FARMER-DRIVEN INNOVATION IN AGRICULTURE: CREATING OPPORTUNITIES FOR SUSTAINABILITY

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Glossary - cropping and livestock terms

Acre	1 acre = 4046.856 square metres 1 acre = 0.4047 hectares (ha)
Air-seeder	A machine that distributes seed and fertiliser via air propelled through pipes to the furrow made by either a disc or points of a tine.
Auger	In agriculture, the auger is used to move grain between storage bins, trucks or carts. Electrically powered, the auger has 'screw-type' helical flighting that rotates inside a long metal tube, moving the grain upwards. On the lower end, a hopper receives grain from the truck or grain cart. A chute on the upper end guides the grain into the destination location.
Cattle trading (versus cattle breeding)	A cattle trading enterprise is generally geared to fattening steers (castrated male) to weights required for feedlots or slaughter. Weaners (less than one year old, taken off mother's milk) and steers will be bought and sold to take advantage of seasons and markets. A breeding enterprise can involve purebred or a crossbreeding program, where attention to genetics is important and the breeding herd of cows (female that has had a calf) and bulls (male not castrated) creates a self-replacing herd over time. The operation will be geared to support calving and weaning of young progeny – which may in turn be sold to 'traders' who will fatten them for the domestic or export meat market. Many farms do a mixture of breeding and trading or fattening, often keeping the heifers (young female that has not yet calved) and cows and selling or trading steers.
Chaser bin	A chaser bin is a trailer towed by a tractor with a built-in auger system, usually with a large capacity that 'chases' the harvester in the paddock so that the harvested grain can be offloaded without the need for stopping.
Compost Tea	Compost tea is a liquid solution or suspension made by steeping compost in water. It is used as both a fertilizer and in attempts to prevent plant diseases, and can be applied to broadacre crops.
Controlled traffic farming	This is a system to control the traffic that goes across a paddock through the use of set tracks or 'tram lines' for machinery so that the area of soil compaction is limited. This requires standardised equipment that fits to the wheel track widths and a 'guidance system'. The guidance system is usually satellite tracking and auto-steering in the tractor to ensure the tram lines are completely straight.
Cover crop	A crop grown for the primary purpose of maintaining ground cover in a cropping paddock.
Crutching	The removal of wool from around the tail and rear legs of a sheep
Discs	Discs are increasingly popular as a substitute for tines and points in conservation farming systems, due to less soil disturbance.
Deep ripping	Disturbing the soil below the normal cultivation layer, in order to break up traffic-induced or naturally occurring compacted layers.
Direct drilling	Seed is directly sown/drilled into the soil, with minimal or no disruption to the soil surface.
Exceptional circumstances (EC)	Exceptional circumstances (EC) are rare and severe events outside those a farmer could normally be expected to manage using responsible farm management strategies. If an area or region becomes 'declared' as experiencing an exceptional circumstances event, this triggers short-term support for farmers by the Australian Government. Eligibility also means farmers can access their Farm Management Deposits (FMDs) within 12

	months of lodgement without losing their tax benefits as well as receive training and interest rate subsidies. Agriculture-dependent small business operators may also be eligible.
Green manure	A type of cover crop grown to improve soil condition and then later ploughed into the soil. A brown manure crop is similar, except the growing phase is stopped via chemical rather than mechanical means.
Glyphosate	A commonly used broad-spectrum systemic herbicide used to kill weeds. Sold as *Roundup* by Monsanto Company, their patent expired in 2000.
Gypsum	A soft calcium based mineral. It is applied to improve soil structure in heavy clays and to provide a source of sulphur for plant growth.
Header	A harvester.
Hectare (ha)	1 ha = 10,000 square metres (m2) 1 ha = 2.4711 acres
Marking	Earmarking, castration and tail-docking of lambs and calves.
Parallelogram	A self-adjusting mechanism on a machine for sowing seed, including a gauge wheel, which allows for even seed sowing depth on uneven soils – i.e. it stays parallel to the ground.
Pasture cropping	A zero tilling technique of sowing annual cereal crops into living perennial pastures.
Payment for Ecosystem Services (PES)	Financial payment or incentive for a land manager to protect or provide an ecosystem service(s) such as biodiversity or carbon on their land.
Soil Capacitance Probe	Capacitance sensors use capacitance (ability to hold electric charge) to measure electric fields of a surrounding medium (eg. soil). Changes in capacitance can be correlated to changes in the water content of the soil.
Sowing	The process of planting seeds.
Seeding rate	The seeding rate is essentially the rate of seed (kg/ha) that needs to be sown in order to achieve target plant density in a crop (plants/m2). It is calculated using factors such germination percentage, seed size, seed weight and plant establishment percentage. Plant density has an important influence on crop yield.
Stubble	Plant residue left after harvest.
Tines and points	Tines are thin metal arms on sowing equipment on which a metal point is placed at the base to create a small furrow in the soil for sowing.
Virtual fencing	The concept builds on the basic principle of an electric fence, except there is no fence. Using a wireless sensor network containing microcomputers, radios and sensors, some of which are fitted into cattle neck collars, sounds and small electric shocks are used to teach the animals to avoid the virtual boundary – defined by satellite technology and global positioning system (GPS) coordinates. Producers could reset a new fence line anytime, from the office, as well as continuously monitor where their cattle are located. Still in prototype phase, CSIRO is currently working to develop virtual fencing for cattle in Australia.
Water Use Efficiency (WUE)	A calculation derived from a combination of soil water available at sowing time, in-crop rainfall and evaporation that determines the amount of grain produced per hectare (kg/ha) per unit of available water.
Weed seeker	The WeedSeeker® technology uses sensors and nozzles to detect the light reflected by green plants. It only sprays the green plant, not the soil or crop stubble, reducing herbicide and water use. It can be fitted to a boom spray (broadacre spraying machine).

Western Division	The Western Division (also called 'Western Lands') makes up 42% of the area of NSW. Most of the land in the Division is held under perpetual leasehold from the Crown, with only a small area of land being held as freehold. With a mostly semi-arid climate, grazing is the primary land use, with some dryland and irrigated agriculture along rivers.
Zero tillage (or No-Tillage)	When a crop is sown directly into undisturbed soil that has not been ploughed/tilled prior to sowing or since the harvest of the previous crop. Weeds are controlled with herbicides instead of ploughing. Stubble is retained for erosion control and soil health.

Acronyms and abbreviations

ABARE	Australian Bureau of Agricultural and Resource Economics
ABS	Australian Bureau of Statistics
BOM	Bureau of Meteorology
CANFA	Conservation and No Till Farmers Association
CMA	Catchment Management Authority
CSIRO	Commonwealth Scientific and Industrial Research Organisation (CSIRO)
DAFF	Commonwealth Department of Agriculture, Fisheries and Forestry
DEEDI	QLD Department of Employment, Economic Development and Innovation
DPI	New South Wales (NSW) Department of Primary Industries (DPI) was formed in July 2004, with the amalgamation of: NSW Agriculture, NSW Department of Mineral Resources, NSW Fisheries and State Forests NSW. In July 2009, DPI was amalgamated into New South Wales Department of Industry & Investment. Farmers still tend to refer to it as "Department of Ag" or "DPI".
EU	European Union
GRDC	Grains Research and Development Corporation
NSW	The State of New South Wales
OECD	Organisation for Economic Co-operation and Development
PP Board	Many farmers still use the term PP Board to refer to the district organisation responsible for the management of animal health, pest animal and insect control and travelling stock reserves. In NSW, this was the role of the Pastures Protection Boards (PP Boards) from 1934 until 1989, when they were replaced by the Rural Lands Protection Boards (RLPB), which were in turn replaced in 2009 by the Livestock Health and Pest Authorities (LHPA).
QMDC	Queensland Murray-Darling Committee
RIRDC	Rural Industries Research and Development Corporation
SME	Small to medium enterprise

A note on the use of quotes: This thesis uses quotes from farmers and other people working in agriculture. To allow their own voices to be heard, and for ease of reading, minor grammatical errors have been overlooked where they do not affect the meaning of the quote.

1. Introduction

1.1 Innovation for nature

One hundred thousand years ago, there were 10,000 people alive on earth. Today, there are almost 7 billion humans sharing the planet (Flannery, 2008). The activity that covers half the Earth's entire land surface and requires more land, water and human labour than any other is agriculture (Kiers et al., 2008). More than half of all the world's species exist primarily in agricultural landscapes, outside protected areas (World Bank, 2008). In the past fifty years, global food production more than doubled, keeping pace with population growth but also increasing the environmental footprint of agriculture at the same time (Khan and Hanjra, 2009).

There is evidence that the productivity of many intensive systems cannot be maintained with current management (World Bank, 2008). Industrial agriculture uses 2-3 times more fertilisers and 1.5 time mores pesticides for the production of 1 kilogram of food than it did 40 years ago (UNCTAD, 2010). Growth in production will have to come in part from increasing yields, but will also depend on an increased area of production (Miles et al., 2008). Without serious interventions, it is likely that the world will experience a period of rapid global agricultural expansion and land-use change over the next 40 years. Yet many regions of the world now face a shortage of land for additional cropland expansion (Morton et al., 2006). The average amount of arable land per person fell from 0.39 hectares in 1960 to 0.21 hectares in 2007 (Evans, 2010). This is contributing to ongoing debates over intensive versus extensive agriculture. Both past intensification and extensification have brought different environmental problems of their own (World Bank, 2008). Widespread land degradation, soil erosion, yield losses due to climate change and changes in the proportion of non-food crops to food crops all have impacts on the available cropland for food production (Bai *et al.*, 2008 ; Foley *et al.*, 2005 ; Kiers *et al.*, 2008 ; UNEP, 2007 ; von Braun, 2007). Meanwhile, cropland is being converted all over the world to other uses due to increasing urbanization, industrialization, energy demand and population growth and there are limitations to the amount of new land that can be taken into cultivation (OECD-FAO, 2008 ; UNEP, 2009). Extensive land degradation, increasing resource scarcity and climate change raising questions of whether it is possible to feed a world population of 9.1 billion by 2050 (FAO, 2009a ; Gilland, 2002 ; IAASTD, 2008 ; Lewis, 2008 ; Williams *et al.*, 2004 ; World Bank, 2008)

The pathway to sustainable agriculture is long and steep and we are running out of time. Calls are being made for increased agricultural resilience and productivity. According to Seabrook et al. (2011 p. 407), "we must systematically assess and proactively redesign and manage the landscape we inhabit so they can continue to provide ecosystem services essential for all species, including humans" How is this to be possible given the many forces driving agriculture in the 21st century?

A common response is that it will be possible through innovation (Douthwaite, 2006) - that the answer is the transformation of high-input industrial agricultural systems into knowledge intensive regenerative agricultural systems that are more sustainable (UNCTAD, 2010). Environmentally, socially and economically sustainable development is said to require an "interdisciplinary, holistic and systems-based approach to knowledge production and sharing" (IAASTD, 2008 p. 7). Such development calls for "public investments in agricultural knowledge systems to promote interactive knowledge networks (farmers, scientists, industry and actors in other knowledge areas)" (IAASTD, 2008 p. 11). The OECD advocates severing the link between economic growth and environmental degradation through more innovation focused environmental policies - and environmentally focussed innovation policies (OECD, 2005). They propose that such policies will achieve environmental and economic outcomes. But what do knowledge intensive agricultural systems look like? Who is best placed to find land management practices that can reconcile conservation and production goals? If "strengthening the innovative capacity of farmers is a precondition for sustainable agriculture and natural resource management", as Waters-Bayer et al. (2002 p. 352) suggest, then the question becomes what is the nature of farmer-driven innovation?

1.2 Nature of Innovation

In this thesis, innovation is not defined as invention but rather the novel application of new or existing information, integrated in innovative ways (Eliasson, 2000 ; Kiers *et al.*, 2008 ; Spielman, 2005 ; Spielman *et al.*, 2008). Put simply, innovation is the application of technical, organisational and/or other forms of knowledge to achieve positive novel changes in a particular situation (Conroy, 2008). This knowledge may be brand new, but can also involve the new use of existing knowledge. This may involve both product and process innovations and more often than not concerns the small changes associated with incremental learning and problem solving (Andriopoulos and Dawson, 2009 ; Hall, 2006).

Innovation has been studied by many different disciplines, including institutional and evolutionary economics, industrial economics, systems analysis and operations research, sociology and the political sciences. It has been described through theories of organisational change and knowledge management, actor-network and communication theories, and technological change theories, among others (Carrillo-Hermosilla et al., 2009). It is not unusual for research into innovation, particularly in the social sciences, to be cross-disciplinary (Fagerberg, 2005). This is not least because "innovation is a multifaceted phenomenon that cannot be easily squeezed into a particular branch of the social sciences or humanities" (Fagerberg et al., 2005 p. v). The way that innovation processes are conceptualised impacts on capacities to foster change at a range of scales (Douthwaite, 2006). it is important to also appreciate the many processes that underpin it (Lilja and Dixon, 2008). Over time, our conceptualisation of knowledge and our understanding of innovation has changed. In turn, our capacity to facilitate innovation has also changed, as will be shown in section 2.2 (Blay-Palmer, 2005).

Roling (1992) drew attention to the fact that innovations can come about in various ways, including from farmers themselves. When Biggs (1990) compared two models of agricultural research and technology diffusion – the central source versus the multiple source model – he recognised that theory, however well conceptualised, can risk lacking relevance if not related to developments on the ground. He also recognised that innovations could come from diverse sources, not least farmers (Biggs, 1990). Poncet et al. (2010) included farmers in their list of actors capable of producing knowledge for innovation. Kristjanson et al. (2009) described farmers as agricultural entrepreneurs who are active in the acquisition of knowledge and information to support their business strategies and innovation projects. Notwithstanding contributions such as these, it is still more common to see farmers described as recipients of knowledge, or adopters of technology, rather than generators of innovation (Guerin and Guerin, 1994 ; Nicholson *et al.*, 2003 ; Pannell *et al.*, 2006 ; Vanclay, 2011). It is rare to see farmers described within an innovation network as also suppliers and intermediaries of knowledge, and not just a source of demand. Innovation has largely remained conceptualised as an off-farm endeavour and the dominance of product innovations over process and practice innovations has remained (Oreszczyn et al., 2010).

A consequence of this is that the experiences of on-farm innovation (as distinct from adoption decisions) are not well documented, despite their obvious practical and theoretical implications. The agricultural innovation systems approach, which will be

described in Chapter Two, provides a valuable analytical framework. However, it is also recognised that all theories or ways of seeing are inevitably partial: they are informed by the purposes and values of the agents constructing them (Midgley, 2000). What the systems approach has not yet become is an operational concept - with policy options and targeted interventions to improve everyday innovation capacity (Klerkx et al., 2010).

1.3 The goals of this research

> *"More study of the dynamics of innovation is needed. This includes the study of non-state actors in relation to, separate from, or even in spite of public sector research organizations" (Spielman, 2005 p. 33).*

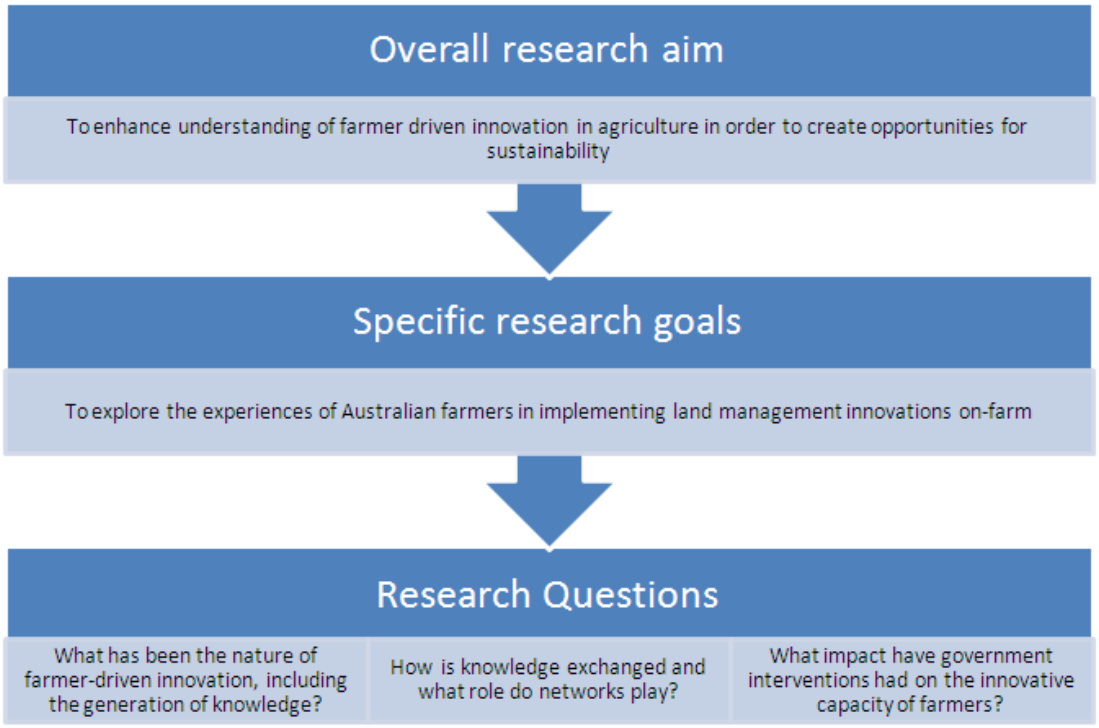
There is a role for research that is decision oriented and applied to on-farm circumstances, to counter an intellectual and policy shift away from focusing on individuals – a shift that some consider has probably gone too far (Tonts et al., 2010). Therefore, the primary goal of this thesis is to enhance the understanding of farmer driven innovation in agriculture, including the generation of knowledge on-farm. In contrast to the many studies of agricultural innovation in developing countries, the focus here is on understanding innovation in developed country agriculture. By focussing at the level of the individual and the innovation networks at this scale, this research aims to provide insights into how concepts of innovation may be better applied practically (Klerkx et al., 2010). To create this understanding, in-depth research has been conducted with farmers in New South Wales, Australia, exploring their experiences in implementing land management innovations. This leads to the first specific research question of the thesis – what has been the nature of farmer driven innovation, including the generation of knowledge on-farm? See Figure 1 below.

There also remains a need to better envisage knowledge networks and flows – to ensure that discussions do not lose sight of the diversity of actors and networks within an innovation system, processes of social learning and negotiation and patterns of coordination (Leeuwis, 2004). To this end, the second research question explores how knowledge is exchanged and the role of knowledge networks.

The capacity to innovate is determined by the combined function of the actors involved, the skills they bring to partnerships and the institutional contexts that shape the interrelationships (Hall et al., 2003). In other words, in order to understand innovation, it is important to also appreciate the context and the many processes that underpin it (Lilja

and Dixon, 2008). The increased interventions of governments seeking greater environmental outcomes in agricultural landscapes are one such context that could materially impact on innovation capacity. Given this, the third research question explores the impact that government interventions have had on the innovation capacity of farmers. This also informs a subsidiary goal of the thesis - to understand how such interventions could potentially be better framed.

Figure 1. Research goals and questions



1.4 Research questions and thesis structure

As a first step in addressing the research goals and questions outlined above, the thesis begins with a review of the current literature in Chapter Two. This chapter introduces the theoretical framework for the thesis. It explores the existing literature on innovation in agriculture, including how different approaches such as innovation systems thinking conceive of knowledge and knowledge networks and flows differently. Theories of farmer decision making are also reviewed, including the traditional focus on the adoption of innovations, as well as the potential for the concept of opportunity to play a greater role. Consideration is also given to the institutional context of farming, including thinking on the farm as a firm and the farmer as an entrepreneur. The intention of this chapter is not to develop a single coherent theoretical framework, but to shine a spotlight on innovation in

agriculture by drawing on the strengths of numerous theoretical perspectives, with a particular focus on knowledge generation and exchange.

Chapter Three explores the changing context of Australian agriculture. It looks at the recent history of the paradigm of neoliberalism and the concept of multifunctionality. It follows with an overview of public policy and government interventions in agriculture and land management, including those targeting innovation and environmental sustainability. The purpose is to contextualise the study and embed the findings in time and place.

Chapter Four explains the exploratory framework of the research. It introduces the qualitative research method chosen, of grounded theory. It explains how the in-depth interviews with a range of farmers from New South Wales, Australia, were undertaken, with a focus on research design, sample location, sample strategy, data collection and analysis. This chapter also considers the influence of researcher positionality on the findings and the steps that were taken to ensure research validity.

Chapter Five presents the results of research that specifically relates to the first research question on the nature of farmer-driven innovation, including decision making and the generation of knowledge on-farm. The first half of this chapter looks at how farmers innovation and make decisions. It considers motivations for change, perceptions of innovation, shared decision making, the need to maintain motivation and change over time, business and risk management and family farm succession as a means of knowledge transfer. The second half of the chapter looks at whether and how knowledge is being generated on the farm. It explores the implementation of land management specifically through ongoing testing and trialling, observation of signals from the landscape, adaptation to water scarcity, management of timing and the development of new machinery. This revealed a lot of information about on-farm experimentation and management changes.

Chapter Six presents results pertaining particularly to the second research question on the exchange of knowledge and the role of networks. It also reports on findings that have implications for agricultural sustainability. In this context, it explores whether knowledge networks have played a role, and the evidence of farmers as active seekers of information, as well as the influence of farmer-to-farmer knowledge exchange and the influence of farmer groups. Farmer experiences with agronomists, government advisors, and collaborative research is reviewed as potential actors within each farmers own knowledge

networks. In terms of the land management changes taking place, these are reviewed for their implications for sustainability – in particular the processes of property redesign and specialisation. The counterbalancing views of non-farmer agricultural professionals on innovation are also considered.

Chapter Seven presents results that relate to research question 3, in particular the question of how to better frame interventions to influence innovations in land management. The experiences of farmers with government efforts directed at influencing their decision making for changed management practices are described. Farmer views on issues such as scale and speed, flexibility, ongoing monitoring, institutional learning and subsidies are documented. Farmer responses to a hypothetical model of payment for ecosystem services are also documented, particularly their views on compensation, outsider threats, additional land uses and specific markets. Lastly, this chapter details the kinds of opportunities farmers would like to see in the future and their responses, which can be grouped around the themes of environment, knowledge, economics and resources. Again, the alternative views of non-farmer agricultural professionals are also presented, this time in terms of external interventions .

In Chapter Eight, the findings for the research questions 1 and 2 (from Chapters Five and Six) are analysed and discussed. They reveal innovative farmers who are motivated but resource constrained, the importance of gradual transition rather than radical change and the trend towards greater professionalism in farm business management. This in turn reveals insights into the role of management decisions, knowledge and networks, and the farmer as an innovator and entrepreneur. The analysis in this chapter also highlights the time and effort that innovation takes on-farm, beyond the initial stages of implementation and compares the findings of this research with other studies.

Chapter Nine begins with analysis of the findings of research question 3 (from Chapter Seven) in relation to government interventions and the potential implications for farmer driven innovation. In particular, the role of opportunity creation, not just for innovation but for sustainability is made apparent. Decision makers need opportunities in order to realise their motivations. The distinction is made between the traditional focus within decision making theory on the motivations of landholders and barriers to change as compared to the opportunities required for landholders who are already motivated. This may sound like a subtle difference, but the implications are not. It also became particularly evident that many external interventions to promote innovation can actually result in perverse

outcomes. The chapter concludes with a discussion that spans the three research questions and makes the case for a new approach to 'intervention' in order to create enabling environments and opportunities for innovation.

Chapter Ten concludes the thesis with a summary of the theoretical and policy implications of the research. In doing so, it draws upon the key findings for each research question and explains how the goals of the research have been met and areas where further research is required.

1.5 Summary

For individuals, particularly for environmental and resource management practices, the process is ongoing and frequently being reassessed (Barr and Cary, 2000). Many conservation practices take years to demonstrate their worth in trials and across the farm. The outcomes are uncertain and largely unpredictable and recipes for adoption and implementation will inevitably disappoint. Given the role that individuals play in land management, it is clear that there is a need for a balance between the conceptual and practical, and between a focus on either the decision making of the individual and that of the collective system or network. The research goals and questions outlined above seek to strike such a balance. In doing so, it is the intention of this research to enhance the understanding of innovation, knowledge and decision making in theoretical and practical contexts. The resulting findings will provide insights into the creation of enabling environments for innovation, given the reality that is modern farming in the 21st century. The first step is to better understand the existing literature, as presented in Chapter Two.

2. Innovation in agriculture: a theoretical framework

2.1 Introduction

As explained in Chapter One, this chapter introduces the theoretical framework for the thesis. It explores the existing literature on innovation in agriculture, including how different approaches such as innovation systems thinking conceive of knowledge and knowledge networks and flows differently. Theories of farmer decision making are also reviewed, including the traditional focus on the adoption of innovations, as well as the potential for the concept of opportunity to play a greater role. Consideration is also given to the institutional context of farming, including thinking on the farm as a firm and the farmer as an entrepreneur. The intention of this chapter is not to develop a single coherent theoretical framework, but to shine a spotlight on innovation in agriculture by drawing on the strengths of numerous theoretical perspectives, with a particular focus on knowledge generation and exchange.

2.2 Approaches to agricultural innovation

> *"Invention culminates in the supply (creation) of knowledge, but innovation encompasses the factors affecting demand for and use of knowledge in novel and useful ways" (Conroy, 2008 p. 311).*

Over recent decades there has been a strong interest in both the drivers and processes of innovation. In essence, there has been one overarching paradigm for innovation which later conceptual approaches either built upon or deviated from. This is the transfer of technology paradigm. As the following section will show, these approaches largely seek to understand knowledge creation and knowledge transfer, whether it be through research systems or communication systems. There are many ways to classify different paradigms of innovation. For example, Hall (2007), categorised a range of innovation approaches along the lines of their research and learning characteristics. Given that the conceptual approach has implications for the construction of research systems, this makes sense. However, the focus of this thesis is on farmers rather than research systems. Therefore, I have tried to simplify what is a complicated and rich field (with strong elements of overlap) by focusing on another key aspect, knowledge flows and whether

they are conceptualised as one-way, two-way or multiple pathways. The evolution of models of technical change and innovation has been influenced by the changing conceptualisation of what knowledge is and how it is produced (Wolf, 2008). As it has become evident that knowledge is not mobile and simply additive, nor is it easily abstracted from its context, it has also become apparent that models reflecting interactive rather than linear processes are also more appropriate. It is reiterated here that comparisons of linear and networked models of innovation inevitably focus on their critical differences, but in reality many research systems fall somewhere on the spectrum between the two extremes (World Bank, 2006).

2.2.1 One-way knowledge flows

Within the transfer of technology paradigm, scientific research is seen as the main driver of innovation. New knowledge and technology is to be created and then transferred and adapted to different situations (World Bank, 2006). While operating in isolation from farmers, scientists were still trying to help farmers, as the following excerpt from 1934 shows (Box 1).

Box 1. 'Research for the farmer's sake'. From the Journal of the Franklin Institute, Volume 217, Issue 2, February 1934, Pages 266-267

Research for the Farmer's Sake.—The farming industry also has its research laboratories in the shape of the Experiment Stations of the U. S. Department of Agriculture. More than ever, the various stations curtailed their building programs this past year and devoted a corresponding larger share of their appropriations to meeting the pressing demands for service to the farmers. There follows a partial list of the several State Experiment Stations and their recent accomplishments.

Arkansas found that too much manganese in some soils injures rice, but that lime corrects this condition.

The Nevada and Utah stations have made snow surveys as a guide to estimating the water available for irrigation.

The Montana station has specialized in wheat breeding and more than 90 per cent. of the wheat planted is of the varieties recommended on the basis of comparative tests. Two new varieties, Karmont and Yogo, have distinctive merits.

A dominant perspective for decades, under the transfer of technology paradigm, was the expectation that innovations were developed on research stations and the resulting technologies were then promoted and transferred to farmers (Barr and Cary, 2000). This framework can be conceptualised as a one-way model of knowledge transfer. Table 1 demonstrates examples of how this paradigm has been applied.

Table 1. One-way models of knowledge transfer

Model	Key Features	Time introduced
National Agricultural Research Systems (NARS)	Early NARS research efforts were focused on generating crop improvement in commodities that were imported by the colonial powers. In the late 1940s, NARS were further expanded, although expansion proceeded at different rates in different countries. In the mid-1950s, in response to changes in the demographic structure of populations and in food demand, a network of International Agricultural Research Centers was established (Evenson and Gollin, 2007). The transfer of technology (TOT) model has been the standard framework for NARS in many countries since the 1960s (Ramirez, 1995). NARS continue to operate today, with a focus on strengthening research supply. An example is the Consultative Group on International Agricultural Research (CGIAR), established in 1971. It is a partnership of donors that support 15 international centres that collaborate globally with governments and civil society organizations, as well as private businesses (CGIAR, 2010).	One of the older approaches, NARS were established in many developing countries in the late 19th century, often by colonial governments.
Innovation Diffusion Models	At the heart of much of the literature on innovation and diffusion is the work of Schumpeter (1934) who defined three phases of technological change: invention, innovation and the dispersal of innovation (Tonts et al., 2010). Rogers' (1962) seminal work on how innovations diffused was based on the belief that the causes of poor agricultural performance were essentially technological and could be solved by developing technology and improving the delivery of this technology (Guerin and Guerin, 1994). To clarify, adoption related to innovation uptake, while diffusion related to the spreading of innovation within a community (Klerkx, 2004). The idea was that focussing on the "progressive" farmers would be beneficial to other farmers as well (Klerkx, 2004 p. 133). These earlier views essentially reflect the transfer of technology model. Based on identified patterns of the rate at which people adopted innovations, it was common to see the following set of categories used (Klerkx, 2004): 1) Innovators 2.5% 2) Early adopters 13.5% 3) Early majority 34% 4) Late majority 34% 5) Laggards 16%	1960s onwards

	In essence, farmers became categorised by their willingness and capacity to adopt innovations (Ramirez, 1995) . Under this linear diffusion model, it was the role of extension officers to interpret the science and convey it to farmers – to act as the conduit between science and practice (Carr and Wilkinson, 2005).	

2.2.2 Two-way knowledge flows

As a challenge to the transfer of technology paradigm, new approaches which emphasised the importance of farmer participation were introduced from the 1960s. The growing focus on participatory research more broadly is seen as a way to move from producing knowledge that has to be applied, to developing applied knowledge for specific contexts upfront. It assigns importance to understanding farmers' capacity to experiment and adapt. In its more collaborative modes, it seeks to give farmers equal status in the process as partners in the research process (Conroy, 2008). Table 2 shows approaches that can be broadly conceptualised as a two-way model of knowledge transfer.

Table 2. Two-way models of knowledge transfer

Model	Key Features	Time introduced
Participatory Technology Development	The Participatory Technology Development approach "refers to collaboration between farmers, development agents and scientists in a manner that combines their knowledge and skills" (Reij and Waters-Bayer, 2001a p. 5). Used particularly in a pro-poor development context, it builds on farmer experimentation as a means for improving the well-being and livelihoods and families and communities. More a framework than a model, this approach has similar origins to Participatory Rural Appraisal and Participatory Action Research (Leeuwis, 2002). Rather than convince farmers to change practices, it seeks to build farmers' capacity to seek out and test new possibilities that suit their circumstances. Farming Systems Research can be viewed as an expression of this broader participatory approach. Examples of the Participatory Technology Development are two Dutch funded programmes that focused on farmer innovation in land husbandry in Africa. The philosophy behind the research was that, in contrast to the 'transfer-of-technology' paradigm:	1960s onwards

	> One should first look at what farmers themselves are experimenting with and then use this as a starting point for joint research and development by farmers and scientists (Reij and Waters-Bayer, 2001b p. xix). Building on farmer-to-farmer extension, local innovation and a participatory approach, the projects pay particular attention to farmers they describe as often overlooked as a source of inspiration for development (Reij and Waters-Bayer, 2001a).	
Farming Systems Research (FSR)	FSR used a range of methods to gain a better understanding of farmer decision-making processes (Lawrence et al., 2007). Attempts to develop whole new farming systems were generally discredited as it became clear that farmers rarely took-up entire new systems designed by scientists. As a second phase, on-farm research was seen as a useful intermediate step between field trials and extension, and as a way for researchers to get feedback on their work. Yet, it was still firmly embedded in the technology transfer paradigm. A third phase within this framework saw a shift to greater stakeholder participation to increase actual and perceived research relevance, as well as to secure farmer involvement in the changing of their systems. Farming systems research is still applied today. For example, Australia's Commonwealth Scientific and Industrial Research Organisation had a farming systems research program until recently (CSIRO, 2007a)	1960s to present day, evolving through phases
Farmer First	The Farmer First approach has been described as a "loose and diverse coalition of people, networks and organisations committed to developing, promoting and sharing bottom-up, farmer-centred approaches to technology development for agriculture" (Scoones and Thompson, 2009 p. 4). Its core message was that farmers continuously experiment, adapt and innovate and that this has implications for extension. Viewed as innovators and recognised for their skill in surviving, farmers need less a standard recipe or package but rather more choices and options. The hope was that this recognition would lead to support for farmer innovation through more flexible research processes and dynamic interactions between farmers and researchers (Chambers et al., 1989). Similar to other participatory research approaches, it suggests that farmers' knowledge has been undervalued and that they should be	Late 1980s

	equal partners with scientists in the research process. Part of the reason given for this undervaluing is that farmers do not usually keep written records of their findings or publish or patent them (Rhoades, 1989). A 20 year review of progress in Farmer First methods found that progress had been made in creating networks for sharing farmer experimentation and rural innovation as well as new research partnerships between farmers and scientists to promote innovation (Scoones and Thompson, 2009). However, many of the examples provided were in relation to developments in developing country agriculture. It would seem that the Farmer First approach by-passed dominant agricultural research institutions in developed countries.	
Learning selection model	The learning selection model is evolutionary and focuses on learning by using and doing, particularly in the early adoption phase. It requires users (farmers) to be able to modify the technology and have ways of evaluating changes (Douthwaite, 2006). The authors of this approach, (Douthwaite et al., 2002) refer to Rogers' (1962) categories of early and late adopters. They suggest the need for a nurturing of new technology during its early adaptation and adoption, until the point where the beneficiary stakeholders are sufficiently numerous and have adequate knowledge to play the evolutionary roles themselves. They propose that the model could provide a theoretical underpinning for participatory technology development. Both this and participatory research models highlight the importance of "hands-on learning" consistent with adult learning and farmer field school approaches (Conroy, 2008 p. 321).	2002

Participatory approaches paved the way for the emergence of concepts of 'demand-led' research in the early 2000s – largely in development discourse and pro-poor policy. While this led to increasing attention on farmers' needs, the traditional bias towards academic pathways of research dissemination has remained. This means that the results of research remain largely inaccessible to the farmers who were supposed to benefit from the research. Researchers also retain concerns about the validity of farmer opinion. In other words, the rhetoric of demand-led research has not been matched by practice. Such difficulties led Heffernan and Misturelli (2011) to conclude that "it is the differing value systems of those responsible for assessing demand to those responsible for its utterance, which poses the largest constraint to demand-led process" (Heffernan and Misturelli, 2011

p. 116). Like concepts of participation, notions of demand can still be manipulated to reflect dominant views and processes. They suggest objective and effective tools to measure and capture demand are needed that will not be so easily swayed by subjective perceptions of what constitute appropriate research and dissemination pathways (Heffernan and Misturelli, 2011).

Unfortunately, both scientists and farmers continue to have a poor record of respecting each others' skills, professionalism and knowledge (Carr and Wilkinson, 2005). Shifting to a more participatory approach does not necessarily change this situation. There is a tendency in the literature on participatory approaches to avoid critical reflection on the approach itself and instead focus on the need to get "recalcitrant policy makers, bureaucrats and academics to appreciate and adopt these new methods and techniques" (Biggs, 1995 p. 11). Taking this stance can not only alienate these actors, but fail to allow for the evolution of more mature participatory methods.

2.2.3 Multiple pathways for knowledge flows and innovation

Particularly in the past decade, the more linear models of innovation diffusion in agriculture have been replaced by concepts of innovation that recognise multiple players, networks, directions of exchange and means of communication (Conroy, 2008 ; Howells, 2006 ; Klerkx and Leeuwis, 2008a ; Poncet *et al.*, 2010). These approaches draw on the many branches of systems thinking (Klerkx, 2004). They can be conceptualised as recognising multiple pathways for knowledge exchange. Table 3 shows relevant examples of multiple pathways of knowledge exchange.

Table 3. Models for multiple pathways of knowledge exchange

Model	Key Features	Time introduced
Innovation Systems	Innovation systems can be envisaged as learning platforms, where communication, knowledge management and collective learning all play important roles (Ramirez, 1995). The Innovation Systems approach arose out of systems theory and evolutionary economics and was first used as an analytical framework to explain patterns of industrial growth in the developed world (Spielman, 2005 ; World Bank, 2006). In the agricultural sector, it is referred to as Agricultural Innovation Systems (AIS) thinking, where innovation is considered the result of a process of networking and interactive learning among diverse actors including	Originally emerged in the 1970s and 1980s. Applied to the agricultural sector in the 1990s.

	researchers, extensionists, traders, input industries and farmers, to name a few (Klerkx et al., 2010). The AIS focus is on demand for research and the capacity for innovation (World Bank, 2006). It refers to the system of all actors involved in the production, diffusion, adoption and use of knowledge and emphasises the study of attributes and interactions among diverse elements of a set (Leeuwis, 2004). It recognises the roles of actors outside government, and the potential for actors to play multiple roles at various times, as both sources of supply and demand of knowledge (World Bank, 2006). Particularly relevant is its recognition of the role of the private sector in innovation (Conroy, 2008). The model of Agricultural Knowledge and Information Systems (see below) essentially arose out of this systems approach. Past studies on the self-organizing nature of AIS are often undertaken at the national level, while less attention has been given to the micro-level of individual innovation networks (Klerkx et al., 2010). Klerkx et al. suggest that accepting self-organisation may increase opportunities for innovation if "properly facilitated to create and use windows of opportunity" (Klerkx et al., 2010 p. 399).	
Agricultural Knowledge and Information Systems (AKIS)	The AKIS perspective highlights linkages between research, education, and extension in generating knowledge and fostering technological change. The concept draws upon the study of information economics in order to better understand how knowledge flows among and between agents (Klerkx and Leeuwis, 2008a). Röling (1989 p. 1) described AKIS as: > A set of agricultural organisations and/or persons, and the links and interactions between them, engaged in such processes as the generation, transformation, transmission, storage, retrieval, integration, diffusion and utilisation of knowledge and information, with the purpose of working synergically to support decision making, problem solving and innovation in a given country's agriculture or domain thereof. Since then, there has been much theoretical debate about this and other systems and evolution over time in its meaning (Klerkx, 2004). Meanwhile, notions like AKIS have become popular in international policy institutions such as the Food and Agriculture Organisation of the United Nations (FAO)	Researchers at Wageningen Agricultural University in the Netherlands proposed the "agricultural knowledge and information systems" (AKIS) model in the late 1980s
Multiple Source Model	Biggs (1990) proposed the Multiple Source Model, which essentially recognised that innovation can originate in a diversity of places and not just through formal research or linear processes. In particular, this	1990

	approach recognised that ideas can originate from farmers themselves (Conroy, 2008). Biggs model is often cited in subsequent literature on innovation systems.	

The innovation systems concept is still interventionist in many senses, in that farmers are still identified as users of knowledge and information, as compared to producers or suppliers of innovation (Guerin and Guerin, 1994 ; Nicholson *et al.*, 2003 ; Pannell *et al.*, 2006 ; Vanclay, 2011). They are conceived of as the target of actions through networks to change behaviour. On the positive side, a systems approach has a greater focus on fostering new patterns of coordination and networks for communication. It has enabled broader discussions of national innovation systems to inform perspectives of agricultural innovation. Proponents claim that this new approach to innovation in agriculture provides a "framework for the analysis of complex relationships and innovative processes that occur among multiple agents, social and economic institutions, and endogenously determined technological and institutional opportunities" (Spielman, 2005 p. 1). Innovation is viewed as the outcome of various actors combining knowledge from different sources. This process of combining requires forms of interaction (Wolf, 2008). Informal structures, inter-personal contact and even physical mobility are all considered mechanisms for the mobilisation of knowledge (Wolf, 2008). As evident from the discussion and table above, both knowledge exchange and knowledge networks play an important role in innovation systems. Therefore, I have tried to simplify what is a complicated and rich field (with strong elements of overlap) by focusing on another key aspect, knowledge flows and whether they are conceptualised as one-way, two-way or multiple pathways. The evolution of models of technical change and innovation has been influenced by the changing conceptualisation of what knowledge is and how it is produced (Wolf, 2008). The following section expands on what is meant by knowledge and networks.

2.3 Knowledge and knowledge networks

"When we ask whether some particular thing is possible we are asking about our own state of knowledge and thought" (Shackle, 1974 p. 9).

2.3.1 Knowledge

Knowledge is an important concept that relates to both innovation and decision making. Knowledge is not the same as information. Midgley (2000) uses the term "knowledge" in a wide sense to mean any understanding, whether this is phrased in language or whether it takes the form of imagery in the absence of language. Knowledge creation and diffusion is

more than data collection and dispersal. Widely defined, knowledge can include perceptions, implicit understandings, unconscious motivations and behavioural habits. He suggests that knowledge only exists within the presence of a knowledge generating system - a system containing a sentient being or beings (Midgley, 2000). Therefore, actions are undertaken by an agent under the influence of the knowledge generating system in which the agent is embedded.

As Myrdal wrote, "we almost never face a random lack of knowledge. Ignorance, like knowledge, is purposefully directed" (Myrdal, 1969 p. 29). Individuals can pursue and construct knowledge through a range of approaches, ranging from tenacity and intuition through to rationalism and science (Lawrence et al., 2007). There are also different types of knowledge. For example, tacit knowledge is the knowledge we know but can not necessarily or easily communicate – the practices and traditions we inherit, the values that are implied and the prejudgements we may not even be aware that we make (Polanyi, 1966). Within agriculture, it is often the more tacit and less formal knowledge and practical advice from other individuals, together with a farmer's own practical experiences, that informs their decision making processes (Oreszczyn et al., 2010). This informal knowledge is distinct from formal scientific knowledge - the result of scientific research, the aims of which Beunen and Opdam (2011) describe as seeking to understand generic and universal phenomena and establish rules and relationships.

Tacitness is not just a type of knowledge, but also has implications for the means of knowledge transfer (Breschi and Malerba, 2001). This is because knowledge is actually a relatively immobile resource and knowledge is dependent on interpretation (Breschi and Malerba, 2001). Interpretation is in turn influenced by perspective. Most of us hold more than one perspective at any given time, but may dedicate only one perspective to any particular subject (MacDonald, 1998). Changing perspectives can require unlearning what we previously thought we knew or letting go of a particular world view. Or, as Starbuck described it, "often, before they can learn something new, people have to unlearn what they think they already know. That is, they may have to discover that they should no longer rely on their current beliefs and methods" (Starbuck, 1996 p. 725).

2.3.2 Knowledge networks

Given the nature of knowledge, its relative immobility and its distinction from information, much attention has been given to how knowledge moves through human networks. There are many definitions of what constitutes a network. Gross Stein and Stren define a

network as "a spatially diffuse structure, with no rigidly defined boundaries, consisting of several autonomous nodes sharing common values or interests, linked together in interdependent exchange relationships" (Gross Stein and Stren, 2001 p. 5). They emphasise the repetitive interactions between members as well as converging interests. The absence of hierarchy gives networks flexibility. Knowledge networks do not need to be rigidly conceived and organised. They may come and go over time. This is in contrast to an information or 'broadcasting' network. Instead, knowledge networks rely on members actively participating in the exchange of information. Such exchanges add value for all participants by improving the knowledge that is shared. The challenge is creating a governance structure that provides for coordination and accountability, but does not inhibit the ability of members to draw on local resources to generate and shape knowledge, or members' flexibility to reshape agendas. Even in the age of electronic communication, face-to-face meetings and interactions remain crucial for a network to retain its effectiveness (Gross Stein and Stren, 2001).

Networks are characterized by continuous interactions between actors (Carrillo-Hermosilla et al., 2009). The relationships that sustain the acquisition of knowledge and allow for interactive learning can take many forms, including through partnerships, commercial transactions and networks (World Bank, 2006). Important interactions include those among individuals and organisations that are characterised by learning and feedback processes (Spielman, 2005). The role of such interactive knowledge networks and flows is important, because as Oettinger states, despite information technology and the development of other information systems, the "creative processing of substance to turn raw data into useful knowledge remains a monopoly of our flesh and blood minds" (Oettinger, 2001 p. 12). In the context of rural change, there has been an interest in network theories for improving understanding of the complex nature of rural development, and in development a network paradigm that offers an alternative to conventional linear approaches (Oreszczyn et al., 2010). However, less attention has been paid to networks in agri-environmental environments.

Relationships can change over time as a result of knowledge transfers, feedback mechanisms, institutional learning, decision rules, adaptive behaviour and organisation transformation (Spielman, 2005). When it comes to the advice of scientists about new technological developments, farmers want trustworthy, independent information, backed up by robust science (Oreszczyn et al., 2010). In the case of uncertainty and complex, ambiguous environments, decision-makers can resort to simplifying behavioural rules

based on habit to make their decisions, or 'rules of thumb' (Murray-Prior and Wright, 2001). Farmers will often seek knowledge from someone who has been found to be reliable in the past (Gross Stein and Stren, 2001). For example, in a study of New Zealand dairy farmers' access to and use of information, as levels of risk increase, so too does the importance of trust. Therefore, farmers seek knowledge of best practice from others thought to be in a similar situation, strengthening interpersonal ties at the same time (Sligo and Massey, 2007). They are likely to "sieve their incoming data through a fine mesh of perceived credibility and trust, and do so against a backdrop of substantial risk of both financial and environmental dimensions" (Sligo and Massey, 2007 p. 181). This meant that they were constant users of information from numerous sources, and monitored their incoming data in the light of strategic needs, "reflecting their roles as both farming practitioners and business owners" (Sligo and Massey, 2007 p. 170).

As awareness of this variety in information sources has grown, so too has the interest in communities of practice or networks of practice has increased, accompanied by a recognition of the importance of rural networks in learning and innovation (Oreszczyn et al., 2010). In the context of such networks and the development of an innovation systems approach, interest in innovation intermediaries has also risen. In the past, in the field of extension and diffusion, the focus was on 'change agents' or brokers. Over time, the focus has broadened to consider a diverse range of actors, organisations and networks (Howells, 2006). It is now more widely accepted that extension services are not the only intermediaries of innovation. Various studies have also explored the significance of innovation intermediaries. For example, in their research on innovation over time in a large scale irrigation system in Morocco, Poncet et al. (2010) indentified an evolution where a reliance on top-down technology transfer and scientific knowledge eventually translated into a range of knowledge sources, including fellow farmers who became intermediaries themselves, advising fellow farmers. These stages were couched within a very different socio-economic and political context, but they do remind us that farmers can become innovators, even if they were not before. Poncet et al. (2010) draw attention to the role intermediaries play in learning a new practice; facilitate the supply of inputs; and, allow marketing. Intermediaries may include private companies, family networks, government agencies and labour networks.

In the sense of having a formal role, an innovation intermediary can offer more than one-off services, to also offer longer term, relational innovation capabilities. In this sense, Klerkx and Leeuwis (2008a p. 374) refer to knowledge infrastructure and the role that an

"animateur" can play in creating new possibilities in a system by connecting multiple actors. They suggest that public funding should then be directed towards supporting such tasks as 'network brokerage roles' for the early, pre-competitive[1] stages of the innovation process. Poncet et al. (2010) recommend a new role for extension agents as systemic and formal innovation intermediaries, facilitators of knowledge exchange and interaction among stakeholders. Importantly, extension agents need to become local experts in the knowledge systems of local farmers, and likewise respect farmers as another kind of expert, not just an adopter. The role of intermediaries will be discussed in the context of this research in more detail in chapter 8.

2.4 Decision and innovation on-farm

2.4.1 Decision making

Another approach to understanding farmer-driven innovation is through the consideration of decision making. There is a whole field of research into farmer decision making, much of which does not cross-reference the literature on innovation and knowledge systems. That said, it still provides important insights. The 'decision making' paradigms of rural sociology actually have similar origins to that of the innovation systems school of thought. Both have evolved from an earlier focus on models of innovation diffusion, as explained in Table 1. While the innovation systems approach has shifted focus away from the individual agents of innovation, the tradition of inquiry into decision making by farmers has retained a focus on the actions of the individual and their adoption of innovations and practice changes (Conroy, 2008). It is important to make the connection between the two disciplines as they both provide important insights into farmer-driven innovation. The following section describes the evolution in the approach to decision making.

Shackle, (1974 p. 1) wrote that "decision is not, in its ultimate nature, calculation, but origination". It requires imagination, because knowledge of the context in which present action will take effect is necessarily imperfect. This is true of farming, where farmers' information needs are extensive because of their roles both as farming practitioners and managers. They make decisions on a diverse range of topics including some (though relatively few) where there are known "correct" answers, but many others where experts disagree and with differing points of view" (Sligo and Massey, 2007 p. 175). A decision "is a

[1] The pre-competitive phase is early in the life of a product, before its commercialisation, when competitors may chose to collaborate.

choice of action" (Baron, 1988 p. 3). By necessity, farmers make decisions based on imperfect information for a range of reasons. Past studies have shown that a range of components and context specific factors can all play a role in not only the decision being made, but the information that informs the decision (Farmar-Bowers, 2010 ; Nicholson *et al.*, 2003). It follows that decisions to adopt new practices are made based on a range of factors, many of which are not motivated by profit (Vanclay, 2004). Decisions to dis-adopt practices also have a range of contributing factors.

Over time, the focus of research into decision making has shifted. Individual decision making as a key component of farm management has long been studied across a range of disciplines (Brodt *et al.*, 2006 ; Koontz, 2001). It can be approached at many levels, from concern with physiological processes at one extreme to concentration on social institutions at the other (Ajzen, 1991). Starting in the 1950s, studies began investigating the reasons why people did or did not adopt new agricultural technologies and practices (Klerkx, 2004). In the 1960s, the development of models of agricultural extension and adoption were being sought after in both academia and policy circles (Leeuwis, 2004). Such interest continued through to the 1970s and was largely consistent with emerging behavioural approaches at the time (Tonts et al., 2010).

