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Attitudinal modelling and monitoring of factors influencing land management practice in the Central West and Lachlan Catchments

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Cover Photograph:

Description: Hay bales, Lachlan catchment NSW
Photographer: Jennifer Price

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The PUTTI project is a collaborative research initiative between the CSIRO and nominated NSW Catchment Management Authorities. The project is focussed on dryland farming and is funded by the Australian Government's National Action Plan for Salinity and Water Quality/National Heritage Trust Program (NAP/NHT) and CSIRO.

EXECUTIVE SUMMARY

The monitoring and evaluation activities detailed in this report are part of the third and final phase of the 'Partnerships and Understanding Towards Targeted Implementation' (PUTTI) research project. The PUTTI project is funded by the Australian Government's National Action Plan for Salinity and Water Quality/ National Heritage Trust Program and CSIRO. The research is a collaboration between the Lachlan and Central West Catchment Management Authorities (CMAs), landholders, the broader Lachlan and Central West catchment communities and researchers at the CSIRO.

The PUTTI research project aims to progress knowledge of the features and context of land management practice at a farm level, so that catchment management can better reflect and address the drivers of decision-making at the individual property level. The project uses qualitative and quantitative behavioural science methodologies to identify and assess the drivers of land management decision and the context in which decisions are made. This process may also identify the most effective strategic intervention points to effect change in land management practice and improve catchment health..

Past experience has shown that best practice land management as identified by Catchment Management Authorities and government agencies does not always coincide with what landholders think is best for their farms or lifestyles (Barr & Cary 2000; Curtis & Byron 2002). Farming is more than an economic activity. It is underpinned by experience, local understanding, local knowledge about the environment shared by landholders and others in the community, and a set of beliefs, values and attitudes that are specific to individual landholders.

As part of the first phase of the PUTTI project, research was conducted in the Bell and Cudgegong sub-catchments of the Central West Catchment of New South Wales (Porter et al., 2007). In the second phase of the project, research extended into the Humbug and Mandagery sub-catchments within the Lachlan catchment of New South Wales (Bates et al. 2008). Several indicators of desirable land management practice were identified through these preliminary phases of the project and have iteratively informed the research activities detailed in this report.

This report details the re-surveying of 422 landholders from both the Central West (first interviewed in early 2007) and the Lachlan catchments (first interviewed in early 2008) about their land management practices.

.The following questions drove the current research:

- Can farmers' land management practices be predicted by their attitudes, traits, values, beliefs and farm characteristics?
- To what extent does environmental context influence individual farmer decision-making and land management practices?
- Have land management practices in the Central West and Lachlan catchments changed over the course of the PUTTI project?

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A predictive regression model of the key factors that influence, or predict, land management practices was developed from data collected through telephone questionnaires conducted with landholders as part of a survey of their practices, attitudes, beliefs and characteristics. The model attempted to identify the psychological and social determinants of best practice land management. Land management practice scores were assigned to respondents in the telephone survey based on their answers to open-ended questions relating to their management of weeds, perennials, stock, soil and native vegetation. The responses given to these questions were assigned a numeric value based on whether the CMA identified it as desirable and likely to result in positive or negative environmental outcomes.

The resulting model had good predictive capacity, explaining 38% of the variance in land management practice scores. It sheds light on the attitudes and traits that influence farmers' land management decisions and practices. The following factors were found to have the most influence on land management practice:

- Having a sense of being in control over events and outcomes (i.e. having an internal locus of control), which is in turn influenced by perceived access to resources. Locus of control influences whether a landholder is likely to undertake property planning. It is also reciprocally related to the levels of risk and innovation that a landholder demonstrates with respect to their production techniques.
- Valuing native animals and plants
- Trusting and being influenced by agronomy professionals
- Perceiving oneself as being influential to other farmers, which is also related to the level of risk and innovation

The survey revealed only minor changes in attitudes and land management practice over time. There was a significant but slight improvement in land management practice scores for landholders from the Mandagery sub-catchment, and a significant but slight decline in land management practice scores for the Bell sub-catchment. Land management practice scores in the Humbug and the Cudgegong sub-catchments remained stable.

Farmers in the Humbug were found to be suffering disproportionately from the drought compared to those in the other sub-catchments. They displayed different land management practices, farm goals and motivations, and reduced levels of psychological resources (e.g. a more external locus of control). This indicates that degradation of the physical environment is having a strong influence over aspects of psychological well-being.

Women in the study were found to have less access to formal agricultural education and were differentially affected by environmental conditions, which in turn affected their land management practices.

The work contained in the monitoring and evaluation component goes beyond traditional investigations into incentives associated with land management practice and adoption. It examines the social and psychological drivers and barriers associated with land management practice, and provides recommendations on how the formal and informal programs of CMAs can be structured accordingly. Recommendations relating to social influence, property planning, women in farming, program packaging and incentive funding are provided.

This report is one of a series that provides details of findings from the PUTTI research. In addition to the report on the first and second phases of the project (Porter et al. 2007; Bates et al., 2009) the following research reports are available:

1. Leviston, Z., Price, J., Tucker, D., Bishop, B., Bates, L. E., & Nicol, S., (2009). 'Partnerships and Understanding Towards Targeted Implementation – PUTTI: Attitudinal modelling and monitoring of factors influencing land management practice in the Central West and Lachlan Catchments'. CSIRO: Water for a Healthy Country National Research Flagship.

2. Green, M.J., Dzidic, P.L., Tucker, D.I., Nicol, S.C., Bates, L.E., Bishop, B.J., Leviston, Z., & Price, J. (2009). 'Partnerships and Understanding Towards Targeted Implementation – PUTTI: Landscapes and Livelihoods: Community requirements for sustainable change'. CSIRO: Water for a Healthy Country National Research Flagship.

3. Tucker, D., Lusher, D., Green, M., Dzidic, P., Bates, L. E,, Leviston, Z. Robins, G. & Pattison, P. (2009). 'Partnerships and Understanding Towards Targeted Implementation – PUTTI: Social Networks and Environmentally Sustainable Land Management . CSIRO: Water for a Healthy Country National Research Flagship.

4. Bates, L. E., Leviston, Z., Green, M. J., Tucker, D. I. Price, J., Dzidic, P.L. and Nicol, S. C. (2009) Partnerships and Understanding Towards Targeted Implementation – PUTTI: Final report - Conditions underpinning the voluntary adoption of sustainable land management practice. CSIRO: Water for a Healthy Country National Research Flagship.

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1. INTRODUCTION

Traditional agricultural production techniques may not be sustainable in the long term due to their continuing negative impact on the environment and the ongoing depletion of natural resources. The adoption of alternative approaches requires landholders to change their management practices in a context of high uncertainty, which includes climate variability and drought; reduced agricultural extension; changing global markets; and financial strain.

Agriculture is more than just an economic activity; it is a 'social process' (Pannell et al., 2006) that is influenced by rural communities and is underpinned by the individual landholders' personal experiences, local knowledge, beliefs, values and attitudes. Adoption of farming practices depends on the characteristics of the practice, such as its profitability, but also a range of personal, cultural and economic factors (Barr & Cary, 2000; Pannell et al., 2006). International agricultural adoption studies often fail to consistently identify determinants, or predictors, of adoption due to the diversity of farmers and rural communities (Knowler & Bradshaw, 2007; Rogers, 2003). The lack of convergence between studies indicates that contextual and personal factors are crucial to explaining adoption practices. Indeed, individuals' characteristics have been found to be reciprocally linked to their environmental context. For instance, Van Haaften and Van de Vijver (1996a; 1996b) have found that farmers' psychological traits are negatively influenced by environmental degradation, reducing the likelihood of farmers undertaking mitigation behaviours.

Effective catchment management requires integration of local knowledge and scientific understanding of the biophysical, social and economic features of an area. Past experience has shown that best practice land management, as identified by Catchment Management Authorities (CMAs) and government agencies, does not always mesh well with what landholders think is best for their farms or lifestyles (Barr & Cary 2000; Curtis & Byron 2002). It is imperative that CMAs obtain the support and cooperation of the agricultural community so that more sustainable land management practices are adopted and environmental outcomes are improved.

CMAs are required to formulate targets for natural resource management in their region as part of their Catchment Action Plans (CAPs). Target areas include soil, water, vegetation, biodiversity and salinity. The targets in these areas have historically been based on the CMA's conception of 'good' land management practice. To encourage landholders to assist in meeting these management targets, incentive programs have been designed that offer financial assistance for eligible landholders.

The current research is part of a wider program - The Partnerships and Understanding Towards Targeted Implementation (PUTTI) project. The PUTTI project has been undertaken to assist the Lachlan and Central West CMAs to more effectively implement their CAPs and incentive programs so that natural resources are managed sustainably and rural communities in the area remain productive and resilient. The project is developing and implementing an ongoing program to support and encourage change and build mutual trust between community members, scientists and decision-makers. The monitoring and evaluation component detailed in this report was conducted in the third and final phase of the PUTTI project, and builds on the findings from previous phases. Each of the three phases was comprised of a number of activities, which are outlined in Figure 1.

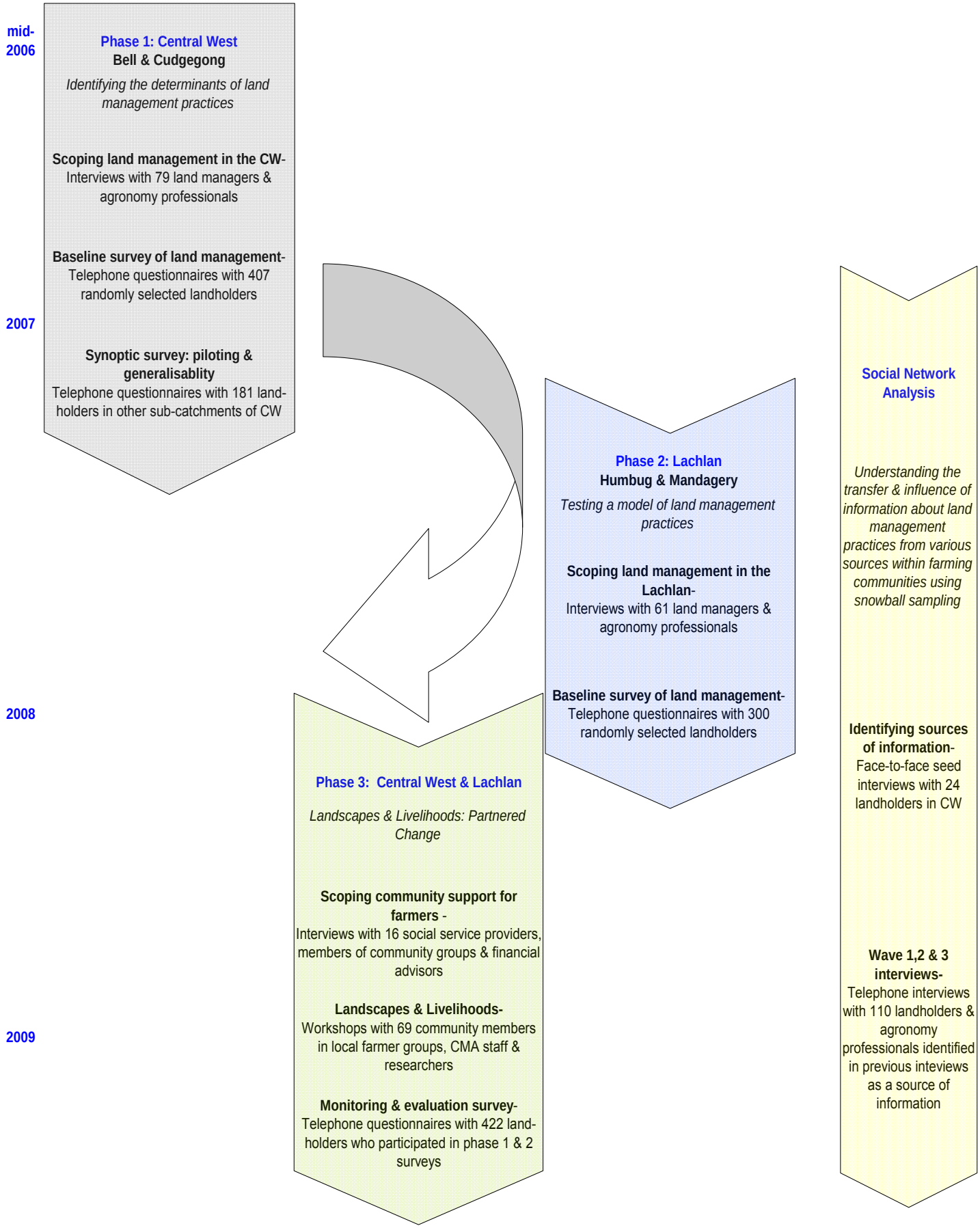


Figure 1. Schematic of PUTTI research activities

The PUTTI project adopted an iterative approach, in which findings from earlier research activities informed the development and analysis of later stages. The first phase of the PUTTI project took place in the Bell and Cudgegong sub-catchments of Central West catchment area, while the second phase took place in the Humbug and Mandagery sub-catchments of the Lachlan catchment. The third phase was conducted over both catchments. These study areas are predominantly dry-land with large pockets of irrigated agriculture. They are characterised by mixed farming activities such as broad-acre cropping and cattle and sheep production. Each phase was comprised of both quantitative and qualitative research activities such as surveys, interviews and workshops. Social Network Analysis was conducted throughout all three phases of the PUTTI research in order to better understand the transfer and influence of agricultural information throughout communities in the catchments (detailed in Tucker et al., 2009).

A predictive model of best practice land management (as defined by the CMAs) was developed during the first phase of the PUTTI research, using a technique called Structural Equation Modelling, to identify the social and psychological factors that influence practices in the catchments. The model was tested and refined in subsequent phases of the project. Each model was developed using data from telephone questionnaires that were conducted as part of a survey of landholders' practices, attitudes and values. Participants in the surveys were asked open-ended questions about their management of weeds, perennials, stock, soil and native vegetation, and covered the following areas:

- *What* specific practices were undertaken on their farm;
- *Why* the practices were undertaken; and
- *How* the practices influenced other practices or outcomes on their, farm.

The responses given to these questions were later assigned a numeric value based on whether the CMA identified it as desirable and likely to result in positive or negative environmental outcomes. By quantifying all responses given in the survey, a land management score could be calculated and assigned to all survey participants. The structural equation models described above were developed to predict the land management scores obtained by survey participants by using information about their attitudes, values, traits, beliefs and farm characteristics (see Appendix 1 and Appendix 2). The following factors were found to be associated with desirable land management practices in the second phase of the research, and have had direct bearing on the research activities detailed in this report:

- Having a written property plan – particularly plans created with the aid of a professional/consultant;
- Seeing themselves as being in control of their circumstances (having an internal locus of control);
- Having trust in and being influenced by their peers and informed groups (such as other farmers, scientists, agronomists, Department of Primary Industry);
- Possessing a value system that conveys concern for the physical and naturally occurring environment (such as native animals, birds and plants); and, interestingly,
- Possessing a value system that conveys secondary or reduced concern about the impacts of environmental problems on family and self.

Characteristics of the land-management practices themselves (e.g. their profitability, complexity, trialability and so on) were not investigated as this information is widely discussed in the agricultural adoption literature (e.g. Pannell et al., 2006; Cary & Wilkinson, 1997). Theories of agricultural production that focus on characteristics of the practice rather than the characteristics of the farmer have been criticised as overly simplistic, as they fail to account for the full range of motivations in agricultural change (Clark & Lowe,1992; Battershill & Gilg, 1997). As such, farmers' traits, characteristics and attitudes were the primary focus of the modelling undertaken for the PUTTI project.

The current report, which is part of the Monitoring and Evaluation activity described in Figure 1, details the re-surveying of 422 participants from both the Central West and Lachlan catchments. Its aim is threefold:

- Firstly, it aims to validate and refine the model of land management practice developed for the Lachlan catchment, and assess whether a suitable model can be developed for multiple catchments in NSW.
- Secondly, it aims to investigate differences in land management practice over different sub-catchments.
- Thirdly, it aims to identify changes in land management practice that have occurred since the initial phases of the PUTTI research.

A Glossary providing definitions of statistical procedures, psychological concepts and agricultural terminology is included before the reference section.

2. WHAT ARE THE FACTORS THAT INFLUENCE LAND MANAGEMENT? A REVIEW OF THE LITERATURE

Adoption of farming practices depends on the characteristics of the practice as well as a range of personal, cultural and economic factors (Barr & Cary, 2000; Pannell et al., 2006). As such, agricultural adoption can be viewed as a social process. Continuing land degradation in Australia indicates that current social and economic conditions affecting agricultural communities are not conducive to widespread adoption of sustainable conservation land management practice (Barr & Cary, 2000). It can be difficult to identify conditions which influence adoption of agricultural practices due to the diversity in management strategies used by individual farmers as well as agricultural communities. The empirical literature regarding agricultural adoption is vast but does not consistently identify determinants of adoption practices which are agreed to be central in prediction (Rogers, 2003). In a review of 31 international studies, Knowler and Bradshaw (2007) indentified 167 variables that have been used to predict or explain adoption of conservation agriculture. They suggest that the relationship between such variables and adoption is inconsistent, with positive, negative and non-significant results reported for the same variables. The lack of convergence between studies indicates that contextual factors are crucial to explaining adoption practices. They concluded that *"few if any universally significant independent variables"* predict conservation agriculture adoption and that regional differences may contribute considerably to land management practices (Knowler & Bradshaw, p.42).

To contextualise our research, this literature review is guided in part by key psychological or social factors that influence agricultural adoption in the Central West and Lachlan catchments that were identified through extensive qualitative research undertaken in the area (see Bates et al., 2008). Interviews were conducted with 140 landholders, land managers and agronomy professionals in the Bell and Cudgegong sub-catchments of the Central West in September 2006 and the Humbug and Mandagery sub-catchments of the Lachlan in October 2007.

The qualitative research in the Central West and Lachlan indicated that rural communities in the area have been experiencing numerous pressures related to climate variability and changing global markets. Their terms of trade have declined where input costs have risen, whilst commodity prices have declined along with the societal value placed on agriculture. The issues facing rural communities need to be seen as a threat not only to the well-being of individual farmers but also to the environment and economy. Key factors influencing the adoption of agricultural innovation and conservation practices identified in the qualitative research included the following:

- the extent to which individuals believe they can control events that affect them i.e. their locus of control;
- environmental values and attitudes towards land stewardship;
- risk perceptions and risk management in agriculture;
- access to financial resources;
- optimism, motivation and future orientation; and
- the nature of the interactions between CMA staff and land-managers.

2.1. Theoretical frameworks of pro-environmental behaviour

It has been suggested that research regarding the environmental behaviours of farmers has been limited due to an absence of adequate theoretical frameworks capable of accounting for contextual differences (Bayard & Jolly, 2007). The adoption of conservation land management practices, like other forms of environmentally responsible behaviour, may be difficult to encourage as they can result in personal expense and inconvenience. The literature pertaining to pro-environmental behaviour more broadly (e.g. recycling, transportation modes, purchasing patterns and so on).

The drivers of pro-environmental behaviour can be highlighted through examining behaviours that provide public rather than private benefit. Farmers' decision-making is a complex process that involves the balancing of public and private benefit. Public benefit may be a strong motivation for farmers and a source of great pride, particularly in areas where social norms celebrate stewardship ethics (Lynne, 1995). It should be noted that many environmentally responsible farming practices can provide public *and* private benefit, due to the reduced input and labour costs associated with some of these practices (Bates et al., 2008). As such, not all theories relating to pro-environmental behaviour can be transferred to explaining agricultural adoption; however some useful theoretical frameworks are provided.

In a review of the psychological and social determinants of pro-environmental behaviour, Bamberg and Möser (2007) found that knowledge influences whether an

individual is likely to take personal responsibility for pro-environmental behaviour (i.e. attribute responsibility internally rather than externally). Their analysis supported a proposed integrated model in which pro-environmental behaviour is presented as a combination of self-interest and pro-social motivations. They suggest that environmental behaviours can be explained by two dominant theoretical models:

1. **Rational-choice** models such as Ajzen's (1991) Theory of Planned Behaviour (TPB) which is based on the principle that people are self-interested and motivated to attain rewards and avoid punishment. Research has demonstrated that TPB can explain successfully a range of environmental behaviours (see Steg & Vlek, in press); and
2. **Norm-Activation** models (Schwartz, 1977; Schwartz & Howard, 1981) in which people are morally obligated to behave pro-socially as a form of altruism. In this model, helping behaviours are thought to be predicted by awareness of need, awareness of consequences and awareness of responsibility. Upon identifying a need and personal ability to act, an individual weighs up whether they are morally responsible for the act against their own values and socially accepted standards whilst considering overall costs and benefits. Socially accepted standards conveyed by peers, family, community or society can be thought of as norms. Completing an action that is congruent with one's values is thought to result in a sense of self satisfaction, often called intrinsic satisfaction (De Young, 1996).

Schwartz and Howard (1981) identified three types of *boomerang effects* that occur when norms, or socially accepted standards, that typically activate helping behaviours have the opposite effect, as follows:

1. Suspicions arising when the purported need for action has been over-stated. This may raise questions about motives of those expressing the need as well as the real extent of the need, resulting in mistrust;
2. Reactions against perceived manipulative or coercive actions of others in the form of disengagement, resistance and antagonism; and
3. Internalised benefits and satisfaction from an action can be undermined by the provision of external regulations or incentives. For instance, financial incentives may make individuals reframe a 'moral' action in terms of monetary rewards (Thogersen, 1996 as cited by Blamey, 1998).

Blamey (1998) extended the Norm-Activation Models described above (Schwartz, 1977; Schwartz & Howard, 1981) by considering the institutional and social context in which norms are activated and environmental behaviours undertaken (see Figure 2 below). In this model, individuals' acceptance of policy initiatives, trust in institutions and trust in other citizens are thought to influence their levels of awareness and resultant behaviours. Issues such as the procedural and distributive fairness of institutions' actions and policies are identified as important in this model.

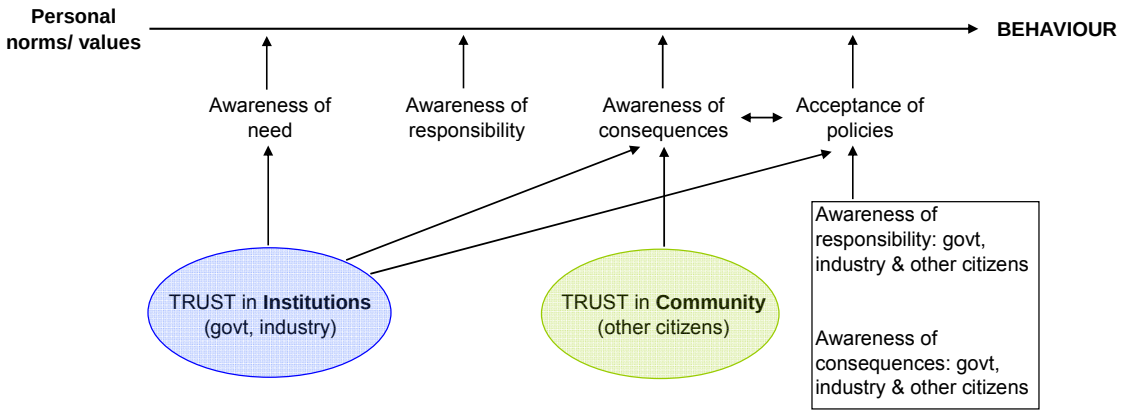


Figure 2. Extended Norm-Activation Model (adapted from Blamey, 1998, p. 689)

The framing of pro-environmental behaviours as a form of altruism has been widely explored in a number of other theoretical frameworks, including the Value-Belief-Norm (VBN) theory of environmentalism (Stern, 2000; Stern, Dietz, Abel, Guagnano, & Kalof, 1999) and Geller's (1995) Actively Caring Hypothesis. The VBN theory of environmentalism connects Norm Activation theories (Schwartz, 1977; Schwartz & Howard, 1981) with the New Environmental Paradigm (NEP) perspective (see Dunlap, 2008 for a review) to explain environmental behaviours (see Figure 3 for a schematic). The NEP is defined as a new worldview that developed as a reaction against the dominant and anthropocentric worldview held in western society that nature exists solely for human use (Dunlap & Van Liere, 1978). The NEP is based on beliefs that development should be limited and the balance of nature preserved. Each variable presented in the VBN schematic is thought to causally influence the variables further along the chain. The values in the model are presented as relatively stable general traits, whereas the beliefs are thought to be more specific and focused on the nature and outcomes of humans' relationship with the environment. Pro-environmental personal norms are activated by beliefs regarding environmental threats and personal ability to address threats, which in turn prompt a range of behaviours.

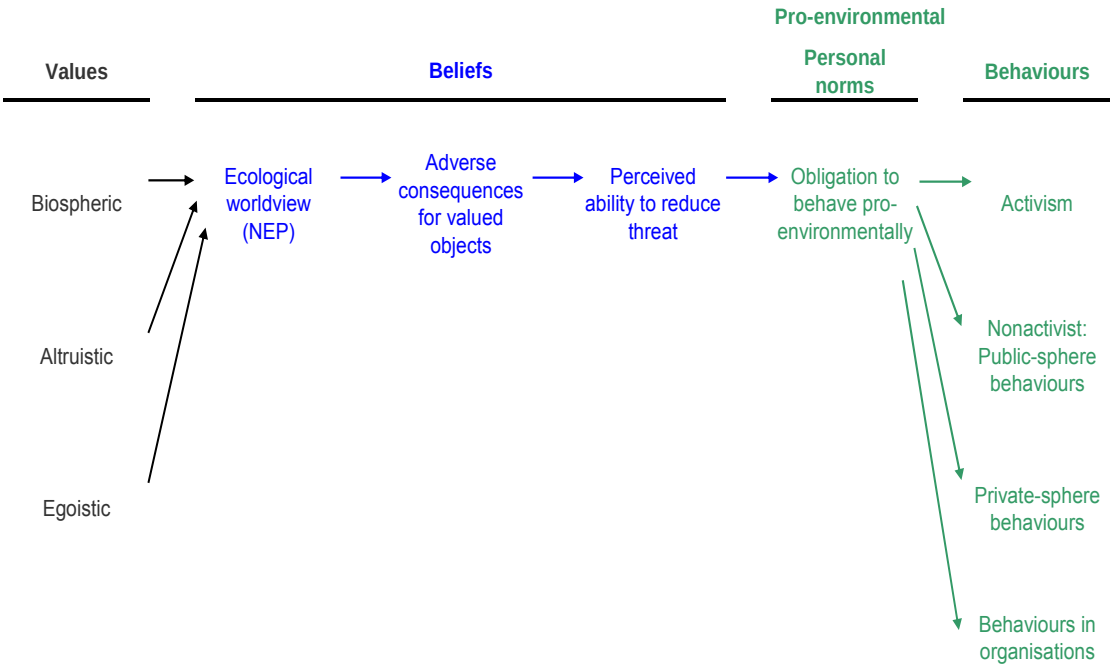
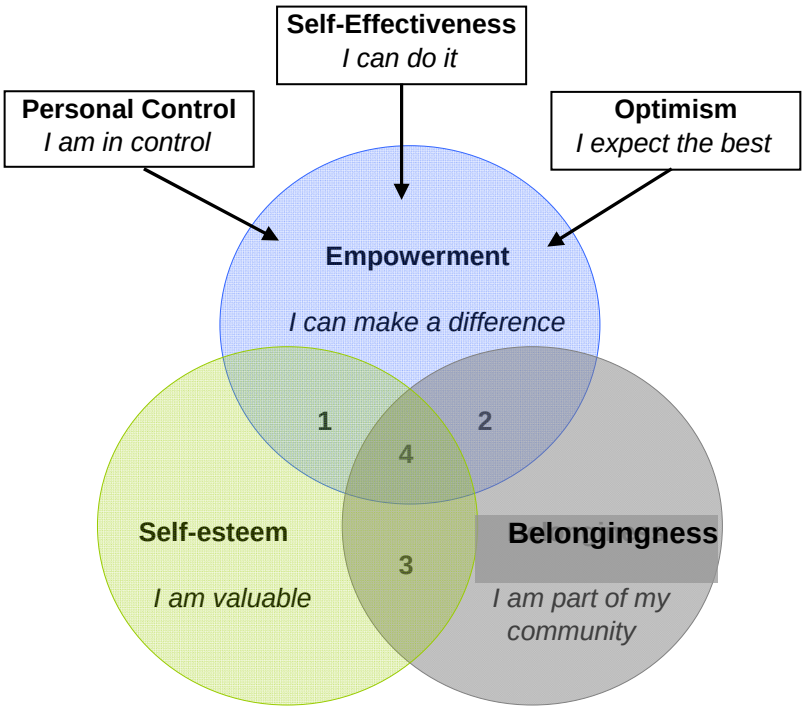


Figure 3. Values-Belief-Norm theory of environmentalism (adapted from Stern, 2000, p.412)

The Actively Caring Hypothesis, on the other hand, refers to a state in which individuals are concerned enough about the environment, and therefore the welfare of the broader community, to undertake behaviours that may be of minimal personal benefit (aside from intrinsic satisfaction). Geller suggested that individuals' personal psychological needs must be met before they can behave altruistically. These needs are identified as self-esteem, belonging, personal control, self-efficacy and optimism, and are illustrated in Figure 4. Geller's (1995) assertion that personal needs must be met before one can develop a sense of 'other directedness' draws on Maslow's (1971) Hierarchy of Needs; this is defined as the human tendency to attend to the more immediate and basic human needs, such as food, water and safety, before being driven to satisfy less tangible needs, such as self-development and self-fulfilment (see Mischel, Shoda & Ayduk, 2007). In support of the Actively Caring Hypothesis, Allen and Ferrand (1999) found that personal control and sympathy were inter-related and could predict environmental behaviours. They concluded that sympathy might explain the relationship between personal control and environmental behaviours.



1. I can make a **valuable** difference
2. **We** can make a difference
3. I am a **valuable** community **member**
4. **We** can make a **valuable** difference

Figure 4. Antecedents of propensity to actively care (adapted from Geller, 1995, p 193)

2.2. Locus of control: Feeling in control of outcomes

The extent to which an individual feels in control of outcomes and the events that affect them can be described by the concept of locus of control, which was first introduced by Rotter (1966). It is thought that individuals can be grouped into one of two categories based on their general expectancies about where control over events and outcomes is located. Those with an *internal* locus believe that outcomes are contingent on their own actions; those with an *external* locus believe that chance, fate or powerful others control outcomes (see Levenson, 1981; Paulhus and Van Selst, 1990 for reviews and adaptations).

Locus of control has been identified as an important personality trait that may influence farmers' decision-making styles, interpretation of events and, subsequently, levels of stress (Pannell et al, 2006). An internal locus of control has been found to predict environmentally responsible behaviour (Darner, 2009; Bamberg & Möser, 2007; Hwang, Kim & Jeng, 2000; Hines, Hungerford & Tomera, 1987; Huebner & Lipsey, 1981), attitudes (McCarty & Shrum, 2001) and environmental concern (Pettus & Giles, 1987). Furthermore, an internal locus of control has been found to be related to higher levels of farm planning and subsequent farming performance (Tanewski, Romano & Smyrnios, 2000). In an analysis of 15 studies Hines, Hungerford and Tomera (1987) found that locus of control/self-efficacy demonstrated a positive moderate correlation (r=.37) with pro-environmental behaviour. Twenty years on,

Bamberg and Möser (2007) found a similar mean correlation (r=.30) between perceived behavioural control and pro-environmental behaviour in an analysis of 18 studies published since 1986. Locus of control was found to have the largest effects on intentions to act in an environmentally responsible manner of all the variables included in a hypothesised model of pro-environmental behaviour (Hwang et al., 2000). Hwang et al. (2000) concluded that an internal locus of control precipitates positive attitude change, which in turn affects an individual's intentions to act.

There is some debate as to whether locus of control is a stable personality trait (Rotter, 1966) or a malleable state that is issue specific (Huebner & Lipsey, 1981; Kinnear, Taylor & Ahmed, 1974). Research supports the view that there is a mutual relationship between the physical environment and the psychological health of those that inhabit that environment (Van Haaften, Zhenrong & Van de Vijver, 2004; Rossier, Dahourou & McCrae, 2005; Higginbotham, Connor, Albrecht, Freeman & Agho, 2007). For instance, environmental degradation can result in negative psychological consequences such as stress, marginalisation and an external locus of control. In turn, low levels of psychological resources can trigger practices that may exacerbate environmental degradation. Van Haaften and Van de Vijver (1996a; 1996b) showed that extreme environmental degradation in the Sahel region of Burkina Faso and Mali is related with external loci of control in farmers. These results support the view that locus of control may be an alterable state. An associated concept, Learned Helplessness, may develop when attempts to manage adverse environmental conditions are unsuccessful, resulting in diminished feelings of control, and even depression (Seligman, 1975).

2.3. Environmental values and awareness

There is some evidence that pro-environmental behaviour is influenced by the extent of environmental concern that an individual demonstrates; however the strength of this relationship has been questioned (Poortinga, Steg & Vlek, 2004; Schultz & Zelezny, 1999). Farmers' attitudes towards the environment influence their environmental behaviours (Napier & Brown, 1993), adoption of conservation practices (Carlson, Schnabel, Beus & Dilman, 1994) and participation in land re-generation programs (Luzar & Diagne, 1999; Willcock et al., 1999; Vogel, 1996).

Research indicates that people may be concerned about environmental problems because of the impacts on aspects of the natural and physical environment (such as plants and animals) – termed 'biospheric' environmental values, as well as themselves and their family – termed 'egoistic' environmental values. Specifically, a propensity to value biospheric elements over egoistic elements can predict conservation behaviour and resource sharing (Arnocky, Stroink & DeCicco, 2007). Further, adoption of agricultural technologies such as conservation tillage is influenced by awareness of environmental threats such as erosion and poor soil health (Gould, Saupe & Klemme, 1989; Napier & Camboni, 1993)

2.4. Financial resources

The adoption of conservation practices on the farm may be related to farmers' access to financial resources, particularly if such practices require new equipment or other inputs (Knowler & Bradshaw, 2007). High incomes and profitable farms positively influence adoption (Gould et al., 1989; Saltiel, Bauder & Palakovich, 1994;

Somada, Nianogo, Nassa & Sanou, 2002). There is debate in the social science literature regarding how socio-economic conditions influence individuals' environmental attitudes (Bayard & Jolly, 2007), with some authors arguing that environmental concern is a luxury for the rich (Diekman & Franzen, 1999; Inglehart, 1995) and others arguing that concern for the environment is universal irrespective of socio-economic standing (Brechin & Kempton, 1994). There is some indication that the relationship between environmental attitudes and behaviours is stronger for low income groups relative to high-income groups (Tarrant & Cordell, 1997). Bayard and Jolly (2007) investigated the potential effect of socio-economic conditions on farmers' attitudes and behaviours. They found that awareness had a greater effect on the behaviours of farmers in high socio-economic conditions relative to those in low socio-economic conditions.

2.5. Attitudes to risk

Risk attitudes are conceptualised as being similar to a personality trait and an important predictor of adoption decisions made on the farm (Pannell et al., 2006). For instance, Pannell et al. (2006) suggest that risk-averse farmers are more likely to adopt innovations that reduce risk (citing Shapiro et al., 1992) and avoid or prolong the adoption of risky innovations (citing Abadi Ghadim et al., 2005). Risk-averse farmers are also more likely to hedge and use futures as well as price risk-management instruments (Pennings & Garcia, 2001). In other studies, farmers that perceived pesticides to pose a risk to health were more likely to use alternative pest management strategies (Lichtenberg & Zimmerman, 1999). The relationship between risk attitudes and conservation agricultural adoption is not clear cut; however one could posit that very new innovations that are yet to be established as reliable or effective are unlikely to be adopted by risk-averse farmers.

