and farming it can be seen that *comfortable non-adaptors* were mostly interested in continuing with their existing lifestyles and farming methods. They did not believe in climate change. There was no immediate pressure for change and therefore they did not see a need to be seeking out new alternatives through information or leaving the industry. In the context of climate change, while they have the resources to adaptive, their current adaptive capacity had to be rated as low.

Transitioners formed the smallest group representing 19% of respondents. *Transitioners* were farmers under considerable pressure. They reported the worst risk levels, the lowest incomes and the fewest resources with which to adapt to the demands of climate on their properties. They also report the worst health. They were generally isolated from information services and were the group with the most problems accessing support services. They were generally uncertain about climate change and how they should adapt to the environment. *Transitioners* reported the largest proportion of respondents considering exiting the industry. Aside from their mental capacity to continue to cope with adversity (what one might call high psychological resilience), tempered in part by reasonable proportion still reporting higher incomes, *transitioners* would generally be said to have low adaptive capacity. Their farming conditions are poor, most are in drought, they have high levels of debt and lack access to professional and social support. *Transitioners* are less certain about the realities of climate change but were nonetheless seeking to adapt their farming practices to manage risk and to be sustainable.

Adding new knowledge: The importance of health and social factors in understanding farmer adaptation

To date, there has been very little socially-oriented research conducted on how Australian farmers are adapting in the face of climate change. A preliminary workshop concerning landholder responses to climate change was held late in 2009 at Charles Sturt University (CSU), Albury, Australia. Most of the work reported at this workshop had not been published at the time of writing.[2] We note with interest, the forthcoming work of Nikki Mazur, Rik Thwaites and Maureen Rogers of CSU and of Chris Evans, Christine Storer and Angela Warden-Johnson. The preliminary analysis of data presented at this conference indicated that the latent concepts identified in the present study are broadly consistent with those being identified in studies across Australia. Similarly, we note that forthcoming work being conducted in preparation for the Murray-Darling Water Basin Plan builds on the structure and insights of the present study and is producing consistent findings.

The Victorian based Widcorp Group (2009) reported on a study of farmers' knowledge about and attitudes towards climate change, climate variability and GHGEs. A large part of this study was centred on more technical aspects of climate such as the *perceived climate drivers*[3], use of climate monitoring tools and evidence of climate impacts. A part of the study examined farmer typographies based on the above kinds of climate factors, structural characteristics, geographic factors and attitudinal statements. Geographic features, such as farming in the peri-urban environment, featured strongly in their typologies (it was a differentiating factor in three of the four typologies which they identified). While the results of these studies are not easily compared in their current forms, Widcorp's first cluster group, which they referred to as *autonomous*, was quite similar to the *comfortable non-adaptors* noted in this study. Some of their attributes included being older, self-reliant and not particularly concerned about climate change. A key attribute of Widcorp's second group (referred to as *speculative*) was that they were primarily focused on short-term farming practices, an attribute shared by many of the famers in our sample, particularly by members of our '*transitioner*' group. Their third cluster (referred to as *ambitious*) was similar to our *cash poor longer-term adaptors*. Their attributes included having the largest farms, being younger than the average, having mixed views on climate change, showing a readiness to diversify into other enterprises, valuing new technology and planning ahead. Their fourth group (*prudent*) were well-educated farmers ready to take on new ideas and technologies, but who were risk-averse. This group did not readily reflect one of the typologies in the present study.

Aspects of the results of the cluster analysis are quite consistent with Berry's work on social participation and wellbeing (Berry, 2008). In that paper, Berry observed that people excluded from social participation had poorer mental health and were socially worse off. Women were common among this disadvantaged group. This description is quite consistent of the *transitioners* group. By contrast, Berry observed that social elites (similar to the *comfortable non-adaptors* in the present study) enjoyed high levels of community participation, good health and access to resources.

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[2] http://www.csu.edu.au/research/ilws/news/events/climate%20change%20forum09.htm. Of the work reported at this conference, most had not published at the time of writing.

[3] Note that cross-sectional studies in this emerging field of research often refer to 'drivers' of climate change adaptation, although causal inferences such as this cannot be made based on the analysis of cross-sectional data. In order to provide careful, accurate and *not* potentially misleading advice to government, it is important to avoid implying by the use of such language that scientists currently know which factors are causally related and how. Causality is yet to be determined.

Limitations of this study

This study provides a snap-shot of factors influencing farmers' decision making in the face of climate change at a given time and place. Multiple cross-sectional as well as longitudinal and intervention studies are required to further investigate and build upon the insights offered in this study. We are encouraged that other researchers conducting similar work are producing similar findings. An essential next step in research is to bring together the data produced in each of these individual studies for analysing as one larger meta-dataset. Considerable public resources could be saved by developing a uniform approach to measuring and monitoring the social aspects of farmers' adaption to climate change. In turn, such a methodology needs to be fielded so that policy-makers can design appropriate support, where necessary, to enable Australian farmers to continue to contribute to both Australia's and the world's needs for food and fibre.

In this study, we developed a preliminary indicator of farmers' adaptive capacity, viewing it, as we did, through a health and social lens. This work was constrained by the limited range of relevant variables in the dataset. We note, nonetheless, that we were able to produce statistically and substantively valid measures of the health and social aspects of adaptive capacity which were sensitive to the differences between and the capacities of different types of farmers. In developing these measures, we were able to take into account the very real human elements that are at play within adaptive decision-making grounded in the realities of running farm businesses. We consider, nonetheless, that far more comprehensive, sensitive and insightful measures of human adaptive capacity could be developed and note that more work needs to be undertaken in this area. Given that the measures of human adaptive capacity in the BRS dataset were quite limited, we would envisage that, when improved indicators are available, the extent to which these factors impact on farmer decision-making may become more apparent. We note, too, in the light of the quite distinct differences we detected between types of farmers in terms of their overall personal adaptive capacity, that the differing capitals or assets (physical, human, social, financial, natural) may not be equally informative with respect to understanding farmer decision-making. Instead, we anticipate that some types of capital will be more important than others.

Implications of our findings for policy

In this section we consider a number of policy issues which arise from this work. These include a need to focus on longer-term adaptations to climate change, the kinds of strategies which may be required to facilitate farmer transitions to farming under new climatic conditions, potential dis-connectedness between values and behaviour, the need to broaden research approaches to health and social aspects of adaptive capacity and the need for policy makers to better understand factors associated with the decision to adapt.

Short-term thinking

It is evident from our findings on planned approaches to risk management that a majority of farmers is preoccupied, at best, with seasonal adaptation and managing their farms with a focus on short-term horizons. Climate change demands much longer-term planning and decision-making, including considering decisions to change production types and, possibly, the location of farming practices. Trustworthy (to farmers) processes need to be put in place that will enable farmers to make the longer-term changes which are necessary for their farming practice to be sustainable in the face of (largely adverse) climate change. We say 'processes' because such changes involve changes not just in knowledge and farming practice but, potentially, changes in where farmers live and even what they do (or end up doing) for a living. In particular, new processes need to be developed to manage and improve the way in which information is exchanged between researchers, advisers and farmers.

Sources of information

It is evident from the present study that the source of farmer advice is critical to their decision-making, as one would expect. We note that the relevance of advice offered by non-government organisations and the like is not keeping up with the demands farmers are facing in the context of climate change and variability. Moreover, farmers are consistently turning towards trusted (often established and not necessarily the most up-to-date) sources to inform their decision-making. It is not to be assumed that these trusted sources of information are necessarily cognisant of the kinds of information or transitional strategies that farmers need to access. Strategies are required that enable much needed pieces of information on transition and adaptation to become part of the dynamic process of information exchange that is already occurring among farmers. In addition, it is evident that possibly whole sub-groups of farmers are simply disengaged from information services relevant to their farming practices and that the reasons for such disengagement differ by farmer profiles. In developing engagement strategies, policy-makers will need to consider that a one-size-fits-all approach will not be appropriate to these users' information needs and will not, therefore, be persuasive in encouraging behaviour change. Some farmers are alienated from the process altogether, while others are so time-poor (and resource-poor) that particular consideration will need to be given to exactly how the information is transmitted such as that they can readily absorb and put the information to good use.