The 1970s saw greater effort put into understanding the thinking of the farmer, the influence of personal characteristics, goals, values, and how extension could use these factors to achieve increased adoption rates (Barr and Cary, 2000). In some instances, this branched out into other approaches, such as adult education. However, in general, the emphasis in definitions of extension shifted away from 'education' to supporting decision making and problem solving (Leeuwis, 2004). This shift in emphasis echoed the work of Simon (1955), who proposed the concept of "approximate" or bounded rationality. As opposed to the economic idea of the fully rational man [sic] who will give prominence to financial considerations through utility optimisation and profit maximisation, this concept recognised that decisions are made within constraints of certainty, time and resources and are subject to an individual's cognitive ability to process information (Chavas, 2008). While not conversely irrational, these constraints mean that fully rational decisions are not possible.

During the 1980s, the emphasis on individual decision making was criticised for what was considered an excessive focus on individuals and for overlooking the role of public and private institutions (Tonts et al., 2010). Expectations that understanding and changing the

attitudes of farmers would lead to changed behaviour were considered simplistic and misleading. This perception gained favour in policy making circles with the result that publicly funded extension became more and more focused on group rather than individual extension, and on-farm advice dwindled (Pannell et al., 2006). This trend was not unique to Australia. In New Zealand farm extension services still exist, but they have gradually become less comprehensive, particularly at the farm level (Sligo and Massey, 2007). It should be noted here that theory would have been unlikely to drive this change alone. There would have been a role played by the shift from the mid-1980s onwards to results-oriented and economically efficient management in the Australian public service – discussed further in the section on neoliberalism below (Wallington and Lawrence, 2008).

The traditional approach to decision making in agriculture, largely framed around the question of how best to do 'extension', came under increasing criticism in the 1990s. Even so, there remains a focus to this day on this aspect and the transfer of knowledge and technologies in order to achieve adoption of new practices as advocated through extension (Koontz, 2001). It is still often assumed that farmers take up practices developed by scientists (Guerin and Guerin, 1994 ; Pannell *et al.*, 2006). In contrast, a 1992 study found that innovative famers were in direct contact with researchers, had research trials on their properties and were independently putting research into practice where its value has been demonstrated (Wylie, 1992). This insight appears to have been overlooked since. Guerin and Guerin (1994) rebuked Wylie's finding, instead suggesting that "this is an extreme and rare situation and that most farmers, even if relatively innovative, are not of this sort" (Guerin and Guerin, 1994 p. 560). In their widely cited paper, Guerin and Guerin (1994) claim that "farmers tend to select from the package of practices developed by scientists" (Guerin and Guerin, 1994). With an emphasis on knowledge transfer, lack of adoption was blamed on a failure of communication. This reflected a strongly embedded assumption that farmers were information deprived and relatively passive recipients of knowledge (Pannell et al., 2006). Such assumptions may reflect was Blaikie (1985) suggested were lingering characteristics of the colonial model in the present day policies. He wrote of a "colonial or classic model of soil conservation" in developing countries whereby "the problem of soil erosion is seen primarily as an environmental one, rather than a complex 'socio-environment' problem" (Blaikie, 1985 p. 4). In this model, land-users are to blame for being "lazy, ignorant, backward or irrational" (Blaikie, 1985 p. 4). An alternative approach would be to understand that the outcome of any intervention will be influenced by the broader contradictions in society that caused the problem in the first place.

A common thread through this evolution in research approaches has been the focus on individual aspirations and motivations as the lens through which options are assessed and decisions justified (Greiner and Gregg, 2011). It has therefore remained a common objective among decision research to understand the motivations of the land holder, in the hope of gaining insights into land use (Koontz, 2001). Adoption decisions are still often explained through reference to goals and motivations (Greiner and Gregg, 2011). That being said, research into farmer motivation has provided insights into the importance of informal and local networks (van der Horst, 2011). For example, Thorsten Hagerstrand's 1930s model of innovation diffusion as a spatial process found communication within the local farming community to be an important agent of change (Hagerstrand, 1967 ; van der Horst, 2011). The important role of farmer-to-farmer communication and neighbourhood networks has also been affirmed by other studies (van der Horst, 2011 ; Wynn *et al.*, 2001). In the context of van der Horst's (2011) research, existing farmer networks are of interest because of their potential to provide "cheap" innovation diffusion (van der Horst, 2011 p. 674). Times change and so do communication methods. The effect of proximity in 2011 will differ to that of the 1960s or even the 1990s. This is particularly so in country such as Australia, which has a population density of less than 0.1 persons per kilometre (McManus, 2005). Factors such as the level of cohesion within a farming community also play a role and will change over time (van der Horst, 2011).

As described above, the 'decision making' paradigms of rural sociology actually have similar origins to that of the innovation systems school of thought. Where innovation systems thinking has tended to focus at the macro level, decision making studies have tended to focus at the micro level. From the 1950s onwards, there was a strong focus on studies to investigating the reasons why people did or did not adopt new agricultural technologies and practices. Effort was put into understanding the personal characteristics, goals and values of the farmer in order to better target extension programmes. From the 1980s, as group rather than individual targeted extension became a more popular approach with policy makers, a gradual awareness of the importance of informal and local networks. With that evolution, studies of decision making and those of agricultural innovation systems are again sharing common areas of inquiry. The other important point is the understanding that motivations and goals alone do not explain decisions or choices of action, but that institutional factors and resource constraints are also influential.

2.4.2 The adoption of innovations

Given the insights above into networks and the individual actions of farmers, it is informative to review some specific conceptual models of farmer decision making. These examples highlight the emphasis given to individual farmer characteristics and also draw attention to a history of interventions that have aimed to influence farmer adoption of technology. An objective behind much research into farmer decision making has commonly been an attempt to better understand what motivates farmers to adopt certain practices, as well as the values and motivations underpinning behavioural choices. As explained above, it is generally accepted that models of decision and adoption must include the motivations of the farmer (Guerin and Guerin, 1994). In order to better group behaviours or anticipate responses to interventions, some studies have created typologies of farmer goals, management styles and other categorisations of farmers (Burton, 2004). For example, Fairweather and Keating (1994) identified three styles among pastoralists and crop farmers in New Zealand:

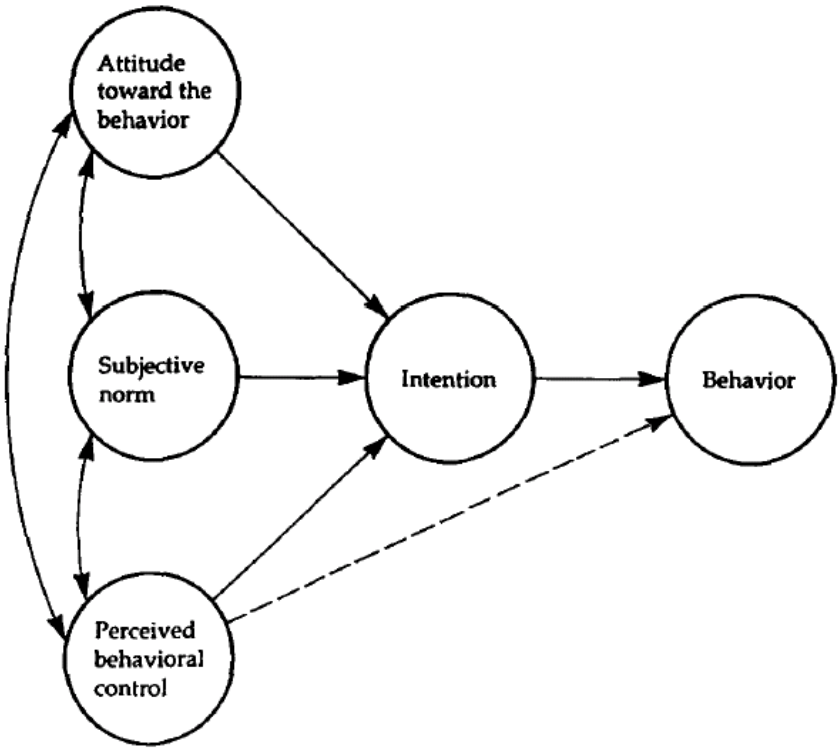
1) the dedicated producer: with a keen interest in the goal of achieving the best quality product and who strongly disagrees with the idea that there is no joy in farm work;
2) the flexible strategist: who looks beyond the farm gate for both effective marketing and for pursuing off-farm activities; and,
3) the environmentalist: where environmental awareness is of major concern, and the environmentalist strives to reduce the use of agricultural chemicals on the farm.

In California, Brodt et al., (2006) ranked economic and social values and goals of farmers. They concluded that farmers make decisions following diverse management strategies and this needs to be accommodated in outreach programs. They came up with three categories for the farmers, based on farmer's goal statements: environmental stewards, production maximisers and networking entrepreneurs. In the Brodt el at (2006) model, a "production maximiser" might reduce the use of pesticides to save money while an "environmental steward" might do so out of concern for biological health on the farm. These categories are similar to those identified by Fairweather and Keating (1994). In contrast, Howden and Vanclay (2000) found through their research into the farming styles of broadacre farmers in Australia that they could not substantiate the conceptualization of tangible farming styles and that there were difficulties in identifying any one farmer's style.

They warned of the impact of the chosen method and also that the results were influenced by the assumptions made in the construction of categories.

Another oft referred to theory is that of planned behaviour, designed to predict and explain human behaviour in specific contexts. It is an extension of Ajzen and Fishbein's earlier theory of reasoned action (Ajzen and Fishbein, 1980), with the addition of perceived behavioural control (see Figure 2). The Theory of Reasoned Action was revised and expanded by Ajzen and Fishbein the 1970s. By 1980 the theory was being used to study human behaviour and develop appropriate interventions (Sarver Jr, 1983).

Figure 2. A diagram of the Theory of Planned Behaviour (Ajzen, 1991)



As in the original theory of reasoned action, a central factor in the theory of planned behaviour is the individual's intention to perform a given behaviour. Intentions are assumed to capture the motivational factors that influence a behaviour and indicate how much effort the decision maker is willing to go to in order to perform the behaviour – noting that this is only possible if the behaviour in question is under the control of the individual (Ajzen, 1991). In reality, few behaviours are under the total control of the individual. That is, control is limited by non-motivational factors such as the availability of requisite opportunities and resources (e.g., time, money, skills and cooperation of others). Collectively, these factors represent people's actual control over the behaviour. The main

point of relevance here is the idea that behavioural achievement depends not only on motivation (intention) but also on ability or opportunity (behavioural control). An additional factor is the level of perceived behavioural control, where the performance of a behaviour is a joint function of intentions and perceived behavioural control. The greater the perceived behavioural control, the stronger should be an individual's intention to perform the behaviour under consideration. In other words, to the extent that a person has the required opportunities and resources, and intends to perform the behaviour, he or she should succeed in doing so (Ajzen, 1991). This theory is valuable in conceptualising the importance of opportunity - or what Sarver referred to as "the context of opportunity" (Sarver Jr, 1983).

This links to an important point – that the ability to realise goals according to motivations is often constrained by limits in available resources, risk, uncertainty and external forces such as regulations (Greiner and Gregg, 2011 ; Herzon and Mikk, 2007). Such factors affecting the choices that farmers make are the subject of much attention (van der Horst, 2011). Given its origins, it is not surprising that the characteristics required for the adoption of innovations - as defined by Rogers (1962) – are commonly restated and reused (see for example Guerin and Guerin (1994) and Barr and Cary (2000)). These characteristics or criteria that influence a farmer's decision to adopt a new practice include: relative advantage, compatibility, complexity, trialability and observability. Barr and Cary (2000) also argue that financial incentive, financial capacity, skill capacity and appropriate technology are necessary before changes in farm management behaviour can be expected.

This is consistent with Trompf and Sale (1998), who found that the major factors restricting the implementation of the productive pasture system onto larger areas of Australian farms were commodity prices and seasonal conditions. These were regarded as being more important as restricting factors than environmental concerns or the lack of suitable soil types. Interestingly, in this study the lack of information or expertise was seen as the least important restricting factor. In a study by Morgan et al. (2010), participants gave several reasons, including that a change of strategy would require not only skill in realising the opportunity but also in creating and managing a business strategy and that context, such as climate, location and market conditions could be limiting factors. In terms of increasing the ability to realise opportunities, they found a wider network of contacts from a broader set of market relationships appears to facilitate both the recognising and realising of opportunities (Morgan et al., 2010).

2.4.3 A role for opportunity?

While decision research in the past has focussed on motivation, there has been acknowledgement also of the importance of opportunity, at least what Sarver Jr (1983) referred to as the context of opportunity. The importance of 'opportunity' has been recognised by some authors. In his study of decisions of land users in the United States, Koontz (2001) concluded that research needed to go beyond motivations, to link characteristics to activities and outcomes. The importance of opportunity was also affirmed in a study by Farmar-Bowers and Lane (2009), who found that farmers saw opportunities as something they created from personal and external components, and which were greatly influenced by random components such as droughts and market fluctuations. Using a concept of lenses, they explored how decision- makers might satisfy their own interests and their family's motivations in the long term. They suggest that decision-makers were quite aware of the direction in which they wanted their personal career path to go and were actively creating opportunities for advancement. It was therefore felt that policies that supported intrinsic interests and motivations would better harness the energy and thinking capacity of farmers and their unique knowledge of their own farms (Farmar-Bowers and Lane, 2009). They propose a 'drivers model' and recommend further efforts to identify the components farmers need in order to create opportunities in the relevant decision system, including which components policy can control (through increased or even decreased farmer access to specific components) (Farmar-Bowers and Lane, 2009).

As described above, authors such as Koontz and Farmar-Bowers and Lane recognise the importance of opportunity and recommend further research that can better link activities and outcomes through understanding how to create opportunities. Though this is a welcome acknowledgement, to date the emphasis of actual research and field studies has still tended to be more about identifying constraints to change or the adoption of desired practices rather than on what actually creates change (Brodt *et al.*, 2006 ; Curtis, 2001 ; Greiner and Gregg, 2011 ; Guerin and Guerin, 1994 ; Pannell *et al.*, 2006 ; Rodriguez *et al.*, 2008). This has meant that, while there is a level of consensus around the importance of opportunity, there remains a gap in our understanding of what is actually required to foster change where motivation already exists.

So what is opportunity? Opportunities and constraints for new land uses are created by a range of factors, not least markets and policies, increasingly influenced by global

circumstances (Lambin et al., 2001). Opportunistic behaviour can also be aided by cooperation and nonmarket exchanges, in turn promoted or impeded by institutional settings (Spielman, 2005). Part of understanding opportunity is to realise that neither adoption nor innovation are one-off instances. Pannell et al. (2006) recognised the ongoing nature of implementing on-farm change. They wrote that "the adoption process is never completed, in the sense of eliminating all uncertainty. All options are continuously open to question and review as new information is obtained or circumstances change" (Pannell et al., 2006 p. 1408). Nicholson et al. (2003) described a continuous three-stage process of motivation, trialling-exploration and farm practice change. Their model suggests adoption follows a continuous and logical sequence that involves three key stages, with transition between the stages involving a conscious decision to progress. Stage one, motivation, is underpinned by continual exposure to the opportunities created by the practice change and combined financial, social and environmental opportunities that make trialling and farm practice change possible. Nicholson et al. (2003) recognise that traditionally, most extension programs have focused on providing support only during the motivation and exploration/trialling stages of the practice change process. They therefore make a valuable contribution by conceptualising a third stage - farm practice change - with three elements of support necessary:

- Peer support and encouragement
- Effective answering of questions (if not answered effectively, the outcome can result in discontinuation of the trialled practice)
- Supportive structure between producers and scientists.

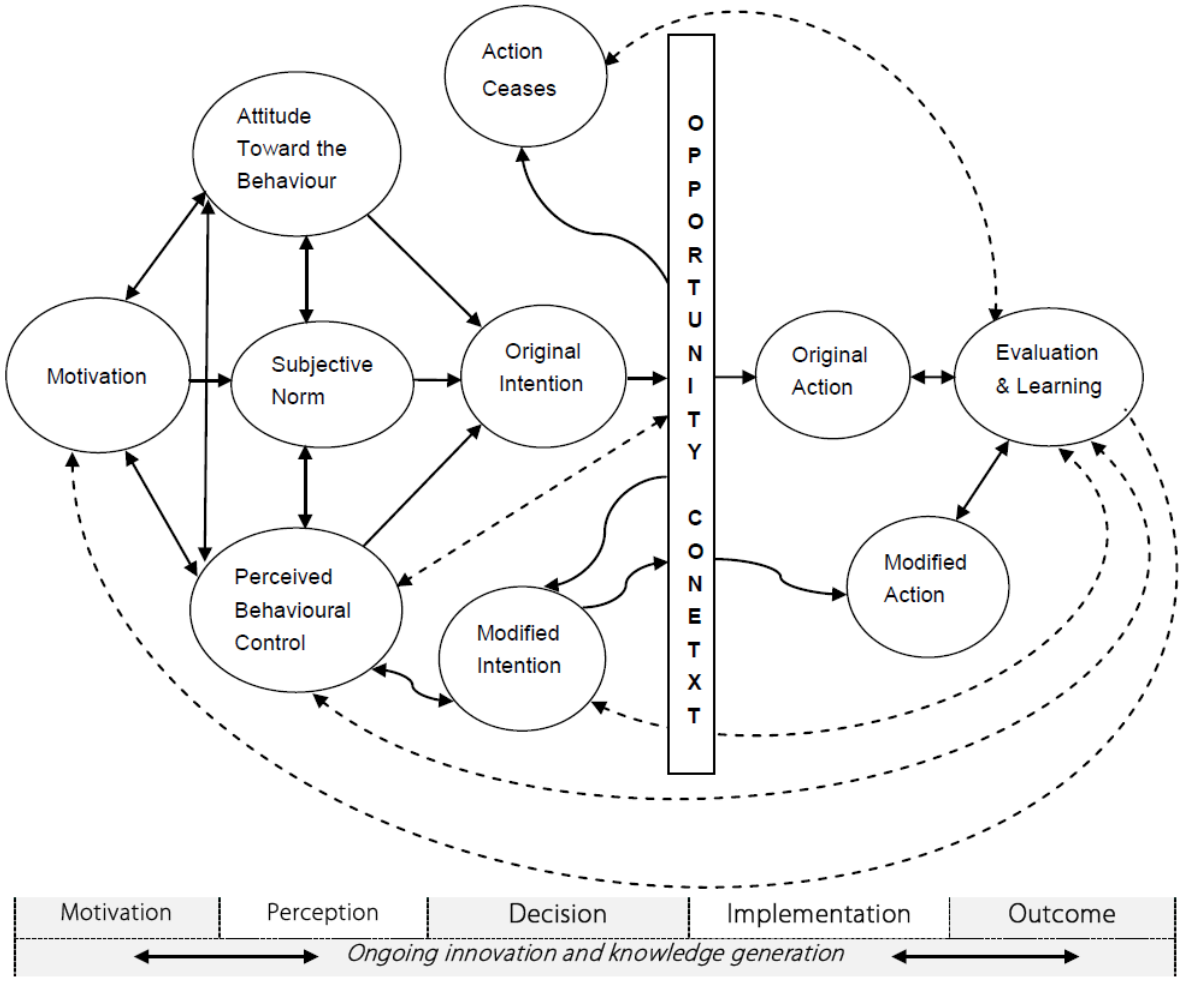
It is a useful model, although it stops short of making a connection between whole farm change and ongoing innovation. This is despite Nicholson et al. (2003) recognising that "between the farm practice change and motivation stages [farmers] need to make a decision to seek further opportunities to improve their grazing systems. This implies a continuous planning, trialling, adoption and evaluation cycle" (Nicholson et al., 2003 p. 693). In other words, although this continuous process post-adoption is recognised, there is little explanation of how it works in reality.

Despite the contributions outlined above, researchers and government policy makers continue to overlook the difference between ability and willingness. For farmers to make certain decisions, they need access to appropriate capital and resources (Valbuena et al., 2010). Farm businesses are made dynamic and adaptive when a farmer has the ability to sense and seize opportunities (Grande, 2011). Where lack of resources is a barrier to seizing

such opportunities, building dynamic capabilities like the ability to integrate knowledge and resources, improve marketing and strengthen strategic alliances may help to offset this barrier (Grande, 2011). Farmers may also require certain conditions to initiate changes in farm management, such as appropriate institutional contexts, knowledge exchanges and partnerships. It follows that these conditions would need to be maintained over time for ongoing change to occur. In the context of innovation, the ability to take action is referred as "innovation agency" by Klerkx et al (2010). This agency is determined by the "resources and competences that an actor or organization has at its disposal for innovation (i.e. knowledge, skills, material and financial resources)" (Klerkx et al., 2010 p. 391).

Agency is also determined by the range of uncertainties innovating actors are exposed to as well as external events, such as government policy, that are outside their control. I have therefore taken the liberty of building upon Ajzen's (1991) diagram (Figure 2) to make the opportunity context more explicit (Figure 3). The diagram below incorporates stages of motivation, perception, decision, implementation and outcome. In this model, knowledge is both a component of the ongoing decision making process and part of the opportunity context. Where the opportunity context is appropriate, actions will take place. Where it is not, intentions and actions will be modified. The aim of the diagram is to show the feedback loops and non-linear nature of decision making. It demonstrates that the relationship between knowledge, decision making and innovation is not linear, but it is multifaceted and interconnected. Knowledge generation, exchange and application both inform decisions and allow decisions to be realised. Likewise, innovation is itself both an opportunity and a means to realise opportunities.

Figure 3. Diagram of ongoing innovation and knowledge generation



2.5 Farms as firms, farmers as entrepreneurs?

2.5.1 Farms as firms

Within the broader innovation literature (beyond the agricultural sector), it is the institutions not individuals that are a crucial component of the innovation system (Lundvall, 2007). These institutions are a "main character" in the innovation process and have the ability to either constrain or facilitate innovation depending on its compatibility with the change process (Edquist and Johnson, 2005 p. 41). Cooperation, and the nonmarket exchanges that allow for opportunistic behaviour by agents involved in the exchange, is one of the key behavioural aspects of agents in an innovation system and is conditioned by the institutions that promote or impede it (Spielman, 2005). It is therefore important to give some thought to farmer-driven innovation not just as the result of the decision of the farm, but also as a result of the nature of the farm as an institution.

Definitions of institutions can be broad, and include behaviour and rules, or be limited, and simply refer to organizations (Edquist and Johnson, 2005). In this thesis, the term "institution" is used broadly to mean rules and social norms as well as organisations. The term "firm" is used to mean an actual business operation. The 'farm as a firm' can be conceived of not just as a business, but as a bundle of property and knowledge based resources and capabilities. Knowledge-based resources can include tacit knowledge (described in section 2.3.1) related to specific skills, traditions or opportunities on the farm. Such resources can be protected by knowledge barriers – the fact that a competitor may not be able to mimic a firm's operations (Grande, 2011). This is a reflection of the relative immobility of knowledge (as opposed to information) as is also described in section 2.3.1. In this context, it is the aspects of cooperation and competition amongst firms and mechanisms that coordinate interaction and enable such linkages that impact on knowledge flow (Breschi and Malerba, 2001). It is the "innovating firm" that is the focus of innovation policy and the expected point at which policies interact in a way that either incentivises or disincentivises innovation (OECD, 2005 p. 37). Conceiving of farms as firms makes it easier to think of farmers as professional business managers and entrepreneurs – a title which is more usually associated with business operators in other sectors rather than agriculture (Richards and Bulkley, 2007).

2.5.2 Farmers as entrepreneurs

Entrepreneurship plays an important role in farm management, although it is often overlooked for reasons described below. Firstly, the definition of entrepreneurship needs to be clarified. Here, the link with opportunity again becomes important. York and Venkataraman define "the act of entrepreneurship as one of discovering and evaluating opportunity" as well as the creation of new opportunities (York and Venkataraman, 2010 p. 451). Morgan et al (2010) define entrepreneurship as being associated with "innovation, reorganisation and creative action and in (re-) ordering resources to take advantage of, or to create, opportunities for realising value" (Morgan et al., 2010 p. 119). In this context, entrepreneurship is "inherently concerned with solving problems of uncertainty, innovation and resource allocation" (York and Venkataraman, 2010 p. 452). Schumpeter (1934) identified entrepreneurship as a key creative force, where disruption of the old was necessary to usher in the new – coining the term 'creative destruction' (Hall, 2010).

The problem is that the existence of entrepreneurs in the farming community is often overlooked and there has been little research devoted to the subject (Richards and Bulkley, 2007). The exception are authors such as Klerkx and Leeuwis (2008a), who describe farmers

as agricultural entrepreneurs and highlight that the constraints experienced by agricultural entrepreneurs are similar to those experienced by non-agricultural small to medium enterprises (SMEs) - as both types of enterprise display similar characteristics. Resistance to considering farmers as entrepreneurs partly flows from a traditional view of farms and farmers as being separate from "normal market logic" where a farmer's identity is primarily that of producer rather than business person (Morgan et al., 2010 p. 119). Entrepreneurship is also usually described as a neoliberal value, alongside competition and efficiency (Lockie et al., 2006). The result is that by perceiving farms primarily as businesses and farmers as entrepreneurs (similar to other industrial sectors) the reflex is to assume that they are agents of the agro-industrial paradigm (Morgan et al., 2010). For example, Dibden et al. suggest that the neoliberal emphasis on sound business practices and "resulting construction of farmers as self-reliant entrepreneurs sits uneasily with the narrative of farmers as altruistic land stewards" (Dibden et al., 2009 p. 306). Though having potentially different objectives, there is an interesting consistency between the emphasis in innovation literature on entrepreneurialism and that of neoliberalism.

In this thesis, it is not assumed that entrepreneurship precludes environmental stewardship. Rather, it is argued that looking at entrepreneurial behaviour can provide insights on innovation and actions taken to create opportunities for realising value (Morgan et al., 2010). Indeed, there is a growing literature on the potential for entrepreneurship (outside agriculture) to solve environmental problems. While environmental problems can arise from market failure, so too can environmental solutions, with entrepreneurship the means to capitalise on what is essentially a gap in the market (Dean and McMullen, 2007 ; York and Venkataraman, 2010). However, that the ability to realise an opportunity (as opposed to perceiving it) can also be constrained by context (eg. climate, market, regulations) and resources (eg. labour, capital, assets). The challenge is that for profit-seeking entrepreneurs, the market benefits of agricultural sustainability are few. Yet, if governments intervene to create new markets, the opportunity that was itself a function of market failure may disappear. In other words, the window for entrepreneurs may be too short lived. In agriculture, this is a particular challenge, not only due to the lack of environmental markets, but because of the lack of profitability for farmers within commodity markets and the sector at large. As is further discussed in Chapter 9, establishing appropriate baselines to measure the provision of environmental services is key. The second challenge distinct to agriculture is that farms are often long lived businesses, potentially over a period of generations. In other industries, environmental innovations are considered more likely to emerge from new firms that can do what

incumbent firms cannot (York and Venkataraman, 2010). For farmers, innovation means finding new ways to operate within the constraints of existing conditions. Again, it follows that changing these conditions through ineffective interventions can potentially undermine the opportunity for innovation.

There is a view that entrepreneurship and indeed business management in farming has unique characteristics due to its embeddedness in biophysical and social contexts (Morgan et al., 2010). Likewise, while the management of knowledge in many sectors of the economy has become an important issue over the past ten years, little attention has been given to what this means for SMEs, such as those run by farmers (Oreszczyn et al., 2010). Instead, the study of knowledge, networks and learning has more usually been done for medium to large enterprises, rather than SMEs (Sligo and Massey, 2007). The challenge is to appreciate to distinctive characteristics of farm businesses whilst still learning the lessons of innovation in other sectors. Considering farms as firms or institutions as per businesses in other sectors can help to make lessons on innovation from those industries more obvious.

An example of the insights made possible by drawing on lessons from other sectors comes from Eliasson's (2000) work on 'the competence bloc' or innovation cluster. Incorporating institutional theory of efficient economic selection and industrial policy, Eliasson established principles for the efficiency and completeness on which the competence bloc is reliant, including exit markets that facilitate ownership change. This ingredient is particularly relevant, considering that in the agricultural sector market entry is undermined by the very land prices that prevent forced exit, and where the choices of European consumers or Chinese buyers can have impacts half-way around the world (Sayre, 2009). Likewise, it is Eliasson's (2000) view that the most important diffusion mechanisms involve the movement of people with competence, facilitated by a functioning labour market. Again, these insights have relevance for agriculture, where skilled labour shortages are severe, where one farmer can manage the same land for a lifetime, and where a family of farmers can live and work for generations. A plentiful supply of skilled labour is also considered "a precondition in forming the basis for entrepreneurship" (Breschi and Malerba, 2001 p. 823). Agriculture is different to other industries in that it doesn't necessarily have a pool of specialised and skilled labour to accompany a firm's innovative activities. These skills are more likely to be those of the owner/manager and family members. This links into the literature on intermediaries and raises questions about the role of private consultants, third-party contractors and other

exchanges that create a form of labour mobility that would not otherwise exist. Likewise, if "it is more efficient policy to make sure that all institutions of the competence bloc are in place than to encourage and/or support particular high-tech industries or to attempt to pick winners and commercialise particular technical innovations", (Eliasson, 2000 p. 227) then this raises serious questions for current agricultural policy in Australia.

2.6 Summary

This chapter has reviewed the existing literature on innovation in agriculture as well as theories of how farmers make decisions. In doing so, it has become apparent, just as Howells (2006) highlighted, that there is a lack of cross referencing not only within the innovation systems literature but between it and other perspectives of decision and innovation. Much can be gained by drawing on the theoretical insights of both in order to better understand agricultural innovation. Linked to this is the need to understand the context in which farmers are operating.

The literature above has reviewed some of the key concepts that this thesis will engage in, as per the three research questions outlined in Chapter 1:

1. What has been the nature of farmer driven innovation, including the generation of knowledge?
2. How is knowledge exchanged and what role do networks play?
3. What impact have government interventions had on the innovative capacity of farmers.

Concepts of innovation systems, knowledge networks and decision making particularly inform questions 1 and 2. Question 3 draws on these concepts as well as being informed by the ideologies and paradigms influencing government interventions in the past. This relates particularly to common approaches to influencing farmer behaviour – through the agricultural extension approach and the neoliberal hybrid approach of increased farmer self-reliance and increased environmental regulation. Chapter Three explains this link in further detail. It provides an overview of innovation from a public policy perspective, as well as that of recent approaches to land management and sustainability - both of which are driving renewed interest in agricultural innovation and interventions in farmer practices. In this context, the influence of neoliberalism on the characterisation and encouragement of farmers to be entrepreneurs is also discussed.

3. Australian agriculture's changing context

3.1 Introduction

Before delving further into the nature of innovation and interventions into innovation on-farm, it is important to better understand the context in which farmers are operating and in which broader conceptual and policy approaches are embedded. This chapter explores the changing context of Australian agriculture. It looks at the recent history of the paradigms of neoliberalism and multifunctionality. Public policy developments and the renewed focus on agricultural innovation are also detailed, from both a global and Australian point of view. The purpose of this chapter is to contextualise the study.

3.2 Changing paradigms

3.2.1 Neoliberalism

In reality, "neoliberalism is not a widely agreed upon term" and in practice it can be expressed through a range of "hybrid neoliberalisms" (Haughton and McManus, 2011). What is common across the "complex assemblage of ideological commitments" is an enthusiasm for self-regulating markets that "goes hand-in-hand with political and ideological antagonism towards state interference" (McCarthy and Prudham, 2004 p. 276). Neoliberalism is said to have been "manufactured" in the 1970s in Chicago by philosopher-economists such as Milton Friedman (Power, 2003 p. 9). It promotes an economic-growth strategy based on removing government restraints, economic deregulation, reduction in state subsidies and the prominence of the market. Yet, in effect, what is described as the current "neoliberal period" does not so much reflect a radical shift in thinking, but rather an extension of the ongoing liberal emphasis on market mechanisms, including privatisation, commercialisation and free trade, an emphasis that has been evolving since the 1950s (Sayre, 2009 p. 705). Between World War II and the Organization of Petroleum Exporting Countries (OPEC) oil price shock of 1973, agricultural systems in developed countries underwent significant capital and technological intensification. Farming became increasingly incorporated into agri-commodity chains and global agri-food regimes (Argent, 2011). This period of transnational restructuring of the agriculture sector coincided with an era of strong state protectionism (Argent, 2011). The mode of governance of this time has been described as that of the welfare-state (Lockie and Higgins, 2007). Politics in Western democracies at this time was bound by "welfarist, statist

and Keynesian systems of thought" (Mudge, 2008 p. 705). From the 1980s, this mode was significantly replaced by neoliberal policies including the deregulation of many sectors. Peck and Tickell, (2002), described the 1980s as a period of regulation 'roll-back', while the 1990s was more about the 'roll-out' of new 'third-way' approaches that sought to overcome the limitations of neoliberalism that become apparent in the previous decade. As Mudge aptly describes it, policy makers had to start asking the question "how much market", while during the Keynesian era their predecessors were faced with the question of "how much state" (Mudge, 2008 p. 724).

Current neoliberalism still concentrates its efforts in three main areas: international free trade in goods and services, the free circulation of capital (through the deregulation of markets) and freedom for investment (through the ongoing corporatisation and privatisation of formerly state-owned entities) (Argent, 2011). In these efforts, competition is seen as fundamental (Power, 2003). While economists are criticised for not acknowledging that the market itself is an institution and the importance of market failures and institutions as "conditioning factors" for development, neoliberalism remains a dominate ideology globally (Power, 2003 p. 160). It is the basis of the 'Washington Consensus' which dominates development theory and policy – measures to promote wealth and favourable investment climates in developing countries (McCarthy and Prudham, 2004 ; Power, 2003). The idea of 'latecomers' needing to catch up with existing and advanced systems and practices is central (Power, 2003). Central too is the conceptualisation of development as a series of progressive stages of activity, as well as notions of free-trade and self-regulating markets – both reflections of the 18th century philosopher Adam Smith's enduring influence (Power, 2003).

Australian governments have adopted a rationality of market rather than state rule, reflecting the neoliberal belief that this will better position Australia to capture a greater share of the global economy (Lockie et al., 2006). In this context, the Australian agricultural industry, like agriculture in many other places in the world, has undergone significant changes over recent decades. The 'roll-back' of the 1980s saw the dismantling of statutory marketing boards and other institutional arrangements intended to collectively manage risk (Lockie and Higgins, 2007). Farmer-owned cooperative boards were "virtually all abolished, corporatized or privatised during the 1980s and 1990s (Argent, 2011 p. 18)". These changes signalled the end of strong state and federal government support for the sector (Argent, 2011). The 'roll-out' of the 1990s saw the introduction of new natural resource management programmes such as Landcare, property and catchment

management planning as well as the Natural Heritage Trust and the National Land and Water Resources Audit (Lockie and Higgins, 2007). It was followed in the latter half of the decade with the introduction of native vegetation laws to restrict land clearing, particularly in the states of NSW and QLD.

Production is now largely dependent on capital intensive technologies and global markets (Pritchard et al., 2007). It has become increasingly deregulated and, as a net food exporter, integrated into global networks of trade and knowledge (Tonts et al., 2010). While total production is not large when compared globally, Australia's share of many agricultural export markets is, especially for wheat, beef and lamb (Wight and Laffan, 2008). Some would suggest that agriculture maintains a "politically protected status" (Wallington and Lawrence, 2008 p. 287). Relative to other economic sectors within Australia this may be true, but compared to the agricultural sectors of other countries with which Australian farm businesses compete this is less so. For example, countries in the Organisation for Economic Co-operation and Development (OECD) collectively pay subsidies to their farmers of around USD $1billion per day (Nature, 2010). New Zealand farmers are the least subsidised in the OECD at 1% (support expressed as a % of producer revenues), followed by Australia, where producers receive an average of 4% support. This compares to the United States which receives 9% and the European Union (EU) which receives 23% (OECD, 2010).

It is not surprising that efforts in both the European Union and England to create a more entrepreneurial farm sector have faced significant challenges due to the long history of exceptionalism and separation of the agricultural sector compared to their non-agricultural counterparts (Phillipson et al., 2004). As explained above, Australia has long relied on unsubsidised and highly competitive and productive agriculture to win markets (Dibden et al., 2009). In line with the emergence of neoliberal governance approaches has been "a trend in rural and agricultural policy towards programmes that seek to facilitate various forms of self-regulation, self-help and entrepreneurialism" (Lockie and Higgins, 2007 p. 1). These new approaches embodied an expectation that farmers would independently seek entrepreneurial solutions to improve productivity and competitiveness. In this context, agriculture research has largely been driven by an agenda of increasing on-farm productivity and profitability, particularly in the short-term (Pannell, 2003). In a study of the Australian tomato industry, farmers were found to exhibit behaviour "reminiscent of any entrepreneurial capitalist involved in input into an industrial chain" (Pritchard et al., 2007 p. 85). They were found to be "exceptionally entrepreneurial,

market-sensitive, technologically-oriented, knowledge seeking and highly capitalised" (Pritchard et al., 2007 p. 85). This was claimed to be partly a response to heightened international competition, where becoming more professional and entrepreneurial is required for economic security. It was also seen by the authors as conforming to a productivist paradigm, "with all that implies". Yet it is an experience common across the wider economy, where local firms of all sectors feel the pressure to continuously innovate, and they are challenging governments to develop policies to stimulate and support and innovation process (World Bank, 2006).

The consequences of neoliberalism on environmental condition and degradation are extensive and yet not always obvious. One result has been a trend towards creating markets to value ecosystem services (discussed in more detail in section 3.3.2 below). The problem is that there is no objective way to price these services as other commodities may be priced. Critics argue that payments for ecosystem services (PES) result in the (imperfect) commodification of nature, where market approaches fail to address the drivers of environmental degradation and where it is not possible to put a value on all environmental benefits and services (Cocklin et al., 2007). Pricing will inevitably be incorrect because interpretations of neoliberal strategies to put a price on ecosystem services will always be influenced by constructions of nature and perceptions of science and economics (Robertson, 2004). The ability of ecosystem scientists to be able to translate holistic measures and values of ecology into tradeable commodities defined by static and "uncontroversial measures of weight, volume or time" are seriously questioned (Robertson, 2006 p. 367). This argument has some merit in that, within neoliberal theory, price has the role of quantifying value and providing markets with information. The mechanisms by which prices are discovered (or created) can vary. In the context of markets for ecosystem services, it is yet unclear how best to price public goods or what commodity definitions and practices are appropriate (Robertson, 2007). Practical guidance on this issue is sparse.

Given the problems associated with the commodification of environmental goods and services, it is not surprising that a key source of political opposition to neoliberalism has been environmentalism. What has followed is an assumption that neoliberalism and environmentalism are polar opposites. With this duality in mind, technological solutions, such as conservation farming, are judged by critics of neoliberalism as simply being an extension of the dominant agro-industrial system, continually requiring high inputs and the intensification of production (Lockie et al., 2006). Robertson views the commodification of "ecological relations" as a "project of mobilizing ecological forces in

the service of neoliberal hegemony" (Robertson, 2004 p. 362). While McCarthy and Prudham (2004) recognise the cross-fertilisation between the two concepts in recent years, they still describe sustainable development as "neoliberalism's main contender in challenging post-socialist development orthodoxy", repeating the critique of sustainable development's collapse "in policy circles into light-green capitalism" (McCarthy and Prudham, 2004 p. 276). Castree (2007 p. 53) agrees that "the neoliberalisation of nature in both theory and practice ought certainly to be the subject of our censure for all sorts of compelling reasons". However, he also cautions against assuming that the actors for whom neoliberalisation seems to "work" are "the victims of ideology, 'sell-outs' or otherwise naïve (Castree, 2007 p. 53). In fact, there are both counter veiling and co-existing philosophies that temper neoliberal forces, such as models for local participation and eco-centric solutions such as national reserves. Rather than being polar opposites, these "co-existing" mentalities result in more of a hybrid model than an approach that could be said to be typically neoliberal (Lockwood and Davidson, 2010).

Another consequence of neoliberalism has been the tendency for environmental solutions, and hence blame, to be focused on individuals (that is, farmers) rather than the market or the state, and for responsibility to be devolved from government, with little attempt to correct the economic conditions driving the over-use of land (Lockie et al., 2006). What were once collective problems have now become the fault of the individual. The original objective was not to simply shift the blame away from central governments. It was in fact assumed that devolving responsibility would be more efficient and effective – hence the introduction of a regional approach (McCarthy and Prudham, 2004 ; Wallington and Lawrence, 2008 ; Wentworth Group, 2002). This devolution was also consistent with a general tendency for decentralisation within government – something which has manifested itself in a public service dominated by results oriented management and "horizontal forms of accountability" (Wallington and Lawrence, 2008 p. 283). The shift to a new type of public management has meant that the system of natural resource management planning in Australia has become more performance based, at the same time as regional bodies have become overburdened by the excessive accountability framework that they must now satisfy. In addition, although responsibility has been decentralised, control of natural resource management remains largely centralised (Lockie et al., 2006). Such inconsistencies prove problematic not only for the organisations that seek community participation without having the power of implementation, but for the community participants who soon realise that participation does not stop centralised interventions. Meanwhile, the traditional focus on environmental protection on one hand,

and interventions to change agricultural management practices for environmental outcomes on the other, still remain (Wallington and Lawrence, 2008). Challenging this division between production and consumption (at least theoretically) is the increasingly popular concept of multifunctional agricultural systems.

3.2.2 Multifunctionality

Multifunctionality challenges the prominence of neoliberalism in agriculture by shifting academic focus from the traditional production of food and fibre towards the potential for agricultural resources to serve multiple functions relating to social, economic and environmental wealth and sustainability (Crossman and Bryan, 2009). Given its potential numerous functions, multifunctionality has also become an alluring concept for policy makers seeking to balance multiple interests in the landscape (van der Horst, 2011). Definitions of multifunctionality vary. As Morgan et al. (2010) describes, it can be:

- Restricted to pluriactivity within the agro-industrial model;
- Arise from a 'post-productivist' paradigm in which other land uses gain prominence aside from agriculture; and,
- Part of a sustainable rural development paradigm, where agriculture is seen to be linked to the wider socio-economic context of an area and to the wider economy in general.

In effect, all three types of multifunctionality could exist alongside each other within a landscape. Likewise, both post-productivist and productivist agriculture could occur on neighbouring farms. Bjørkhaug and Richards (2008) suggest that the term 'multifunctionality' or multifunctional agriculture might be seen as a policy or regime within, beside or beyond productivism and post-productivism as it includes several functions of agriculture in addition to its primary role which has been mainly understood as producing food and fibre (Bjørkhaug and Richards, 2008 p. 101).

Generally, multifunctionality has been associated with smaller farms rather than large-scale commercial enterprises, where forces of market liberalisation and policies favouring neo-productivist agriculture are pitted against policies seeking to encourage multifunctional landscapes and non-market values (Morgan *et al.*, 2010). The preference is clearly for multifunctionality that challenges the productivist paradigm and results in improved natural resource management, biodiversity conservation, and the increased provision of ecosystem services (Crossman and Bryan, 2009 ; Lamine, 2011 ; Renting *et al.*, 2009).

Multifunctional agriculture has particularly been promoted in Europe through the Common Agricultural Policy of the European Union – although more recent reforms since 2003 to open agriculture to competition may be eroding this support (European Commission, 2010 ; Phillipson *et al.*, 2004). The concept also has some currency in the United States, although the policy context is less conducive to its realisation (Crossman and Bryan, 2009). In Australia, there have only been weak shifts towards multifunctional agricultural, in both a theorectical and policy sense (Bjørkhaug and Richards, 2008). Authors such as Argent (2002) and Holmes (2008) are some of the few to have discussed Australia's transition to multifunctionality. The increase in environmental regulation, as well as the interest in market based instruments (see section 3.3.2) both show some of the characteristics of multifunctionality but not a widespread realisation of the concept (Bjørkhaug and Richards, 2008).

Challenging notions of post-productivist or multifunctional landscapes is the trend in Australia agriculture towards land use specialisation (Chavas, 2008). While farm diversification is promoted as a way to reduce risk and increase profitability in traditional farming enterprises, diversification alone does not necessarily solve farm income problems, particularly where resources are channelled away from the core business to support other secondary efforts (Grande, 2011). On the other hand, specialisation allows farmers to focus their attention and skills on fewer enterprises, potentially resulting in greater productivity and efficiency (Chavas, 2008). In Australia, governments still show strong support for productivist resource management (Lockie et al., 2006). This continued acceptance of market rule, despite government investments in environmental rehabilitation, caused Lockie et al. (2006) to ask whether governments can be unaware of the "fundamental contradiction" between seeking sustainable development and the productivist pathways promoted by the current competitive global market regime (Lockie et al., 2006 p. 40). As discussed above, neither entrepreneurial activity nor neoliberalism are necessarily enemies of sustainable development. Given the role that economic institutions have played in causing environmental degradation, it follows that reformed economic institutions and activities may in part be a remedy.

3.3 Public policy and government interventions

3.3.1 Policy approaches to innovation

Chapter Two introduced the concept of innovation systems. Although the concept emerged several decades ago, it remains relatively novel and unheard of for many policy makers and researchers (World Bank, 2006). Instead, the 'transfer of technology' approach, including the innovation-diffusion tradition (also discussed in Chapter Two), can still be found underpinning a range of government policies, even those with different productivity and conservation agendas (Hall et al., 2009). It is not unusual to see publicly funded programs with an end goal of adoption – be it a particular knowledge or action – with the emphasis on the transfer of technologies and information to encourage certain practice changes on farm, but with little focus on what happens on-farm after an initial decision to adopt a practice has been made. The focus remains on barriers to change and what makes farmers make this initial decision to adopt certain land use practices or technologies. Farmers are viewed as actors in a network that is reliant on intermediaries, and as recipients of knowledge. For example, the Australian Bureau of Agricultural and Resource Economics 2006 report on natural resource management on Australian farms explicitly draws upon the "diffusion of innovations" framework to discuss influences on adoption of sustainable farm practices (Hodges and Goesch, 2006). Likewise, a set of socio-economic indicator protocols endorsed by the National Land and Water Resources Audit Advisory Committee in June 2008 relate to land managers' capacity to adopt new management practices (NLWRA, 2008). The framework was "designed to help understand the key barriers and drivers of adoption" and is clearly informed by linear concepts of innovation-diffusion, with a focus on aspirations and individual capacity rather than networks and knowledge infrastructure (NLWRA, 2008 p. 8). On the positive side, it does include post-adoption success as a measure, something that is too easily ignored, given that "most extension programs have focused on providing support only during the motivation and exploration/trialling stages of the practice change process" (Nicholson et al., 2003 p. 693).

In contrast to traditional extension approaches, the conceptualisation of innovation in the *Australian Innovation System Report 2010* is more consistent with recent systems thinking. The Australian innovation system is described as "an open network of organisations interacting with each other in an environment that stimulates and regulates their activities and interactions" with three main components that "collectively function to produce and diffuse innovations that have economic, social and/or environmental value": organisations

(including individuals), interactions and environment (Commonwealth of Australia, 2010b p. 8-9).

In general, innovation policy still tends to receive most attention as an extension of research and development approaches and a "generic policy area in which governments can promote an innovative, flexible adaptation of their economies" (OECD, 2005 p. 7). Innovators are characterised as high-end research and development of corporations and universities rather than individuals in smaller firms, and least of all farms. This reflects an ongoing assumption that innovation is the domain of scientists, researchers and corporations. Yes, they are innovative, but not exclusively so.

Perhaps without realising the implications of the term, innovation is often promoted as an objective of government programs. In 2007, the NSW Government established The Innovation Council in order to advise it on policies and strategies which create an environment where it is easier for businesses to innovate, improve the innovative capacity of the NSW private sector and help increase investment and build stronger rural and regional economies. This followed the release of the NSW Government Statement on Innovation (2006), which recognised that involvement and intervention in key sectors should be undertaken only after acquiring deep knowledge of the role that innovation plays in how the sector operates. The statement also set out key goals for innovation policy, including "upgrade knowledge and information infrastructure". Another example is the objective of the Australian Government Department of Agriculture, Fisheries and Forestry (DAFF) to work with stakeholders to achieve:

> More sustainable, productive, internationally competitive and profitable Australian agricultural, food and fibre industries through policies and initiatives that promote better resource management practices, innovation, self-reliance and improved access to international markets (DAFF, 2010).

Likewise, it is a principal activity of Australia's Rural Industries Research and Development Corporation (RIRDC) to in invest in research and development with the aim of:

> helping the rural sector become more profitable, dynamic and sustainable for the benefit of rural industries and the Australian community through the enhancement of innovation in the rural and related sectors (DAFF, 2010).

Institutions, policies and laws are a crucial feature of the enabling environment for innovation (Conroy, 2008). Intervention generally means "purposeful action by a human agent to create change" (Midgley, 2000 p. 113). Different assumptions about the nature of knowledge will give rise to "different forms of intervention practice" (Midgley, 2000 p. 7). Breschi and Marlerba (2001) suggest that accommodating policies that support the creation of enabling infrastructure and institutions, rather than policies that seek to make defined interventions, are likely to be more successful in promoting innovation. This distinction is further discussed in Chapter Eight.

3.3.2 Policy Approaches to environmental sustainability

Governments can use a variety of policy tools to encourage landholders to change their management practices and "internalize the benefits provided by the natural capital on their property" (Kemkes et al., 2010 p. 2070). Many developed countries have a mixture of voluntary incentive-based, compliance and regulatory programs to encourage sustainable land management practices within agricultural landscapes (Crossman and Bryan, 2009). Debate continues over the merits of regulatory versus market or incentive based instruments. There are challenges to using a regulatory approach in agriculture, meaning that there tends to be a greater focus on providing direct or indirect incentives to farmers to adopt changes in production practices that result in improved environmental outcomes (Blandford and Josling, 2009). For example, regulatory action such as imposing performance standards for the agricultural and food sector would require sanctions for producers who do not conform. The problem is that it can be difficult to administer an adequate monitoring and inspection program to identify non-compliance and put in place sanctions (Blandford and Josling, 2009). Despite these costs, there are a range of regulatory mechanisms that can be employed to influence land management, such as industry codes of practice, environmental certification and eco-labelling programmes (Cocklin et al., 2007). An example is the National Framework for Environmental Management Systems in Agriculture, which is compatible with ISO14001 and enables verification of farmer compliance (Higgins et al., 2007). An example of eco-labelling occurs in Cape Floral Kingdom, South Africa, where wine producers who commit to conserving at least 10% of their vineyard are awarded "championship status". This award can be displayed on their product labels (European Communities, 2008). Another new approach is landscape labelling, which is actually a hybrid approach that combines a market approach with product certification principles to allow product differentiation at the landscape rather than farm scale. The proposal is that, where ecosystem services are determined to be delivered against appropriate criteria, a 'landscape label' could be granted to market

products from that landscape. In addition to improved market recognition anticipated under the scheme, payments would also be delivered to community-based organisations to reinvest in the region (Ghazoul et al., 2009).