2.6. Property planning

Another aspect found to link with land management practice is property planning. Cary, Barr, Aslin, Webb and Kelson,et al. (2001), in an analysis of government data of several agricultural industries, found that having a documented farm plan was a useful indicator of landowner capacity to change to sustainable land management practices, while Curtis and Byron (2002) found that farmers in the Wimmera region with property plans were more likely to adopt recommended practices. Catchment management research by Byron, Curtis and MacKay (2006) found that involvement in property planning was linked with the adoption of recommended farming practices.

3. METHODOLOGY AND SAMPLING

3.1. Study areas

Research for the PUTTI project was undertaken in the Central West and Lachlan Catchment management areas. These two areas are adjacent to each other and are located in central New South Wales. Two sub-catchments were selected by each Catchment Management Authority as focal areas for the study: the Bell and Cudgegong in the Central West; and the Humbug and Mandagery in the Lachlan (see Figure 5 for catchment and sub-catchment boundaries).

3.1.1. Central West Catchment: Bell and Cudgegong

The Bell and Cudgegong are tributaries of the Macquarie River with boundaries defined by topographic features. The majority of the Bell and Cudgegong sub-catchments fall within the NSW electoral district of Orange. The population within this boundary is 68,527. Eleven percent of the industry effort in the region is involved in agriculture, forestry and fishing (NSW Electoral Commission, 2007).

The Bell River rises in the flat to undulating country of the Orange plateau and flows north-west to join the Macquarie River before Dubbo (Figure 5). The Orange Local Government Area (LGA) was not included in this study as it has a higher residential density than normal rural settlements and as such involves many farmers with fewer than 10 acres, who were not classed as dryland farmers for the purpose of this study. The Wellington and Cabonne LGAs house the bulk of the Bell sub-catchment study area. In 2001 Cabonne had a population of 5,427, and 28.8% of the area's population was within the Bell study area. The Wellington LGA had a population of 41,368 in 2004 and the value of agricultural commodities produced in 2001 totalled $32.4 million (Australian Bureau of Statistics, 2006).

The Cudgegong River rises in the uplands around Rylstone and flows west to join the Macquarie River at Burrendong Dam (Figure 5). The Mid-West Regional LGA comprises the bulk of the Cudgegong sub-catchment study area and had an estimated population of 22,289 in 2003. The largest industry employer was Agriculture, Forestry and Fishing (16.3%). The sheep-beef cattle farming industry had the highest growth rate between 1996 and 2001, employing 100 of the 571 new jobs in this period (Mid-Western Regional Council, 2006). The Rylstone LGA also includes a portion of the Cudgegong sub-catchment. In 2001 it had a population of 3,784 (Community Relations Commission for a Multicultural NSW, 2007).

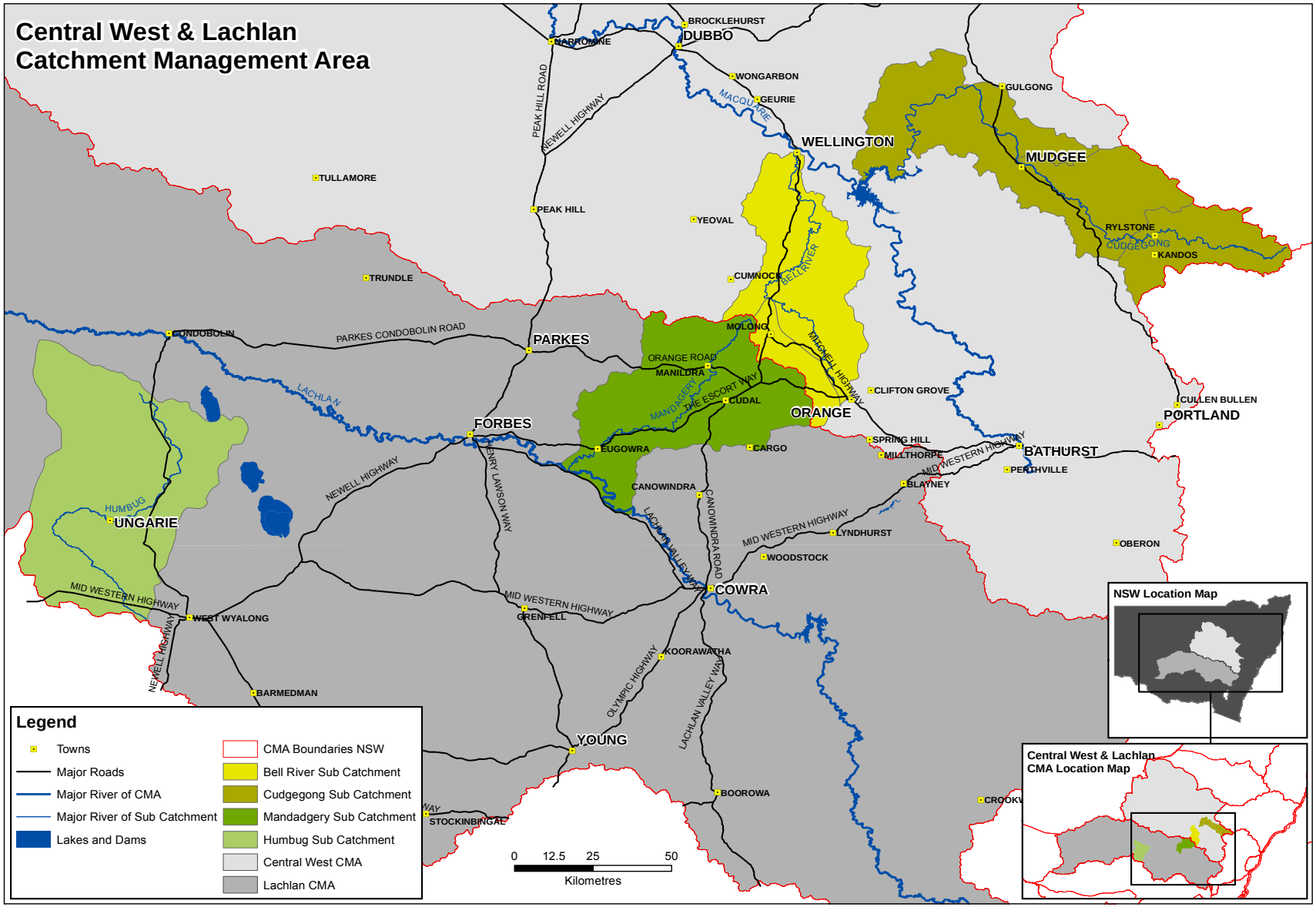


Figure 5. Study sub-catchments: Bell, Cudgegong, Humbug and Mandagery in the NSW Central West and Lachlan Catchment Management Authority regions.

3.1.2. Lachlan Catchment: Humbug and Mandagery

The Humbug and Mandagery sub-catchments were selected as the focal areas of the Lachlan Catchment for inclusion in the study. The Lachlan CMA adjoins the Central West CMA to the south, and the Mandagery sub-catchment shares a common boundary with the Bell sub-catchment in the Central West. The Lachlan catchment covers an area of approximately 84,700km^2 and has a population of 106,000 (Lachlan Catchment Management Authority, 2006). Major townships in the Mandagery sub-catchment include Manildra, Cudal and Eugowra, with Cargo located on the boundary. The townships of Parkes, Forbes and Canowindra are in close proximity to the Mandagery in adjoining sub-catchments. Ungarie, located between Lake Cargelligo and West Wyalong, is the main township in the Humbug sub-catchment. The Humbug and Mandagery Creeks are tributaries of the Lachlan River. Mandagery Creek rises at Noahs Ark Ridge near Molong and flows south-west to join the Lachlan River. Humbug Creek rises in the south near West Wyalong before flowing north to join Wallaroi Creek which then joins the Lachlan River. Participants in the survey were drawn principally from the two sub-catchments. To obtain the desired number of respondents for the survey, it was necessary to extend the sampling boundaries beyond the sub-catchment borders, particularly in the Humbug sub-catchment, and sample from adjacent areas with consistent landscapes.

The Humbug and Mandagery sub-catchments display many similarities in terms of land management practice, values, and attitudes (Lachlan Catchment Management Authority, 2006). A current distinction between the two relates to the severity of the drought and the flow-on impacts to the community. The sub-catchments are characterised by different physiographic and hydro-climatic conditions which affect land use. The Humbug sub-catchment receives less rainfall and has less fertile soil than the Mandagery. Over the three year study period the Central West and Lachlan catchments recorded approximately 70-80% of their average rainfall (Australian Bureau of Meteorology, 2009) Furthermore, at the time the survey was conducted, much of the Central West and Lachlan Livestock Health & Pest Authority districts (which are roughly comparable to catchment areas) were classified as being in drought conditions and eligible for drought assistance by the NSW Department of Primary Industries (2009).

The proximity of the Mandagery sub-catchment to the prosperous regional centre of Orange has seen capital and vibrancy injected into the area. The areas surrounding Orange have attracted interest from Sydney investors and have benefited from the resultant high land-values. Orange is rapidly growing with increased subdivision and hobby or lifestyle farms. Despite devastating drought impacts, high land values have enabled landholders in the Mandagery to sell properties at relatively good prices. In contrast, this has not occurred in the Humbug where it is either difficult or impossible to dispose of assets.

3.2. Sampling

Two baseline surveys to determine factors motivating the land management behaviours of landholders were conducted in phases one and two of the PUTTI research project in the Central West (2007) and Lachlan (2008) sub-catchments. During the earlier phases, respondents were asked if they would like to participate in future stages of the project. The majority (87.3%) indicated their on-going support. For the final monitoring and evaluation survey, random selections from lists of the initial supportive respondents in the Bell, Cudgegong, Humbug and Mandagery sub-catchments and adjacent areas were re-contacted and asked if they would be willing to participate in a re-surveying of their attitudes and practices by telephone. Interviewers were instructed to contact each property at least five times, at different times of the day and across different days, before the property could be

classified as a 'non-contact'. In total, 422 landholders were re-surveyed, the breakdown of which is presented in Table 1..

Table 1. Respondents surveyed by sub-catchment area

	Respondents (n)	Respondents (%)
Bell	116	27.5
Cudgegong	127	30.1
Humbug	91	21.6
Mandagery	88	20.8
TOTAL	422	100.0

Table 2 depicts the refusal details over the two sub-catchments as a whole, which gives a combined refusal rate of 20.1%. The refusal rates for the Bell and Cudgegong sub-catchments were 12.1% and 21.6% respectively, while the refusal rates for the Humbug and Mandagery sub-catchments were 10.8% and 33.3% respectively.

Table 2. Reasons given for non-participation in survey

Reason	Bell	Cudgegong	Humbug	Mandagery	TOTAL
Not Interested	4	14	6	14	38
Too Busy	11	15	3	24	53
Elderly/Too Old	1	1	0	0	2
Ill/Sick	0	1	1	2	4
Hung Up	0	3	1	0	4
Aborted	0	1	0	4	5
TOTAL	16	35	11	44	106

Appendix 3 provides a detailed analysis of the characteristics of the respondents and their farms, such as their age, gender, the number and size of properties that they actively managed, the time they had spent farming, and the time their family had been involved in farming.

3.3. The questionnaire and scales used in the study

A series of attitudinal statements was presented to respondents which later grouped together to form the scales (measurements of a concept) that were used in this study. These forty-six attitudinal statements were developed through analysis of the qualitative research in the Lachlan and the Central West as well as a comprehensive literature review in the areas of assessing environmental values (see Schultz, 2000, for a review), locus of control (Rotter, 1966; Marsh & Richards, 1986; Nuthall, 2006; Paulhus & Van Selst, 1990; McNairn &

Mitchell, 1992; Stayner, 1997) and risk and innovation (Bard & Barry, 2000; Pennings & Garcia, 2001). Table 3 provides a summary of scales and the items these scales were based on.

Table 3 lists the scales used to measure each key concept measured in the survey, the items included in each scale and the associated Cronbach's alpha. After recoding of reverse-worded items, a single score was calculated for each respondent on each variable by averaging the respondent's scores across the items comprising the scale. The Cronbach's alpha provides a measure of the reliability of the scales; scores can range from 0 to 1 with scores closer to 1 indicating higher reliability. All the scales had satisfactory to high levels of reliability.

A Principal Components Factor Analysis (PCA – see the Glossary for a detailed explanation) was performed on the attitude statements used in the questionnaire in order to establish which statements were measuring the same concepts. This analysis revealed that the attitude statements in the questionnaire statistically grouped together to form scales in a manner that was consistent with previous research (Bates et al., 2008). The output of the PCA was used to construct the scales (or variables) that are used throughout this report. A number of the scales were significantly correlated, or related to each other; for example, the variable *social influence* had a correlation of .41 with *risk and innovation* – meaning that the two variables have a moderate linear relationship with each other. Correlations between variables were typically weak (See Appendix 4 for the correlation matrix for key variables).

Table 3. Summary description of scales used to measure attitudes and values

Concept	Item	Reliability- Cronbach a
Locus of control The extent of control people feel that they have over events that affect their lives. Those who have an: • *external* locus of control feel that powerful others, fate and other external factors affect outcomes; • *internal* locus of control feel that they have personal control over outcomes.	The fate of farming is in the hands of the people in power and there's not much that individual farmers can do about it	.718
	The success of the farm is mostly determined by factors outside of my control	
	The weather and commodity prices can knock you around in the short term, but in the long run there is still a lot you can do to stay ahead of the game	
	Many times I feel that I have little influence over the things that happen to me	
	No matter what things I try on the farm, the drought prevents them from working	
Scale details: Measured on a 5 point scale ranging from 1 (strongly disagree) to 5 (strongly agree). High scores indicate greater sense of control over events that affect one's life		
Perceived social influence The extent to which people feel that they have social influence in their agricultural community	How often do people come to you for agricultural advice?	.747
	How much influence do you think you have on other farmers when it comes to agricultural practices?	
Scale details: Measured on two separate 5 point scales ranging from: 1 (never) to 5 (all the time); 1 (no influence) to 5 (significant influence). High scores indicate higher levels of perceived social influence		
Risk and innovation The extent to which people are willing to try innovative methods/ technologies and take risks on their farms	I am always one of the first producers in my area to adopt new technology	.678
	I am happy to try new farming methods that aren't used a lot	
	I am willing to take higher than average risks in order to get higher financial returns	
	I am willing to take more risks than other farmers in the area with respect to my production methods	
Scale details: Measured on a 5 point scale ranging from 1 (strongly disagree) to 5 (strongly agree). High scores indicate higher levels of farm innovation and willingness to take risks		
Perceived resources The perceived level of and satisfaction with the resources (time, money & knowledge) that people feel they have available to undertake land management activities.	There are many resources such as time, money and knowledge, that impact on what one can do on their property. Sometimes there is a gap between the current situation and what we would like the situation to be. If 10 represents the very best situation that you can think of for yourself and 1 represents the worst, can you rate your current situation with regards to your resources to carry out land management activities?	.642
	How satisfied are you with the difference between your current situation and your ideal situation with regards to resources?	
Scale details: Measured on two separate scales ranging from: 1 (worst situation) to 10 (very best situation); and 1 (not at all satisfied) to 5 (extremely satisfied). High scores indicate higher levels of perceived resources		

Table 3 CONT. Summary description of scales used to measure attitudes and values

Concept	Item	Reliability- Cronbach a
Property planning The extent to which people undertake formal property planning activities with the aid of agricultural professionals	Do you have a written property plan?	
	Was your property plan created with the aid of a professional consultant?	
	Do you hire an agronomist to help you with any of your farming activities?	
Scale details: Measured as a dichotomous variable: Yes or No		
Change intentions The extent to which people feel that changing their land management practices is likely and desirable	How likely is it that you will make changes in your land management practices over the next 3 years?	
	Do you want to change your land management practices over the next 3 years?	
Scale details: Measured on a 5 point scale ranging from 1 (highly unlikely) to 5 (highly likely); and as a dichotomous variable: Yes or No		
Egoistic/ Social concerns The extent to which people are concerned about the impact of environmental problems on their stock, themselves and other people	How *concerned* are you about environmental problems because of the potential consequences for the following:	
	Stock	
	You	
	Your future	
	Your family	.964
	Your lifestyle	
	Your health	
	All people	
	Children	
	People in your community	
Scale details: Measured on a 5 point scale ranging from 1 (not at all concerned) to 5 (extremely concerned). High scores indicate high levels of concern about consequences of environmental problems on self and other people		
Biospheric concerns The extent to which people are concerned about the impact of environmental problems on aspects of the biosphere, such as native plants and animals	How *concerned* are you about environmental problems because of the potential consequences for the following:	
	Native animals	.917
	Native plants	
	Native birds	
Scale details: Measured on a 5 point scale ranging from 1 (not at all concerned) to 5 (extremely concerned). High scores indicate high levels of concern about consequences of environmental problems on aspects of the biosphere		

4. CAN WE MEASURE AND PREDICT LAND MANAGEMENT?

4.1. How was land management practice measured?

Respondents were asked a series of questions about their land management practice in relation to five key areas in dryland farming: soil management, integrated weed management, perennials management, native vegetation management and, where applicable, stock management. These areas of practice were identified as important during qualitative phases of the PUTTI program (Bates et al., 2008) and through reviews of agricultural research and the CAPs developed by the CMAs. Respondents were asked to report their actual land management practice rather than intended behaviour or attitudes towards such practice. Open-ended questions were asked about each key area of practice, along the following themes:

- *What* specific practice was undertaken on the farm
- *Why* the practice was undertaken
- *How* the practice influenced other practices or outcomes on the farm

The answers provided by respondents to these questions were recorded verbatim by interviewers. The responses were later assigned a numeric value that reflected whether the practice and the motivations behind it were likely to result in positive or negative environmental outcomes. To ensure the responses were scored validly, members of the research team worked with representatives from the Lachlan CMA in early 2008 to determine the most appropriate numeric values to assign. Each of the responses given in the survey about land management practice was examined and quantified according to whether the CMA staff believed it to be a desirable or important practice. More important areas of practice were weighted accordingly. Discussion and deliberation occurred until consensus was reached about the scoring. By quantifying all responses that had been given in the survey, a land management score could be calculated and assigned to all survey respondents. An example of the scores given to responses is provided in Table 4, with desirable responses receiving higher scores.

Table 4. Calculation of Land Management Practice score - scoring examples

Area	Example Item	Example Response and score
Stock Management	**What** have you done to reduce the impact of your stock?	"Fenced of waterways" = 2 "Move the troughs around" = 1
Soil Management	**How** do soil tests influence what you do on your property?	"They don't" = 0 "To counter-act acidity" = 2
Native Vegetation Management	**Why** do you have native vegetation?	"Haven't got rid of it yet" = -1 "Improve water flow quality" = 2

Analysis in the first phase of the study conducted in the Central West catchment was preliminary in nature. As a result, landholders from the Central West were initially surveyed using a slightly different measure of land management practice. During this final phase, two scores were calculated for Central West respondents – one that aligned to the process

described above, and the other that utilised the data for common items from the 2007 survey. This second score allowed for comparisons across time to be made for Central West respondents.

4.2. What characterises land management in the study area?

Respondents were asked a range of questions about aspects of their current practices as well as any anticipated changes in their practice in the future. They were allowed to make multiple responses for the open ended questions. A summary of land management characteristics is provided in Table 5.

Table 5. Summary of most common responses to land management behaviour items

Soil Management	
Do you have regular soil testing done on your property?	**Yes** – 42.5% **No** – 57.5%
(for those answering "Yes" to the above question) Does a consultant perform your soil testing?	**Yes** – 58.7% **No** – 12.8% **Sometimes** – 28.5%
What do you test for?	**Most common responses:** pH levels (n=200) Trace elements (n=78) Phosphorus (n=75)
How do these soil tests influence what you do on your property?	**Most common responses:** Understand fertiliser requirements (n=213) Understand soil nutrients (n=100) Inform farm management (n=55)
Barriers to soil testing	**Most common responses:** No barriers (n=211) Financial constraints (n=165) Weather constraints (n=21) Time constraints (n=12)
Perennial Pasture Management	
Do you have land under perennial pastures?	**Yes** – 87.4% **No** – 12.6%
What type of perennial pastures do you have?	**Most common responses:** Lucerne (n=155) Phalaris (n=155) Native grasses (n=145) Rye Grass (n=67)
Why do you have perennial pastures?	**Most common responses:** Feed or stock grazing (n=268) Groundcover / dust suppression (n=57) Naturally suited to conditions (n=49) Soil health and productivity (n=35)
Barriers to perennial pasture management	**Most common responses:** Weather conditions (n=204) Financial constraints (n=98) No barriers (n=93)

Table 5 CONT. Summary of most common responses to land management behaviour items

Native Vegetation Management	
Is native vegetation management part of your property planning?	**Yes** – n=338 (80.1%) **No** – n=84 (19.9%)
What type of native vegetation do you have?	**Most common responses:** Unspecified grasses (n=133) Eucalypts - unspecified (n=69) Yellow box eucalypts (n=87) White box eucalypts (n=63)
Barriers to native vegetation management	**Most common responses:** Weather conditions (n=55) Financial constraints (n=54) Terrain (n=21)
Weed Management	
How much of your farm management is focussed on weed control?	**1 – No focus** - n=4 (0.9%) **2** - n=30 (7.1%) **3 – Some focus** - n=105 (24.9%) **4** - n=134 (31.8%) **5 – Large focus** - n=149 (35.3%)
What weed management techniques do you employ?	**Most common responses:** Spot spraying (n=206) Boom spraying (n=171) Chemical spraying (n=144) Grazing (n=104) Hoeing (n=71) Chipping (n=69)
Why do you use these techniques?	**Most common responses:** Efficiency and effectiveness (n=207) Price (n=58) Ease of use (n=53)
Barriers to weed management	**Most common responses:** No barriers (n=193) Cost (n=71) Time (n=40) Weather conditions (n=31)
Stock Management	
Have you taken action to minimise the impact of stock on your land?	**Yes** – 84.9% **No** – 15.1%
Have you reduced stocking rates?	**Yes** – 77.3% **No** – 22.7%
Have you erected fences to exclude stock from rivers and waterways?	**Yes** – 41% (it should be noted that this did not control for those with properties not adjacent to rivers or waterways)
Have you erected fences to exclude stock from revegetation areas?	**Yes** – 64.8% **No** – 35.2%
How have your actions reduced the impact of your stock?	**Most common responses:** Reduction of soil degradation (n=143) Conservation of native/perennial pasture (n=131) Allow for new growth/regeneration (n=91) Make creek banks more stable (n=35)
Barriers to stock management	**Most common responses:** No barriers (n=182) Cost (n=79) Weather conditions (n=77)

Respondents were asked whether they would like to change anything about their land management practice. Two-thirds of respondents (n=281) answered in the affirmative, 25.1% (n=106) answered *no*, while the remaining 8.3% (n=35) were unsure. For those participants who indicated they would like to change their land management practices, the most common stated desired change was to improve pastures/pasture types (n=59) followed by improving soil health (n=28) and improving ground cover (n=24).

Respondents were asked if they thought actions on their properties effected overall catchment health. A total of 288 (67.9%) participants said *yes* while 28 (6.6%) where unsure and 106 (25%) said *no*. The 316 who said *yes* or were unsure were asked in what way their activities influenced catchment health. Over a third of responses (n=106) referred to actions on their property impacting on erosion in the catchment. A further 28.5% of responses (n=86) referred to run-off affecting rivers, and 19.5% (n=59) referred to the maintenance of groundcover being impacted by their actions.

Respondents were asked whether the drought had changed what they did on their property. 80.8% of respondents answered in the affirmative. Those that answered *yes* were asked what the drought had changed about their property management. The most common response was reduced stocking rates (51.5%, n=176). Other common responses included failure of, reduced, or inability to plant crops (16.1%, n=55) and reduced income and increased financial pressures (10.2%, n=35).

4.3. Predictive model of land management practices

For each survey conducted as part of the PUTTI project a predictive model of land-management practice was developed. Over time these models were iteratively refined and additional variables were included that were thought to contribute to land management practice. The predictive model of land management practices that is detailed in this report was also informed by results from: the qualitative research that was undertaken for the project; agricultural adoption and pro-environmental behaviour literature; and previous research carried out by CSIRO. Confirmatory testing of the model emerging from the Lachlan phase of the project is presented in Appendix 5.

In the latest iteration of the model of land management practice a particular focus was placed on how property planning might be related to attitudes. This was done in order to identify the factors that motivate landholders to formalise their property management in written property plans. The relationship between locus of control and other predictive variables was also explored in depth in this model. As explored in the previous section, there is some debate as to whether locus of control is a stable personality trait or an alterable state. The new model allowed for further investigation of potential determinants of state-based locus of control such as resources and the physical environment.

The exploratory model detailed in this section was developed using Structural Equation Modelling. Analysis of the causal relationships between the components of the hypothesised model was conducted using the robust maximum likelihood estimation method in LISREL 8.72 (Joreskog, Sorbom, du Toit & du Toit, 2000).This is a statistically efficient method that uses all available information (Diamontopolous and Siguaw, 2000) The complete version of the model generated through this analysis can be seen in Appendix 6. As an initial step, all non-significant relationship pathways to the dependent variable (Land Management Behaviour) were removed. The pathways removed during this initial step were as follows:

Figure 6 shows a simplified version of the behavioural model with all of the non-significant variables removed. The strength of the relationships between variables in the model presented are listed as coefficients which range from -1 (a strong *negative* relationship) to +1 (a strong *positive* relationship).

The model indicates that the following conditions lead to an increased likelihood of undertaking desirable land management practice:

- Having an **internal locus of control-** which can be defined as having a sense of being able to determine one's own actions and outcomes;
    - An internal locus of control is influenced by perceived access to resources to undertake land management activities.
    - An internal locus of control is also related to having a property plan, and higher levels of risk and innovation
    - **Property planning** in turn is influenced by higher levels of risk and innovation, and higher levels of perceived environmental threat to the region. Property planning does not directly influence land management practices;
- Perceiving oneself as having **social influence,** which can be defined as being sought after by other farmers for advice and being influential in this capacity;
    - This is in turn influenced by the extent to which people are willing to try innovative methods and take risks on their farms
- The extent of **risk and innovation** that people demonstrated in regards to their production methods was only indirectly related to their land-management practices. As such, the relationship between land management practices and risk and innovation was mediated, or explained by, people's perceived levels of social influence. Risk and innovation was directly influenced by perceived access to resources to undertake land management activities.
- Possessing strong **biospheric environmental values,** which can be thought of as having a value system that conveys concern for naturally occurring features of the environment such as native animals, birds and plants; and
- Demonstrating high levels of **trust** in key sources of **agronomy advice** (i.e. agronomists, agribusinesses and the Department of Primary Industries) and stating that such sources **influence** land management practices.

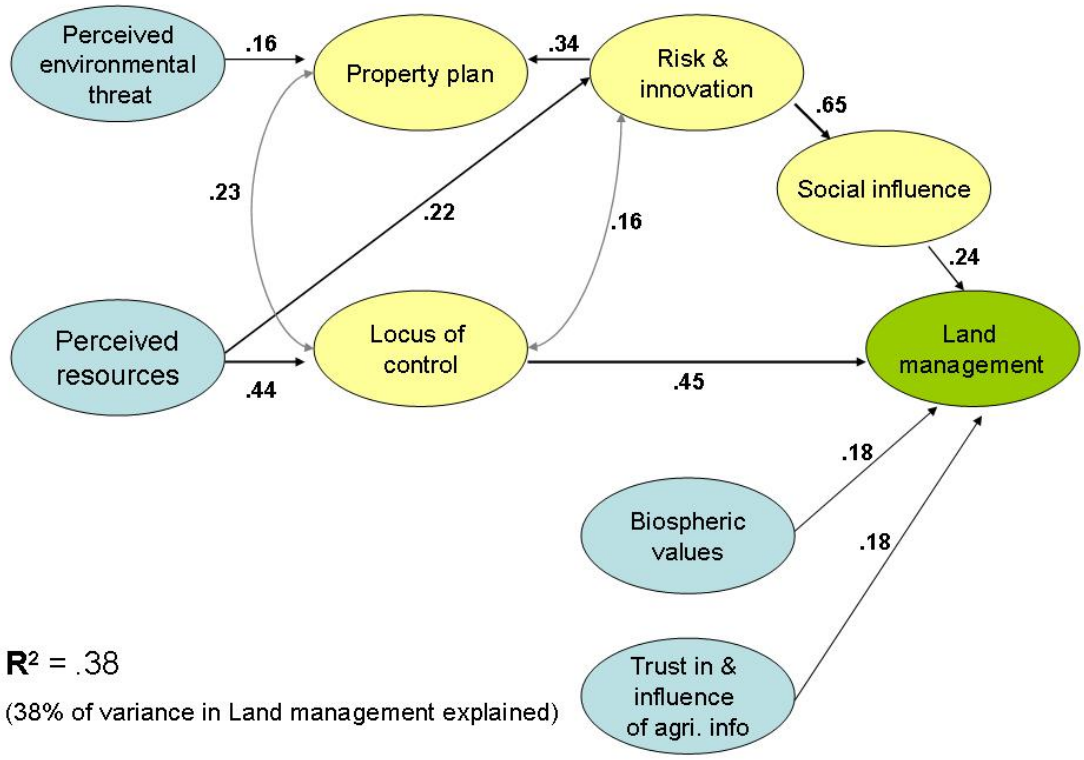


Figure 6. Simplified exploratory model of land management practice

The model detailed in Figure 6 accounted for 38% of the variance in land management practice. The model accurately explained the data, as demonstrated by the goodness of fit indices (see Table 6). Goodness of fit refers to the extent that observed data (the data obtained through our questionnaires) fits the hypothesised model. Further explanation of the goodness of fit or Model Fit Indices is provided in the Glossary.

Table 6. Model fit indices for exploratory structural equation model

Fit Statistics	Obtained Value	Recommended Value
Chi-square (df)	284.17 (256), *p*=.109	*p* > .05
CFI	1.00	≥ .90
GFI	0.94	≥ .90
RMSEA	0.42	≤ .08

The model of land management practice detailed in Figure 6 demonstrates a number of similarities to the models of pro-environmental behaviour that have been presented in the literature (see Section 2 of this report for a review). The key theoretical similarities between the model of land management practice detailed in Figure 6 and those in the literature are as follows:

1. **Locus of control** can be thought of more broadly as a form of self-efficacy and is akin to:
    a. The perceived ability to reduce threat as outlined in the Value-Belief-Norm model (Stern, 2000);
    b. Empowerment in the Geller's (1995) Actively Caring Hypothesis;
    c. Awareness of responsibility in Schwartz's (1977) Norm Activation model, which is informed by perceptions of personal ability to act in response to a perceived need; and
    d. Perceived control in the Theory of Planned Behaviour (Ajzen, 1991)
2. **Perceived environmental threat** is aligned with Adverse consequences for valued objects, as outlined in the Value-Belief-Norm model,
3. **Biospheric values** is also included in the Value-Belief-Norm model
4. **Trust in and influence of agronomy** is similar to trust in institutions which is incorporated in Blamey's (1998) Extended Norm Activation model, which draws on Schwartz (1977)
5. **Social influence** may demonstrate similarities to Belongingness as outlined in the Actively Caring Hypothesis

A hierarchical multiple regression was also conducted in order to assess the relative impact of the key predictive variables on the individual components of land management practices (i.e. management of soil, perennials, weeds, stock and native vegetation) whilst controlling for demographics and farm characteristics (see Appendix 7 for a full account).

After controlling for demographics and farm characteristics, the variables that were able to significantly predict land management practice scores were as follows for each component of land management:

- **soil management**: trust in and influence of agronomy sources, gender, education, farm planning and region.
- **stock management**: locus of control and education.
- **perennials management**: region and locus of control.
- **native vegetation management**: region, locus of control and biospheric values.
- **Integrated weed management** could not be predicted.

5. WHAT ARE THE DIFFERENCES BETWEEN SUB-CATCHMENTS?

The differences between the four sub-catchments were investigated using a series of statistical analyses. Correlation analysis, one-way and two-way analysis of variance (ANOVA), cross-tabulation, paired sample t-tests and reliability analysis (see the Glossary for definitions) were used and effects were considered significant at $p < 0.01$. For the open-ended questions, more than one answer was allowed; hence percentages do not always add up to 100%. Results of open-ended questions are presented with the number (denoted as "n") of times this response was offered and as a percentage of the number of people responding.

5.1. Main activities and goals on the farm

Respondents were asked to nominate the main farming activities carried out on their properties as well as the main focus of their farming activities. Most respondents (n=247) were engaged in more than one farming activity on their property (e.g. cattle and sheep farming, cattle farming and broad acre crops). The main farming activities were cattle (52.3% of respondents), sheep for wool or breeding (51.3%) and broad acre crops (42%) (Table 7). There were differences across the sub-catchments in terms of the proportions of respondents undertaking certain activities. For instance, approximately 90.1% of respondents from the Humbug reported that they were involved in broad acre cropping compared to 15.9% of those from Cudgegong. Likewise, approximately 39.8% of respondents in Mandagery were involved in fat lamb production compared to 12.7% of those from Cudgegong.

Table 7. The main farming activities undertaken on properties

Main farming activities	Bell % (n=116)	Cudgegong % (n=126)	Humbug % (n=91)	Mandagery % (n=88)	Total % (n=421)
Cattle	64.7	65.1	25.3	45.5	52.3
Sheep- wool/ breeding	47.4	45.2	67.0	48.9	51.3
Broad acre crops/ cereals	21.6	15.9	90.1	56.8	42.0
Prime/ fat lambs	20.7	12.7	25.3	39.8	23.3
Pasture crops/ legumes/ grazing	21.6	13.5	19.8	15.9	17.6
Other animals- pigs, goats, alpacas etc	7.8	18.3	4.4	6.8	10.0
Speciality- vegetables, orchards, cottage industries	4.3	11.1	0.0	4.5	5.5
Natives- plants & seed production	0.0	0.0	3.3	1.1	1.0

Note: respondents were able to identify up to five farming activities carried out on their properties. As such the proportions listed in the table sum to more than 100%

Respondents were asked to describe the main focus of their farming activities by choosing one of six options: finding a way to leave farming; downsizing; diversifying; increasing the size of the enterprise; just hanging in there; or 'other' (Figure 7). Overall, the majority of respondents (54.6%) stated that they were *just hanging in there*, with 15.1% stating that they were *diversifying*. There were differences observed between the sub-catchments in terms of the main focus of their farming activities. Approximately 64.8% of respondents from the Humbug indicated that they were *just hanging in there* compared to only 48.2% of those from Mandagery. When respondents stated that the main focus of their farming activities was 'other', they were asked to specify what their main focus was. The most common answers were maintaining the status quo (3.1% of total sample), and improving the property (1.0%).