Attitudes, values and practices

We note that there is, at times, a disconnect between attitudes, values and practices. A clear example arose in relation to the widespread belief among farmers that there was a moral responsibility for the community to act to reduce GHGEs. Yet, at the same time, at best only one-third of farmers were actively engaged in developing more sustainable practices. Farmer interest in sustainability was mostly reflected in their interest in green power, in moving towards sustainable practices and in adopting planned approaches to managing the multiple pressures they face.

The human face of adaptation

Our findings on the human side of adaptive capacity make it apparent that economic conditions occur in the context of social values and relationships. To date, adaptation research has been approached within the context of an objective (or, as objective as possible) assessment of farmer assets with an underlying but unstated assumption that farmers will act in a 'rational' manner on the basis of their asset positions. Assets are certainly necessary in terms of having access to the resources needed to implement on-farm decision-making. But such asset-centred decision-making sits within a broader context of farmer wellbeing and aspirations. The 'assets only' approach does not take into account the big questions (Sousness 2009) faced by farmers; questions which address significant personal issues as to whether one is happy with one's life overall, the financial viability of the undertaking now and into retirement and the extent to which one's family supports staying involved in farming.

Reasons for leaving farming

The present study was unable to shed much light on the factors that encourage non-viable producers to leave farming. The data only provided limited insight with regards to the role played by poor health and ageing in informing the decision to exit. Further work is required to identify which factors are most strongly associated with the decision to exit the industry. Taking into account the discussion immediately above, further insights may be found by conducting studies which better describe the personal outcomes *as well*, rather than just the economic outcomes, that farmers are seeking from farming. In addition, such research might give consideration to the insight that rural communities act as much as social identities as they do as individuals. To this end, social policy initiatives centred on

individualised responses and support may be misplaced when individuals and their communities are engaged in making significant decisions (such as exiting or adapting).

Inclusion, exclusion and community connectedness

A large body of research has described how communities and individuals that are rich in social capital (community participation and the social cohesion that it generates, Putnam, 2000) are advantaged across a wide spectrum of economic, social and health domains (for examples of recent studies, see Engström, Mattsson, Järleborg, & Hallqvist, 2008; Kawachi, Subramanian, & Kim, 2008; Schultz, O'Brien, & Tadesse, 2008; Snelgrove, Pikhart, & Stafford, 2009; Sundquist & Yang, 2007). Altruistic social values are associated with higher levels of 'personal social capital' (Berry & Rickwood, 2000), but access to social capital and the resources that come with it are not (Berry, 2009; Carpiano, 2008; Derose & Varda, 2009; Islam, Merlo, Kawachi, Lindstrom, & Gerdtham, 2006; Lindström & Lindström, 2006; Mansyur, Amick, Harrist, & Franzini, 2008; Pearce & Davey Smith, 2003; Veenstra, 2002; Ziersch, 2005). Low levels of social capital are evident among socio-economically and demographically disadvantaged members of rural Australian communities (Alston, 2002; Berry, 2008; Ziersch, Baum, Darmawan, Kavanagh, & Bentley, 2009) and they go hand-in-hand with poor physical and, especially, mental health (Berry & Shipley, 2009; Berry & Welsh, 2010). Our findings were consistent with this complex interplay of social and health factors: social values (such as perceiving a moral imperative to respond to climate change) were related to greater connectedness; and poor health was related to poorer connectedness. And, as in other studies, we also found significant barriers preventing the highest-need types of farmers from accessing support and resources together with lower levels of social connectedness. Further, health and wellbeing featured prominently in the complex of factors surrounding disadvantage, particularly among our 'transitioner' type of farmers. At the other end of the spectrum, our 'comfortable non-adaptors' enjoyed the greatest access to all resources, including social connectedness.

Issues requiring further research

We have noted that there are several emerging studies concerned with the social aspects of farmer adaptation to climate change. We also noted that these studies were conceptually and practically quite similar with potentially compatible data and, at a preliminary level, consistent findings. With a view to maximising value for money in supporting research such as this, we consider that considerable efficiencies may be gained through creating a meta-database of these emerging datasets. This would permit analysis of a much larger sample and variables, potentially enabling the refinement of the latent variables of interest in this field and contributing to the development of a publicly accessible and well-developed uniform approach for conducting these studies. Preliminary inquiries among these researchers suggest strong support for a collaborative study of this kind.

Building on this proposal, in this study we report on our preliminary work to develop a multi-faceted measure of farmers' human adaptive capacity. We note that the social and human items available in the BRS dataset were not informed by analysis of the social capital data presently available in the Department of Families, Housing, Community Services, and Indigenous Affairs' (FaHCSIA) survey of Household Income Labour Dynamics of Australia (known as 'the HILDA Survey'). The social capital and health group at The Australian National University has undertaken extensive work on these items, including considering them in the context of climate change. We consider that a study concerned with the direct measurement of these items among farmers would lead to the development of a far more robust and parsimonious set of measures relating to social capital. Further, as the measures developed by the ANU team and included in the HILDA Survey are now increasingly used internationally, use of these standardised items would permit comparison of Australian circumstances with those of other countries.

Finally, more work needs to be undertaken to understand factors associated with farmers leaving the industry. This study showed that very few farmers were even considering leaving the industry at the time of the survey, despite the fact that many readily acknowledged their lack of financial viability and significant continuing pressures. Our work suggests that farmers' sense of identity, life satisfaction, personal and family aspirations and social connectedness are as important to the exit decision as are the economic and environmental determinants. As the Commonwealth develops its new drought policy, further work on social factors linked to staying in farming are required to inform the continued development and refinement of this work. It will also be a vital consideration in understanding farmers' capacity to adapt to a different way of life, perhaps in a very different environment, should they decide to leave farming.

Conclusion – Towards a sustainable future for Australia's farming

A majority of Australian farmers is yet to adapt their farming practices to a future which is increasingly being shaped by a rapidly changing climate. While evidence is reported in this study which suggests that there is a small group of early adaptors, the majority of farmers have not oriented their practice to a scenario which encompasses a distinctly new form of sustainable farming. The solution moving forward is not just concerned with the flow of information to farmers alone. Information is just part of the challenge. The questions appear to be centred on the need for transitional mechanisms which enable farmers to achieve the gear shift required from current to sustainable practices. While only one-third of existing farmers may be engaged in sustainable practices, almost 80% of farmers are interested in making this transition. The question, then, centres on the development of the kinds of strategies farmers need to make the transition, a transition which for some may mean a facilitated exit from the industry. The analyses which underpinned our latent concept on sustainability (a key factor in our regression analysis) provide critical insights here. Three key insights are particularly noted. Certainly, policy-makers need to translate emerging knowledge on adaptive practices into user-friendly strategies, tools and practices that farmers can readily adopt. Second, there is a need to enable farmers to access and master these strategies, tools and practices. Finally, there is a need to recognise that a big-step change in farming practice entails 'retooling' and that agriculture will need practical financial incentives to retool. Structural adjustment has widely been considered as part of a practical, environmentally-centred strategy in managing the transitional needs of the Murray-Darling Basin Water Plan; such strategies may also be required to secure Australia's farming future in the face of climate change.

Appendix A. Full hierarchical regression models

Table A1 Planned approach to risk management (full model).