As discussed above, a consequence of neoliberalism (and ironically a possible avenue for multifunctionality), has been the increase in popularity of creating markets to govern agri-environments through the incorporation or internalisation of environmental values (Higgins et al., 2011). In this context, payment for ecosystem services (PES) is a frequently cited incentive based solution. The concept of ecosystem services is closely related to other terms including natural capital, multifunctionality and environmental services (Greiner et al., 2009b). PES can be generally defined as "voluntary and conditional transactions over well-defined environmental services (or land uses likely to produce the services) between at least one supplied and one user (Wunder, 2005 ; Wunder and Alban, 2008 p. 685). The argument goes that farmers do not value biodiversity as an asset because there is no incentive to do so in current markets and institutions. Therefore, the solution lies in changing the design of these markets and institutions (Pascual and Perrings, 2007).

PES actually forms part of a broader suite of market-based mechanisms for environmental policy, though it is often used as a generic term to describe more than one approach (Jack *et al.*, 2008). Other mechanisms include altering market prices, quantity based approaches such as setting caps on resource use, and market friction based approaches that seek to improve the way a market works or create new markets where previously one did not exist (Coggan et al., 2009 ; Greiner et al., 2009b). Alternatively, in Australia, the term PES is much less common than the term market based instruments (MBIs) for ecosystem services (Coggan *et al.*, 2009). Despite the different terminology, Australia in fact has a range of PES/MBI schemes in place, both publicly and privately funded (Greiner et al., 2009b). These interventions create economic incentives intended to change the decisions of relevant actors. Examples include conservation tenders or auctions (eg. BushTender, Victoria; Murrumbidgee EcoTender II project, NSW; and Desert Upland corridors, QLD), environmental offsets (eg. Biodiversity Banking, NSW; EcoFund, QLD; and CarbonSMART, Australia-wide), and cap-and-trade mechanisms (for both water and carbon) (Australian Government, 2011). Other related approaches include direct compensation payments, tradable habitat rights, insurance schemes and tax relief mechanisms (Commonwealth of Australia, 2010a ; de Fraiture *et al.*, 2010 ; Turner and Daily, 2008). Such market based approaches are becoming increasingly popular within the neoliberal approach to agri-

environmental governance, not just in Australia but in other countries around the world, particularly in Europe and North America. Other well known examples include Ecuador and Costa Rica (Coggan *et al.*, 2009 ; Kerr *et al.*, 2004 ; Wunder and Alban, 2008).

Globally the debate continues over the merits of farm wide conservation friendly practices versus sparing land deliberately for conservation and sacrificing other land for agriculture (House et al., 2008). For example, House et al. (2008) maintain that substantial improvements in conservation performance in these landscapes will only come about through reductions in agricultural production. Meanwhile, the World Bank (2008) states that the solution is to find more sustainable production systems, rather than slow down agricultural development. In Australia, the focus has tended to be on protecting remnant vegetation rather than reconciling production and conservation objectives on agricultural land. To this end, actions on private land have typically focussed on fencing remnant woodland and riparian areas to exclude livestock, re-establishment of woodland through revegetation and weed control (Attwood et al., 2009). Less frequent are efforts to go beyond a focus on remnant vegetation to reconciling production and conservation objectives on agricultural land. This reluctance may partly be a result of ongoing debate described above as well as the perception that conservation and production as mutually exclusive objectives – a false dichotomy which has for too long influenced resource management and resulted in the ecological value of human modified land being underestimated (Franklin and Lindenmayer, 2009). This is despite the fact that the segregation of biodiversity conservation and agricultural production will not necessarily protect the resource base on which both depend (Dorrough et al., 2007). If it is possible to build productive and sustainable farming systems, then this will have implications not only for agricultural policy, but for natural resource management and conservation planning. If it is not possible to reconcile production and conservation objectives, then it may eventuate that the best solution is for minimum viable populations of species to be maintained on farms, and for high quality habitat to be provided through extensive nature reserves. Either way, at some point, agricultural and environmental objectives will have to translate into sensible policy approaches.

Coinciding with the neoliberal emphasis of independence and entrepreneurialism has been a trend in Australia towards increased regulation for the public good. In line with neoliberal thinking, "normative values of economic efficiency, individual self-reliance and ecological sustainability" have become underlying principles of agri-environmental policy (Argent, 2011 p. 21). These apparently contradictory approaches are reflective of an

assumption that both self-reliance and sustainability can be aligned – because "the prudent and self-reliant farmer will pursue sustainable resource management as an essential component of financial viability" (Lockie and Higgins, 2007 p. 4). They also reflect the hydrid nature of neoliberalism and its complex realisation through both de-regulation and re-regulation (Lockie and Higgins, 2007). Given these developments, it is not surprising that, among agricultural policy and research institutions, an interest in the adoption of productivity improving technologies is now accompanied by an interest in the adoption of innovations that promote land conservation (Pannell, 2003). New South Wales' (NSW) largest provider of public sector research is the Primary Industries Science & Research Division of the NSW Department of Industry and Investment. The Division undertakes projects aimed at increasing the profitability, sustainability and adaptability of the agricultural sector. Their agricultural research is focussed on agricultural, plant and animal science in areas such as productivity, food security, biosecurity, climate and water (NSW Department of Industry and Investment, 2010). As agricultural departments continue to pursue traditional productivity related extension, natural resource management to optimise sustainable use of landscapes has become a focus for environmental agencies at the national and state government level in Australia (House et al., 2008). This division of responsibility, as well as the potentially contradictory policy approaches inherent in a hybrid approach to neoliberalism described above perhaps help to explain the ongoing tension between the government agencies responsible for increasing agricultural productivity and those tasked with delivering conservation outcomes.

In total, Australian State and Federal governments (excluding local government) now spend approximately $8 billion each year on environmental programs and initiatives (Wentworth Group, 2008). Since 1980, government agencies have sought to promote 'bottom-up' approaches to environmental management through programs such as Landcare, the Natural Heritage Trust and Caring for our Country (Higgins et al., 2007). The Caring for our Country initiative brings together the Environmental Stewardship Program, the National Heritage Trust, the National Action Plan for Salinity and Water Quality and a number of other programs (Hatfield-Dodds and Proctor, 2008). These programs have largely been administered by environmental rather than agricultural departments. Between 2008-2010, over $1.7 billion was invested in the Caring for our Country initiative with a focus on six national priority areas including biodiversity, community engagement and sustainable farm practices (Commonwealth of Australia, 2011b). Under the area of sustainable farm practices, "targets" include:

- Assisting at least 30 per cent of farmers to increase their uptake of sustainable farm and land management practices that deliver improved ecosystem services;
- Increasing the number of farmers who adopt stewardship, covenanting, property management plans or other arrangements to improve the environment both on-farm and off-farm; and,
- Improving the knowledge, skills and engagement of at least 30 per cent of land managers and farmers in managing our natural resources and the environment.

Despite these considerable investments, the resource required to make the transition to a more sustainable agriculture are simply not adequate given the task. In 2004-05, around 60% of Australian broadacre farmers reported signs of degradation on their land (Hodges and Goesch, 2006). Of these farmers, 80% felt they had the necessary skills and information to address degradation on their property. What they lacked was time, finances and incentives to overcome the constraints of implementing more sustainable farming practices (Hodges and Goesch, 2006). The resources required are not insignificant. For example, in 2006/07, agricultural businesses in NSW invested over 3 million person days and AUD$933 million in managing weed, pest, land and soil problems (ABS., 2008b). In the Goulburn Broken Catchment in Victoria, it was found that most landholders did not have the financial capacity to introduce new enterprises or change management practices on their properties. Only 16% had a total household income above the $50,000 threshold considered the minimum to sustain a family and provide sufficient funds to maintain the natural and capital assets of a property (Curtis et al., 2001). Likewise, House et al. (2008), modelled economic impacts to show that there are substantial opportunity income losses from applying conservation-based scenarios, and that there are limited opportunities to offset these with changed farming practices that do not create other environmental problems (House et al., 2008).

As mentioned in 3.2.1 above, another consequence of a neoliberal approach to resource management has been the introduction of a regional approach, involving 56 natural resource management (NRM) regions around the country. NSW has 13 Catchment Management Authorities (CMAs), including the Central West CMA. This CMA receives funding from both the Federal and NSW governments for NRM targets specified under the respective funding programs. It in turn offers a range of financial incentives and training programs for landholders throughout the catchment area. Most of the incentives are targeted to address specific natural resource management issues identified within the CMA's Catchment Action Plan (CWCMA, 2010). Landholders in the Border Rivers-Gwydir,

Central West and Namoi CMA regions are able to apply for stewardship payments as part of the Australian Government's Environmental Stewardship Multiple Ecological Communities Project (CWCMA, 2010). These payments can last for up to 15 years and are essentially a grant based subsidy for the management of a range of ecological communities, such as box gum grassy woodland and weeping Myall woodland.

A number of CMAs also offer incentives related to native pasture management, including the Central West and Murrumbidgee CMAs (Attwood et al., 2009). NSW CMAs have also promoted certain farming systems through the distribution of financial incentives (Seddon et al., 2011). The aim of much of these efforts has been to change farm practices in order to enhance the environmental services that agriculture provides - with a goal of reversing trends of ecosystem degradation (de Fraiture et al., 2010). Again the focus is on the individual land user.

3.4 Summary

This Chapter has shown that there are a range of policy approaches being employed to change farmer behaviour and land management. Accompanying efforts are underway across Australia, Europe and North America to create a more entrepreneurial farm sector. At the same time, there has been an increased emphasis on market based instruments. Both approaches are consistent with a neoliberal tendency for environmental and economic solutions, and hence blame, to be focused on individuals (that is, farmers) rather than the market or the state. In parallel, though not necessarily in competition, are visions of multifunctional agricultural landscapes that go beyond traditional productivist enterprises. Despite these approaches, it remains evident that deriving conservation solutions that are acceptable in the context of the demands of both the landscape and the farming enterprise is an ongoing challenge (House et al., 2008). Clearly, there is a need for innovative solutions in land management that can deliver this outcome. However, the increasing number of interventions that seek improved environmental outcomes on farms, both through regulatory and incentive based approaches, do not appear to be informed by an understanding of how innovation systems function. Instead, the concept of innovation systems remains relatively novel and unheard of for many policy makers and researchers who still rely on the 'transfer of technology' approach. Such interventions have the potential to impact on on-farm innovation in unintentional and negative ways. To this end, Chapter Four outlines the exploratory framework for this research, which seeks to enhance the understanding of farmer driven innovation in agriculture in order to create opportunities for sustainability in agricultural systems.

4. The research framework

4.1 Introduction

Chapters Two and Three have introduced the theoretical framework and the changing context that influences the agricultural sector in Australia. This chapter provides an overview of research framework and the methods used to answer the three research questions outlined in Chapter One. Informed by the research goals and aims, qualitative methods were chosen to conduct this research. Qualitative research involves the deployment of a variety of interpretive practices and the collection of a range of empirical materials (Denzin and Lincoln, 2005). Given the intangible nature of decision making, knowledge and the often informal characteristics of both farmer networks and innovation, flexible and qualitative methods were judged as the most appropriate means to investigate the three research questions (as identified in Chapter One). In this instance, the research framework was largely informed by grounded theory.

Grounded theory, as originally defined by Glaser and Strauss (1967) and more recently by Corbin and Strauss (2008) and others, embodies well-constructed themes, development of context and explanations of process and change over time. It is essentially the building rather than the testing of theories. Grounded theory has traditionally been associated with knowledge accumulation through qualitative social research, fieldwork, case studies and participant observation in particular. Throughout the process, the researcher evaluates empirical and analytical results in order to develop explanation based theories (Lundvall, 2007). It has been widely used in the past and its associated methods have evolved dynamically over time. In the context of the grounded theory approach, the sections below provide specific information on researcher positionality, the choices made in interview design, selection of sample location, sampling strategy, data collection and analysis. Limitations and implications of the chosen research methods are also outlined just as efforts to ensure research validity are detailed.

4.2 Positionality

Within qualitative methods generally, there is a need for reflexivity or self-awareness by the researcher of their role in the research process, including dimensions of power within an interview setting as described above. Reflexive management is part of the grounded theory approach to research and evaluation (Baxter and Eyles, 1999). However, there is tension in the grounded theory between the idea that research should be 'data led' as well

as reflexively managed. Inevitably, because the data is socially constructed through the interaction between the researcher and study participants, the data will at least be 'researcher led' to some degree. To claim otherwise is to ignore the subjective reality of conducting research (Baxter and Eyles, 1999). Tactics such as reflexivity and an awareness of positionality help to situate knowledge. Situating knowledge avoids claims of objectivity or universality. It acknowledges that "the sort of knowledge made depends on who its makers are" (Rose, 1997 p. 306).

Recognising this, one effective method of reflexive management is to make efforts to feed back interpretations to study participants in order to better understand their own views. This is often referred to as 'member checking'. (Baxter and Eyles, 1999) Likewise, Birks and Mills (2011) contend that "engaging in a grounded theory study means that researchers commit to a relationship of reciprocity with the participants that ideally includes a reflexive consideration of existing power differentials" (Birks and Mills, 2011 p. 56). As outlined in section 4.6 below, I sought to engage with the participants both from the point of view of 'member checking' and reciprocity, as well as with consideration of power imbalances.

In this case, awareness of positionality means recognises the implications of coming from a farming background. I grew up on a mixed livestock/cropping farm in Central West NSW. As Adriansen and Madsen (2009) observe, being an insider has its advantages. It gives the interviewer and interviewee a sense of shared history and a common frame of reference. These advantages can outweigh the disadvantages, especially during the interview process. With my family well known land holders in the area, levels of access and trust within the farming community were greater than might otherwise have been expected and helps to explain the 64% response rate from the original interview requests sent by mail inviting participants to take part in an interview. Familiarity with farm etiquette, dress code and local issues all assisted in 'developing a rapport with respondents' and gave me the "ability to use this to develop information-rich conversations which shape the data gathered" (Baxter and Eyles, 1997 p. 513). Several farmers recounted negative experiences with researchers and were only taking part this time because they knew I was from a farm and hoped that I would do justice to the information they provided.

A disadvantage of being seen as an insider is that it can mean that the interviewee assumes the interviewer has certain knowledge which they may not. This can put the interviewer in an awkward position as they have to ask for clarification, potentially threatening the insider status (Adriansen and Madsen, 2009). There were times when I felt

under pressure to avoid asking 'dumb questions'. Yet, in reality, the status of the researcher can switch back and forth between insider and outsider during the research. The roles can even overlap. This is partly because "we all belong to a number of communities simultaneously" (Adriansen and Madsen, 2009 p. 147). Even by being a researcher, an insider can become an outsider within a community of which they are part. Although coming from a farming background, I was still seen as essentially a non-farmer, someone who had moved away from farming to live in the city. Being female also creates a different status. This has advantages and disadvantages. While it preserves the 'outsider' status, it also meant that I did not pose a threat to farming pride because I did not appear to know more about farming than the farmer interviewees did. Moser (2008) suggests that personality, not just positionality, affects the research process. She recognises that as an interviewer she is also being judged by the interviewee, and that this judgement will be influenced by factors such as social skills, emotional responses and interest in local events. In short, the way an interviewer conducts themselves can in turn influence the material the interview generates (Moser, 2008). For example, some interviewees sought to provoke a response from me by being particularly opinionated or expressing views clearly intended to shock. When this occurred I endeavoured to remain neutral. Given my mixed insider/outsider status, the challenge remained to make sure that distance to the research was achieved, especially during analysis.

The risk of building strong rapport is that the researcher can become too close to the subject – have lack of distance to the research - and be too subjective in evaluating the issues raised particularly during analysis (Adriansen and Madsen, 2009). This is often referred to as 'going native' (Baxter and Eyles, 1997). A way to overcome this - to protect against 'going native' and to ensure research validity- is to be aware of the impacts of the insider role. This must occur not just during the interview stage but in the planning and analysis stages of the research as well. Field work and analysis were designed with this in mind.

4.3 Interview design

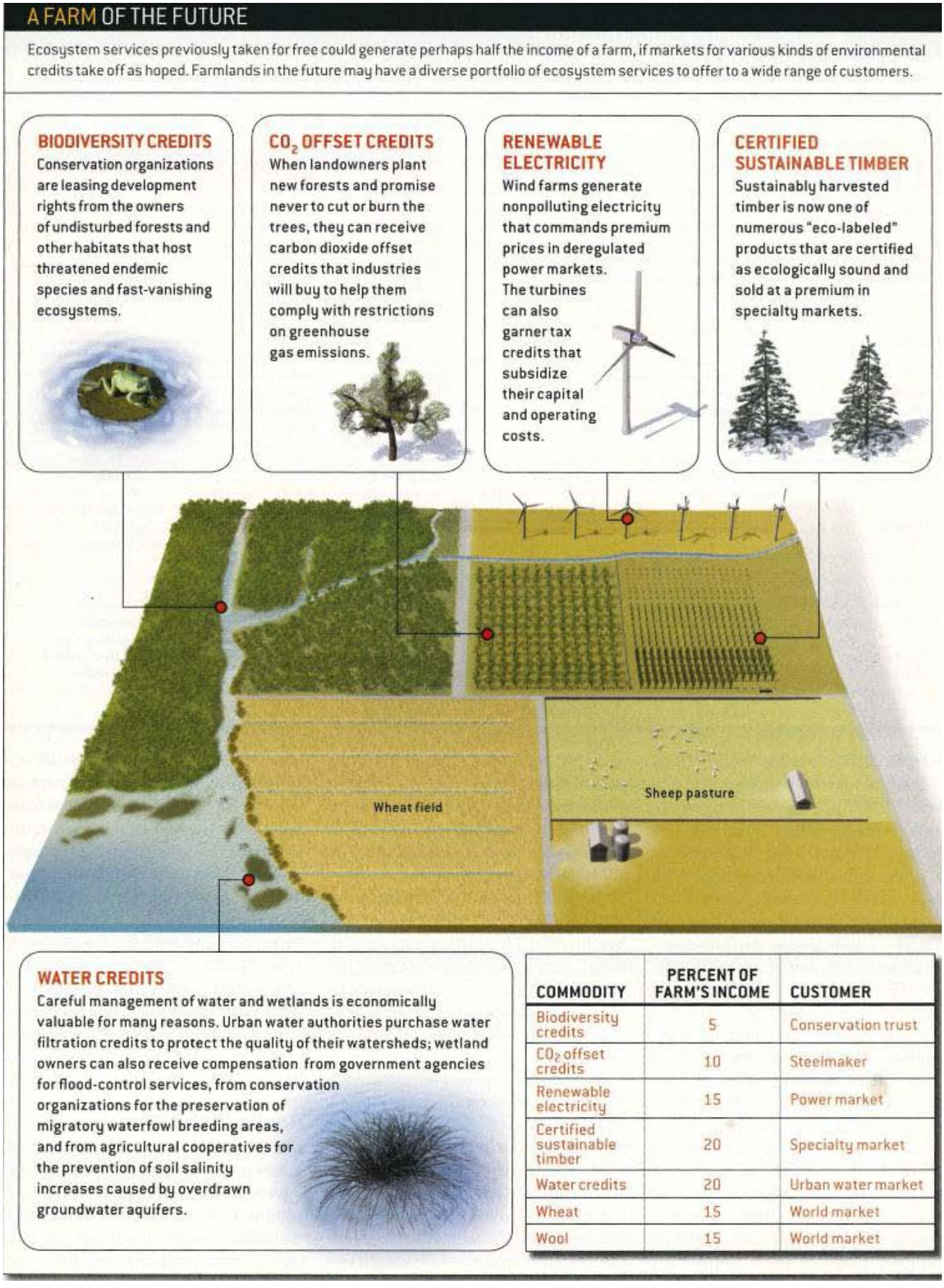
It is usual to see more than one interpretive practice used in any study (Denzin and Lincoln, 2005 ; Tashakkori and Teddlie, 2003). In this instance, interviews and field observation, as well as personal experience and content analysis of texts were employed. However, the primary method chosen was in-depth interviews. This was chosen because the aim was to understand unique experiences of a targeted sample in a meaningful and context rich way. This approach allowed for rich detail and deep understanding. A semi-

structured, interview guide was prepared in advance, revolving around a broad set of themes such as motivations and opportunities, farm management practices, system changes, perceptions and evaluation of innovations (see Appendix 1). The guide was designed to elicit information about farmers' experiences with innovation, whilst being flexible enough to allow a conversation to evolve naturally and in-depth enough to allow expression of the everyday complexities of farming and conservation in agricultural landscapes (Ahnstrom et al., 2008). It was my intention to retain sufficient flexibility and freedom to explore the topic in depth - without giving rise to unlimited possibilities and to enable ongoing analysis and the redirection and revision of interview questions over time. The guide was structured to allow this flexibility, including the inclusion of new topics as relevant and the exclusion of themes that either became saturated or irrelevant as the research evolved.

My approach to the interview was refined after a pilot test with two Central West farmers and informal conversations with other farmers. This pilot test helped to fine tune the interview approach to ensure the suitability and effectiveness of the research, which led to a modification of the interview guide and style. Originally the intention was to direct the conversation through a loose set of themes. However, it quickly became apparent that it was better to let the farmers tell their stories in their own way and in their own order. The task was to ensure comprehensiveness of the interview, without stifling conversation or being too directional. This led to a more narrative approach to interviewing, where the researcher actively listens and responds to the story being told (Willis, 2006). As a separate component of the interview, factual information was also sought such as average rainfall, current land uses and crop rotations, to allow a better understanding of context and the land management practices being undertaken. The interview guide, participant information statement and consent form can be found in Appendix 1.

In addition to the interview guide, I used a second strategy of exploring a hypothetical scenario where landscape and farm management intertwine. Without passing judgement on their suitability or desirability, an image of a "future farm' (Wayt Gibbs, 2005 p. 91) was shown to farmers, and they were asked for their immediate response to whether such a future was desirable or helpful (see Figure 4 below). This 'straw man' was to seek their response on the likely barriers, costs, opportunities and basic possibilities in a scenario where there are incentive systems in place to try and maximise both productive and conservation values.

Figure 4: Hypothetical payment for ecosystem services (PES) scenario: 'a farm of the future'.



COMMODITY	PERCENT OF FARM'S INCOME	CUSTOMER
Biodiversity credits	5	Conservation trust
CO_2 offset credits	10	Steelmaker
Renewable electricity	15	Power market
Certified sustainable timber	20	Specialty market
Water credits	20	Urban water market
Wheat	15	World market
Wool	15	World market

Image from *Scientific American*, September 2005 (Wayt Gibbs, 2005 p. 91).

The intention was to trigger further conversation and reaction and to allow further response based on a hypothetical scenario that could be visualised clearly and did not require prior knowledge. The fact that it is an American image was noted by this interviewer, and this seemed to help reassure interviewees that the model was indeed hypothetical. At the same time however, the image reflected elements of current policy debate in Australia about the use of payment for ecosystem services as a means of encouraging and rewarding farmers for conservation practices. The image was shown at the end of the interview and elicited a diverse range of responses and helped to trigger additional insights into the experiences of the farmer. Chapters Five through to Seven report the results of these interviews.

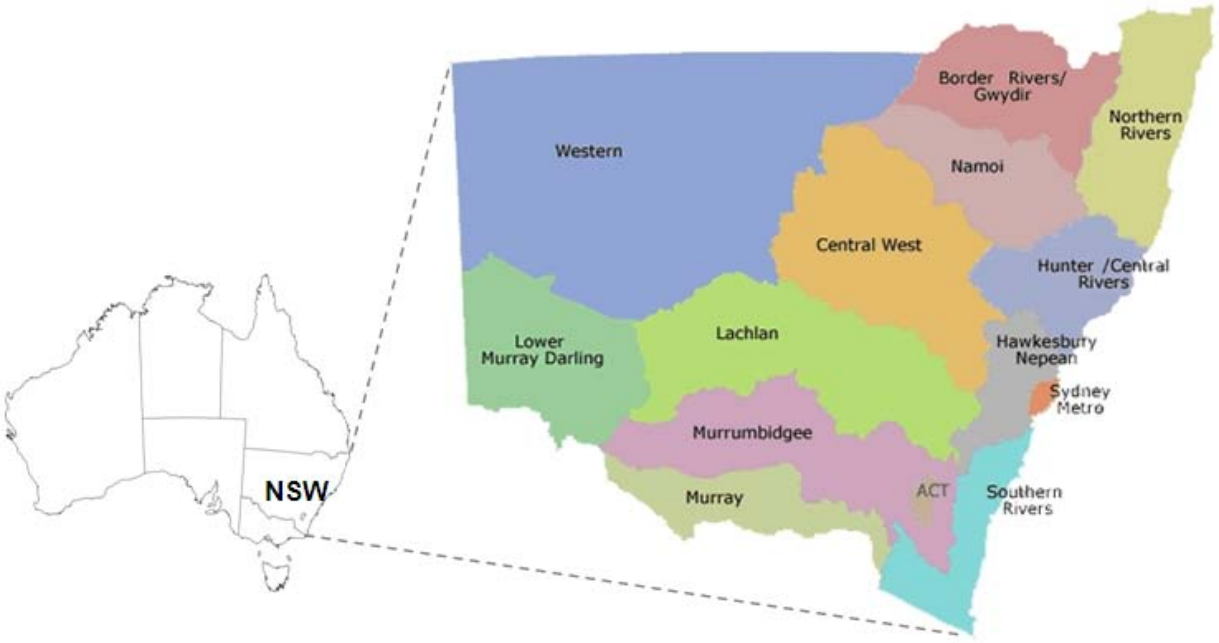
4.4 Selecting sample location

Interviews were undertaken across farms in the New South Wales wheat/sheep/cattle belt. This is a diverse region with a range of agro-ecological zones, where livestock and cropping land uses tend to co-exist (Malcolm et al., 2008). The farms were mostly located within an agro-ecological region referred to as "temperate seasonally dry slopes and plains" by the CSIRO (Williams et al., 2002 p. 14). The climate is characterised by hot summers, cool winters and a winter-dominant rainfall. The natural vegetation (eucalypt, casuarina and acacia woodlands and chenopod, mixed and acacia shrublands) has been extensively cleared for cropping and grazing. Further north the climate transitions to a summer-dominant rainfall (Doherty et al., 2010). Further west, is the agro-ecological zone of the "temperate semi-arid plains and arid interior" (Williams et al., 2002 p. 14). Riverine floodplains and stony hills are key landforms. Much of the native vegetation, predominantly low woodlands of acacia, eucalypt and casuarina with chenopod shrublands and hummock grasslands, has been modified due to extensive livestock grazing (Williams et al., 2002). This area of central and western NSW was chosen as the location of the research because it has an interesting history of policy mechanisms designed to offer incentives and support for certain types of innovation, and because the researcher was aware of the existence of a range of "innovative farmers" operating across the area.

Specifically, the chosen farms were located in five Catchment Management Authorities (CMAs) in NSW. There are 13 CMAs in NSW, all of which are responsible for coordinating natural resource management in their catchments (see Figure 5). The majority of farms were undertaken within the bounds of the Central West Catchment Management Authority (CMA). However, interviews were also conducted in 4 other neighbouring

CMAs, the Lachlan, Hunter, Western and Murrumbidgee Catchment Authority boundaries, to get a more comprehensive coverage of the 'NSW experience'.

Figure 5. Location of the NSW Catchment Management Authority boundaries



4.5 Sampling strategy

A challenge in the reporting of the use of grounded theory is how to best encapsulate the analytical and evaluation process in a concise way (Baxter and Eyles, 1999). Too often this is not clarified, possibly because the distinction between data collection and analysis is somewhat arbitrary. This is because grounded theory is intended as a systematic but flexible method that involves simultaneous data collection and analysis. In other words, it requires the researcher to continuously move between data gathering and analysis (Baxter and Eyles, 1999 ; Charmaz, 2011). In this case, the research was conducted in a series of 'waves'. This involved five field excursions over a period of one to two weeks, each excursion followed by an 'intermission' of several days back in the office. Each break allowed a shift from data collection to analysis and the compilation of more detailed notes and memos. Birks and Mills (2011) refer to data generation as episodes. They acknowledge that given geographical and logistical constraints, it is not always possible to conduct intermittent analysis between each episode of data collection. In my case, geographical, logistical and financial constraints meant it was not possible to return to the office after each individual interview. Instead, the process of 'waves' of research allowed me to conduct an iterative and reflective process as required by grounded theory, at the same time as managing logistical constraints. Interviews were also allocated a generous amount

of time, usually a whole day each, to allow for reflection and memo writing between interviews whilst in the field. This iterative process enables 'theoretical sampling' which essentially involves the ongoing process of data collection, coding and analysis, which in turn informs the next stage of the data collection process, including what data is required and where to find it (Birks and Mills, 2011 ; Glaser and Strauss, 1967).

In-depth qualitative interviews of landholders were undertaken on broadacre family farms (still the dominant form of ownership) across the wheat/sheep belt, in NSW, Australia to investigate farmers' experiences in implementing practice change and creating their own innovations. Purposeful sampling was used to aid the development of a conceptual framework (Baxter and Eyles, 1997). The sampling targeted farmers who had a record of innovative land management on their farms. In this instance, farmers were selected not as representative of the typical farmer in the region but rather as examples of a minority, at the leading edge – where they are adopting innovative whole-of-farm management practices such as conservation farming or rotational grazing.

Innovators and early adopters are said to compose approximately 2.5% and 13.5% of the farming population respectively (Klerkx, 2004). To tap into the experiences of this minority, it was decided that in-depth qualitative interviews of landholders would be the most appropriate method. Therefore, a relatively small number of famers were intentionally chosen, with the aim of facilitating in-depth research across a very geographically dispersed area. Each farm provided a rich source of material, lending itself to discoveries arising from the "type of intense observation made possible by the case study" as compared to statistics applied to large groups (Flyvbjerg, 2004 p. 429).

After obtaining University of Sydney Human Research Ethics Committee approval, the interview process commenced. The process for identifying farmer innovators is not simple, because farmers are not necessarily aware that they are innovating, nor may they consider themselves innovators (Reij and Waters-Bayer, 2001a). Therefore, it was decided that initial contact would best be facilitated by farmers themselves as peers. The Conservation Agriculture and No-till Farming Association (CANFA) agreed to facilitate initial contact and distributed letters to 30 landholders (see Appendix 1). CANFA is a farmer led organisation that supports the profitable, sustainable conservation agriculture and no-till farming practices of its members across NSW. The criteria were landholders who:

- Are operating at the leading edge of what is 'known' by science;
- Have a track record in innovative land management at the whole-of-farm scale;

- Are the owner/manager of a family farm; and,
- Have undertaken broadacre dryland cropping or grazing or a mixture of both.

This process led to interviews with 21 farmers on 14 farms (64% of a total 22 farms and 33 farmers). This initial purposeful sampling was following by a 'snowball' sampling method, which allows the progressive selection of relevant participants for data collection, as required by grounded theory. Snowball sampling involved farmer participants suggesting the names of their peers as suitable for an interview. In this way, additional interviewees were progressively identified over time by other land holders. This led to interviews with another 12 farmers on 8 farms (36% of the total). Snow ball sampling is a non-probability method that relies on referrals from initial subjects to generate additional subjects and has been used to study of hard to find populations and 'elites' (Bernard, 2000).

In total, 22 'farming units' (such as husband and wife or father and son) were interviewed. All together, 33 farmers took part in this research. In 18 instances, interviews were followed by a farm tour, where participant behaviour was observed, more management specific information was obtained and photos of the farms were taken. The total time spent on each farm varied from between 1 to 6 hours. Though a small sample size, an element of saturation still occurred, whereby repetitive themes and constructs did being to emerge over time. Whilst recognising the limits imposed by the sampling strategy, it is believed that the findings are transferable to contexts outside the study. This is because transferability is not directly related to the size of the sample but can also relate to whether the insight of one person may be meaningful to many (Baxter and Eyles, 1999).

In terms of characteristics of respondents, the age of the farmers varied from being in their mid-twenties to their late sixties, with the most represented age category being the 40-49 year bracket. This is slightly younger than the national median age of farmers in the sheep/ beef/grain farming category, at 54 years (DEEWR 2009). One third of the interviewees were female, reflecting the dominance of males in agriculture - 69% of the national workforce in the sheep/ beef/grain farming category (DEEWR 2009). It is noted, however, that these are statistics for employment, and do not recognise the unpaid work that women do on farms. Until the 1996 census, farm women's work was not even formally counted (Haslam McKenzie and Stehlik, 2005). The true percentage of women involved in agriculture no doubt continues to be significantly underestimated (Alston, 1995 ; Paterson, 2002 ; Pini, 2007).

The size of properties ranged from 600 hectares (ha) to 26000 ha. The smaller farms were generally further east, in higher rainfall areas (600 millimetres), while the larger farms were generally further west, in more marginal areas of NSW (300 to 400 millimetres). 73% of farms were mixed farms, in that they had both cropping and grazing enterprises, while 100% undertook cropping and only 4% had never dealt in livestock. Prior to 1993 and the collapse of the Australian wool market, 96% of the farms had both cropping and livestock enterprises. All 22 farms included cropping as a land use, while 16 undertook some form of grazing/livestock management and could be classed as mixed farms. Prior to 1993, all but one farm would have been mixed farms. Two-thirds of the interview respondents were members of CANFA, while one-third were not.

A separate set of interviews was conducted with five professionals from various locations in NSW who were not farmers, but who worked in the agricultural industry. These interviewees came from both the public and private sector. The letter of invitation and question guide for these interviews can be found in Appendix 1. The professions of the interviewees were:

- Agribusiness Consultant (specialising in holistic management)
- Agribusiness Consultant (specialising in business benchmarking)
- Bank Manager (from one of the 'big four' banks, in a major NSW regional centre)
- Government district agronomist (Industry and Investment NSW)
- Senior Government officer (General Manager of one of the NSW CMAs)

Again this was a snowball sampling methods, where participants were selected based on information volunteered by farmer interviewees and their apparent influence on farm management decisions. This was an iterative process with the interviews helping to provide an alternative perspective and a means of triangulating the results of the farmer interviews. These participants have been coded 'AS1' through to 'AS5'.

4.6 Data Collection

As described in section 4.2, power relations are an important component of an interviewer and interviewee relationship, particularly where the researcher is seen to hold a position of authority (Adriansen and Madsen, 2009 ; Chacko, 2004 ; Rose, 1997 ; Willis, 2006). In this case, as a university student rather than a paid academic or government researcher, it was felt that the power was more in the hands of the farmer. The interviews also conducted face-to-face on the farm, on the farmers' 'turf', and by invitation only (in response to a formal letter of request). This also aided critical inquiry, which demands that research

practice is grounded by observation in the real world (Bailey et al., 1999). Making a conscious effort to accommodate for the research subject's work schedule and time constraints is also important (Chacko, 2004). Fieldwork was conducted between July and September 2009, deliberately timed to coincide with a less busy time of year on the farm, between crop sowing in April, shearing, lambing and spraying in September and harvest from October onwards. Flexibility was recognised to be important, and several interviews where rescheduled at short notice to accommodate changes to the interviewees' schedule for a range of factors including weather (which impacts on the timing of various tasks such as crop spraying). I tried to avoid my visit coinciding with lunchtime as generally the farmer would then feel responsible for and insist upon providing a meal and I didn't want to impose additional costs on them. This wasn't always avoidable, particularly when the visit lasted for several hours. A common show of hospitality is to offer a 'cup of tea', regardless of the time of visit, and this offer was always accepted rather than rejected, to avoid giving offense.

As explained for interview design, no particular order was insisted upon to address the themes within the interview guide. Rather, issues were allowed to arise in whatever order came naturally in the conversation, with some prompting used to ensure that all issues were covered. This was to allow farmers to tell their story in whatever way made sense to them. Where possible, each interview was followed by a farm tour in which more management specific information was obtained and photos could be taken. Examples of these photos can be found in following chapters throughout the thesis. Crucial additional information was often revealed during the farm tour. This is because participants may be more at ease and because they have had time to reflect on earlier questions and comments. For example, additional information revealed after the interview but during the farm (and several times farm office) tour included:

- maps of their property
- satellite yield mapping
- written farm plans and other written materials such as training manuals
- historical photos

During the farm tour, stops were made in paddocks to look more closely at soils, plants, livestock, new machinery and experiments, and in some cases, wildlife such as lizards and birds. It was usually my job to open gates (and in one case, to help when we got bogged). I was also given several 'points' from the tines of cropping machinery (for sowing) by two farmers to keep so I could compare new and old methods, as well as a bucket of

chickpeas, training manuals and farm plans to keep. Several farmers were keen to show the farm management software they used on their computers to calculate factors such as water use efficiency and gross margins.

Interviews were digitally recorded and additional field notes taken. All digital recordings were fully transcribed for later analysis. Transcription has the advantage of being an objective record of the conversation. While a researcher may only take notes on what seems important at the time, a full transcription allows the researcher to revisit the conversation later in time. This can mean that, during analysis, as their understanding of what is important evolves, new insights can be drawn from the original transcript (Willis, 2006).

As noted in 4.2, reciprocity with participants is important. To facilitate such an exchange, a summary report was provided as feedback to the interview participants in November 2009 and a subsequent report to update farmers on research progress was provided in September 2010. These reports can be found in Appendix 2.

4.7 Analysis

Key strategies of analysis in grounded theory include coding and memo writing (Birks and Mills, 2011). Memo writing is an important step in recording the research as well as a means of reflexive management. It requires the researcher to ask questions of the research and to explore and record analytic details and concepts. Coding involves labelling data to enable the data to be taken apart and new meaning sought. It also facilitates the sorting of data and the identification of key categories as they arise from the data. The point to make here is that the codes arise from data, they are not applied to the data in a preconceived way. This requires significant researcher interaction with the data, including making of comparisons between pieces of data. As described in Section 4.5, this research was conducted in a series of waves. The interview findings were then analysed, codified and used in the development of grounded theory. As a first step of analysis, interviewee identities were removed and replaced with codes to preserve confidentiality and to create distance from the subject. The codes relate to the CMA in which the farmer was located, in order to allow for cross-catchment comparisons. The codes were:

Farmer Code	*CMA location*
CW1 through to CW20	Central West
HT1 and HT2	Hunter

LC1 through to LC7	Lachlan
MB1 and MB2	Murrumbidgee
WD1 and WD2	Western

Interview transcripts were then studied individually as well as in comparison to the responses of other interviewees. Further coding was undertaken. The content was used to analyse decision making processes and experiences with innovation, as well as identify key knowledge sources and networks. Quotes and concepts were organised into key themes. The experiences of respondents were analysed with consideration given to broader contexts. The analysis involved an element of progressive textualisation, whereby specific people-environment interactions are placed within progressively wider contexts (Vayda, 1983). This essentially requires treading a careful analytical path between fieldwork and theory (Bailey et al., 1999).

As required by grounded theory, rigid categories were not imposed prior to the research. This allowed an element of fluidity in the development of themes during analysis. Relationships between different themes/findings were explored, such as comparisons of responses of interviewees from different catchments, and with different land uses. Cases that did not 'fit' with other findings were also acknowledged. Perceptions and experiences were considered in conjunction to better understand how farmers came to hold the views they did. Key themes arose from the analysis such as the role of knowledge, networks and perceptions in decision making and the importance of on-farm research in innovation.

It is important here to explain the significant use of quotes in the thesis. The chaos of research data does not organise itself into knowledge by observation alone (Myrdal, 1969). In critical inquiry there is the need to avoid both the selective treatment of qualitative data in order to legitimise pre-existing theories and the failure to move beyond the subjective accounts of respondents (Bailey et al., 1999). However, the use of "richly textured stories" is important to the ability of qualitative research to provide a window on the human condition (Baxter and Eyles, 1999 p. 180). In this thesis, I have tried to retain such detail through the use of quotes and the participants' own voice. Where possible, data was summarised in a way that did not affect the depth of the case studies or impose selective interpretation by the researcher. Concepts are represented through the thesis as researcher commentary as well as the use of participant quotes. Additionally, it has been my aim to write in an accessible manner and to avoid "elaborate and strange terminology" which (Myrdal, 1969) complained meant social scientists impaired their ability to

understand one another "and perhaps occasionally even themselves" (Myrdal, 1969 p. 42). He was neither the first nor the last to complain of this and I hope to communicate without such barriers in this thesis.

4.8 Ensuring research validity

Grounded theory has numerous advantages and disadvantages. A potential challenge for grounded theory is that it calls for the exclusion of previous knowledge. In reality this is not really feasible (Bohnet et al., 2011). In fact, there is a degree of contention between practitioners on the appropriate level of engagement with the literature at the early stages of a grounded theory approach to research (Birks and Mills, 2011). For the original proponents of grounded theory, Glaser and Strauss, the ideal was that literature is to be avoided to prevent the uptake by the researcher of preconceived concepts that are not grounded in the data (Glaser and Strauss, 1967). In reality, however, no researcher can truly "avoid earlier theories and empirical studies in the areas of their research interests" (Charmaz, 2011 p. 166). Indeed, it must be said that all theories are inevitably partial and informed by the values of the agent(s) constructing them (Midgley, 2000). Therefore, the important thing is not so much to avoid all literature, as to engage with the appropriate literature as it becomes relevant given the data. The preparation of a research proposal and obtainment of approval from the University of Sydney's ethics committee required a substantive literature review that could not be avoided at the earlier stages of my research. However, I endeavoured to engage with the literature in a flexible way, with a willingness to discard and move on from literature that proved to lack relevance as the research progressed. Such an approach is advocated by practitioners like Urquhart (2007), who recognises that a literature review can be a common requirement in many universities. She refers to Urquhart and Fernandez (2006), who suggest that a preliminary literature can be conducted so long as the researcher recognises that the theory generated by the data will later determine the literature's relevance. This requires revisiting and extending the literature review later in the research process – which is the path that I chose.

Accepting that it has its limitations, grounded theory was chosen as a lens to make sense of the world, but with an eye to alternative realities, perspectives and theories. In addition, a mix of methods helped to test the validity of research findings through methodological triangulation (Marshall, 2008). Triangulation can be broadly defined as "the combination and comparisons of multiple data sources, data collection and analysis procedures, research methods, and/or inferences that occur at the end of a study" (Tashakkori and Teddlie, 2003 p. 674). As mentioned above, personal experience, interviews and farm tours

as well as content analysis of texts all informed the study of the subject. Source triangulation was also used – where quotes from several different respondents are presented on the same theme (Baxter and Eyles, 1997). In addition, a summary report was also provided as feedback to the interview participants in order to consolidate findings without losing a sense of context or "the complex reality of farming and conservation in the agricultural landscape" (Ahnstrom et al., 2008 p. 45). This is an important strategy for checking for the adequacy of analytic categories/ constructs/ hypotheses with members of the group(s) from which the data were obtained (Baxter and Eyles, 1997). In this case, such checking was done in the spirit of an 'exchange of ideas' rather than a formal process of seeking approval. It was also felt that there was an ethical imperative to provide feedback to the participants, who had freely and generously given of their time and knowledge.

It was also recognised that qualitative researchers need to be mindful of self-selection biases which may come from certain strategies like snow-balling (Baxter and Eyles, 1997). In order to further confirm validity of the research results, a separate set of interviews were conducted with five professionals from various locations in NSW who were not farmers, but who featured in the agricultural networks of the interviewees and who worked in the agricultural industry, from both the public and private sector – as described above.

Analysis of literature and studies conducted in other developed and developing countries (including Canada, Finland, New Zealand, Tanzania, United Kingdom and the United States) was also undertaken in order to cross check against the themes those arose in these studies (see for example (Blay-Palmer, 2005 ; Brodt *et al.*, 2006 ; Chikozho, 2005 ; Convery *et al.*, 2005 ; Fairweather and Keating, 1994 ; Herzon and Mikk, 2007 ; Jackson, 2008 ; Morgan *et al.*, 2010 ; Wilson and Hart, 2000). It became evident that, while institutional and market contexts differ, there are some common challenges for innovation and sustainability in agriculture. Additionally, results were also tested with colleagues during several conferences and farmer events. Examples include:

- Thirteenth Annual Conference of the Central West Conservation Farming Association in Dubbo, NSW, in July 2008;
- Symposium on New Pathways to Adoption and Diffusion of Primary Industries Innovations hosted by the University of New England and the NSW Department of Primary Industries in Armidale, NSW, November 2008;
- Grains Industry Productivity Workshop hosted by the Australian Bureau of Agricultural and Resource Economics in Dubbo, NSW, in July 2009;

- Nyngan Agricultural Expo in Nyngan, NSW in August 2009;
- Inaugural Agriculture and Rural Development Day hosted by the Consultative Group on International agricultural Research (CGIAR) / Global Donor Platform for Rural Development/ University of Copenhagen in Copenhagen, Denmark in December 2009;
- New Zealand Geographical Society (with the Institute of Australian Geographers) Conference 2010, in Christchurch, New Zealand in July 2010; and,
- The second Agriculture and Rural Development Day hosted by the Consultative Group on International agricultural Research (CGIAR) / Global Donor Platform for Rural Development in Cancun, Mexico in December 2010.

There are further implications of choosing a qualitative approach to the research. While qualitative methods can reveal rich details about individuals' experiences, this information is not easily comparable to other data from individuals within and between studies. While representative sampling and statistical comparisons were not a component of this research, the research was still designed in a way to ensure that the findings were credible and had a degree of transferability beyond the immediate case. Flyvbjerg (2004) maintains that formal generalisation, be it on the basis of large samples or single cases, is considerably overrated as the main source of scientific progress. He argues in favour of the case study, where he believes there are "more discoveries stemming from the type of intense observation made possible by the case study than from statistics applied to large groups" (Flyvbjerg, 2004 p. 429). He says "the case study contains no greater bias towards verification of the researcher's preconceived notions than other methods of inquiry. On the contrary, experience indicates that the case study contains a greater bias towards falsification of preconceived notions than towards verification" (Flyvbjerg, 2004 p. 429). This is not a rejection of other methods of research in social science, but rather an argument that both quantitative and qualitative approaches have their place in the field.

4.9 Summary

This chapter has provided an overview of the design and methods of the research explored in this thesis. It explains the choices made and the efforts taken to ensure research validity. Limitations are acknowledged while relevance is explained for understanding beyond the immediate case studies that make up this research. The importance of positionality and the impacts of being a farming 'insider' have been emphasised. Chapter Five presents results of this research, particularly in relation to the nature of farmer driven innovation, including knowledge generation.

5. Farmer-driven innovation (1): decision making and knowledge generation

5.1 Introduction

This chapter presents the findings for the research question 'what is the nature of farmer driven innovation?' To answer this larger question, the results are presented by addressing two sub questions:

- How do farmers innovate and make decisions?
- What experiences have innovators had in generating knowledge on the farm?

The first half of this chapter looks at how farmers innovation and make decisions. It considers motivations for change, perceptions of innovation, shared decision making, the need to maintain motivation and change over time, business and risk management and family farm succession as a means of knowledge transfer. The second half of the chapter looks at whether and how knowledge is being generated on the farm. It explores the implementation of land management specifically through ongoing testing and trialling, observation of signals from the landscape, adaptation to water scarcity, management of timing and the development of new machinery. This revealed a lot of information about on-farm experimentation and management changes. As explained in Chapter Four, this is based on research undertaken in NSW, Australia.

5.2 How do farmers innovate and make decisions?

5.2.1 Motivations for change

> *"The number one thing you need to be a successful farmer is you need to be motivated. Motivation is key. I don't care what your registration standard is or what's your knowledge level, what's your ability, you can always find people to help you in any area, whether they be government people, whether they be neighbours, other farmers, industry professionals, marketers, advisors. If you're motivated, if you're driven, you will be successful". (CW12)*

On the whole, motivation for undertaking changes in land management varied between farmers. Most farmers recalled particular points in time when they knew the time had come to change. Generally it was not training that triggered the change. It was often an

occurrence on farm, combined with a chance encounter, or even in one case the gift of a new book, that led the farmer(s) to question what they were doing and to seek new information and answers. This is not to say that it was a single event that triggered change, but that there were specific instances where a culmination of events seem to come together to create a point in time when a new path is chosen.

The most common theme for motivation to change was soil health. For CW1, it was the shock of soil test results that triggered her to rethink her practices. She had been doing all the things recommended as best practice, including zero tillage, but the soil test "came back as though it was sort of dead". She said they "have been told that our fungi levels increase because we don't cultivate the ground, but so why hasn't it increased?" This led them to question their practices and start their own program of research on farm. Recognising that "it's a very complex complex world underneath the ground", they were still left puzzled. There were general statements and explanations such as herbicides were to blame, but she was not convinced and said "there is enough of a scientist in me to say you can't give a general statement. There's got to be good and bad". This triggered a range of new trials and research on their farm.

For HT1, it was the visit by "a soil conservation fellow who came to this place in about 1990" and who said "the soil structure is stuffed on this place". Yet again, "he couldn't tell me really how to fix it" so this farming couple also went out and did their own research and looked at what other farmers had done before implementing widespread management changes across their own farm. LC4, who had been practicing zero tillage since 1995, said that the initial reason for going into zero till was a "big storm". He said he had already been direct drilling:

> When we got these major erosion events, which was after we finished sewing, it was the worst erosion I'd seen on this place in my lifetime. I said this is not going to happen again so that is when we went completely on zero till.

CW15, who hadn't burnt stubble for at least 30 years, recalls that "we had three of the wettest years we've had in the last century,' 51, I think, '55, and '56, soil erosion and all those sort of factors made their mark". For CW5, who had not long come home to her family's grazing property with her husband (CW6), "both the drought for us and coming back was a real catalyst I guess for change". They "just didn't want to go through that

drought period again, feeding stock and not knowing from when we start feeding them when are we going stop feeding them".