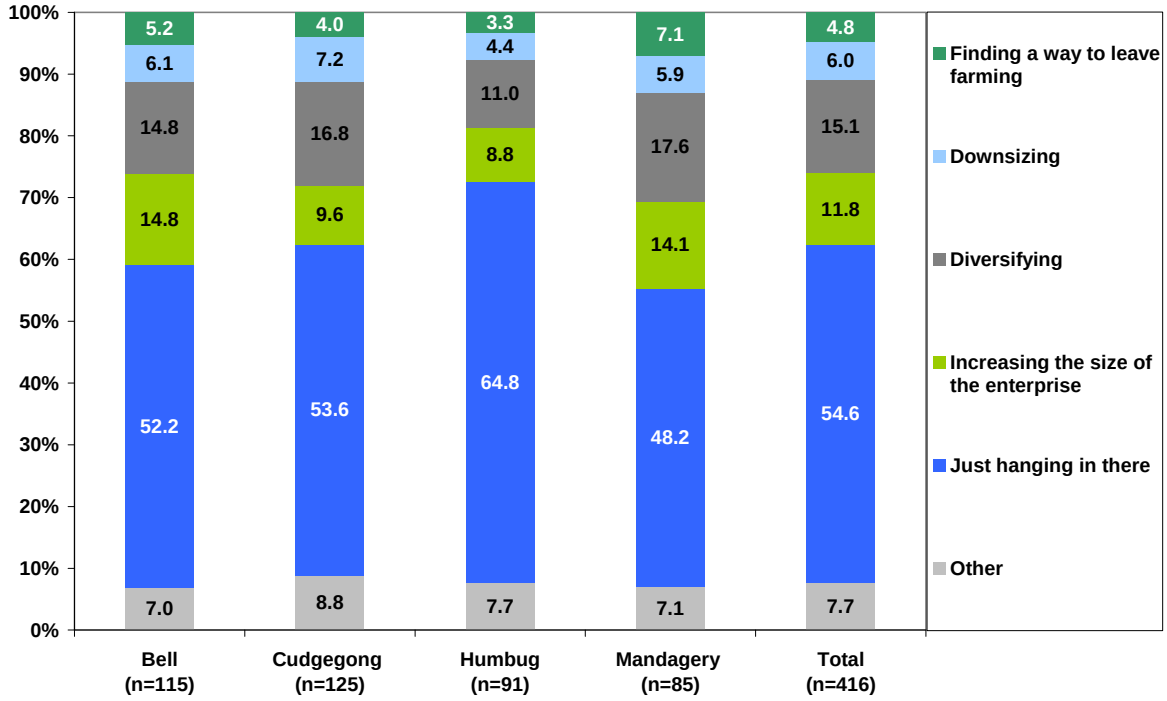


Figure 7. Main focus of farming activities: Bell, Cudgegong, Humbug and Mandagery sub-catchments

The predictive model of land management practice (refer to Figure 6) revealed that locus of control made the largest contribution to land management practice of all the variables included in the model. To assess whether locus of control influenced other attitudes and behaviours, respondents were grouped into categories ('internal' and 'external') on the basis of their locus of control score (see Section 2 of this report for an overview of locus of control and other factors thought to influence land management). Respondents with a locus of control score one standard deviation (.76) above the whole sample mean (3.29) were categorised as 'internals' and those with scores one standard deviation below the mean as 'externals'. As stated previously, those with an *internal* locus believe that outcomes are contingent on their own actions; those with an *external* locus believe that chance, fate or powerful others control outcomes.

There was a significant difference (Chi-square tests = $p<.01$) in the pattern of responses given by those with an external and internal locus of control when asked to describe the main focus of their current farming activities (see Figure 8). For instance, respondents with an internal locus of control were more likely to state that the main focus of their farm activities was increasing the size of their enterprise (20.7%) compared to externals (1.4%). Farmers who have diversified or wish to increase the size of their holding tend to have an internal

locus of control belief structure; however 17.8 % of 'externals' have also diversified and are doing something about their situation. It should be noted that locus of control is a *generalised expectancy* that predicts but does not determine an individual's actions. 'Internals' still need to act upon their expectancies, and 'externals' can choose do something about their situation despite believing that external sources have more control.

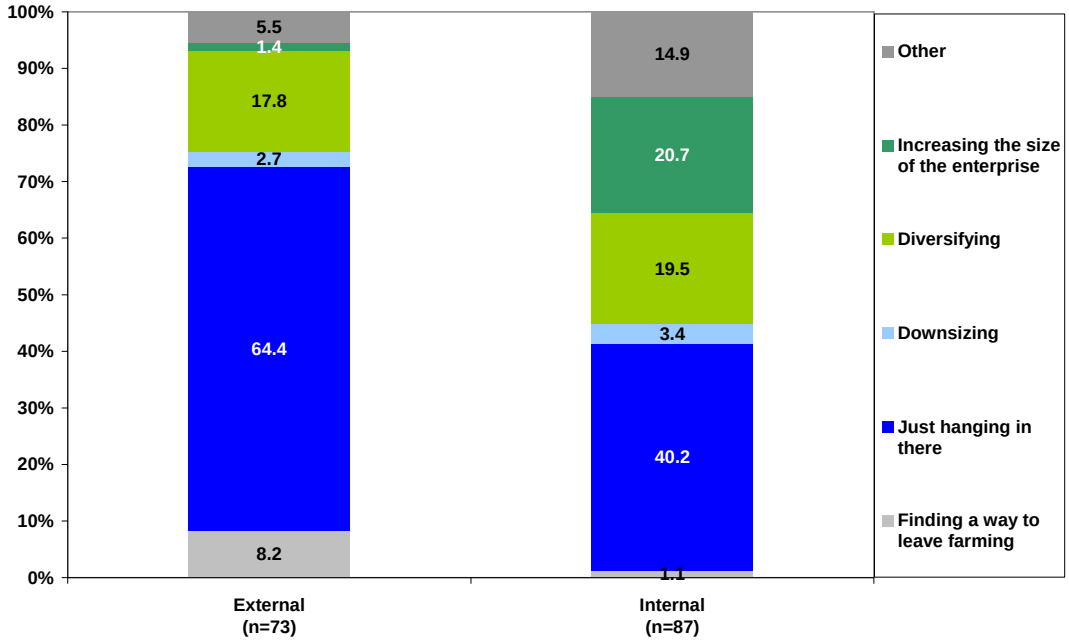


Figure 8. Main focus of current farming activities of those with external and internal locus of control

Respondents were also asked to describe the main motivations of their farming activities by choosing from several options. The main response from respondents overall (35.1%) indicated that their farm activities were primarily motivated by a desire to ensure financial security for themselves and their families. Again, there were differences across the sub-catchments in terms of respondents' motivations for farming. For instance, approximately 30.2% of the respondents from the Bell were motivated by a desire to improve the environmental health of their property compared to 16.7% of those from Humbug (see Figure 9).

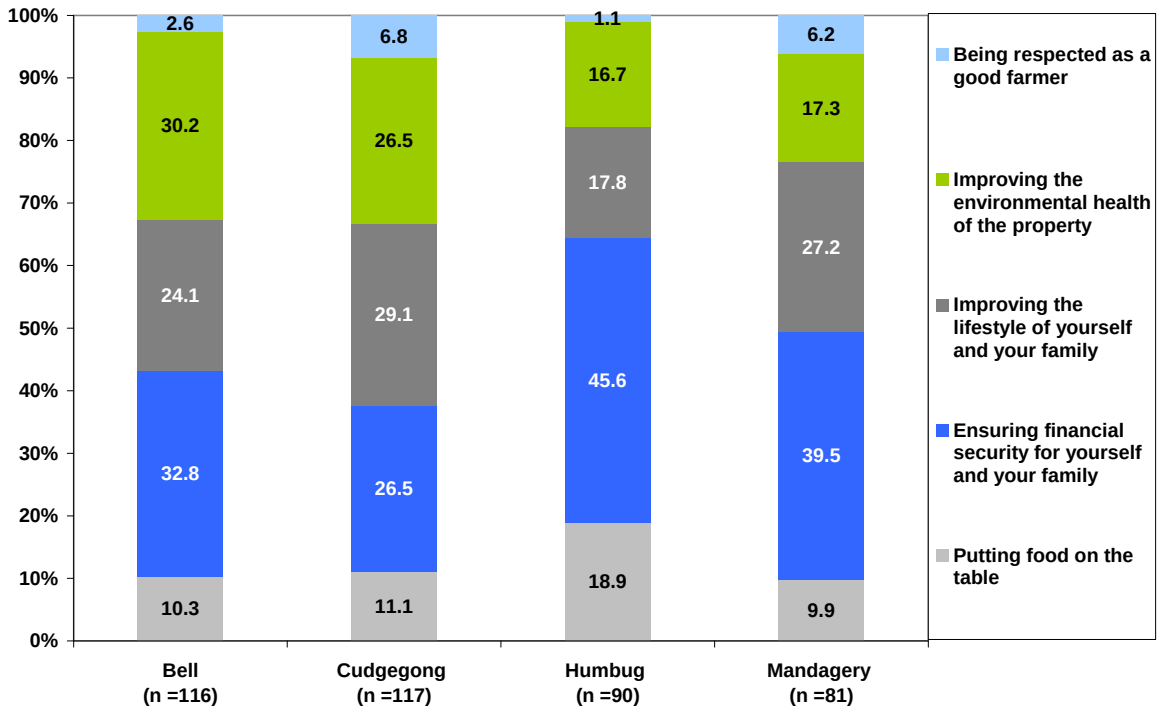


Figure 9. Main motivation for farming activities: Bell, Cudgegong, Humbug and Mandagery sub-catchments

Respondents were asked to describe their main motivation for their farming activities by choosing from one of the five following options: putting food on the table; ensuring financial security for yourself and your family; improving the lifestyle of yourself and your family; improving the environmental health of the property, and; being respected as a good farmer. These motivations had been identified in qualitative scoping activities as important and are related to a range of goals such as peer respect, land stewardship, lifestyle and leisure, security and survival. There is a significant difference (Chi square test = p<.01) in the pattern of responses given by those with an external and internal locus of control when asked to describe their main motivation for farming (see Figure 10).

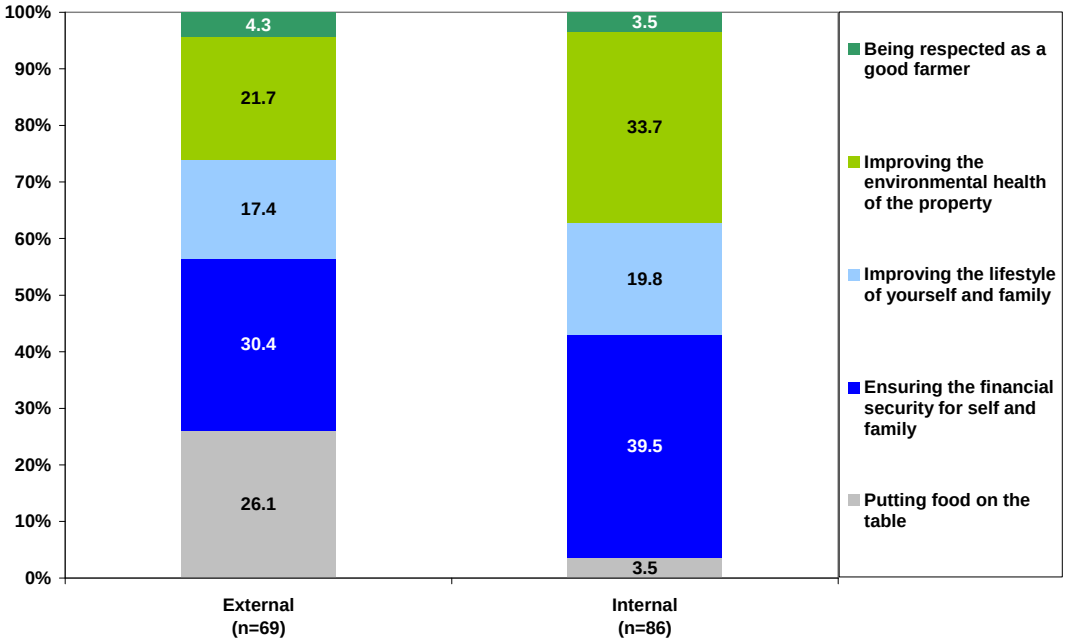


Figure 10. Main motivations for farming of those with external and internal locus of control

Those with an internal locus of control were more likely to be motivated by improving the environmental health of their property (33.7%) compared to externals (21.7%) who were more likely to be motivated by putting food on the table (26.1%) when compared to internals (3.5%).

5.2. Comparison of land management practices across sub-catchments

The sub-catchments recorded significantly different ($p<.01$) mean scores for land management (see Figure 11). The Bell sub-catchment recorded the highest mean land management score (52.65) compared to the Mandagery (52.24), Cudgegong (46.85) and the Humbug (41.4); however the Bell was only statistically significantly higher ($p<.01$) than the Humbug.

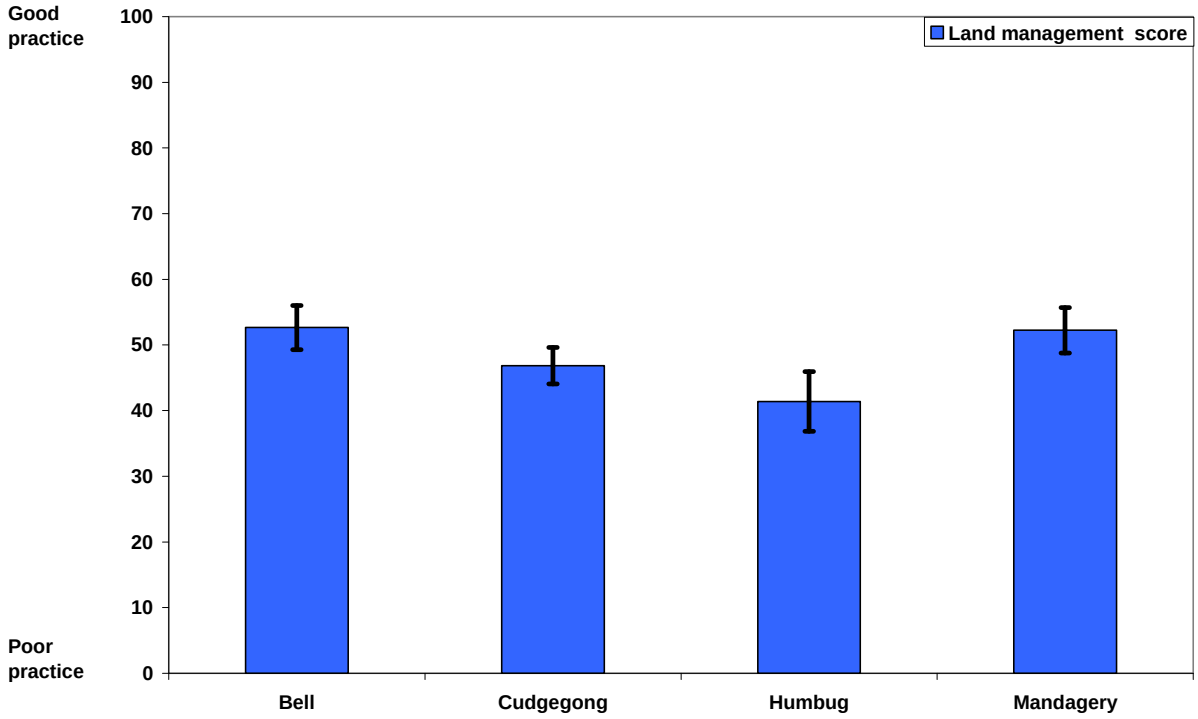


Figure 11. Overall land management scores across sub-catchments:95% confidence intervals

Figure 12 displays the mean scores obtained by respondents in each sub-catchment for the key areas of practice that comprise the overall land-management scores.

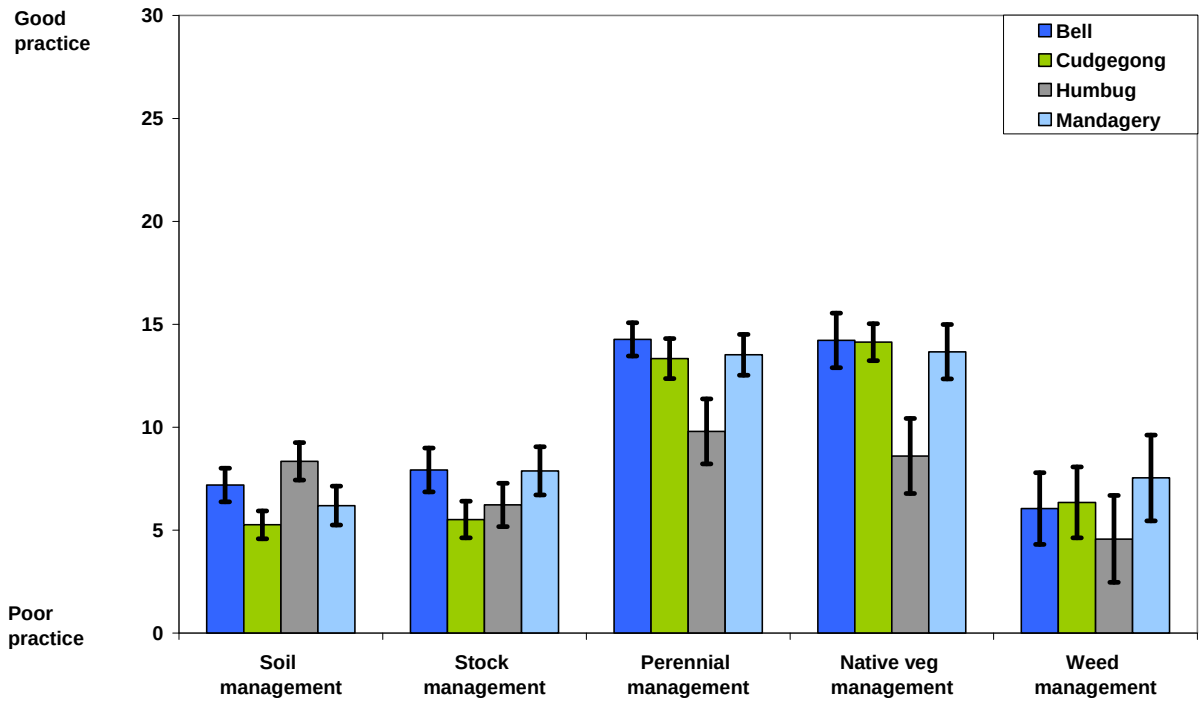


Figure 12. Soil, stock, perennial, native vegetation and weed management scores across regions: Means & 95% confidence intervals

The sub-catchments recorded significantly different ($p<.01$) mean scores for the management of soil, stock, perennials and native vegetation, *but not* weed management ($p>.05$). The differences observed are as follows:

- The Humbug sub-catchment recorded the highest mean soil management score, which was statistically significantly higher than both the Cudgegong and the Mandagery;
- The Bell sub-catchment recorded the highest mean stock management score, which was only statistically significantly higher than the Cudgegong;
- The Bell sub-catchment recorded the highest mean perennial management score, which was only statistically significantly higher than the Humbug;
- The Bell sub-catchment recorded the highest mean native vegetation management score, which was only statistically significantly higher than the Humbug; and
- The Mandagery sub-catchment recorded the highest mean weed management score, but this was not statistically significantly different to the other sub-catchments.

5.3. Environmental responsibility

Respondents were asked to indicate how much personal responsibility they felt for the existence of the following hazards: degraded soil health; weeds; poor water quality; and erosion (see Figure 13). The regions recorded significantly different ($p<.01$) mean perceived responsibility for each of the hazards measured. The Bell and Humbug sub-catchments recorded significantly higher mean levels of perceived responsibility for soil health, water quality and erosion than the Cudgegong and Mandagery sub-catchments.

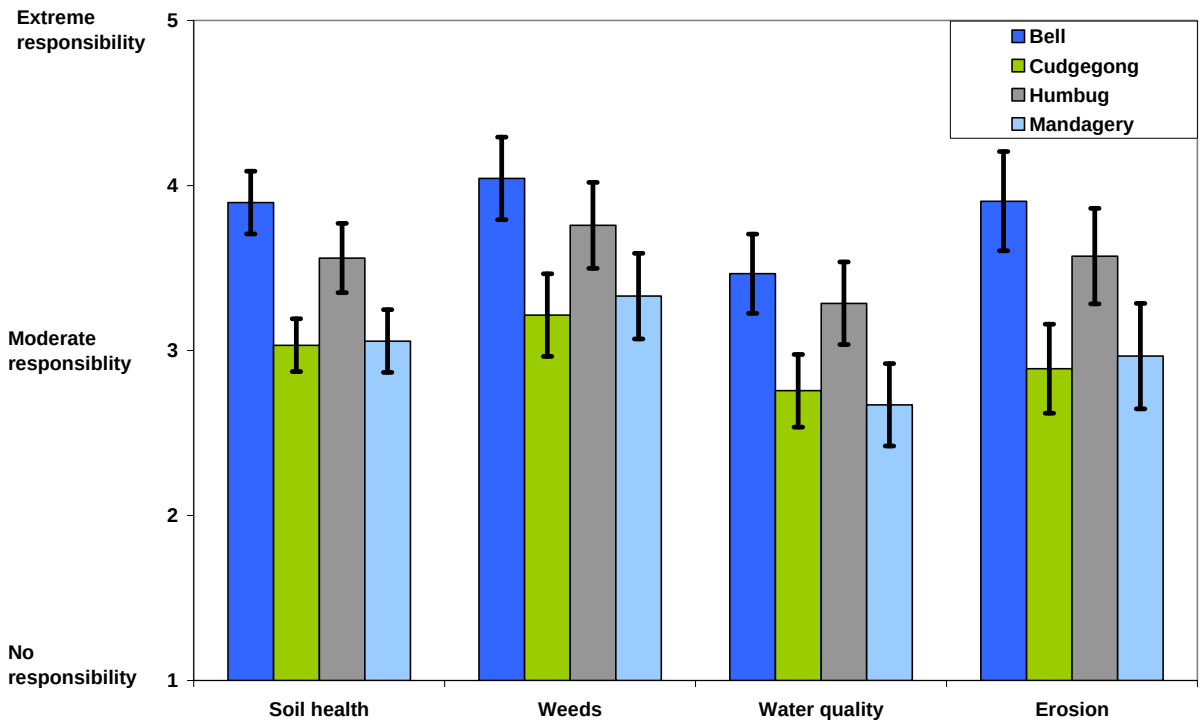


Figure 13. Perceived responsibility for environmental threats across regions: Means & 95% confidence intervals

5.4. Resources to undertake land management

5.4.1. Financial resources

Respondents were asked to rate their current situation with regards to their resources to carry out land management activities. They were also asked to rate their satisfaction with the difference between their current situation and ideal situation with regards to resources. The mean level of perceived resources for each sub-catchment is presented in Figure 14. Respondents from the Humbug sub-catchment recorded significantly ($p<.01$) lower mean levels of perceived resources than all other sub-catchments.

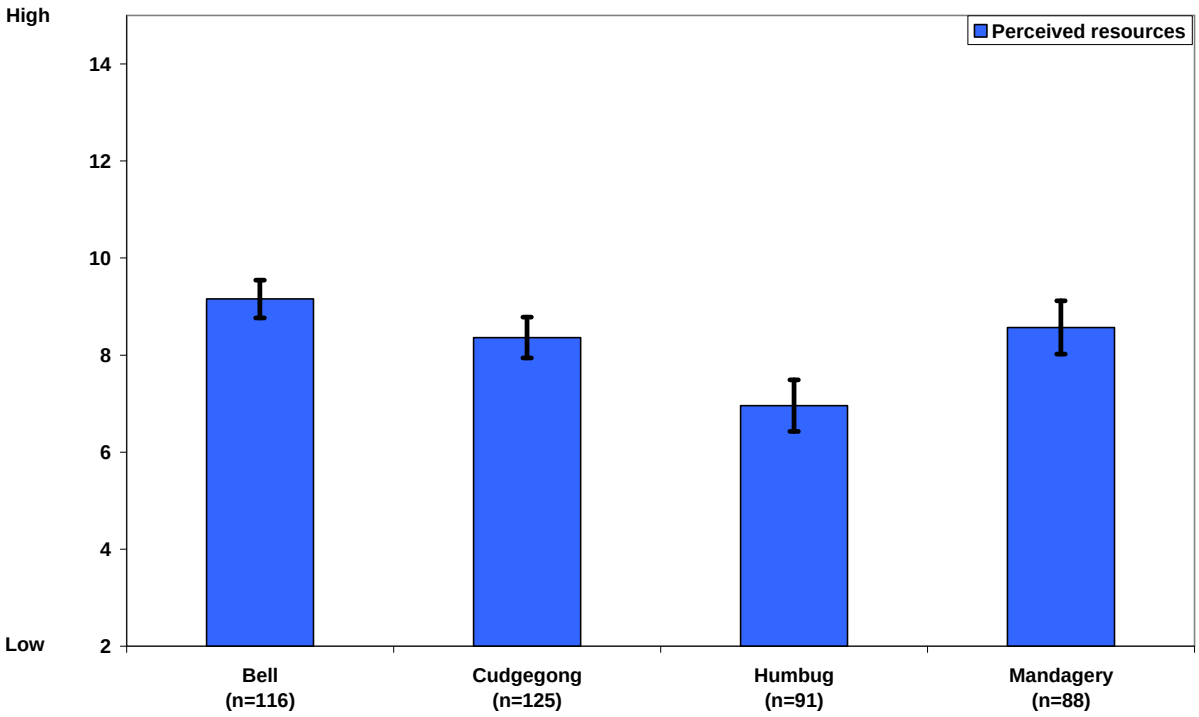


Figure 14. Perceived resources to undertake land management: Means & 95% confidence intervals for Bell, Cudgegong, Humbug and Mandagery

5.4.2. Psychological resources

Respondents in different regions exhibited significantly different levels of locus of control (see Figure 15). Specifically, respondents in the Humbug region demonstrated statistically significant more external mean levels of locus of control than those in the Cudgegong and Bell region.

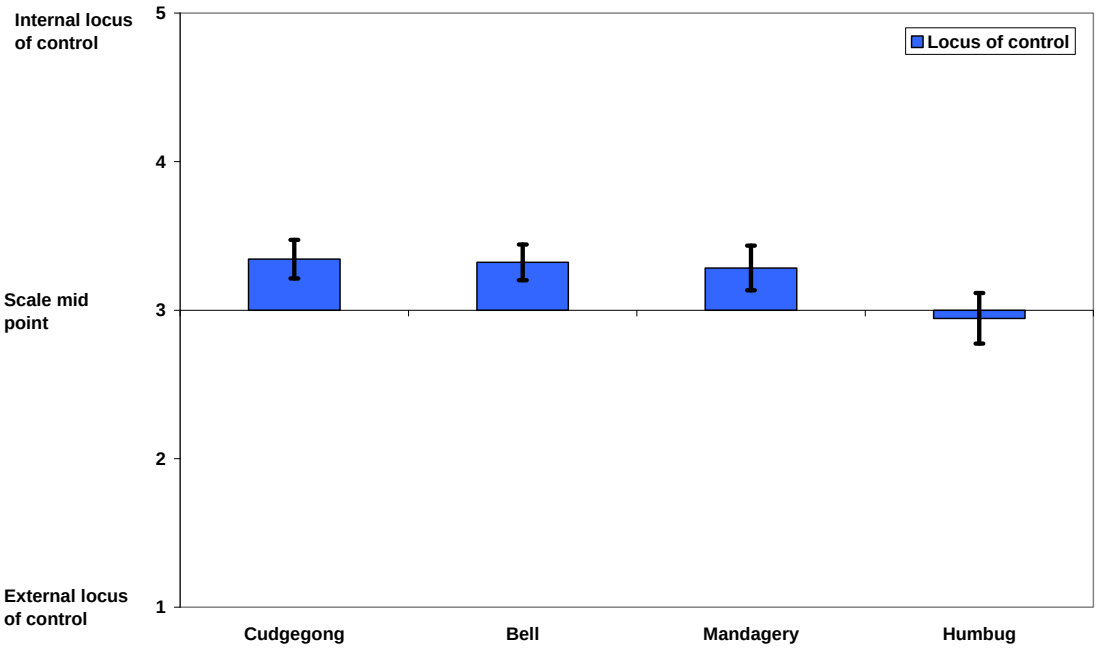


Figure 15. Locus of control across regions: Means and 95% confidence intervals

As shown in Figure 16 those participants with an internal locus of control demonstrated significantly higher mean levels of perceived resources available to carry out land management activities.

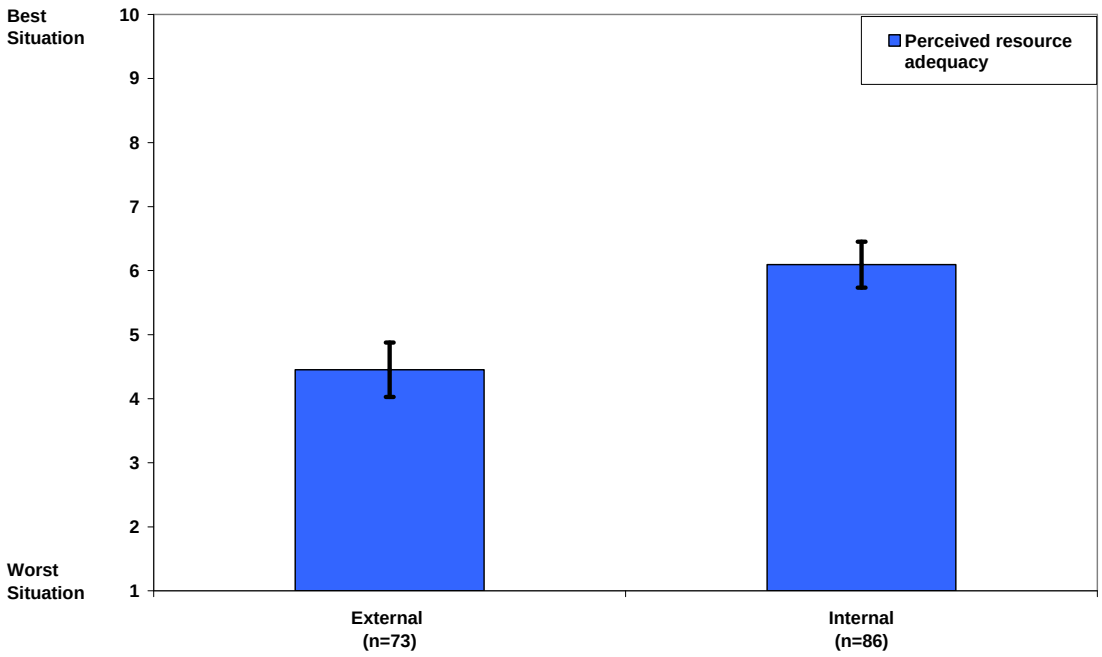


Figure 16. Levels of perceived resource adequacy of those with an external and internal locus of control: Means and 95% confidence intervals

5.4.3. Agricultural qualifications

Over one third of respondents reported having formal agricultural qualifications (36.3%). The most common agricultural qualification was from TAFE (17.5%), and approximately 2.6% of respondents had more than one qualification (as shown in Figure 17). There were differences between the sub-catchments in terms of agricultural qualifications, with approximately 26.4% of respondents in the Humbug indicating that they had a TAFE qualification compared to 13.7% of those from the Bell.

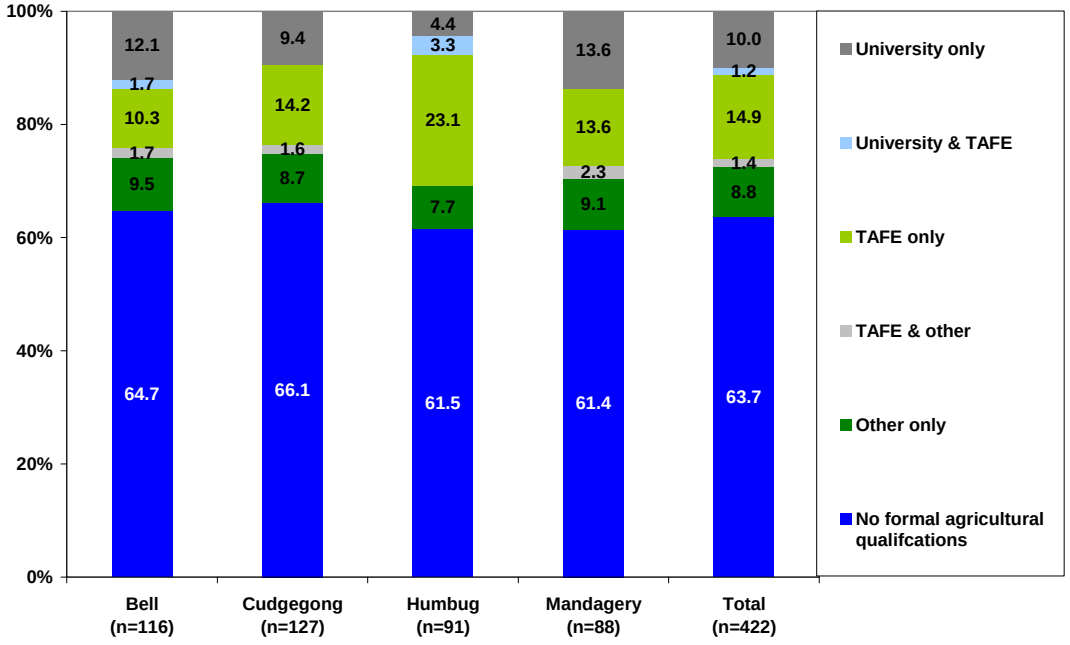


Figure 17. Agricultural qualifications: Bell, Cudgegong, Humbug and Mandagery sub-catchments

A two-way between groups ANOVA was conducted to explore the impact of agricultural qualifications and region on land management practices (see Figure 18).

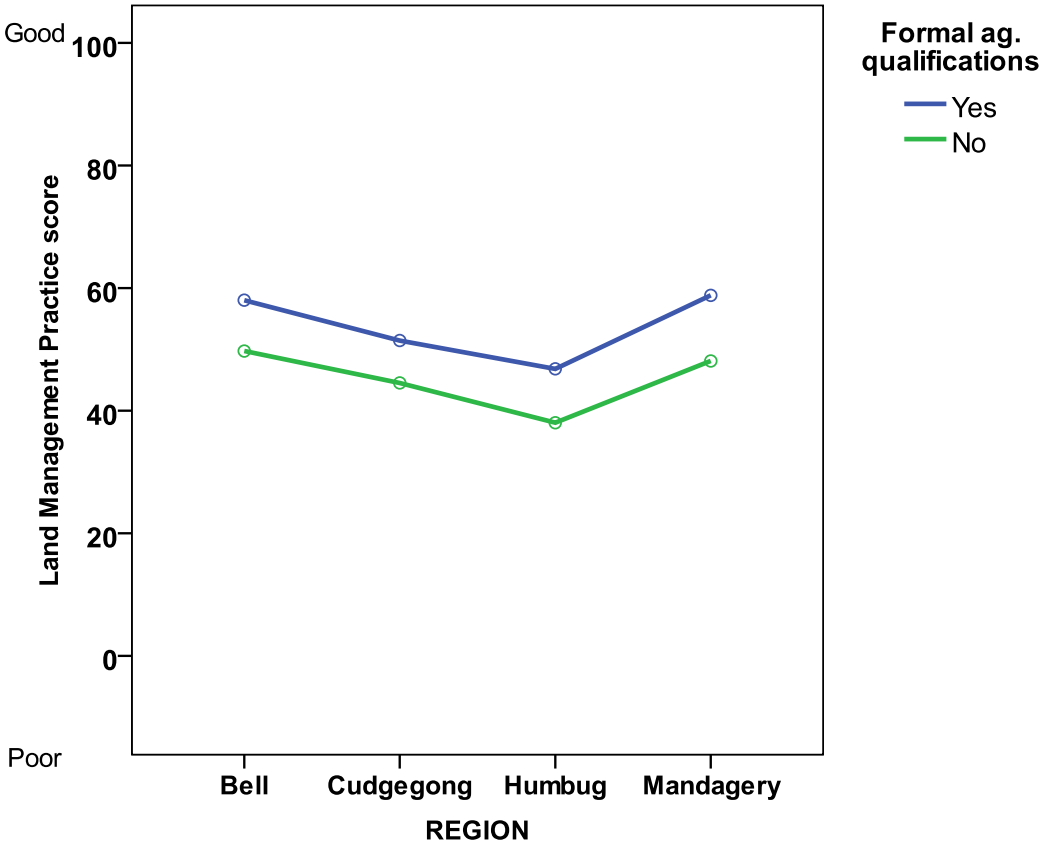


Figure 18. Main effects for agricultural qualifications and region on land management practice

As shown in Figure 18, respondents with formal agricultural qualifications recorded higher levels (statistically significant main effect) of land management practice in each region than those without, which represents a small-medium difference statistically (partial eta squared = .05; see Glossary). The interaction was non-significant.

5.4.4. Impact of resources and gender on practices

Differences were observed between male and female respondents in terms of education, locus of control, land management practices and perceived resources. These differences were not consistent across the sub-catchment regions however. For instance, the Bell sub-catchment was the only region that did not record differences between men and women.

Female respondents were significantly less likely (chi square = p<.01) to have formal agricultural qualifications compared to males, as shown in Figure 19.