	B	Std Err B	β	R^2
CONTEXT				
Model 1: Socio-demographic				0.08***
Gender	0.12	0.05	0.04*	
Age	-0.02	0.00	-0.22***	
Years of Education after Year 10	0.05	0.01	0.11***	
On-property income	0.03	0.01	0.07***	
Off-property income	-0.02	0.01	-0.03*	
Model 2: Problems on the farm				0.14***
Age	-0.01	0.00	-0.15***	
Years of Education after Year 10	0.06	0.01	0.13***	
On-property income	0.04	0.01	0.09***	
Barriers	0.07	0.02	0.07***	
Debt pressures	0.15	0.02	0.17***	
Crude risk index	0.12	0.04	0.08***	
SOCIAL CAPITAL				
Model 3: Civic engagement				0.18***
Age	-0.01	0.00	-0.14***	
Years of Education after Year 10	0.06	0.01	0.12***	
On-property income	0.03	0.01	0.08***	
Barriers	0.06	0.02	0.06***	
Debt pressures	0.14	0.02	0.16***	
Crude risk index	0.13	0.04	0.09***	
Member of a community group	0.10	0.01	0.14***	
Volunteered in the last 12 months	0.06	0.01	0.08***	
Model 4: Social cohesion				0.19***
Age	-0.01	0.00	-0.14***	
Years of Education after Year 10	0.06	0.01	0.12***	
On-property income	0.03	0.01	0.08***	
Barriers	0.06	0.02	0.07***	
Debt pressures	0.14	0.02	0.16***	
Crude risk index	0.14	0.04	0.10***	
Member of a community group	0.09	0.01	0.12***	
Volunteered in the last 12 months	0.05	0.01	0.07***	
Support in problem	0.04	0.02	0.04*	
Reciprocity	0.05	0.02	0.04*	

Model 5: Trust				0.19***
Age	-0.01	0.00	-0.14***	
Years of Education after Year 10	0.06	0.01	0.12***	
On-property income	0.03	0.01	0.08***	
Barriers	0.06	0.02	0.07***	
Debt pressures	0.14	0.02	0.16***	
Crude risk index	0.14	0.04	0.09***	
Member of a community group	0.09	0.01	0.12***	
Volunteered in the last 12 months	0.05	0.01	0.07***	
Support in problem	0.05	0.02	0.04*	
Reciprocity	0.05	0.02	0.05***	
Trust	-0.04	0.02	-0.03*	
ATTITUDES				
Model 6: Belief in Climate Change				0.22***
Age	-0.01	0.00	-0.13***	
Years of Education after Year 10	0.05	0.01	0.11***	
On-property income	0.03	0.01	0.08***	
Barriers	0.07	0.02	0.08***	
Debt pressures	0.15	0.02	0.17***	
Crude risk index	0.12	0.03	0.08***	
Member of a community group	0.08	0.01	0.12***	
Volunteered in the last 12 months	0.04	0.01	0.06***	
Support in problem	0.04	0.02	0.03*	
Reciprocity	0.05	0.02	0.05***	
Trust	-0.06	0.02	-0.05*	
Moral responsibility	0.24	0.02	0.21***	
Notice evidence of climate change	-0.08	0.02	-0.08***	
Model 7: Denial				0.22***
Age	-0.01	0.00	-0.13***	
Years of Education after Year 10	0.05	0.01	0.11***	
On-property income	0.03	0.01	0.08***	
Barriers	0.07	0.02	0.08***	
Debt pressures	0.15	0.02	0.17***	
Crude risk index	0.12	0.03	0.08***	
Member of a community group	0.08	0.01	0.12***	
Volunteered in the last 12 months	0.04	0.01	0.06***	
Support in problem	0.04	0.02	0.03*	
Reciprocity	0.05	0.02	0.05***	
Trust	-0.06	0.02	-0.05*	
Moral responsibility	0.24	0.02	0.21***	
Notice evidence of climate change	-0.08	0.02	-0.08***	
Model 8: Desire for help				0.33***
Age	-0.01	0.00	-0.11***	
Years of Education after Year 10	0.04	0.01	0.08***	
On-property income	0.03	0.01	0.07***	
Barriers	0.07	0.01	0.08***	

Debt pressures	0.13	0.01	0.15***	
Member of a community group	0.05	0.01	0.07***	
Reciprocity	0.04	0.01	0.04**	
Trust	-0.07	0.02	-0.06***	
Moral responsibility	0.15	0.02	0.14***	
Notice evidence of climate change	-0.09	0.01	-0.09***	
Financial help & advice	-0.04	0.01	-0.06***	
Advice from rural organization	-0.23	0.01	-0.28***	
Sustainability	0.17	0.01	0.17***	
PREPARING TO ACT				
Model 9: Adaptive intention				0.38***
Age	-0.01	0.00	-0.08***	
Years of Education after Year 10	0.03	0.01	0.05***	
On-property income	0.03	0.01	0.07***	
Barriers	0.06	0.01	0.06***	
Debt pressures	0.13	0.01	0.15***	
Member of a community group	0.04	0.01	0.05***	
Reciprocity	0.03	0.01	0.03*	
Trust	-0.04	0.02	-0.04**	
Moral responsibility	0.08	0.02	0.07***	
Notice evidence of climate change	-0.10	0.01	-0.10***	
Financial help & advice	-0.04	0.01	-0.05***	
Advice from rural organization	-0.18	0.01	-0.22***	
Sustainability	0.10	0.01	0.10***	
Adaptive practices	0.25	0.02	0.25***	
Production of green-power	0.07	0.02	0.06***	
Model 10: Seeking information				0.40***
Age	-0.01	0.00	-0.07***	
Years of Education after Year 10	0.02	0.01	0.04**	
On-property income	0.03	0.01	0.06***	
Barriers	0.06	0.01	0.06***	
Debt pressures	0.12	0.01	0.14***	
Member of a community group	0.03	0.01	0.05***	
Moral responsibility	0.07	0.02	0.06***	
Notice evidence of climate change	-0.10	0.01	-0.10***	
Financial help & advice	-0.04	0.01	-0.06***	
Advice from rural organization	-0.17	0.01	-0.20***	
Sustainability	0.08	0.01	0.08***	
Adaptive practices	0.23	0.02	0.23***	
Production of green-power	0.07	0.01	0.06***	
Non-electronic information sources about weather/climate	0.09	0.02	0.06***	
Online sources of weather/climate	0.14	0.02	0.12***	
Model 11: Financial viability				0.40***
Age	-0.01	0.00	-0.07***	

Years of Education after Year 10	0.02	0.01	0.04**
On-property income	0.03	0.01	0.06***
Barriers	0.06	0.01	0.06***
Debt pressures	0.13	0.01	0.15***
Member of a community group	0.03	0.01	0.05**
Moral responsibility	0.07	0.02	0.06***
Notice evidence of climate change	-0.09	0.01	-0.10***
Financial help & advice	-0.05	0.01	-0.06***
Advice from rural organization	-0.17	0.01	-0.20***
Sustainability	0.08	0.01	0.08***
Adaptive practices	0.23	0.02	0.23***
Production of green-power	0.07	0.01	0.06***
Non-electronic information sources	0.09	0.02	0.06***
Online sources of weather/climate	0.14	0.02	0.12***
Financial viability	0.02	0.01	0.03*

Notes: 1. *** p-value <.001, ** p-value <.01, * p-value <.05; 2. All estimates were calculated using robust standard errors

Table A2 Intention to adapt (full model).