For WD1 and WD2, it was a mix of environmental and financial factors. They had read historical accounts of the area from the 1800s where "there are stories of the horses sinking to their fetlocks in soft soil". This led them to reject the modern day conventional wisdom that it was normal in their area to have "hard red soils". Though you could "go out there now and kick your toe and nearly break it" they refused to accept that this was the way it had to be.

CW20 undertook a more formal process, where his family all sat down "and wrote a goal and that sort of incorporated social, ecological and financial aspects". They wanted to be "in the situation where our production was driven from a strong ecology rather than from an input that cost money. So that was our goal and we started looking around".

It was clear that there was a diversity of motivations behind farmers' actions. These weren't limited to external prompting by experts or the trigger of crises such as drought and erosion events. They also included personal philosophies and ethos, as well as lessons learnt from history. LC4 put it down to stage in life, saying that his "management ethos would have started to change somewhere in my 30s". WD1 felt it was more a matter of "the attitude in your head, where you have got your head at - if you can get your head around it". WD2 felt that "you can waste a huge amount of energy trying to change people who don't want to change, not ready to change". This view was echoed by LC4, who said that "everyone has such different ideals, goals, knowledge base, education base, that the dynamics within the farming group are amazingly different". He therefore felt that the reasons for action or inaction were irrelevant, because anyone could find a reason or excuse to do either. His view was "you either have the ethos that you do want to go that way or you have the ethos that you don't".

5.2.2 Perceptions of innovation

"I'm an innovator. That just means you go broke quicker". (LC7)

When people think about innovation, it wouldn't be surprising if they think of progress, cleverness and ingenuity. The description "innovator" can be seen as a positive attribute. Yet, for farmers in this research, the perception of innovation was quite different. It was viewed more as a mixed blessing. These land managers were acutely aware that what they

are doing is potentially putting their business at risk, at least in the short term. They believe they are working longer, harder and with less proven methods than their neighbours. They know that to be an innovator is to take risks. In an industry where "just surviving" is the challenge of the day, risks can bring great rewards or great hardship.

There were mixed views on whether innovation was a good or bad thing. One farmer viewed it as "technological bravado" and cited examples of where he felt other farmers had got "carried away with the whiz bang of it all" to the point of being financially irresponsible. He felt that for some, having the latest and greatest gadgets and being a field day attraction for other farmers "becomes a drug". In his view, the focus must remain on profit. His point was you might be able to "do this, this, this and this" to guarantee a crop every year, "but what did it cost you?".

For the majority of the farmers interviewed, innovation was seen as a crucial part of their business and their ethos. Experimenting with and improving their land management was part of what they viewed as their responsibility as land managers. Yet, they also shared a sense that innovating can also become a strong driver or an obsession, which is hard to turn off when the bank balance is running low.

In talking to farmers about their land management, some were more comfortable being described as innovators than others. A few felt the term was apt, while others felt they didn't really deserve the description. CW3 wanted to clarify that "I don't think we are ahead of the pack of the people who are doing it. We might be ahead of the pack of the average farmers". CW6 had recently implemented major changes in his livestock enterprise. Yet, with the introduction of rotational grazing and all the infrastructure this entails he still didn't see what he and his wife were doing as "cutting edge". Though he was one of the first to apply it in his district, he knew that elsewhere it was something "a lot of people have been doing for a number of years now". The problem for him was that despite this history, "it is still seen as a bit of hocus-pocus" by others.

While some accepted that they might be in the 'innovator' category, they didn't want it to be assumed that they had found all the answers or to be described as an expert. CW16 had many years experience but emphasised that "I am still learning. Truly, every year is so different". In fact, CW4 and CW15 felt that what they were doing now, though pursuing better practice, wasn't really innovative or new so much as revisiting and reinventing the wheel better than before. CW4 said "innovation, like disc openers and all these latest

innovations, it all happened thirty, fifty, years ago. We are not innovators. We are going back to the stuff we did before". The difference he saw was that "we go back, we do it better now and we make a dollar out of it and we analyse why it didn't happen and how we can make it work". CW15, who took over management in 1968 of the farm his family had owned since 1928, said that a lot of current innovations weren't necessarily as ground breaking as previous ones. He recalled that "dramatic things happened even in the '50s. You might think we're moving on now, but to me the big changes were then".

One thing that many of the farmers had in common was the view that innovators don't get much support. LC7, who had implemented a range of leading edge changes across his farm long before any of his neighbours, felt that "innovation and leading blokes just get no support". Although he clarified that "they actually don't want money support - they want information support".

This same farmer gave an example of a farm that he bought from his neighbours. On a drive around the property, he showed how run down it was and described what he was doing to restore it. He explained how "they spent no money and then when they sold this place they were quite well-off. They didn't do any environmental works. They didn't look after the farm and yet when they retired it was pretty good money". He figured that "really I should have done the same. I would be far further in front to where I am now because of the huge debt because I've done all this stuff". In LC4's view, compared to 25 years ago:

> Most people are running their farms much more environmentally friendly now and are able to manage drought much better. There are a few exceptions and they stand out dramatically, but as an industry standard I think the bar has been raised a lot higher.

While some lamented the fact that innovators got little support, others felt that this was the risk that you took in order to be innovative and that was just the order of things. To them, innovation and change are essential for survival. They saw it as the only way to both economic and environmental sustainability. For example, WD1 described it as:

> Something you just have to do it. The interest and the passion was there. What else do you do? Be like every other farmer and end up broken at the end of your life or go back to the city? It is a pretty easy question to answer really.

HT1 felt that it was too easy to "say government has got to do something or to blame government". His view was that:

> If somebody has got an idea get it out into the paddock. If somebody has got any ideas don't sit back with the things - I know it might cost them money, because it is no good in five years time saying 'oh gee I wish if somebody in the government department will do something' because you can't. The environmental side of things can not wait.

An element of failure in farming is acceptable, indeed it is inevitable. For some, the fear of failure was a constant, exacerbated by a feeling of lack of community support for what they were trying to do. CW6 explained that:

> I feel the pressure even more once we've made the change to keep it moving ahead. My biggest fear is that it will slip back to what it was or it will fail and people will say 'see I told you so'.

Given the feelings of peer pressure and lack of community support, there is a risk that promoting farmers for what they are doing or being promoted by others as a role model could alienate them from the community. HT1 felt that receiving recognition publicly would lead people to think "you are too far up yourself". He explained what happened when one farmer received recognition for conservation farming and how:

> The district didn't think…well I don't know, do you talk to him?...I dread the thought of someone thinking that he is just so far up himself it is not funny. And I'm not like that. We are not that type of people.

Others felt that society in general didn't value what they were doing. (CW13) was disturbed by recent anti-meat campaigns, anti-transport and eat local campaigns which she felt were anti-farmer in many ways. LC1 emphasised that agriculture:

> Is a sexy industry and no one knows about it…The only thing we need now is lasers and we've got satellites and robots and all these other things that every kid wants to work with and they all think we chew straw…or maybe they don't know what we do.

5.2.3 Sharing decision making

There was often more than one person involved in making management decisions, or at least being involved in the brainstorming of ideas (see Figure 6). Having someone to bounce ideas off was seen as important.

Figure 6. Photo of father and son inspecting the paddock and pondering their options

CW3 said that "you've got to have someone to talk to, to bounce ideas off. You don't have to agree but you can discuss and talk through a point". He also felt that it was better if this person had an economic stake in the farm, rather than just being an independent advisor. He figured that someone whose income was dependent on the farm would put in more thought and think differently than "someone who is giving you advice who is taking their wage from somewhere else and is not involved in the financial returns".

There was also evidence that several farmers had someone in their life who helped put the brakes on their curiosity and remind them of the financial realities. This was usually another family member. Generally, this intervention was acknowledged as important by the farmers concerned. CW9 explained how his wife "keeps me on my toes, as far as certainly on the cost side of the operation". CW7 said that his wife was his "business plan" and that he has "got to justify everything I spend to her - it is bloody hard work sometimes".

In addition, it seemed that involving other decision makers or partners in any significant training that leads to a different world view was vital to ensure that they were 'brought along' in the process. In one example, with the two generations managing the property, they "made a conscious decision that we would all train". Now they are all advocates of changing their land management. In this case, the son (WD2) said that his "old man, he did the training with us and he wouldn't have driven the change, he would have said it was all too hard, he wouldn't have known where to start" and yet "10 years on, he now gets up at meetings and says if you aren't doing it, if you aren't doing planned grazing, or timed cell grazing, you are an idiot".

In another example, again with two generations, the parents and the daughter and son-in-law were unable to reconcile different goals. The result was that when the younger couple "started to make some changes and do the training and split up paddocks", this proved to be a "trigger point" (CW6) for the parents to leave the business because "they didn't feel happy" with the changes being made. Even without training, it can be important to have a joint goal. As CW1 said, "it takes a lot of time and it doesn't work unless your partner is there with you. Because well it is like the composting, it is a big investment of money, $50,000 for a turn, you don't just go lightly. So they've got to be convinced as well".

Linked to the issue of shared decision making is the difficulty in finding skilled and unskilled labour. Having on-going skilled labour to assist in the day to day management of the farm can be very important. Yet, LC4 felt that "people are doing more by themselves". In his experience, "most guys used to have wives who worked on the farm, there is basically no one in the district now whose wife doesn't work to an extent, off-farm". In addition, it was less expected that children would return home to work, even in the busy periods, and that "kids are leaving pretty well straight after high school and going elsewhere". Similarly, LC7 explained the difficulty in finding skilled labour. He said:

> You can get anyone out to chip - well actually it is hard to get anyone out to chip weeds or spray burrs - but it is really hard to get blokes to do stuff that no one else has done before.

Even when labour could be both afforded and found, there was a fear that it was an insecure investment, because once the staff member had been trained or 'up-skilled', there was nothing to stop them leaving. LC1 felt it made more sense to train yourself because "it is very hard to afford train someone up that can then leave, because you've just

trained someone up whose got these awesome skills and they are very marketable". LC2 agreed and explained that because the skill set needed is quite specialised, with all the technology now on farms, they can't afford to pay for it. He was of the view that this is why it always comes "back to family farms".

In contrast, CW5 and CW6 had taken on a backpacker from the United Kingdom who had a farming background. They found that it was worthwhile training him. He would return to work for them every few months between travels, and they were considering sponsoring him for a visa. A common strategy was to rely on family for surge capacity in busy times like harvesting, shearing or fencing. CW12 said that when he can't get something done on his own, he would get contractors for the cropping and "my mum and dad will help me with a little bit of stock work when we're marking calves and that sort of thing". LC7 had to rely on his wife and children to help him in re-fencing the property. MB1 relied upon his family or:

> I just try and do as much as I can myself. Then the family suffers. I think since 2006 we wouldn't have had two weeks holiday and those sorts of things are starting to wear us down as a family unit.

For LC4, the solution was sharing the employment costs with other farmers. He said, of his employee, that his employee is:

> Working for two other places and I try to get him for a day every couple of weeks, and he is a skilled labourer and he has probably got more work than he knows what to do with.

For CW7, having only one full time person employed on the farm meant the need to "be machinery efficient". This meant owning a tractor, front end loader, truck, air-seeder and super spreader. MB2 said that he does most of the labour himself, except in peak times like sowing, when his 65 year old father would come out and help him, with "one on the boom spray and one in the sowing rig".

In total, 15 (68%) farms employed casual or part time labour. 8 farms had 1 full time employee (the farmer), while 14 had two or more full time labourers (such as father and son). Only 2 farms managed with one full time position on no casual or part time labour at all. In addition, several farms were continuing to employ staff who were getting too old for

physical duties, out of loyalty or the knowledge they would struggle to find work elsewhere at that age. (CW14) continued to employ a 68 year old labourer on a casual basis because "he came with the place he knows where all the waters are, he knows absolutely everything like that. He is reliable. He is only meant to come three days a week. But I know that when we are away he comes seven days a week".

5.2.4 Maintaining motivation and change over time

Considerable time and effort can go into seeing results of changes implemented on farm. When it came to the conversion of cropping systems to conservation farming systems, many of the farmers had been slowly refining their system since the early 1990s. This involved shifts from minimum to zero tillage, as well as from stubble burning, grazing or ploughing to stubble retention. Another gradual shift has been the movement to controlled traffic via global positioning systems and precision spray applications.

For example, LC4 began no-till cropping in 1995 and CW1in 1996. CW3 began trialling minimum tillage cropping in 1990, before switching to total zero-till in 2006. CW13/14 began trialling minimum tillage cropping in 1994, again a precedent to zero-till, as did LC5/6 in 1995. CW15 stopped burning stubble in the 1970s.

CW7 told how he "first looked at no-till in about 1982". They moved to widespread adoption of direct drilling in about 1990, starting off with "tines off and changing points and narrow slot sowing". In 1995, they implemented "no-till canola" across the whole farm. It was at this time that "everything was just starting to come together. The no-till points were just becoming to be able to be purchased so you didn't have to keep on making your own. He drew support from "a few blokes around" who were also experimenting with no-till, and also "a core group of Queensland growers that had modified machinery at that stage".

WD1 and WD2 began fencing more than 200km of their property more than 10 years ago. They are 50% of the way to completion. CW20 was pioneering a new system of pasture cropping, with perennial vegetation and low input requirements in order to provide flexibility and efficiency. Getting the system running in the way he wanted was also a long term project. He explained how his "farming system is in transition at the moment". He said:

> We're seven years down the track now and probably got 60 percent of the way where we would like to be as far as achieving the diverse grassland right across the whole place, giving us that permanent structure there. There's still a long way to go actually. Sixty might be talking it up a bit… we see that as a way of building our resilience, managing our risk.

Not everything works out or happens as one might expect. CW10 pointed out, "agriculture is just not a 12 months business, it's a 10 or 20 year business really". C11 explained how "people trying to go from conventional to zero til" assume they can just go "okay, we're not conventionally farming this year, we're just going to zero til next year". The problem as she saw it was that it is a slow process to actually get the results. CW10 agreed and said "the first question most people say is 'How much will the yield increase?' and I always say to them 'It will actually decrease probably the first year or two until they get their soil bio-order working".

CW1 felt that with innovation, it was important "to be flexible enough. For us say well we are doing compost tea but if it doesn't work we want to get out of it we don't want to be locked into it". Yet it was clear there were tensions between maintaining flexibility and persisting with a practice over a long period of time. For example, CW9 changed his farming practices in 1990. Yet, it is now "20 years later and still to this day soil carbon building has been incredibly slow". They were only beginning to see results in the last 4 or 5 years and even then, they were not big results.

HT2 recalled that there was a time "when there was a bit of nitrogen tie up" when the stubble was not breaking down, and it took several years for everything to start moving. Yet, she felt that the slowness of change wasn't an issue. She pointed out that "castles were built over three or four generations. So why can't farms be built up? Why can't one generation be happy?" She felt that if each generation can leave the farm in a better position environmentally and economically than the one before it, then that was significant in itself.

Making changes to a farming system is not something that can necessarily be divided into neat sequential steps. While the transition occurs over time, sometimes the scale and complexity are there from the start. For LC7, investments in farm infrastructure was "like buying a car - you can't buy one wheel this year and one wheel in three years time. You've

got to do it all up front". CW3 explained how the implementation of a rotational grazing system and a pasture cropping system went hand in hand. He recalled:

> A lot of this was all interlinked. Because our pasture on set stocking wasn't good enough to increase the grazing and do rotations and all the rest of it. And then by starting to do that and all the pasture and things improved which was going to help. And it is a bit hard to get one without the other. You've sort of got to do the whole lot.

CW6 was frustrated by the slowness of change. For him, it was because:

> You only get certain periods of cash flow. So then you don't get to see those changes. Then you can run into some dry times that can mask those things. So we've been putting changes in place here for the last two-and-a-bit years, but we are only just starting to see results now.

Perhaps most importantly, these farmers felt that there was still a lot to learn, test and implement and that the potential for further change and evolution definitely existed. There were many aspects that farmers were hoping to have a chance to trial and implement on their farms in the future. In cropping, this included more work on soil biology, composting, pasture cropping, manures and other news ways to increase organic matter and naturally replace removed minerals. On the grazing side, there was interest in doing more with native grasses, perennial species, fencing, ground cover and biodiversity. Soil biology was a very strong focus. CW9 was "trying to make the soil work better rather than just pouring everything out of a bag that we're buying in".

This issue linked in part to time itself and the ability to physically get everything that needed to be done in a day completed. Time is precious and finding ways to 'save' time is crucial. Finding ways to cut back on the long hours spent working was also a re-occurring theme. LC5 summed it up well when he said:

> I don't know of any farmers that want to work 15 hours a day all year and be tired and cranky. I think they would all like to do their 50 hours a week and be happy and not stressed and people drive past their farm and look at it and think 'Geez they're doing a good job over there'.

For CW4, "everything is so slow, the cycle is twelve months". The only thing he could see being sped up was possible "fat lambing" which he thought you could get down to nine months. CW6 also agreed "it is a slow process" and he couldn't see how it could be sped up, unless "you went from what we are doing now into a feedlot and started to generate cash flow from the day the feedlot finished".

Linked to shared decision making, finding "like-minded" people was a common theme in terms of maintaining motivation. It was mentioned by some farmers that they were worried they would lose the drive to 'change' overtime and not remain innovative as they got older. CW6 explained how he and his wife (CW5):

> Speak about this a bit. We get really scared and say like I don't want to be, when [his sons], if they want to come back, I don't want to be where we are now in 40 years time or 20 years time. I hope we are doing something completely different again. I hope that is has moved forward.

For CW6, the solution was "to keep testing to see what you are doing is working. You've got to do a lot of monitoring. So we try to push ourselves on the monitoring side of things". Through monitoring they want to avoid that situation "where people they don't realise there is a problem". CW15 was just as clear about wanting to remain innovative, saying "I don't want to be involved in farming even tomorrow if I'm thinking I'm doing the same things as what we did here 10 years ago, or even last year".

5.2.5 Managing the business and risk

No matter what size you are, to make the next step you have sort of got a push one part ahead and then push the other, it is very hard to push ahead evenly. Like you have either got to get more land by either buying it, share farming or leasing, but then you need more gear but then you need more manpower so you have got to take a risk, you have got to take a risk. Which I like. I like risk. I like that… you have got to. But I mean, I mean sometimes you lay awake at night. (CW16)

Several farmers were keen to emphasise that family farms are modern businesses. As CW6 said, "to get any business going forward, you've got to treat it like one". LC4 considered this a recent phenomenon, saying that "there has been a real change in the mindset I think of finances and being professional about what we do and what we don't do". LC5 also felt that "you've got to take this emotion out of it". He suggested farmers would have less trouble viewing the farm as a business if they lived in town rather than on the farm. In fact,

CW4 did live in town, and found it helped to be able to get away on the weekends, especially during drought and tough times.

Taking the emotion out of business decisions was a common theme for both business and risk management. CW2/CW3 and CW5/CW6 had both recently built new offices. CW6 felt that "what separates some of the businesses as well is getting that office right and admitting that it is a business, not a farm". CW3 also hoped that his recently built new office would make business management and planning easier. He figured that "with the office done up, it might make it feel like it is a bit easier to sit in and do all the stuff that you want to do rather than in a daggy place".

Each farmer interviewed had a vision of where they wanted to get to, but finding the time and money were constant challenges. Being disciplined about finding time for planning was a recurring theme as well. CW2 described it in the following way:

> The jobs we do in the office are $1000 an hour jobs. The ones we do in the paddock are only $20 an hour jobs… it is easy to procrastinate and put that off and go and move some sheep. But at the end of the day you'll make more money planning than you will moving the sheep from paddock to paddock.

For CW14, implementing change, in this case "deep ripping and putting gypsum" on his soils, was slow simply because "we are only doing one paddock a year. That is all we can possibly afford". However, once it has been done "you can see improvement in the crops". He also described how his troughs are old-fashioned, installed in 1969, and that they "always have balls coming off floats". His comment was that he knows he "should really be replacing them - but it is all cost isn't it?" CW4 spoke about struggling to find the time for planning, but recognising that this was the most important thing to be doing. His logic was similar to CW2 in that he said:

> You can spend all your life running around the paddock trying to make 5 bucks an acre, or you can spend an hour on a Saturday morning doing marketing and make 25 bucks an acre in one decision, by being informed.

WD1 and WD2 addressed the issues of being time poor for planning by holding formal planning meetings three times a year on long term business planning, as well as monthly

meetings on more practical business matters including the tasks at hand and the division of labour for the month.

There was a sense that to survive in farming, every year you have to get more efficient and find ways to maximise returns. CW12 explained it as "the thing you've got to remember in farming, if you're not actively going forward in farming, you're going backwards. When asked about his plans for the future, LC3 responded "surviving at the moment. Lack of profitability in agriculture is the biggest threat to agriculture". CW1 felt that they had been lucky, in that in the past decade their only crop failure was in 2002. Still, she said:

> They haven't been easy years either and we survived…And you might not earn a lot of money but it is still there. You don't have to have heaps of money. You have just got to keep going.

LC4 spoke about the last couple of years of ongoing drought. He said that "most people have still survived. Most people would be dragging in reserves and probably not having spent what they wanted to spend and not having done the improvements they wanted to have done". In his view, if it wasn't for improvements in land management and lessons learnt since the 1983 drought:

> The decimation over the past 5 to 7 years of dry seasons would have been horrendous. It still hasn't been good, don't get me wrong, but it has been a lot better than it could've been and we can still do it better.

It is also not just about making something work, but making it pay, balancing the costs of implementation, demands on time and labour and the uncertainties of the season. Good intentions cannot always be realised. The majority of farmers interviewed were weighing profitability right down to the last hectare and kilogram. For example, MB2 explained how he has:

> A gross margin on each paddock. I work it all out on a spreadsheet so that I know what my costs are per hectare and can basically tailor how the season is going, prices are going, to see how profitable paddocks are going to be and what we've got to do. What I find with that is it really takes the emotion out of the decision making.

The importance of making gains wherever possible should not be underestimated. There was a sense that every little bit counts and finding that extra percent efficiency gain or increased profitability can be the difference between getting ahead or getting deeper into debt. For CW2, surviving is all about:

> Trying to maximise our return from every millimetre of rainfall, so every decision we make, whether it is feedlot lambs or whatever, you are trying to grow something to maximise your return so if the market changes you need to analyse whether you are better off growing sheep or cattle.

This partly related back to the recognition that a 'niche' in a market can also be a dead end if market demand changes. Farmers recognised that they were dealing with a volatile commodity market. As CW4 expressed:

> When you are driving out here and you know the Chicago December delivery is at five thirty two cents, it went down 3.2 cents on Friday night, you think, you know, are we in charge?

For CW3, part of surviving was recognising the need to ongoing change and that "people are having to change to survive" but that once you make a start on change "it is easier to keep going".

MB1 accepted that "our costs are going to continue to go up and unless our prices continue to match – which as a rule they don't – productivity's the only thing that continues to drive healthy farm business". For him, the answer was "productivity and scale" recognising that "scale helps but it's not the be all and end all. Just because you're increasing scale doesn't necessarily mean you're decreasing your costs". He showed his yield results for the past 9 years and aside from the four years that earned income, "the rest of the years have either been treading water or going backwards".

CW4 had also noticed a trend in scale in his district, recalling that when he left school, "the average size farm was probably 600 acres. And it's gone out, you'd probably need 3,500 acres now to survive". LC3 also said that they had doubled their farm size in the past 6 years, while LC7 said that his farm had also grown in size. He highlighted the decline in numbers of young people in the community and how:

> We are all being pushed more and more and that is why we are leaving farming at such a huge rate. I think in 10 years time is going to be interesting. I'm a young farmer at 47. [His town] couldn't rake up a footy team of farmers under 35.

For CW6, the issue was that land value is less and less related to the ability to make a living. He gave the example of a place for sale nearby that had a high price per acre. He said that if you ran into a drought, you'd never be able to make the repayments on the property. He felt that "there is an unrealistic expectation on what the land value is and what the potential of making money off it is" and that "it is almost getting to the stage where people can't afford to buy that it". CW12 also recalled that when he bought his first block of land in 1996 it cost him $50 an acre. Thirteen years later, in 2009, it cost $300 an acre, six times as much. However, as CW3 pointed out, once you did own land, "you've got the land as an asset which can grow as capital asset, capital value". This is an advantage that other businesses don't necessarily have where they may be renting a property and where there is no capital appreciation.

Concern over rising fixed costs was raised by CW2, LC3 and LC2. Both CW2 and LC3 spoke about the recent rise in "PP Board" rates[2] and also shire rates. As CW2 said, "the shire rates have gone up and they won't even grade the bloody road… we don't get curb side recycling". LC3 also mentioned the costs of insurance, compliance and vehicle registration. He compared these fixed costs now to 60 years ago, where if it was:

> The [19]40s and if you had a drought, well you just put the cheque book in the bottom draw and you could really. But now every vehicle has got to be registered.

LC2 said that:

> We've got a lot of other costs coming in. Council is not as cashed up as they used to be, so we now have a grader and we grade our own roads where we can.

CW4 was concerned about the declining competitiveness of Australian produce globally:

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[2] Many farmers still use the term PP Board to refer to the district organisation responsible for the management of animal health, pest animal and insect control and travelling stock reserves. In NSW, this was the role of the Pastures Protection Boards (PP Boards) from 1934 until 1989, when they were replaced by the Rural Lands Protection Boards (RLPB), which were in turn replaced in 2009 by the Livestock Health and Pest Authorities (LHPA).

> We used to be very cheap to build anything in Australia, but with OH&S and everything else it has gone the other way… if we are going to stand on our soapbox and have Workcover and EPA… if we are going to protect our workers by doing that, then surely we should protect our producers by putting tariffs on imports or doing something.

For CW9, the issue was oil and transport:

> Peak oil is around the corner, whether we like it or not. At the same time we've had a State Government for the last 15 or 20 years that has really let rail infrastructure crumble. Warren, like Coonamble, we're nearly nine hours from the coast from our major grain terminal. So grain production has taken a giant leap backwards in this country. What it used to cost to get a tonne of grain to the coast has now quadrupled and what should be a modernised more advanced system in 2009 compared to 1980 is not, it's far worse.

He could see a future where grain production in the west of NSW takes "a back seat because of the cost of producing it out here". For CW9:

> It's a real worry. You've got to carry it on rail in a country the size of Australia. At the moment it's just not happening and you can't put it on the road. You can't afford to. When diesel's back at $2.00 it'll force a lot of bloody restructuring in agriculture.

It was a contributing factor in his decision to sell his current property and buy one further east, closer to the necessary infrastructure. But as he said "we can't all fit over there".

Several farmers were keen to build their businesses further, conscious that they needed to increase productivity either through increased scale or efficiency gains in order to remain viable. LC5 explained that he didn't really want to be "one of those farmers that's really working long and hard when they're 60". He was very aware of the need to increase the scale of the farm, and so they were "trying to do what we do on our existing country better but also expand the size of our operation as well". Overall, farmers felt that the trend was that farming was becoming more professional, that farmers would have to get better at making the most of opportunities presented to them and to fine tune their systems and minimise inputs to remain viable.

There are many risks in farming. For MB1, the biggest thing in farming "is the management of risk". To mitigate this risk, farmers pursue different strategies. For him, it was about "improving the farming system to negate that risk – well not negate it, but minimise that risk" and being able to "understand how much you can bite off and the risks attached to it". However, he also he felt that:

> You need an element of luck in farming, in business because you can't control the seasons and despite your best endeavours to manage risk, you need to spend money to make money. It's an old cliché, and in farming it's those risky decisions sometimes that pay the greatest dividends.

For some, the risks a farmer has to take each season are getting greater. CW12 said:

> It's just the costs of farming. Like they're so big now that you can't gamble. A lot of people just used to scratch the crop in and put a bit of fertiliser and a bit of spray, but the costs of fertiliser and spray and everything, and the machinery is so expensive…You can't afford too many failures.

For CW12, it was a matter of having off farm income. He explained how:

> Some of the people that have tried to do what I've done without any off-farm income, are not here anymore. The farm's gone. They've sold it. They've been forced to leave because they picked the wrong time to go into a big capital expenditure program and they didn't have the income to back it up because of droughts, because of misfortune. Had they got good seasons, they could be the smartest farmer in the district, but their timing was out. And you don't know whether your timing's right or wrong until after the event.

In other words, luck also has a role to play. CW12 saw a role for risk averse farmers, otherwise:

> There'll be people going broke all the time…the number one thing, you've got to be here next year. You're not going to be a conservation farmer next year if you're not here.

For LC5, the solution to managing risk was to find ways to:

> Spread our cost and our risk out over a bigger area it helps us to win bigger when we have a year that wins and if we have a bad year it helps us to spread the risk a bit, sort of spreading our eggs from being all in the same basket and trying to reduce our costs per hectare as well. So we still lose in the bad years but we don't lose quite as much or as hard yet when we win we can maybe have the chance to put a few dollars away to carry us through the bad ones…we've got to really make the wins good wins and try and reduce the shockers.

Many farmers do not use a lot of inputs (especially up front) as a risk management strategy due to unpredictable rainfall. LC4 highlighted that while lower interest rates have given people "breathing space", fertilizer and fuel prices spiked and "all our input costs went up dramatically. So for people to make up for that, most people cut back quite a bit". WD1 also said that they:

> Spend a fair bit of time making sure our inputs are low and at the other end of that the overhead costs and things don't get away on us. So you have to plan it to work that way.

System wide changes are also farm wide changes - actions which cannot be done in halves. There was a recognition of the risk of failure to the point of losing the farm and, at the same time, the strong desire to do whatever possible to avoid this outcome. In other words, there is no point implementing radical change if you are going to be out of business next year anyway. HT1 said:

> You can't build something and have a property fail. You can build a stock crate or a piece of machinery and say I'll park it over there and start again but you can't borrow a lot of money and take on a place and it just fails and you are broke in the first 12 months.

5.2.6 Succession as a means of knowledge transfer

95% of the interview participants grew up on a family farm, although 23% no longer lived on a farm that had been owned by preceding generations of their family. 50% of farms have a younger generation in line to take over. That is, children who have come home in the past 10 years to work on the farm. In several cases, succession issues have not been

resolved in that for the next generation to take over, they will still have to purchase the land from siblings or find the funds to pay out the parents so they can retire.

Succession was raised as a specific issue by a small proportion of the farmers. This was often in the context of the problem of having no one to hand the farm on to in the future, rather than in regard to the challenges where there were successors. A key concern was loss of knowledge. LC7 told how none of his three children were showing an interest in coming home to the farm. C11 worried that lack of succession meant that "there's a wealth of knowledge in so many farmers that possibly won't get passed on". He explained that:

> It was just like when we drove around a while ago, you see things different to what I see but because we've been here all our lives and know all the background of why certain soils is where it is. I mean I could draw a soil map or a yield map of all our paddocks now… because I know from experience whereas if you just suddenly got given this place… then you take another 10 years.

CW10 also felt "that's the trouble. There's a lot of farmers out there with some really good skills but it just gets lost". CW13 and CW14 believed that the lack of renewal could partly be put down to the fact the children "have seen their parents struggle all their lives, why would they go and do it?" They see that the ones that tend to hang on are the ones who "are old and poor", with no "children who are interested in taking it over" and they don't have enough money to retire anywhere else so they keep living on the farm. In contrast, CW15 did have his sons return home and his priority was assisting them "in their endeavours to do things bigger and better and whatever".

Linked to the issue of succession is the issue of ownership. CW5 and CW6 found getting into farming very difficult. They wouldn't have been able to do so without the support of parents. CW6 felt that "there are a lot of people out there who would love to own a farming business who don't have the capital to get in but are very bright people, with business like sense".

For CW4, part of the problem was also that the banks will not lend to young people. He recalled how a young neighbour tried to get a loan to buy a property, but the banks would not give him the loan because "he's got no collateral". They didn't take into account that "he's been in the industry for thirty years – the collateral is in his head and his machinery and stuff". In the end it was bought by a 63 year farmer who already owned

land in the district. Meanwhile CW4 could not see how the younger farmer could ever get economies of scale if the banks did not back him.

CW10 also believed that there are "a lot of young blokes that really want to be on the land" but because they have to go to the city first, they end up staying there. In his view, this meant "you're probably losing some of the best farmers because there isn't a niche there for them to be able to get going". While making a lot more land available for a transition in ownership would effectively reduce everyone's net land value, he felt that the opportunities it could create would be worth it for the next generation.

In contrast, WD1 saw opportunity in the Western division[3] for "young farmers to get a foot in the door into owning land" because "there is a hell of a lot of Western division not being run well". WD2 felt that "if you want to use the conventional model of agriculture, it is hard to get in. If you want to own your land and own your stock then it is hard" but if you were willing to be creative and think of alternative ways, then it might not be impossible. LC1 felt that part of this relates to the fact that people don't tend to have an "exit strategy" and the trigger is usually your bank. By the time the bank says they are not going to lend any more, the farmer is in a pretty bad situation. CW19 explained how his family had moved to the district five year prior because the area where he grew up had no land for sale to expand when he came home to the farm. "It was very tightly held" within families and their place "was the first place to go to auction in 40 years".

Some felt family ownership increased the burden on the farmer. CW1 said that they felt "blessed because we bought this place from our own resources. We have got no ties. If we go broke so what? We don't have a guilt which I think a lot of farmers if they have inherited farms would have". The added fact that none of their children wanted to come home to the farm "has given us freedom to decide our own future" without the pressure of needed to have the farm to hand on. For them the issue wasn't so much getting out of agriculture, but the difficulties faced by "people who want to expand or get into the industry". CW6 also saw emotion and pride being a factor in family farms and that "people hanging on and staying in some of the farms around here, you aren't generating enough change. They are still doing the same thing but they are just hanging on and there is no real change".

[3] The Western Division (also called 'Western Lands') makes up 42% of the area of NSW. Most of the land in the Division is held under perpetual leasehold from the Crown, with only a small area of land being held as freehold. With a mostly semi-arid climate, grazing is the primary land use, with some dryland and irrigated agriculture along rivers.

LC4 and LC5 said both of their districts in central NSW had experienced unprecedented change in land ownership in the past 10 years. LC4 compared this to twenty years ago when there would have been "stuff all" change. LC5 said how 10 years ago when they wanted to expand they bought in another district because they didn't expect any land to become available in their own. However, for them:

> It was a decision we really got wrong because since then there's been quite a few places come on the market around here - more than what we thought there would be in the next six or eight years.

LC4 felt that the trend was partly explained by the demand for what is seen as a "Safe area" where premiums are paid for more certainty in rainfall.

In terms of access to land, no one agreed that the answer might be to remove the support for farmers who were struggling and let them go broke. CW20 felt that this would have negative impacts on rural communities. He would "rather see more family farms than less and I'd rather see more diversity in the industry than less". To him "the people diversity is just as important as the ecological". CW6 also felt the need to bring the whole community along a sustainable path, because "if you can repopulation (sic) the landscapes, you are improving that community" whereas if no one helps each other then this is to the "detriment of the community". In other words, the idea of neighbours going broke, although it would create opportunities for farm expansion, was generally not welcomed at the expense of having a viable local community.

In three specific cases contracting was related to succession issues. When the son had come home to live and work on the farm, the use of outside labour was either scaled back or avoided. For example, CW14 explained that when <his son> came home:

> We looked at our budgets and we worked out how we could justify his existence. And we worked out we had a pretty large spray figure in our budget, very large.

In his view, they were actually over staffed and one way around this was to cancel the spray contracting they had been using and to buy their own equipment. In addition, the son could take on contracting work for other farmers. It was a business approach that

involved taking emotion out of the equation and finding a financial argument for his son to come home.

CW2/3 and CW19 also went from using contractors to becoming contractors. In other words, there was a shift to doing contract work to create the economic capacity to sustain the presence of the next generation on the farm. In addition, the off-farm contracting helps recover the costs of machinery investments. CW3 explained that "with the harvesting, not so much spraying yet, but with harvesting we've picked up the odd job at harvest time as contract work ourselves to help make the payments" (on the machinery).

CW6 also used this strategy of undertaking contracting as a means of gaining "some other small forms of income" that helps cover "a repayment on machinery". Likewise, CW16 had recently bought a new specialised 'weed-seeker' spray rig, and was planning on employing a third person, in order to take on extra contract work. This was a way of diversifying the business. He had also bought a new header, but not because of problems with contractors:

> They were here and we had no problems. They stayed with me, they never left…so I had no drama, and I didn't buy the header for that reason. I bought it for harvesting the sorghum and doing a bit of our own, as well now we have got more employees, it was the whole thing to try and utilise it a bit.

5.3 Is knowledge being generated on the farm?

> *We have had no one to follow, we have had no one else in the area that is further advanced in it than we are. So really we have just grown like topsy and figured it out as we went along really. (WD1)*

There was awareness from a range of the interviewees that they were in front of what was 'known' or proven, and there was recognition that this has consequences. For some, this is simply a matter of learning more from other farmers to prevent problems where possible. CW6 told how he:

> Wish we'd found more information out or had more help when we were designing our rotation system than what we had. We did make mistakes. They were not costly but, in terms of spending on infrastructure we overcapitalised.

5.3.1 Ongoing testing and trialling

Interviews demonstrated that testing and trialling is conducted continuously and independently on-farm by innovative farmers. All interview participants had conducted independent trials on their farms in the pursuit of their own research agenda. This included 50% of farmers who conducted grazing management/livestock related trials. Conducting these trials helped to provide the farmers with unique information on how certain practices would work on their farms. Chapter Six further reveals a tendency for farmers to be critical of information and weigh it up from a variety of sources. There were many examples given of the types of solutions farmers have been able to find through trialling and experimenting their own unique ideas. For example, 55% had done or continue to do ongoing testing within cropping land on either soils or plants, such as soil carbon and plant foliar testing. Table 4 provides examples of the diverse range of tests and trials that have taken place on the participants' farms (in addition to crop variety trials and livestock breeds).

Table 4. Examples of testing and trialling on the participant's farms

Testing and monitoring on-farm	Cropping trials	Grazing and other farm trials
Carbon, Nitrogen, Potassium, Phosphorus	Biological farming	Agroforestry
pH	Manure sourced from cattle feedlot, chicken farm	Companion tree planting (eg. eucalyptus and acacia)
Foliar testing (for micronutrients)	Companion cropping (eg. chickpea and linseed)	Gully restoration
Ground cover and litter levels (%)	Composting and Compost "tea"	Machinery (design, build)
Native perennial species composition	Controlled traffic	Mallee for CO2 sequestration
Salinity (electromagnetic conductivity surveys)	Cover cropping	Native vegetation seed planting
Sodicity	Fungicides	Perennial grasses for biodiversity
Soil biology (microbial activity)	Green and brown manure (crops as mulch)	Pasture cropping (for groundcover or for grain)
Soil moisture (via soil capacitance probes)	Integrated Pest Management (beneficiary insects)	Rotational grazing
Water use efficiency	Liquid lime	Salt tolerant plant species
Yield and soil mapping (via aerial and satellite imagery)	Liquid and foliar fertilisers	Stock exclusion from water courses
	Machinery (design, build, patent)	Subdivisional fencing
	No-kill cropping (sowing grain into grassland)	Telemetry (system for remote livestock data collection)
	Weed seeking technology	Weirs (in-creek to control erosion)
	Worm farming	Wetland creation

As is evident from Table 4 (above) and Figure 7 (below), these tests and trials were sophisticated, complex and require a high level of scientific knowledge on the part of the farmer. Ongoing experimentation is part of the innovation process. CW9 said he was "not afraid to sort of push the boundary I suppose on products and things and do a lot of experimentation and trials and things behind our own farm gate". At the same time, he also admitted that he would trial products and sometimes fail, but he would "always learn something from it".

Figure 7. Photos of on-farm trials

Soil moisture probe (1)

Soil moisture probe (2)

Native grasses responding to pasture cropping

Liquid fertiliser storage tanks

In relation to cropping, there were many examples given of the types of solutions farmers have been able to find through trialling and experimenting their own unique ideas. MB2 described a process of trial, error and intuition to figure out a puzzle posed by fox holes. He found that where fox holes had been on poor sandy soil, the crop was "every bit as good as it was down in the flats or the better parts of the paddock". He couldn't figure out why

this sandy soil was suddenly responding well and thought perhaps it was from organic material the foxes had accumulated. However, when they did the soil tests, "there was absolutely no difference in any of nitrogen or phosphorous or any trace elements or anything. The only difference was pH". So that led him to realise that perhaps applying lime on the sand rises would help. At the time of being interviewed, he had begun trialling this in various areas at different rates of application. It was worth it to him because "if we can lift these parts of the paddock up which might account for say a third of the paddock, we've all of a sudden lifted the average of the paddock up quite considerably".

CW7 trialled cover cropping for 6 years, but hasn't "quite been able to get it to work for us", due to the fact that they don't receive "enough rainfall to a cover crop plus a cash crop at the same time". CW8 told how the cover cropping is an attempt to make up for the fact that "the chickpeas and linseed they don't provide a lot of groundcover". CW7 also sold one of his paddocks to a chicken farm on the condition that he get first access to the chicken manure, which he then takes away and composts before applying it to his cropping country. As fertiliser prices have risen, the benefits of this approach have become even more evident. CW7 originally "looked at doing a bit of pulses in summer time for nitrogen input" but in the end he found that the "chook manure has overcome the need for the pulse crops to a certain extent". CW20 has sought to control disturbances from chemicals, animals and machinery through the implementation of a pasture cropping program. CW20 explained:

> We have found we've pushed it a bit too far in some situations. We've grown six years of wheat in a row and we have recruited grasses and we have built diversity, but at the same time we're still seeing the annual weeds you'd expect to see in a degrading ecology. And I think that's because we're still using chemical two or three times a year on the same paddock. We're getting back on the merry-go-round of where we were. So from an ecological point of view I think we've got to be careful with the continuous pasture cropping. But from a gross margin efficiency point of view it can still be profitable and still probably ahead ecologically than a sort of no-till or conventional cropping system because it does have the diversity. It still has permanent perennial grasses in it.

In relation to livestock, innovations included moving away from traditional methods and concepts of fencing. The replacement of barbed wire with two/three wire and electric fences was widespread across the farms with livestock, as seen in Figure 8.

Of the 16 mixed cropping farms that were part of this study, 7 had implemented rotational grazing practices. While these farmers were demonstrating that rotational grazing is feasible in lower rainfall zones than previously thought, three farmers specifically mentioned a lack of technical support in regard to science on the effects of rotational grazing on soil health, animal health and overall productivity.

This was a similar challenge for LC1 in relation to cropping. For him, it wasn't so much about getting the research done. He accepted that "it will have to come out of our bottom line which is fair enough". The challenge for him was "actually getting results that are useful and can then be conveyed to someone". What he wanted help with was the "design and monitoring and data collection and analysis for some of this stuff to make it relevant".

Figure 8. Photos of new ways of fencing

Newly installed three-wire electric fence

Single electric tape being used as a gate

5.3.2 Observing signals from the landscape

Part of creating a successful land management system is being responsive to the signals coming from the land. WD1 and WD2, who were pioneering rotational grazing in the rangelands of western NSW, accepted that there was no recipe to follow and that they were committed to:

> A process of observation and then thinking about why something is happening and not just banging away at the symptoms - trying to understand the natural processes.

In addition to implementing a new rotational grazing system for several years (and which is still being rolled out over 26000 hectares), they searched "for animals that were better suited to the environment instead of beating ourselves against a wall and trying to run an English countryside animal". They travelled to South Africa to learn from practices there. They also looked to the cattle industry and the experiences associated with the introduction of Brahmans into Australia. Eventually they decided to introduce Dorpers, a meat sheep originally bred in South Africa and better adapted than the traditional merino to rangeland conditions. For WD1, it was a matter of doing as much as they could afford to each year, depending on what the seasons would allow. She told how:

> Through a process of trial and error, on this front country, we have discovered what works here, and the long-term plan is just to continue to duplicate it on the rest of the place. We have figured out, I mean we haven't probably got it figured out 100%, but we have figured out enough that we can make a huge difference. So just duplicate that… there is a whole heap of country we can just continue to affect out the back… So just keep going.

As mentioned above, CW20 was pioneering a pasture cropping program. He had begun monitoring progress with photographs and had set up a range of transect sites. He explained that they "pick paddocks from a low base so we can track their progress over the next five or six years".

For CW5 and CW6, telemetry and a weighing system had been installed as a means of remotely monitoring the progress of their cattle as they gradually refined their new rotational grazing system. They designed and built the system themselves, basing it on a similar design used in the Northern Territory, and were the first to use it in the region. The telemetry system communicated data wirelessly back to the farm office, as shown in Figure 9. Though told by some people that "collecting that information in agriculture won't work because you've got so many variabilities in terms of weather and everything else" they challenged this and felt that "by collecting a lot of that information that you are probably taking a lot of the variability out of it". It was giving them a means of quantifying the impacts of their new land management practices. Having started getting results, the

next step for them was to figure out "what do those results mean?" and how could they "start to use them in our decision making?"

Figure 9. A farmer-designed and built telemetry system for collecting data on cattle

MB1, MB2, CW2 and CW3 were using yield maps done via satellite imagery at high resolution. It allowed them to see trends from space that the naked eye could not perceive. For MB1, the results showed how fifteen year old tracks made from tractor wheels could still be seen in the soil due to compaction. Evidence of soil disturbance was causing MB2 to wonder whether he would be better off "just sticking permanent tracks in there that are going to end up like the road". It also showed how different management practices being trialled were performing and allowed them to make decisions on what was important in terms of future implementation.

CW19 explained how in the five years since they'd arrived on the farm, they have gradually cut back their seeding rate[4]. This is because of the use of a parallelogram[5] for sowing, where they "just get so much better seed germination with it". CW19 had also found that sowing with fertiliser actually had a negative effect on yield. In 2009 they trialled some liquid fertilizer but were waiting to see the impact on yield at harvest time. CW12 also recommended that "when you start using disc seeding and no till, cut your seeding rates right back". He felt it wasn't just the machinery that caused this but also "a response to dry

[4] The seeding rate is essentially the rate of seed (kg/ha) that needs to be sown in order to achieve target plant density in a crop (plants/m2). It is calculated using factors such germination percentage, seed size, seed weight and plant establishment percentage. Plant density has an important influence on crop yield.

[5] A self-adjusting mechanism on a machine for sowing seed, including a gauge wheel, which allows for even seed sowing depth on uneven soils – i.e. it stays parallel to the ground.

seasons" because "you only need enough roots and enough stems and enough heads to hold the grain" for the amount of moisture you've got in the ground.

LC1 had put in place a soil capacitance probe[6] to better understand what happened to water in the soil after it rained, including how long it took to either move down the soil profile or evaporate back in to the atmosphere (see Figure 7 above). This attention to water in the soil profile was reflected by many farmers, with water scarcity playing an important role in management decisions.

5.3.3 Adapting to water scarcity

A range of adaptive solutions were being put in place to reduce the risks associated with less certain seasons, and to increase the flexibility of the agricultural enterprise in order to respond to uncertainty. This translated into a focus on moisture conservation and improving the effectiveness of limiting resources, particularly through an increase in the farm's water use efficiency – calculated as kilograms of grain produced per hectare for every millimetre of rainfall. Climate change was not raised as an issue so much a shift in rainfall patterns and in particular lower than average rainfall. MB1 told how:

> One of the biggest risks to our business is not getting enough rain. Now, what we're improving in terms of managing our risk is improving our management techniques by whatever rainfall we do get, we make it effective.

It is rare to get through a decade without at least one crop failure or downscaling of livestock numbers due to drought or the absence of the autumn break, a time when rain is needed to sow winter crops. Yet, there was a sense that crop failures are getting more frequent. CW12 told how "the last seven or eight years we haven't had many good years in there -I mean there's hardly any of them". LC2 told how they had their first ever crop failure in the past decade, the first in 100 years of farming. LC3 said he thought "there are three problems and it is water, water, water". LC4 told how they were "supposedly in a 600 mm rainfall area" but had only received 450 – 500mm in the past few years. MB1 told how his rainfall average should be 400mm, but that it was probably "edging back" towards 375mm. This has meant that "the last few years have been tough, really tough, even yield wise".

[6] Capacitance sensors use capacitance (ability to hold electric charge) to measure electric fields (dielectric permittivity) of a surrounding medium (eg. soil). Changes in capacitance can be correlated to changes in the water content of soil.

For MB1, the way of addressing water scarcity was to work on "improving the effectiveness of our limiting resources", particularly to increase the farm's water use efficiency (WUE). This basically meant getting as high a yield as possible for every millimetre of available water. Increasing ground cover to reduce the "radiator" effect of bare ground was a common strategy– as was the corresponding challenge of balancing this increased plant growth with the water that plants withdraw from the soil reducing moisture availability (see Figure 10 below). For CW9, his hope was that other land holders would begin increasing their ground cover. He felt that increasing the presence of ground cover would mean "you'll have a dew point at night. You just get a little bit more cycling of atmosphere and stirring it all up". This sentiment was echoed by MB2, who said "ground cover is king", though he said it is very hard to maintain "in drought years because you're flat [sic] growing anything". He was a firm believer that "we grow crops, but at the end of the day we're farming moisture".

Cover cropping was being trialled by many of the farmers. It is not a perfect solution as growing the extra biomass reduces the amount of water available for crop plants. An increasingly popular alternative for ground cover was green or brown manure – where a crop is grown but for the purpose of providing mulch rather than a harvestable product (Figure 10). It is either sprayed or slashed and left to break down into the soil before it can remove too much soil moisture.

In the absence of season uniformity or predictability, another common response was to reduce risk by reducing upfront inputs at the start of a season. LC4 was exploring how to improve the reliability of long-term weather forecasting. He has become involved in an Australian Government research project with the aim of providing "a bit more relevant information and a bit more specific information" about how much rainfall distribution might change over time. This was because projections of reduced rainfall in southern Australia due to climate change were not exact and the impacts on his property were unclear. LC4 asks:

> Where the exact line is can be blurred by several hundred kilometres and the reality is going to be if you're on the top side or the bottom side of that line - and we don't know - is the line cut and dry or is it just a general fade, a quick fade, or are you in the transition area between those lines?

Meanwhile, CW14 said that he had "given up with most long-range weather forecasts and those sort of things. I find them totally unreliable".