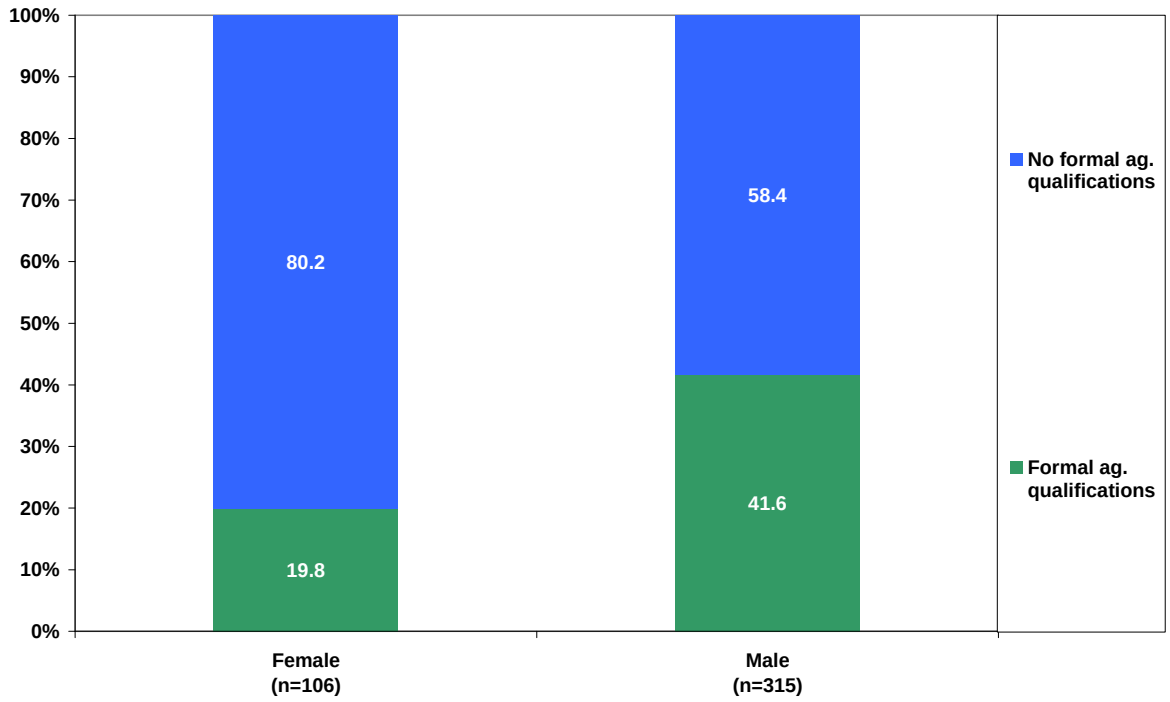


Figure 19 Formal agricultural qualifications: gender differences

Male respondents recorded higher levels of locus of control (i.e. they were more internal) than female respondents in all except the Bell sub-catchment, as shown in Figure 20. There was a statistically significant main effect for gender and region (partial eta squared = .03 and .05 respectively).

Male respondents also recorded higher levels of perceived resources to undertake land management activities than female respondents in all except the Bell sub-catchment, as shown in Figure 21. Again, there was a statistically significant main effect for gender and region (partial eta squared = 02 and .09 respectively). The mean score of perceived resources for the Humbug sub-catchment (M=6.96; SD= 2.56) was statistically significantly different ($p<.01$) to that of the Bell (M=9.16; SD= .2.1), Cudgegong (M=8.4; SD= 2.33) and Mandagery (M=8.57; SD= 2.59). The interaction was non-significant.

Male respondents recorded higher scores for land management practice than female respondents in all except the Bell sub-catchment, as shown in Figure 22. Again, there was a statistically significant main effect for gender and region (partial eta squared = 02 and .06 respectively). The mean score for the Humbug sub-catchment (M=41.4; SD= 21.9) was statistically significantly different to that of the Bell (M=52.65; SD= 18.21) and Mandagery (M=52.23; SD= 16.33). The interaction was non-significant.

Respondents were classified as high, mid or low in perceived resources on the basis of a tertile split (i.e. the highest, middle and lowest third of scores). As shown in Figure 23, the interaction between gender and resource groups was non-significant; however, the mean land management score obtained by women in the low resource group (M=38.92) was significantly lower than the men in the low resource group (M=47.92). This represents a large effect size (r=.24). There were no significant differences between men and women in the high resource group.

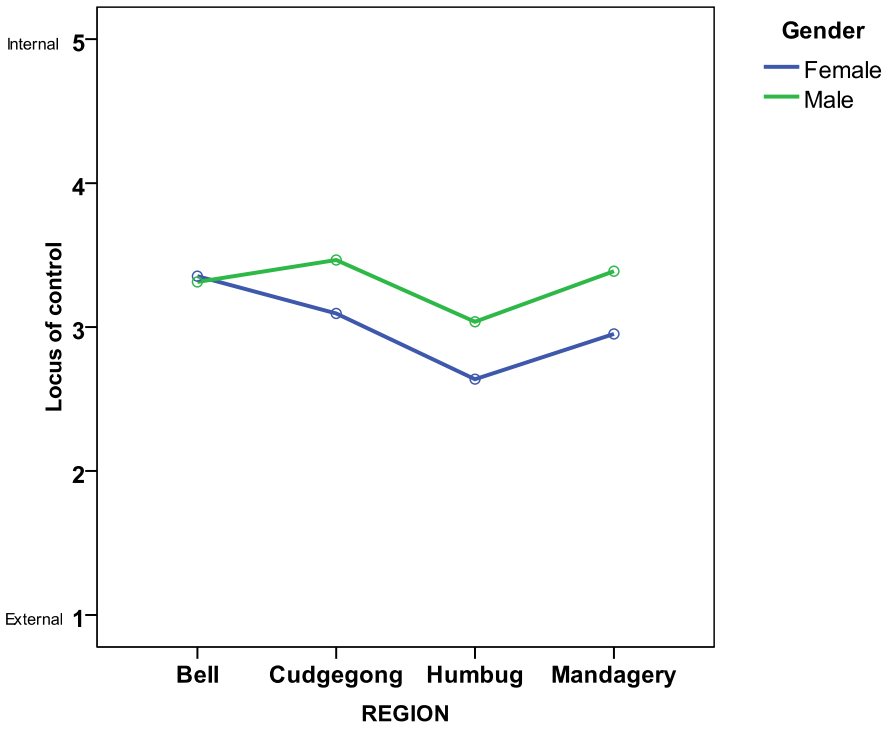


Figure 20. Main effects for gender and region on locus of control

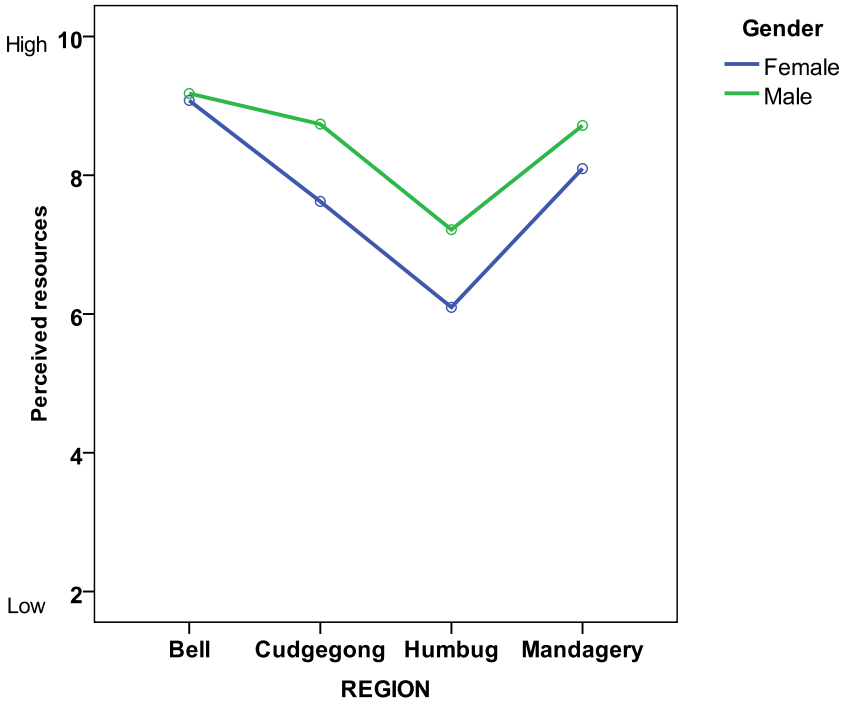


Figure 21. Main effects for gender and region on perceived resources

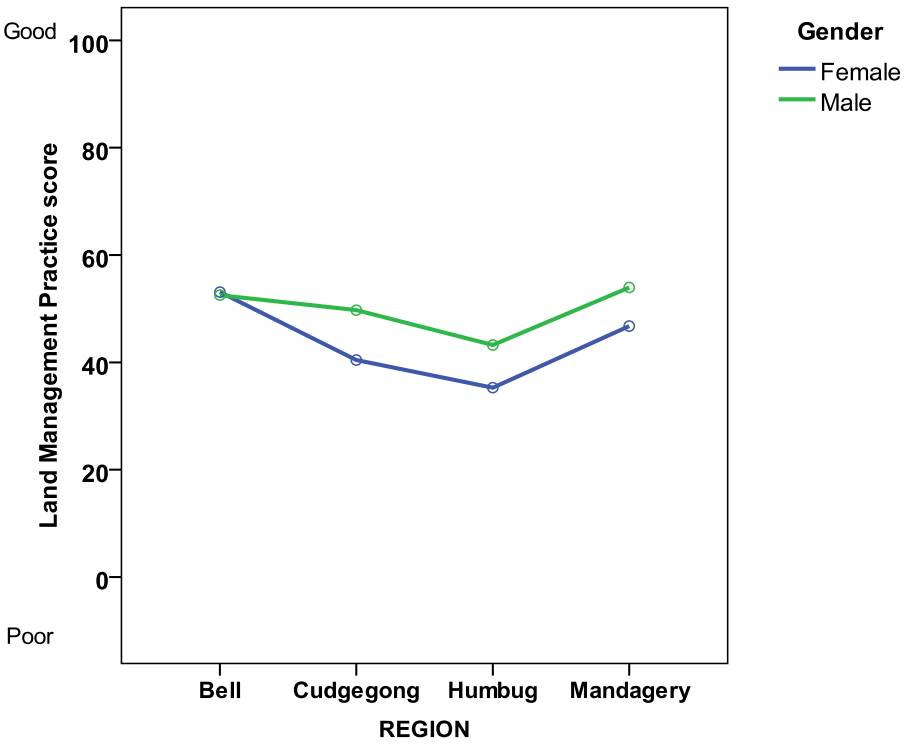


Figure 22. Main effects for gender and region on land management practice

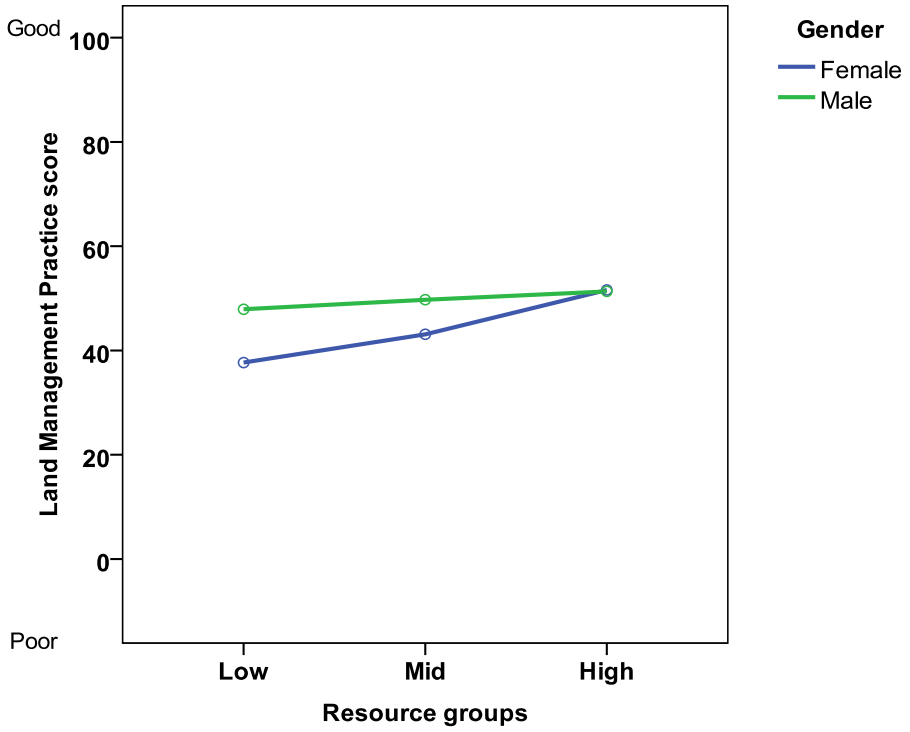


Figure 23. Main effects for resources and gender on land management

5.5. Perceptions of community interactions

Respondents were asked whether they thought opportunities to interact with other farmers had increased or decreased in the last three years. Results are presented in Table 8.

Table 8. Perceived interaction opportunities: Bell, Cudgegong, Humbug and Mandagery

Do you think that opportunities to interact with other farmers have increased or decreased over the last 3 years?	Increased	Stayed the same	Decreased
Bell (n = 116)	24.1	32.8	43.1
Cudgegong (n=124)	37.9	39.5	22.6
Humbug (n=91)	31.9	38.5	29.7
Mandagery (n=87)	37.9	20.7	41.4
Total (n=418)	32.8	33.5	33.7

Respondents were asked whether they thought the community would be doing well in 10 years. Results are presented in Table 9.

Table 9. Levels of confidence in community's future

How confident are you that the community will be doing well in 10 years?	Bell % (n=116)	Cudgegong (n=125)	Humbug (n=91)	Mandagery (n=86)	Total (n=418)
1 – not at all confident	5.2	9.6	20.9	9.3	10.8
2	8.6	8.8	22.0	18.6	13.6
3 – somewhat confident	37.1	32.0	38.5	37.2	35.9
4	36.2	35.2	15.4	27.9	29.7
5 – extremely confident	12.9	14.4	3.3	7.0	10.0

The mean rating for the Humbug was lower (i.e. they were less confident about the community's future) than were those in the other sub-catchments. Respondents were also asked to rate their levels of confidence that their own property would be successfully farmed in 10 years time. Results are presented in Table 10.

Table 10. Levels of confidence in individual property's future

How confident are you that your property will be successfully farmed in 10 years time?	Bell % (n=116)	Cudgegong (n=125)	Humbug (n=91)	Mandagery (n=86)	Total (n=418)
1 – not at all confident	0.9	7.9	6.6	8.0	5.7
2	6.9	15.1	14.3	2.3	10.0
3 – somewhat confident	30.2	19.8	30.8	32.2	27.6
4	37.9	32.5	34.1	31.0	34.0
5 – extremely confident	24.1	24.6	14.3	26.4	22.6

Humbug participants were more pessimistic about the future of their individual properties than those in the Bell sub-catchment.

5.6. Decision making on the farm

5.6.1. Sources of information: Trust and influence

Respondents were asked to rate how much they trust information from a range of sources and how much influence each of these sources has on what they do on their property, using two separate 5 point scales ranging from: 1 (no trust) through to 5 (complete trust); and 1 (no influence) to 5 (significant influence). The mean levels of trust and influence in sources of agricultural information is presented in Figure 24 (more detailed statistics can be found in Appendix 8).

The most trusted source of information was agronomists (mean=3.65) followed by other farmers (3.56), field days (3.52) and the DPI (3.40). Respondents had at least some trust in all of the sources of information presented, apart from industry groups and government departments, both of which recorded means below the scale mid-point (2.99 and 2.76 respectively). Overall, respondents demonstrated some trust in the CMA which recorded a mean of 3.11 – above the mid-point of the scale.

Overall, respondents indicated that they were most influenced by other farmers (mean= 3.32), followed by agronomists (3.23), and field days (3.11). Interestingly, except for those sources just listed, respondents did not feel their farm management was influenced by sources of information, irrespective of the level of trust that they had in those sources.

There were differences observed between the sub-catchments in terms of degrees of trust and influence in different sources of agricultural information (as shown in Figure 24 and Figure 25 and in detail in Appendix 8).

The most trusted sources of information for each of the sub-catchments are described below. Respondents in the

- Bell sub-catchment most trusted: Agronomists (3.72); other farmers (3.65); The DPI (3.61); and Field days (3.57).
- Cudgegong sub-catchment most trusted: Agronomists (3.64); Field days (3.46); Other farmers (3.41); and Scientists (3.36)
- Humbug sub-catchment most trusted: Agronomists (3.78); Field days (3.74); Other farmers (3.71); and The Kondinin group (3.56)
- Mandagery sub-catchment most trusted: Other farmers (3.49); Agronomists (3.43); Organised course (3.36); and Field days (3.33).

The most influential sources of information for each of the sub-catchments are described below. Respondents in the

- Bell sub-catchment were most influenced by: Other farmers (3.29); Agronomists (3.06); Field days (3.04); Scientists (2.84); and Landcare (2.82).
- Cudgegong sub-catchment were most influenced by: Other farmers (3.33); Agronomists (3.25); Field days (3.06);The DPI (2.92); and Scientists (2.90)
- Humbug sub-catchment were most influenced by: Agronomists (3.55); other farmers (3.48); Field days (3.34); The DPI (2.90) and organised courses (2.79).
- Mandagery sub-catchment were most influenced by: Other farmers (3.19); Agronomists (3.11); Field days (3.03); Organised courses (2.80); and; The CMA (2.55).

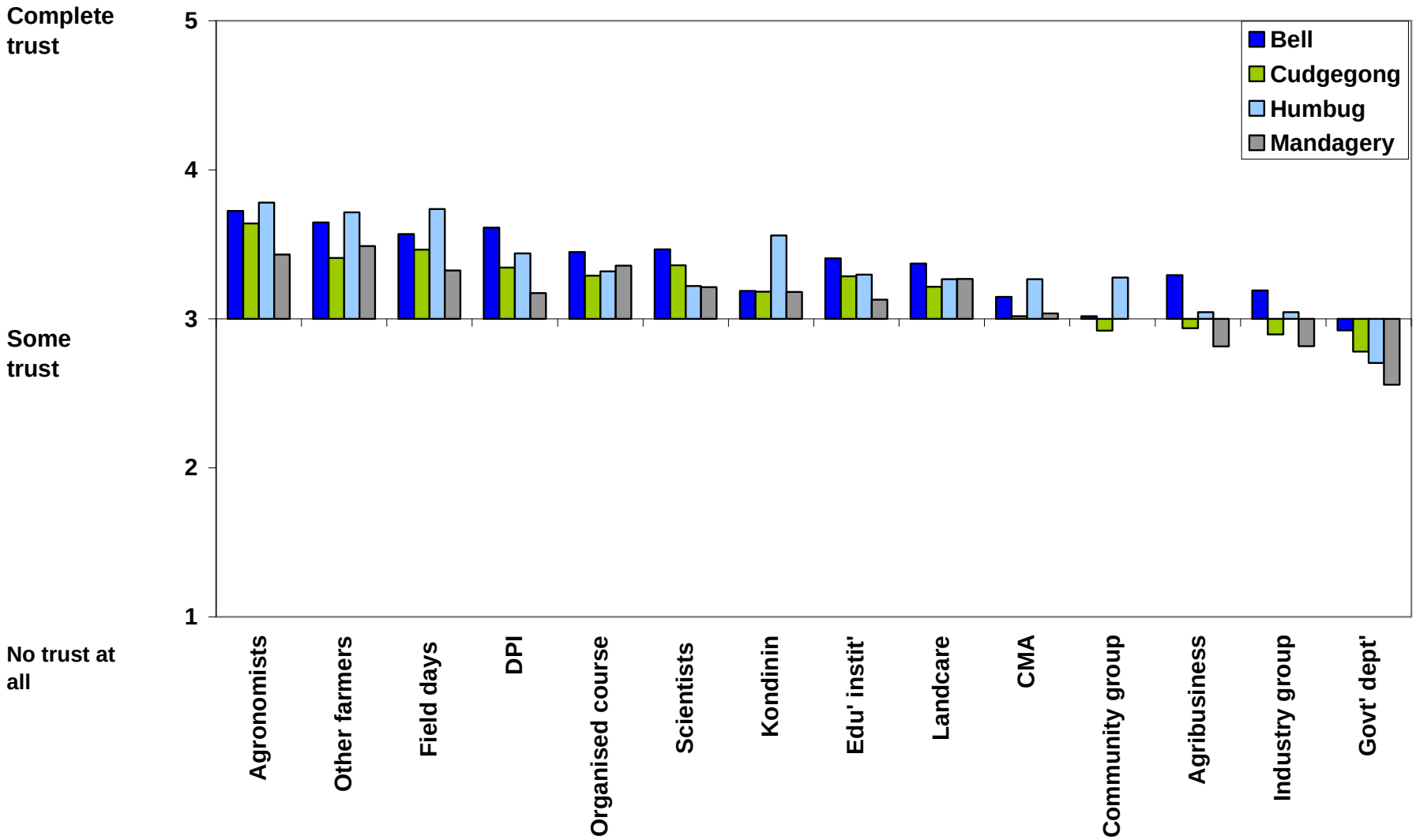


Figure 24. Mean trust ratings: Bell, Cudgegong, Humbug and Mandagery

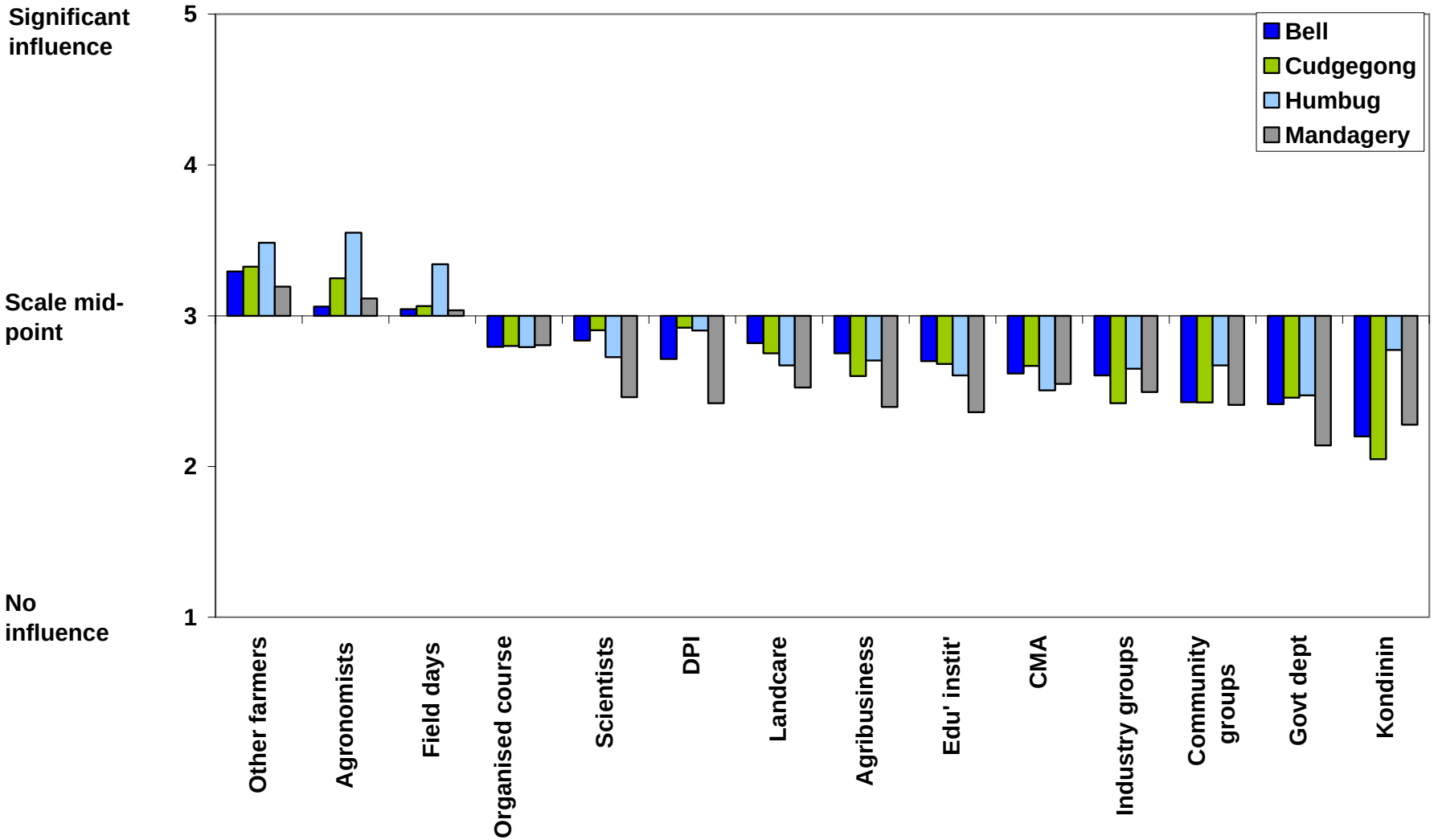


Figure 25. Mean influence ratings: Bell, Cudgegong, Humbug and Mandagery

5.6.2. Agronomy advice

Overall most respondents (64.5%) did not hire an agronomist to assist with their farm practices (see Figure 26). A relatively high proportion of Humbug respondents (50.5%) did consult an agronomist however, compared to the other sub-catchments, in particular the Cudgegong in which only 24.4% of respondents hired an agronomist. The low proportion of respondents overall indicating that they hire agronomists may be related to respondents seeking agronomic advice from consultants employed at rural supply stores who do not charge for their services.

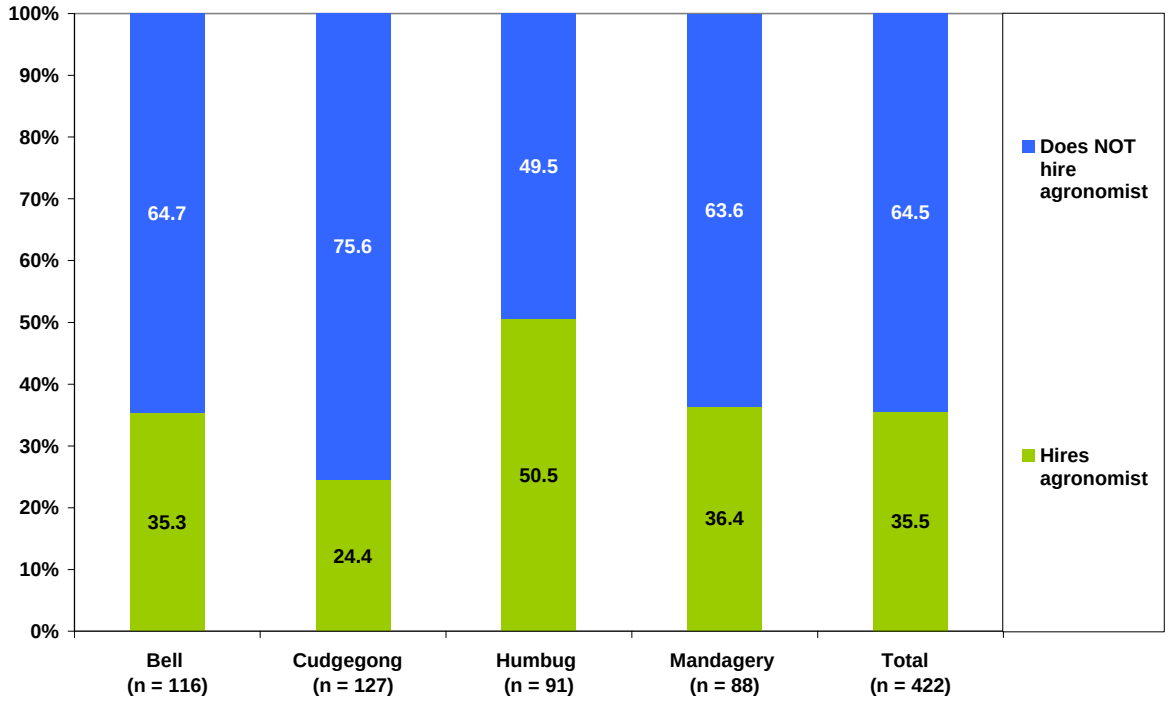


Figure 26. Proportion of respondents that hire agronomist to help with farm activities across regions

5.6.3. Property planning

The majority of respondents overall (73%) stated that they did not have a written property plan and approximately half of those that did have a written property plan (13.0% of respondents overall) had created it with the aid of a professional (as shown in Figure 27). Proportionately more respondents from the Bell sub-catchment had a written property plan created with the aid of a professional (18.1%) compared to the Humbug (13.2%), Mandagery (10.2%) and Cudgegong (10.2%).

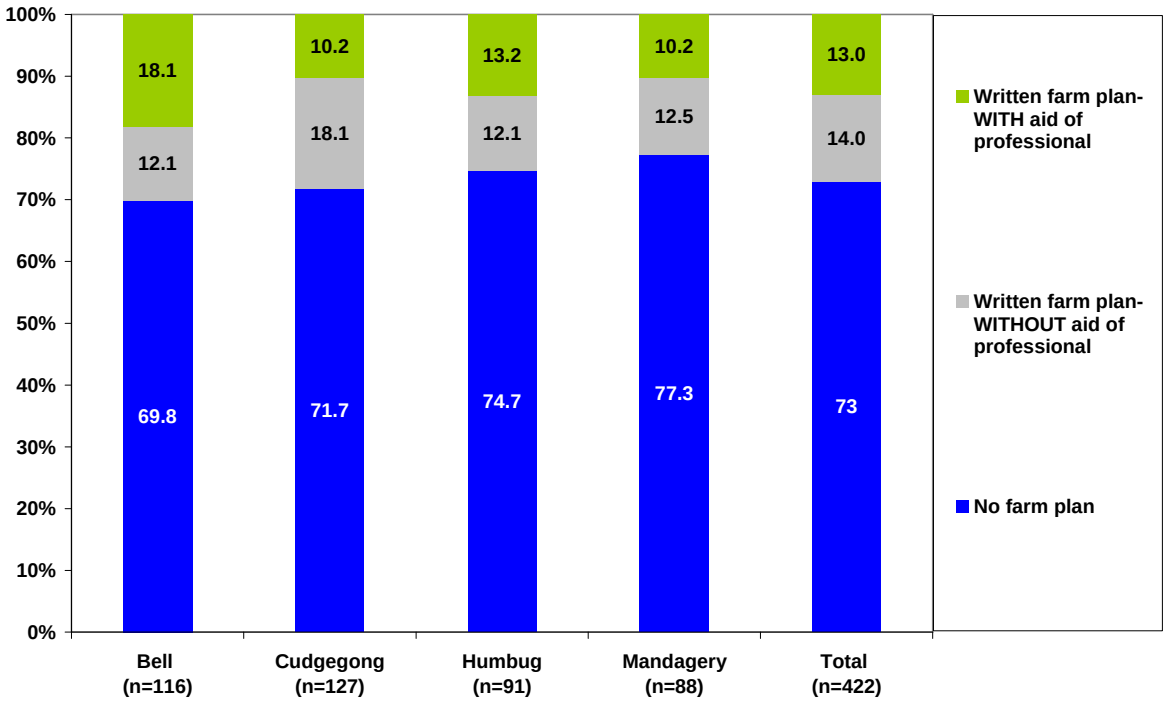


Figure 27. Proportion of respondents undertaking property planning across sub-catchments

The 111 respondents with written property plans were asked about their motivations for creating the plan. Over a quarter (27.9%, n=31) of those respondents created written plans as a result of attending a course. A further 11.7% (n=13) created the plan so they would have an idea of where they were headed and to define goals, and 8.1% (n=9) suggested that they developed a written property plan to better understand their property and make management easier. (A full list of responses is available in Appendix 9, Table 27).

The 308 participants who stated they did not have a written property plan were asked what they did in lieu of a plan. The most common response was to use common sense and knowledge (47.4%, n=146). The next most common responses were to use personal experience (16.9%, n=52) and to discuss things with others (9.4%, n=29). (A full list of responses is available in Appendix 9, Table 28).

6. WHAT DO PEOPLE THINK OF THE CMA AND ITS PROGRAMS?

6.1.1. CMA funding and assistance

Respondents were asked if they knew anyone who worked for the CMA and if the CMA had assisted them with their agricultural practices (as shown in Table 11). Just over half of the respondents (51.9%) knew someone in the CMA. Proportionately more respondents from the Mandagery sub-catchment (60.2%) knew someone from the CMA compared to Bell (51.7%), Humbug (51.6%) and Cudgegong (46.5%).

Over one-third of respondents (35.3%) stated that the CMA had assisted them with their agricultural practices. Proportionately fewer respondents from the Bell sub-catchment (29.3%) felt that the CMA had assisted them compared to Humbug (38.5%), Mandagery (37.5%) and Cudgegong (37.0%).

Table 11. CMA assistance in the sub-catchments

Region	Do you know anyone in the CMA? (n = 422)		Has the CMA assisted you with your agricultural practices? (n = 422)	
	Yes %	No %	Yes %	No %
Bell	51.7	48.3	29.3	70.7
Cudgegong	46.5	53.5	37.0	63.0
Humbug	51.6	48.4	38.5	61.5
Mandagery	60.2	39.8	37.5	62.5
Total	51.9	48.1	35.3	64.7

Just over half of the participants (52.8%; n=224) were aware of CMA funded programs. One-hundred and one participants (23.8%) had applied for CMA funding. Of these, nearly a third had applied for funding related to fencing (32.7%). The next most common funding target was tree planting (11.9%), followed by erosion control (10.9%) and direct drill machinery or machinery conversion (10.9%). (A full list of responses is available in Appendix 10, Table 29).

Those participants who had received CMA funding were asked how the CMA funding effected their property management. For over a third of participants the funding effected no change (21.8%, n=22) or was not received (18.8%, n=19). A further 16.8% (n=17) of participants fenced areas as a result of funding. (A full list of responses is available in Appendix 10, Table 30).

When respondents were asked what they would like to see the CMA do to help with farming practices, 15.6% (n=63) of participants replied *nothing,* 8.4% (n=34) said they would like to see more funding, 6.9% (n=28) wanted more advice and information about what was available. A further 5.9% (n=24) replied that the CMA should keep doing what they are doing. (A full list of responses is available in Appendix 10, Table 31).

6.1.2. CMA programs

The research team held a number of workshops around the Lachlan and Central West catchments for the Landscapes and Livelihoods component of the research, where questionnaires pertaining to the usefulness of CMA information and programs were given to participants. Participants in the Footprints, Gumble Creek and Walli workshops were involved in a targeted program by the CMA. While it is acknowledged that the number of participants in these questionnaires is quite low, results are included for the insight they provide. Results are outlined in Table 34 Appendix 11.

Table 12. How useful do you find the CMA for your farm management?

	n=12
1 – not at all useful	0
2 –	0
3 – somewhat useful	4
4 –	6
5 – extremely useful	2
Mean rating	*3.83*

6.1.3. Monitoring and evaluation – The PUTTI program

Respondents in the final behavioural survey (422 respondents) were asked whether they thought projects like the PUTTI program were worthwhile. In all, 84.6% of respondents answered in the affirmative while 9% answered in the negative; the remaining 6.4% were unsure. Of those who thought the PUTTI program was worthwhile, the most common reasons given included that the more information there was the better (n=58), that it made them more aware of what was happening and/or available (n=48), that it made them question what they were doing (n=30) and that it provides an idea on how other people do things (n=29). For those who did not find the PUTTI program worthwhile, the main response given was that they didn't know about the PUTTI project (n=16). (A full list of responses is provided in Appendix 12, Table 48 and Table 49).