	B	Std Err B	β	R^2
CONTEXT				
Model 1: Socio-demographic				0.06***
Age	-0.015	0.001	-0.178***	
Years of Education after Year 10	0.053	0.007	0.115***	
Off-property income	-0.024	0.010	0.040*	
Model 2: Problems on the farm				0.08***
Age	-0.01	0.001	-0.16***	
Years of Education after Year 10	0.059	0.01	0.13***	
Off-property income	0.03	0.01	0.05**	
Barriers	0.05	0.01	0.05**	
On-farm resource condition	0.97	0.02	0.97***	
Market pressures	0.14	0.02	0.09***	
SOCIAL CAPITAL				
Model 3: Civic engagement				0.11***
Age	-0.01	0.00	-0.15***	
Years of Education after Year 10	0.06	0.01	0.12***	
Off-property income	0.03	0.01	0.06***	
Barriers	0.04	0.02	0.05**	
On-farm resource condition	0.01	0.02	0.05**	
Market pressures	0.13	0.02	0.09***	
Member of a community group	0.06	0.01	0.09***	
Volunteered in the last 12 months	0.06	0.01	0.09***	
Model 4: Social cohesion				0.11***
Age	-0.01	0.00	-0.15***	
Years of Education after Year 10	0.06	0.01	0.12***	
Off-property income	0.03	0.01	0.06***	
Barriers	0.04	0.01	0.05**	
On-farm resource condition	0.1	0.02	0.1***	
Market pressures	0.13	0.02	0.08***	
Member of a community group	0.05	0.04	0.08***	
Volunteered in the last 12 months	0.06	0.01	0.08***	
Feel part of my community	0.04	0.02	0.04*	
ATTITUDES				
Model5: Belief in Climate Change				0.21***
Age	-0.01	0.00	-0.12***	
Years of Education after Year 10	0.05	0.01	0.10***	
Barriers	0.06	0.02	0.06***	
On-farm resource condition	0.07	0.02	0.07***	
Market pressures	0.16	0.02	0.1***	
Member of a community group	0.05	0.01	0.07***	
Volunteered in the last 12 months	0.05	0.01	0.07***	
Feel part of my community	0.04	0.02	0.04*	

On-farm resource condition	0.05	0.02	0.05***	
Moral responsibility	0.37	0.02	0.33***	
Model 6: Denial				0.21***
Age	-0.01	0.00	-0.11***	
Years of Education after Year 10	0.05	0.01	0.1***	
On-property income	0.03	0.01	0.08***	
Barriers	0.06	0.02	0.06***	
On-farm resource condition	0.07	0.02	0.07***	
Market pressures	0.16	0.02	0.11***	
Member of a community group	0.05	0.01	0.07***	
Volunteered in the last 12 months	0.05	0.01	0.07***	
Feel part of my community	0.04	0.02	0.04*	
Moral responsibility	0.36	0.02	0.32***	
Normal weather will return soon	-0.04	0.02	-0.04*	
Model 7: Desire for help				0.30***
Age	-0.01	0.00	-0.08***	
Years of Education after Year 10	0.03	0.01	0.07***	
Market pressures	0.11	0.02	0.07***	
Volunteered in the last 12 months	0.04	0.01	0.06***	
Moral responsibility	0.27	0.02	0.24***	
Agriculture extension advisers	-0.22	0.03	-0.11***	
Non-government organisations	-0.83	0.08	-0.15***	
Sustainability	0.24	0.02	0.24***	
PREPARING TO ACT				
Model 8: Risk management				0.35***
Age	-0.00	0.00	-0.05**	
Years of Education after Year 10	0.03	0.01	0.06***	
Market pressures	0.08	0.02	0.05***	
Volunteered in the last 12 months	0.03	0.01	0.04**	
Moral responsibility	0.25	0.02	0.22***	
Agriculture extension advisers	-0.10	0.03	-0.05***	
Non-government organisations	-0.56	0.08	-0.1***	
Sustainability	0.19	0.02	0.19***	
Risk management practices	0.27	0.02	0.27***	
Model8:Green power				0.40***
Age	-0.00	0.00	-0.03*	
Years of Education after Year 10	0.02	0.01	0.04**	
Market pressures	0.06	0.02	0.04**	
Volunteered in the last 12 months	0.02	0.01	0.03*	
Moral responsibility	0.22	0.02	0.20**	
Agriculture extension advisers	-0.12	0.03	-0.06**	
Non-government organisations	-0.43	0.08	-0.08*	
Sustainability	0.17	0.01	0.16**	
Risk management practices	0.23	0.02	0.23**	
Greenpower	0.25	0.01	0.23**	

Model 9: Info sources				0.40***
Age	-0.00	0.00	-0.03*	
Years of Education after Year 10	0.02	0.01	0.04**	
Market pressures	0.05	0.02	0.04**	
Volunteered in the last 12 months	0.02	0.01	0.03*	
Moral responsibility	0.22	0.02	0.19***	
Agriculture extension advisers	-0.11	0.03	-0.05*	
Non-government organisations	-0.41	0.08	-0.07***	
Sustainability	0.16	0.04	0.15*	
Risk management practices	0.21	0.02	0.21*	
Greenpower	0.25	0.01	0.23**	
Non-electronic information sources about weather/climate	0.06	0.02	0.04**	
Online sources of weather/climate	0.05	0.02	0.04**	

Notes: 1. *** p-value <.001, ** p-value <.01, * p-value <.05; 2. All estimates were calculated using robust standard errors

Multiple hierarchical regression estimates for the prediction of variance for intention to adapt by context, social capital, attitudes of farmers and preparation to act, and without factoring in health problems.

Table A3 Intention to withdraw from farming (full model).

	B	Std Err B	β	R^2
CONTEXT				
Model 1: Socio-demographic				0.023***
Age	0.01	0.00	0.12***	
On-property income	-0.04	0.01	-0.09***	
Model 2: Health				0.064***
Age	0.01	0.00	0.09***	
On-property income	-0.03	0.01	-0.08***	
My health/fitness	0.16	0.01	0.21***	
Model 3: Problems on the farm				0.073***
Age	0.01	0.00	0.12***	
On-property income	-0.03	0.01	-0.07***	
My health/fitness	0.13	0.01	0.17***	
Debt pressure	0.04	0.02	0.04*	
Market pressure	-0.05	0.03	-0.04*	
Crude risk index	0.11	0.03	0.08**	
SOCIAL CAPITAL				
Model 4: Civic engagement				0.073***
Age	0.01	0.00	0.12***	
On-property income	-0.03	0.01	-0.07***	
My health/fitness	0.13	0.01	0.17***	
Debt pressure	0.04	0.02	0.04*	
Market pressure	-0.05	0.03	-0.04*	
Crude risk index	0.11	0.03	0.08**	
Model 5: Social cohesion				0.075***
Age	0.01	0.00	0.12***	
On-property income	-0.03	0.01	-0.07***	
My health/fitness	0.13	0.01	0.17***	
Debt pressure	0.04	0.02	0.05*	
Market pressure	-0.05	0.03	-0.04*	
Crude risk index	0.11	0.03	0.08**	
Reciprocity	-0.05	0.02	-0.05**	
Model 6: Trust				0.075***
Age	0.01	0.00	0.12***	
On-property income	-0.03	0.01	-0.07***	
My health/fitness	0.13	0.01	0.17***	
Debt pressure	0.04	0.02	0.05*	
Market pressure	-0.05	0.03	-0.04*	
Crude risk index	0.11	0.03	0.08**	
Reciprocity	-0.05	0.02	-0.05**	
ATTITUDES				
Model 7: Belief in Climate Change				0.080***

Age	0.01	0.00	0.13***	
On-property income	-0.03	0.01	-0.07***	
My health/fitness	0.13	0.01	0.17***	
Debt pressure	0.04	0.02	0.05*	
Crude risk index	0.08	0.03	0.06*	
Reciprocity	-0.05	0.02	-0.05**	
Moral responsibility	0.04	0.02	0.04*	
Notice evidence of climate change	0.05	0.02	0.05**	
Model 8: Denial				0.080***
Age	0.01	0.00	0.13***	
On-property income	-0.03	0.01	-0.07***	
My health/fitness	0.13	0.01	0.17***	
Debt pressure	0.04	0.02	0.05*	
Crude risk index	0.08	0.03	0.06*	
Reciprocity	-0.05	0.02	-0.05**	
Moral responsibility	0.04	0.02	0.04*	
Notice evidence of climate change	0.05	0.02	0.05**	
Model 9: Desire for help				0.083***
Age	0.01	0.00	0.13***	
On-property income	-0.03	0.01	-0.06***	
My health/fitness	0.13	0.01	0.16***	
Debt pressure	0.04	0.02	0.05*	
Crude risk index	0.10	0.03	0.07**	
Reciprocity	-0.04	0.02	-0.04*	
Moral responsibility	0.06	0.02	0.05**	
Notice evidence of climate change	0.05	0.02	0.06**	
Advice from rural organization	0.04	0.01	0.04**	
Sustainability	-0.03	0.02	-0.04*	
PREPARING TO ACT				
Model 10: Adaptive intention				0.086***
Age	0.01	0.00	0.13***	
On-property income	-0.03	0.01	-0.07***	
My health/fitness	0.13	0.01	0.16***	
Debt pressure	0.04	0.02	0.05*	
Crude risk index	0.09	0.03	0.06**	
Reciprocity	-0.04	0.02	-0.04*	
Moral responsibility	0.05	0.02	0.05*	
Notice evidence of climate change	0.05	0.02	0.05**	
Advice from rural organization	0.04	0.01	0.05**	
Sustainability	-0.04	0.02	-0.04*	
Production of green-power	0.06	0.02	0.06***	
Model 11: Seeking information				0.087***
Age	0.01	0.00	0.14***	
On-property income	-0.03	0.01	-0.07***	