Figure 10. Photos of soil water management

Moist soil under clover (top left) compared to dry soil on bare ground (bottom right)

Soil moisture retained under the stubble

Chickpeas sown into stubble

Field peas being trialled as green manure

The failure of the September rains was causing hardship, particularly for the farmers in the southern half of NSW. This had caused LC5 to question if it the strategies to adapt to water scarcity were really helping. He explained, "the technology has been so good these days that everybody seems to get to August or September before their crops fail whereas if you went back 20 years the technology and the know how probably wasn't there, like half the crop wouldn't have got in the ground in some of these seasons". Now everyone is "pretty bloody good at doing that, they can always seem to get to August or September and then the wheels fall off". He questioned whether "maybe we're doing ourselves no justice by having all these tools, we might have been better off not trying so hard".

In established zero tillage systems, farmers are finding that other new challenges are also emerging. Due to improved soil biology, stubble retention over summer months was

becoming more difficult in northern parts of the state because of the quicker breakdown and decomposition of the plant matter. Options such as pasture cropping were now being explored by farmers as replacements for the lost stubble, with mixed results. Likewise, better machinery, improved soil health and drier seasons meant that many farmers practicing conservation farming were having to wind back seeding rates at sowing time, to avoid having too much plant growth at the expense of grain yield come harvest time. Increased resistance of weeds such as ryegrass to glyphosate[7] was also requiring new management practices.

CW1 has discovered that "no till was not quite working up to 100% capacity because the autumn evaporation rates are so high in the soil". Despite retaining adequate stubble cover, she believed that this was not enough to kick start the biological cycling and reduce evaporation rates. Therefore, she had begun trialling green manure, a deviation from standard cover cropping. Her hypothesis was that this may also address moisture scarcity and provide a slow release of nutrients for the microbial population. She was worried that with zero-till, "we've been given a recipe" and are "so reliant on commercial agronomists".

For CW19, dealing with water scarcity was all about conserving what you had. He felt that "it is just imperative to conserve your moisture over the summer". For CW7, part of the solution was taking livestock out of the equation and becoming a cropping rather than mixed farm. He felt that this provided a greater degree of drought tolerance because "we store our moisture rather than grow stock feed, and things like that… all the compromises that the mixed farmer makes, we have eliminated those".

HT1 was experiencing "trouble with summer crops in that they were getting burnt off in January" because he had been sowing them with a "full profile of moisture". Then, as the weather got hotter "the roots couldn't grow fast enough to keep up with the way the moisture was getting away from it". They have found that changing the sowing time to when there was only "50% content of moisture in the ground" made the plants hardier and they are "now growing very good sorghum crops".

Aside from rainfall, the other theme raised was the convergence of the timing of harvest across the state, where crops were becoming ready for harvest in the north and south of the state at the same time. Normally the north and west have an earlier harvest, with the

[7] Glyphosate is a commonly used broad-spectrum systemic herbicide used to kill weeds. Initially sold as *Roundup* by Monsanto Company, their patent expired in 2000.

southern crops maturing later. CW1 said that "I don't know if it is climate change but harvest time seems to be coming together".

For CW14, there was scientific uncertainty about the impact of hot summers and drought on the soil microbial population. Likewise, he was conscious that "everything is a moving goalpost" especially when seasonal constraints are exacerbated by drought. He explained:

> As soon as we have a couple of good seasons, we get good residue of straw on the paddocks and all of the sudden we actually conserve more of the moisture, the system works a lot better - and then you have a couple of years of drought.

For MB1 it was the same. He said that "You just keep getting this carrot dangled. You know that you can get there if you get the right years and we're just not getting the right years". CW12 acknowledged that while it may seem like there are always solutions available, sometimes, especially in bad seasons, it can be tough to see a way forward. He said it is "easy to get dejected" in these bleak times and that:

> I've said to my wife at various times I just don't know. I'm looking at this here and I'm seeing a blank. I know what I want to do and I know where I want to go and I know how I want to do it, but the seasons are just not letting this work.

5.3.4 Managing timing

Due to unusual climatic events in 2008, crops became ready for harvest at the same time across a lot of NSW, instead of the crops gradually ripening from north to south. This meant that there were not enough contractors to harvest the grain and some farmers then lost their crops due to the time delays and rain. This impacted on farmers' views of the reliability of contracting services. In a 'once bitten twice shy' mentality, anecdotal evidence points to this being a trigger for farmers to buy their own harvester.

For CW13 this was definitely the case, as she was sick of asking "where are those bloody harvest contractors?" CW7 also said contracting "was a bit of a nightmare, it didn't work for us last year, mostly it does". In the end, his neighbour, who did have his own harvester, managed to come in late one night to do his canola, in between harvesting his own crops too. He "was able to do about 400 acres of canola while he was still waiting for his oats to dry" (from a shower of rain).

CW19 was at the point of finalising the purchase of a new header at the time of his interview. They had already experienced "three contractors pull out on us this year" and there were only 2 months to go until harvest. He didn't think that there were suddenly fewer contractors, so much as it being "the way the seasons are going". He spoke of a friend who farms in northern Victoria who "started before us here last year and he is looking to be doing it again this year…that is unheard of".

Part of the problem seems to be that it can be hard to predict the exact timing of the busiest periods, such as sowing and harvesting, because they depend on the season and the weather. Therefore, lining up contractors and extra staff in advance, particularly for short periods of time, has proven been difficult. There is also likely to be more competition in a district for any labour that is available during that key period. For example, CW4 recalled how his neighbour once had to work "76 hours straight" to get his canola sown before the rain came, because you simply "can't find the workers", skilled or unskilled.

The issue of contractors related closely to the issue of timing. It was emphasised by various farmers that even a half a day can make all the difference at crucial times such as sowing and harvesting. This had led some farmers to increase their investment in machinery so that they had the control over its availability rather than rely on a contractor. For example, CW1 explained:

> These days, more and more, it is the timing. Timing is the big thing as I understand it. Like, you have got to kick in and do things when they need to be done… that is why having your own gear and the manpower - I need the manpower now. I am not overly thrilled about employing people but you find good people…the idea is, especially in the summer, is to go and hit it quick and fast and get on it.

For CW3, having his own machinery was also about "doing it at our pace to do the job right". In his view "the he contractor still is there to make money and he will try to cover the most amount of area at the shortest time". He also found that the shortage was particular to "not so much stock contracting but crop contracting because that all has to happen at the same time". Therefore, he had just bought a spray rig "because it was getting harder and harder to get the person when you wanted it, at the right time and it was costing too much". He thought this could be due to a decline in the number of contractors. However, he felt that this loss of labour was partly compensated for by the increase in efficiency of the machines. The challenge is that the more efficient the

harvester (as an example), the more "you need other support machinery or chaser bins and stuff to go with it". At the same time, "if that one header then stops, it puts an awful lot of things behind". For CW18, the "machine needs to be ready to go and able to plant on the right day". For him, "timing is everything". CW2 echoed this view saying that "it is timing. It is all time dependent".

5.3.5 Developing new machinery

In coming up with a new idea, it is common to find that the machinery to implement ideas does not exist. It therefore has to be created in order to bring the idea to fruition. As MB2 said, "innovative people, I suppose everything else happens behind them". For example, several farmers who wanted to trial green manure found that the equipment required was not commercially available. CW9 built his own "40-footer" machine based on a much smaller model he had seen being pulled behind a donkey in South America. Likewise, CW1 also found that the equipment they needed for green manure, such as a roller, was not commercially available "so you have got to make your own and you've got to reinvent the wheel each time". LC7, who had developed his own machine for zero tillage systems that used discs for sowing, recalled:

> A classic statement from my old man was why do you have to build it - why don't you just buy the bloody thing? But there actually is nothing there to buy.

Due to local constraints, LC7 found it was easier to get the machinery he had designed made in America and then imported back into Australia – something which he noted was illogical but unfortunately more economical. He said that farmers prefer if machinery is built by a farmer for farmers, rather than by an engineer who would give the machine "so many moving parts". In his words, farmers "want something that goes - he hasn't got the time to spend three weeks here on maintenance, it has got to go now". Despite his success, it has been a big risk in investing in the series of patents required. After nine years he was only "getting payback now" and paying off all the money he borrowed to develop the machinery (Figure 11).

Having the right machinery isn't the only thing that comes in to play. It is also the cost of the technology. Even if equipment does exist, it can be extremely expensive. A new tractor, with the two machines required to sow and carry the crop seed can quickly add up to $1million. At least in the trialling stages, this cost can be prohibitive. One approach is to rely on cooperation with other farmers. For example, to avoid the investment prior to

trialling, CW3 got a farmer friend from within the district to bring his disc machine over to sow a crop straight into a pasture paddock to see if it would work. In the "straight pasture paddock", the result was that "the crop came up better than our actual cropping country so we realised we had to change - and that is when a lot of the things actually got changed".

Figure 11. A farmer-designed and built machine for zero tillage cropping systems.

For LC4, when he wanted to change his cropping system in 1994, he went halves in the purchase of sowing equipment with his next-door neighbour because the "infrastructure costs are horrendous". For him, "that was the start of it". Another option is to build a cheaper version of the technology that is commercially available. MB2 was building his own self propelled boom spray with the help of an engineer. To buy it would have cost about $400,000. Instead, MB2 bought a second hand spraying platform and was then building a boom on to the old platform. He was hopeful that he could complete the machine for under $200,000, half the cost of purchasing it. Likewise, CW7 still had the air-seeder he built back in the 1990s. He had bought a piece of equipment that an agricultural company had been using for research, changed the coils, wheels and points on it, and towed it behind a tractor for about 5 years.

CW19 was keen to purchase new "weed seeker technology"[8]. However, his concern was "it is just a matter of justifying it really. It is pretty pricey to set up". To get around this issue of cost another farmer, CW10, had built his own weed seeker by modifying a self propelled boom spray (see Figure 12).

[8] The WeedSeeker® technology uses sensors and nozzles to detect the light reflected by green plants. It only sprays the green plant, not the soil or crop stubble, reducing herbicide and water use. It can be fitted to a boom spray (broadacre spraying machine).

Figure 12. Photos of a farmer-built weed seeker

Modified boom spray

Tractor and boom spray of weed seeker

Some farmers felt the role of farmers in developing machinery was not properly recognised. CW15, who had heard farmers described as slow to adopt technology viewed this as "a great insult". In his view, "farmers are the ones that create technology. It is bodies like the Department of Agriculture and CSIRO will pick up on what the best farmers are doing and convey that info to others". CW15 also recalled a time when a "a machinery maker from Wellington" made the comment that "it's about time us machinery makers start making machines that farmers want, rather than making a machine that we want to sell them." He said this comment was triggered by the machinery maker seeing the equipment at a field day that farmers had built themselves. CW15 had also designed his own sheep yards, including using old tractor tyres to make the ramp into the shed softer on their hooves, which meant the sheep did not become alarmed like they would if the surface changed from dirt to concrete.

Issues of intellectual property were raised, particularly in the context of machinery development, but they were not seen as paramount. Most farmers supported the idea of continuing to make information freely available between farmers, but did not appreciate ideas being poached, patented and profited from by private companies. For example, (CW5) explained that:

> I wouldn't mind if it was other farmers. That wouldn't worry me. It would frustrate, it would annoy me if a company came in and made a heap of money out of it and selling it to other farmers.

CW6 agreed and pointed out that "we copy off other farmers - everyone does". LC1 had thoughts along similar lines, explaining that:

> You could go down the banking or research type of thing and everything is IP and you can't talk about anything you do - or you've got to look at it possibly a bit more holistically and say look I do need a community around me. I do need services that I can access, so I do need a viable farming community. So I do need to share some of this stuff.

5.4 Summary

In terms of the nature of farmer driven innovation, these results show the importance of looking beyond motivations and barriers to change, and the role of management decisions, knowledge, networks. It is clear that there are farmers who are generators of knowledge and innovation - are engaged in scientific and technical on-farm research, trialling and experimentation, both independently and in collaboration with other organisations. Chapter Six presents a range of findings on how knowledge is exchanged and the role that networks play. It also looks at innovation in relation to sustainability and the results of interviews with non-farmer agricultural professionals.

6. Farmer-driven innovation (2): knowledge networks and sustainability

6.1 Introduction

The previous chapter revealed the considerable time and effort that is required to implement innovations and phases of transition that can be required. This chapter presents results pertaining particularly to the second research question on the exchange of knowledge and the role of networks. It explores whether knowledge networks have played a role, and the evidence of farmers as active seekers of information, as well as the influence of farmer-to-farmer knowledge exchange and the influence of farmer groups. Farmer experiences with agronomists, government advisors, and collaborative research are reviewed as examples of interactions within each farmers own knowledge networks. It also presents findings on how this innovation may be impacting sustainability – in particular land management changes such as property redesign and specialisation. Given the results in both Chapters Five and Six, the counterbalancing views of non-farmer agricultural professionals on innovation are also outlined.

6.2 Have knowledge networks played a role?

"A lot of what helps is looking at what/ how other people are doing best practice and how they've adopted their thing. I don't think there is any best practice that is going to fit everything. You are going to adapt it to what you want. It is often hard to work that out without having seen it on someone's place". (CW3)

6.2.1 Actively seeking information

Farming is increasingly information intensive. Among the interview participants, it became evident that they were innately curious and proactive when it came to actively seeking out and synthesising new information. Rather than waiting to attend training or speak to other farmers and researchers at a field day, CW9 told how he would often telephone people directly because he found it:

> A better means for me to get it and get the information into my head and get around it than sitting at a field day listening or whatever. I'd rather be doing it.

CW1 said "you've got to find it for yourself". She explained how they have worked to build their own network of contacts and how:

> That's been our philosophy all along is that we go and seek everyone's opinion and then take it all back and say what works for us? We don't want to be tied down to a specific philosophy or way of doing it because nine times out of ten they will lead you down the garden path and then shut the gate on you.

CW2 said "you do need to hunt it down yourself and you go and see what other people are doing". For him, the way to test the usefulness of advice was to do some research first and "then ask the departments to see what they say or to see how much they know" because he could "research something and go and ask a person a specific question. If they don't know the answer to it, you know not to worry about them, because they've got no idea". He also said that in recent years:

> We've gone away from approaching a lot of people, government departments or those sort of things for advice and we are seeking our own information and talking to people who are doing it and making our own decisions.

CW16 also preferred to make his own judgements and said that over time he had become "more independent than what I ever was". Rather than lamenting a lack of information or guidance, these farmers felt that the information to undertake further change and evolution was definitely out there, but it was up to farmers to be proactive about pursuing it and piecing it together. As LC1 said, "the tools are out there - it is also about bringing it all together".

6.2.2 Farmer-to-farmer learning and knowledge exchange

Implementing change across a farm takes time, resources, commitment and technical skill. There is no simple recipe because every farm has different biophysical characteristics, climate and land management history. In essence, each farm is its own unique ecosystem. Farmers know this and don't tend to think of 'one way' as the only way. Therefore they will be naturally suspicious of others who advocate a recipe as 'the answer'. This often translates into a suspicion of "snake oil salesmen". There was a fear that "people can tell you anything and will sell you anything" depending on their agenda (CW1). Therefore, there was a tendency to value the advice and experiences of other farmers over that of

non-farmers. CW3 explained that farmers who have "actually tried it and seen the benefit, they are often better to listen to than someone who is actually trying to sell you a product".

CW12 appreciated people that would admit honestly that "we tried this but this happened and it really didn't work". Learning about failures was seen as crucial, because a lot of things that are trialled on farms do not work, and to pretend otherwise is to again invoke suspicion. He had also found that he would still learn from farmers who others might not think of as "very progressive" because "he's got little knick knacks and little things he does that can be very beneficial to you".

Farmers can also provide advice that is less traditional and proven than an agronomist will, because the agronomist can be subject to constraints of liability. CW2 explained it as the "farmers that have done it before… they've tried different chemicals that might be off label that work but an agronomist is not going to tell you that". WD1 felt that, for many farmers, it was largely a matter of seeing results on someone else's farm, and "you can talk until you are blue in the face, but a picture is worth a thousand words".

Several of the interview participants expressed an interest in learning about the management practices of the other interviewees. They were keen to hear but said it isn't always easy to find out who the other "likeminded" farmers are out there. LC7 explained "we tend not to tell people what we have been doing because we are sick of getting bagged out". He suggested getting farmers together would be good. Similarly, CW9 told how, when asked by his neighbour about his crop yields, he would tell him an average figure for the district, rather than admit the high yields he was getting, to avoid looking like he was "showing off".

It was suggested that neighbouring farmers were unlikely to be interested and most requests for advice come from outside the district. WD2 said "it doesn't matter what district you are in, your neighbours won't look at what you are doing. It is always outsiders". There were a range of theories to explain this, the most popular being that if you are from another district with different conditions, you always have the option to say, "well that won't work on my place", but neighbours don't have that excuse.

CW6 also found "you tend to get more interest from away than locally". He gave the example of a rotational grazing field day held on a farm in northern New South Wales,

where there were reportedly 100 people who turned up but, disappointingly, only a few of those people were from the local district. LC1 felt that it was important not to let who your neighbours are dictate your actions. He recommended not being:

> A fish in your local pond, regardless of size, because your local area can be really encouraging if it is a dynamic area and it can be really poisonous if it is not. So getting out of your own little box so you can see what's out there and give yourself a bit of an idea of where you sit with other growers.

CW18 felt that it was getting to the point where "everyone is putting a day on" and there was just not enough time to attend all the good events being held. This was similar to the views of several other farmers, including CW1, who also expressed the belief that, "there's an overload of workshops now" and "people are just going nah, not interested".

While advantageous in some ways, a heavy reliance on other farmers can be a burden for those whose knowledge and advice is constantly sought. While farmers were willing to be very generous with their time and had hosted farm tours as well as permitted trials to be undertaken on their land (and a PhD researcher to tour their farm and conduct interviews!); there was a sense of overload. WD1 was considering scaling back the number of field days they allowed to be held on their place. She was thinking that it might be better to "just do a field day where you get 150 people" so that it only takes a "couple of days, and you can affect a lot of people". By August, she and her partner had already run five field days for different organisations that year and there was another one to be held at the end of the month. Though they were getting paid for their time, they felt that perhaps it would be better to focus on their own work and let the results speak for themselves. CW16, who had years of accumulated experiences, told how he had "pulled back" in recent years from participating in a lot of field days and groups (see Figure 13 for an example of an event targeted at farmers).

Some farmers felt more it was more efficient to just ring a farmer rather than attend a field day. CW12 explained that "if I know there's a farmer who I think is doing something that I'm interested in… I'll try and track somebody down that knows him and just ask a little bit more about what they're doing. And if they say "he's a good operator, he's doing this, doing that," I'll just ring him up". This same farmer felt that when farm tours came to his place, "everything's got to be spot on and you want everything to be right and that. There's a lot of pressure in that". He was very conscious of the time taken to show

someone around a farm and said that he would "always leave a gift. I'll never go to someone's farm and not leave a gift. Like the last guy's place I went to, I took him a bottle of black label Johnny Walker scotch".

Figure 13. Photo of a district agricultural expo, Nyngan, NSW, in 2009.

6.2.3 The influence of farmer groups

It became apparent during the interviews that a variety of farmer groups existed and that these were of considerable importance. 68% of the interviewees were members of the Conservation and No Till Farmers Association (CANFA)[9]. This was partly a function of the research method (as explained in Chapter Four) where the CANFA board helped to identify interviewees. However, even the 32% who were not members of CANFA were still involved in farm groups – for example, more than half were involved in groups such as TOPCROP[10] and FarmLink[11]. There were a wide range of examples given of farmer groups that the interviewees said they took part in, including:

[9] A farmer run organisation promoting farm management practices that improve soil health.
[10] TOPCROP Australia, initiated by GRDC, provides resources for grain grower groups for on-farm training and testing through facilitation, training and information packages as well as informal grower-led activities. It also provides group skills and leadership training for grow groups through initiatives such as TOPTEAMS.
[11] FarmLink is made up of growers, advisers and researchers in southern NSW, with the objective of co-ordinating private, public and grower group funded research and development activities within the region. Sponsors have included GRDC, Caring for Our Country, Meat & Livestock Australia, Australian Wool Innovation and Land & Water Australia.

- A group of 16 farmers who had come together to jointly employ a crop nutritionist to undertake a liquid fertiliser program on their farms and to purchase the products required;
- A local cooperative started by one farmer which recently held a field day on disc planters, to which about 250 people turned up from all over the state;
- A consultant run business group that was involved in completing set projects and reporting back to the group as well as farm trips;
- A national ram breeders group that worked together on genetics, purchasing of livestock and marketing;
- An association started by 3 farmers who had gone into the business of training other farmers, with an information sharing platform for any farmer across Australia who has been trained;
- A 15 member self-run farmer advisory group that was focused on regenerative agriculture and systems that achieve triple bottom line results;
- An agronomist led group of a dozen growers with which the agronomist shared new findings and information;
- A group of about 20 croppers who met several times a year to talk; and,
- Several farmer driven research groups which conducted research and hold field days, such as CANFA, CWFS, Stipa.

Whether these groups were initiated by farmers or led by external organisers, there was a shared sentiment expressed by CW2 that:

> If you are grouped together with enthusiastic people you are going to achieve a lot more than people that don't want to achieve anything or are not necessarily wanting to change.

Particularly noticeable was the emphasis placed on the importance of enthusiasm, support and lesson sharing. Several farmers mentioned the CANFA annual farm tours that go to other countries and interstate as great opportunities to learn from other farmers and to make connections. They explained that this was because they had time to get down to the nitty gritty. CW1 explained it as "after 30 days, after a few beers, you are telling them anything and you are prepared to tell them anything because they are not a direct competitive threat to you". Travelling was the mechanism for this, where they "learnt a lot from where we have gone, but we have learnt more from the people we have travelled

with". CW7 told how it was during a trip to South America that he learnt about "disc seeders and cover cropping and all those sort of things".

6.2.4 Agronomists and government advisors

While agronomists were clearly a key source of advice for farmers who grow crops, the use of agronomists differed between farmers. There was a mix of retail (free service but attached to an agricultural products retailer such as Elders) and 'fee for service' agronomists (paid for independently by the farmer) being called upon. Some farmers had a high reliance on an agronomist and saw it as a valid way of outsourcing an area of expertise. Others used agronomists as another tool but would not always take the advice. Some no longer used agronomists at all. As Table 5 shows, only one farmer relied exclusively on a government agronomist. The other 18% who mentioned government agronomists, also got advice from retail agronomists. In total, 32% used retail agronomists. 32% used fee-for-service agronomists. CW12 was happy to pay for agronomic advice because he felt that:

> A good agronomist will add a lot of value to your farm because one spraying done wrong, costs thousands and thousands of dollars. Well you've more than paid for the 12 months subscription for the agronomist in one hit. And because mine does a bit of marketing, he's invaluable to me.

The increasing use of 'fee-for-service' related back to the issue of timing. For example, LC5 and LC6 switched to a 'fee for service' agronomist because they were finding they couldn't get the retail agronomist at the right time. They felt the cost was worth it because:

> We get the advice when we want it and it does allow us then to shop around for our chemicals and we can subsidise the cost of the agronomist by doing that.

The fee-for-service users did not mention consulting with government agronomists, although they did mention taking advice from retail agronomists and other farmers. 14% no longer use agronomists at all. For example, CW9 stopped using an agronomist altogether because:

> It became too hard. For me I found it almost became like an antagonism. I just felt – I don't know whether they're coming out of university and they're just probably a little bit structured and set in their way. I believe the way modern farming's going

> and certainly with our rainfall and whether it's climate change or whatever, but we've really got to be flexible in our thinking.

LC4 has also stopped using an agronomist. However, he explained:

> In the agronomist's defence, they are very much going down the prescription farming, and I think quite a bit of it is so that they don't get sued, because that is a whole new ballgame, that is a whole minefield in its own right.

LC4 was considering reverting back to a fee-for-service arrangement because he had met another agronomist who seemed to be better suited to what he was trying to achieve. Though the issue of agronomy was raised in the interview, CW1, CW5/6 and WD1/2 didn't specify what source or type of agronomic advice they received.

LC2 said that they had a good relationship with their local government agronomist, but she "hasn't got any funds. We have a good relationship with the department but she can't afford to go out of the office", because of limits on travel expenses. They spoke favourably of her work on beneficiary insects, but felt she "can't do a proper trial because she hasn't got the funds for it". CW15 recalled how "the departmental agronomists, they used to be freely available". He said they used to visit just about "every fortnight" but "due to cutbacks in staff, that sort of goodwill thing sort of waned a bit. The agronomist lady we've got here now has got to cover a bigger area and there's far more bureaucracy she's got to comply with".

Table 5. Farmer engagement with agronomists

Farmer Code	Not any more	Government Agronomist	Retailer	Fee for Service	Other comments
CW1	-	-	-	-	Does own soil tests
CW2/3		Yes	Yes		Thinking about doing own agronomy
CW4				Yes	Also pooled resources with 15 other farmers to employ crop nutritionist
CW5/6	-	-	-	-	-
CW7/8				Yes	The fee-for-service agronomist also works for a retailer
CW9	Yes				
CW10/11	Yes				Do own agronomy
CW12				Yes	Private agronomist with 10 clients.

CW13/14				Yes	
CW15		Yes	Yes		Cut backs mean he now relies more on retail than Government
CW16			Yes		But don't soil test anymore
CW17/18				Yes	Annual soil testing. No plant testing at the moment.
CW19		Yes	Yes		
CW20			Yes		Moving towards self diagnosis. Gets some advice from the retailer buy chemical from.
LC1/2/3				Yes	The fee-for-service agronomist also works for a retailer
LC4	Yes				Will probably go back to paying an agronomist
LC5/6				Yes	For the past 5 years
LC7	-	-	-	-	
MB1		Yes			
MB2		Yes	Yes		
HT1/2			Yes		
WD1/2	-	-	-	-	

Farmers were quite critical of the advice provided not only by agronomists, but by extension agents and government officers. CW3 told of how for years they "had a paddock that had invasive weeds in it – weeds we didn't want. I didn't know what I could do with it". He told how:

> Years before, over different times, I had agronomists come and have a look at it and the advice continually was to plough it and I didn't really want to plough it but that's all the advice I could get, so nothing really happened.

Eventually, he figured for himself a way to control the weeds without ploughing the soil, and "once we started doing this, well then it was a way to do it". For him, it appeared to be the case that not "many agronomists as such or department people" were promoting these new approaches. Instead "it is more farmers that have done it". Without any concrete guidelines, "it is a case of actually initialising it and trying a bit yourself and then once you've seen that then you can follow on because you know how it works on your place". CW2 was of the view that:

> A lot of agronomists and Department of Ag[12] staff – it's outside their blinkers and they are very much traditional science based and they wouldn't be able – they could tell you to plough it or do something - but I don't know that many of them are actually up to date with pasture cropping or alternate strategies.

In particular, there was scepticism of government staff, although in some cases, respect for the 'old' guard of government advisors who have been around for decades. Various farmers held the view that the Primary Industries section of NSW Industry and Investment was useful in some ways, but limited in breadth of focus. CW5 felt that "DPI people tend to be pretty narrow vision people. Not saying that is a bad thing but they are usually pretty focussed on their section, whatever that may be". CW1 felt that the DPI researchers "are very good. They are very good in their division. If you want to go outside the norms, they are not the people to look at".

CW12 was of the view that "there's some tremendous work being done by the New South Wales Department of Primary Industries" and GRDC. He said, despite them "cutting back a lot on the farm research and everything" there are still people in there who are "dedicated people and they're very good. And if you take the time to nut out the nitty gritty with them, they're happy to talk to you and they'll tell you in infinite detail what they know". Likewise, CW19 spoke very positively of a new district government agronomist and how he was "running trials and a lot of field days at the moment". For CW3, the issue was "any of these ideas or organisations have still got to have integrity, people have to believe in them". He said that DPI was useful "to some extent… but they still weren't right up there with what we were doing or what a lot of other people were doing".

Most farmers blamed the government in general for funding cuts rather than individuals within an organisation for research gaps. CW15 recalled how frustrated the local government agronomist was because, "according to the Department, the recommendations for her area were to be taken from the trial that was conducted here". In other words, the crop variety and management guidelines were being given for two areas with different climatic conditions.

[12] The NSW Department of Primary Industries (DPI) was formed in July 2004, with the amalgamation of: NSW Agriculture, NSW Department of Mineral Resources, NSW Fisheries and State Forests NSW. In July 2009, DPI was amalgamated into New South Wales Department of Industry & Investment. Farmers still tend to refer to it as "Department of Ag" or "DPI".

For CW3, the frustration was that while they "are trying to do things or expand it", it is "very frustrating to see them continue to cut back Department of Ag[riculture] and projects like that". For him, it meant "you've got to do more yourself. If they really want to push improvements a lot of those things should be actually have been expanding not contracting".

CW1 was worried that the CMAs "are really pushing no-till". The risk with targeting adoption was that the CMAs could soon be promoting an outdated system, when everyone else has already "moved on to something totally different". She could envisage this being the case if glyphosate could no longer be used - due to weed resistance or its detrimental impact on soil biology. By then they've "put all these people into this basket" and then they will have to say "oh sorry you've got to come out of that basket again". This echoed CW2's concern that:

> A lot of the people in those organisations that are on the ground, doing the implementation, know less than what you do. Their skill levels leave a lot to be desired.

CW20 had found the CMAs to be encouraging. In contrast he had found that the agricultural department was "not at all supportive - they tend to keep their distance. I think they're expecting the wheels to fall off". He felt that DPI didn't "buy into the goal of trying to achieve a healthy landscape or regenerative agriculture". He would like "some of the extension staff to think of regenerative agriculture rather than production agriculture" while still maintaining their expertise in production. He thought they should also use their network to promote other approaches.

WD1 found the recent CMA funding cuts "disappointing because there actually are some really good people in the Western division trying to have a red hot go". WD2 also felt it was a shame that the CMAs "haven't got any money from now on" and that the cuts impacted "a lot of good people with their best intentions". To him, the cuts are short sighted and miss the chance for "a lot better stimulus from the economy point of view" into a local area.

6.2.5 Collaborative research

In addition to conducting their own trials, at least half the participants were also allowing trials to be conducted on their farms in partnership with government research

organisations or private industry (see Figure 14). The majority of these collaborative trials were cropping related. There were also several instances of agro-forestry trials but no examples of livestock related research partnerships.

Figure 14. Photos of on-farm crop variety trials for public and private organisations

On-farm crop variety trials(1)

On-farm crop variety trials (2)

A common problem was for farmers not to hear back from researchers who implemented a trial on their property. Abandoned tree plantings, soil measurement probes and other instruments were still in the paddock years later, with the farmer not sure whether to just take them out (see Figure 15). There was a sense that this lack of follow up was resulting in 'reinventing the wheel' instead of a systematic approach to implementing learning gained through both private and public funded trials, research and experience.

For example, HT1 and HT2 had a major success with an environmental services scheme run by a NSW Government department. However, they had a different experience with a CSIRO trial. HT2 told how they were doing a companion planting trial of "gum trees with Acacia plants" and apparently "nobody ever came back to check". The irony was that they were told they "didn't have to label every tree" because the researchers would know what species they were.

HT1 gave another example of a researcher from a government research centre near Trangie who also did trial work with different cultivars, monitored through photos and built new machinery. However, when it came to writing up the results the researcher was told he couldn't because the funding was finished and "so he said they can stick the job".

Figure 15. Photos of an abandoned tree plantation on one interviewee's farm

A farm forest planted by researchers and then abandoned

The project partners include a department that no longer exists

LC7 recounted a negative experience he had with Land and Water Australia where the high staff turnover rate meant that not only did the people involved keep changing, but "they just didn't know what they were doing". For him, the fault didn't lie with "the actual individuals you were dealing with, it was from higher up". For him "it would be interesting if they actually just listened and get the story right". He gave another example of a deep drainage project using Mallee that a government department and CSIRO were going to implement on his property. He had done all the work getting the paddock ready and putting in "rip lines" and getting "the little Mallee seedlings out of the ground". However, when the staff came out to the farm, he found out that they "wouldn't pay for quantitative measurement" and "they weren't actually going to measure it, they were trying to model it". From his point of view, "until you are going to measure it - it had absolutely no advantage". So he withdrew his participation.

Farmers expressed concern about the lack of ambitious or explorative research. One farmer explained there "is very little blue sky research in agriculture" (LC2). And that, with the cutbacks in publicly funded agricultural research, there would be no one to fill the gap. (LC1) couldn't see why private companies would fund such work. He posed the question:

> If no one is doing that long term blue sky stuff, well who is going to worry about frost tolerance in wheat?… Any of that stuff that has got an intrinsic value that can't be captured… why would Monsanto do that?"

For LC1, "it comes back to agriculture not being profitable enough". CW2 was also concerned that with "the biological type science stuff, you have to be very careful because

they [retailers] are trying to push their own bandwagon – and make money out of it and with very little scientific background". The answer to this according to CW2 was that "you've got to sift through it yourself and do tests and background research on your own property".

While for some the concern was the sale of unproven science, for another farmer, the concern for LC2 was that some of the research companies are not "using up to date technology disc seeders or things like that, where things are going. They are still testing our wheat varieties on old machinery and old farming practices".

WD1 was critical of the narrow views of 'science', whether it is up to date or not. She felt that science would never be particularly instructive because "science and holistic management doesn't go together particularly well". WD2 agreed that the problem with "science is it tries to break it down into little bits that we can know all about, that is fine in a confined set of parameters" but not when you need to "take a step back into a bigger picture". To them it has been too much "science and agronomy and oh it is a healthy crop, but it is a bloody monoculture". They want to discover "what is a healthy environment?" (WD1).

LC7 felt that "the researchers aren't even researching what we are doing - they are researching stuff that we did 10 years ago". He suggested that scientists should work with 15 or 20 leading farmers from mixed farms in order to "short-circuit ten years of grief - because they could actually be releasing accurate up-to-date stuff at the time it is happening instead of 10 years later or longer". CW7 expressed a similar view. He felt that:

> Most people think that farmers get the benefit from scientists but it is the opposite way around. Where science will research a farmers gut feeling for them..... I mean, that is what scientists do.

What was popular were farmer driven research programs such as Central West Farming Systems (a platform for on-farm trials driven by the knowledge needs of the farmers in the district that are involved). For example, MB1 said he was:

> A big supporter of the Central West Farming Systems program. We've got a reasonably strong network… I really think that we're pushing the frontiers out with a lot of stuff that we do and it's privately driven.

6.3 Are these land management changes good for sustainability?

Given the challenge of finding ways to increase productivity and sustainability at the same time, the environmental outcomes of changes in land management are important. While located in this chapter as a more tangible example of farmer-driven innovation, it is important to note that the actions outlined below also have bearing on the results presented in Chapter Five, particularly section 5.3. In this research, two potentially opposing forces were uncovered. The first, property redesign, has the potential to reconcile competing goals of production. The second, specialisation, poses a serious threat to notions of multifunctional and diverse agricultural landscapes.

6.3.1 Property Redesign

In this research, (45%) 10 of the 22 farms had been redesigned. Of these 10 farms, 8 were mixed farms, while 2 were cropping farms. These new layouts reflected more than a change in fence lines and a lot of labour intensive work, but also a broader conceptual shift thinking about management systems on the farm. Examples of changes included:

- establishing shelterbelts/ tree corridors across the property
- stock exclusion from natural water courses such as creeks
- subdivisional fencing and laneways for stock movement
- new grazing management practices
- changes in weed and pest management, including chemical and pesticide usage
- alternative nutrient sources for crop soils
- increasing groundcover and retaining native pastures
- regenerating native timber and conserving areas of native/ remnant vegetation
- rebuilding wetlands
- reducing erosion of paddocks and creeks

Generally, grazing paddocks were being made smaller as part of a livestock rotation system that sought to increase the planned movement of stock around a number of paddock cells - where timing is based on the requirements of grass species rather than the stock, and a desire to increase the proportion of native and perennial grasses in the pasture. To do this, new water points and piping had to be installed, often matched with a "wagon wheel" pattern of fencing out from a water point (see Figure 16).

Figure 16. Photos of 'wagon wheel' fencing around a central water point

Water point for rotational grazing (1)

Water point for rotational grazing (2)

Meanwhile cropping paddocks were also being modified. In general they were getting bigger, to facilitate controlled traffic and auto-steering, where the tractor is directed along a pre-programmed route via GPS. This reduced overlap of machinery tracks, hence increasing the efficiency of sowing, spraying and harvesting and reducing soil compaction.

The replacement of barbed wire fences with two/three wires and removable electric fences provided the advantage of flexible fencing configurations. In the Lachlan, two farmers had significantly changed their farms. LC7 explained how:

> There are no original fences or roads on this place… I have gone to cell grazing, two small rotational grazing, 200 acre paddocks… there are electric fences on the whole place. Roads are in suitable places.

Meanwhile, LC4 had also redesigned his paddocks (see Figure 17). He said:

> I have basically re-fenced this whole place in the past 5 to 6 years down to between about 15 to about 12 or 10 ha for anything that is arable and my salt paddocks I come back to around 6 or 7 ha. I have re-watered the whole place. I have new lines and troughs across the whole thing.

LC4 was conscious of the need to be flexible. He explained that in redesigning the layout of his property he used "all fencing that is movable because I wouldn't be surprised if in

another 20 years time the way I have got it set up is probably no longer relevant". He could even see fencing replaced by virtual fencing[13] within his lifetime.

Figure 17. Photos of the new tree and fence lines on one interviewee's farm

CW20 was also conscious of the ongoing change that was required on his farm. For him, flexibility was about being able to respond to the seasons. He explained how the shift to "permanent perennial grassland which we graze or grow crops into" gave them the opportunity to "make a decision on that each season". For him, it is important to have "the flexibility to choose either or without having to put much time or money into switching from grazing to cropping. It's the permanent perennial grassland that gives you that flexibility".

HT1 had deviated from the wagon wheel model and decided to instead fence his grazing country "by soil type, grass species, the changes in North, South, East, West slopes". This

[13] The concept builds on the basic principle of an electric fence, except there is no fence. Using a wireless sensor network containing microcomputers, radios and sensors, some of which are fitted into cattle neck collars, sounds and small electric shocks are used to teach the animals to avoid the virtual boundary – defined by satellite technology and global positioning system (GPS) coordinates. Producers could reset a new fence line anytime, from the office, as well as continuously monitor where their cattle are located. Still in testing, CSIRO is currently working to develop virtual fencing for cattle in Australia.

had resulted in significant improvements to ground cover, soil health and carrying capacity. For MB2, erosion events had led him to change the "whole farming layout now to suit the slope. Similar as you would with your corrugated iron roof".

Other farmers were keen to make changes to farm design in the future. Although LC4 pointed out that farmers trying to implement the changes he already had would struggle because "there is no way in the world I could economically justify doing it now. Fencing has more than doubled, the poly pipe, everything has more than doubled in the last five years". For him, the question was how to do it differently? He emphasised:

> You literally can't achieve in the time frame we have been achieving things - the things that you can now - because of the doubling of all the costs and because of your reduced income… so you are much more limited.

CW12 wanted "a couple of good seasons" so that he would be able to afford to:

> Get the whole place fenced properly so that I've got a certain area of cropping which I would continue to tram track and no till with no stock whatsoever. And then the rest of the country I would sow to a lot of perennial species.

6.3.2 Specialisation

"I think it is very unusual to see a really good cropping manager and a really good stock manager in the same person". (CW7)

As farming has become more complex and economic survival more precarious, some farmers had chosen to specialise, focusing on one type of land use. While a function of economic considerations, specialisation was also found to be driven by the need to simplify and focus – to do one thing well, rather than trying to do too much and be an average performer. In other words, farmers were finding they were more effective if they could concentrate their efforts on one enterprise. As CW11 said "it's not going to be perfected in every area by one person having – you'd be too thinly spread".

Some farms have destocked all together or are keeping livestock totally separate from their cropping system (see Figure 18). In this study, 16 out of 22 farms (73%) were mixed farms. However, prior to 1993, 96% of the farms in the study would have been mixed. Of the 6 farms that now focus on cropping, only 1 had never dealt in livestock. And while

73% of farms had some form of livestock enterprise, 100% undertook some form of cropping. Specialisation was seen as a key rationale for removing livestock from the equation.

Figure 18. Photos of livestock and their changing role in farming systems

Purebred poll dorsets which are periodically rotated on to cropland to graze.

Cattle trading can provide a quicker return than cattle breeding

Fence posts removed and stacked after the switch to a cropping-only enterprise

A stockpile of water-troughs after the livestock component is removed from the farm business

CW10 explained how they had moved from being a mixed farm to just a cropping enterprise. To him, any reduced income from getting out of cattle was compensated for by the fact they have "been able to get our timing much better on our cropping". In his view, it didn't matter so much if you chose to be a grazier or a cropper, but "if you are a grazier, and rather than do a bit of part time cropping, you're probably better off to be a straight out grazier". CW10 also worked with three other siblings to manage their cropping farm. Each sibling further specialised in an area of cropping, for example engineering, agronomy or marketing. For them, this additional focus was part of the secret to their

enterprise being one of the most productive in the region. They felt this was important because:

> A 15% increase in production basically doubles your profits, or 20% or 15% reduction in inputs, one way or the other. So that's the thing, you don't have to change those parameters very much to make a farm viable or go broke basically.

LC1 had a similar view. He likened it to the:

> GP versus your specialist. If I need brain surgery I don't want my GP to take it or open heart surgery. There is that level of professionalism now – or it has to go that way.

LC5 farmed with his brother and their main focus was cropping. He said that "probably really 90% of our business is cropping and we trade in livestock when the seasons and the markets suit basically". Within the business they also specialised. His "brother tends to look after the accounts and that side of the business as well as the livestock" while he tended "to focus on the cropping and to a lesser extent maybe the machinery". His father was semi-retired and "a bit of an onlooker on everything really these days, just helps out when he wants to or when he thinks we need it". For CW17 and CW18, although they still had a mixed cropping, sheep and cattle farm, they were "seriously considering" their "enterprise mix" to try and cut back on the long hours, and to improve gross margins, because they were "not doing three things well".

Where mixed farming remained, the trend was for the grazing and cropping enterprises to be separate – where livestock are no longer run on cropping country and where grain from the cropping enterprise is less likely to subsidise the livestock operation. Both CW2 and CW14 mentioned that they had changed their grazing operations. Rather than running their livestock on their cropping country, they have separated the two. For both farmers, this was partly to prevent negative pressures on the cropland soils such as compaction from the livestock.

It isn't all about time and knowledge. For CW13 and CW14, it was also a matter of preference. CW13 said that they have kept cattle and cropping, but "the sheep have gone because [CW14] doesn't like sheep" and because the shearing sheds and fences were in a state of disrepair. CW14 explained it as "someone likes cropping and someone likes

grazing". CW7 had exited the livestock industry over a decade ago because his "family partnership had lost its common goal" and he "never really fitted into the livestock side of it". In addition, their farm was fragmented, lacked the appropriate infrastructure to run livestock "so it was a pretty easy decision to make". For LC3's family, it was clearly a financial decision. They got out of livestock entirely in 2001 after failing to make their merino enterprise profitable. They told how:

> We did everything to try - we went from September shearing to a February shearing, we went from an autumn lambing to a July lambing. And we just couldn't make it work. And so, October 01 came and the wool market didn't do anything so we said right, the whole lot are going after shearing, after February.

In contrast, several farmers were finding that after having excluded livestock, they wanted to bring them back in to the system. This was linked to mixed views on the role of livestock in causing soil compaction and the tradeoffs of removing stock from the system. CW15, CW9 and CW20 firmly believed that livestock is important to soil health. For CW20, it wasn't about whether livestock are in or out of the system, but how they are managed in it. He believed "it is usually the manager's fault whether there's compaction, not the stock's fault". CW20 believed livestock are an integral part of his pasture cropping regime. He said:

> You need them to cycle the grasses and promote biology. The crops actually help with the livestock too because they're providing high quality forage and they're providing another choice for animals to mix with dry grass. So they both help each other.

CW15 also felt that it was a mistake to remove livestock out of the farming system (see Figure 18). He felt that the success of cropping rotation, continuous for 110 years, came from being able to "devise a rotation utilising stock to ensure stock health and soil health". CW15 found other farmers who have recently gotten out of livestock resistant to the idea of having to bring them back in again. However, he gave the example of one farmer who had switched to all cropping several decades ago, who had recently said he would have to reintroduce livestock because "we just can't keep doing that to this country".

CW9's father had run a traditional cattle/sheep/wheat operation. When CW9 bought his family out of the partnership in 1998 he "switched very quickly to complete cropping". He recalled how the livestock were causing soil compaction and crops were failing and he

thought that with "these beautiful soils….. we've got to be able to do this better….."to do this better in this environment". So, they switched to "zero till and then very, very quickly jumped into controlled traffic because as soon as I moved livestock the improvement hit me in the face". Yet, for CW9, the question of how to build carbon into the farming system remained. He began to ask:

> How can we maintain a healthy soil, grow grain, take grain out the gate but start building the central component, carbon? How do we do it?… So that's where we're at right now and I think a lot of farmers in the country are… I think DPI and those guys, they're 10 years behind. They'll be waking up to this.

Given these concerns, CW9 has decided he will reintroduce some livestock into the system because he believes that the soil biology could benefit from "a bit of manure in the system, a few hoofs in there".

CW12 had spent "almost 10 years with no stock at all". He was now "looking to expand the stock area and cut back a bit on the cropping". For him, he felt that reintroducing breeding[14] Angus cattle would give him the flexibility to make the most of his grazing country and he also thought it would be less time intensive that cropping.

MB1 had sold all his livestock "in the interests of time management". However, there was a possibility that he "we would contemplate bringing sheep back in" on one area of the farm where they don't crop because they were successful in obtaining an Envirofund[15] grant to put in new fences and a holding area to fatten lambs.

Either way, the trend towards specialisation looks set to continue. CW2 predicted that "grazing people are going to have to change and improve the way they do it". CW3 agreed that "cropping areas will stay there" and that "pasture areas I think will probably have to improve and be done better".

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[14] A trading cattle enterprise is generally geared to fattening steers (castrated male) to weights required for feedlots or slaughter. Weaners (less than one year old, taken off mother's milk) and steers will be bought and sold to take advantage of seasons and markets. A breeding enterprise can involve purebred or a crossbreeding program, where attention to genetics is important and the breeding herd of cows (female that has had a calf) and bulls (male not castrated) creates a self-replacing herd over time. The operation will be geared to support calving and weaning of young progeny – which may in turn be sold to 'traders' who will fatten them for the domestic or export meat market. Many farms do a mixture of breeding and trading or fattening, often keeping the heifers (young female that has not yet calved) and cows and selling or trading steers.

[15] A Commonwealth Government funding program under *Caring for Country*

6.4 The views of non-farmer agricultural professionals on innovation

As explained in Chapter Four, in this research, findings were triangulated through a separate set of interviews with five individuals from various locations in NSW who were not farmers, but work in the agricultural or government sectors. The views expressed in these interviews on decision making, innovation, research, extension, and networks provide an alternative perspective on innovation and land management on Australian farms.

6.4.1 Decision making

While the farmers interviewed felt that decision making was becoming more businesslike and professional, AS2 felt that "a large proportion of the decision-makers in agriculture make irrational decisions. They make decisions based on emotion, subjectivity and irrationality". In his view:

> There is a minority of the agricultural industry that makes rational, objective and well considered investment decisions, and considers their business a business and therefore considers their decisions as investment decisions.

AS2 felt that there should be a greater business focus in agriculture. He felt that "farmers are notorious for wanting to go and tinker" and that there was scope for "some of these farmers to take some of the energy they expend in production and put it into business management".

AS3 held a similar view. She suggested that farmers needed to "diversify what they can tinker with". For example, instead of spending more time modifying a tractor or piece of machinery, spend it investigating marketing options.

AS2 said the difference was that "profits is not sexy, production is sexy… And farmers tend not to think in marginal productivity gains and marginal costs. And our experience is that comes at a cost". In his view:

> Our best producers do nothing sexy. They have a low cost of production. How do they do it? So, they don't chase markets. They accept they are in commodity markets, sure they may look to maximize or optimize price, so how do they do it? They have efficient systems.

AS1 highlighted that:

> Agriculture is not a mob of homogeneous people… the reality is they're as diverse as small business in Australia. They all have niches, they all have different goals and values and resource base and constraints… they are small family business people and when you understand that, you understand that if people aren't working well together you can't make good decisions and so you can only innovate to the extent that the capacity of the humans to work together allows it.

On shared decision making, AS1 felt that it was crucial and that "if you could draw a correlation between level of innovation and brain capacity it would be massive, the more brains the better". The good decision makers are "not looking at barriers, they are looking at opportunities, and it's the old thing, you can only develop your business as quick as you develop yourself".

6.4.2 Innovation

In essence, AS1, AS3, AS4 and AS5 recognised that there were innovative farmers within the agricultural sector. AS1 felt that support for the farmer groups should be given a stronger weighting than support for some of the more centralised R&D programs, to have a better balance of both. In his view farmer led groups were the home of innovation and:

> The only hope is the CANFAs the Stipas those people and the Birchip Cropping Group… it's those groups that will drive innovation and change and the more they can get supported the better… The innovative stuff is probably better in the hands of the people that have a commercial stake in making it work and let them match it dollar for dollar so that they've got a stake in the research.

To him, farmer groups were the logical home for innovative research because it meant "you don't have to worry about an extension policy, and let them employ the scientists to do their research". In his view, the distinguishing feature of successful farmers and innovators was that they had completed Holistic Management or Grazing for Profit programmes. To him:

> What they've done is they've given these farmers a framework to make sense of the world, to make sense of the profit stuff, the people stuff, the land stuff and the production stuff. They can go 'Ah huh' and off they go. And I think if you look at a

> lot of the CMA boards and stuff like that you will find a lot of the innovative farmers that have been selected there have a similar background in those things. I think those programmes have been incredibly important in driving change in the rural industries but are unrecognised.

AS5 was also of the view that, especially in the area of the science of pasture and grazing management, farmers were leading the way. AS3 felt that "as an industry we are too willing to support people who aren't innovative or sustainable". AS4 wanted to highlight that "it is not always the younger blokes being innovative, it is the older guys too".

In contrast, AS2 was of the view that "those people who are innovators take a hit for the cause". Therefore, rather than be the tinkerer who "will go and modify it and go and do this and that, and it might be 30 modifications later that they come up with the final product" he suggests " if you come in after the 30th time and buy that product, you will be better off". He explained further that:

> Those innovators are great, because they play a role, but in terms of profitability, our experience is, you know, it comes at a cost, both time wise and investment wise. So they make a lot of wrong calls, they go up the dry gullies. The blokes who sit back and wait for it, work out who and where all the problems are and then dive in, assuming there is some sort of profitability or production gain, in our experience are better off.