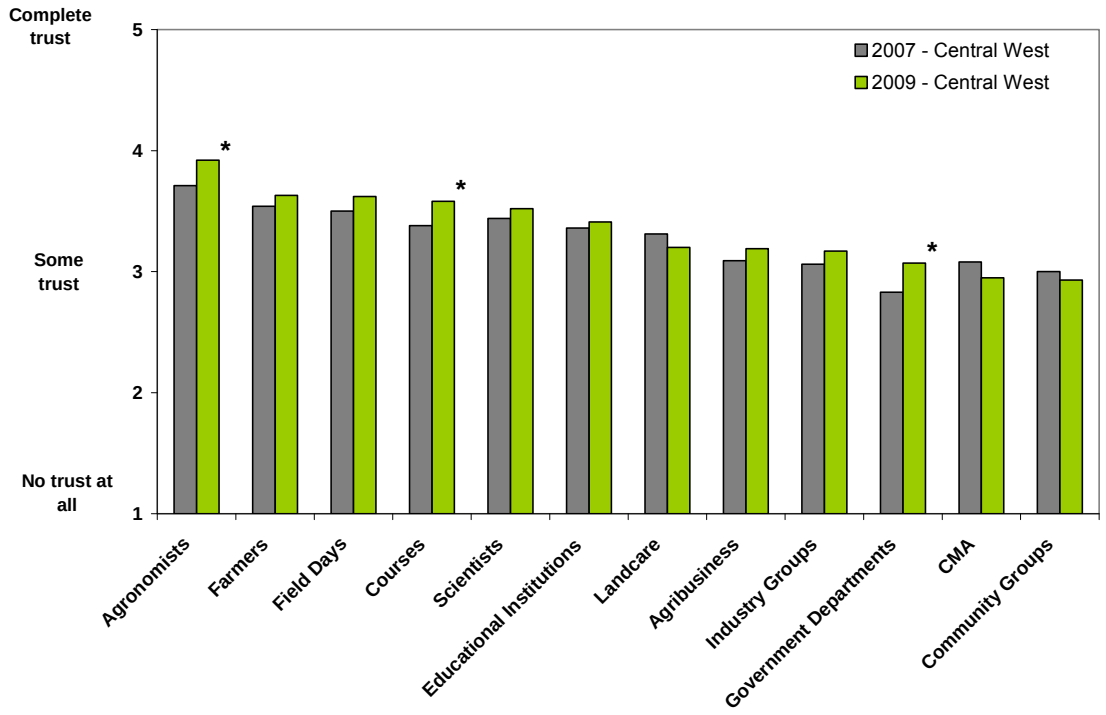
7. HAVE LANDHOLDERS CHANGED OVER TIME?

Statistical analyses (paired samples t-tests) were performed to identify any differences in responses to particular questions based from the time of the first interview (Central West – February 2007; Lachlan – January 2008) to the current interview (February 2009).[1] A number of significant differences were identified. These are reported in the following section.

7.1. Central West Catchment

7.1.1. Trust and influence

Trust and influence levels in a range of information sources remained relatively stable. Figure 28 provides a comparison of trust scores for Central West landholders for the initial testing period against the most recent testing period.

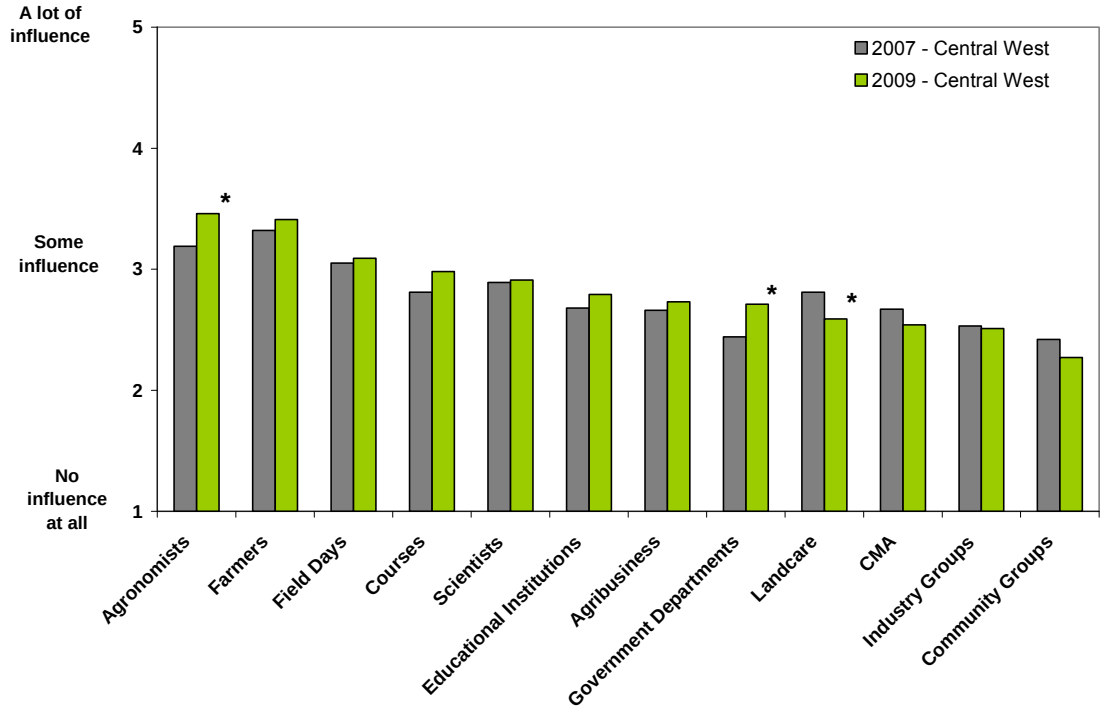


***** denotes a statistically significant difference over time at the *p*<.01 level

Figure 28. Levels of trust in different information sources over time for Central West respondents

The figure suggests that increases in trust ratings occurred in relation to Agronomists, Courses and Government Departments. Figure 29 provides a comparison of influence ratings from Central West respondents.

[1] It should be noted that the time-lapse in the initial testing periods between the Lachlan and the Central West may contribute to there being more changes of significance in the Central West than in the Lachlan.



***** denotes a statistically significant difference over time at the *p*<.01 level

Figure 29. Levels of influence of different information sources over time for Central West respondents

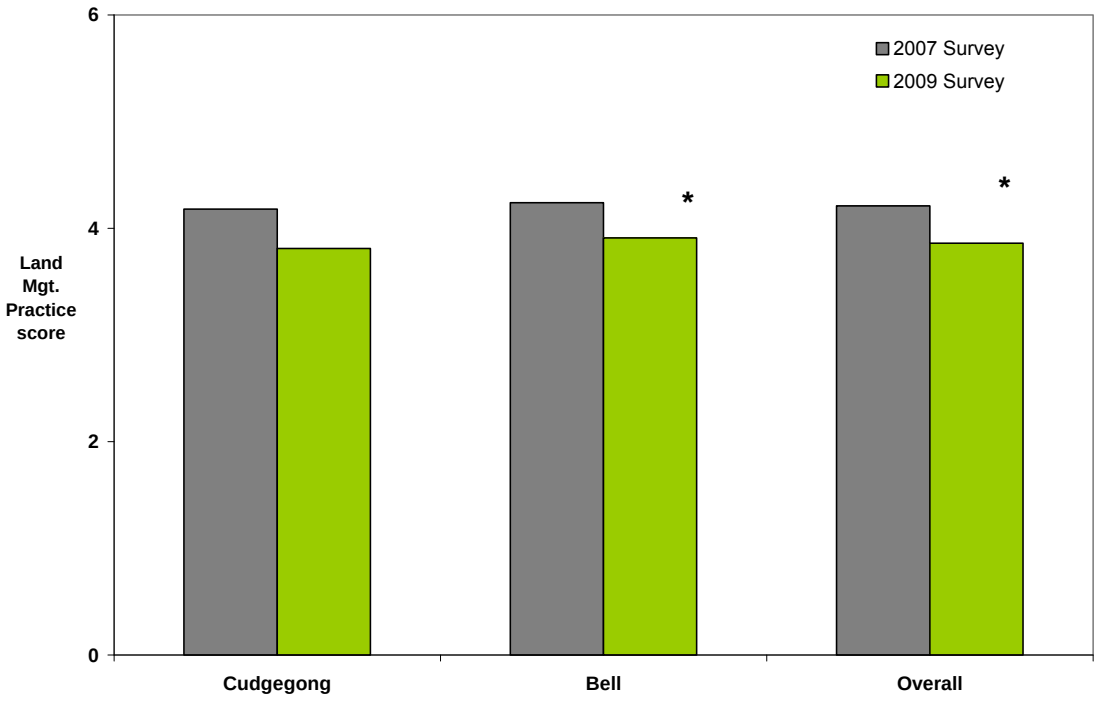
Figure 29 shows that significant increases in influence ratings occurred for Agronomists and Government Departments. Meanwhile, a significant decrease in influence ratings occurred for Landcare.

7.1.2. Attitudinal statements

Three attitudinal statements were common to both Central West surveys; however there were no statistically significant differences in ratings over time for these statements.

7.1.3. Changes in land management practice scores – Central West catchment

Land management scores were calculated for respondents for both surveys. There was a statistically significant decrease in land management practice scores from the 2007 survey (Mean=4.21, *SD*=1.10) to the 2009 survey [Mean=3.86, *SD*=1.42, *t*(228)=-3.6, *p*<.01]. By sub-catchment region, Cudgegong had no statistically significant difference from the 2007 survey (Mean=4.18, *SD*=1.17) to the 2009 survey [Mean=3.81, *SD*=1.48, *t*(114)=-2.4, *p*>.01]; while Bell had a significant decrease in scores from the 2007 survey (Mean=4.24, *SD*=1.04) to the 2009 survey [Mean=3.91, *SD*=1.36, *t*(113)=-2.=7, *p*<.01]. These differences are summarised in Figure 30.



***** denotes a statistically significant difference over time at the *p*<.01 level

Figure 30. Summary of Central West Land Management Practice scores over time

7.2. Lachlan Catchment

7.2.1. Trust and influence

Trust and influence levels reported from Lachlan catchment respondents were stable over time, with no statistically significant differences reported. A comparison of trust and influence ratings for both survey periods is presented in Figure 31 and Figure 32 respectively.

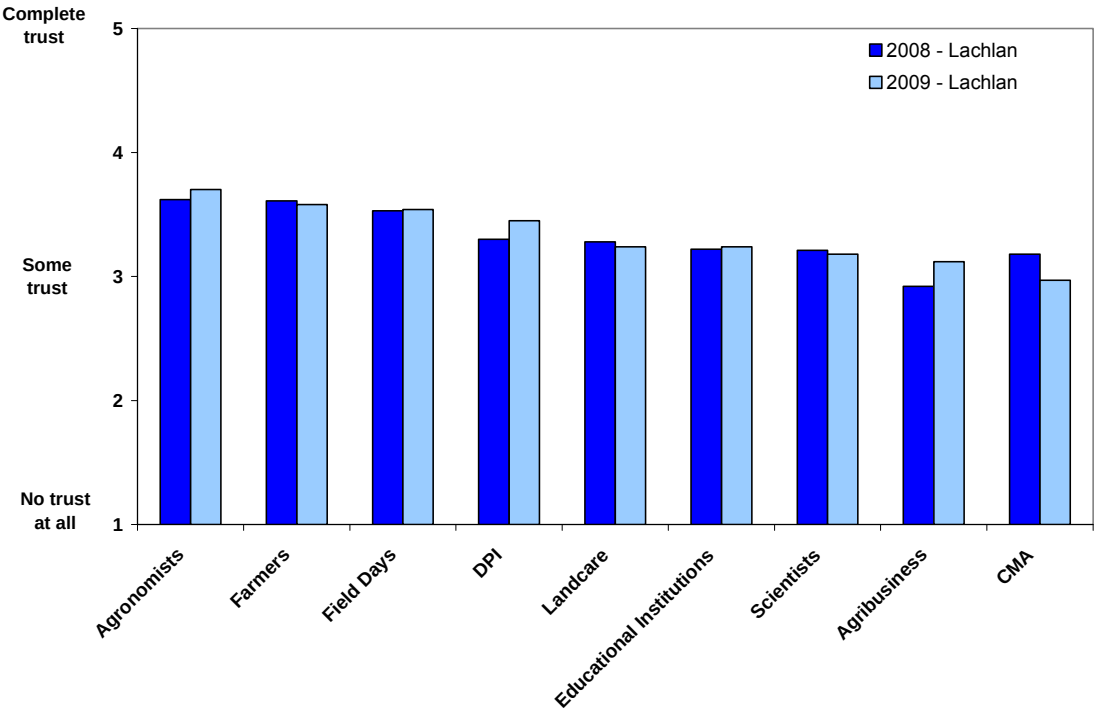


Figure 31. Levels of trust in different information sources over time for Lachlan respondents

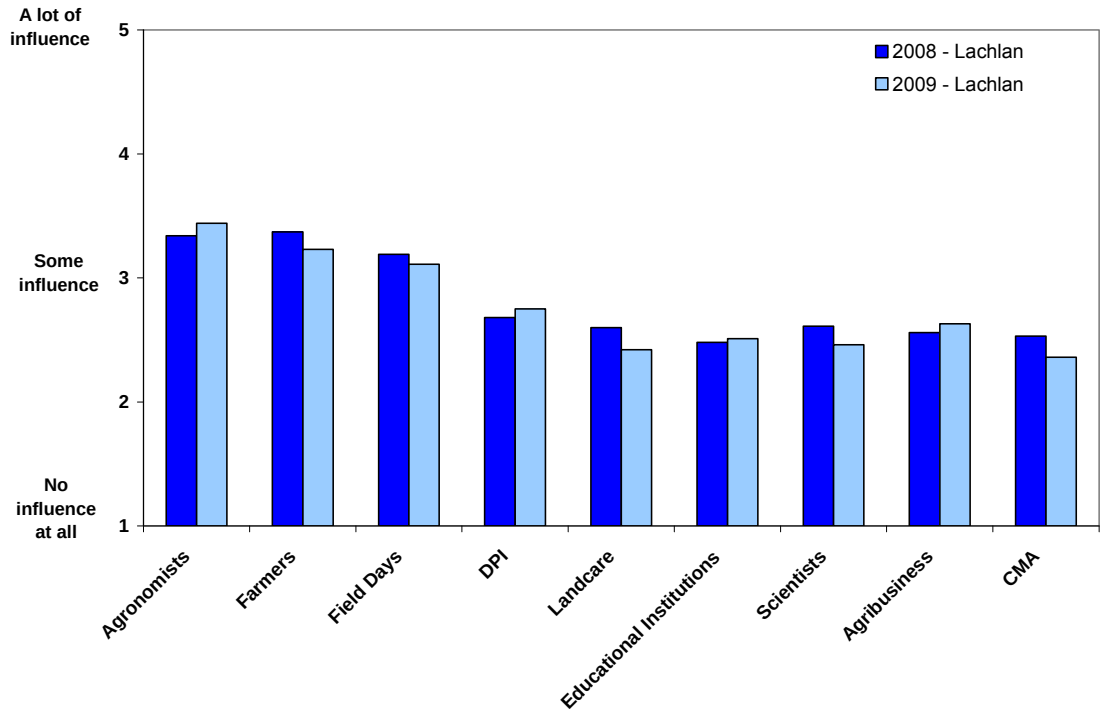


Figure 32. Levels of influence of different information sources over time for Lachlan respondents

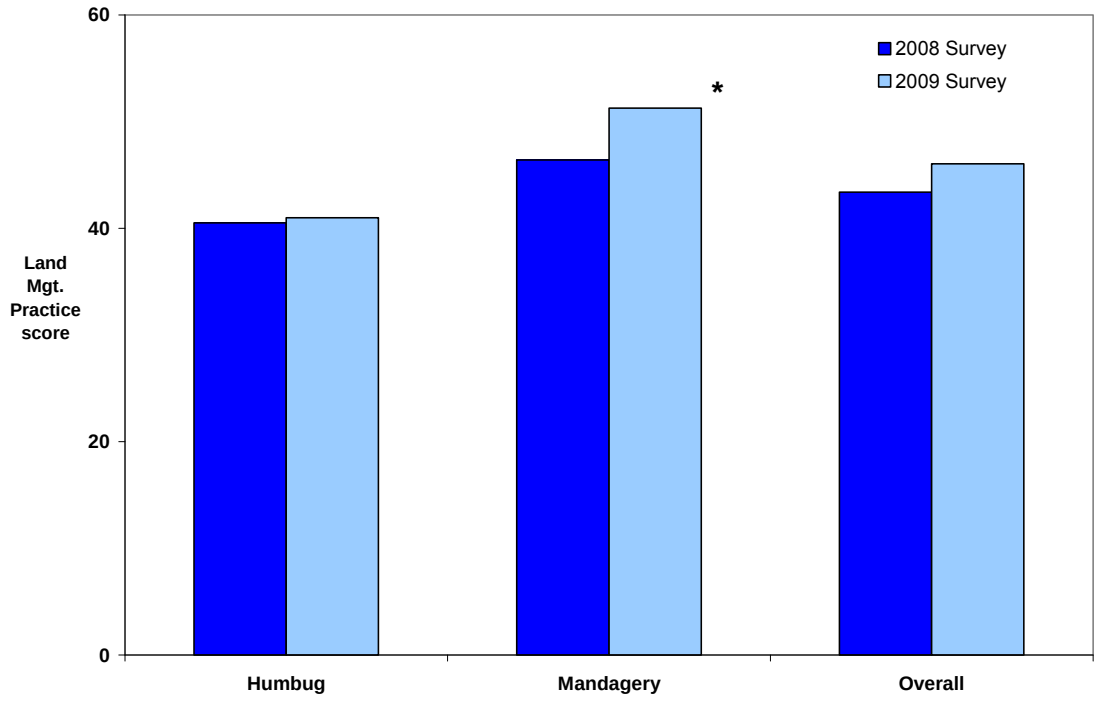
7.2.2. Attitudinal statements

There were no significant differences in responses to attitudinal statements common to the first and second surveys, except for the following: *I am happy to try new farming methods that aren't used a lot*. Respondents agreed with this statement to a greater extent when first surveyed (mean=3.66 on a 5-point Likert scale) than when re-surveyed (mean=3.44) at the $p<.01$ level.

7.2.3. Changes in land management practice scores - Lachlan Catchment [2]

Land management scores were calculated for respondents for both surveys. There was no statistically significant difference in land management practice scores between the 2008 survey (Mean=43.39, *SD*=17.79) and the 2009 survey [Mean=46.04, *SD*=20.05, $t(170)=1.88$, $p=.063$]. By sub-catchment region, Humbug had no statistically significant difference in land management scores between the 2008 survey (Mean=40.50, *SD*=17.22) and the 2009 survey [Mean=40.99, *SD*=22.20, $t(86)=.223$, $p>.01$]; while Mandagery had a significant increase in land management scores between the 2008 survey (Mean=46.40, *SD*=17.96) and the 2009 survey [Mean=51.27, *SD*=16.06, $t(83)=2.91$, $p<.01$]. These differences are summarised in Figure 33.

[2] As previously stated, for time comparison purposes, Lachlan land management scores were derived in a different manner from Central West scores – hence the range of scores in the two catchments are quite different and cannot be compared over time.



***** denotes a statistically significant difference over time at the *p*<.01 level

Figure 33. Summary of Lachlan Land Management Practice scores over time

7.3. Further differences over time for all the sub-catchments combined

Other quantitative items common to both surveys were tested for differences over time. While the majority of items showed no differences over time, the following statistically significant (*p*<.05) differences emerged:

- Respondents were more concerned about the consequences of environmental degradation for birds the first time they were tested (Mean=3.60, *SD*=1.19) than the second time they were tested [Mean=3.30, *SD*=1.09, *t*(170)=-3.18, *p*=.002].
- Respondents were more concerned about the consequences of environmental degradation for their future the first time they were tested (Mean=3.92, *SD*=1.16) than the second time they were tested [Mean=3.64, *SD*=1.05, *t*(170)=-2.71, *p*=.008].
- Respondents were more concerned about the consequences of environmental degradation for their family the first time they were tested (Mean=3.98, *SD*=1.07) than the second time they were tested [Mean=3.73, *SD*=1.06, *t*(169)=-2.66, *p*=.009].
- Respondents were more concerned about the consequences of environmental degradation for their lifestyle the first time they were tested (Mean=3.74, *SD*=1.08) than the second time they were tested [Mean=3.44, *SD*=1.11, *t*(170)=-2.83, *p*=.005].
- Respondents were more concerned about the consequences of environmental degradation for all people the first time they were tested (Mean=3.85, *SD*=1.06) than the second time they were tested [Mean=3.52, *SD*=1.07, *t*(169)=-3.43, *p*=.001].
- Respondents were more concerned about the consequences of environmental degradation for their children the first time they were tested (Mean=4.09, *SD*=1.06) than the second time they were tested [Mean=3.71, *SD*=1.10, *t*(170)=-4.00, *p*<.001].

8. DISCUSSION

The results of this study confirm many of the concepts outlined in the pro-environmental and agricultural adoption literature, and also highlight a number of key differences between sub-catchments, genders and across time in our study regions. A discussion of the key points arising from the research is presented which may improve understanding of the factors influencing land management.

8.1. Differences between sub-catchments

There were striking and consistent differences between the Humbug sub-catchment and the other sub-catchments in the study. This sub-catchment is in distress. Generally, participants in the Humbug were more focussed on ensuring financial security for their family, or 'just putting food on the table'. They were also more likely to report that they were 'just hanging in there' and reported lower levels of perceived resources to undertake land management activities. Furthermore, respondents from the Humbug were more likely to have an external locus of control, and less desirable land management practices (i.e. lower scores) than the Mandagery and the Bell. Taken as a whole, the results indicate that Humbug is suffering disproportionately more from the drought than the other catchments.

The Humbug sub-catchment is the furthest inland of those included in the study and demonstrates less favourable hydro-climatic conditions for agricultural production, particularly under extended and on-going drought conditions. The results of the research detailed in this report indicate support for a relationship between the physical environment and the psychological and social wellbeing of farmers, which in turn influences land management practices. Environmental degradation may increase the levels of debt and stress experienced by individual farmers, whilst simultaneously acting to reduce their psychological resources (i.e. internal locus of control, optimism and so on) to undertake land management. This is consistent with other research citing the social and mental health impacts of rural decline, rural restructuring and environmental degradation (e.g. Connor et al., 2004; Fraser et al., 2005; Higginbotham et al., 2007; Van Haaften & Van de Vijver, 1996 a, b; Van Haaften, Zhenrong, & Van de Vijver, 2004). The findings are also consistent with themes emerging from qualitative phases of the PUTTI research program, where it was found that those in the Humbug displayed greater levels of farming stress and pressures than those in other sub-catchment (Bates et al., 2008).

8.2. Differences over time

Over time, the Mandagery was the only sub-catchment to significantly improve their collective land management practice score. There were no significant changes over time for both the Humbug and the Cudgegong. The Bell was the only sub-catchment to record a significant decrease in their collective land management practice score. The relative stability of land management practice scores over the course of the study supports suggestions that practice change occurs incrementally and slowly (Green et al., 2009; Ison, Roling & Watson, 2007). In the Central West, there were only minor differences in the levels of trust in and influence of sources of agricultural information over the course of the study (of most note was increased ratings for agronomists). In the Lachlan, there were no differences observed in the trust and influence ratings for sources of agricultural information overtime; however there was less time between surveys (one year instead of two years as in the Central West).

8.3. Modelling land management behaviour

The social and psychological drivers identified during this final stage of the PUTTI project were able to predict 38% of the variance in land management practice across the four sub-catchments. While consistent with the Lachlan findings, the latest iteration of the model was able to account for slightly more variation in land management scores and had better goodness of fit indices; hence it represents an improvement from previous phases of the PUTTI project.

The remodelling of land management behaviour revealed the following points:

- a number of socio-psychological variables were identified as significantly related to property planning
- risk and innovation along with perceived social influence strongly contributed to land management practice
- locus of control dominated the model; an internal locus of control predicted a more desirable land management practice

The model of land management practices developed is consistent with models of pro-environmental behaviour including the: Value-Belief-Norm model (Stern, 2000 Actively Caring Hypothesis (Geller, 1995); Norm Activation model (Schwartz, 1977); and the Extended Norm Activation model (Blamey, 1998). The model may also address some of the criticisms of research on the environmental behaviours of farmers (Bayard & Jolly, 2007), by providing a theoretical framework capable of accounting for contextual differences.

8.3.1. Perceived influence

The results suggested no significant relationship between good land management practice and being influenced by others. Paradoxically, respondents who perceived themselves as being socially influential to other farmers are more likely to be good land managers. This suggests one of two things: either the message of the influential farmer is not being converted into practice by others, or the 'good farmer' *thinks* s/he is more influential than s/he actually is. The first is consistent with notions emerging from the qualitative data that a 'tall poppy syndrome' is evident. The following scenario may serve to illustrate: a farmer that has been identified as 'good' in the region talks to lots of farmers, but this communication is formalised through the CMA; a bus tour to his property might be organised, he might host field days or be asked to present at conferences. The average farmer nods his head dutifully, goes back to his farm and chats with his neighbour about it, including how self assured the other farmer is, and that the first farmer is bound to be 'good' as he evidently gets preferential treatment from the CMA after all. For the 'good farmer', his perceived influence perpetuates his good farming practices (and improves them) through a combination of the normative pressures of being observed, and an internalisation of a 'good farmer' status to his/her self-identity. Alternatively, the link between perceived social influence and land management practice could reflect farmers' levels of self-regard or self-esteem which in turn support the kind of risk taking behaviour that underpins practice innovation.

The observed relationship between perceived social influence and land management practices could also be explained by the 'Hawthorne effect'. This can be viewed as positive change in behaviour that occurs when people feel that they are being studied or observed (see Adair, 1984 for review). As such, farmers that think others are paying attention to their practices may actually improve their land management. This improvement may be related to a sense of social obligation to impart positive information.

8.3.2. Trust in and influence of agronomic information

Once again, trust in and influence of agronomic information was a predictor of good land management behaviour, highlighting the importance of fostering trust between the community, CMA staff and local agribusinesses.

Respondents from the Humbug made more use of external sources of help such as agronomists. This is consistent with qualitative findings by Bates et al. (2008) suggesting that farmers in the Humbug had a greater relationship with and reliance on agronomists, and were more influenced by agronomists. Yet this relationship did not translate into higher land management scores for Humbug participants as a whole. The answer may lie in the predominant style of farming method in the Humbug, the characteristics of the relationships between agronomists and farmers in the Humbug, or in the degraded environment and financial situation that is making it challenging to conduct good land management practice. An external locus of control style, for instance, would dictate that one is more likely to delegate decision-making to an external source – in this case, agronomists. Fostering relationships that are empowering for the farmer, then, should be encouraged.

8.4. Feeling in control on the farm: Understanding how locus of control affects land management

8.4.1. Is Locus of Control a trait or a state?

Locus of control has traditionally been viewed as a personality trait-based concept. That is, it is thought to form an unmalleable part of an individual's personality. An alternative perspective that is gaining support in the literature is that locus of control can be altered by external contextual factors. The results of this study suggest that locus of control is, in this case, at least partially state-based. More respondents in the Humbug had external locus of control scores which is the most environmentally degraded sub-catchment of the study. Humbug farmers are more likely to feel that they do not have control over events and outcomes, and as such are less likely to engage in desirable land management practices and other mitigation strategies. The unfortunate implications are that, in times of hardship and changing climates, farmers are likely to feel less in control and subsequently will be less likely to mitigate their conditions. Effectively their objective *and* subjective capacity is reduced. The oft-heard expression that 'anyone can be a good farmer in good times; it's when times are tough that the genuinely good farmers emerge' has its parallels in the locus of control concept.

Van Haaften and Van de Vijver (1996b) found that environmental degradation reduced the carrying capacity (defined as the extent of stress and marginalization) experienced by rural communities affected by deforestation in West Africa. They concluded that individuals' motivations to participate in environmental change were reduced by environmental degradation. These results have been replicated in Chinese rural communities (Van Haaften, Zhenrong & Van de Vijer, 2004) where resilience was found to be affected by locus of control and environmental degradation. Van Haaften and Van de Vijver (1996a) summarise this relationship as follows:

> *"Environmental degradation and its psychological aspects form an enduring process with mutual feedback loops. An environment that starts to erode will induce psychological consequences such as stress and marginalisation. The psychological consequences can lead to behaviour that will accelerate degradation (e.g. overgrazing)." (p.427)*

8.4.2. How does locus of control affect property planning?

Property planning is encouraged by CMAs as a component of good land management practice, yet the number of participants with professionally developed property plans is low at 13% It should also be noted that property planning did not have a direct significant relationship with land management practice in the model detailed in section 4. The rates of property planning were aligned with the number of participants who indicated that they had undertaken courses aimed at property planning. Most participants generated a property management plan as a result of a course. Other participants generated one for goal definition purposes.

The model presented in figure 6 represents the relationship between locus of control and property planning as bi-directional. That is locus of control is thought to influence the likelihood of having a formal property plan, while concurrently, having a written property plan may also influence your locus of control. Planning ahead is considered to be an aspect of internal locus of control, so it is to be expected that those with a more internal locus of control would be more likely to engage in formal property planning. How might this work in the other direction?

One possibility is that having a property plan 'demystifies' certain aspects of the property and, in so doing, aids decision-making through allowing the input of objective observations into their property planning as part of an iterative improvement process. As a consequence, there is less reliance on received wisdom and intuition (the chiefly cited response to what people did in lieu of a formal property plan was to use "common sense" and knowledge, which included statements such as "go by feel"). In addition, the visual aspects of property plans allows the farmer to view the entire property at once; this perhaps facilitates a focussing of locus of control towards the internal – the following train of thought might serve to illustrate: "I can see my property laid before me, I have objective data, my risk in taking a decision is therefore reduced, and now all I have to do is make it work. If something doesn't work, I factor that back in to my property plan, and that makes it an even more powerful tool".

Again, it should be noted that locus of control is a *generalised expectancy* that predicts but does not determine an individual's actions. 'Internals' still need to act upon their expectancies, and 'externals' can choose do something about their situation despite believing that external sources have more control.

8.4.3. Women in farming

The results suggest that women have less formal agricultural qualifications and are disproportionately suffering from a perceived lack of resources in the study area. Furthermore, environmental degradation is more likely to result in external loci of control in women compared to men in this study, a finding which is consistent with previous research. Generally women have been found to be more externally oriented than men due to a range of socio-political factors (Rossier, Dahourou & McCrae, 2005). Women in rural communities have been found to be more externally oriented and to experience greater degrees of stress and marginalisation than their male counterparts (Van Haaften & Van de Vijver, 1996a). This trend is thought to be related to the lower status socially attributed to women within their communities. It is interesting to note however that the gender differences observed in the current research did not hold for the Bell sub-catchment, where women and men rated similarly in terms of perceived resources, locus of control and land management practice.

The Australian national identity is intrinsically linked to agriculture, where masculinity plays a central role. Pini (2005) suggests that the notion of heroic farmers is pivotal to this national identity and involves the image of 'man on the land' (p74). Women in Australian agriculture are typically presented as marginal or peripheral figures despite undertaking land management activities whilst negotiating domestic duties, and actively contributing to community sustainability through participation in community groups. Williams (1992) went as far as terming women 'the invisible farmer' in a government report on Australian agriculture (cited by Pini, 2005). It has been suggested that the predominantly male image of Australian agriculture impedes rural women's ability to contribute to positive change in their communities (Coakes & Kelly, 1997). Coakes and Kelly suggest that empowerment strategies can contribute to resilient rural communities and improved outcomes for women. They suggest that empowerment programs developed in health promotion may be of particular benefit for Australian rural women and may also be able to increase the internal locus of control of individuals.

The concept of empowerment was first introduced to outline the influence of power-dynamics, including the differential control over resources, on community and individual wellbeing (Rappaport, 1981; 1987). Empowerment can be viewed as an outcome or a process in which individuals and communities gain a sense of mastery over their lives and outcomes. This involves the development of a sense of control, opportunities for democratic participation and an ability to exert social influence, (Zimmerman & Perkins, 1995; Rappaport, 1987; Fawcett et al., 1995; Speer & Hughey, 1995). A widely supported definition of empowerment is proffered by the Cornell University Empowerment Group (1989):

> *"Empowerment is an intentional, ongoing process centred in the local community, involving mutual respect, critical reflection, caring, and group participation, through which people lacking an equal share of valued resources gain greater access to a control over those resources". (p.2)*

There a several domains in which individuals and groups can be empowered to develop capacity and organise their efforts towards change. Laverack (2006) defines this as areas in which the community can be assisted to:

- Improve levels of participation, mobilisation of resources and networks
- Develop local leadership and organisational structures
- Increase ability to identify problems, ask questions and influence management of programs
- Create equitable relationships

Empowerment has been conceptualised as being comprised of three dimensions: Objective power, subjective power and competence (Cook, 1997 cited by Ugbomeh, 2001). As an individuals' sense of control develops so does their personal abilities and subsequently new opportunities become available and their access to information improves.

The empowerment of rural women may be important for a number of reasons. The research detailed here suggests that women with more external loci of control demonstrate less desirable land management practices. As such, an improved sense of control developed through empowerment processes may result in improved environmental outcomes. Furthermore, socio-political participation is a function of empowerment; if women are more empowered they may be more likely to participate in community and agricultural groups. Natural resource management (NRM) groups comprised of women have been found to be

significantly more likely to self-sustain collective action and achieve NRM outcomes (Westermann, Ashby & Pretty, 2005). The positive outcomes of female participation in NRM groups were found to be related to women's enhanced capacity to collaborate, develop solidarity and resolve conflict.

Empowering rural women is thought to be particularly important in the sustainability of developing countries (Ugbomeh, 2001; Lahiri-Dutt & Samanta, 2002). In this context, rural women empowerment is a process in which women are supported to challenge those structures and ideologies which maintain their marginalisation. Ugbomeh highlights strategies for rural women empowerment in Nigeria, such as vocational training and women agricultural extension agents. These targeted female learning environments remove obstructions to learning such as the traditional power relationships between men and women. State-initiated rural women empowerment programs have also been implemented in India, where Continuing Education Centres are developed to support cultural, sporting and educational activities for women along with self-help groups (Lahiri-Dutt & Samanta, 2002).

Empowerment has also been recognised as an important aspect of rural community development and poverty alleviation in the USA and has been formalised in the guise of 'Empowerment Zones' (for reviews see Aigner et al., 1999). This initiative was put in place in 1994 by then President Bill Clinton and involves targeted support for 33 rural areas over ten years. The program was designed to encourage citizen participation in rebuilding local economies and developing sustainable communities. As part of this, communities were encouraged to develop networks and planning arrangements with other regions and organisations (O'Neal & O'Neal, 2003). An integrated focus was applied to employment, education, housing and health.

8.5. Bringing it together: Taking back control of the farm

Farmers' decision-making behaviours are driven by multiple personal objectives, motivations or goals. Understanding the goals that drive practices on the farm can be useful in prediction and policy formation. Decision-making models based on a single-objective, such as profit maximisation, may be able to predict behaviours at a macro-level, but often fail to adequately predict individual behaviour.

Individuals' goals are thought to be ordered hierarchically, as reflected in Maslow's Hierarchy of Needs (see Mischel et al. 2007 for review): the most pressing and basic human needs must be satisfied before other less tangible needs can be attained. When each level of need is met, other 'higher' needs emerge. In addition to physiological needs such as food, water and shelter, Maslow included needs surrounding safety and security, love and belonging, esteem, and self development (or 'self-actualisation') in ascending order on the needs hierarchy (Maslow 1943). Goals can be thought of as reflecting an individual's perceived needs.

The goal orientations of the respondents in this study may offer some contextual insights. The majority felt that their main focus was 'just hanging in there'; this was especially marked for those with an external locus of control. It is not surprising then, that 'improving the environmental health of the farm' or 'being respected as a good farmer' is the main motivation for only around one-quarter of our farmers. The majority are mainly motivated, at this stage, with more immediate concerns surrounding their families and financial security.