My health/fitness	0.13	0.01	0.16***	
Debt pressure	0.04	0.02	0.05*	
Crude risk index	0.09	0.03	0.06**	
Reciprocity	-0.04	0.02	-0.04**	
Moral responsibility	0.05	0.02	0.04*	
Notice evidence of climate change	0.05	0.02	0.05**	
Advice from rural organization	0.05	0.01	0.06***	
Sustainability	-0.05	0.02	-0.05**	
Production of green-power	0.06	0.02	0.06***	
Online sources of weather/climate	0.04	0.02	0.03*	
Model 12: Financial viability				0.087***
Age	0.01	0.00	0.14***	
On-property income	-0.03	0.01	-0.07***	
My health/fitness	0.13	0.01	0.16***	
Debt pressure	0.04	0.02	0.05*	
Crude risk index	0.09	0.03	0.06**	
Reciprocity	-0.04	0.02	-0.04**	
Moral responsibility	0.05	0.02	0.04*	
Notice evidence of climate change	0.05	0.02	0.05**	
Advice from rural organization	0.05	0.01	0.06***	
Sustainability	-0.05	0.02	-0.05**	
Production of green-power	0.06	0.02	0.06***	
Online sources of weather/climate	0.04	0.02	0.03*	

Notes: 1. *** p-value <.001, ** p-value <.01, * p-value <.05; 2. All estimates were calculated using robust standard errors

Multiple hierarchical regression estimates for the prediction of variance in Withdrawal by context, social capital, attitudes of farmers and preparation to act, and factoring in health problems.

Table A4 Health (full model).

	B	Std Err B	β	R^2
CONTEXT				
Model 1: Socio-demographic				0.019***
Age	-0.01	0.00	-0.10***	
Years of Education after Year 10	0.02	0.01	0.05**	
On-property income	0.02	0.01	0.05**	
Off-property income	0.03	0.01	0.05**	
Model 2: Problems on the farm				0.067***
Age	-0.01	0.00	-0.12***	
Years of Education after Year 10	0.02	0.01	0.05**	
On-property income	0.02	0.01	0.04**	
Off-property income	0.02	0.01	0.04*	
Barriers	0.05	0.02	0.05*	
Debt pressures	0.15	0.02	0.16***	
Market pressures	0.11	0.03	0.07***	
Crude risk index	-0.53	0.04	-0.34***	
SOCIAL CAPITAL				
Model 3: Civic engagement				0.088***
Age	-0.01	0.00	-0.11***	
Years of Education after Year 10	0.02	0.01	0.04*	
On-property income	0.02	0.01	0.04*	
Off-property income	0.03	0.01	0.04**	
Barriers	0.04	0.02	0.04*	
Debt pressures	0.14	0.02	0.15***	
Market pressures	0.10	0.03	0.06**	
Crude risk index	-0.52	0.04	-0.33***	
Member of a community group	0.08	0.01	0.11***	
Volunteered in the last 12 months	0.04	0.01	0.05**	
Model 4: Social cohesion				0.156***
Age	-0.01	0.00	-0.13***	
Years of Education after Year 10	0.02	0.01	0.05**	
Off-property income	0.02	0.01	0.04*	
Barriers	0.06	0.02	0.06**	
Debt pressures	0.12	0.02	0.13***	
Market pressures	0.08	0.03	0.05**	
Crude risk index	-0.47	0.04	-0.30***	
Member of a community group	0.04	0.01	0.05**	
Support in problem	0.27	0.02	0.23***	
Sense of belonging	0.05	0.02	0.04*	
Reciprocity	0.08	0.02	0.07***	

Model 5: Trust			0.158***
Age	-0.01	0.00	-0.13***
Years of Education after Year 10	0.02	0.01	0.05**
Off-property income	0.02	0.01	0.03*
Barriers	0.06	0.02	0.06**
Debt pressures	0.12	0.02	0.13***
Market pressures	0.09	0.03	0.06**
Crude risk index	-0.47	0.04	-0.30***
Member of a community group	0.04	0.01	0.05**
Support in problem	0.26	0.02	0.22***
Sense of belonging	0.05	0.02	0.04*
Reciprocity	0.08	0.02	0.07***
Trust	0.05	0.02	0.04**
ATTITUDES			
Model 6: Belief in Climate Change			0.159***
Age	-0.01	0.00	-0.13***
Years of Education after Year 10	0.02	0.01	0.05**
Off-property income	0.02	0.01	0.04*
Barriers	0.06	0.02	0.06**
Debt pressures	0.12	0.02	0.13***
Market pressures	0.09	0.03	0.05**
Crude risk index	-0.46	0.04	-0.29***
Member of a community group	0.04	0.01	0.05**
Support in problem	0.26	0.02	0.22***
Sense of belonging	0.05	0.02	0.04*
Reciprocity	0.08	0.02	0.07***
Trust	0.06	0.02	0.05**
Moral responsibilities	-0.04	0.02	-0.04*
Model 7: Denial			0.159***
Age	-0.01	0.00	-0.13***
Years of Education after Year 10	0.02	0.01	0.05**
Off-property income	0.02	0.01	0.04*
Barriers	0.06	0.02	0.06**
Debt pressures	0.12	0.02	0.13***
Market pressures	0.09	0.03	0.05**
Crude risk index	-0.46	0.04	-0.29***
Member of a community group	0.04	0.01	0.05**
Support in problem	0.26	0.02	0.22***
Sense of belonging	0.05	0.02	0.04*
Reciprocity	0.08	0.02	0.07***
Trust	0.06	0.02	0.05**
Moral responsibilities	-0.04	0.02	-0.04*

Model 8: Desire for help				0.159***
Age	-0.01	0.00	-0.13***	
Years of Education after Year 10	0.02	0.01	0.05**	
Off-property income	0.02	0.01	0.04*	
Barriers	0.06	0.02	0.06**	
Debt pressures	0.12	0.02	0.13***	
Market pressures	0.09	0.03	0.05**	
Crude risk index	-0.46	0.04	-0.29***	
Member of a community group	0.04	0.01	0.05**	
Support in problem	0.26	0.02	0.22***	
Sense of belonging	0.05	0.02	0.04*	
Reciprocity	0.08	0.02	0.07***	
Trust	0.06	0.02	0.05**	
Moral responsibilities	-0.04	0.02	-0.04*	
PREPARING TO ACT				
Model 9: Adaptive intention				0.162***
Age	-0.01	0.00	-0.12***	
Years of Education after Year 10	0.02	0.01	0.04**	
Off-property income	0.02	0.01	0.04*	
Barriers	0.05	0.02	0.05**	
Debt pressures	0.12	0.02	0.13***	
Market pressures	0.08	0.03	0.05**	
Crude risk index	-0.46	0.04	-0.30***	
Member of a community group	0.03	0.01	0.04**	
Support in problem	0.26	0.02	0.22***	
Sense of belonging	0.04	0.02	0.04*	
Reciprocity	0.08	0.02	0.07***	
Trust	0.06	0.02	0.05**	
Moral responsibilities	-0.07	0.02	-0.06**	
Adaptive practices	0.06	0.02	0.06***	
Model 10: Seeking information				0.162***
Age	-0.01	0.00	-0.12***	
Years of Education after Year 10	0.02	0.01	0.04**	
Off-property income	0.02	0.01	0.04*	
Barriers	0.05	0.02	0.05**	
Debt pressures	0.12	0.02	0.13***	
Market pressures	0.08	0.03	0.05**	
Crude risk index	-0.46	0.04	-0.30***	
Member of a community group	0.03	0.01	0.04**	
Support in problem	0.26	0.02	0.22***	
Sense of belonging	0.04	0.02	0.04*	
Reciprocity	0.08	0.02	0.07***	
Trust	0.06	0.02	0.05**	
Moral responsibilities	-0.07	0.02	-0.06**	
Adaptive practices	0.06	0.02	0.06***	