6.4.3 Research and extension

AS4 wanted more time to see the results of the trials he was conducting, as well as more researchers to work in the area. In his view, there was a brain drain in western NSW and only "one specialist agronomist west of the Newell".

AS5 felt that a big issue was the lack of "access to appropriate extension". He was critical of the ability and philosophy of the Department of Industry and Investment. He felt that the CMAs were doing a good job but that funding cuts were detrimental to this effort.

AS1 felt that there were state variances in the quality of agricultural departments, and that "the South Australian and Victorian ones seem to be a lot better. New South Wales are like dinosaurs". AS1 found that the private sector had to compete so much with NSW

Government departments for funding grants. In his view, this swamping of the private sector "makes no sense for innovation or change". It was detrimental because they:

> Run out programmes in competition with the private sector, and that is enormously damaging because they run their programme for six months, the money finishes and then they pull out the resources and nothing is left behind.

6.4.4 Networks

AS3 felt that there were underutilised resources such as Rural Financial Counsellors. She felt that farmers would benefit from being more open to other opinions, to value the services and skills of outsiders, without having to rely on them.

AS1 felt that there were too few generalist consultants in agriculture and that there were too many "specialists that know lots and lots about an ever diminishing amount of things". For him, agriculture has lost its systems approach and there is no one helping farmers to "put it all together". For him, "the biggest breakdown that I've seen in my career is that we've lost that capacity to have an overall view".

For AS4, the lack of consultants in the area means that government agricultural services will have to play a bigger role. In his view, there were too many "outside the square" approaches being promoted and farmers were being "suckered by salesman types".

In terms of networks, AS1 also felt that the opportunity for farmers "to gather with like minded people three or four or five times a year and to hear what people are doing" was important. However, the challenge in a small business environment is prioritising this time against more immediate priorities like "paying the bills this month". He thought it would be good to have "some sort of support for group activity that creates local, regional and national sharing of ideas, like a national innovation forum".

AS1 was concerned that the "agri business industrial complex" had become too powerful. He worried that the industry of selling products to farmers had become so large that "a lot of people coming out aren't really advisory they're actually sales people but they're cloaked in that advisory role". He compared this lack of transparency with that of financial planning, where he said it would not be acceptable and that "in the financial planning industry you can't do it but in agriculture it's accepted, and that's an issue". AS2 also expressed concern that "research into the future it is becoming less independent and

there is more vested interests [sic] in research and therefore the outcomes may be driven by agendas".

AS1 suggested that the research and development that exists is not innovative. In his view, "R&D in agriculture is a minimum of 10 years behind the farmers". To him, this is due to "a failure of the structures that exist around and the 'club' atmosphere that exists in the R&D, that we have research and development but we don't have innovation". These conventional structures mean that there are some "really good leading scientists that [sic] simply can't get a run". On the issue of change, he asks if the big organisations like CSIRO can't change themselves, "how can they expect to be promoters of it?"

6.5 Summary

In terms of the nature of farmer driven innovation, these results show that farmers have complex and evolving knowledge networks. They are increasingly engaging with a wider range of experts and other farmers, in Australia and internationally. Particularly important was the role of farmer groups and farmer-to-farmer knowledge exchange. In terms of the impacts of land use change, trends of both property redesign and specialisation clearly have implications for sustainability. Meanwhile, the views of non-agricultural professions provide a different perspective. While recognising that farmers can be innovative, the benefits of innovation are not always apparent and the challenges ongoing. The following chapter explores the experiences and views of innovative farmers in regard to government incentives intended to influence their decision making for environmental outcomes.

7. How can interventions to influence innovations in land management be better framed?

7.1 Introduction

This chapter presents results that relate to research question 3, in particular the question of how to better frame interventions to influence innovations in land management. The focus of policy makers and researchers on land management for sustainability and environmental outcomes has indirect and direct implications for decision making and innovation in farming. This chapter explores the experiences and views of innovative farmers in regard to government incentives intended to influence their decision making for environmental outcomes. In addition, this chapter presents farmers' views on a hypothetical model for payment for ecosystem services and what farmers want to see happen in the future.

7.2 Farmers' experiences with government funding

More than half the farmers interviewed had received some level of funding to undertake environmental management actions on their farm. The most common funding source was the local CMA. In terms of what was funded, it was often grants to partially cover the costs of fencing materials and tree plantings. In terms of incentives or funding from government, no one is asking for a blank cheque. Very few of the farmers interviewed had any real desire or request for financial help or assistance. They just wanted a couple of "good seasons" to get ahead. Several common themes arose, including:

- Scale and speed
- Lack of flexibility
- Ongoing monitoring and follow-up
- Subsidies

7.2.1 Scale and speed

As shown in Chapter Six, significant resources are required to implement change on-farm. It follows that, when it came to funding, it wasn't so much a matter of making things happen, but rather it was about making this happen more quickly and at a larger scale

than they would have without the funding. For example, in speaking about the radical changes they have made to their grazing management, CW2 said that the funding they received "made it happen a lot quicker". He said "we may have done it, but it would have been a lot slower and you wouldn't have seen the results". CW3 agreed and said "it would have been very hard to fund it yourself right from scratch, all the time, everything".

CW6 told how they "were very fortunate" to have "received quite good funding from the Central West CMA and Stipa[16]". In his view, "without that funding we definitely wouldn't be as far down the path as we are now". However, he regretted that "we didn't spend the first funding wisely because we didn't have that knowledge" [of how to implement a rotational grazing system].

During the farm tour, LC7 pointed out his tree lots. He said that, without funding he received in the "early 2000s", he "would never have done the scale of fencing I have done otherwise". However, he did note that tree lots weren't necessarily his first preference for managing the trees on his property (he would have preferred a different configuration) but that was all that was eligible for funding.

HT 1 and HT2 spoke about the environmental services scheme they had participated in. For HT1 "the environmental services scheme was probably one of the best, well it was the best thing that has ever come to this place" (although his wife interjected that she hoped it was in fact the second best thing, her being the first!). Under the scheme, they submitted a tender which was successful and resulted in them planting 10,000 trees over 40,000 hectares. They were able to fence off grazing country around cropland, plant trees on it and utilise it more effectively.

For CW1, the CMA and Landcare funding they received to plant salt bush on a hillside and to fence off a watercourse made a big difference because they:

> Wouldn't have done this without external funding because we can't put a value on it… but if someone is giving you money, even though we had to put in- match it - it is an incentive to do it.

[16] Stipa Native Grasses Association (run by a volunteer committee of landholders and industry specialists)

WD2 also had grants to create new fences and water points in their grazing system from the CMA. They also said they "wouldn't have been able to do what we have done without the grants". CW9 thought that past funding programs "allowing farmers to convert old existing machinery to zero till" had a big impact. He felt that:

> If they did more ground based incentive programs like that, they would have a huge impact just on the basic way grain is grown in this country. It's very hands on, very simply implemented. People don't feel threatened.

MB1 has been successful in receiving funding to put in new fences and a holding area to fatten lambs. His funding came from the Commonwealth Government's Envirofund (a Caring for Country program). He found the process of applying for the funding useful as it meant he had to think about his farm plan because "there had to be good rational reasoning as to why they should give you that money".

Funding is not usually for 100% of the costs of an action. For CW10, the funding helped but it didn't come close to the full cost. He had received "$1,500 towards some tree planting". However, he said that the "the tree costs alone would have cost us about $8,000 to $9,000 for what we've planted so far and plus the time". They had planned the layout with GPS, and also created small trenches in which to plant the trees in order to increase water retention and survival rates.

CW18 was one of the few farmers who hadn't had any recent experience with funding. He believed that it wasn't really a fair system because "the same people know the system and get the funding".

7.2.2 Flexibility

Flexibility, or the lack of it, was a common theme. While farmers were positive about the funds they had received, they were more negative about the rules that accompanied the funding and the interactions with the funding agencies themselves. Several farmers raised flexibility, particularly in the context of government funding rules, land use legislation and how they feared that increasing regulation would further limit their ability to flexibly manage their land.

CW14 received CMA funding for subdivisional fencing, where an area must be "locked up" for five years. They "were allowed to graze it for two days, three times a year, in that period

of time but it has worked well. There are lots of young little Wilgas[17], growing up". The problem was that, once fenced, an outbreak of spiny burr grass occurred. They proposed to plant some Buffalo grass to try and outcompete it, however the CMA would not let them do this, so "the spiny burr is just as thick if not thicker now" than before they did the fencing.

LC4 was also critical of the rules that the CMA had for tree planting. To him, the minimum eligible plantation size of 30 metres wide or two hectares is "too bloody big". He and his neighbouring farmers had planted 40,000 trees across the whole catchment in the 1990s through Landcare. Yet, under the current CMA funding guidelines "none of the 40,000 trees" that they planted would have been eligible. This didn't make sense to LC4, who felt that "40,000 over zero makes a sh-tload of difference". As Chairman of the local Landcare group, he had been talking to the CMA about this issue and told them that "there are some people out there who just want to do smaller lots and do smaller things and most people learn and grow and go from the smaller amounts". He said the response is "oh well we have been getting rid of our money so we don't want to change it". The fact that the rules are based on CSIRO science does not give him confidence. He still found a lot of the people involve "short sighted" and put it down to how "everyone wants to cover their arse for everything that is being done… everyone is risk averse - through the whole scenario".

LC2 felt that having to "bring you local CMA along to get the funds" was difficult because "you are trying to drag along people that don't understand what you are doing as well, rather than just being able to get on and do it". CW9 gave the example of tree planting. He plants trees on his property annually. While he could remove them again under current native vegetation laws, he anticipates that, based on past changes, the rules will change again in future to prevent removal. He said that:

> People want to put in buffer zones for wind and for temperature and crop protection and all that sort of stuff. But it mightn't be too far down the track and I might be regulated by covenants by areas that I have planted the trees, by all these rules. So you can be putting yourself into a corner real quick. So it's all a bit scary and I think there's a lot of reluctance from people to try new things for that reason.

[17] The Wilga (*Geijera parviflora*) is a small drought tolerant tree; native to Australia and a source of high protein fodder for livestock.

He suggested "a simplified system" for major biodiversity grants. He would prefer a system where there is an "incentive to do it and also not have restrictions then" because he felt that "people are very reluctant to go and plant trees if they know that they can't change that land use in another 10 years time". In his view "they just need to free it up a bit and say "Look, biodiversity's beneficial to your business. Let's have some incentives and grants to put it in".

CW2 said they chose not to apply for CMA funding. He said that instead, "Macquarie 2100[18] and Stipa funding interested us was because they were more flexible". Rather than take any funding that was available, CW2 looked at "a number of funding opportunities and we chose the one that fitted our criteria". Yet, CW2 and CW3 told how the land he had improved through improved grazing practices was now having restrictions applied to it. They were notified in a letter from the NSW Government that it had been identified as having "environmental values". The Government would only allow them to convert their land to freehold if they agreed to place a covenant on the land title. The alternative was to pay a much higher rent than they had in the past. Ironically, the rules of the covenant would prevent them from implementing new grazing and pasture management practices on the land, the exact methods that had actually led to the improved environmental conditions. They had written to the Department responsible, as well as the Minister, but neither would budge. Meanwhile, the CMA and other organisations wanted to use the farm as a field day site to show best practice.

WD2 also raised this as a concern. It was his view that:

> What they are trying to do now, they are trying to control the process. They are trying to that tightly regulate it then if someone does something differently they are outside the box and they are trying to pull everyone back into the slightly different way to get this outcome and it won't work because everyone is different and everyone does things different and everyone's mind thinks differently.

LC7 also expressed frustration at ongoing changes in government regulation. He said that the improvements that he made to his place also would "all now be illegal". He said that "there were very few native grasses when I came here", but it was evident during a tour of the paddocks that there were a lot of native grasses now growing. For LC7, his request

[18] A Landcare and community organisation

from government wasn't assistance. He said "I don't think it is the role for them to help. I think it is a role for them not to hinder so much". The irony was that, while "they will tell you their rules don't work out here, they know that, but they put them in there anyway". And yet, the government had "used this place, they have brought people out to this place to show what you should do, but under the present rules I couldn't have actually done what I have done". This was the same experience for CW2 and CW3.

Meanwhile, LC7 recalled how, in getting a land clearing permit a few years ago he had to get someone from the CMA to come out and inspect the site. In hindsight, he said he should not have even been worried about it because the officer who came to inspect it:

> Had no idea what was good and bad… someone like that should not be coming out and telling someone with my experience what they can and can't clear.

7.2.3 Ongoing monitoring and institutional learning

Having ongoing monitoring as part of the conditions of receiving funding was not seen as an obstacle by farmers. If anything, there was a sense of disappointment that the funding bodies weren't taking notice of the achievements made possible by the funding. CW5 and CW6 told how, after dividing their paddocks and implementing a rotational grazing system, they were following up with twice yearly monitoring, which was part of their funding contract. However, when they tried to send this information back to the CMA, they were told that the CMA wasn't in a position to receive this information that they should "just keep that". They found this disappointing because for them it meant the CMA wasn't doing anything to review the effectiveness of its funding. Instead, CW6 said "they seem to be wanting just to meet targets all the time". They did have a 10 year contract, so "it did have teeth in terms of that" but this related to an obligation on the farmers' side. In terms of CMA undertaking to learn how to improve the funding process and to review what funding has or has not worked, he didn't know if there was anything behind the process. He thought that:

> What would have been really beneficial is then to go back and revisit some of those funding applications or funded farms or businesses and see what changes they have made or what they have implemented as a result… so the same mistakes aren't made down the track.

CW6 didn't want this to be a policing role, but rather "as an advisory type role" to help people. He said that there was already enough reluctance by farmers in the area to take on a funding agreement because people were worried that "you will have people crawling all over your place once you put it up to be funded".

CW3, who had chosen a non-CMA funding route, still felt that "you need a bit of incentive to make sure you follow on with what you are going to do". In other words, monitoring as part of the package was fair enough (see Figure 19). However, he still felt that "the funding needs to be towards something that is going to be making a profit because that is why you are doing it".

LC4 spoke about previous NRM programs that "just sort of disappeared - they didn't really learn anything from it. They just started reinventing the wheel again". He was frustrated by this and said:

> My biggest single issue with a lot of the natural resource management stuff - a lot of it has been done to death and they just keep recycling and not implementing the learning that is out there. There is a stack of learning out there. That could be implemented without doing more work than has already been done.

Figure 19. Photos of a transect to monitor ground cover - as required by funding

7.2.4 Subsidies

In contrast to funding, HT1 spoke about subsidies with antipathy. HT1 had seen poor practices in Europe and assigned blame for this to their subsidy system, although he said "I am probably wrong saying don't subsidise things". In his view, "if someone kept propping us up we are not going to perform and it is not until you squeeze somebody - until the fuel prices get the truck driver's company saying we've got better motors and more efficiency, you tend not to do it". Yet, HT2 felt that "grants and subsidies and things like that" was the way that Australian agriculture was heading, whether it "be for people paying for carbon or other funding coming in to help with fencing and things like". In her view, tapping in to that funding was part of being a "progressive farmer".

Two farmers raised the issue of quality for free conferences and courses. CW5 said for example, that if she and her husband "wanted to go to a field day we would just go to it. I wouldn't expect to get paid for that". CW1 wanted to highlight "the problem with funding like Farmbis[19] support". In her experience, where you can have a course for free:

> You go to the course and you think, well that was a bloody waste of time, all [the consultant delivering the course] were doing was profiting from the money, they weren't giving you anything.

In her view "if it is worth going to, we'll pay for it". In contrast, LC3 emphasised the importance of grants to local communities, saying that several years ago when former Deputy Prime Minister John Anderson initiated a "replanting grant" for northern NSW:

> That money just went so many times around local communities. Guys went and paid their CRT bill, they went and put lime on, they went and did a bit of fencing.

To him, the downside is that this evident community impact from grants "is just symptomatic of how finely agriculture is running to the wind" - or in other words, the lack of profitability. Four farmers raised drought support as a particular issue. CW10 wondered if the money that went into exceptional circumstances (EC)[20] had instead "gone to research

[19] FarmBis was a Commonwealth/State program that ended in 2008. It provided eligible producers with funding support for education and training in business, risk and natural resource management.

[20] Exceptional circumstances (EC) are rare and severe events outside those a farmer could normally be expected to manage using responsible farm management strategies. If an area or region becomes 'declared' as experiencing an exceptional circumstances event, this triggers short-term support for

wouldn't we be far better off?" CW11 was worried that regular payments were not reflective of the irregular income pattern of farming, and that EC recipients getting fortnightly or monthly payments may have:

> Learnt practices with this regular income that they're not going to be able to upkeep and uphold and continue with, because it's got to stop eventually, there's going to be an end… it's given them false hope.

MB1 felt that the "interest rate subsidy has been really helpful for a lot of people". But he also said "it's surprising how many farm businesses at the moment have become reliant on drought support" and that when it ends, "it will possibly trim the poorer or the less efficient or less business savvy farmers out". He wasn't sure what the alternative criteria should be for subsidy payments, but that it would be good "if you're able to give support to the guys that do have that longer term goal of business sustainability, they're the ones that need the kick along". For (CW12) it was more a matter of it being unfair. He said that:

> On a personal level you can talk about the drought tolerance. I mean I feel that my farm suffers the same drought as everybody else's. You need a drought strategy. So I put one in place and the very first thing that happens is they say 'Right, you don't get any help at all. You're out on your own', but somebody that sits on their backside and does absolutely nothing, gets everything.

CW13 suggested that:

> The EC could be a HECS[21] scheme that you get the money when you need it and pay it back over time. Some people will never pay it back but at least if you have a big year you can pay at the back. I think everyone would be happy with that.

There was a sense that the 'exceptional circumstances' were getting less exceptional, while funding payments were becoming a regular occurrence.

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farmers by the Australian Government. Eligibility also means farmers can access their Farm Management Deposits within 12 months of lodgement without losing their tax benefits as well as receive training and interest rate subsidies. Agriculture-dependent small business operators may also be eligible.

[21] The Higher Education Contribution Scheme (HECS) was replaced in 2005 by the Higher Education Loan Program (HELP). A HECS-HELP loan is available to eligible students enrolled in Commonwealth supported places at university. The loan covers all or part of the student's tuition fees. After graduation, the student must start repaying their HELP debt when their income gets above the minimum threshold for compulsory repayment.

7.3 Provision of and payment for ecosystem services

The following section reviews farmer responses to the hypothetical model for payment for ecosystem services (PES) that was presented to farmers (see Figure 4 in Chapter 4). The aim is to better understand their views on possible incentive systems of the future. What became evident was that these views were mixed, and that the image triggered a range of responses and concerns that were not just about the idea of bringing in alternative markets for ecosystem services such as water, carbon and biodiversity. In terms of environmental markets in general, while some welcomed the idea, there were also significant opposition. CW16 thought this was the general direction the industry would take, but he clarified that "things like that will gradually happen - I don't see it as being as shattering, like being a sudden transition, I think it will be a steady transition like it has always been". MB1 viewed the model favourably, but felt that:

> You need to understand the constraints of the resources that you rely upon in the first place. So you can start putting crosses through some of those boxes simply because the resource base from which your farm resides on won't support them.

Three farmers rejected the model outright. CW18 said she didn't "see that as a picture for this region" and LC4 also felt "it is really pie in the sky stuff. I am not saying it is bad but the reality of it and on ground level is bugger all". CW15 felt that if Australia didn't "share a bigger responsibility as far as their reserves and their capabilities to produce food for a hungry world" then he worried that "someone else may take this country over and do it". He asked where are the "new earth breaking projects similar to what we had in the Snowy Mountains 50 years ago? When are we going to turn some rivers around and make this country more productive?"

7.3.1 Flexibility

> *"Just to go and try and make change in your operation at a grass roots level is just becoming ridiculous. We've got people sitting in offices on the other side of the country making rules and regulations up that I find are extremely detrimental to the way modern agriculture should be performing and where it should be heading" (CW9).*

Again flexibility was an issue. Several farmers feared that long term contracts would limit flexibility in the future. On looking at the image, CW2 said that:

> My first initial thought with that is how flexible is it? Because you get locked into something and something changes, how are you going to be able to – I mean what is a bush fire going to do to all your credits? What is a drought going to do to your credits?"

CW1 was worried that if it turns out not to be a good thing, "can you get out of it and to get out of it, have you got to pay back everything they have paid you?" She wondered what would happen if:

> Fifty years down the track when we realise s#-t we have got too many trees on the planet… and governments in the Australian history of farming have not had a good track record… if you've got people tied into this system and you say woops sorry it isn't the right thing… or you know, some long term extreme consequence, can you afford to get out of it? And that is what my worry about innovation is that you have got to be flexible enough.

7.3.2 Payments and compensation

Several farmers felt that compensation for protecting parts of the property should be given. CW6 spoke about their attempts to protect "the ecological character" of around 20% of their land. She felt compensation would be needed given the foregone productivity and that "we also need to be able to generate an income off that environmental aspect". CW12 said that although he was increasing the level of perennial grasses on his farm, he "couldn't do it if it wasn't good for profit as well".

CW13 also felt that people "should be encouraged to lock up a portion of their place and be paid a little bit for it". However, there was an expectation that any payments would go to the farmers who haven't done anything yet and have a long way to go, rather than the farmers who are already increasing their carbon and biodiversity. In other words, the innovators would miss out again. CW20 could see the future going this way. He said:

> It would be a bit disappointing if they were able to gain an advantage over us by starting from a lower base and picking up credits or picking up a financial reward by ending up where we've just come from or where we are. And then because we were already there we weren't able to participate.

Still, he was philosophical and felt that "if we could prove we had the skills, there might be some great opportunities for us to assist other farmers". LC4 also asked about the baseline for the scheme. He suggested "you should probably have an average rate and people are paid until they get up to the average rate" however, he also said "you want to try and not sacrifice the guys who are the good guys". Or in other words, farmers are paid to meet a standard.

LC2 questioned whether people living in the cities actually cared about paying for such services. In her view "it is all about lifestyle… how many people leave their heating on all day? In Sydney you live in shirt sleeves. It is all about the convenience of the person". LC1 agreed and said "they don't care and they are not going to pay for it". WD1 felt that in urban areas there "has got to be a reestablishment of responsibility… they need to understand that it is their responsibility also to manage this land". WD2 also felt that people in the city "are not going to care". He felt that "if society wants those things they should pay for it and it shouldn't just be the farmers' responsibility to provide them". In his view, such an incentive based model would help send a message back to the marketplace, where "if you are providing those services and values, you should be able to get paid for it".

LC5 reiterated that "we've got a lot of expectations on us from the community and we're all expected to do that as well as make some money and everything else". In his view, "there wouldn't be many other businesses at all that would have the environmental aspects to it and the social aspects to it".

7.3.3 Outsider threat

There was a sense of an outside threat. CW1 was concerned that once it becomes about conservation, "then the external people have got to come in". In her view, it was a clash of two different paradigms and:

> It will take someone from this who can understand this to start a dialogue… if you can't get out of your world view and look at someone else's, there is no solution to the problem.

CW9 thought that conversations about ecosystem services can be threatening to people. However, he felt that the model shown was "pretty close to being spot on personally" and

he suggested that an incentive (rather than penalty) approach would be sensible. He suggested it is explained to others as a model:

> That represents a far more sustainable farm and we have proof that it does do it, we will give credits to those land holders that are pursuing this type of change. The ones that choose not to are left sitting on the fence. There's no help there. So it makes it simple then. That way if people don't want to do it, that's fine.

7.3.4 Too many land uses

While diversifying the types of markets available to farmers could be a good thing, it was also felt that there would not be the time in the day nor the resources available to incorporate more enterprises into the business. If anything, farmers are moving more towards specialisation. Instead, CW3 thought "it might work on a total catchment area, one area might be forest and one area not, but down to individual, every farm like that, I think it would be too inflexible… It still has to be flexible". In his view:

> It would be hard because some farms are more suitable to one particular thing rather than a whole lot of different things and you can't actually make that work on every farm.

C11 also felt that for all this "to be run by one farmer is near impossible… to be able to cover all the other industries and to be up on all of that knowledge is, for one person, is nearly impossible". CW10 agreed and said that "the first thing that springs to mind is the fact that you've got five or eight different enterprises there and I mean the chances of one person being able to be totally tech savvy at all of those". He suggested that:

> Imagine if you had those same industries all spread over say five farms and each farmer was their best at that particular – the productivity could be 20% higher probably… if we just did the wheat and somebody else does the turbines and somebody else does the forestry.

MB2 felt that "a lot of this carbon dioxide credits and trading and stuff" were not actually addressing any problem. He said "it is grabbing the bull by the tail or the horns or anything, but sitting on the thing and riding it!" He suggested that "to actually do all these things on the one farm, it's a bit like saying 'righto, I'm going to have an offshore fishing venture here' - We've got no water. We've got no ocean".

CW1 suggested that just because you have agriculture on one farm, it doesn't mean it isn't sustainable in the bigger picture, where "this farm might be all wilderness and this farm might be intensive". This relates to the question of scale as well as changing ideas of what constitutes a farm.

In terms of the mix of land uses, CW14 felt that "a lot of these things are working in opposing ways". For example, the more that is done with vegetation, the less water runs off to rivers.

7.3.5 Specific markets

In terms of the specific markets mentioned in the model, renewable energy was viewed the most favourably. The response to biodiversity and carbon was mixed while timber and water credits were viewed negatively.

Renewable energy was viewed favourably because it was not seen as in conflict with existing management strategies. Installing a wind turbine or solar panel requires an up-front investment, but little ongoing effort to maintain it. Experts can be called in to install the product and energy companies are responsible for paying for the power produced. In other words, it isn't an additional burden on management.

The lukewarm response to both biodiversity and carbon credits particularly came from farmers who were already working to improve their carbon and biodiversity levels and either felt that it should be done anyway, or that as leaders they would be unlikely to receive any benefit under a credit scheme. Others felt that carbon was either too difficult to increase or measure.

Sustainable timber was not really seen as an option by anyone due to constraining factors such as low rainfall, poor infrastructure, distant markets and constantly changing rules. Water barely rated a mention, except in the context of its value for biodiversity, probably due to the fact that these were all dryland farms which are faced more often with water shortages than any excess.

7.4 What do farmers want to see in the future?

When asked what they wanted to see in the future, there were a range of responses given, largely focused around environmental, knowledge, economics and resource concerns.

7.4.1 Environment

Improving groundcover through the use of perennial native grasses, pasture cropping and cover cropping were common objectives. Perennial wheat was also raised as a possibility to achieve improved groundcover. The purpose of increasing groundcover was described as a way to increase soil biology and soil moisture content. CW10 for example explained:

> Getting that ground cover more consistent over our paddocks and looking at the cover cropping, like using the native grasses like we have in the summer, for us that would be an area where we can get a fair increase in soil biology and ground cover and moisture build up and also growing that summer grass too it also perpetuates or increases our biodiversity.

CW17 and CW18 were keen to reduce their reliance on fuel and to "come up with a system – figure out how we can naturally replace removed minerals - get more sustainable" (CW18). CW17 suggested that if they could find a better way "to increase organic matter. That would help everything".

CW7 and CW9 both were interested in trialling "introduced biology" such as integrated pest management, composting and biodynamics.

7.4.2 Knowledge

CW20 wanted better advice on pasture systems and agronomy that was not about adding more inputs. He said his wish would be to find:

> A soil expert which was really focused on natural systems and trying to get the best out of soil biology for natural production with an emphasis on managing risk and costs at the same time. I'd love an advisor to be independent and come in and analyse I guess our soil and biology, and develop up a low cost stimulating program, rather than probably synthetic fertiliser program.

Both CW1 and CW10 suggested the idea of new entrants to farming gaining an apprenticeship type position with an experienced conservation farmer. For CW10, the idea was that this could be a type of 'adopt a farmer' scheme for those who do not have children coming back to the farm. CW1 suggested that, again for a farmer with no children coming home, the farmer could sell the farm, but the buyer would lease it back to them and work for the experienced farmer for 12 months or longer to learn how to run the farm

properly. It would also give the retiring farmer time to transition - to gradually leave the farm and still have some income.

Both LW7 and CW9 proposed that more attention should be paid by researchers and others to leading farmers within a region to learn from them. As mentioned in Chapter 6, LC7 suggested that researchers work with the leading farmers to ensure they remain up to date with developments happening on farm. Several farmers also mentioned the need for improved short and long term weather forecasting. CW12 probably captured the view of everyone when ask what he would like most, he asked "can you make it rain?"

7.4.3 Economic

Related to the issue of weather was the lack of predictable income. As a solution, CW9 wished for "more season uniformity" while LC1 suggested "a scheme to take out the bottom end, the years where you spend all the money but you get no income". This would be a type of insurance against the lack of season uniformity and hence lack of predictable yields.

CW4 suggested reforms to the depreciation rates on infrastructure such as silos so that instead of it taking 25 years to depreciate, "why not accelerate that down to 5 years?". He suggested that investment should be rewarded but not directly subsidised. It should go to people who were willing to invest the money back into their farm.

CW4 also wanted government to "regulate the quality of imports - if you can't say that you haven't used DDT on your strawberries, then you can't bring them in". In his view, that would allow Australian farmers who were subject to more stringent standards and regulations to better compete with imports. LC2 wanted a way to "differentiate our grain" in the market place, such as a promoting conservation farming in a similar way to how organic produce has been marketed.

7.4.4 Resources

CW3 suggested that farmers with a good track record could be assisted to purchase "run down grazing properties" which they could then improve using the latest best management practices. In his view, there were potential opportunities out there to purchase degraded places and fix them up, "if the margin was right".

Both CW10 and CW16 felt that advances would not come from big dramatic gains, but from fine tuning and minimising the amount of inputs. On WD1 and WD2's wish list were "just the resources to be able to speed it up" (WD2). WD1 suggested:

> Fencing contractors, money… you would put it into wire and water – its where you would put it, fixing the water, and all you have got to do then is move the stock and grow the grass, gets those seasons to go with you.

LC5 wanted to become better at "making the most of opportunities" and have a system with "key starts" where you could flick the switch depending on what conditions arose.

7.5 Views of non-farmer agricultural professionals – on interventions

Again, the views of non-farmer agricultural professionals were sought in regard to the role that current institutional settings play and how best to foster change. They were also asked about the sort of alternative funding programs might be needed. The responses are reported here in three sections – on funding, payment for ecosystem services and 'what farmers want'.

7.5.1 Funding

In regard to government funding, AS1 felt that the "thing that kills anything is the three year funding cycle, that's an absolute killer for multiple reasons". He explained:

> If you're lucky, and it takes you a year to get it off the ground, you hit your straps for a year and then everybody goes looking for a job, which is fair enough, in the last year. And if you have a drought in between then nothing happens anyway. So that's almost a farce.

AS2 gave an example of what he thought was "a really good investment decision made by the CMAs" where there was "an environmental consideration but it was linked to productivity". This was the funding to fence off stock containment areas which allow people to de-stock in drought and also feed stock in confinement, giving pastures a rest. In his view, "if you can have some sort of link with a productivity gain then I think it is far easier to implement the strategies that are going to result in positive environmental outcomes".

For AS5, it was unclear whether or not the funding invested by the CMA was changing outcomes. For him, "the question is would they have done it anyway?" He strongly felt that it was worth supporting innovation, but that it was a leap of faith, as "the data isn't there" in terms of how much of it is dissemination or trickling down.

AS1 also noted that the CMA's funding had been drastically cut and "what was a really good model that had lots of potential, typical government, after six years 'that will do' and pulled the plug and all it does is harvest community capacity and good will".

7.5.2 Payment for ecosystems services

AS3 felt that "policy is not necessarily the answer". AS1 was of a similar view and that "a lot of the things our government do is about reinforcing things we know that don't work". In regard to payment for ecosystem services (PES), AS2 felt that good producers already have a low cost of production so they don't need political intervention to achieve the environmental imperatives; they are doing it anyway by doing what they do. He wondered if we should be legislating for is better productivity gains instead, or for lower costs of production "so all those other things follow?" AS2 said that the other issue is:

> The perception of maintenance. For someone perception of maintenance maybe this, trees all over the place. For someone else, it may be having a nice wheat field that is highly productive. And for someone else it may be having this row of wind turbines up there.

AS1 thought that it could be possible to "see more incentive payments for better farming practices". For example, "the community might say 'ground cover is really important, it is, so we want to pay farmers that maintain more ground cover because everyone benefits".
AS4 felt that "regional centres would also have to be receptive" to any such PES model because otherwise the producers would be isolated and too far from transport, electricity grids and markets. The pulp mill would need to be close by and the local centres would need to use the energy produced. In his view "accountability runs both ways" and he gets "angry at big steps. Do steady steps… the whole community has to be involved".

AS5 felt that the central west is perfectly positioned to implement all the things in the PES model due to its diverse landscapes, from semi-alpine to rangelands and its three large population centres. However, it would also require valuing real estate that has conservation value on it. He told of a property that had a covenant on it that the National

Parks authority wouldn't enforce, and when valued had a zero dollar worth. When the issue of liability was raised, AS5 dismissed this as an excuse that farmers used to avoid taking action and likened it to OH&S being a similarly used excuse.

7.5.3 What farmers want

In regard to what farmers want to see in the future, AS2 felt that "people look for the panacea, they look for the next big thing, when the answer may be within, it may just be a discipline issue, or an implementation issue, or a rigour issue". He felt that:

> So long as we are in agriculture farmers will want silver bullets rather than getting back to basics and for things that drive profitability… in 100 years time, regardless of what scientific advances there have been, there will still be someone selling some snake oil that does wonders for your soil and all the rest of it, supposedly. And there is only one person who gets rich out of it and that is the marketer. It is just the reality in agriculture I think. And we are suckers for it a bit.

AS4 felt that a lot comes back to understanding the system and basic agronomy. In his view, "best practice at the moment isn't sustainable". He agreed with AS2 that there are "no silver bullets". AS1 thought that:

> When you look forward you don't worry about barriers to adoption or whatever, you say 'If we want to be in this game, how does our business have to be?' and then we make strides for it.

7.6 Summary

This chapter has shown the importance of funding that allows for scaling and speeding up management changes in a flexible way. There was support from farmers for ongoing monitoring and institutional learning but more mixed views on the role of subsidies in agriculture. The provision of payments for ecosystem services also generated mixed views, with clear reluctance to take on the liability and new demands of additional enterprises and long term contracts. Farmers had their own ideas about what might be useful for promoting innovations in the future, particularly in regard to addition resources, knowledge and economic and environmental advances. Again, the views of the non-agricultural professionals provided a useful contrast to those of the farmers, with some points of agreement but also points of difference. The following chapter analyses the research results present in Chapters Five and Six.

8. The nature of farmer-driven innovation

8.1 Introduction

Chapter Eight analyses the results of Chapters Five and Six in relation to the original research questions 1 and 2 are discussed. The results reveal innovative farmers who are motivated but resource constrained, the importance of gradual transition rather than radical change and the trend towards greater professionalism in farm business management. This in turn provides insights into the role of management decisions, knowledge and networks, and the farmer as an innovator and entrepreneur. The analysis in this chapter also highlights the time and effort that innovation takes on-farm, beyond the initial stages of implementation and challenges the conceptualisation of farmers as adopters rather than generators of knowledge. The chapter draws upon the current knowledge and understanding of innovation among farmers, as first presented in Chapter Two and compares the findings of this research with other studies.

8.2 Decision making for innovation

8.2.1 Motivated but…

As discussed in Chapter Two, a common objective among decision research is to understand the motivations of the land holder, in the hope of gaining insights into land use (Koontz, 2001). In turn, adoption decisions are still often explained through reference to goals and motivations (Greiner and Gregg, 2011). In this research, motivation for undertaking changes in the farming system varied between farmers. There was a belief among the farmers interviewed that better environmental management doesn't deliver an economic reward, nor does worse management deliver a penalty – a belief perhaps best encapsulated by LC7s comment "I'm an innovator. That just means you go broke quicker". This is a reflection of the reality that, while some costs of land degradation are borne by the landholder responsible, for the most part neither the producer, nor the consumer of the products, bear the full cost of their actions (Requier-Desjardins et al., 2011). This is because environmental costs are 'external' to current commodity markets for food, fuel and fibre. Therefore, those seeking to manage their land better have to either find synergies between productivity and conservation or be driven by considerations other than short term financial gain. And when farmers do find a financial imperative, for example to participate in an agri-environmental scheme, the financial imperative for

participation does not necessarily exclude conservation-oriented motivations. Though Barr and Cary (2000) concluded that the perceived financial advantages of environmental innovations are one of the best indicators of their subsequent adoption, they also point out that financial rewards are not the sole criterion considered by farmers in evaluating alternatives. This was the finding of a study by Wilson and Hart (2000) of nine EU countries and Switzerland, where economic incentives for conservation are much more common. In a study of French farmers' adoption of integrated crop protection and organic farming, Mzoughi (2011) also found that, although economic concerns were important, moral and social concerns also played a strong role. A combination of factors is more likely. It could be that a longer-term view of benefit is causing some farmers to invest in innovation and new practices, with the hope that they can stay in business long enough to see them realised. As CW3 said, "the feedback you really want is that it is going to make you more money or improve your ground or whatever you've got".

There were often particular moments in time that the interviewees could pinpoint as being an influential motivator, and the two most common themes were drought and soil health (both biological such as microbial populations and physical properties such as erosion and compaction). In the case of drought, it is the lack of rainfall relative to expectations that has an impact. In the case of soil erosion, it is dramatic storm events that create an impact. The immediacy of the outcome in both cases can also partly explain farmers' ability to recall these events as pivotal, while gradual biodiversity decline or land degradation may be less noticeable and less memorable. A range of researchers have looked at the implications of "insidious hazards" on decision making and found that individuals and the general public can become unresponsive or muted in their response to chronic yet insidious or ambiguous environmental problems (Averick *et al.*, 2008 ; Botterill and Mazur, 2004).

The prominence of drought was expected given the years of low rainfall over the last decade. What was more surprising was the emphasis on soils. For at least five farms, soil condition was a key motivator for changing management practices. In effect this shouldn't come as a surprise because soil is clearly an asset on the farm. It can be directly related to production and financial outcomes, compared to other environmental attributes, such as biodiversity, which are not as easily attributed to the bottom line, and are also not necessarily within the direct control of the land holder.

Two recent studies have had similar findings in different parts of Australia. Smith (2008) conducted a study of revegetation of private lands by landholders in Western Australia. He found that revegetation was typically driven by a "mixture of motives", including salinity, nature conservation, soil erosion and aesthetics (Smith, 2008 p. 77). In a study of farmers in the Tamar region in Tasmania, Hajkowicz and Collins (2009) found that soil was a priority, regardless of external interventions. Farmers viewed good soil management as "just part of the farm business". They were reluctant to identify soil conservation works or many other activities with private benefit as "stewardship services" that could potentially be eligible for incentive payments. A study in north-eastern Germany of farmers' acceptance of conservation measures also found soil conservation was of prime interest to farmers. While it was important that conservation measures, did not negatively impact on yield or product quality, cost was not the most important matter. Risks, effectiveness, or time and effort required to implement a certain measure were equally or even more important depending on the situation (Sattler and Nagel, 2010). In the developing country context, Reij and Waters-Bayer (2001c) found most of the innovators farming in countries such as Tanzania, Ethiopia, Cameroon and Burkina Faso were also actively seeking ways to improve soil fertility and conserve soil moisture.

This emphasis on soil is not new. In fact, many 18th and late 19th century economists promoted soil health as a measure of national economic health. An economic development theory known as Physiocracy maintained that a nation's wealth comes from its agricultural and land development. This theory was particularly popular in France in the 1700s (Backhaus, 2011). Physiocracy preceded Adam Smith (1776) who wrote about the significance of soil and climate for the wealth of nations during the British Agricultural Revolution. Such thinking was later replaced by other schools of thought. As outlined Chapter Three, a "colonial or classic model of soil conservation" was implemented in the 1900s in developing countries. However, in this case "the problem of soil erosion is seen primarily as an environmental one, rather than a complex 'socio-environment' problem" (Blaikie, 1985 p. 4). In the present day, the link between soil and socio-economic concerns has received renewed attention as environmental degradation becomes an increasing urgent problem.

The point of this section is not to try to generalise about causes of motivation. When Knowler and Bradshaw (2007) conducted a global literature review in order to better understand the reasons behind why farmers adopted conservation agriculture, they found that there were "few if any universal variables that regularly explain the adoption of

conservation agriculture across past analyses" (Knowler and Bradshaw, 2007 p. 25). Factors such as age, education and farm size, while identified in particular studies as potentially correlated with adoption, were not found to have universal application. Given what they saw as the limited prospect of identifying such variables through further research, they recommended that efforts to promote conservation agriculture be tailored to reflect the particular conditions of individual locales. As LC4 stated, the reasons for action or inaction were irrelevant, because anyone could find a reason or excuse to do either. His view was "you either have the ethos that you do want to go that way or you have the ethos that you don't". This view was echoed by WD2 who also felt that "you can waste a huge amount of energy trying to change people who don't want to change, not ready to change". Given this, the benefits of trying to further isolate causes of motivation are questionable compared to trying to understand what opportunities enable a motivated person to act. That being said, it is important to avoid oversimplifying the links between willingness and ability. Hall and Dijkman (2009 p. 2) concluded that "agricultural innovation is usually opportunity-driven, with entrepreneurs (micro or corporate) responding to market opportunities and threats". Yet in a review of traditional versus innovative graziers in Queensland, Australia, (Bohnet et al., 2011) cite "an increasing body of empirical evidence" that graziers are motivated by pursuing personal values rather than simply following opportunities, particularly if they are inconsistent with these values and business aspirations (Bohnet et al., 2011 p. 636).

As detailed in Chapter Five, there were mixed views on whether innovation was a good or bad thing. While most farmers were comfortable being described as innovators to some extent (although they would deny they were the very best) several felt what they were doing was not really innovative or new so much as revisiting and reinventing the wheel better than before. This is probably partly a reflection of a perception of how innovation is defined – whether it is viewed as invention or the new combination of existing knowledge. For the majority of the farmers interviewed, innovation was seen as a crucial part of their business and their ethos. Innovation was also viewed positively as a means of survival. Yet, several farmers who have chosen innovation as a survival strategy also perceived there were downsides, such as the real risk that innovators go broke quicker (LC7) or that having all the latest gadgets was "technological bravado" (CW12) that could go wrong. Several of the participants told stories of 'innovators' in the district who had recently sold their farms. In Chapter Six, it was described how study participants from the agricultural sector held differing views on the decision making and innovation of farmers. In particular, AS2 explained how he did not encourage innovation for his clients. He felt

that "the blokes who sit back and wait for it, workout who and where all the problems are and then dive in, assuming there is some sort of profitability or production gain, in our experience are better off". This also links to the discussion in section 2.4.2 on the different goals of different farmers, and the constraints that can impact on motivations being expressed through action.

Negative views of innovation contrast to the view in industrial markets that the better the innovation performance of a company, the greater its competitive advantage (Chen et al., 2009). It also differs from claims within the agriculture sector, such as that "innovation is the key to the future success of the Australian wool industry" (Johnson, 2006 p. 64). This raises an interesting point – latecomer advantage. Those who come late to a new innovation can be rewarded because greater scale and lower cost are possible. The origins of the latecomer concept lie in the work of the economic historian, Alexander Gerschenkron, who studied 19th century European catch-up industrialisation. The concept was more recently applied to the rapid rise of manufacturing in East Asia and now to the rise of biofuel industries in South America (Mathews and Goldsztein, 2009). At a national scale, examples of latecomer advantage include the development of renewable technologies in developing countries, drawing on the latest advances in technology and management, for example Argentina's late foray into biofuels (Mathews and Goldsztein, 2009). Latecomer advantage can include having access to institutions that provide technology (including public research institutes), finance and risk management (such as regional commodity markets). The key weapon for the latecomer is the existence of institutional support (Mathews and Goldsztein, 2009). Therefore, there is logic in waiting. Many of the innovators themselves expressed an awareness of this logic, although they chose to take the risk anyway.

In contrast is the concept of first-mover advantage. Opportunity recognition and selection is a basic business strategy (Foster et al., 2006), often in response to a changing regulatory environment. Early action can mean first-mover advantage can be achieved. However, if the regulatory environment is volatile and constantly shifting in focus, then the gains of first movers can quickly become a disadvantage (Foster et al., 2006). Given dramatic changes in government policies on native vegetation and resource management in the past decade, it is not surprising that farmers held the view that it was likely dramatic changes in regulations would occur in the next decade (Valbuena et al., 2010). This, and volatile market conditions, may explain why being a latecomer can be seen as more advantageous in agriculture than a 'first-mover'.

Whether it is accurate that innovators "go broke quicker" is hard to know. At least across the sector as a whole it is certainly evident that some farmers are going broke. Australian farm survey results show that in NSW, farm business profit was negative for both 2007-08 and 2008-09, demonstrating a lack of profitability (ABARE, 2009). While farm cash income increased from $5020 in 2006-07 to $14300 in 2007-08, farm debt increased at the same time from $496090 to $597000. While rising land prices have helped to offset this growth in debt and maintain strong business equity (84% in NSW in 2007-08), the trend is for an increasing part of debt to go towards simply providing working capital, not just for land purchases. Those without land or larger debts would be struggling in this situation. In this research, all but one farmer was in debt, some more exposed than others. For several farms, that debt level had been significantly increased due to investments in the infrastructure and machinery required to implement new management practices.

LC7's view that "leading blokes just get no support" was echoed by several farmers. There are interesting parallels with a study exploring innovation policy and organic agriculture in Ontario, Canada. In that study, Blay-Palmer (2005) found that although all the farmers interviewed conducted their own experiments on-farm, there was no compensation for, or record of, their innovations. They also felt that they were not well linked to innovation networks and expressed feelings of being isolated. In the Australian context, this feeling of isolation can probably be partly explained by the traditional focus of extension programs on providing support only during the motivation and exploration/trialling stages of the practice change process (Nicholson et al., 2003). Those who have already adopted the practices being advocated are largely left to their own devices.

In addition to any direct support, several farmers in this research also felt indirect support from society in general was not forthcoming. This perception of a lack of support for farming was reinforced by public campaigns against eating meat, exporting live sheep and mulesing and public campaigns promoting vegetarianism, organic food and consideration of food-miles. This feeling of not being supported was also reflected in a study of Swedish farmer's perceptions of social conditions where interviews revealed they saw themselves as marginalised by society (Nordstrom Kallstrom and Ljung, 2005). They perceived a lack of control over their own future and a dependence on the good will of politicians and decision-makers, often far away at the European Commission in Brussels. Nordstrom, Kallstrom and Ljung (2005) concluded that the best way to address these feelings of

isolation and marginalisation was to increase societal recognition. The idea was to motivate farmers to keep up what they perceive as good work.

Some farmers, such as Peter Andrews (Natural Sequence Farming), Alan Lauder (Carbon Grazing) and Colin Seis (Pasture Cropping), have sought to promote their innovations publicly, written publications and set up businesses to do so (Andrews, 2006 ; Bruce and Seis, 2005 ; Lauder, 2007). This is in contrast to the majority of interviewees in this research, who expressed discomfort at being recognised individually or singled out within the community. They would prefer recognition in the form of higher prices for their products, rather than publicity for themselves. This probably reflects in part the 'tall poppy' syndrome within Australia and general discouragement in society for seeking recognition because if you get "recognition publicly people think you are too far up yourself (HT1)". Even in the United States, where 'tall poppy' syndrome is not so prevalent, the "understated mannerisms of the prevailing farm culture, especially when among their peers" has been noted (Richards and Bulkley, 2007). Perhaps recognition for what farmers are doing not as individuals but as sub-groups within the sector would be more appropriate and would address LC1's concern that "they all think we chew straw……or maybe they don't know what we do".

8.2.2 …Resource constrained

Implementing change across a farm takes resources, commitment and technical skill. Each farmer interviewed had a vision of where they wanted to get to, but there was a clear sense that management and long-term planning was constrained by resources and income. Farmers had much more they wanted to implement if and when they had the capacity to do so. As CW1 said, "we always have a five-year plan and want to do something new in five years like buy country, we'll have an investment. It is always constrained by financing but that is the aim".

Agricultural input costs are much higher now than they were in the past (de Fraiture et al., 2010). For example, in 2007, phosphate rock prices increased by up to 400%, while freight costs increased from $35 per tonne in 2000 to $125 in 2008. With the majority of fertiliser being imported to Australia, these freight costs impact significantly upon fertiliser cost (ACCC, 2008). In 2008/09, farm business profit in the State of New South Wales (NSW) averaged (minus) -$4000 (ABARE, 2009). In the same year, the largest costs for mixed livestock-cropping farms were interest payments and fertiliser.

There are many other external factors which influence decision making on-farm. As explained in Chapter 3, Australian agriculture has become increasingly deregulated and unsubsidised as governments have favoured a neoliberal approach to free trade (Dibden *et al.,* 2009). In turn, the industry has become increasingly integrated into global commodity markets and subject to heightened international competition (Pritchard et al., 2007 ; Tonts et al., 2010). Farmer responses to policy and market conditions can be dynamic and diverse (Morgan *et al.*, 2010). The conditions are not limited to contractual arrangements with retailers and processes, but also include commodity markets, international competition and global trade (Tonts et al., 2010). A simple example of the link between the farm paddock and international markets is Ramadan. The date of Ramadan moves backwards about eleven days each year depending on the moon. This timing is something over which farmers have no control but which significantly impacts on the chickpea market, with India the largest buyer of Australian chickpeas (QLD DPI, 2010). Another example is the serious drought Russia experienced in 2010, which significantly affected their yields. News of the drought and accompanying bushfires quickly led to increased demand for and price of Australian wheat (Wen, 2010).