In order to encourage more environmentally sustainable practices it may be necessary to consider the social sustainability of farming families and communities. Landholders must be able to satisfy basic needs for themselves and their families before they can entertain less pressing needs, such as feelings of self-worth and the formation of positive identities. It may be more important for landholders to be a good parent or good community member than it is to be a 'good' farmer, as these things satisfy immediate needs for security and belongingness rather than less tangible needs for self-fulfilment. The importance of rural 'social sustainability' for effective catchment management and environmental outcomes has also been highlighted in research undertaken in the WA wheat-belt, where:

> "*issues of amenity, provision of social and health services, adapting to reduced water availability, and managing the effects of growing or declining populations are paramount as are the implications these hold for community identity and cohesion, land use change and infrastructure*" (Taylor et al. 2008, p. 66)

8.5.1. Some recommendations for the CMA

Social influence: The role of social influence (or the perception of having social influence) amongst peers may be an important way of investing farmers with the impetus and ongoing motivation to adopt sustainable land management practices. Such peer-on-peer influence could be utilised by the CMA by promoting programs that enhance opportunities for interaction between *all* farmers, not just the 'best' ones, and encouraging farmers at a range of levels to host field days and talk about their properties in a relaxed and supportive environment.

The role of CMAs within the community: The CMA's role in delivering Government policy could be augmented through further integration of CMA staff and other community members, and recognising and promoting that the CMA itself is made up of community members and landholders..

Property planning: Consideration should be given to how property planning is encouraged and marketed, so that it is both relevant and empowering. Promoting property planning as a mechanism for enhancing feeling in control of things that are happening on the property may be one effective technique. The motivations for CMAs to encourage property planning could be made explicit, especially in terms of how the landholder benefits.

Women in farming: Continue and expand programs designed to assist women in agriculture. Consideration should be given to utilising success stories – e.g. why are women from the Bell faring better than their counterparts in other sub-catchments?

Package programs to suit differing landholder intentions and skills: The incentive programs could be designed to recognise and capitalise on individual differences between farmers with regards to landholder intentions or focus (e.g. expansion, diversification, downsizing). A 'one size fits all' approach to incentive funding acts as a barrier to adoption. By acknowledging farmers' pre-existing skills the CMA may be better able to enable them to be their own agents of change. A diversion of funds towards a greater emphasis on extension activities and working one on one with landholders may help them to understand their own property in more detail.

Ensure that incentive funding appeals to a broad range of motivations: Incentive funding should also cater for lifestyle and other personal priorities. This may be achieved by emphasising some of the more pragmatic benefits that CAP targets might deliver to the landholder. Incentive programs need to be appropriate for hydro-climatic conditions, there should be clear connections between the incentives and the aims of the CAP and CMA, and the benefit to landholders and their neighbours.

GLOSSARY

ANOVA – Analysis of variance – a statistical procedure used when you have two or more groups and you wish to compare their mean scores on a continuous variable. A two-way ANOVA allows you to test the impact of two independent variables on one dependent variable.

Biospheric environmental values – a value system that conveys concern for the physical and naturally occurring environment (such as native animals, birds and plants).

Correlation – The linear relationship between two variables. A correlation coefficient's value ranges between -1 a +1, with the sign indicating the direction of the relationship and the numerical value its strength.

Catchment Action Plans (CAPs) – 10 year Natural Resource Management plan for the Central West which outlines specific Management Targets aimed at improvement of natural resources.

Conservation farming – farming practice that draws on a range of farming methods aimed at minimising soil disturbance. Practices include stubble retention and minimum or zero tillage.

Cronbach's alpha – a measure of the extent to which a set of questionnaire items are consistent. It is a correlation value and the closer it is to 1.0 the better, or more internally consistent, the items are considered.

Egoistic environmental values – a value system that conveys concern about the impacts of environmental problems on family and self.

Latent variable – a variable which itself is unobservable (or theoretical), but that can be measured through the combination of a number of directly observable variables.

Locus of control (LOC) – whether one believes their actions are controlled by themselves (internal LOC), or controlled by people or conditions external to themselves (external LOC).

Minimum till – broad acre farming methods of post-harvest stubble retention. Distinct machinery pathways are made preventing crop soil compaction, allowing for a deeper soil and moisture profile.

Model fit indices – **Chi-square** is a test of differences in frequencies which can be used to estimate the statistical significance (or validity) of conclusions about the differences between groups. It also can be used as a measure of the goodness of fit (the extent to which a derived modelling solution can reproduce the original data). As a measure of goodness of fit, a non-significant or smaller chi-square indicates a good fit, while a large value indicates a poor fit. **CFI** (Comparative Fit Index), **GFI** (Goodness of Fit Index) and **RMSEA** (Root Mean Square of the Errors of Approximation) are further statistics associated with goodness of fit. Goodness of fit indices are measures of the extent to which the derived model approximates the original data. A good fit is one that explains the data well. These indices need to be within a certain limit to indicate a good fit. More detailed information can be found in Structural Equation Modelling references such as Diamantopoulos and Siguaw (2000).

Paired-samples t-test – a statistical procedure used when you have only one group of people and data from two different occasions, or under two different conditions.

Partial eta squared – the effect size, or 'strength of association' between two variables. The partial eta squared indicates the relative magnitude of the difference between two means.

Principal Components Analysis (PCA) – A mathematical technique to reduce a high-dimensional space to just a few orthogonal axes called principal components, which are defined in terms of weighted combinations of variables that maximize the variance of the data along those axes. PCA is typically used for clustering data and making its visualization easier.

Reliability analysis – a statistical technique used to assess the internal consistency of a scale, that is, the degree to which the items that make up the scale are all measuring the same underlying construct.

Structural Equation Modelling – statistical technique for understanding the causal relationships between two or more latent variables.

Stubble retention – where stubble residue is maintained rather than removed through grazing or burning.

Zero till – broad acre farming method of post-harvest stubble retention. Distinct machinery pathways are made preventing crop soil compaction, allowing for a deeper soil and moisture profile.

APPENDIX 1

Land management practice model from the Central West CMA phase

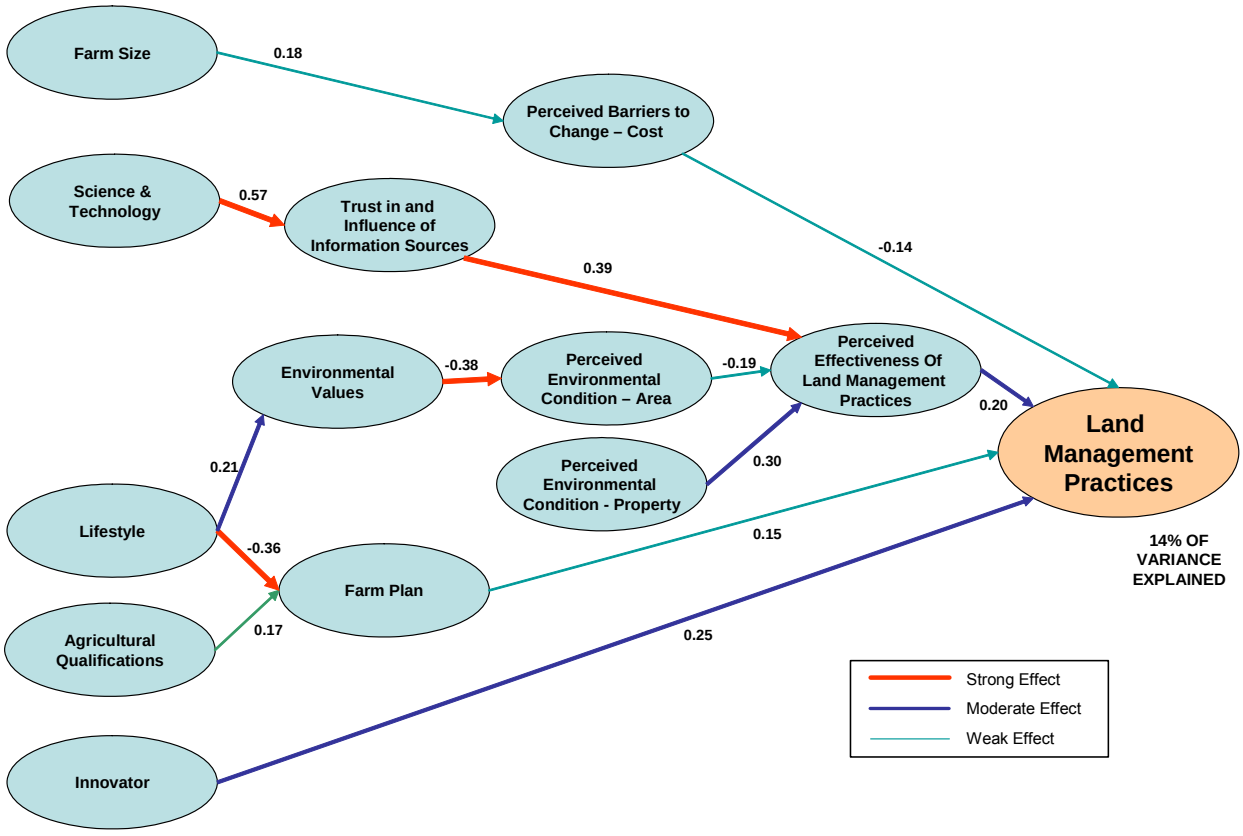


Figure 34. Central West CMA Land Management Practice Model

APPENDIX 2

Land management practice model from the Lachlan CMA phase

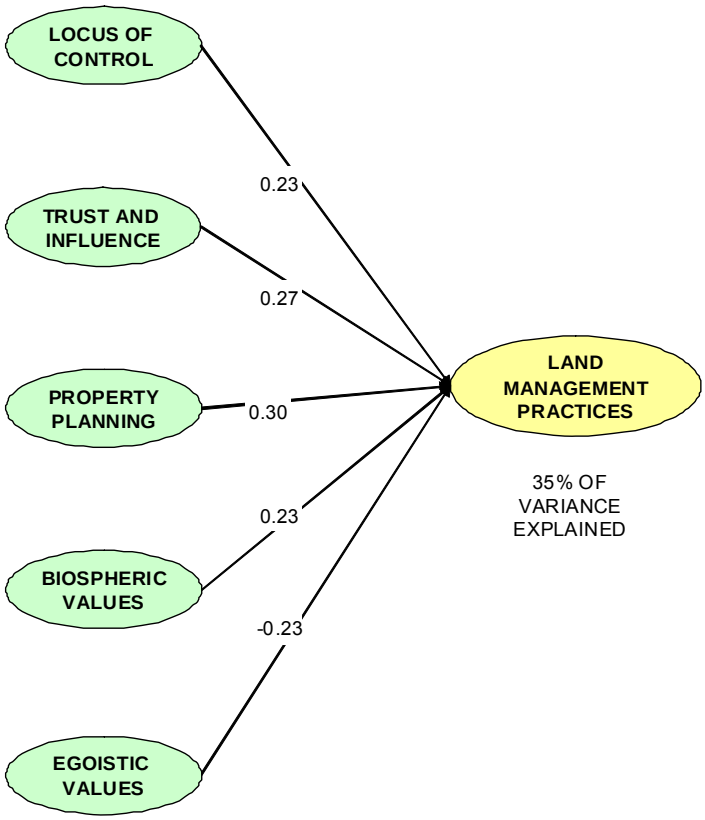


Figure 35. Model of factors influencing land management practice emerging from the Lachlan study

APPENDIX 3

Characteristics of respondents & their farms

The length of time respondents had been dryland farming in the area ranged from three to 82 years, with the average being a length of 28.5 years. Over a third of respondents had been farming for between 16 and 30 years (see Table 13).

Table 13. Years respondents had been dryland farming

Years in agriculture	Bell % (n = 116)	Cudgegong % (n = 127)	Humbug %(n = 91)	Mandagery %(n = 88)	Total % (n = 422)
0-15 years	28.40	34.65	14.29	22.73	26.07
16-30 years	25.86	38.58	39.56	39.77	35.55
31-45 years	27.59	11.02	35.16	22.73	23.22
46+ years	18.10	15.75	10.99	14.77	15.17
Mean	29.66	25.91	30.30	28.83	28.50
Std dev.	17.170	17.676	12.901	16.070	16.312

The length of time respondents' families had been farming in the area ranged from zero to 250 years, with an average length of 71.8 years (see Table 14).

Table 14. Length of time respondents' families had been farming in the area

Years family has been in farming	Bell % (n = 116)	Cudgegong % (n = 115)	Humbug % (n = 91)	Mandagery % (n = 83)	Total %
0-24 years	25.9	30.4	6.6	16.9	21.0
25-49 years	14.7	14.8	17.6	20.5	16.5
50-74 years	14.7	10.4	17.6	10.8	13.3
75-99 years	8.6	11.3	31.9	12.0	15.3
100 + years	36.2	33.0	26.4	39.8	33.8
Mean	75.01	66.17	75.57	71.10	71.82
Std. dev.	59.61	50.68	34.30	41.05	48.53

Respondents were asked about the size of their farm and the number of properties involved. They were also asked about how many properties they actively managed which were under agricultural production. The average farm size was 1381.4 hectares (ha). Within the specific sub-catchments, the average property size in the Humbug was 2706.2 ha, substantially larger than Bell (1408.1ha), Mandagery (896.3 ha) and Cudgegong (743.8 ha, as shown Table 15). Almost one third of the respondents overall (35.1%) had properties over 1000 ha.

It should be noted that there was a substantially larger degree of variation in land sizes among properties in the Bell than among properties in the other sub-catchments.

Table 15. Farm sizes for Bell, Cudgegong, Humbug and Mandagery sub-catchment respondents

Hectares farmed	Bell % (n = 116)	Cudgegong % (n = 127)	Humbug % (n = 91)	Mandagery % n = 88)	Total
0-99 ha	37.9	38.6	5.5	19.3	27.3
100-399 ha	26.7	11.0	6.6	22.7	16.8
400-999	14.7	23.6	12.1	34.1	20.9
1000-2999 ha	17.2	22.8	42.9	19.3	24.9
3000+ ha	3.4	3.9	33.0	4.5	10.2
Mean	1408.08	743.79	2706.21	896.30	1381.37
Std. Dev.	9265.75	1074.62	2556.89	1915.66	5148.28

The majority of respondents overall (62.1%) actively managed only one property under agricultural production. On average, respondents managed 1.79 properties (see Table 16 for details). Respondents in the Humbug sub-catchment managed statistically significantly ($p<.05$) more properties (average of 2.37) than all other sub-catchments measured.

Table 16. Number of properties actively managed in Bell, Cudgegong, Humbug and Mandagery sub-catchment

Number of properties managed	Bell % (n = 116)	Cudgegong (n = 127)	Humbug (n = 91)	Mandagery (n = 88)	Total (n = 422)
1	75.0	65.4	44.0	59.1	62.1
2	17.2	18.9	17.6	19.3	18.2
3	3.4	10.2	19.8	12.5	10.9
4	1.7	3.1	5.5	4.5	3.6
5	1.7	0.8	5.5	3.4	2.6
6	0.0	0.0	5.5	0.0	1.2
7	0.0	0.0	1.1	0.0	0.2
8	0.0	0.0	1.1	0.0	0.2
10	0.9	1.6	0.0	1.1	0.9
Mean	1.44	1.66	2.37	1.82	1.79
Std. dev	1.121	1.364	1.671	1.386	1.417

The majority (53.3%) of respondents overall were aged between 45 and 64 years (see

Table 17). However, the Humbug sub-catchment had a higher proportion of respondents aged less than 45 years (34.1%) when compared with the Mandagery (26.1%), Cudgegong (19.7%), and Bell (15.5%).

Table 17. Details of respondents' age

Age	Bell % (n = 116)	Cudgegong (n = 127)	Humbug (n = 91)	Mandagery (n = 88)	Total (n = 422)
25 to 34 years	5.2	4.7	5.5	6.8	5.5
35-44 years	10.3	15	28.6	19.3	17.5
45-54 years	29.3	26	22	29.5	26.8
55-64 years	27.6	28.3	24.2	25	26.5
65-74 years	23.3	20.5	16.5	17	19.7
More than 75 years	4.3	4.7	3.3	2.3	3.8
Refused	0	0.8	0	0	0.2

The majority of respondents were male (74.8%). This was similar for all sub-catchments; however there were proportionately more female respondents from the Cudgegong sub-catchment (30.2%).

Table 18. Details of respondents' gender across sub-catchments

Gender	Bell % (n = 116)	Cudgegong % (n = 126)	Humbug % (n = 91)	Mandagery % (n = 88)	Total % (n = 421)
Female	22.4	30.2	23.1	23.9	25.2
Male	77.6	69.8	76.9	76.1	74.8

APPENDIX 4

Correlation matrix for key variables used to predict land management practices

Variables		1	2	3	4	5	6	7	8	9	10	11	12
1	Land management practice												
2	Locus of control	**.32****											
3	Trust in and influence of agronomy	.14**	.02										
4	Risk and innovation	.13**	.21**	.09									
5	Biospheric concern	.16**	.03	.03	-.02								
6	Social influence	.23**	.19**	.09	**.41****	-.03							
7	Farm planning	.22**	.24**	.05	.19**	.08	.24**						
8	Perceived resources	.16**	**.32****	.07	.10*	.07	.13**	.05					
9	Environmental threats	.03	.00	.04	.06	.29**	.07	.181**	-.04				
10	Responsibility for environmental threats	.10*	.03	.15**	.08	.16**	.06	.135**	.11*	.16**			
11	Change intentions	.08	.15**	.07	.18**	.13**	.16**	.140**	-.06	.16**	.08		
12	Education	.22**	.09	.01	.11*	-.02	.23**	.203**	-.18*	.12*	-.02	.12*	
13	Hire agronomist	.15**	.00	.17**	.18**	.01	.13**	.188**	-.07	.08	.10*	.08	.06

** Indicates statistically significant (p<.01)
* Indicates statistically significant (p<.05)

APPENDIX 5

Confirmatory modelling

The second phase of the PUTTI research identified a number of variables that influenced the likelihood that landholders will engage in good land management practice. Figure 36 details this model while Table 19 provides an overview of model component names and what they were designed to measure.

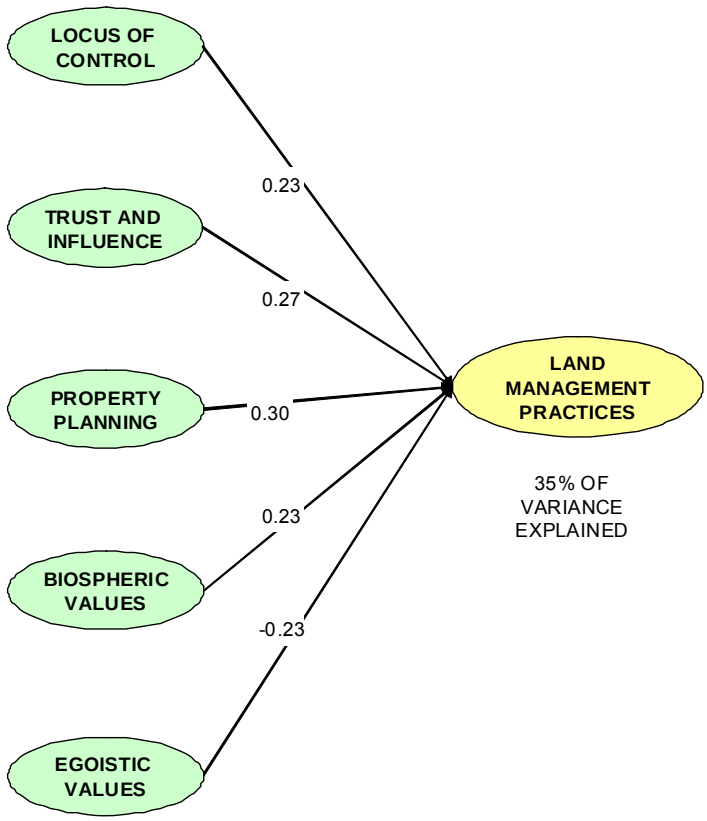


Figure 36. Model of factors influencing land management practice emerging from the Lachlan study

Table 19. Variable names and descriptive labels for the Lachlan Structural Equation Model (Figure 36)

Estimated Structural Equation Variable Name	Model Component Name
LOC	Locus of control—sense of being in control over decisions
TINF	Trust and influence scale
PROPPLAN	Property planning
BIOS	Biospheric environmental values – concern for environment as it effects native plants and animals
EGOIS	Egoistic environmental values – concern for the environment as it affects family and self
BEHAV	Land management practice

The model from phase two found that the following factors predicted higher land management practice scores:

- Increased trust in and influence of outside sources such as other farmers, scientists, field days and the Department of Primary Industries;
- Having an internal locus of control – the sense of being able to determine one's own actions;
- Having a formal property plan, created with the assistance of a professional;
- High biospheric environmental values - a value system that conveys concern for the physical and naturally occurring environment (such as native animals, birds and plants); and
- Low egoistic environmental values - a value system that conveys secondary or reduced concern about the impacts of environmental problems on family and self.

This model was tested in the current phase of the research using results from 422 resurveyed respondents from all four sub-catchments. The confirmatory model is shown in Figure 37.

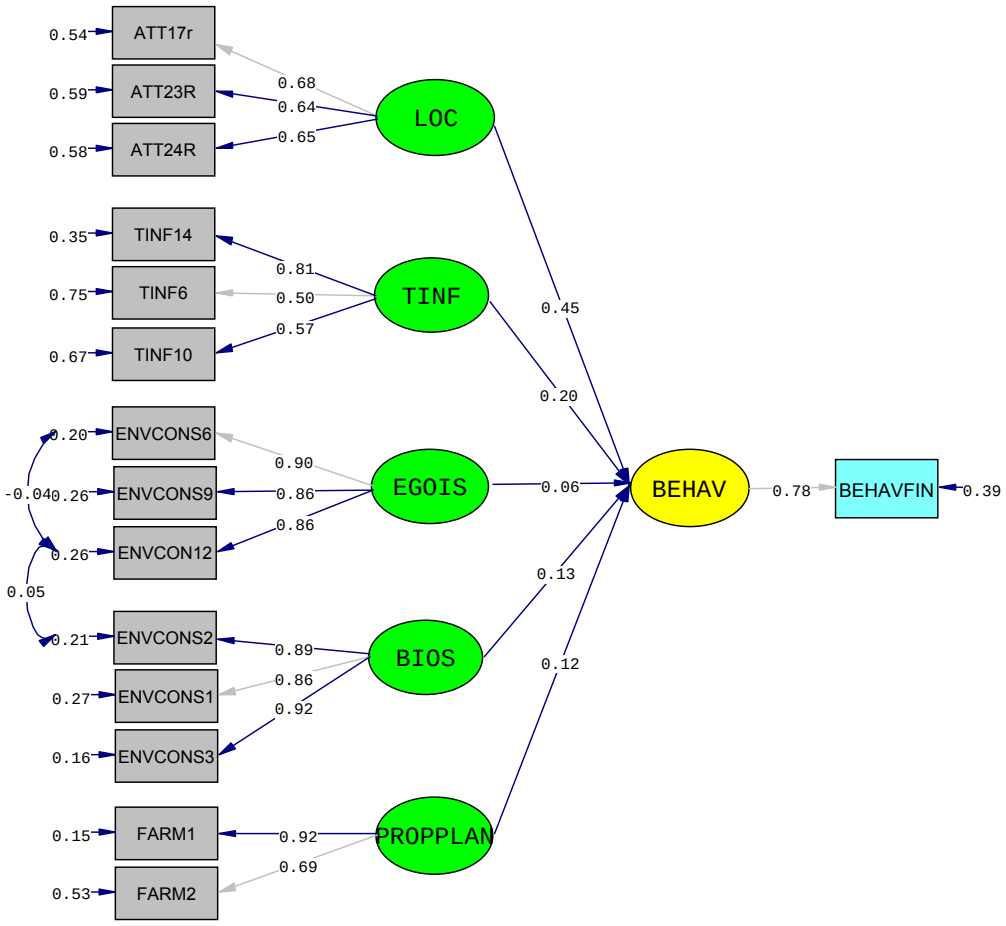


Figure 37. Confirmatory Land Management Practice structural equation model

Structural equation modelling found that, while approaching significance, three of the factors failed to reach statistical significance: egoistic values, biospheric values and property planning. Once egoistic values and biospheric values were removed, property planning reached significance, with fit indices suggested that this paired down model was confirmed. The model was able to predict 33% of the variance in land management practice scores. Fit indices are presented in Table 20 and a simplified version of the model is presented in Figure 38.

Table 20. Model fit indices for paired down confirmatory structural equation model

Fit Statistics	Obtained Value	Recommended Value
Chi-square (df)	33.84 (22), *p*=.051	*p* > .05
CFI	0.98	≥ .90
GFI	0.98	≥ .90
RMSEA	0.036	≤ .08

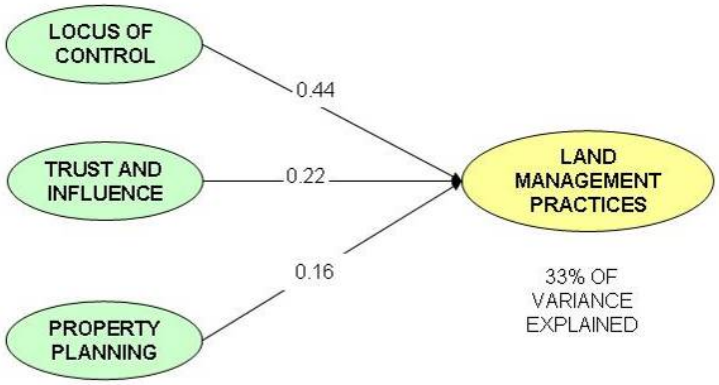


Figure 38. Simplified Confirmatory Land Management Practice structural equation model with non-significant pathways removed

While these results suggest that factors identified in phase two of the PUTTI project remain relevant to the wider catchments, it was felt that exploratory modelling would service both interpretation of previous modelling and result in a model of broader relevance.

APPENDIX 6

Exploratory modelling

Figure 39 shows the relationships between the latent variables (shown in the model as ellipses) and their respective indicators (shown in the model as rectangles). The model schematic reveals how well the indicators measure the latent variables. For example, *ATT24R* is one of three attitudinal statements intended to measure locus of control. The value of the co-efficient on the path indicates how well the statement (*ATT24R*) actually measures the concept of locus of control. Coefficients on these paths can range from -1.0 (i.e. a strong *negative* relationship between the latent variable and the indicator) to +1.0 (i.e. a strong *positive* relationship between the latent variable and the indicator). Each of the indicators included in the model were sufficiently reliable measures of the latent construct they were designed to represent (as demonstrated by the Cronbach's alpha scores of the scales presented in Section 3.3).

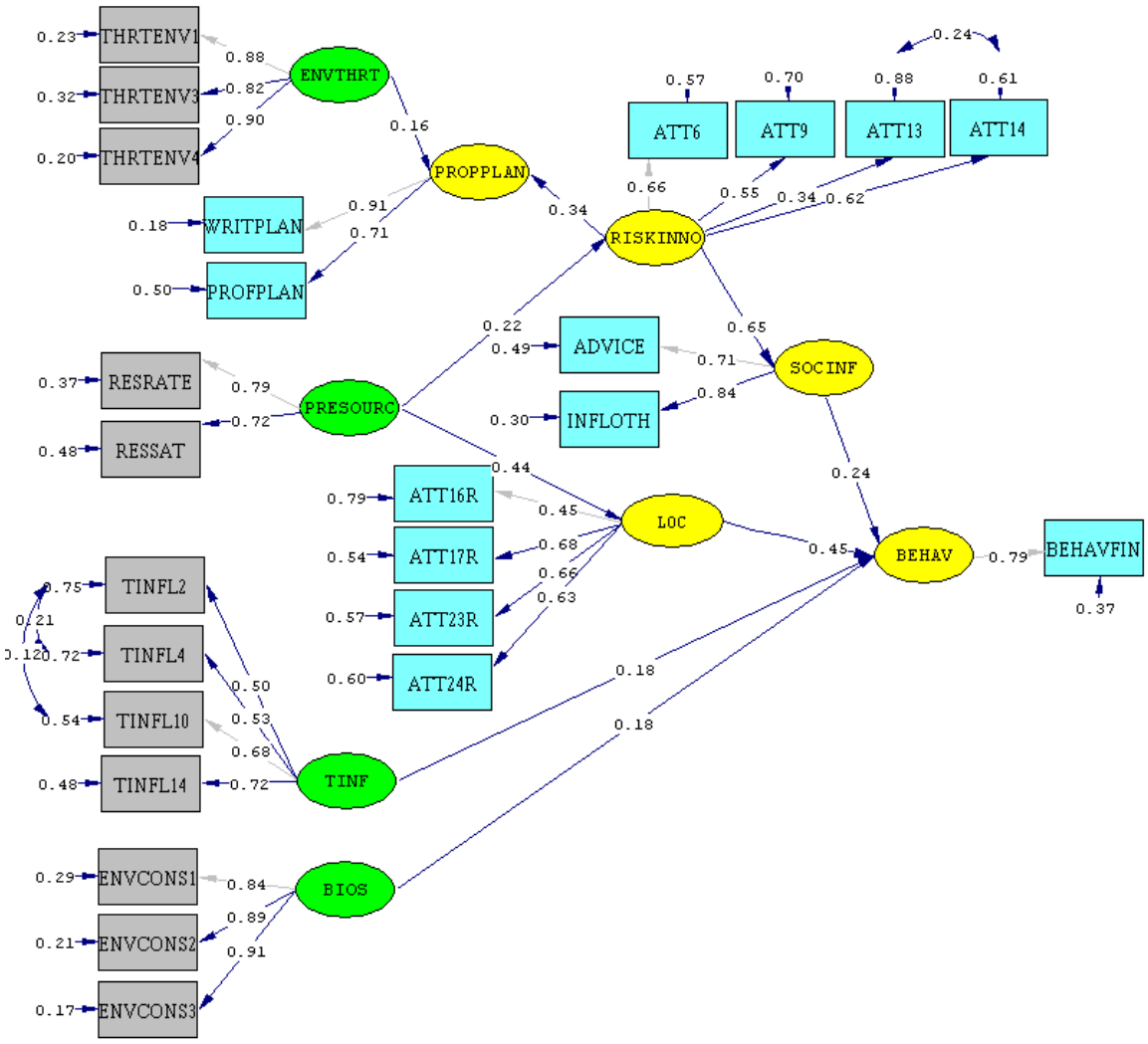


Figure 39. Estimated model predicting land management practice in the Lachlan and Central west study areas [3]

[3] Variable labels in the Estimated Structural Equation Model (Figure 39) are as they appear in Lisrel 8.72, and differ from the descriptive labels in the simplified model (see Figure 6).

Table 21 shows the variable names as they appear in the Estimated Model (Figure 39) and the corresponding model component names.

Table 21. Variable names and descriptive labels for the exploratory Structural Equation Model (Figure 39)

Estimated Structural Equation Variable Name	Model Component Name
ENVTHRT	Perceived level of environmental threat faced by the region
PRESOURC	Perceived resources - the level of satisfaction with the resources (time, money & knowledge) that people feel they have available to undertake land management activities.
TINF	Trust and influence – trust in and influence of a range of agricultural information providers
BIOS	Biospheric environmental values – concern for environment as it effects native plants and animals
PROPPLAN	Property planning
RISKINNO	Risk and innovation - the extent to which people are willing to try innovative methods/ technologies and take risks on their farms
LOC	Locus of control—sense of being in control over decisions
SOCINF	Social influence and connectedness - the extent to which people have social influence in their agricultural community
BEHAV	Land management practice

APPENDIX 7

Hierarchical multiple regression

Hierarchical multiple regression was conducted in order to assess the relative impact of the key predictive variables on components of land management practices whilst controlling for demographics and farm characteristics (see Figure 40). This analysis was conducted in order to answer the following research question:

> *If the potential effects of age, gender, education, resources, off-farm income, farm size and region are controlled for, do the key variables (Locus of control; risk and innovation; Biospheric concerns; environmental threat; farm planning; and trust and influence in agronomy sources) still predict a significant amount of the variance in the individual components of management scores* (*Soil, Stock, Perennials, Native vegetation and Integrated weed management)?*

It should be noted that Hierarchical multiple regression does not assess inter-relationships between predictive variables, and as such does not consider mediated or indirect relationships like those found in the Structural equation model. The Hierarchical multiple regressions that were conducted only account for the direct contributions of each predictive variable to land management practices.

The variables that were able to significantly predict:

- **soil** management after controlling for demographics and farm characteristics included trust & influence in agronomy sources, gender, education, farm planning and region.
- **stock** management after controlling for demographics and farm characteristics included locus of control and education.
- **perennials** management after controlling for demographics and farm characteristics included region and locus of control.
- **native vegetation** management after controlling for demographics and farm characteristics included region, locus of control and Biospheric values.

The demographics and farm characteristics and psycho-social variables were *not* able to predict a significant amount of the variance in **integrated weed** management scores.