Model 11: Financial viability				0.194***
Age	-0.01	0.00	-0.13***	
Years of Education after Year 10	0.02	0.01	0.04*	
Barriers	0.04	0.02	0.04*	
Debt pressures	0.17	0.02	0.18***	
Market pressures	0.09	0.03	0.05**	
Crude risk index	-0.43	0.04	-0.27***	
Member of a community group	0.03	0.01	0.04*	
Support in problem	0.23	0.02	0.19***	
Sense of belonging	0.05	0.02	0.04*	
Reciprocity	0.06	0.02	0.05**	
Trust	0.05	0.02	0.04*	
Moral responsibilities	-0.05	0.02	-0.04*	
Adaptive practices	0.07	0.02	0.06***	
Financially viable	0.19	0.01	0.21***	
ACT				
Model 12: Adapt or withdraw				0.205***
Age	-0.01	0.00	-0.11***	
Years of Education after Year 10	0.02	0.01	0.04*	
Barriers	0.04	0.02	0.04*	
Debt pressures	0.17	0.02	0.18***	
Market pressures	0.08	0.03	0.05**	
Crude risk index	-0.40	0.04	-0.26***	
Support in problem	0.22	0.02	0.19***	
Sense of belonging	0.06	0.02	0.06**	
Reciprocity	0.05	0.02	0.05**	
Trust	0.04	0.02	0.03*	
Moral responsibilities	-0.04	0.02	-0.04*	
Adaptive practices	0.06	0.02	0.05**	
Financially viable	0.19	0.01	0.20***	
Adapt	0.04	0.02	0.04*	
Withdrawing	-0.12	0.02	-0.11***	

Notes: 1. *** p-value <.001, ** p-value <.01, * p-value <.05; 2. All estimates were calculated using robust standard errors

Multiple hierarchical regression estimates for the prediction of variance in Health by context, social capital, attitudes of farmers and preparation to act, and without factoring in health problems.

Table A5 Health controlling for farmers' current health and fitness.

	B	Std Err B	β	R^2
CONTEXT				
Model 1: Socio-demographic				0.019***
Age	-0.01	0.00	-0.10***	
Years of Education after Year 10	0.02	0.01	0.05**	
On-property income	0.02	0.01	0.05**	
Off-property income	0.03	0.01	0.05**	
Model 2: Health				0.338***
Age	0.00	0.00	-0.03*	
Years of Education after Year 10	0.02	0.01	0.03*	
On-property income	0.01	0.01	0.03*	
My health/fitness	-0.49	0.01	-0.57***	
Model 3: Problems on the farm				0.344***
Years of Education after Year 10	0.02	0.01	0.04**	
On-property income	0.02	0.01	0.03**	
My health/fitness	-0.52	0.01	-0.60***	
Debt pressures	0.05	0.01	0.06***	
Resources	0.06	0.01	0.06***	
SOCIAL CAPITAL				
Model 4: Civic engagement				0.356***
Years of Education after Year 10	0.02	0.01	0.03*	
On-property income	0.01	0.01	0.03*	
My health/fitness	-0.51	0.01	-0.59***	
Debt pressures	0.05	0.01	0.05***	
Resources	0.06	0.01	0.05***	
Member of a community group	0.06	0.01	0.08***	
Volunteered in the last 12 months	0.03	0.01	0.04*	
Model 5: Social cohesion				0.408***
Years of Education after Year 10	0.02	0.01	0.04**	
My health/fitness	-0.49	0.01	-0.57***	
Debt pressures	0.05	0.01	0.05***	
Resources	0.07	0.01	0.07***	
Support in problem	0.22	0.02	0.19***	
Sense of belonging	0.06	0.02	0.05***	
Reciprocity	0.08	0.02	0.07***	
Model 6: Trust				0.409***
Years of Education after Year 10	0.02	0.01	0.04**	
My health/fitness	-0.49	0.01	-0.57***	
Debt pressures	0.05	0.01	0.06***	
Resources	0.07	0.01	0.07***	
Support in problem	0.22	0.02	0.19***	
Sense of belonging	0.06	0.02	0.05***	

Reciprocity	0.08	0.02	0.07***	
Trust	0.04	0.02	0.03*	
ATTITUDES				
Model 7: Belief in Climate Change				0.409***
Years of Education after Year 10	0.02	0.01	0.04**	
My health/fitness	-0.49	0.01	-0.57***	
Debt pressures	0.05	0.01	0.06***	
Resources	0.07	0.01	0.07***	
Support in problem	0.22	0.02	0.19***	
Sense of belonging	0.06	0.02	0.05***	
Reciprocity	0.08	0.02	0.07***	
Trust	0.04	0.02	0.03*	
Model 8: Denial				0.409***
Years of Education after Year 10	0.02	0.01	0.04**	
My health/fitness	-0.49	0.01	-0.57***	
Debt pressures	0.05	0.01	0.06***	
Resources	0.07	0.01	0.07***	
Support in problem	0.22	0.02	0.19***	
Sense of belonging	0.06	0.02	0.05***	
Reciprocity	0.08	0.02	0.07***	
Trust	0.04	0.02	0.03*	
Model 9: Desire for help				0.409***
Years of Education after Year 10	0.02	0.01	0.04**	
My health/fitness	-0.49	0.01	-0.57***	
Debt pressures	0.05	0.01	0.06***	
Resources	0.07	0.01	0.07***	
Support in problem	0.22	0.02	0.19***	
Sense of belonging	0.06	0.02	0.05***	
Reciprocity	0.08	0.02	0.07***	
Trust	0.04	0.02	0.03*	
PREPARING TO ACT				
Model 10: Adaptive intention				0.410***
Years of Education after Year 10	0.02	0.01	0.03**	
My health/fitness	-0.49	0.01	-0.57***	
Debt pressures	0.05	0.01	0.05***	
Resources	0.07	0.01	0.06***	
Support in problem	0.22	0.02	0.19***	
Sense of belonging	0.05	0.02	0.05**	
Reciprocity	0.07	0.02	0.07***	
Trust	0.04	0.02	0.03**	
Adaptive practices	0.04	0.01	0.04**	

Model 11: Seeking information				0.410***
Years of Education after Year 10	0.02	0.01	0.03**	
My health/fitness	-0.49	0.01	-0.57***	
Debt pressures	0.05	0.01	0.05***	
Resources	0.07	0.01	0.06***	
Support in problem	0.22	0.02	0.19***	
Sense of belonging	0.05	0.02	0.05**	
Reciprocity	0.07	0.02	0.07***	
Trust	0.04	0.02	0.03**	
Adaptive practices	0.04	0.01	0.04**	
Model 12: Financial viability				0.427***
My health/fitness	-0.48	0.01	-0.56***	
Debt pressures	0.01	0.01	0.11***	
Resources	0.06	0.01	0.06***	
Support in problem	0.20	0.02	0.17***	
Sense of belonging	0.06	0.02	0.05*	
Reciprocity	0.06	0.02	0.06***	
Adaptive practices	0.05	0.01	0.05***	
Financially viable	0.14	0.01	0.15***	
ACT				
Model 13: Adapt or withdraw				0.428***
My health/fitness	-0.47	0.01	-0.55***	
Debt pressures	0.10	0.01	0.11***	
Resources	0.06	0.01	0.06***	
Support in problem	0.20	0.02	0.17***	
Sense of belonging	0.06	0.02	0.05**	
Reciprocity	0.06	0.02	0.05***	
Adaptive practices	0.05	0.01	0.05***	
Financially viable	0.14	0.01	0.15***	
Withdraw	-0.04	0.01	-0.04**	