Agriculture is linked across local, regional and global scales through global food production, distribution and retail systems (Blay-Palmer, 2005). Jackson (2008) writes that, in the context of Iowa in the American Upper Midwest "Corn Belt", in contrast to the view that the farmer is the key agent of change, it is in fact global agribusiness corporations that are designing agricultural production systems and landscapes. In her view, the continued focus on the farmer serves the interest of these corporations by drawing away the attention of consumers and taxpayers. She writes that "when the causes of a landscape pattern are poorly understood, public policy undertaken to correct it will be mistaken as well" (Jackson, 2008 p. 24). Jackson (2008 p. 24) calls for an end to the "myth" of farmers at fault and for agribusinesses to be pressured into taking responsibility for healthy agricultural landscapes and healthy food. There are parallels in the colonial or classic model of soil conservation that typically "lays the blame on land-users themselves, and identifies them as lazy, ignorant, backward or irrational" (Blaikie, 1985 p. 4). There are also parallels in the continuing emphasis that is placed on land holder fault in developed countries such as Australia and the United States today – an emphasis that often overlooks the other drivers of land use affecting decisions made on-farm. Family farming is still the dominant form of tenure in Australian agriculture. Even so, market signals can be strongly influenced by government policies and corporations further along the value chain and beyond national borders. This in turn influences individual behaviour on the farm, without

any change in farm ownership required. As Castree (2008 p. 137) points out, "transnational rules and mechanisms of environmental governance are impacting upon otherwise distinct places and biophysical resources". But as Castree (2008 p. 142) also notes, it is a trend of neoliberalism for deregulation and reduced state involvement, with the aim of actors becoming "self-governing within centrally prescribed frameworks". Taking on transboundary and trade issues would potentially require greater effort and interventions on behalf of the state.

This has relevance for the widely cited 2008 report of the International Assessment for Agricultural Knowledge, Science and Technology for Development (IAASTD). This report not only called for recognition of farmers as producers and managers of ecosystems but also for new incentive systems, not just for farmers, but along the extended value chain of agriculture (IAASTD, 2008). This awareness that farmers are not the only decision makers impacting on land use is important. However, the policy options that IAASTD subsequently propose relate mainly to farmers, such as payment for ecosystem services (PES), incentives for alternative markets, certification for produce meeting environmental standards and better defined property rights (IAASTD, 2008). It is rarer to see solutions that relate to other components of the value chain.

In this research, the farmers interviewed did recognise that they were dealing with a range of factors they could not control, not least a volatile commodity market. As CW4 said, "when you are driving out here and you know the Chicago December delivery is at five thirty two cents, it went down 3.2 cents on Friday night, you think, you know, are we in charge?". These observations are not new. The Chicago Board of Trade was formed in 1848. By 1859, grain trade in Chicago had "three key institutions: the elevator warehouse, a privately regulated central market and the grading system for grain (Cronon, 1991 p. 120). With the introduction of the telegraph, the news of events such as war and harvest volumes in distant places had as much influence on price, if not more, than local events such as drought or frost. As communication became faster, a "new market geography" arose that "had less to do with the soils of climate of a given locality than with the prices and information flows of the economy as a whole" (Cronon, 1991 p. 121).

It was interesting that AS2 felt that agriculture was a low risk business because:

> You can cruise along, depending on your starting level of equity, you can cruise along and get negative returns year in and year out for a long long long time

> before you go broke in agriculture… you can still draw down on equity as people have been doing, for the last eight years or so when things have been bad, and stay in business.

AS2 also did not think that high input costs were a problem. In his view, a farm business must be geared to capture the profits that come in only 20 to 30% of years. He advises that farmers are better off to "capture the good years than to minimize risk in the bad years by lowering inputs". He explains this is "because anything you do that has an impact on, by lowering costs, on productivity, will be counterproductive because you will miss out on those good years".

He may have a point, but over the past 10 years, the average debt for cropping farms has increased by 168% in real terms, reflecting high levels of capital investment (ABARE, 2009). This partly reflects a major shift in land use since the 1990s, where there has been a steady decline in the size of the Australian sheep flock and an increase in the area under broadacre cropping. Sheep numbers decreased by 5% to 72.7 million between 2006/07 and 2008/09, the lowest level since 1905 (ABS., 2010). It also reflects a trend over the past three decades to replace increasingly expensive capital and labour inputs with chemicals, fertilisers and machines. For example, it is estimated that the use of pre-emergent selective herbicides in Australian winter broadacre crops grew from less than 1 million hectares (ha) in 1990 to nearly 7 million ha in 2003 (D'Emden et al., 2006).

Ongoing decline in terms of trade, international competition and increased pressure of resources such as land, water and fertilisers are taking their toll (Jackson, 2010). The number of family families in Australia declined by 9% between 2001 and 2006 (Pritchard et al., 2007). Long periods of drought in the Murray-Darling Basin have severely tested the resources of farming families and communities. It has resulted in marriage breakdowns, spouses having to live and work in different places, a decline in social infrastructure within communities and mental health issues (Alston and Witney-Sloanes, 2008).

For the farmers interviewed to survive in farming, every year they have to get more efficient and find ways to maximise returns – to increase the quantity of outputs from a given quantity of inputs (Jackson, 2010). In other words, increased precision and productivity is required. This could mean continually finding that extra percent efficiency gain or extra kilogram of yield for every millimetre of rainfall, or lowering inputs to reduce risk (Keating *et al.*, 2010 ; Robertson, 2010). It could also mean making the most of the

"good years", as AS2 suggested. The challenge is defining what a good year means in a variable climate. Prices fluctuate based on availability, and can be higher in drought years. Meanwhile enterprise mix, seasonal conditions, water use efficiency and input costs complicate a clear picture of productivity and profitability on any single farm (Hutchings, 2009). Keating et al. describe this dilemma through a framework that explores what they call the "efficiency frontier" (Keating *et al.*, 2010 p. S-109). Either a farmer improves productivity by moving along the efficiency frontier and by increasing investment risk, or by adopting new technologies. In Australia, it is thought that leading farmers are already close to the efficiency frontier for crop yields, given the level of investment risk that is acceptable under current market conditions (Keating *et al.*, 2010). Climate change adds another dimension of risk and vulnerability into the equation. Adding to the puzzle is the fact that total factor productivity[22] growth averaged minus (-) 2.0 per cent a year for the mixed-crop livestock industry in Australia over the past decade. This is in comparison to average annual growth of more than 3 per cent for much of the 1980s and 1990s (Jackson, 2010). This slow down is causing concern for the industry and policy makers alike (Robertson, 2010 ; Sheng *et al.*, 2010).

If survival requires ongoing adaptation and change, the challenge is to ensure that long term vision can co-exist with what is required to remain viable in the short term. Opportunities do exist. One option is to seek economies of scale. This option is similar to the findings of a New Zealand study of dairy farmers, where one respondent pointed out that his economic situation was finely balanced, and that in order to better manage cost and expenditure, he bought an adjacent farm to achieve economies of scale (Sligo and Massey, 2007). Interestingly, LC4 and LC5 said each of their districts had experienced unprecedented change in land ownership in the past 10 years. LC4 compared this to twenty years ago when, in his view, there had been "stuff all" change.

Labour was also raised as an issue by more than half the interviewees. The two key concerns were the ability to afford labour and ability to find labour. The difficulty in finding extra staff, particularly for short periods of time, meant a reliance on family for surge capacity in busy times like harvesting, shearing or fencing. This cost or value of family labour in agriculture is difficult to measure (Chavas, 2008). However, it was evident that, as wives work off-farm and children choose not to come home to the farm, farmers are finding they need to perform more tasks on their own – a task that gets harder as the farmer ages. Beyond surge capacity, there were difficulties in finding on-going skilled

[22] Total factor productivity (TFP) is calculated as the ratio of total inputs to total outputs.

labour to assist in the day to day management of the farm. In addition, because the skill set needed is becoming increasingly specialised, this is increasing the costs of the labour. When it can be found, there was a fear that it was an insecure investment, because once the staff member had been trained or 'up-skilled', there was nothing to stop them leaving.

Between 2001-2006 employment numbers in agriculture in Australia fell by 19% (ABS., 2008a). Eliasson (2000) in his work on industrial policy, competence blocs and the role of science in economic development, writes about the requirement for functioning labour markets as a necessary requisite for a 'competence bloc' (see Chapter Two). Yet, the difficulty of finding labour in Australian agriculture is not new. Labour as a resource has been traditionally scarce (Guerin and Guerin, 1994). Fifteen years ago, Gray et al. (1995) found that farmers felt back then that it was getting increasingly difficult to find employees, particularly for casual labour for several days at a time.

Many landholders have a strong stewardship ethic, though such attitudes are not always linked to increased adoption of best practices (Curtis et al., 2001). Governments often assume that poor adoption rates for best practices arise from a lack of awareness of land degradation issues of lack of knowledge or skills (Pannell, 2003). Sometimes it simply it comes down to lack of resources.

8.2.3 Gradual transition rather than radical change

In Chapter Two, it was highlighted that innovation is an ongoing process, not a one-off event (Nicholson *et al.*, 2003 ; Pannell *et al.*, 2006). This circular process is too often ignored when the focus is on the point of 'adoption' rather than ongoing generation of something new. In overlooking the ongoing nature of innovation, it becomes easy to undervalue the importance of time and its impact on decisions. An example here is CW20, who said that "we're seven years down the track now and probably got 60 percent of the way where we would like to be". Making changes to a farming system isn't something that can necessarily be divided into neat sequential steps. Transitions do not occur in a linear way. Switching from conventional to alternative modes of agriculture can occur in a series of overlapping stages, including phases of efficiency, substitution and redesign, with some transitions less reversible and more robust than others (Lamine, 2011). While the transition occurs over time, the complexity can be there from the start. Changes can occur over days, such as erosion from a storm, or over decades, such as the build up of carbon in the soil. When it comes to ecological processes, long timeframes within which farmers must operate can be widely different from the rapid pace of the modern industrial economy (Adam, 1998).

Many conservation practices take longer than two or three years to demonstrate their worth in trials. Significant changes in some farm management practices may be even be measured in decades or generations (Barr and Cary, 2000). For example, conservation cropping with stubble retention may take ten years for the benefits of improved soil structure to become obvious. Whilst methods can be trialled, the outcomes of the methods can be uncertain and a leap of faith is required (Barr and Cary, 2000).

Participants expressed frustration at how droughts could interrupt trials and mask the results of change. A similar problem was revealed by growers in a workshop run by ABARE, where there was an optimistic view among participants that the full benefits of conservation farming systems would be realised "when seasonal conditions improve" (Jackson, 2010 p. 12). In this context of long timeframes, the importance of processes of fine tuning should not be underestimated. Innovation is not just about frontier research and technology, but also about incremental problem solving, or the constant minor adjustments and improvements that farmers make to succeed (Hall, 2006). It can be as important as radical change and is more often the only realistic option on the ground. As CW16 said, he didn't see agriculture suddenly transforming in the next few years, rather, "it will be a steady transition like it has always been".

Both CW6 and CW15 were worried they would lose the motivation to change over time and not remain innovative as they got older. As Pannell et al. (2006) state, people who adopt one innovation are not necessarily early adopters of all innovations. These NSW farmers were very conscious of the ongoing challenge of remaining innovative and did not take this for granted at all. One of the solutions for this was referred to by several farmers, who spoke of the importance of finding "like-minded" people in order to maintain motivation. This seems consistent with Nicholson et al. (2003) who reported graziers in their study felt that given major changes to their grazing management system did involve a degree of 'faith', social inclusion, recognition and support were critical in helping to maintain confidence and commitment, particularly if the results were below expectation or slower than expected. Again, recognition may not necessarily be in the support of publicly identifying individuals, although this is an option.

As also explained in Chapter Two, feedback is an important component of the decision making process. It was interesting that several farmers mentioned that their soils were not responding the way that scientists had predicted. Farmers are being told that zero tillage and stubble retention will improve soil carbon and soil biology. Yet this is turning out to

not necessarily be the case. This is the danger of advocating solutions that may not work. Nicholson et al., (2003) wrote that if a technology is dis-adopted due to technical ambiguity (rather than outright failure), then it may have been better if the technology had not been adopted in the first place. This is because negative perceptions of the technology are likely to be stronger and less easily overcome in the future. In CW1's case, the outcome was positive in that the negative soil test results led her to start a new program of on-farm research, but independently and with a focus on better understanding the system for herself and not trusting the scientists advocating a particular suite of practices.

8.3 Taking the emotion out of decision making

8.3.1 Farmers as business managers

Studies such as Morgan et al., (2010) write of farmers having unspoken and unwritten business strategies and plans, and a reluctance to describe an identifiable strategy. This is in contrast to the farmers in this research, who had written business plans and the ability to clearly articulate their strategic vision. They also had a view that farmers in general were increasingly "being professional" about finance and business management. Morgan et al., (2010) also contrasts with the finding of the Australian Bureau of Statistics that more farm operators are seeing themselves less as farmers and more as managers with skills that have much in common with other business managers outside agriculture (ABS, 2008a).

As one farmer said, "you are a business at the end of the day. I just can't emphasise enough". Business management and making time for effective planning were reoccurring themes. In the past, farmers have typically run their businesses from home, often literally from the dining room table (Sligo and Massey, 2007). Those days are going. Greater attention to office space, at least for the farmers interviewed, meant constructing new offices, often in refurbished rooms, garages or sheds.

The majority of the farmers interviewed were consciously weighing up the profitability of their enterprises right down to the hectare used to produce each kilo of meat or grain. MB2 explained during the interview that he has a "gross margin on each paddock" and that using spreadsheet calculations he knows what his "costs are per hectare" and he can adjust his response according to "how the season is going, prices are going, to see how profitable paddocks are going to be and what we've got to do". Alongside this

microscopic focus on costs, a shift in enterprise mix seems to be occurring, which is discussed in more detail in section 8.6.2 below.

This contrasts to the findings of Murray-Prior and Wright (2001), who developed decision models of wool producers' decisions in the context of an ambiguous decision environment and major price changes. They concluded that producers unconsciously filtered, or often deliberately ignored, information about the short-term relative profitability of their major enterprises. They explained that this was because producers developed a long-term orientation because of the difficulty of predicting prices and their experiences of price volatility. They observed that in such an environment, producers tended to maintain their existing mix of enterprises unless something occurred that triggered them to consider a change. In the case of this research, either something has occurred to trigger the change in the way Murray-Prior and Wright (2001) described, or perhaps the reality was always different. Certainly the ability to be more opportunistic and short term focussed was viewed in a positive light, as mentioned in Chapter Five. For example, LC5 spoke about the need for "key starts" where "if there's an opportunity we grab it and run with it". LC5 viewed this as a necessity not least because of the return to a lower rainfall regime in the area (see also section 8.4.3 for more on water scarcity).

The non-farmer agricultural professionals interviewed held views of farmers that did not compare well with the actions of the innovative farmers who were the subject of this research. They did not seem to distinguish between sub-groups of farmers. This could be due to the open-ended nature of the interviews themselves which, while focussed on innovation, also allowed for discussion of farming more broadly. For example, several participants suggested that farmers were not businesslike or professional enough, that they made irrational decisions, were not focussed enough on profit and instead spent too much time tinkering rather than being time and labour efficient. As previously quoted, only one participant, AS1, pointed out that "agriculture is not a mob of homogeneous people… the reality is they are as diverse as small business in Australia". This is an important reminder that generalisations are limited in their usefulness, and while they can help to simplify certain aspects of farming, they should not be taken as an indication of how all farmers behave.

In terms of farm management, there was often more than one person involved in planning, or at least available for brainstorming ideas. For some farmers, having an advisor or business partner who has invested in the business and is just as exposed to risk meant

they trusted their advice more. There was often also someone who could put the brakes on and reinforce financial realities - someone who helped put the brakes on the innovator's curiosity and reminded them of financial realities. This was usually another family member – often female. Generally, this intervention was acknowledged as important because the widespread belief that it is the innovators who risk going broke. These two different advisory functions were acknowledged as important by the farmers. This has implications for the assumption, such as that made by Farmar-Bowers (2010), that the influence of women in decision making is "long-term". He suggests that women may be more concerned with social and family issues than men and therefore "policies aimed at implementing sustainable development ideals" should cater to the interest of women. In this research, it became apparent in at least three separate interviews that the pressure to make more money was coming from the wife, from a point of view of managing the books as well as improving quality of life. This meant they had to be constantly concerned with profit. This goes against assumptions that the woman in a farming partnership will tend to be more environmentally conscious and that it is the man who is preoccupied with production and profit. Likewise, Farmar-Bowers (2010) writes that women's participation in off-farm activities contributed to the sustainability of farming families. It is true that over time, there has been an increase in dependence of farming families upon off-farm income (Barr and Cary, 2000). Yet, given the importance of shared decision making, there is another cost of women working off-farm, in that their role as financial advisor, brainstorming and business partner may be lost, potentially removing an important component of farm success. In fact, as Pfiefer et al. (2009) notes (see section 8.6.2 below), it is possible that a family member leaving the farm to work and gain off-farm income can have a negative impact on farm diversification, not least because less labour is then available for on-farm work.

Succession, or the lack of it, has implications for both business management and labour on-farm. Both CW1 and CW10 suggested similar 'adopt a farmer' concepts as a means of addressing the predicted loss of knowledge to the sector that will come as ageing farmers retire without a successor. The idea is that the new entrant to farming would undergo a type of apprenticeship that would enable the transfer of accumulated knowledge from the retiring farmer. On many Australian farms, the main adjustment to declining profitability has been the abandonment of expectations of intergenerational transfer. In other words, older farmers are deferring farm exit, have an increased dependence on off-farm income and do not expect to transfer the farm to another generation (Barr and Cary, 2000 ; Barr *et al.*, 2005). Delayed transfer of assets to the next generation has also been

noted as an issue among farm families in the United States (Richards and Bulkley, 2007). The deferral of farm exit in response to a lack of perceived alternatives available has partly contributed to the aging of the farm population (Barr and Cary, 2000 ; Barr *et al.*, 2005). This aging is exacerbated by the lack of young people entering the industry (Barr, 2004).

The issue of inter-generational transfer is a major contributing factor determining the adoption of new practices or investment. This is partly due to the fact that many of the strategic decisions farming families make depend on their family's stage in life or 'life-cycle' (Farmar-Bowers and Lane, 2009). For example, as discussed above, the return home of a son or daughter to the farm led some farm businesses to diversify into contracting work in order to generate off-farm income from the additional labour available. Elderly farmers without successors are less likely to be actively investing in capital and intensifying production compared to their peers with successors. If it appears that the next generation will take on the farm, there is greater incentive to build up the business and accumulating capital, actions which affect both day-to-day decisions and long-term planning" (Potter and Lobley, 1992). They are also more likely to have simplified their enterprise structure and to have begun consuming material assets, if only to reduce the workload and hours worked (Potter and Lobley, 1992). This can have particular implications for schemes that rely on voluntary participation. On one hand, they may not have the capacity or might be running down their land, but on the other, a publicly recognised role as a landscape manager might suit those with lower consumptive needs, such as those without successors (Potter and Lobley, 1992).

Both AS1 and AS3 raised succession planning as a big issue. Both were concerned about it being delayed, barriers to exit and debt accumulation. AS1 suggested that "succession planning is such a big issue in agriculture, such a big issue, but it's sort of like the orphan, everyone knows it's there but no one wants to own it". While their concerns were related to structural and financial adjustment, for farmers in this study the key concern was that lack of succession meant that knowledge accumulated over a lifetime would not be passed on. Without a succession plan, often a farmer may not have an exit strategy. For too many, the trigger to leave is the bank. As AS3 from the banking industry said, "the hardest part is when they don't want to see it". Reluctance to consider farm exit is understandable, in that farm exit can be very difficult for some farm businesses and households. This is not least because it often requires a movement away from familiar production activities or practices, or developing a new set of management practices and skills (ABARE, 2007). While the bank can be a trigger, there are combinations of drivers of structural change in

Australian agriculture more broadly including: changes in technology, changes in consumer demand for agricultural products, policy induced reforms, the effects of international trade and changes in the natural resource base and environmental condition (ABARE, 2007).

Farm businesses have a permanence that is different to businesses that can be opened, closed and relocated. They are living systems within the landscape and cannot be moved in the same way (Richards and Bulkley, 2007). However, they are still modern businesses. Though embedded within a unique set of social and economic circumstances, lessons from other sectors can be applied to farming (Richards and Bulkley, 2007). The constraints experienced by agricultural businesses are similar to those experienced by other non-agricultural small to medium enterprises (SMEs), and there are lessons to be learnt from both (Klerkx and Leeuwis 2008). Unfortunately, the study of networks and learning in work contexts has more usually been done for medium to large enterprises, rather than SMEs (Sligo and Massey 2007). This is despite studies showing that both agricultural and non-agricultural SMEs prefer sources of information such as peers above research and development institutes (Klerkx and Leeuwis 2008).

Considering farms as SMEs raises the issue of entrepreneurship. Looking at entrepreneurial behaviour can provide insights on innovation and actions taken to create or realise opportunities (Morgan et al., 2010). Farmers have been encouraged to consider themselves entrepreneurs in many contexts as markets have been increasingly liberalised and government institutions reformed (Phillipson et al., 2004). Yet many studies are reluctant to consider farmers as entrepreneurs in the same way as it might be considered in other business sectors, arguing that entrepreneurship in farming has unique characteristics due to its biophysical and socioeconomic contexts (Morgan *et al.*, 2010). While this argument is similar to Richards and Buckley's (2007) point about the connection between farm business and landscape, unfortunately it has led to a lack of comparison between farms and other rural firms (Phillipson et al., 2004).

Farms that are seen as primarily businesses (like in other industrial sectors) can be labelled as part of the agro-industrial paradigm (Morgan et al., 2010). In a study of the Australian tomato industry, farmers were found to exhibit behaviour similar to that of any entrepreneurs involved in an industrial value chain (Pritchard et al., 2007). They were found to be tuned in to technological advances, proactive in seeking knowledge and highly capitalised. This behaviour reflects the pressure that local firms of all sectors feel to

continuously innovate - firms which are challenging governments to develop policies to support the innovation process (World Bank, 2006). The accompanying pressures of increased capital requirements and the struggle to maintain family ownership meant that there was greater attention being paid to professionalism and "selective entrepreneurialism" (Pritchard et al., 2007 p. 81).

8.3.2 Risk management

Risk is an important factor in decision making and individual farmers will have different levels of risk tolerance (Barr and Cary, 2000 ; Guerin, 1999). The ability to manage complexity and financial risk is also an important factor in achieving sustainability on-farm (Barr and Cary, 2000). A range of factors, including context, knowledge, beliefs and attitudes will influence perception of risk. In a review of mostly Australian studies, Botterill and Mazur (2004) conclude that "it is generally agreed that farmers tend to be risk averse" (Botterill and Mazur, 2004 p. 16). They do note, however, that there is not enough research to determine whether farmers have different perceptions of risk than other parts of society. The idea of farmers being risk averse does not seem consistent with the fact that farming can be high risk. That is, if risk is linked to uncertainty, then it would seem that risk tolerance is inherent to farming. In fact, while society has come to associate risk with negative connotations, farmers are one sector in society who are more likely to retain a view of risk as a gamble with potentially positive outcomes (Botterill and Mazur, 2004). Farmers interviewed in this research acknowledged taking risks is a part of farming. The ability to be more opportunistic and short term focussed was viewed in a positive light and this seemed linked to a perception that volatility could bring benefits by creating opportunities. This attitude of the interviewees seemed more consistent with the findings of Brodt et al. (2006), who interviewed almond and wine grape growers in California's Central Valley about biologically integrated farming systems. They found, for that group of farmers, that risk-taking was seen as an inherent aspect of farming and was "probably tied to the perceived need to remain innovative" (Brodt *et al.*, 2006 p. 101). Yet being risk tolerant does not mean that these farmers are "venturesome individuals" that "desire the hazardous, the rash, the avant-garde, and the risky" (Rogers, 1963 p. 253). Rather, it seems that what these farmers desire is to survive and to still be around to continue farming next year and the year after that. As CW12 said, "the number one thing, you've got to be here next year. You're not going to be a conservation farmer next year if you're not here".

It is worth noting here that perception and action are not always aligned. Greiner et al. (2009a) found that Queensland graziers' own perceptions of whether they were risk takers

was not always matched by actions. Yet, they also found that farmers generally did have a good sense of their relative risk taking behaviour in relation to others, even if they could sometimes be more conservative than they realised in their decision making. They also found that those who considered themselves to be 'risk takers' in relation to the introduction of new grazing practices showed higher levels of implementation of rotational grazing, a practice which was being undertaken on seven of the farms visited in this research.

There was also recognition of the negative aspects of risk, including that there is no point implementing radical change if it is going to put you out of business next year. In this sense, taking risks by innovating is primarily a business strategy rather than a personality trait. Part of this strategy is to seek to "get to scale", either scale in terms of production or in terms of farm size, in order to spread the risk and reduce the costs per hectare. Inevitably, this requires a large 'leap of faith' at some point as big investments are made, and an annual gamble every time more livestock is bought or more crops are sown. The rising costs of inputs have implications for this because, as (CW12) said, the costs of farming are "so big now that you can't gamble". As (CW10) pointed out, if you put a lot of inputs onto a crop, and the crop fails, it is a "double loss" because you've not only lost the income, but also the investment in the inputs too. This perception of increased risk was influencing management practices, for example, some farmers switching from putting fertiliser on the crop at sowing time to applying liquid fertiliser on a needs basis as the season developed.

8.4 Generating knowledge for innovation

As explained in the review of literature in Chapter Two, knowledge generation and transfer are important components of both decision making and innovation. While our understanding of knowledge production is changing, so too is the actual nature of knowledge production itself (Gross Stein and Stren, 2001). Farming is becomingly an increasingly complex business employing a wide range of technologies and practices that require the continual assimilation and assessment of new knowledge (Oreszczyn et al., 2010). This means that while still reliant on traditional skills of land management, farmers have to develop an increasingly technical and sophisticated skill set. Changing knowledge processes challenge traditional divisions between local and scientific knowledge. The process of knowledge generation is "becoming more and more heterogeneous rather than homogenous", transdisciplinary rather than disciplinary, and 'operation' as well as abstract (Gross Stein and Stren, 2001 p. 22). As Carr and Wilkinson (2005) wrote:

> For many years, agricultural science assumed that research was done by scientists, repackaged by extension officers, and launched at farmers. Both their knowledge systems and cultural roles were seen as different. Nowadays their roles are converging and their boundaries are eroding" (Carr and Wilkinson, 2005 p. 255).

The alternative definitions of what is knowledge is - either scientific, general and global, or specific, local and particular are becoming less relevant as the boundaries blur. Farmers are incorporating more science and more global networks, while scientists seek to work with farmers to apply their research (Carr and Wilkinson, 2005).

In this study the interviewees spoke of being in front of the science, and having "no one else in the area that is further advanced" for them to follow. They felt that there was still a lot to learn, test and implement and that the potential for further change and evolution was definitely there. A common comment was that "this is just the beginning" or "we are just getting started".

8.4.1 Testing and trialling

This study has shown the prevalence of independent testing and trialling, the time and resources need to implement change, and the importance of the ability to observe the landscape and respond accordingly. Interviews demonstrated that testing and trialling is conducted continuously and independently on-farm by innovative farmers. These tests and trials are sophisticated and complex and require a high level of scientific knowledge on behalf of the farmer. This included 50% of farms that conducted grazing management/livestock related trials. Of the 16 mixed cropping farms that were part of this study, 7 had implemented rotational grazing practices. These findings echoed those of Blay-Palmer's (2005), whose study found all organic farmers interviewed in Ontario, Canada, conducted their own experiments too.

Common features of the farmers interviewed were their willingness to challenge accepted wisdoms and conduct their own research on their farms. Trials and experiments are continuously conducted on-farm by both the farmers themselves and also external parties. This in itself is not unique, in that for most farmers the "process of generating knowledge through experimentation is part of their everyday agricultural activities" (Reij and Waters-Bayer, 2001a p. 9). On-farm trialling is also regularly undertaken before any new practice is adopted. However, the testing and trialling outlined in this research is particularly sophisticated and were often about finding solutions and experimenting based on their

own unique ideas, rather than simply adopting technologies or practices developed elsewhere.

As also discussed in Chapter Two, it is often assumed that farmers take up practices developed by scientists (Guerin and Guerin, 1994 ; Pannell *et al.*, 2006). However, it was evident from the interviews and subsequent tours of the farms that these farmers were creating something new, not just adopting the practices conveyed to them by extension agents and scientists. Several farmers even criticised the time lag between the date when they implemented new practices or created new inventions and the number of years it took for science to catch up. This validates Eliasson's (2000) suggestion that scientists tend to encode the principles of the innovations that have already been created and implemented in practice. This adoption of farmers' ideas by researchers has received much less attention than the flow of information to farmers (Chikozho, 2005). From a research and development point of view there is evidence of time lags between research investment and impacts of farm productivity of up to 30 years (Chavas, 2008). Yet, how much time passed before what was originally a farmer's idea was tested by science, and then later advocated through extension to other farmers? In other words, just because the time to adoption for one group of farmers may be long, other farmers could be well ahead of the science. Perhaps this oversight can be attributed to the problems scientists have expressed with the design of on-farm research? For example, Guerin and Guerin (1994) questioned whether field experiments conducted by personnel who are not trained in scientific methods are likely to be of any use to the wider scientific community.

In terms of research design, there are few packages available to support the on-farm research being undertaken by the wider network of farmers and farmer groups across Australia (Lawrence et al., 2007). Some guidelines do exist, including the 'Doing successful on-farm research' module developed by Lawrence et al. (2004) for on-farm research through a participatory process. It is worth noting that the workshop "targeted people with authentic, not hypothetical, issues that they were already motivated to address" (Lawrence et al., 2007 p. 160). In this case, the participants wanted on-farm research to test general principles in their own situations rather than test or develop new understandings of cause and effect. In other words, the goal was not to generate new theories or journal papers, but to solve problems relevant to specific individual circumstances (Lawrence et al., 2007). There are other examples such as the well-known Birchip Cropping Group in southern Australia, who have developed considerable research capacity and have a staff of 17 (BCP, 2010). Yet for those with fewer resources or less formal research agendas,

assistance in research design is scarce. Such lack of guidance could contribute to the perception that on-farm trials are not as legitimate as trials conducted in controlled conditions. There remains a reward system in academia that perpetuates the status quo of science and privileges formal and written knowledge over informal and tacit knowledge (Kroma, 2006). This is unfortunate as interactions with farmers have been shown to transform scientific thought and lead to changes in the methods and approach of scientists (Crawford et al., 2007). And many scientists do value this interaction.

8.4.2 Landscape observation

Innovation requires application and experimentation at the farm level. While scientific and technological innovation will continue to play an important role in the development of sustainable farming, so too will an improved understanding of how actions at that level affect landscape processes, such as ecological and hydrological function (Williams and McKenzie, 2008).

Regenerative agriculture argues for a holistic and systemic understanding of nature in which the sum of the parts are not necessarily equal to the whole (Kroma, 2006). The idea is to ensure that plant and animal interactions mimic as closely as possible natural ecosystem processes and functions. Local investigation through observation and adaptive management is a key means of knowledge acquisition.

It was clear from this research that farmers were alert not just to the signs displayed by crops and livestock, but to the signals the landscape is providing, how they are changing and the effects of current land uses. For example, WD1 and WD2 spoke about being committed to "a process of observation and then thinking about why something is happening and not just banging away at the symptoms - trying to understand the natural processes". For many components of Australian agricultural landscapes, such as the impacts of agricultural intensification on species such as birds, systematically collected data are lacking (Attwood et al., 2009). Obtaining data at the landscape scale is crucial for identifying interactions among biophysical factors, such as soil erosion and water quality, and socio-economic factors, such as human health, social well-being and income, over the short and the long term. Such data would also provide a bridge between farm-level data and national, regional or global monitoring efforts (Sachs et al., 2010).

8.4.3 Adapting to water scarcity

One of the reoccurring themes of this research was the importance of effective ways to retain water in the landscape – a challenge that appears to have been a key driver of on-farm knowledge generation. Given that 2009 was the ninth consecutive year with below average rainfall for NSW and the warmest year on record, this focus on moisture conservation is not surprising (BOM, 2010). The perception of there being a climate shift underway was shared by many of the farmers interviewed. The surprising thing was that, although a change in rainfall pattern and general climate was acknowledged, there was less certainty about whether this was anthropocentric climate change or natural variability. Farmers seemed reluctant to underestimate the natural variability of the Australian climate. Given their past experiences, they did not necessarily want to attribute changed rainfall patterns to climate change.

Another study of farmers in north-west Victoria also found opinions to be strongly polarized over whether previous dry seasonal conditions were due to natural climate variability or anthropogenic climate change (Nuttall *et al.*, 2010). Given the variability of climate in Australia, even scientists are reluctant to state with certainty that the past several dry years are a direct result of climate change. The South Eastern Australian Climate Initiative , while one of the first to provide evidence that changes in weather patterns over south-eastern Australia are associated with global warming, also said that natural variability was a contributing factor (CSIRO, 2010). CSIRO (2010 p. 2) cautiously states:

> To the extent that the current changes in temperature and rainfall are linked (at least in part) to climate change, it is possible that the climate in south eastern Australia is shifting. This raises the possibility that the current dry conditions in south eastern Australia may persist, and even possibly intensify. However, given that natural variability is also likely to be playing a role in the rainfall decline, it is also possible that there may be a return to somewhat wetter conditions in the short-term… Further work is being done to improve our understanding of the relative influences of natural variability and global warming on current changes in climate.

A lack of faith in the science of climate change may also be explained by the negative views and experiences farmers recounted of dealings with 'science' and scientists. In a 2005 study of thoroughbred breeding in the Upper Hunter region of NSW, McManus (2008) found "scepticism among some breeders that climate change is happening"

(McManus, 2008 p. 1303). It is interesting that four years later, despite much wider public awareness of climate change and high profile publications on the issue, this scepticism remained in other parts of NSW as well. It may also be partly explained by the 'terminal' condition that climate change implies, whereas drought allows hope for better seasons to return, or that drought means dealing with agricultural scientists whereas climate change implies understanding the work of atmospheric scientists and distant conferences attended by politicians.

Despite the ambiguity, farmers were adapting their practices. This responsiveness didn't necessarily indicate a belief in climate change, but recognition of changed weather patterns. Grothmann and Patt (2005) point to the importance of cognition in adaptation to climate change, particularly perceived adaptive capacity. This link between perception and expectation, what people think they could do, can be as important as beliefs about risk and chance. It also links to the concept of perceived behavioural control, as per the theory of planned behaviour, previously described in Chapter Two (Ajzen, 1991).

In Australia, it seems there is a willingness to be responsive to climate signals. ABS found that 63.6% of NSW agricultural businesses considered that a change in climate had affected their holding. The most common perception was that this had led to a change in rainfall patterns (92.1%), followed by more extreme weather events (74.2%) and warmer temperatures (49.6%). Of those who perceived the change, 49.5% reported they had implemented new management practices in response. The most common change (69.3%) was to change the intensity of cropping (ABS, 2008b). Likewise, though various forms of conservation farming have existed in Australia since at least the 1980s the uptake has gradually increased over the past 30 years, particularly since the 1990s. Approximately 27% of the total 2008/2009 crop area in Australia was under conservation agriculture (Kassam et al., 2009). In an ABARE workshop with farmers in mid-2009, it was suggested by the participants that this increase could partly be attributed to the ability to generate water use efficiency from the practice (Jackson, 2010). This willingness and ability to adapt could perhaps be related to what is a long history in Australian agriculture of "adapting to declining terms of trade, climate variability and change" (Brown et al., 2010 p. 562). That being true, it is important to note that adaptive capacity varies between farmers within Australia.

Key strategies to improve moisture availability included improving soil health and water retention by increasing ground cover. This meant balancing increased plant growth with

reduced moisture availability. Farmers were experimenting with practices such as cover cropping, the introduction of which seems to be a natural progression in efforts to refine the conservation farming system. This is because the primary feature of conservation agriculture is the maintenance of a permanent or semi-permanent soil cover, be it a live crop or dead mulch, which serves to protect the soil from the elements and feed soil biota (Knowler and Bradshaw, 2007). Once a crop is harvested, it can be difficult to maintain this cover, even when stubble is retained. Yet cover cropping also poses challenges in terms of water scarcity. Farmers in this study were coming up with innovative solutions such as green and brown manure to overcome this problem.

Other practices such as stubble retention and pasture cropping were also being introduced, while other farmers were also taking livestock out of the cropping system to reduce soil compaction and increase water infiltration. The absence of reliable long-term weather forecasting was also noted and farmers were finding other ways to reduce their exposure to risk from unpredictable seasons. They did this by reducing the amount of inputs used at the start of the season. Instead of applying fertiliser upfront, using liquid fertilisers meant they could be applied on a needs basis later in the season. This strategy is still not widespread, with less than 30% of Australian wheat farmers having adopted seasonally-responsive fertiliser management (Robertson, 2010). However, this percentage will increase as the rising cost of inputs creates impetus for productivity gains through the more efficient use of inputs, rather than increases in input (Robertson, 2010). Another strategy was the gradual reduction in seeding rates, which avoids unnecessary plant growth at the expense of grain development and yield.

It appears that water scarcity has acted as a catalyst for new thinking outside traditional boundaries. Finding new ways to address water scarcity is crucial. 60-70% of the world's current crop production is rainfed (WBCSD and IUCN, 2008). Losses in yield can result due to soil evaporation, interception losses, surface runoff and deep percolation below the root zone (Rost et al., 2009). While such water losses can in part be avoided through integrated soil and water management strategies that optimise the use of rainwater, these are not always easily adopted or widespread (WBCSD and IUCN, 2008).

8.4.4 Machinery development

Financial considerations and capacity to pay have both been shown to be important in the adoption of conservation farming methods in Australia (Curtis *et al.*, 2001 ; D'Emden *et al.*, 2008). As reported in Chapter Five, two key drivers of machinery development were

availability and cost. In many cases, the machinery required simply didn't exist, so the farmer had to invent it. In other cases, the cost of buying new machinery was prohibitive, This high cost is partly because these farmers are in advance of the critical mass required for the creation of a market for a new agricultural technology to be viable (Parker et al., 2008). As a solution, farmers were building their own new and improved versions themselves to facilitate the changes that they want to make. This revealed that motivated farmers were able to negotiate barriers such as cost to implement the changes that they sought.

It was unexpected that technology would play such an important role, particularly for environmental innovations. Yet, it is clear that technological solutions do play a part, not least in the transition over time from technological to biological inputs and systems. Distinctions between technological versus systems approaches to farming exist only on paper. Farmers create technology and they implement a mix of both to change their practices based on consideration of their merits. As discussed earlier in this chapter, the shift towards more sustainable agricultural practices can be a gradual process, taken in a series of steps, where new technologies and equipment facilitate transition. For example, several farmers were using (or hoping to use) weed seeker technology to reduce the amount of chemical application on cropping paddocks. Another example is the telemetry based monitoring system built by CW5/6 to inform the management of their new rotational grazing system. In this case technology is making a non-technological solution more effective. New designs for fencing, such as two wire electric fencing and the easily installed "Westonfence" were also making paddock subdivision easier.

It appears technology is also enabling changes to farm layout. For example, implementing controlled traffic or guidance systems encourages efficiencies such as bigger paddocks and straighter crop rows to make the most of the ability of the tractor to steer itself in a straight line for long distances. Several farmers spoke about how a paddock tree can ruin the effect of having GPS straight lines for machinery to drive down. It costs time, as well as potential lost yield and looks messy on the satellite photo. Likewise, fences were being removed and cropping paddocks joined to increase the distance between each turn. There do not appear to be many studies of the implications of controlled traffic for land use change, but it definitely has emerging implications.

Given the innovation and invention happening on-farms, and the tendency to protect such discoveries in other industries, I had assumed that intellectual property may be an

issue. Research and development investments by firms are usually made to capture a market advantage (Maurer, 2004b). This is usually transferred through intellectual property, usually in the form of patents and copyrights. An innovator's capacity to benefit from investments in the creation of knowledge is key to innovation and technology policy, as well as the intellectual property system (Leiponena and Byma, 2009). Within the Australian Government's Department of Innovation, Industry, Science and Research, there is an agency called IP Australia with a dedicated role to promote a strong intellectual property (IP) system. The assumption is that a strong IP system will in turn protect and promote innovation, investment and trade (Commonwealth of Australia, 2011c).

The fact that farmers did not show great concern for intellectual property may be in part due to the nature of the intellectual property system itself and its difficulties for small businesses. Across many industries, small firms' strategies for capturing returns to investments in innovation differ to that of large firms. Small firms actually tend to rely on informal means of protection, such as speed to market or secrecy, rather than patenting, which can be expensive to obtain and difficult to defend (Leiponena and Byma, 2009). The problem with patents is that they reward inventors after the fact, and do not help with the upfront costs of research. Meanwhile, the cost of asserting intellectual property has meant a gradual concentration of (protected) inventive activity in large research institutions rather than by individuals. In addition, costs are not likely to be repaid where the science or invention has no commercial value. In other words, the intellectual property regime within competitive markets is an imperfect system and alone will not create adequate incentives for investment in knowledge (Maurer, 2004b).

In effect, farmer-to-farmer knowledge exchange within the agricultural sector operates like an open source model. This was reflected in the views of farmers that generally intellectual property wasn't a concern so long as it was only other farmers copying ideas, and ideas were not being poached and patented by private companies to make a profit. The risk is that cooperation between parties can be undermined if one person or group tries to gain intellectual property rights over what emerges through collaborative learning (Douthwaite, 2006). It is not only a breach of trust, but also an impediment to the free flow of ideas. In a study of men working in the forestry industry as loggers, Peace (1996 p. 48) wrote that "these men are proud of their knowledge because it has been so hard won, and because it has been so integral to their coming through a period of change which has proved the undoing of others". Peace (1996) could have been writing about Australian farmers in 2010. Such knowledge should be somehow protected. Intellectual property

rights may prove useful where they can be allocated in a way that protects trust-based learning networks and strengthens the current 'open-source' model of information and knowledge exchange between farmers. Such an open-source model is being promoted by developing nations and farmers' rights groups in the context of protecting farmer-developed plant varieties from being subject to plant monopoly rights (Beck, 2010). In this context, intellectual property regimes can actually be more important in their absence than presence. Though the lack of publishing or patenting could be contributing to scientists undervaluing the knowledge of farmers, sharing regimes such as "open science", can have the advantage of allowing research to proceed in a more cumulative manner (Rhoades, 1989). The challenge of course for such cumulative efforts is who pays (Maurer, 2004a)?

8.5 Knowledge exchange through formal and informal networks

Knowledge is more than information. As explained in Chapter Two, it does not exist in the absence of a sentient being or knowledge generating system (Midgley, 2000). The exchange of knowledge is therefore subject to the actions of the individuals pursuing and constructing that knowledge. Knowledge transfer is reliant on interpretation and communication. While interpersonal relationships are still seen as an important component of knowledge sharing and networks, the changing nature of electronic communication has the potential to challenge traditional notions of spatial clustering of knowledge and innovation, and may also impact on phenomenon such as knowledge spill over (Breschi and Malerba, 2001). Into this mix come factors such as trust, credibility and reliability (Gross Stein and Stren, 2001 ; Sligo and Massey, 2007). The literature tends to emphasise the informal nature of knowledge exchange between farmers (Isaac *et al.*, 2007 ; Kroma, 2006 ; Oreszczyn *et al.*, 2010 ; Sligo and Massey, 2007). Informal networks tend to be characterised by their emergent, ungoverned and unstructured nature. Formal networks are usually defined as those which have an organisational structure which is imposed by management rather than reflective of any social dynamic (Allen et al., 2007). It is worth stating the obvious here - that information exchanged informally or formally can be of equal value. This section reviews farmer experiences working with both farmers and non-farmers such as researchers. In this study, knowledge was being exchanged through both formal and informal networks. The value of both types of exchange was clear.

8.5.1 Working collaboratively with researchers

It is known that many farmers conduct their own research on their farms (Lawrence et al., 2007). What came as a surprise was to see how much land these farmers were making

freely available to outside organisations so that they could run trials. This is in fact reflects a growing trend in Australia for farmers to join formal grower groups that, along with private agronomists, conduct their own on-farm research programs (Lawrence et al., 2007). Half of the farmers interviewed were involved in collaborative trials. Interestingly, all the trials were cropping related except one, which was a farm forestry trial. There were no grazing trials being held. This makes sense in that several farmers told how, despite attending training courses, there was still little information or guidance on how to actually implement new practices like rotational grazing. It was more a matter of 'try it and see'. It appears that farmers can more easily access advice on cropping as an entity or livestock as an entity. It is much more difficult to obtain advice on the linkages and interactions of both entities within a mixed farming enterprise.

Approximately half the world's food is produced by farmers in mixed crop-livestock systems (Herrero et al., 2010). Despite this, research and development expenditure in the livestock sector has historically been less than that for food crops as has public and private investments in extensive mixed agricultural systems (Herrero et al., 2010). This is because research often focuses on system components rather than the complexities of inter-relationships between enterprises or the system as a whole (Ridley, 2005). This has resulted in a lack of information about the linkages between enterprises, including feedbacks, trade-offs and positive responses (Villano et al., 2010). For example, research funding from organisations such as the Grains Research and Development Corporation (GRDC) largely neglected the interaction between crops and livestock for many years (Ridley, 2005).

It was reported in Chapters Five and Six that farmers expressed concern about the lack of follow-up in terms of both research monitoring and funding. The fact that this was not a one-off incident was troubling. Many of the farmers shared experiences of discontinued trials or instances where researchers simply never came back. There was a sense of a constant "reinventing the wheel" due to this ad hoc approach. This doesn't bode well for future engagement. Research program managers need to be competent not only in the subject but also in communication with clients, and committed to the purpose and the results of programs (Ahnstrom et al., 2008). Evidently, this is not happening in many cases. The problems expressed by participants are not just a symptom of short term funding cycles, but also evidence of a greater underlying issue. Innovation demands sophisticated integration with local partners (Kiers et al., 2008). Innovation capacity is supposed to be evolutionary in the sense that institutional arrangements and partnerships should continuously adjust through learning and in response to changing circumstances (Hall,

2006 ; World Bank, 2006). The lack of follow-up and learning from collaborative research that is already underway potentially undermines the ability for evolution and adaptation – key components of an effective innovation system. Several farmers also held the view that visionary blue-sky research was no longer being conducted. The non-farmer agricultural professions, AS1 and AS2 also worried about the loss of independence in research and the growing power of "agribusiness industrial complex" (AS1) and "vested interests" (AS2). Such observations are similar to those of Blay-Palmer (2005), whose Ontario organics study found such research was difficult to fund due to the requirement that public research dollars be matched by private sector dollars. This meant that research without a lucrative commercial application or established private interest was unlikely to find backing.

In terms of research programs, the most popular were farmer-driven programs such as Central West Farming Systems (CWFS). The popularity of CWFS is not surprising given their research agenda is reflective of the key issues raised by farmers in this research - such as water use efficiency, interactions between cropping and livestock and locally relevant trials (Box 2). CWFS has also run study tours, including a 3 day tour through NSW and VIC. The aim was to allow farmers to visit a number of 'champion farmers', observe the benefits of sustainable farming practices and to increase their decision making skills and confidence.

Box 2. Examples of research driven through farmer input

Central West Farming Systems (CWFS)

CWFS is an independent, not-for-profit, farmer-driven organisation that operates in the lower rainfall, mixed farming areas of Central West NSW (350-500mm rainfall). Formed in 1998, the group now has over 400 members and operates 11 regional sites (CWFS, 2010). Projects include the 'Increasing Water Use Efficiency (WUE) in Central West NSW' project, funded by the GRDC. This seeks to create a database to establish WUE baselines and to better understand the interactions of livestock and cropping systems (CWFS, 2010). Another project, 'Farmers Driving Sustainability and Innovation', funded by Woolworths and Landcare Australia, started in 2009 and supports their Regional Site program and the continuation of trials and farmer run demonstrations (CWFS, 2010).

Farmers Helping Farmers

In 2009, the CANFA and the South Australian No-Till Farmers Association (SANTFA) gained funding from the Australian Government to trial a 'Farmers Helping Farmers scholarship'. The aim of the scholarship was to link growers who have encountered barriers to the adoption of no-till systems with an experienced no-till farmer, who could provide encouragement, knowledge and direction. The scholarship entitled the recipient to 30 hours of the mentor's time (CANFA, 2008).

Grain & Graze

The Grain & Graze Program funded research into the profitability and sustainability of mixed farms. It began as a collaboration between Meat & Livestock Australia, GRDC, Australian Wool Innovation Limited, and Land & Water Australia. Together, they invested $14.5 million over five years to 2008, with substantial co-investment from regional bodies. Farmers were involved in local research and trials and there were more than 100 test sites across Australia. Grain & Graze worked across nine regions, including the Central West/Lachlan of NSW. In this region, it operated in partnership with the then NSW Department of Primary Industries, the Department of Environment & Conservation, Stipa Native Grasses Association, CWFS, Central West Conservation Farming Association, and the Central West and Lachlan CMAs (Land and Water Australia, 2008). A second phase, Grain and Graze II, is currently being delivered across QLD and northern NSW (DEEDI, 2011).

Numerous farmers also mentioned the overseas study tours they had been on with CANFA, and how these had allowed them to really engage with farmers and scientists from other countries during the tour and later through email and online forums over an extended period of time. This is similar to the findings of a study of the Australian tomato industry where the authors were surprised to discover the extent of the farmers' international networks. They discovered that since the 1990s, these growers had been active in organising study trips to key growing sites around the world (Pritchard et al., 2007).

A common perspective of the growers in this research was that they needed to remain in front, in terms of both innovations and new technologies, in order for the Australian industry to survive. The benefits of travel are not unique to Australian farmers. In a study of farmer innovators in Africa, Reij and Waters-Bayer (2001c) it was found that many innovators had been exposed to other areas, often through labour, migration or military service. Travel across the country and overseas helped them to discover new ideas that could be tested after returning home. Vanclay (Vanclay, 2004 ; 2011) believes:

> While it is appropriate to accept that farmers have local knowledge, it is important not to romanticise or overstate the applicability of that knowledge. Local knowledge is unlikely to provide immediate answers to new problems. Of course farmers do experiment and they may over time develop solutions to new problems, and this may help science and other farmers overcome these problems. But farmers could develop partial solutions that treat the symptom but not the cause, and which could exacerbate the problem (or other problems) over time (Vanclay, 2011 p. 57).