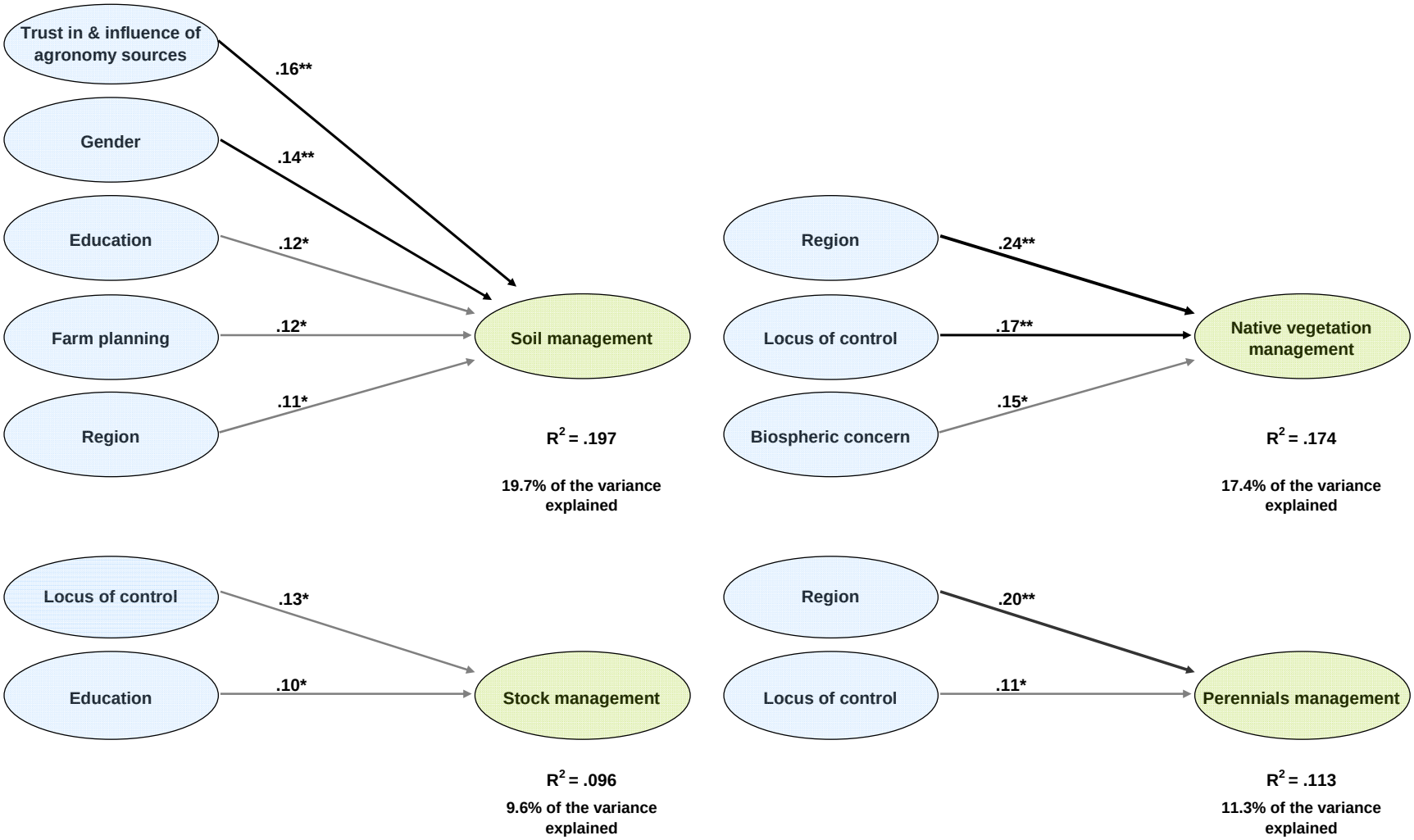


Figure 40. Hierarchical multiple regressions: Predicting management of soil, native vegetation, stock and perennials when controlling for demographics and farm characteristics

APPENDIX 8

Source of agricultural information

Table 22. Summary statistics of trust in sources of agricultural information

	No trust at all	2	Some trust	4	Complete trust	Mean	Std. Deviation
agronomists (n = 420)	3.3	7.6	26.2	46.4	16.4	3.65	.954
other farmers (n = 422)	.9	9.0	36.5	40.5	13.0	3.56	.864
field days (n = 420)	1.9	6.9	37.6	44.0	9.5	3.52	.833
dpi (n = 419)	4.5	12.4	31.3	41.8	10.0	3.40	.982
organised course (n = 418)	3.3	10.3	40.9	38.5	6.9	3.35	.881
scientists (n = 417)	3.4	13.4	39.6	34.3	9.4	3.33	.938
Kondinin (n = 291)	9.6	12.4	27.1	40.9	10.0	3.29	1.111
educational inst (n = 416)	4.3	14.2	38.7	33.9	8.9	3.29	.964
Landcare (n = 417)	6.2	15.6	32.4	35.5	10.3	3.28	1.047
CMA (n = 408)	7.6	15.0	42.4	28.7	6.4	3.11	.992
community groups (n = 413)	7.0	16.0	48.4	23.0	5.6	3.04	.945
agribusiness (n = 418)	5.7	20.6	43.3	25.4	5.0	3.03	.944
industry groups (n = 419)	6.2	19.3	47.3	23.4	3.8	2.99	.911
govt dept (n = 419)	13.8	22.7	40.6	19.8	3.1	2.76	1.023

Table 23. Summary statistics of influence of sources of agricultural information

	no Influence	2	Some influence	4	Significant influence	Mean	Std. Deviation
other farmers (n = 421)	6.2	10.9	37.3	35.6	10.0	3.32	1.005
agronomists (n = 420)	13.1	11.0	28.8	33.8	13.3	3.23	1.206
field days (n = 420)	8.3	16.0	36.9	33.8	5.0	3.11	1.010
organised course (n = 419)	15.3	22.2	34.1	24.3	4.1	2.80	1.096
scientists (n = 416)	15.6	21.4	38.9	20.0	4.1	2.75	1.070
dpi (n = 419)	15.3	23.4	35.3	22.7	3.3	2.75	1.071
Landcare (n = 417)	18.5	21.6	36.0	18.9	5.0	2.71	1.123
agribusiness (n = 418)	14.6	28.0	40.2	15.1	2.2	2.62	.980
educational inst (n = 415)	19.5	24.6	35.2	17.6	3.1	2.60	1.083
CMA (n = 410)	21.5	22.0	34.6	19.8	2.2	2.59	1.096
industry groups (n = 418)	16.5	27.8	42.8	11.5	1.4	2.54	.947
community groups (n = 414)	20.3	29.5	35.0	12.8	2.4	2.48	1.029
govt dept (n = 420)	21.9	31.4	33.6	12.6	.5	2.38	.979
Kondinin (n = 315)	35.2	20.6	22.2	19.0	2.9	2.34	1.219

Table 24. Trust in sources of agricultural information across sub-catchments

Trust	Bell	Cudgegong	Humbug	Mandagery
other farmers (n = 422)	3.65	3.41	3.71	3.49
agronomists (n = 420)	3.72	3.64	3.78	3.43
organised course (n = 418)	3.45	3.29	3.32	3.36
field days (n = 420)	3.57	3.46	3.74	3.33
landcare (n = 417)	3.37	3.22	3.27	3.27
scientists (n = 417)	3.47	3.36	3.22	3.21
kondinin (n = 291)	3.19	3.18	3.56	3.18
dpi (n = 419)	3.61	3.34	3.44	3.17
educational inst (n = 416)	3.41	3.28	3.30	3.13
cma (n = 408)	3.15	3.02	3.27	3.04
community groups (n = 413)	3.02	2.92	3.28	3.00
industry groups (n = 419)	3.19	2.90	3.04	2.82
agribusiness (n = 418)	3.29	2.94	3.04	2.81
govt dept (n = 419)	2.92	2.78	2.70	2.56

Table 25. Influence of sources of information across sub-catchments

Influence	Bell	Cudgegong	Humbug	Mandagery
other farmers (n = 421)	3.29	3.33	3.48	3.19
agronomists (n = 420)	3.06	3.25	3.55	3.11
field days (n = 420)	3.04	3.06	3.34	3.03
organised course (n = 419)	2.79	2.80	2.79	2.80
scientists (n = 416)	2.84	2.90	2.73	2.46
dpi (n = 419)	2.71	2.92	2.90	2.42
landcare (n = 417)	2.82	2.75	2.67	2.52
agribusiness (n = 418)	2.75	2.60	2.70	2.40
educational inst (n = 415)	2.70	2.68	2.60	2.36
cma (n = 410)	2.62	2.67	2.51	2.55
industry groups (n = 418)	2.60	2.42	2.65	2.49
community groups (n = 414)	2.43	2.42	2.67	2.41
govt dept (n = 420)	2.41	2.46	2.47	2.14
Kondinin (n = 315)	2.20	2.05	2.77	2.28

APPENDIX 9

Property planning

Table 26. Property planning summary statistics

Region		Do you have a written property plan? (n = 421)		Was your property plan created with the aid of a professional? (n = 114)	
		Yes	**No**	**Yes**	**No**
Bell	**N**	35	81	21	14
	%	*30.2*	*69.8*	*60.0*	*40.0*
Cudgegong	**N**	36	91	13	23
	%	*28.3*	*71.7*	*36.1*	*63.9*
Humbug	**N**	23	68	12	11
	%	*25.3*	*74.7*	*52.2*	*47.8*
Mandagery	**N**	20	68	9	11
	%	*22.7*	*77.3*	*45.0*	*55.0*
Total	**N**	114	308	55	59
	%	*27.0*	*73.0*	*48.2*	*51.8*

Table 27. What motivated you to create a property plan?

	n	%'age of respondents
Course	31	27.9%
Know where headed/define goals	13	11.7%
Understand property more/easy management	9	8.1%
Necessary for any business	8	7.2%
Advice from CMA/Application CMA	8	7.2%
Landcare funding	5	4.5%
Efficiency	5	4.5%
Need accreditation to prove food to retailers	4	3.6%
Good tool to have	4	3.6%
Gain finance	4	3.6%
CMA awareness	3	2.7%
Funding	3	2.7%
Discussion with others	3	2.7%
Improve place going forward	3	2.7%
Bank	3	2.7%
Always done a plan	2	1.8%
Multiple people manage property	2	1.8%
Property planning workshop	2	1.8%
Excluding stock from environmental areas	2	1.8%
Drought	1	0.9%
Weeds	1	0.9%
Erosion	1	0.9%
Tafe	1	0.9%
Private native forestry	1	0.9%
Simplify things	1	0.9%
Advice from landcare	1	0.9%
Living document - shows why I do what I do	1	0.9%
Son had done an agricultural course	1	0.9%
Part of organic certification	1	0.9%
State water requirement	1	0.9%
Family	1	0.9%
Planning is what I do at DPI	1	0.9%
See if possible for ordinary farmer to do it	1	0.9%
Agronomist training	1	0.9%
Need to know what's added to paddocks	1	0.9%
Wife horticulturalist	1	0.9%
(30 years ago) Soil conservation org	1	0.9%
Husband is ag scientist	1	0.9%
ATO tax concession	1	0.9%
Own interest	1	0.9%
Total	**21**	**18.9%**

Table 28. What do you do in lieu of a written property plan?

	n	%'age of respondents
Common sense / own brain / own knowledge	146	47.4%
Experience	52	16.9%
Discuss with others	29	9.4%
Family discussions	27	8.8%
Weather conditions	26	8.4%
Tackle issues as they arise	25	8.1%
Everyday is different	18	5.8%
Annual calendar / seasonal calendar	15	4.9%
Written diary records	14	4.5%
Same as has been done in the past	13	4.2%
Own budgets / financial records	10	3.2%
Unwritten goals/ plan	9	2.9%
Mapping (computer assisted)	6	1.9%
No time for a written property plan / no need	6	1.9%
Note good intentions/memo	6	1.9%
Year to year	5	1.6%
Crop rotation history	4	1.3%
Too small	4	1.3%
Nothing written down	4	1.3%
Plan for the future	3	1.0%
I did have one	3	1.0%
Drought ruined plan	2	.6%
Instinct	2	.6%
Maps of paddock lay out (and overlays)	2	.6%
Check the land	2	.6%
Goal/Mission statement/Aims	2	.6%
Basic values	2	.6%
Paddock plan	2	.6%
Knowledge from other farmers	1	.3%
Refer to journals	1	.3%
Guess work	1	.3%
Landuse to suit the market	1	.3%
Photographs	1	.3%
Luck	1	.3%
Everyone knows what's planned	1	.3%
Stocking rates in decline	1	.3%
Need to update old one	1	.3%
Husband just does it	1	.3%
Annual budget and weekly updates	1	.3%
Reminders on whiteboard	1	.3%
Hard work	1	.3%
Manager	1	.3%
Committees decide which way we go	1	.3%
Plan for the year	1	.3%
Note what paddock fertilised/when	1	.3%
Marking time	1	.3%
Cropping plan (3yr)	1	.3%
Monthly program	1	.3%
Prioritise projects	1	.3%
Can't plan - CMA programs are so short term	1	.3%
5 year plan	1	.3%
Total	**462**	**148.80%**

APPENDIX 10

Interactions with the CMA

Table 29. Activities for which CMA funding has been sought

	n	%'age of respondents
Fencing	33	32.7%
Tree planting	12	11.9%
Erosion control	11	10.9%
Direct drill machine/modifying machinery to direct drill	11	10.9%
Fencing waterways	8	7.9%
Drought lot feeding	8	7.9%
Perennial Native Pastures	7	6.9%
Revegetation	7	6.9%
Water Quality	6	5.9%
River health/ Waterways	6	5.9%
Dryland Salinity	5	5.0%
Troughs	5	5.0%
Pasture improvement	5	5.0%
Paddock sub-division	5	5.0%
Native Vegetation	3	3.0%
Stabilisation of gullies	3	3.0%
Grazing Control/Management	3	3.0%
Property planning	3	3.0%
Courses/Training	3	3.0%
Salinity degradation problems	3	3.0%
Drought preparedness	2	2.0%
Native birds and reptiles/Nature corridors	2	2.0%
Sustainable Land Management	2	2.0%
Irrigation improvement	2	2.0%
Bulldozing work/Earth works	2	2.0%
Reduce paddock size	2	2.0%
GPS	2	2.0%
Soil test	2	2.0%
Wire	2	2.0%
Water	2	2.0%
Compost tea workshop	1	1.0%
Stabilisation of hillside	1	1.0%
Water catchment	1	1.0%
Put press wheels on seeder	1	1.0%
Interest subsidy	1	1.0%
Shelter belts	1	1.0%
Soil health	1	1.0%
Modifying machinery	1	1.0%
Rock flume	1	1.0%
In the past	1	1.0%
Pasture cropping	1	1.0%
Biodiversity	1	1.0%
Put in pipelines	1	1.0%
Total	**180**	**178.8%**

Table 30. Changes initiated as a result of CMA funding

	n	%'age of respondents
It didn't	22	21.8%
Didn't get funding	19	18.8%
Fenced areas	17	16.8%
Grazing techniques	7	6.9%
Improved water quality	6	5.9%
Doing it sooner	6	5.9%
Better management	6	5.9%
Made easier/improved what we're already doing	5	5.0%
Could grow trees/pastures	4	4.0%
Better pastures	4	4.0%
Conserving water	4	4.0%
Keeps cattle out of creek	4	4.0%
Big difference	4	4.0%
Stock management practices	3	3.0%
New processes	3	3.0%
Planted trees	3	3.0%
Finance problem	3	3.0%
Put in feed lots	3	3.0%
Helps erosion problem	3	3.0%
Ground cover	3	3.0%
Broaden sowing rows/change sowing	3	3.0%
Improved resilience	2	2.0%
Maintain natives	2	2.0%
Aware of soil health	2	2.0%
Mustering easier	2	2.0%
Paddocks divided	2	2.0%
Kept us here a bit longer	2	2.0%
Machinery conversion	2	2.0%
Direct drilling	2	2.0%
Allowed area to recover/revegetation	2	2.0%
Less erosion	2	2.0%
Native vegetation	2	2.0%
Stocking rates - drought management	1	1.0%
Adding microbial inoculants to seeded soil	1	1.0%
Increased facilities	1	1.0%
Added three dams	1	1.0%
Trough water	1	1.0%
Monitored saline areas	1	1.0%
Keep a log for CMA	1	1.0%
Property management plan	1	1.0%
Cropping methods	1	1.0%
Environmentally aware	1	1.0%
Some approved	1	1.0%
Had to give money back to CMA	1	1.0%
Total	**166**	**165.0%**

Table 31. What would you like to see the CMA do to help with farming practices

	n	%'age of respondents
Nothing	63	15.6%
More funding	34	8.4%
Advise on what is available/ provide more information	28	6.9%
What they are doing/well covered	24	5.9%
Erosion	20	5.0%
Unsure of services provided	19	4.7%
More education/courses	18	4.4%
Conservation of waterways	18	4.4%
Funding for fencing sensitive areas	17	4.2%
Can't help me	15	3.7%
Help with weed control	15	3.7%
Funds easier to access, info on how to apply and help with paperwork	14	3.5%
Come out and say G'Day/Personal visits/more accessible	13	3.2%
Include everyone (all farmers, whole state)	13	3.2%
Revegetation	11	2.7%
Make recommendations on my property/free professional advice	10	2.5%
Access to reasonably priced plants	9	2.2%
Don't want them looking over my shoulder	9	2.2%
Water control/sharing	9	2.2%
Pass on knowledge	8	2.0%
Field days	7	1.7%
Incentives/increase incentives	6	1.5%
Give grants - not loans	6	1.5%
Stop spending on wrong things	6	1.5%
Soil conservation and improvement	6	1.5%
Help with no/min till farming	6	1.5%
Implement conservation techniques	6	1.5%
Plant more trees	5	1.2%
Less red tape/strings attached	5	1.2%
Pasture plan/improvement	5	1.2%
Thing outside the square/be flexible	5	1.2%
Dams	5	1.2%
Assistance with Perennials	5	1.2%
Funding to fence off waterways	4	1.0%
Subsidise tillage equipment more	4	1.0%
More courses locally	4	1.0%
Machinery conversion/Machinery	4	1.0%
Everyone has limited funds	3	0.7%
Help me, instead of everyone else but me	3	0.7%
Assist sub division	3	0.7%
Help with salinity	3	0.7%
More native pastures	3	0.7%
Look at a variety of farms	2	0.5%
Funding for collective projects	2	0.5%
Soil test costs	2	0.5%
Drought management	2	0.5%
Audit Bell river	2	0.5%
Assist with wildlife corridors	2	0.5%
Moisture control	2	0.5%
Make it rain	2	0.5%
Irrigation	2	0.5%
Don't help hobby farmers	2	0.5%
Stock water infrastructure	2	0.5%
More on ground staff (less office staff)	2	0.5%
Govt not CMA decides who gets funding	2	0.5%

Info on better use of water	2	0.5%
Real situations/demonstrations/experiments	2	0.5%
Artificial fertilisers	2	0.5%
Don't help hobby farmers	2	0.5%
Hire out equipment	2	0.5%
Supply watering points	1	0.2%
Total environment help	1	0.2%
Subsidise chemicals for weeds	1	0.2%
I don't agree with that	1	0.2%
More info on vertical fodder	1	0.2%
Higher % of funding if all paperwork correct	1	0.2%
Biological farming methods	1	0.2%
Never implement a levy	1	0.2%
Training	1	0.2%
Communicate benefits	1	0.2%
Be more helpful generally	1	0.2%
They ignore you	1	0.2%
Cheap interest	1	0.2%
Follow up queries	1	0.2%
Abolish the CMA	1	0.2%
Funding for forums to bring people together	1	0.2%
Help us make lake from creek	1	0.2%
Keep in touch	1	0.2%
Keep you up to date with soil quality	1	0.2%
Allow us to build another dam	1	0.2%
More research to develop farming	1	0.2%
Less interference from government departments	1	0.2%
Get their facts right	1	0.2%
Info on Carbon trading	1	0.2%
Free courses at farm days	1	0.2%
Provide photographic maps	1	0.2%
Listen	1	0.2%
Do something about controlling when you can spray	1	0.2%
Deal with climate change impacts	1	0.2%
Easier application process based on proven past record	1	0.2%
Show older farmers new techniques	1	0.2%
More direction for part time/hobby farmers	1	0.2%
Stop people sinking bores	1	0.2%
Stop grape growing	1	0.2%
Stop gold mine	1	0.2%
Artificial fertilisers	1	0.2%
Reduce chemical use	1	0.2%
Info on briar spraying	1	0.2%
Remove/leave carbon Emissions	1	0.2%
Grazing management	1	0.2%
Maintaining ground cover	1	0.2%
Produce regular newsletter	1	0.2%
More proactive	1	0.2%
Feed lotting	1	0.2%
More practice with land clearing	1	0.2%
Need holistic view of what people want, not on money basis	1	0.2%
Plant salt bush	1	0.2%
Fix my bridge	1	0.2%
Preparing paddocks	1	0.2%
Change definition of old growth forest	1	0.2%
Check results from funding	1	0.2%
Field days on weekends (other job means can't attend week days)	1	0.2%
Price of fertilisers	1	0.2%

Price of diesel	1	0.2%
Understand what their chemicals actually kill	1	0.2%
Dams	1	0.2%
Reduce chemical use	1	0.2%
Info on briar spraying	1	0.2%
Irrigation	1	0.2%
Remove/leave carbon Emissions	1	0.2%
Monitor local issues	1	0.2%
Allow practices to be trialled in other areas	1	0.2%
Tidying up rocky areas	1	0.2%
Storage	1	0.2%
Sub division	1	0.2%
Educational evenings (I don't have time for courses)	1	0.2%
Total	**573**	**138.2%**

Table 32. Summary statistics of perceived support from CMA for farmers

	No support	2	Some support	4	A great deal of support	Mean	Std. dev
Bell (n = 114)	8.8	23.7	44.7	18.4	4.4	2.86	.967
Cudgegong (n = 119)	8.4	17.6	41.2	21.0	11.8	3.10	1.092
Humbug (n = 88)	10.2	15.9	50.0	19.3	4.5	2.92	.973
Mandagery (n = 81)	9.9	17.3	45.7	22.2	4.9	2.95	.999
Total (n = 402)	9.2	18.9	45.0	20.1	6.7	2.96	1.014

APPENDIX 11

CMA program evaluation results

Table 33 provides an overview of the different workshop groups and where the participants were drawn from.

Table 33. Summary of CMA workshop groups

Group	Workshop Location	No. of Participants
Footprints project group (CWCMA)	Goolma	11
Little River Landcare (CWCMA)	Wambangalang (between Dubbo &Yeoval)	5
Watershed (CWCMA)	Mudgee	10
Humbug (LCMA)	West Wyalong	7
Gumble Creek, LSAP program (LCMA)	Cudal	4
Walli Area, LSAP program (LCMA)	Cowra	5
Lachlan CMA Staff	Cowra	7
Central West CMA Staff	Wellington	9
Lachlan Research Forum (CMA staff & scientists)	Forbes	11
Total		**69**

Below, groups from the Lachlan CMA are combined, as are groups from the Central West CMA. Results from the two CMAs are reported separately.

Lachlan

Participants were asked about how useful they found the CMA for their farm management. Results are presented in Table 34.

Table 34. How useful do you find the CMA for your farm management?

	n=12
1 – not at all useful	0
2 –	0
3 – somewhat useful	4
4 –	6
5 – extremely useful	2
Mean rating	*3.83*

Participants were asked whether they thought that the CMA had provided them with new information. Results are presented in Figure 41.

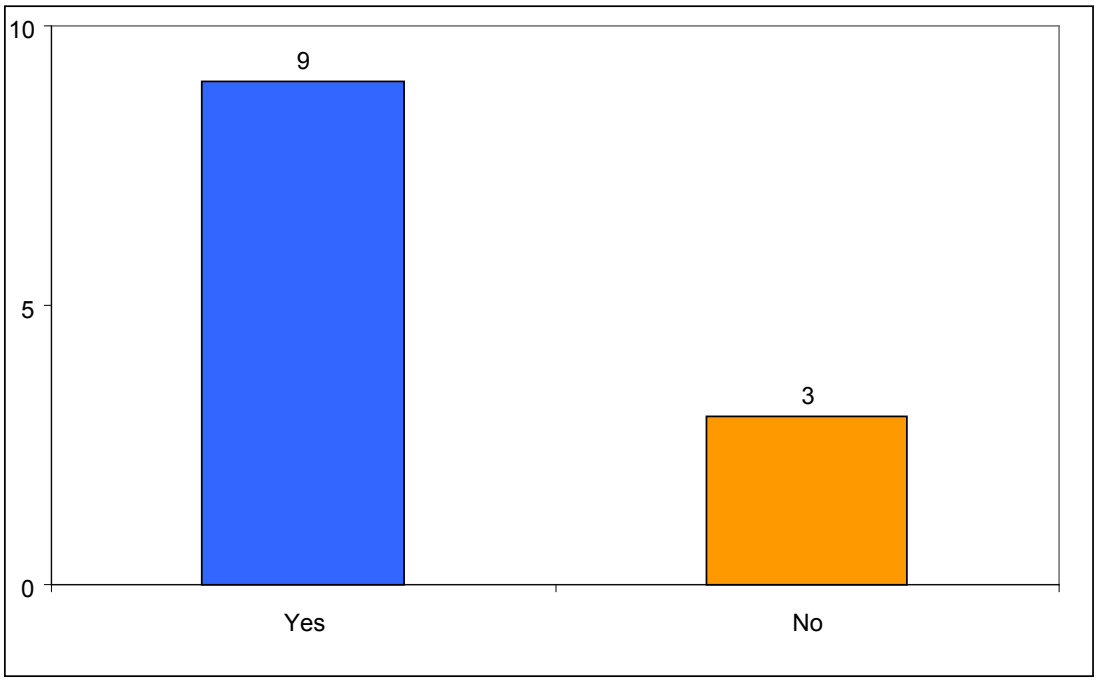


Figure 41. Has the Lachlan CMA provided you with any information that was new to you?

Those who answered *yes* were asked to define what new information the CMA had provided them. Responses are presented in Table 35.

Table 35. What new information has the Lachlan CMA provided you?

New information	Responses
Salinity and Soil	5
General ideas	1
CMA still adamant about finding solutions and local suggestions	1
No till farming methods	1
Drought lotting	1

Participants were asked whether they had passed on any information from the CMA to other farmers. Results are presented in Figure 42.

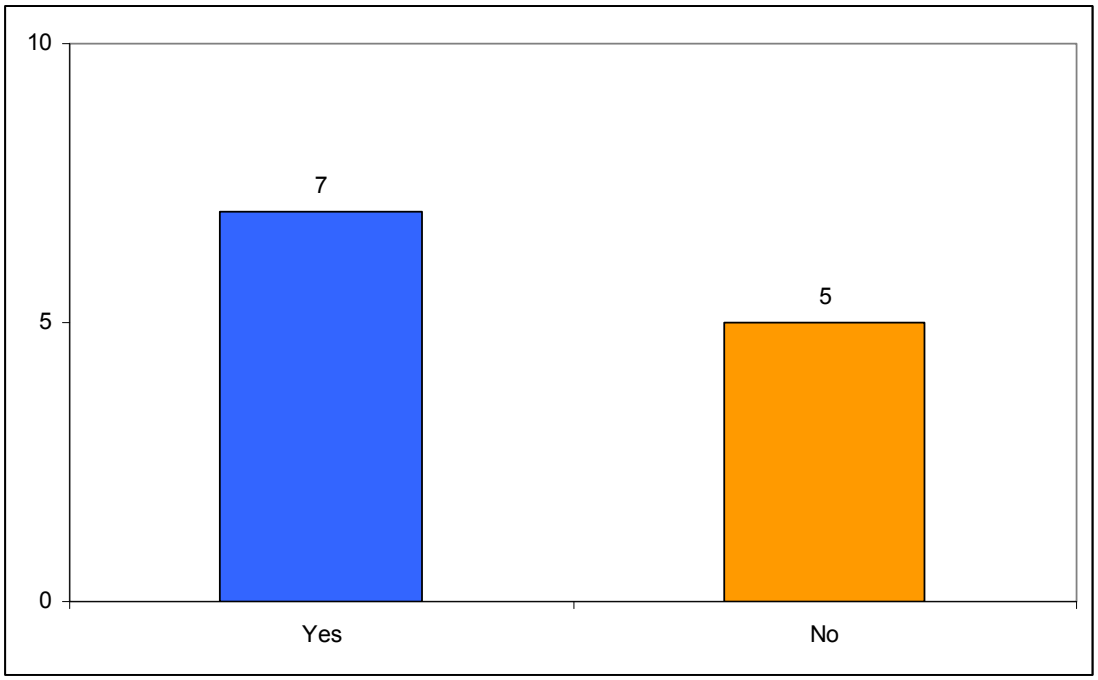


Figure 42. Have you passed on any information from the Lachlan CMA to other farmers?

Those who answered *yes* were asked to define what information they had passed on and to whom? Results are presented in Table 36.

Table 36. What information from the Lachlan CMA and to who have you passed it on?

What information?	To whom?	Reponses
Different chemical uses	Partner	1
Info from field days	Neighbours	1
General ideas	Other farmers	1
Stubble retention	Other farmers	1
Salinity	Other farmers	1
Funding schemes	Community member	1
Tree planting	Community member	1
Fencing	Community member	1

Participants were asked whether any ideas from the Lachlan CMA had influenced the way they were farming. Results are presented in Figure 43.

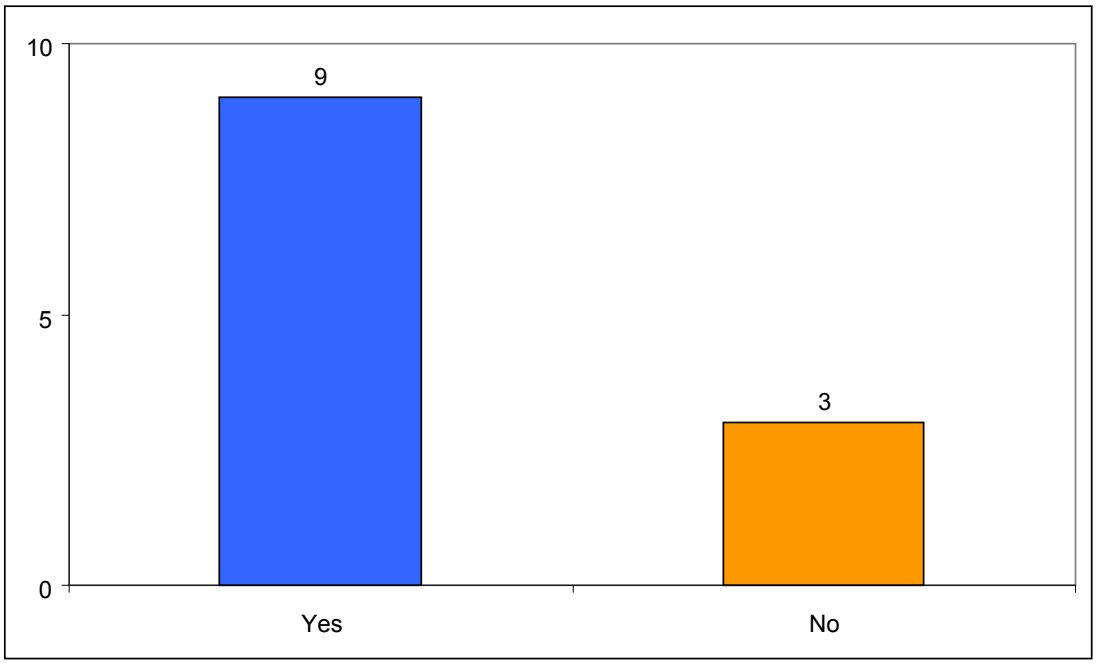


Figure 43. Are there any ideas from the Lachlan CMA that are influencing the way you farm?

Those who answered *yes* were asked what these ideas were. Results are presented in Table 37.

Table 37. What ideas from the CMA influence what you do?

Ideas	Responses
No till farming	2
Direct drilling	2
Fencing areas	2
Not enough contact with CMA to say	1
Chemcial groups for controlling weeds	1
Drought lots	1
Pasture options for sheep	1
Talking to other farmers	1
Cropping systems	1
Machinery conversion	1
Stubble retention	1
Funding available	1
Water Location	1
Tree planting	1

These respondents were also asked how those ideas were influencing what they did. Results are presented in Table 38.

Table 38. How do the ideas from the CMA influence what you do?

How	Responses
Motivated to try	4
Look at following year to do same job in different way	1
Ground cover retention	1
Increased income	1
Expanding knowledge base	1
Didn't know about funding	1

Participants were asked whether they had any concerns with the CMA. Results are presented in Figure 44.

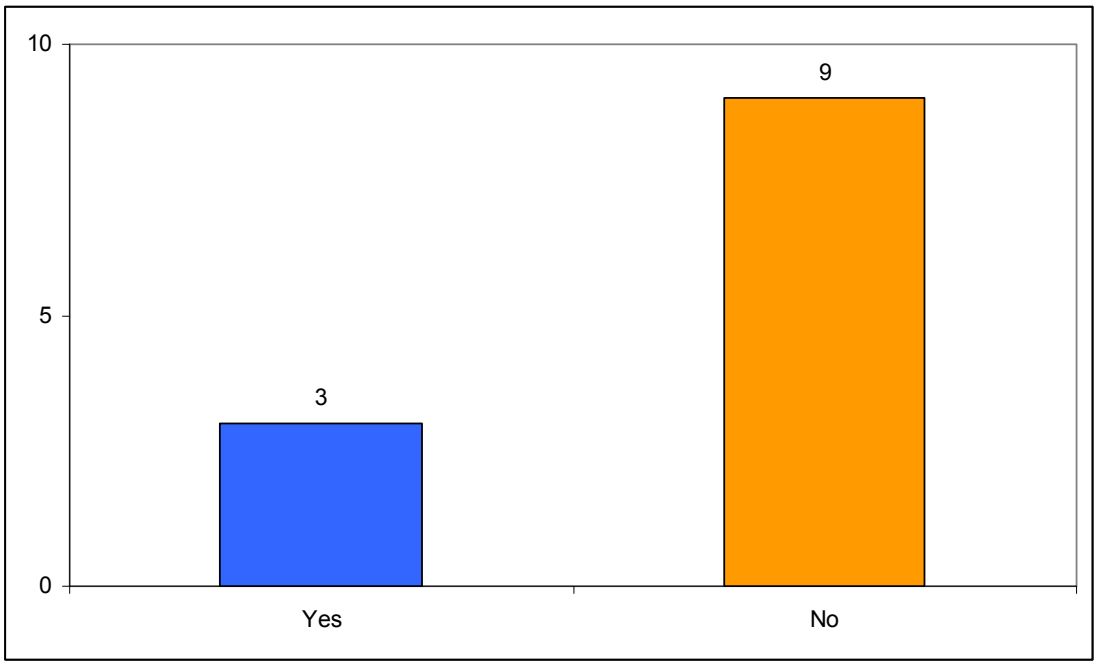


Figure 44. Do you have any concerns with the Lachlan CMA?

Those who had concerns with the CMA were asked what these concerns were. Results are presented in Table 39.

Table 39. What are your concerns with the Lachlan CMA?

Concern	Responses
CMA too focused on revegetation	1
Not enough practical land management	1
Lack of funding	1
Machine conversion	1
Government control	1

Participants were asked whether they thought that there were any social benefits associated with the activities that the CMA was involved in. Results are presented in Figure 45.

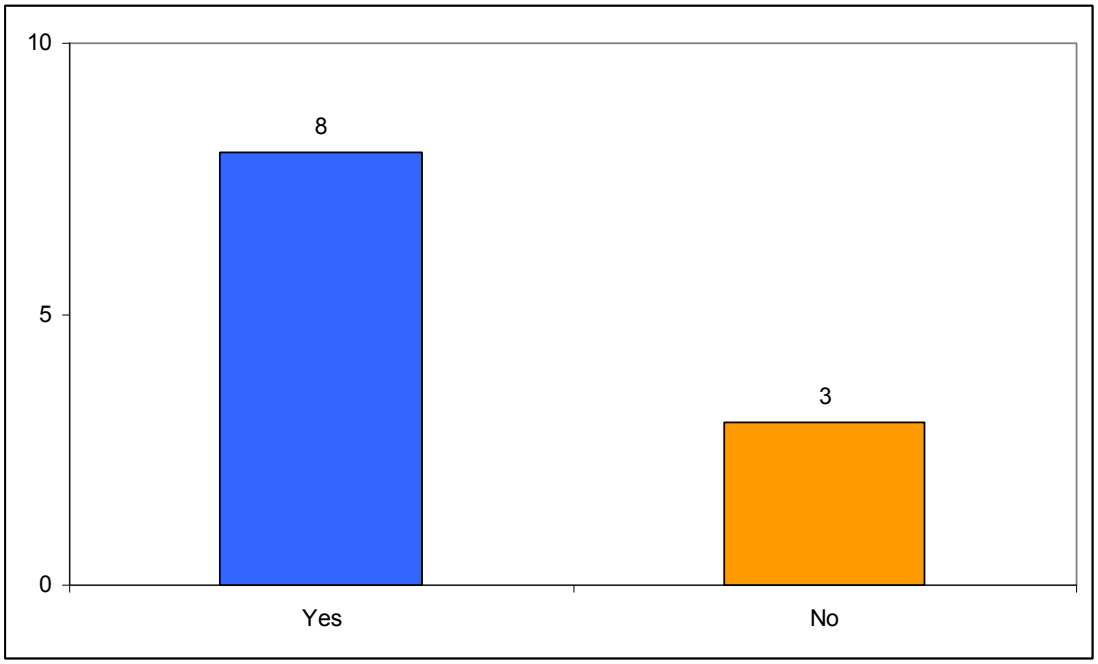


Figure 45. Do you think that there are any social benefits associated with Lachlan CMA-related activities?

Those participants who answered *yes* were asked which activities had social benefits and what those benefits were. Results are presented in Table 40.

Table 40. Which Lachlan CMA-related activities had social benefits and what were these benefits?

Activity	Benefit	Responses
Coming together of like-minded farmers	Talking	1
Property planning	Met a lot of new people from district	1
Days like today	Expands knowledge and ideas	1
Bus tours	Discuss programs	1
	Talking	1
Field days	Discuss programs	1
	Talking	1
	Networking	1
Property inspection	Talking	1
	Get them off the farm for a day	1

Central West

Participants were asked about how useful they found the CMA for their farm management. Results are presented in Table 41.

Table 41. How useful do you find the Central West CMA for your farm management?

	n=23
1 – not at all useful	1
2 –	1
3 – somewhat useful	7
4 –	11
5 – extremely useful	3
Mean rating	*3.61*

Participants were asked whether they thought that the CMA had provided them with new information. Results are presented in Figure 46.