Notes: 1. *** p-value <.001, ** p-value <.01, * p-value <.05; 2. All estimates were calculated using robust standard errors

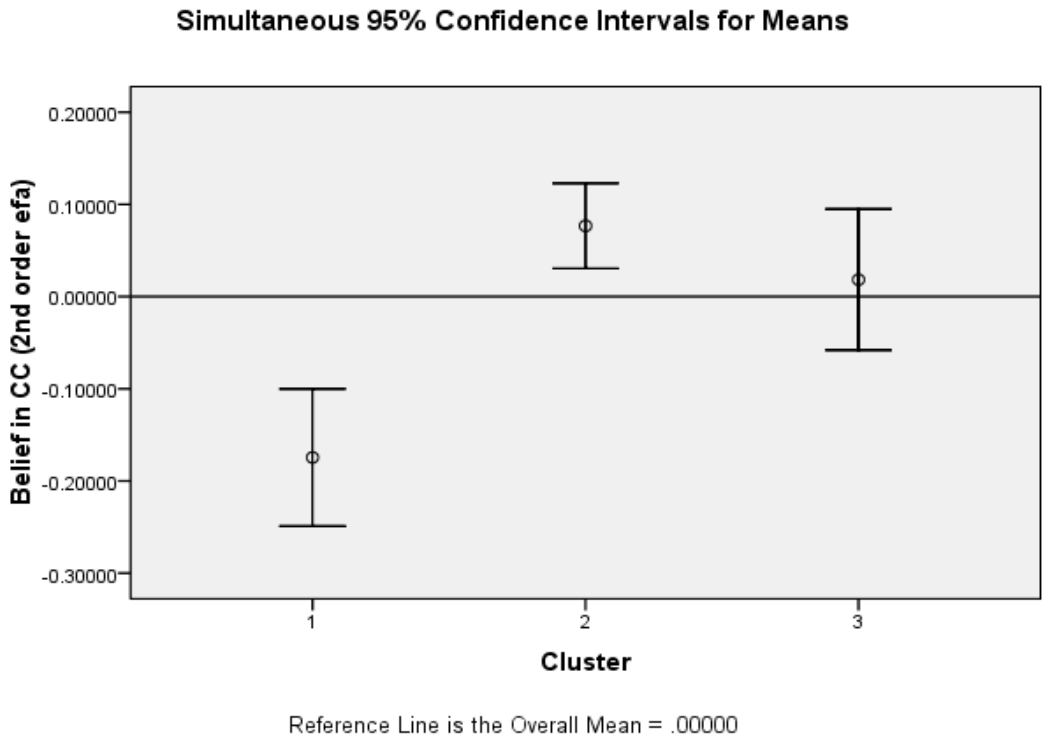
Multiple hierarchical regression estimates for the prediction of variance in Health by context, social capital, attitudes of farmers and preparation to act, and factoring in health problems.

Table A6 Farmers' information sources

Information source	Used but not easily influence by this source	Used and considered to be important in decision making
Scientific publications	19%	19%
Bureau of Meteorology	33%	52%
Consultants, accountants, rural financial counsellors	27%	41%
Industry groups (e.g. National Farmers' Federation, Meat & Livestock Assoc)	36%	27%
Media: TV, radio, print	53%	28%
Landcare or Natural resource Management Groups	30%	21%
Agri-business firms (e.g. Elders; Landmark)	33%	31%
Internet (e.g. google)	32%	28%
Weather forecasters	33%	45%
Books & films	18%	9%
Farm journals and rural press	44%	44%
Word of mouth (e.g. other primary producers and friends)	44%	49%

Appendix B. Between-cluster differences in mean scores for five overarching climate change-related adaptation factors

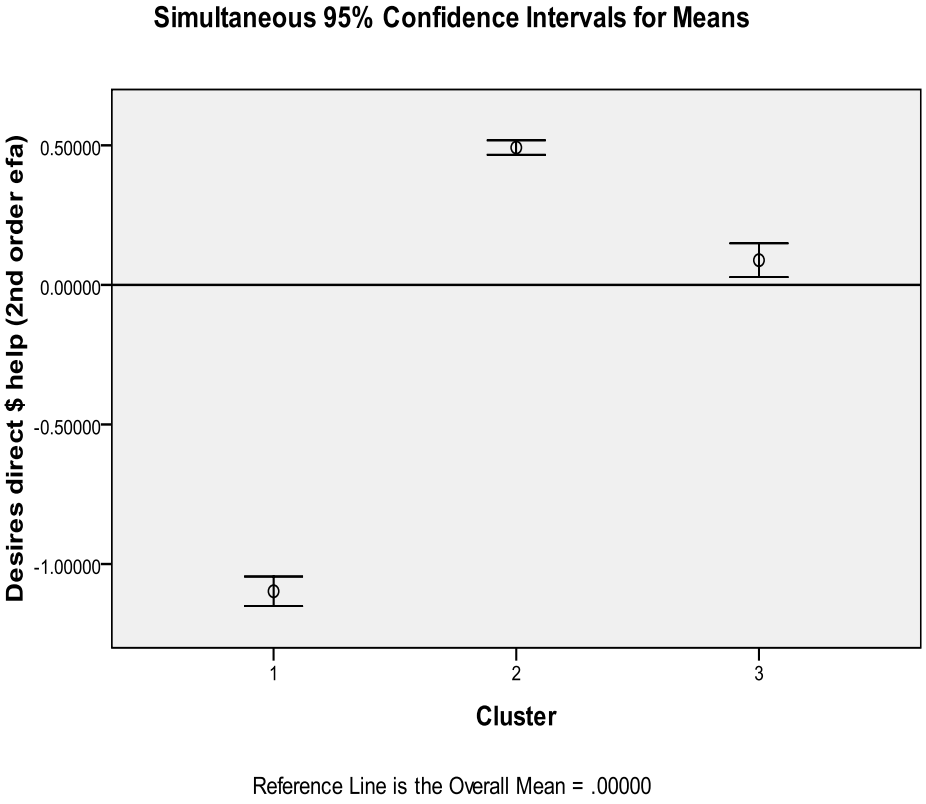
The following Figures show the differences in mean scores for each type of farmer for their degree of belief in the five higher-order factors used to derive the typology. Points on the Figures show mean scores and the whiskers show 95% confidence intervals (CIs). The line represents the grand sample mean. Where the mean scores and 95% CIs fall clear of the grand sample mean, the mean score for that type of farmer is significantly different from the mean. Where the mean scores and 95% CIs for one type of farmer falls clear of the mean score and 95% CIs for another type of farmer, the mean scores for the two types of farmers differ significantly from each other.



KEY

Cluster 1: comfortable non-adaptors; Cluster 2: cash poor long-term adaptors; Cluster 3: transitioners

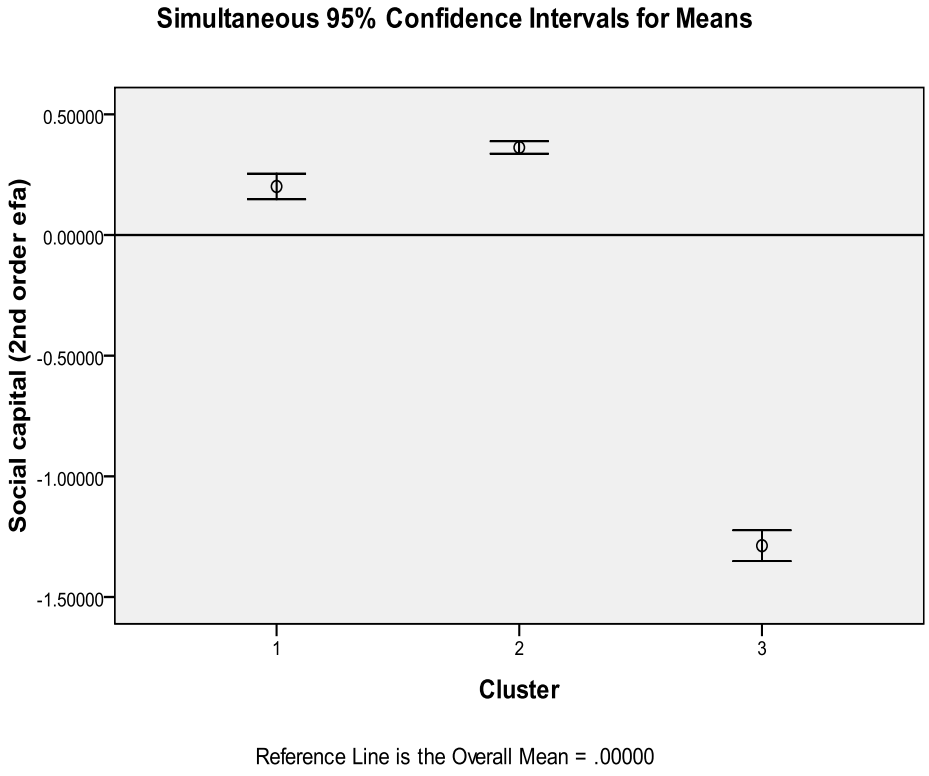
Figure B1 Comparison of clusters by belief in climate change



KEY

Cluster 1: comfortable non-adaptors; Cluster 2: cash poor long-term adaptors; Cluster 3: transitioners

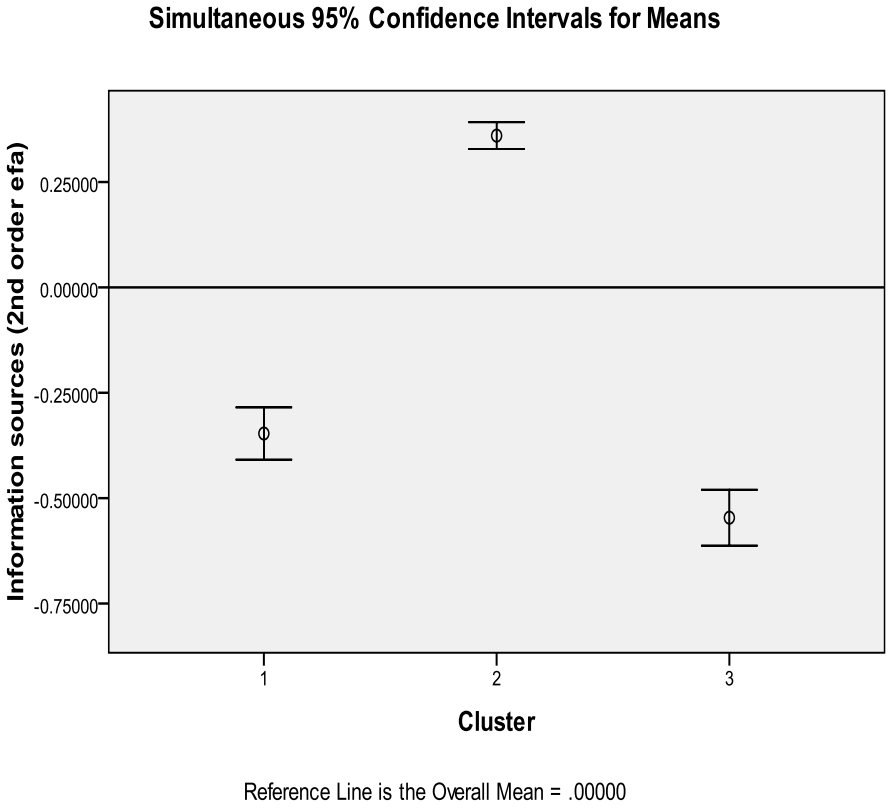
Figure B2 Comparison of clusters by desire for financial help



KEY

Cluster 1: comfortable non-adaptors; Cluster 2: cash poor long-term adaptors; Cluster 3: transitioners

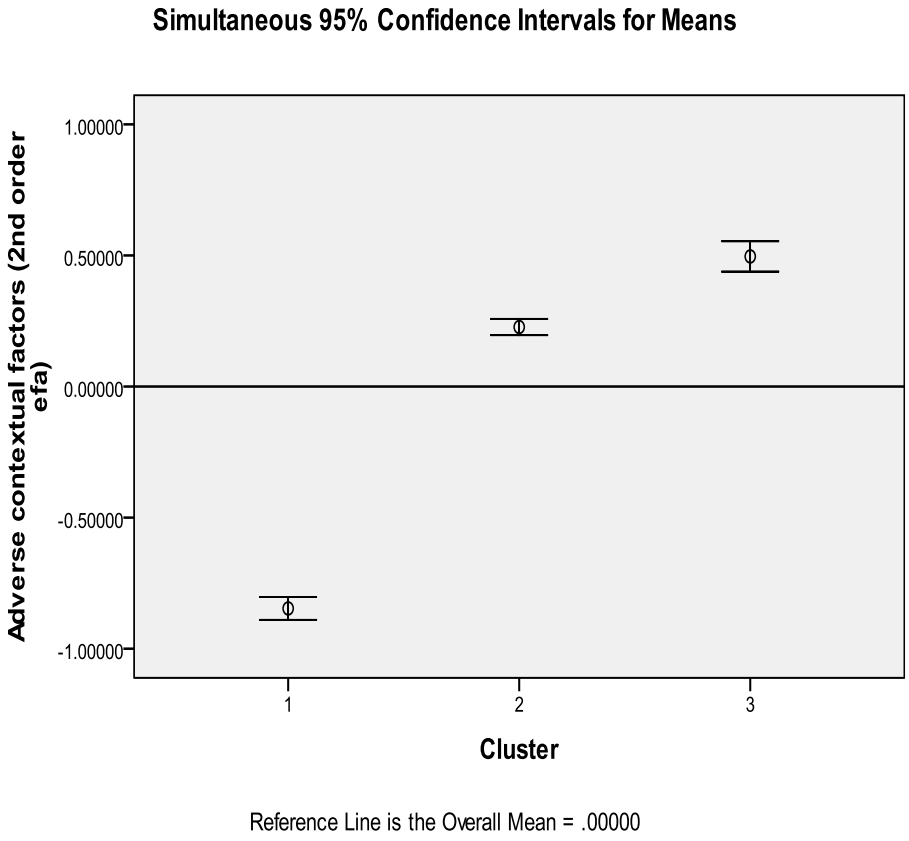
Figure B3 Comparison of clusters by social capital



KEY

Cluster 1: comfortable non-adaptors; Cluster 2: cash poor long-term adaptors; Cluster 3: transitioners

Figure B4 Comparison of clusters by use of information sources



KEY

Cluster 1: comfortable non-adaptors; Cluster 2: cash poor long-term adaptors; Cluster 3: transitioners

Figure B5 Comparison of clusters by farm conditions

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Decisions Made by Farmers that Relate to Climate Change

by Anthony Hogan, Helen L Berry, Suan Peng Ng, and Adam Bode

Pub. No. 10/208

This paper reports on a study of 4,000 Australian farmers. It examines factors that are associated with decisions they may or may not make to adapt to risks posed by climate change.

It reveals that a majority of farmers are simply focusing on surviving in the short term in the face of a myriad of challenges which go well beyond climate; however, it is evident that a large number of these farmers have identified the fact that they are not financially viable in the face of current climate challenges.

Such a conclusion raises many challenges for both farmers and policy makers. In facilitating groups of farmers moving on from existing practices, policy responses need to consider solutions which address the many complexities which will arise.

As farmers come off exceptional circumstances assistance, drought, climate, natural resource management and community service policy makers will need to work closely together to address the myriad of issues that will arise from this substantial process of social change.

Many famers will have little if any equity left with which to rebuild their farms. The property values of some farms will have been drastically reduced because of shifts in water assets or the sale of the same. Some farmers and their families will need support, both social and financial, as they transition to new lifestyles and identities for themselves while others will need help in re-building as they move to sustainable practices.

Electronically published by RIRDC in February 2011
Print-on-demand by Union Offset Printing, Canberra at
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