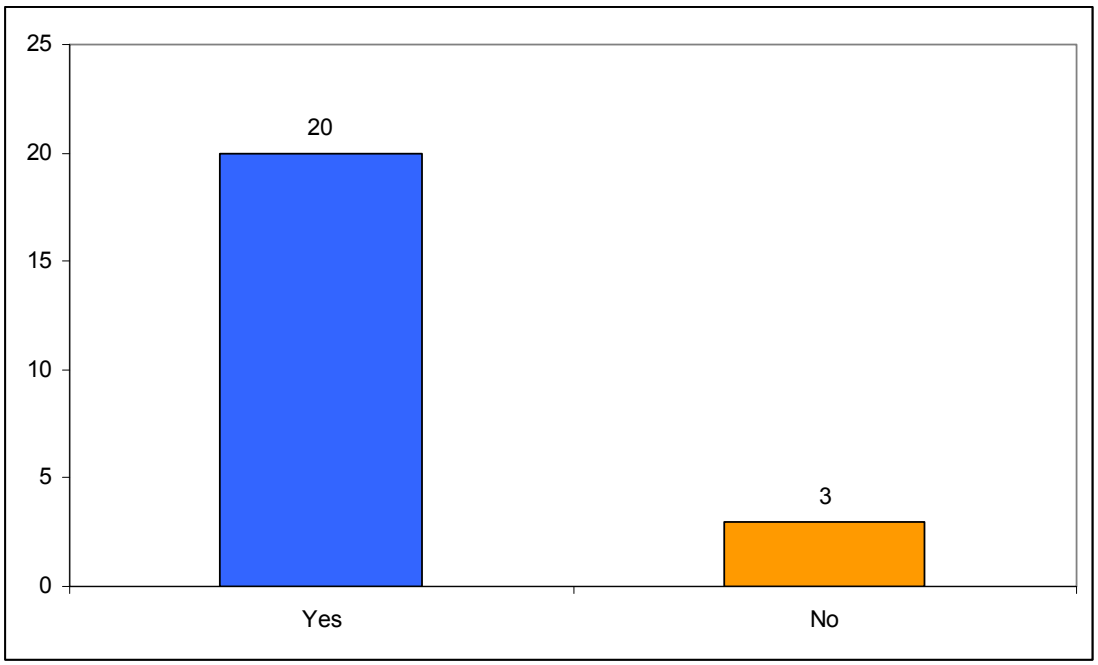


Figure 46. Has the Central West CMA provided you with any information that was new to you?

Those who answered *yes* were asked to define what new information the CMA had provided them. Responses are presented in Table 47.

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Table 42. What new information has the Central West CMA provided you?

New information	Responses
Salinity and soil knowledge	7
Funding options	3
Mapping Soil	2
Grass	2
CMA still adamant about finding solutions and local suggestions	2
General Ideas	1
NRM options	1
Native fish research	1
Occasional expertise	1
They are helping control feral pigs	1
Access to government departments	1
Joint ventures	1
Willow removal	1
Water quality	1
Knowledge of surrounding areas	1
Bear ground areas	1
No till farming methods	1
Drought lotting	1
Farm Planning	1
Mapping ph	1
Planting - to soil	1
Water movements	1
Overall practices	1

Participants were asked whether they had passed on any information from the CMA to other farmers. Results are presented in Figure 47.

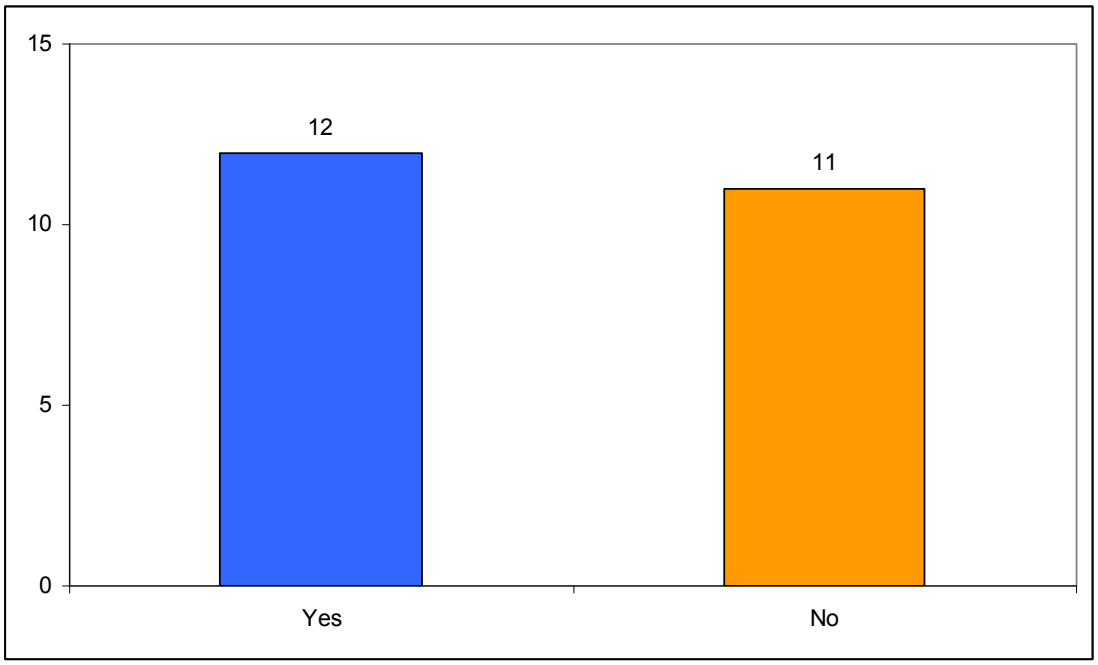

Figure 47. Have you passed on any information from the Central West CMA to other farmers?

Those who answered *yes* were asked to define what information they had passed on and to whom? Results are presented in Table 43.

Table 43. What information from the program and to who have you passed it on?

What information?	To whom?	Reponses
Funding schemes	Other farmers	3
	Central West CMA	1
	Friends	1
Information from meetings	Neighbours	1
	Friends	1
Information from field days	Neighbours	1
	Friends	1
Weed management	Neighbours	1
	Other farmers	1
	Community member	1
	Community member	1
	Community member	1
Feral animal control	Neighbours	1
	Other farmers	1
Hire of equipment	Other farmers	1
	Friends	1
Landcare activities	Community member	1
	Community member	1
	Community member	1
Whole spectrum	Partner	1
Salinity and soil knowledge	Want possible project in area	1
	Community member	1
	Community member	1

Participants were asked whether any ideas from the CMA had influenced the way they were farming. Results are presented in Figure 48.

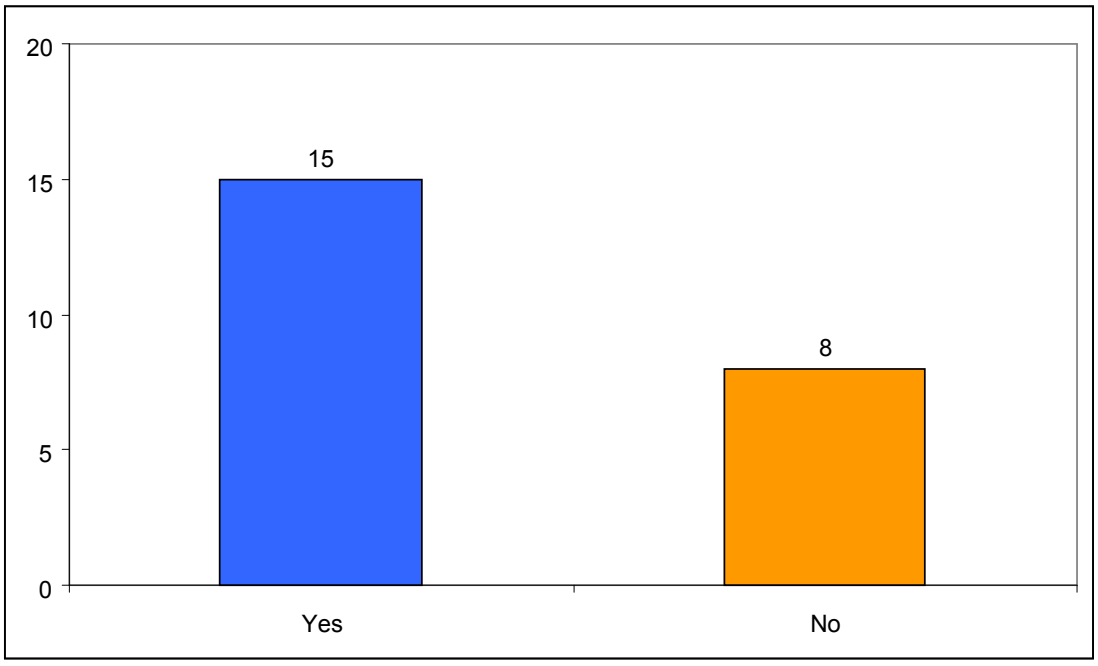

Figure 48. Are there any ideas from the Central West CMA that are influencing the way you farm?

Those who answered *yes* were asked what these ideas were. Results are presented in Table 44.

Table 44. What ideas from the Central West CMA influence what you do?

Ideas	Responses
Pasture management	3
Erosion	2
Grazing - keeping off rocky areas	2
Dividing paddocks	2
Land management	2
Fencing areas	2
Direct Drilling	2
Pasture options for sheep	2
NRM management	1
Advice about the inability of a dam	1
Salt tolerant species	1
Alternative water supplies	1
Tree planting	1
Cell grazing	1
Growing grass that binds soil and prevents erosion	1
Geographical differences	1
No till farming	1
Talking to other farmers	1

These respondents were also asked how those ideas were influencing what they did. Results are presented in Table 45.

Table 45. How do the ideas from the Central West CMA influence what you do?

How	Responses
Provides management options	2
Fencing differently	2
Decided not to spend money fixing dam	1
Have alternative water supplies	1
Raises awareness	1
Sustainability	1
Depends of funding	1
Dividing paddocks	1
Cell grazing	1
Seeded areas	1
Share drill amongst farmers - allows drilling	1
Lower grazing on the flat	1
Ground cover retention	1
Increased income	1
Expanding knowledge base	1
Modifying to direct drilling	1
Rotational grazing	1
Positive way	1

Participants were asked whether they had any concerns with the CMA. Results are presented in Figure 49.

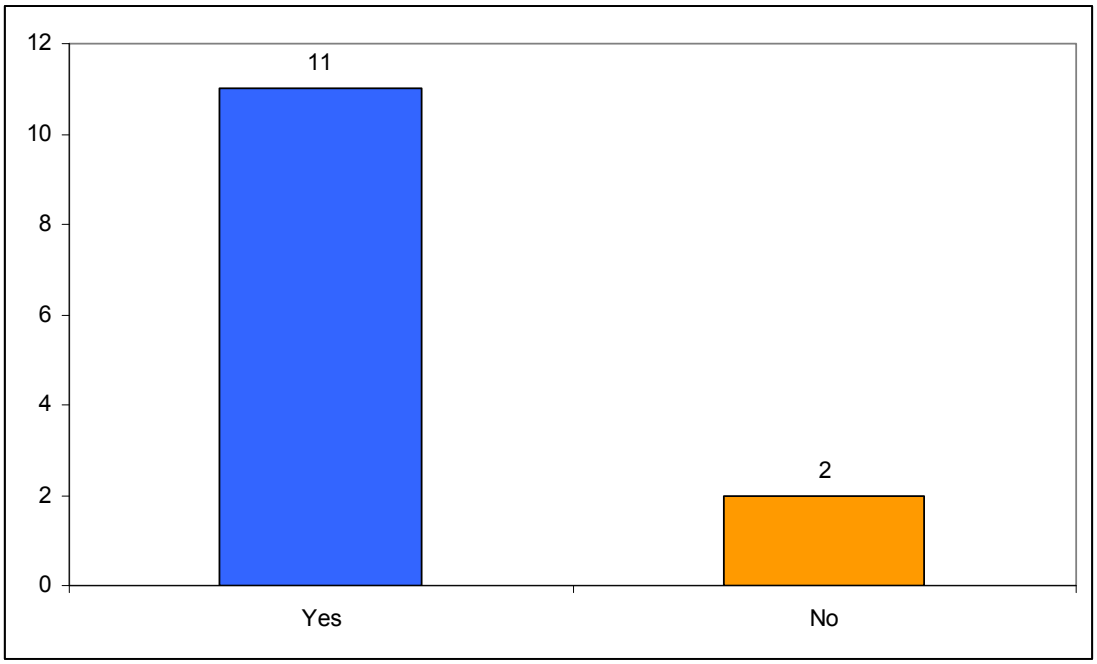

Figure 49. Do you have any concerns with the CMA?[4]

Those who had concerns with the CMA were asked what these concerns were. Results are presented in Table 46.

Table 46. What are your concerns with the Central West CMA?

Concern	Responses
Lack of funding	4
Timeframe - too short	4
No huge dramas/Not really	3
Top heavy with staff	2
Personnel changes	2
Weather - bad season	2
Money situation	2
Funding cut if not enough time	2
Funds taken away from Landcare	1
Meetings focused on funding rather than information	1
Lack of experienced and expertise	1
Messages ignored by government	1
Should be an information and inspiration source	1
Not following projects to the end	1
World issue - wool price	1
Not really involved in detail	1
Limited knowledge of it	1
Give more references to support findings	1
Mixed messages regarding time	1
Hard to gather	1
6 months water system and fencing	1
Government control	1
Messages ignored by government	1
Too much red tape	1

[4] Only Watershed and Little River

Participants were asked whether they thought that there were any social benefits associated with the activities that the CMA was involved in. Results are presented in Figure 50.

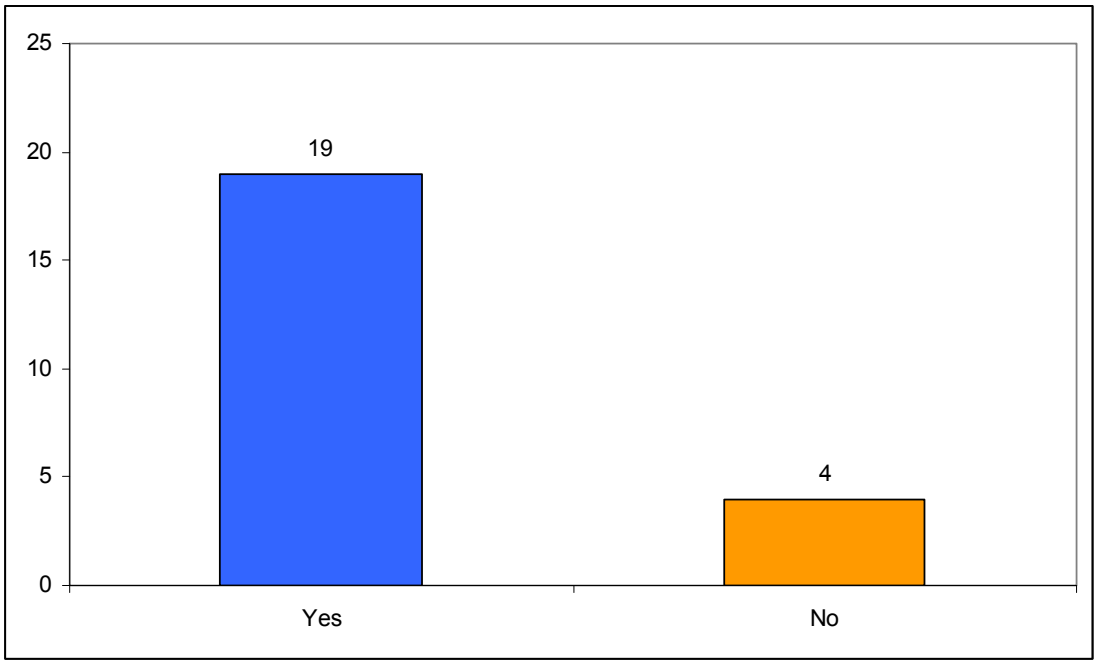

Figure 50. Do you think that there are any social benefits associated with Central West CMA related activities?

Those participants who answered *yes* were asked which activities had social benefits and what those benefits were. Results are presented in Table 52.

Table 47. Which Central West CMA related activities had social benefits and what were these benefits?

Activity	Benefit	Responses
Footprints	Met a lot of new people from district	3
	Local farmers get to talk about issues together	3
	Get to see neighbours/meet neighbours	2
	Social aspect is the greatest benefit	1
	Get to discuss programs	1
	Copy tactics of others	1
	People are 'in it' together	1
	Emotional support	1
	May have community equipment - opportunity to share costs and resources	1
Property inspections	Local farmers talk about issues together	2
	Meet a lot of new people from district	2
	Expands knowledge and ideas	2
	See and meet neighbours	1
Coming together of like minded farmers	Local farmers talk about issues together	1
	Expands knowledge/ideas	1
	Meet absentee landowners	1
Farming systems	Many	1
Meetings	See and meet neighbours	1
	Local farmers talk about issues together	1
	Expands knowledge/ideas	1
Field days	See and meet neighbours	1
	Local farmers talk about issues together	1
	Expands knowledge/ideas	1
	Get off the farm for a day	1
Trial plots	Meet a lot of new people from district	1
	See and meet neighbours	1
	Local farmers talk about issues together	1
Grazing management tour	Meet a lot of new people from district	1
	See and meet neighbours	1
	Local farmers talk about issues together	1
Bus tours	Met a lot of new people from district	1
	Expands knowledge/ideas	1
Workshops	Met a lot of new people from district	1
	Expands knowledge/ideas	1

APPENDIX 12

The PUTTI program

Table 48 Why/why not are projects like the PUTTI project worthwhile? Yes respondents

	n
The more info the better	58
More aware of what's available/happening	48
Makes you question what you are doing	30
Creates an idea on how people do things	29
Help government understand what is needed on farms/policies	27
If it effects change	21
Feedback from farmers	16
Give CSIRO an idea of what's going on	15
Some people need help	13
Research is good/useful - for students/farmers	12
Haven't seen results/outcomes/haven't heard much	10
Learn why/how we make mistakes	9
Help farmers manage environment	8
Communication beneficial	7
See effects	7
As long as results are used in a reasonable way/depends on write up/results	7
Hope for good outcome	6
As long as cross section of farmers used	6
Don't know about PUTTI project	5
Look after LMP	5
Focus interest on whole thing	5
Increase information	5
Farmers sharing info	5
Care of environment	4
Might encourage /help people	4
See what people need	4
If results read by right people	4
Money coming from CMA for projects	4
Discussion groups - share info etc	3
Help families/communities	3
Farmers can't afford to do the research themselves	3
Put new courses on/programs implemented to suit needs	3
Compiles lots of information/ID trends	3
Depends on funding implications	3
Assist organisational targets incentives for CMA	2
CMA doing good work - looking after environmental /farm health	2
Can't do any harm/helps a bit	2
Need information	2
Rest of country to see where we're at	2
Time consuming	2
Want practical ideas	2
Improve image of farmers	2
Improve farm profitability	2
Interesting	2
For big farms	2
Big problems are coming	2
Improving is important	2

Closes gap between CSIRO and farmers	2
Can change attitudes/motivation	2
Govt has reduced R+D funding	2
Education is good/more we know the better	2
Info should get back to the farmers	2
Challenge what we do (farmers)	2
Provides baseline - changes over time	2
Ask about carbon trading	1
To see if public money being spent in right direction	1
Shared priorities	1
Erosion - work has been done to rectify it	1
Relevant questions are ok	1
Someone taking notice	1
Can't see benefit/doesn't affect me	1
Helps different generations	1
Questions are difficult to answer/biased/loaded/difficult to quantify things	1
Encourage CMA to do something about lack of support	1
Must be good as it is keeping you employed	1
Need to look at how grapes affect the water	1
Don't know	1
Need some positive outcomes	1
Just results in more money for the CMA	1
Good for science to benefit farmers	1
Feedback is good	1
See how other areas are effected	1
To raise awareness	1
Scientists are enhancing what	1
Farming practices need to change	1
Need to learn how to handle drought	1
Effective if CSIRO - trust CSIRO	1
Improve lifestyle	1
Show community attitudes	1
See what other farmers are doing/measure of what people are doing	1
Need 'hands on' research and decision making	1
Get to have a say	1
Increased accountability	1
If we get feedback	1
Can be combined with economic data	1
National benefit	1
Total	**464**

Table 49 Why/why not are projects like the PUTTI project worthwhile? No respondents

	n
Don't know about PUTTI project	16
Waste of taxpayers money	3
Can't see benefit/doesn't affect me	3
Won't change many people	2
Research tells us what we already know	2
Assist organisational targets incentives for CMA	1
To see if public money being spent in right direction	1
Give CSIRO an idea of what's going on	1
Info will be ignored	1
If it effects change	1
Focus interest on whole thing	1
Time consuming	1
Won't get feedback	1
Haven't seen results/outcomes/haven't heard much	1
Questions are difficult to answer/biased/loaded/difficult to quantify things	1
Surveys can produce irrelevant results	1
It's just a hobby - not too worried	1
They don't understand individuals situation/finance	1
So we don't lose info	1
Too many experts	1
Total	**41**

APPENDIX 13

Perceived environmental condition and responsibility

Respondents rated the environmental condition of their district, in relation to soil health, water quality, erosion and weeds. On average respondents rated the environment of the broader district in which they resided as being in a *fair condition* (As shown in Figure 51). Significant differences were observed across sub-catchments for the perceived condition of district soil health ($p<.05$) and district weed conditions ($p<.01$). Post-hoc Tukey comparisons revealed that respondents in the Humbug perceived district soil health conditions to be significantly ($p<.05$) worse than those in recorded in the Bell and Mandagery. Furthermore, those respondents in the Cudgegong perceived district weed conditions to be significantly ($p<.01$) worse than all other sub-catchments.

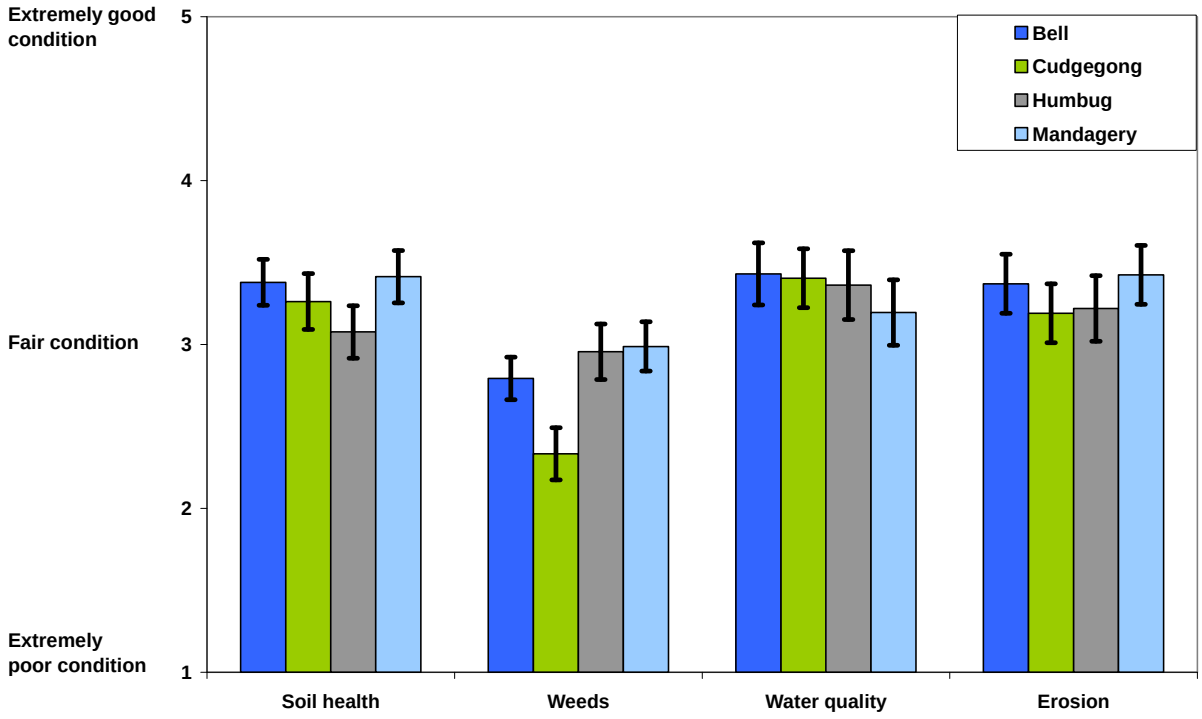

Figure 51. Perceived environmental conditions of district across region: Means & 95% confidence intervals

Overall respondents rated the conditions of their property overall as *fair* to *good* for all aspects. Paired sample t-tests were conducted to compare the mean scores obtained for perceive district and property conditions overall (soil health, water quality, erosion and weeds combined). Respondents overall rated the condition of their properties to be in a significantly ($p<.01$) better condition in terms of soil health, weeds, water quality and erosion than the district (see Figure 52).

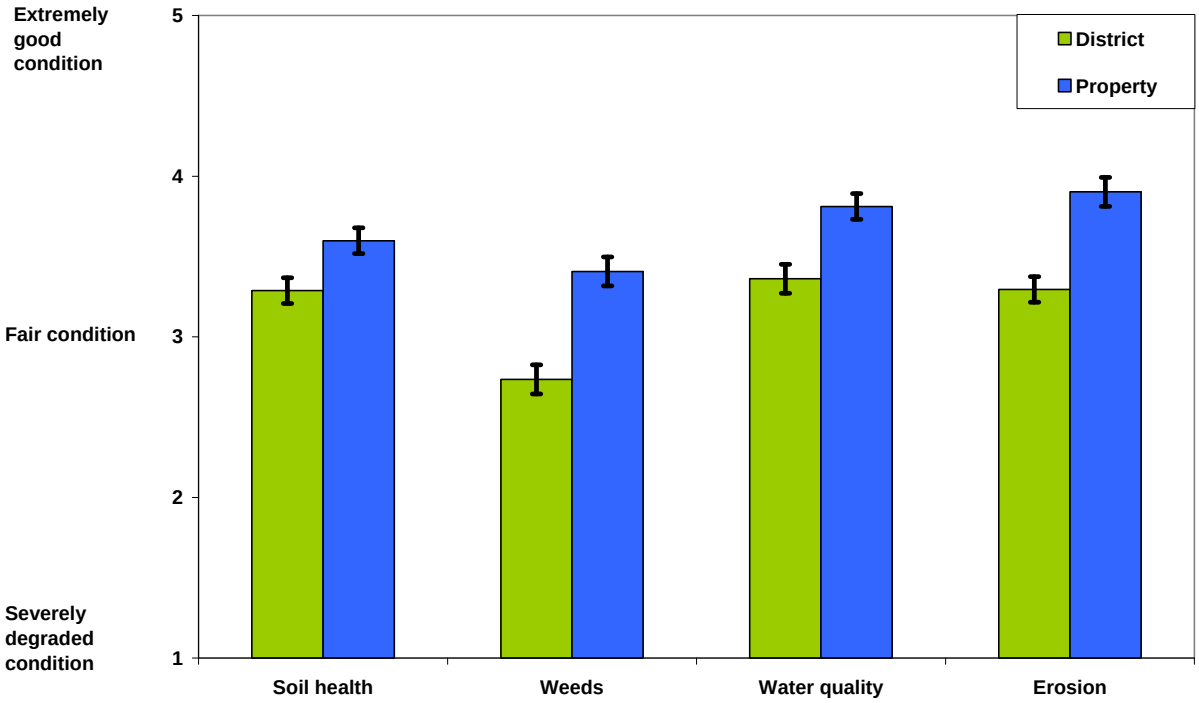

Figure 52. Comparison of perceived environmental condition overall of district and property: Means & 95% confidence intervals

APPENDIX 14

Agricultural courses

Respondents were asked if they had attended any agricultural courses recently, and if so if the courses had helped them to better understand their properties. Respondents who had attended courses recently were also asked if the course(s) had made a difference to what they did on their property.

Table 50. Courses attended and their usefulness: Bell, Cudgegong, Humbug and Mandagery

Region		Have you been to any agricultural courses in the last couple of years? (n = 422)		Did the course help you to understand your property any better? (n = 184)		Did it make a difference to what you do on your property?(n = 184)	
		Yes	No	Yes	No	Yes	No
Bell	N	47	69	37	10	37	10
	%	40.5	59.5	78.7	21.3	78.7	21.3
Cudgegong	N	46	81	39	7	37	9
	%	36.2	63.8	84.8	15.2	80.4	19.6
Humbug	N	46	45	36	10	31	15
	%	50.5	49.5	78.3	21.7	67.4	32.6
Mandagery	N	45	43	36	9	32	13
	%	51.1	48.9	80.0	20.0	71.1	28.9
Total	N	184	238	148	36	137	47
	%	43.6	56.4	80.4	19.6	74.5	25.5

There were slight differences between the sub-catchments, with proportionately less respondents from Humbug who had attended courses (67.4%) indicating that it had made a difference to what they do on their properties compared to Cudgegong (80.4%).

Respondents were asked if they had attended any agricultural courses recently, and if so if the courses had helped them to better understand their properties. Respondents who had attended courses recently were also asked if the course(s) had made a difference to what they did on their property. Close to half (43.6%) of the respondents had recently attended at least one agricultural course. Of these, the majority (80.4%) felt that the course had helped them better understand their property. Further, most respondents (74.5%) that had attended a course recently also felt that it had made a difference to what they did on their property.

Of the participants who had attended agricultural courses in the last couple of years, nearly a third (30.4%) had attended Chemical use training, with a further 12% attending property planning courses and 8.2% the ‘Pro-Graze’ course.

Of those who attended courses, the most commonly cited changes to land management practices were general improved farm management (16.1%, n=22) and changes to chemical and fertiliser input (11.7%, n=16).

Table 51. What courses have you undertaken?

	n	%'age of respondents
Chemical uses / training / certificate	56	30.4%
Property planning: Landcare, CMA	22	12.0%
Prograze	15	8.2%
Soils workshop	10	5.4%
Breeding	9	4.9%
Conservation and Land management	8	4.3%
Wool classing	7	3.8%
Soil health: DPI	7	3.8%
Grazing management	7	3.8%
OHS / Farm safety	6	3.3%
CMA conservation farming	6	3.3%
Drought feeding	6	3.3%
Cattle / stock management	6	3.3%
Pasture	5	2.7%
Sustainable agriculture / holistic farming	5	2.7%
Farm management	5	2.7%
Water management	5	2.7%
Organic farming	4	2.2%
Integrated weed management	4	2.2%
More beef from pasture/beef production	4	2.2%
Spraying techniques	4	2.2%
Cropping	3	1.6%
Grazing for profit	3	1.6%
Grazing for Profit	3	1.6%
Pasture management	3	1.6%
Ag course: weeds	3	1.6%
Marketing	3	1.6%
Direct drilling : CMA	2	1.1%
Biodynamic farming workshop	2	1.1%
"Wool for Wealth": DPI	2	1.1%
Climate change course	2	1.1%
Conservation farming	2	1.1%
Marketing: How to get Even Price/Sales management	2	1.1%
Changing environment: carbon credits	2	1.1%
Field Day courses	2	1.1%
Irrigation water	2	1.1%
Weaning lambs	2	1.1%
Agriculture/sustainable agriculture	2	1.1%
Minimum til	2	1.1%
Salinity	2	1.1%
GRDC updates	2	1.1%
Fire brigade / fire fighting	1	.5%
Field days on farming systems	1	.5%
"Stock Plan" : DPI and Lachlan CMA	1	.5%
Workshop (West Wyalong – CSIRO)	1	.5%
Chemical tickets	1	.5%
Viticulture	1	.5%
Fertiliser care	1	.5%
Merino breeding: Tafe	1	.5%
Farming systems	1	.5%
Climate change day: Lachlan CMA	1	.5%
Pest and weed control	1	.5%

Native pasture	1	.5%
National livestock identification system	1	.5%
Soils and minimum tillage: Lachlan CMA	1	.5%
"Making silage": dpi	1	.5%
Merino course: dr jim watts	1	.5%
Soil food: Web Institute	1	.5%
Ruminant nutrition	1	.5%
Market check	1	.5%
Convert machinery	1	.5%
Aust olive expo	1	.5%
CMA conferences	1	.5%
Traffic control	1	.5%
Mid Lachlan Catchment management	1	.5%
Wool production: Managing the Drought (Michael White)	1	.5%
Shearing	1	.5%
Mapping course	1	.5%
Condobolin rsch	1	.5%
Salt bush management	1	.5%
Chillier Needle grass awareness	1	.5%
LCMA ongoing (Weeds, cropping, herbicide)	1	.5%
Worm farming	1	.5%
Quarantining	1	.5%
Executive Development Program for Primary Producers	1	.5%
Ticket to sell sheep	1	.5%
Ram selection	1	.5%
Mulching	1	.5%
Applying herbicide	1	.5%
Red meat profit day	1	.5%
Futures trading	1	.5%
Stubble management	1	.5%
Horticulture	1	.5%
Grain research update	1	.5%
Seed propagation	1	.5%
Plant identifying	1	.5%
Agribusiness	1	.5%
Wool mulesing	1	.5%
Cat conference	1	.5%
Quality assurance for Pigs	1	.5%
Native grasses	1	.5%
Ecological agriculture	1	.5%
First aid	1	.5%
Hazelnut society	1	.5%
Wool seminar	1	.5%
Alternative fertilisers	1	.5%
Financial management	1	.5%
Total	**303**	**162.30%**

Table 52. Change to property management resulting from agricultural courses

	n	%'age of respondents
General improved farm management (office, decisions, methods)	22	16.1%
More precise in chemical/fertiliser input	16	11.7%
Chemical course for safe practices	15	10.9%
Stock management	12	8.8%
OHS for awareness of safe practices / hygiene	10	7.3%
Looking after pastures better	9	6.6%
Improved soil	8	5.8%
More sustainable land use / Holistic approach	6	4.4%
More precise in making economic decisions	5	3.6%
More precise in making decisions about crop input	5	3.6%
Better farm planning	5	3.6%
Grazing management	5	3.6%
Importance of ground cover (CMA stock plan)	5	3.6%
Knowledge about soil properties	4	2.9%
Invested in more equipment	4	2.9%
Identify Plant species	4	2.9%
Weed management	4	2.9%
Better understanding of stock food quality / quantity	3	2.2%
Improved management of native grasses / plants	3	2.2%
Tightened up objectives on sheep	3	2.2%
Improved techniques/practices	3	2.2%
Recording of data	3	2.2%
Reaffirmed what I knew	3	2.2%
Stubble retention	3	2.2%
Less soil disturbance / till	2	1.5%
More profitable land use	2	1.5%
Putting drought lotting into practice	2	1.5%
More careful in record keeping	2	1.5%
Use of perennials	2	1.5%
Manage water	2	1.5%
Breeding new stock	2	1.5%
Extra storage for grain	2	1.5%
Destocked/Reduce to maintain ground cover	2	1.5%
Compare management practices	2	1.5%
Aware of impact of cattle	2	1.5%
Trying new techniques	2	1.5%
Improved production	2	1.5%
Sheep husbandry	2	1.5%
Stock rotation for better breeding	1	.7%
Knowledge about growing vines	1	.7%
Select summer weeds to retain	1	.7%
More efficient product selection	1	.7%
Use of direct drilling	1	.7%
Grazing for Profit: better insight into land management	1	.7%
Access to new technology	1	.7%
Eroded areas fenced off	1	.7%
Increased tree planting	1	.7%
Better timing on producing silage	1	.7%
Understand tillage practices	1	.7%
All	1	.7%
Drought management	1	.7%
In planning stress	1	.7%
Understand biological processes	1	.7%
Erected more signs	1	.7%
Weeds make you more aware	1	.7%
Water control/fencing waterways	1	.7%

Olive expo - how to get rid of pests	1	.7%
Put in feed lot	1	.7%
Minor influence	1	.7%
Succession planning	1	.7%
Sub-division	1	.7%
Viticulture	1	.7%
Financial assistance	1	.7%
Reduce stock	1	.7%
Conservation of natives	1	.7%
Way we breed	1	.7%
Withholding periods for drugs before slaughter	1	.7%
Long term	1	.7%
Understand how to deal with salt	1	.7%
What seed is available	1	.7%
Total	**220**	**160.00%**

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