Yet these study tours are another important reminder that farmers' can have access to global knowledge and linkages just as scientists can. Nor does scientific research have a monopoly over relevant solutions to new problems. In reality, coming up with new farming systems is a task not only for scientists , agronomists and farmers, but also for ecologists, policy-makers and social scientists (Nature, 2010). Redesigning landscapes requires collaboration between scientists and practitioners, "flexibility in land use and land use planning, and stronger engagement with communities, business and government" (Seabrook et al., 2011 p. 409).

Local and global knowledge should not be seen as mutually exclusive or particular to certain skill sets or positions. Indeed, effective knowledge networks disseminate knowledge by blurring the boundaries between participants and researchers, thereby ensuring that 'global' knowledge is introduced locally, and that 'local' knowledge shapes and, at times, redefines global knowledge" (Gross Stein and Stren, 2001 p. 4) . Study tours may be one way to achieve labour mobility (literally) and knowledge exchange within the agricultural sector as advocated by Eliasson (2000). It may in fact be more common for farmers to be opinion leaders in districts other than their own. As (WD2) said, "your neighbours won't look at what you are doing - it is always outsiders". Farmers were really interested to hear of other farmers in the state who were doing new things because they said it isn't always easy to find out who the other "likeminded" farmers are out there. This is in contrast to traditional assumptions about how innovations diffuse locally (Rogers, 1962). While geographical proximity can be important in some industries, technological and competence integration increasingly occurs over geographical distances, not least via artificial intermediation (such as the internet). Hence, geographical definition is not always appropriate (Eliasson, 2000). Tonts et al. (2010) also highlight the importance of global linkages in informing understandings of processes of innovation diffusion, and point out that much of the research on the spatial diffusion of innovations has focused only on local scales. A recent New Zealand study also found farmers were making use of farmers in different locations, making it apparent that 'communities of interest' were becoming as important as 'community of locality' (Sligo and Massey, 2007). The message from this study was that while face-to-face interactions are important, we should also not neglect the importance of relationships "maintained at a geographical distance" (Sligo and Massey, 2007 p. 177). In this study, farmers also sought to learn from those they saw as 'the best' in a particular area of farm practice, where communities of interest evolved and trust grew over time.

8.5.2 Weighing up the advice of agronomists and government advisors

Contrary to assumptions, farmers are not information deprived nor are they relative passive recipients of knowledge. Instead farmers actually have excessive information, some of which is conflicting, and they are almost never passive recipients (Pannell et al., 2006). It was evident that the farmers interviewed were able to weigh up conflicting advice from a variety of sources, similar to the findings of Sligo and Massey (2007) in their New Zealand study of dairy farmers, previously described above and in Chapter Two. They were proactive in searching for information and people with relevant expertise and innately curious. There was an awareness of "snake oil salesman" and a strong scepticism of

anyone making money out of providing advice. Among those they sought advice from were agronomists and government advisors.

The use of agronomists varied, but more often than not farmers did not rely on one source of agronomic information. Instead they consulted several sources from which they could derive balanced advice. The trend towards fee-for-service instead of agronomists attached to government or retail organisations was increasing, with farmers reporting how they had switched over time from getting free agronomy advice to paying for it. This is consistent with what appears to be a trend towards increased professionalism in agriculture (Pritchard et al., 2007) and a growing recognition among the farmers interviewed that intangible products such as knowledge and training hold as much value for the business as tangible products such as new machinery or other technologies, and are therefore worth investment. The shift to towards 'fee for service' agronomy can also be seen as a function of the decline in government extension services over the last decade. Increasingly, landholders are expected to purchase such services from the private sector (Bjørkhaug and Richards, 2008).

While farmers were complimentary about the locally based government agronomists from the state agricultural department, they were generally sceptical of staff from both the environmental and agricultural departments. This is similar to the findings of Oreszczyn et al (2010), where farmers in the United Kingdom were found to perceive that the agricultural ministry (the Ministry of Agriculture, Fisheries and Food) had better served their interests than the environmental ministry (the Department for Environment, Food and Rural Affairs). That being said, there was still a prevalent and unfavourable view of the general direction that the agricultural department was taking, which could possibly be explained by its reduced funding, limited remit and productivity focus, beyond which farmers in this study are seeking new knowledge. The exceptions made for local agronomists validates the view of Oreszczyn et al. (2010) that it is key people, rather than organisations, who play an important role in farmers' networks of practice.

The scepticism of the direction of the agencies in question reflects the growing scepticism within rural communities more broadly. Communities are becoming increasingly sceptical of the rhetoric of public agencies which place the burden on implementation onto individuals and the community itself. The role of government extension agents and environmental agencies in many states has changed away from that of supporting landholders in making good decisions to achieve their own goals, towards encouraging

landholders to make decisions that achieve outcomes for the public good (Pannell et al., 2006). This split in objectives between different government agencies, and subsequently, the way they were viewed by farmers, has implications to the present day. Community partnerships with government, while having had many positive outcomes, have experienced volunteer burnout in community-based programmes and a lack of adequate resourcing (Cocklin et al., 2007).

As described above, agronomists (public and private sector) were generally more popular than other government advisors. Another study in Central West NSW in 2007 found similar results in terms of who farmers sought information and advice from. Agronomists and other farmers were ranked in the top four for both most commonly consulted and most trusted individuals. In terms of the individuals consulted, the most common four were family members, other farmers, agribusinesses and agronomists (CSIRO, 2007b). A list of twelve sources was also given to farmers (this list did not include family members). In terms of the information sources most trusted (other than family members), the top four were agronomists, other farmers, field days and courses run by organisations. Scientists were ranked fifth, while government departments and the local CMA were ranked tenth and eleventh respectively. This is consistent with other studies that have also shown a tendency for both agricultural and non-agricultural SMEs to prefer other sources of information such as peers, suppliers, clients, professional magazines above research and development institutes (Klerkx and Leeuwis, 2008a). Yet farmer networks and on-farm trials have long been devalued as sources of legitimate agricultural knowledge (Guerin and Guerin, 1994 ; Kroma, 2006).

In terms of training programs, several farmers critiqued the quality of government subsidised training, and said that if it was worth their attending, they would rather pay for it. These experiences echoed the views of participants in a study by Cocklin et al. (2007), who reported experiences of poor quality training, inappropriate formats, content and training methods when discussing agricultural extension and training in Australia. They found that while there was an enthusiasm in general for education, R&D and information, participants found training and education was expensive, inconvenient to attend (because it was off-farm and often involved considerable travel distances) and was, in their view, sometimes misinformed (Cocklin et al., 2007). In this study, farmers were less concerned with cost and more with quality. Given the time constraints of farmers, the emphasis on value is not surprising. In terms of other sources of advice, tension exists between the government organisations responsible for environmental versus productivity outcomes.

This was reaffirmed by the negative views that the environment and agriculture agency interviewees in this research form of the respective department. For example, AS5, from the environmental side, felt that "DPI is at least 10 years behind best practice". For him, the big issue was "access to appropriate extension". He told how the CMA runs field days and conservation farming "and DPI people come". In contrast, AS4, from the agricultural side, felt it was irresponsible to promote alternative practices that are "too much outside the square".

8.5.3 Farmers learning from farmers

Farmers interviewed expressed a strong tendency to rely on other farmers for advice. There were several reasons given for this, including that other farmers are "often better to listen to than someone who is actually trying to sell you a product" (CW3). Honesty was also valued, in that finding out what "really didn't work" (CW12) can be as useful, if not more so, than finding out what did. Farmers were appreciated for being able to give less traditional advice than an agronomist, and to be able to show examples of implementation on a working farm. These findings confirm those of other studies that have found this tendency for farmers to trust their peers as an information source – for example Kahn et al. (2005), Palmer et al. (2009) in Australia and Sligo and Massey (2007) in New Zealand. The fact that farmers want to hear not just solutions, but also what didn't work is consistent with Nicholson et al. (2003), who found that Australian producers wanted to be aware of the "downsides" of any changes in order to be able to work through these potential problems. The desire to see results on someone else's farm first before implementing a similar practice coincides with the findings of Barr and Cary (2000), who examined factors influencing the adoption of improved natural resource management practices on agricultural land in Australia. They concluded that trials observed from a distance are unlikely to be a successful stimulus for behaviour change when relatively complex management systems are being used.

Being reliant on other farmers for advice is not necessarily unique to innovators (Klerkx and Leeuwis, 2008a). However, what may be unique is the sense of overload coming from the number of workshops and events being held. Several of the older and more experienced farmers talked about pulling back from participation in these events, which may have implications for a sector with an aging workforce and for the popular extension technique of using farmers to teach farmers. As Leeuwis (2004) points out, though undervalued, farmer-to-farmer exchange of knowledge or information is increasingly being recognised as a useful network. Indeed, government organisations and extension officers are starting

to use farmer-to-farmer exchange more often to make efficient use of increasingly limited resources. With limited funding for extension efforts, farm tours and 'farmers as teachers' provide a way to reach a relatively high number of farmers with limited expense on the organisation's behalf. The problem is that using farmers as teachers:

- continues to take advantage of farmers by requiring volunteer work while at the same time reducing investments in other ways – in effect a cost shift;
- provides an advantage to the farmers who have not taken the risks to innovate ;
- usually doesn't provide appropriate public recognition for this role farmers play, instead any credit goes to the extension workers or government agency for meeting their performance targets; and,
- potentially promotes farmers for alternative practices that could alienate them within their community.

It is also often assumed that farmers will want to share ideas and experiences with each other, as evidenced by the number of farm visits and field days the interviewees were hosting. While this can be true, it is also true that farms are businesses. Neighbours are competitors – something that seems to be forgotten by those who assume that farmer-to-farmer exchange of information has no cost. According to Eliasson (2000), "innovations or new technologies are often assumed to diffuse mechanically at no costs. This is completely wrong" (Eliasson, 2000 p. 226). It is a strategy that farmers use to their advantage to gain information. It is a transaction. The dilemma facing a farmer is that he does live in a community, one where the decisions he makes can impact on the well-being of that community. On one hand, if another farmer goes out of business, then that potentially makes tightly held land available for purchase to achieve economies of scale. On the other hand, it can mean a small town becomes smaller. In 2001, over 70% of Australia was occupied by less than one percent of the total population, at a population density of less than 0.1 persons per kilometre (McManus, 2005). Decreasing populations threaten the survival of the local services such as the school, hospital and bank. The dynamics of rural Australia are changing and greater sensitivity to this dilemma of balancing the demands of business and community is needed (Cleary, 2010). Threats to the viability of inland settlements are not just manifesting themselves here. Accounts of rural decline and the loss of infrastructure and services that go with it can be found not only for Australia but for many other Western countries including the UK, Europe, New Zealand and the USA (Argent, 2008 ; Argent and Rolley, 2000 ; Cocklin and Alston, 2003 ; Connell and McManus, 2011 ; Pritchard and McManus, 2000). These are important points

for government and private sector organisations to consider as they increasingly seek to host field days on farms and use farmers as guest speakers, teachers and role models.

8.5.4 The importance of farmer groups

In contrast to the 'farmer as teacher' model, farmer groups provide a forum for sharing advice and experiences. In this research, such groups were of considerable importance (see section 6.2.3). These groups provided a venue for interaction with "like minded people" – a factor that farmers had identified as helping to maintain motivation - access to other innovative farmers and an effective network for general information exchange and moral support. Examples were given by interviewees of nine different farmer groups operating in the area. This was not an exhaustive list but the groups in which interviewees were actual participants. From fertilisers and disc planters to ram breeding, business training and overseas study tours, these groups were as diverse as they were popular. Some were privately run while others were a research alliance between farmers and both public and private sector organisations. In fact, there are a growing number of farmers who are joining either formal grower groups or farmer led initiatives in Australia (Lawrence et al., 2007).

Innovations rarely originate from one source, but rather emerge out of "a complex process of multiple agencies and institutions interacting and learning from experience" (Chikozho, 2005 p. 923). In Chapter Two, the idea was introduced that there is a need to create space for the diversity of interactions required to build innovation capacity (Hall, 2009). Farmer groups are in effect a form of social innovation (Conroy, 2008). They tend to evolve gradually and require the building of mutual trust (Ashby, 2009). Research in Australia and New Zealand has shown that farmers are more inclined to test and adopt ideas and knowledge when innovations emerge from within a group or network (Kroma, 2006). This is because farmer networks provide a space for collaborative learning, and in doing so help to reduce the risks of change. While attention has been paid to farmer groups and cooperatives that are formed to strengthen farmers' bargaining power or improve access to government R&D, less recognition has been given to farmer groups as sources of collaborative learning and knowledge exchanges between farmers themselves. An exception is Ridley (2005), who looks at the role of farming systems group approaches in Australia, including farmer driven groups, but in the context of achieving sustainability.

These findings are in contrast with Oreszczyn et al. (2010), who found that farmers' discussion groups, where farmers can gather and exchange ideas and views, were not

considered to be particularly influential by most of the farmer participants in their research. The farmers in their study "felt that they had good relationships with other farmers, although they did not feel they particularly influenced their decisions about running their farms" (Oreszczyn *et al.*, 2010 p. 411). It is not clear why the findings differ so greatly. It could be because Oreszczyn et al. (2010) focused on genetically modified crops (GM) and the interviews were conducted in the United Kingdom, where no GM crops are grown commercially at present, hence there being no active producers within a farmer's network.

Hall and Dijkman (2009) believe that underpinning the capacity of innovative agricultural entrepreneurs is the network in which they are embedded and which they use as a way of accessing knowledge, information and technology. As such, poorly developed linkages among players with complementary information are a major constraint to innovative capacity. Given the feedback from farmers in this research, farmer groups are an effective way to overcome this limitation. Farmers groups could also be a source of enthusiasm, support and lesson sharing. Interestingly, these groups had geographical definitions, but were sourcing from a large enough area that it wasn't simply groups of neighbours but more colleagues from across the region coming together for events and workshops. A valid observation is that of Gray et al. (1995), who observed in 1995 the emergence of "farm management –related groups" and how they were replacing traditional socialising, with the consequence that the participation of other family members was likely to be more limited. Yet, this may be the inevitable result of a trend towards the farmer as the professional and the farm as a business, rather than family farming as a lifestyle.

8.6 Changing landscapes

8.6.1 Redesigning for improved environmental outcomes

Chapter One outlined the increasingly urgent challenge of making agriculture both more productive and more environmentally sustainable. As discussed in 3.3.2, governments are implementing both incentive and regulatory based schemes to achieve changes in land management on farms to try and achieve this. However, the focus has tended to be on protecting remnant vegetation rather than reconciling production and conservation objectives on agricultural land. The perception of production and conservation as mutually exclusive may be why there is little guidance available for farmers on where, when and how they should invest in improving the condition and extent of native vegetation on agricultural land, as distinct from remnant woodlands (Dorrough et al., 2007). Several of the farmers interviewed for this research were interested in answering

questions that dissolve this dichotomy, such as "how does regeneration fit into all of that" and "how can we maintain a healthy soil, grow grain, take grain out the gate but start building the central component, carbon?". Australian farmers are not the only ones faced with a shortfall in applied agro-ecological knowledge. In a study of organic farmers in New York state, USA, Kroma (2006) found that the lack of such knowledge meant that farmers had no choice but to become experimenters. Through informal networks for interaction, sharing and knowledge exchange, these farmers were able to further validate their innovations (Kroma, 2006). In her view, "the science of regenerative agriculture has for long been relegated to the margins of public discourse and has not really been perceived as valid agricultural knowledge" (Kroma, 2006 p. 10). It is not clear where further advice will come from except from farmers' own experience and learning. Particularly in the context of climate change adaptation and mitigation in agriculture, an international organisation along the lines of the IPCC may be needed to rapidly activate multi-disciplinary expertise and provide a global framework for action (UNCTAD, 2010).

In this research, 10 of the 22 farms had been redesigned. Each farm had been redesigned differently, for varying reasons. Land uses changes were partly a reflection of the evolution of technological capability. Implementing controlled traffic or guidance systems requires the ability to drive a tractor for long distances in a straight line. This means cropping paddocks need to get bigger, which was happening in this study. Electric fencing makes smaller paddocks possible. In this study grazing paddocks were being made smaller as part of a livestock rotation system that sought to increase the planned movement of stock around a number of paddock cells. The use of electric fences was widespread across the farms visited that had livestock. The ease with which electric fences can be removed and relocated was an obvious advantage. These changes were resulting in improved environmental condition on the land used for production. This was achieved through more than a change in fence lines and a lot of labour intensive work. It has been achieved through a broader conceptual shift reflected in management changes for grazing, ground cover, native grass recruitment, soil organic matter and so on. This is significant because factors beyond tree cover, such as improved grazing management of native-based pastures, have been found to be important in maintaining biodiversity and prevent further long-term degradation of the resource base (Dorrough et al., 2007). This is partly because agricultural landscapes that have early and late successional habitats can be better for biota than simple landscapes (Jackson et al., 2007). It also makes sense to pay attention to grazing land management, not least because the livestock sector represents the world's

single largest human use of land, covering 26% of the Earth's terrestrial surface (European Communities, 2008).

Of the 10 farms that undertook property redesign, eight were mixed farms (2 were cropping farms). It seems that there is a link between livestock management and reconsidering paddock layout. This may be because paddock redesign is an inherent part of implementing a new rotational grazing system. It could also be because there is more scope for flexibility in paddock design for livestock than cropping. Lastly, the training that farmers receive when they attend a rotational grazing management course such as Holistic Management could play a role. This course is not strictly about a grazing system, although that is a major component, but provides a decision making framework for goal setting and planning and potentially starting points for "chains of innovations" (Reij and Waters-Bayer, 2001c p. 83). Reij and Waters-Bayer (2001c) suggest that over time one innovation, such as improved soil management, can trigger others, such as improved crop management, harvesting and marketing.

8.6.2 Specialising in response to complexity

While landscape redesign was a positive trend, the impact of the increasing specialisation taking place on farms is more ambiguous. It was noted in Chapter Three that there is a trend in Australian agriculture towards specialisation (Chavas, 2008). In the past, specialised agricultural businesses have tended to be conventional commodity based farm systems that have sought to maximise product quality and volume through efficiencies of larger farm size and better management and resource allocation (Richards and Bulkley, 2007). ABARE data shows that productivity growth has been higher for cropping specialists than for mixed crop-livestock specialists as well as livestock specialists for almost 30 years (Jackson, 2010). In this study, 96% of the farms were mixed cropping-livestock farms prior to 1993. Five farms (23%) had since converted to be solely cropping enterprises. In terms of the decline in sheep numbers, part of the reason for this could be due to the peaking of sheep numbers in 1990 and the wool stockpile in 1991. This led to the dramatic Flock Reduction Program which was intended to reduce the size of the national flock by 20 million head. The Flock Reduction Program enabled owners to be paid $1.80 a head for destroying sheep that could not be sold. With no other option, and with little more compensation than the price of a bullet, farmers undertook to shoot their stock. Between 1990-1992, approximately 23.5million sheep were shot, one by one, by farmers across Australia (Clarke and Jenkins, 1993 ; Rudwick and Turnbull, 1993). It was traumatic and disturbing work. CW4 remembered it as "the worst job" of his life. He was one of the

farmers who no longer has any sheep on his farm. Such emotional trauma was recorded during the livestock cull that occurred in the United Kingdom in 2001 due to an outbreak of foot and mouth disease. The complex "agricultural emotional landscapes" that farmers inhabit, where "farm animals may exist simultaneously as 'friends' and sources of food" reveals the importance of conceptual as well as physical markers of place (Convery et al., 2005 p. 99). It reveals the difficulty of 'taking the emotion out of decision making', as described in 8.3. Alternatively, it may also reflect the increased complexity of individual enterprises that is forcing some farmers to focus on one over the other. In other words, there is a knowledge based as well as economic logic to specialisation. The agro-industrial system favours capital and knowledge intensive agriculture (FAO, 2009b). While dabbling in sheep or cattle trading may have once been possible, more and more livestock enterprises require as much precision as cropping to remain viable.

Specialisation allows farmers to focus their attention and skills on fewer enterprises, potentially resulting in greater productivity and efficiency (Chavas, 2008). Interestingly, it has been found that productivity is highest for farmers aged between 55 and 60 years, potentially reflecting the value of accumulated knowledge and experience for the operation of a cropping farm (Zhao et al., 2009). Within most modern industries, implementation and management, or manual and mental labour are usually separated. In contrast, the family farm still sees mental and manual labour combined in the same person (Van der Ploeg, 2008). Meanwhile cropping systems have become more complex and intensive, requiring specialised skills to manage the technical, biophysical, financial and marketing structures (Jackson, 2010). Gray et al. (1995) quoted a farmer who showed increasing frustration at the number of roles he had to perform. The farmer said: "I can't know how to fix the tractor and know how to deal with the bank manager and understand the Chicago future market, I can't do it. Eventually you would say that one person can't do this". This was also found to be the case in the Australian tomato industry, where there was marked pressure for commodity specialisation, rather than diversification (Pritchard et al., 2007). In that industry, there was a process of re-skilling underway, where growers were moving out of diversified production of a range of commodities, towards a more complex, specialised and capital intensive production profile – partly to create the ability to cater to contract specifications. Livestock management is also more than a reflection of economic management. It reflects knowledge and decision making that has been informed by notions of husbandry, resource management and cultural values such as what it means to be a 'good farmer' (Yarwood, 2006).

Another reason for increased specialisation could be the separating the livestock and cropping enterprises as advocated in approaches to conservation farming and rotational grazing. Conservation farming involves the exclusion of livestock to avoid soil compaction. While grain may be stored and fed to livestock, no longer do the sheep graze on the crop stubble or are nutrients returned to the soil through manure. They are essentially run as two separate businesses. These approaches may in fact facilitate a transition to more specialised farming enterprise where either of these land uses is eliminated. This is because complementarity between the two activities has been removed, making the step towards specialisation easier. Complementarity results when one activity increases the marginal productivity of another and creates incentives for diversification (Chavas, 2008). In addition, as prolonged drought has seen breeding herds of sheep and cattle replaced with short term ownership of trading stock, such as steer and wethers, the emotional connection to stock has also potentially been lost. Within geography, the importance of animal-human relations is receiving renewed recognition, particularly in the United Kingdom in the context of dairy farming. For example, Convery et al. (2005 p. 99) considered the "emotional geographies" of the 2001 foot and mouth disease epidemic, while Riley explored dairy farmer retirement as a "moment which breaches the relationship between farmer and livestock" (Riley, 2011 p. 17).

It is also possible that technology is driving specialisation. As mentioned above, some land use changes are reflecting the evolution in farm technology. For example, controlled traffic farming requires large paddock layouts with long runs that minimise the number of times a tractor has to turn. In addition, satellite navigation technology is complex and requires significant skill. In a study of the adoption of precision farming practices (such as yield mapping, soil sampling and variable rate fertiliser application) in Denmark, Finland, Germany and Greece, it was found that of the 5% who had adopted such practices, the majority of respondent farms (50-60%) were focused on crop production, rather than having a combination of crop and livestock production (Lawson et al., 2011).

Mixed systems enable the farmers to integrate different enterprises on the farm and achieve synergies and efficiencies between cropping and livestock production (Herrero *et al.*, 2010 ; Villano *et al.*, 2010). As specialisation replaces diversification, a common risk management strategy, new approaches to risk management become needed. Instead of being able to rely on a mix of enterprises such as sheep, wheat and cattle, and to be able to increase or decrease activities within an enterprise depending on the season, specialised farmers have to find new means of managing risk. One approach to this is to

have what LC5 described as "key starts". This is based on the recognition that only every 3 or 4 years per decade are profitable (AS2), so there needs to be ways to maximise profitability in the good years. Having flexible systems that can be turned on or off depending on the season to capture opportunities enables farmers to maximise returns and minimise losses. "Plastic farm systems" – where farm managers constantly vary crops and inputs based on variable environmental conditions and resources – have been found to deliver higher profits and be more resilient to change (Rodriguez *et al.*, 2011). However, under climate change scenarios, this is only true for less intensive climate shifts. Under more intense climate change, the benefit of such flexibility disappears (Rodriguez et al., 2011). Other alternatives can also create new risk management options. For example, liquid fertiliser can be applied throughout the season rather than all upfront at sowing time when seasonal conditions may be hard to predict. Another strategy, as evidenced in the current research, is to capitalise on the skills farmers have already obtained, by offering contracting services to other farmers.

Another means of spreading risk, or diversifying without increasing land uses, is have multiple holdings in different climatic regions (Rebbeck et al., 2007) . The goal is to reduce farm business exposure to any single risk by investing in multiple activities that each do not share the same sources of risk (Malcolm et al., 2008). This can have advantages of potentially avoiding localised drought or flood, and also can mean that machinery and equipment can be shared between locations if the seasons don't totally overlap. That is, harvest could come earlier in western NSW, followed later by southern and eastern NSW, so machinery could be moved to follow the ripening of the crops. In this research, while several of the farm businesses included more than one property, only three farm businesses included property in a different district or area that could be said to be climatically distinct. AS3 also suggested that it is possible to specialise and maintain diversity, if each family member chooses to specialise in something different. This overcomes the other risk – of not being expert enough in an activity.

Despite the trend towards specialisation, the challenge to balance environmental and production concerns remains, particularly in the case of soil health. While some farmers had separated the livestock enterprise from cropping, or gone out of livestock altogether, several farmers were either reintroducing livestock into the system or determined to keep them part of it despite best practice tending towards separation. They saw livestock as playing a key role in nutrient cycling and ongoing system health. This observation is being reflected in some parts of the world, such as Brazil, where crop-livestock systems are

regaining their importance as a means of improving system diversity, paths of nutrient flux, and other natural processes (Carvalho et al., 2010).

Reducing the number of land uses on farm appears to be in conflict with calls for greater ecological diversity in agricultural landscapes. It is also likely that rather than moving into a more multifunctional or post-productivist mode of agriculture, production in some rural areas of large scale dryland agriculture is in fact becoming more intensified (Tonts et al., 2010). Whether this trend is occurring in less production oriented rural landscapes is not clear. Different modes of rural occupation, in spaces defined by rural amenity, small farm (pluriactive) or conservation values, may be on alternative trajectories (Holmes, 2008). In the context of productivist agricultural landscapes, Iowa again provides an interesting comparison. Farms in Iowa have become increasingly specialised grain or livestock producers since the 1950s. Iowa now has the least amount of natural vegetation remaining of any state in the United States (Brown and Schulte, 2011). Meanwhile, the shrinking of rural towns and the abandonment of rail branch lines has led to higher transportation costs and the loss of market options (Brown and Schulte, 2011). There, while specialisation seemed a logical choice originally, in the long-term farm businesses have become more dead-end than niche. Farmers have been forced to continually seek new technologies and greater economies of scale in order to survive (Brown and Schulte, 2011).

8.7 Summary

This chapter provides further evidence of what Ahnstrom et al. (2008) describes as the complexity of farmer attitudes, the importance of location and individual farmer circumstances, and the multiple factors that influence decisions. It is clear that there is much to be gained paying greater attention to ongoing implementation and change occurring on-farm, with not only theoretical but practical implications. Too little attention has been paid in the past to what ongoing implementation entails and what it means for innovation approaches more broadly. This is particularly relevant when thinking about the opportunities required for those who are already motivated to change. This chapter shows how farmers can be motivated but resource constrained. It also discusses a growing trend, beyond the case studies presented here, towards the professionalisation of agriculture. To this end, the boundaries between formal and informal knowledge and knowledge exchange are becoming less relevant, while farmer-to-farmer exchanges are becoming more organised and increasingly important. The implications of these changes for the environment will be explored in the next chapter.

9. Influencing land management and innovation

9.1 Introduction

Chapter Eight analysed and discussed the broader implications of the results presented in Chapters Five and Six. This chapter begins with analysis of the findings of research question 3 (from Chapter Seven) in relation to the experiences and views of innovative farmers on external interventions to influence their decision making for environmental outcomes government. In particular, the role of opportunity creation, not just for innovation but for sustainability is made apparent. It then explores the wider implications of the research and lessons for government efforts directed at influencing innovation and farmer decision making. The chapter is divided into four sections:

1. farmers' experiences with government funding for environmental outcomes;
2. farmers' views on a hypothetical model for payment for ecosystem services (PES);
3. what opportunities farmers would actually like or expect to see in the future; and,
4. creating opportunities for sustainability

The final section on creating opportunities for sustainability spans the three research questions and makes the case for a new approach to 'intervention' in order to create enabling environments for innovation, the need for new partnerships for new knowledge frontiers and the importance of flexible approaches for healthy landscapes. It concludes with an overview of 'what works' in enabling farmer-driven innovation.

9.2 Farmers' experiences with government funding

As explained in Chapter Three, in addition to the extension and advisory services of agricultural departments, Australian farmers can also receive financial support through subsidies, tax breaks and incentive programs. As also discussed in Chapter Three, natural resource management to optimise sustainable use of landscapes has become a focus for environmental agencies at the national and state government level in Australia (House et al., 2008). While "society" has created nature conservation and environmental programs to counter declining ecosystem health resulting from agricultural intensification and specification, it is often hard to predict how farmers will react to specific "incentive strategies" (Ahnstrom *et al.*, 2008 p. 38). Given both the increasing focus on and

investment in achieving sustainable farming practices and healthier agricultural landscapes, it is worth exploring what farmers' experiences have been with these programs. As reported in Chapter Seven, several common themes arose, including: scale and speed, flexibility, ongoing monitoring and institutional learning and subsidies.

9.2.1 Scale and speed

When it came to funding, it wasn't so much a matter of making things happen at all, but it was about making them happen more quickly and at a larger scale. It was evident from the interviews that funding usually only covered a small component of the costs of implementation. This is consistent with Cocklin et al. (2007), who found that funding is usually a small amount that only reimburses the costs of materials, not the labour contributed to do the works. In other words, financial reward was not the incentive to take action, but it provided the opportunity to make that action possible. This is an important distinction. In a study of ecological restoration of farmland in Western Australia, Abensperg-Traun et al. (2004) found that 60% of farmers would have done the work without a grant, but emphasised that they could have only done this during profitable seasons (whether this would include the season(s) after a profitable season is unclear) (Abensperg-Traun *et al.*, 2004 ; Dorrough *et al.*, 2008 ; Vesk and MacNally, 2006). This meant that, in the absence of funding, their capacity to implement restoration was dependent on the productivity and economic viability of their agricultural enterprises. Abensperg-Traun et al. (2004) concluded that given it was unlikely that there would be significant increases in government funding for rural nature conservation, a better strategy might be to seek viable alternative agricultural strategies. This would seem particularly true so long as the role of biodiversity in agroecosystem functioning and processes is not well understood – in which case it is hard to argue that biodiversity is worth investing in from a productivity point of view (Jackson *et al.*, 2007 ; Pascual and Perrings, 2007). The issue of scaling-up is not only relevant to individual farmers, but also to landscape-wide and nation- wide implementation of sustainable practices. Nationally, the challenge is to ensure that dispersed local actions can be built upon to deliver conservation benefits a wider regional scale (Fischer *et al.*, 2010). Globally, the challenge is to scale up and replicate conservation efforts in effective ways and by orders of magnitude (Rands *et al.*, 2010).

9.2.2 Flexibility

HT1, CW5/6 and CW13/14 were all critical of the "lock-up" mentality of government officers, who wanted to see land set-aside and all active management excluded. Farmers were frustrated that government officers did not recognise that active management was

required of these reserves, to promote native grass growth, control weeds and maintain resilience and ecosystem function. Leading ecologists are beginning to realise the need to move beyond a focus on set-asides and reserves, and are calling for conservation scientists to reconsider the focus of their scientific endeavours (Franklin and Lindenmayer, 2009). AS1 recalled a scientist's statement that "all governments need to do is stop promoting things we know that don't work". He felt that this was the case and that "a lot of the things our government do is about reinforcing things we know that don't work".

Though thinking is changing, funding rules are yet to catch up - to the detriment of farmers who are working ahead of the science and outside the usual land management prescriptions and the "regulatory based fences and fines paradigm" (Sommerville et al., 2010 p. 1262). Though a different context, considerable research has been undertaken into the exclusion of people from protected areas in developing countries. See for example Bray and Velazquez (2009), Fisher et al (2008), Shrestha and McManus (2008), Brockington and Igoe (2006) and Zimmerer (2006). In these cases, resettlement is often forced and exclusion is absolute, not just from part of a property, but from a whole area. The problem arises from a similar source – the interpretation of conservation as requiring the exclusion of humans from resource use (Fisher et al., 2008). That being true, thinking on the people-nature relationship has evolved significantly over the past 50 years (Fisher et al., 2008). Though his work is now 15 years old, I would argue that Cronon (1996 p. 24) still provides a particularly insightful overview of the contested and moving definition of nature in western culture; on the "meaning of nature in the modern world", and how people might reflect on "the peculiarly human task of living in nature while thinking themselves outside it" (Cronon, 1996 p. 459). Over time this thinking will hopefully gain greater currency within environmental policy circles.

The other sore point, particularly for CW2/3 and LC7, was that while the CMA would no longer allow the management practices they had undertaken to improve native grassland condition, they were being held up as examples for the rest of the farming community by the very same CMA. For the example of pasture cropping, some sites and publications targeting farmers make the point that it can be illegal in native grasslands (see for example (VVPCMN, 2010). There was also a debate as to whether pasture cropping was legal in a New South Wales parliamentary committee in 2006 (Parliament of NSW, 2006). However, the impacts of outlawing this method, even when it is used for grassland restoration not grain production, does not appear to be addressed in any literature. Unfortunately, now under Clause 28 Policies of the Native Vegetation Regulation 2005, pasture cropping is

now only allowed on 20% of the extent of native groundcover on a property, and this is subject to a Property Vegetation Plan (NSW Government, 2011). As LC7 said, the government had "used this place, they have brought people out to this place to show what you should do, but under the present rules I couldn't have actually done what I have done". The fact that this was experienced by more than one farmer indicates these are not isolated incidents. The connection between pasture cropping and a real environmental outcome has clearly not been made by the CMAs and only erodes trust and adds to farmer scepticism of the poor level of skill and understanding of government staff.

Several farmers were quite critical, particularly about Catchment Management Authorities, when it came to a lack of flexibility in the rules and eligibility requirements for funding. They felt more comfortable with community led organisations. Such organisations may possess greater social capital and 'trustworthiness' in comparison to government led programs (Marshall, 2009). Regional NRM organisations have been expected to deliver high levels of voluntary cooperation. However, it is important to recognise that just because an organisation is regionally based doesn't guarantee that it will foster community ownership. This requires overcoming barriers such as lack of trust and the perception that these regional bodies are merely extensions of government (Marshall, 2008). Building trust is made more difficult by the pressures put on CMAs to be efficient bureaucracies and to fulfil compliance roles. Farmers will reciprocate only when governance structures value their input rather than being dismissive or worse, using cooperative strategies against them (Marshall, 2008). Within regional organisations, capacity needs to be built to deliver lower level responsibilities without over-stretching or under-utilising staff or triggering conflict and demoralisation (Marshall, 2008).

There were also fears that increasing regulation would further limit farmers' ability to flexibly manage their land, particularly where time and resources had been invested to improve the environmental condition. The lack of flexibility in funding rules and fears for increasingly stringent rules and regulations is unfortunate. Flexibility and trust have been found to be extremely important for rural networks and for agricultural innovation (Oreszczyn et al., 2010).

Cocklin et al. (2007) also found that conditions for the success of voluntary mechanisms included flexibility in timelines and rules for funding, continuity and adequate funding, protection in terms of legal liability and long term planning. Research conducted by Hatfield-Dodds and Proctor (2008) also found that stewardship payments were most

successful when delivered through flexible outcomes-based mechanisms. Such mechanisms would:

- Give priority to supporting innovative approaches to delivering environmental outcomes;
- Explore both farm-level and regional-level approaches for enhancing conservation outcomes; and,
- Focus resources on activities providing the highest environmental returns per dollar.

LC5 and LC6 were critical of the CMA focus on targets. In NSW, thirteen Catchment Management Authorities are responsible for natural resource management at the local level. Each has its own Catchment Action Plan (CAP) complete with a mission statement and targets for natural resource management within the catchment for which they are responsible. The Central West CMA's CAP has targets for salinity, water, vegetation, biodiversity, soil, people and community and cultural heritage. For example, the high level target for vegetation is "by 2016, 1,200,00ha (13%) of the catchment area is managed primarily to maintain or achieve optimal native vegetation condition, and all vegetation types are represented in the catchment". A lower level target is that "by 2016 there will be an increase of 100,00 ha of sustainably managed native grass-based production systems in the catchment" (CWCMA, 2006). In total there are 7 targets involving a cumulative total land area of 3,260,000ha. Recognising that there will be elements of overlap in terms of the land area concerned with the targets, these targets potentially cover around 40% of the catchment area. The majority of this land is privately owned, meaning that there is a strong reliance on landholders to implement the management activities required by the CAP.

In all fairness, CMAs are working to develop better Catchment Action Plans. However, there is still a need for more coherent regional plans built upon the best available science and local knowledge to provide a clear set of investment priorities and to regulate resource use (Hatfield-Dodds and Proctor, 2008). Regional organisations have an unfulfilled potential. They have the opportunity to tailor conservation programs and projects to harness the energies and motivations of local farmers. In doing so, they can play a critical role in the delivery of effective conservation policy that builds on rather than suppresses regional differences (Greiner and Gregg, 2011). The problem is that while the CMA has responsibility for the development and implementation of regional plans, the bilateral agreements that exist between State and Federal Government in effect provide a 'terms of reference' for the plans that must be followed (Wallington and Lawrence, 2008). This need

for CMAs to be business entities accountable to higher levels of government, at the same time as it is expected to engender community ownership and involvement, can create its own set of tensions (Wallington and Lawrence, 2008).

For many land management practices, complexity and uncertainty are inherent. Therefore, the best response may be to devise approaches that can cope with these inherent aspects, rather than try to remove them - for example, through greater linkages to technically relevant information, longer term funding cycles, flexibility in approach and process and feedback over time to learn from mistakes.

9.2.3 Ongoing monitoring and institutional learning

While increased regulation and reduced flexibility were not welcomed, having ongoing monitoring that served an advisory rather than compliance function was welcomed by farmers. Record keeping, monitoring and planning requirements were seen to be helpful in triggering a process of questioning existing practices. This was reflected in a study of Environmental Management System (EMS) participants in Victoria, which found that EMS worked better as a process for environmental planning and for business management, rather than as a marketing tool – not least due to lack of consumer demand (Higgins et al., 2007). The researchers argued that such record-keeping can be important in making the invisible visible through the process of encouraging farmers to reflect on their management.

The emphasis on using monitoring for the purposes of gaining knowledge and seeking advice rather than tested compliance was important. Again, there were fears about having "people crawling all over your place once you put it up to be funded" (CW1). As also discussed in Chapters Five and Eight, concerns were raised that researchers would begin a trial and then suddenly discontinue the work without communicating any reason to the farmer. There was a clear sense of disappointment that the funding bodies weren't taking notice of the achievements made possible by the funding. In addition, the lack of follow-up was felt to also reflect a lack of institutional learning off-farm.

Part of the problem is simply that funding and evaluation cycles are conducted over three to five year times spans, while significant change in some farm management practices may be measured in decades or even generations (Barr and Cary, 2000). This was consistent with the views of the agricultural sector participants, as previously described. For example, AS1 agreed that the CMAs have a problem as their funding has been

drastically cut and "what was a really good model that had lots of potential, typical government, after six years 'that will do' and pulled the plug and all it does is harvest community capacity and good will". AS4 wished he had more time to see the results of the agronomy trials he was conducting, as well as more researchers to work in the area. AS1 also felt that the "thing that kills anything is the three year funding cycle, that's an absolute killer for multiple reasons". These comments point to an underlying problem of communication between program managers and landholders and a lack of capacity within organisations to learn and evolve, progressing their understanding and program development. In its December 2010 review of Catchment Management Authority progress in implementing their action plans, the NSW Natural Resources Commission recommended that the NSW Government implement adaptive management across government "to build-on and share what is working and avoid re-inventing the wheel" (NRC, 2010 p. 50). There was recognition that there remains a need to "institutionalise system wide learning and improvement" (NRC, 2010 p. 51). It remains to be seen if this recommendation is adopted.

In an assessment of the capacity of regional NRM bodies, Fenton and Rickert (2008) found that the majority of regional NRM bodies were of the view that they had an adequate community engagement strategy which guided their decision making. They also judged themselves to have an effective local facilitator network to assist in building partnerships, community awareness and capacity. Regional NRM bodies also scored themselves highly on the quality of the engagement process based on criteria of trust, transparency, inclusiveness, cooperation and commitment. These views are in contrast to those of the farmers and non-farmer agricultural professionals interviewed in this study. This could partly be because the Fenton and Rickert (2008) study is based on self-assessment by regional NRM bodies, Australian, state and territory government representatives. If the Fenton and Rickert (2008) study is reflective of a wider lack of awareness within regional NRM bodies of capacity and engagement issues then this is cause for concern. This self-perception of NRM bodies also contradicts the findings of Robins and de Loe (2009) who reviewed decentralised governance for natural resource management in Australia. They found capacity development challenges to be "pervasive" across human, social, institutional and economic measures (Robins and de Loe, 2009 p. 191). They concluded that all levels of government could do more to support decentralised organisations through strategic capacity development. Marshall (2008) also writes about "a legacy of mistrust in government" and how this loss of trust has often carried over to regional bodies such as the CMAs. Recent state government regulatory approaches to water policy

reform and restricting farmers' rights to clear native vegetation on their properties have exacerbated these "trust problems" (Marshall, 2008 p. 38).

9.2.4 Subsidies

In regard to funding and subsidies generally, there were mixed views. While CW1 and CW5 (both female farmers) felt that if something is worthwhile, then it was worth paying for, others felt that it was inevitable that grants and subsidies will be required, particularly where conservation practices are implemented at the expense of production. Payment would need to be for an action that was additional to 'business as usual', rather than a subsidy just for good farming practice. As noted in Chapter Eight, this is similar to a study of farmers in the Tamar region in Tasmania, by Hajkowicz and Collins (2009 p. 100), where farmers viewed good soil management as "just part of the farm business". These farmers were therefore reluctant to identify soil conservation works or many other activities with private benefit as stewardship services that could potentially be eligible for incentive payments.

HT1 expressed this concern well when he said "if someone kept propping us up we are not going to perform". This is a valid concern. Within the literature there is debate over the value of voluntary mechanisms and the danger of creating perverse incentives. Voluntary approaches are considered most suitable for encouraging desired actions which are not classed as being a legal or moral duty (Hatfield-Dodds and Proctor, 2008). Meanwhile, economists warn that providing a payment for an activity that previously has been undertaken voluntarily, through formal institutions such as regulations and incentive payments, creates an extrinsic motivation that can crowd out the intrinsic motivation (Reeson, 2008 ; Reeson and Tisdell, 2010). This makes sense, in that policies that provide a monetary reward for conservation actions need to avoid reducing farmers' intrinsic interest in undertaking conservation programs (Farmar-Bowers and Lane, 2009). However, it seems illogical to favour those who have not invested in resource management, and to not provide resources and support to farmers who are pioneering ways to improve environmental and production outcomes on their farms; practices which need to be progressed further and implemented more quickly and on a larger scale. The conservation of native biodiversity on farms requires ongoing decisions to ensure the perpetual maintenance of native habitat (Farmar-Bowers and Lane, 2009). These incur costs that cannot be recovered. Substantial improvements in conservation performance generally only come about through reductions in agricultural production, and this will necessarily incur financial loss when applied over large spatial scales (House et al., 2008). Over the

long-term, unsustainable practices may lead to productivity losses, but in the short-term, action to change farming systems can be the greater cost. Such costs to the individual farm enterprise need to be recognised financially – particularly in an export oriented market like Australia's agricultural industry, where producers are not in a position to pass on these costs to consumers (Hatfield-Dodds et al., 2006). The good news is that effectively designed financial incentives may in fact "crowd in" intrinsic motivations - if they support existing voluntary efforts and recognise competence and the importance of an activity. They also need to be perceived as supporting rather than controlling (Reeson, 2008 p. 18).

9.3 Provision of and payment for ecosystem services

In Chapter Three, the concept of payment for ecosystem services was introduced. PES has been proposed as a way to create a value or reward for the conservation of biodiversity and other 'public goods' on private land. It has also been promoted as a potential way to improve the profitability of agriculture. In this research, a model for PES was presented to farmers in order to better understand their views on such incentive systems. The model (see Figure 4 in Chapter Four) included new markets for ecosystem services such as water, carbon and biodiversity. Given that these farmers are implementing conservation farming and redesigning property layout for environmental and production outcomes, it was expected that they would be in support of payment for ecosystem services. Instead, views were mixed and seemed strongly influenced by the history of government incentives, which tend to come too late for early actors. While some welcomed the idea, significant and valid concerns were also raised in regard to flexibility, ineligibility, the threat of outsider involvement and introducing more enterprises into the farm system.

9.3.1 Design flexibility

As with past funding experiences, or perhaps because of them, flexibility was again an issue. There was a concern that entering into a contract to provide ecosystem services could constrain the management options available to the farmer. There were also concerns about rules changing over time – understandable given the history of changing legislation and government organisations in regard to land management in New South Wales. These findings are similar to those by the Queensland Department of Employment, Economic Development and Innovation (DEEDI). Working in conjunction with a range of organisations, the Department held seven workshops in 2010 on carbon markets across Central Queensland involving 126 grazing business participants. Participants were found to be concerned over the duration of contracts, the possibility of rules changing in the future once contracts were signed, and the liabilities associated with losses due to

uncontrollable events such as fire. They concluded that very few Central Queensland cattle producers were likely to participate in a carbon trading scheme unless there was greater clarity on accounting, trading rules and contract frameworks (DEEDI, 2010). McBride et al. (2007) similarly found that lack of budget certainty could compromise conservation outcomes. In 2003, the Land Stewardship Project 10 in Victoria, Australia also surveyed farmers' preferences for policy instruments in a series of workshops (Cocklin et al., 2007). Farmers' first preference was for voluntary and education policy instruments. However, the authors concluded that successful voluntary mechanisms would require flexibility in timelines and rules for funding, in addition to protection in terms of legal liability and continuity of funding. Another study in 2007 in Central West NSW also found farmers to have mixed views about the CMA's incentive program. While some viewed it as creating a positive opportunity, others felt that the program lacked the flexibility needed to cater to the needs of different business enterprises (CSIRO, 2007b).

9.3.2 Ineligibility for payments

In this research, while financial recognition was generally popular, there was a common expectation by the farmers that they themselves would not be eligible. They held the view that such payments would not go to the farmers already working to protect the environment, but would instead go to the farmers who had not yet changed. This is consistent with the trend for existing conservation markets (and incentive systems) to be ad hoc, short-term and of limited scale and participation (Yang et al., 2010). It also is valid given that, under current PES concepts, the criterion of additionality may prove a barrier for participation by early actors. Additionality means generating additional action above and beyond that which would have occurred anyway. Lack of additionality means "paying for activities that would have been conducted anyway" (Engel et al., 2008 p. 668). This creates financial inefficiency for a program because it buys less ecosystem services per dollar. The problem is that the additionality rule can favour late comers, while early actors can be penalised indirectly, because they have commenced an action before the incentive program is put in place. The solution is to develop differentiated and targeted payments that both maximise additionality and avoid perverse outcomes (Engel et al., 2008).

Chapter Three described how the Australian Government's Caring for Country program has funding to assist "at least 30 per cent of farmers to increase their uptake of sustainable farm and land management practices that deliver improved ecosystem services" (Commonwealth of Australia, 2011d). This program does not make any mention of assisting farmers who have already taken up sustainable farming practices to progress

them further. These approaches are partly informed by fears of 'crowding out', where extrinsic take over intrinsic motivations. The general principle is that compensation should not set up incentives for strategic behaviour that jeopardises good environmental outcomes (Commonwealth of Australia, 2010a). Yet neither should compensation penalise intrinsic motivations. In reality, it seems that the main 'crowding out' is that of early implementers, who have already invested their own time, ingenuity and resources, only to see late comers given financial assistance and benefits to undertake the same actions once results are proven.

To avoid perverse outcomes or a 'welfare mentality' arising from incentive payments, various proponents have suggested a 'duty of care' concept. In the 2010 report on Australia's Future Tax System Review, the option of an "environmental duty of care" was raised (Commonwealth of Australia, 2010a p. 368). However, no specific recommendation was made in the report. Therefore no Government response was required in relation to it. The question is whether farmers should be paid to satisfy a duty of care, or when they exceed it. Under the Wentworth Group of Concerned Scientists' proposal for a "catchment care principle", where farmers would be assisted to protect "above average" amounts of native vegetation – beyond what would be expected by a duty of care (Wentworth Group, 2003 p. 7). The principle calls for responsibilities of natural resource managers to be linked to an agreed ecological benchmark rather than simply reflecting current social preferences (Hatfield-Dodds and Proctor, 2008). This type of duty of care could help address the problem of penalising innovative farmers. They would already be above the baseline, eligible for compensation and not penalised for having already acted to increase the ecosystem services provided by their land. They would also not see their competitors compensated for actions that they paid for out of their own pocket. This would also be consistent with Cocklin et al's. (2007) recommendation that, to be successful, incentive programs need to include appropriate recognition and reward for early actors.

The challenge with establishing a duty of care is determining the baseline. It needs to reward early action, but not create a perverse subsidy. It needs to create an incentive for action, but not impose undue additional costs on landholders – costs that landholders will be unable to pass on as they compete in global commodity markets. Most importantly, any standard must allow for the adoption of flexible and innovative approaches by landholders (Commonwealth of Australia, 2010a). Likewise, a 'duty of care' or stewardship ethic that landholders may be assumed to possess should not be used as an excuse to simply offload responsibility of implementation for public good outcomes on to private

individuals (Wallington and Lawrence, 2008). As explained in Chapter Three, such a devolution of responsibility under neoliberal approaches has already been underway (Lockie et al., 2006). Another example of baseline setting is provided by the Australia Soil Carbon Accreditation Scheme, a non-government initiative for the voluntary carbon market. Designers of the scheme proposed it would be based upon annual retrospective payments (paid per hectare) given progressive increases in soil carbon above a baseline. The baseline would be determined through measurement of carbon sequestration rates within a defined sequestration area. Applying a 100 year rule, payments would be 100th of the 100 year rate (Jones, 2007). Such long time frames are not unusual for carbon schemes. For example, the Australian Government's proposed Carbon Farming Initiative has a 100 year timeframe over which carbon stocks must be maintained because "sequestration is generally regarded as permanent if it is maintained on a net basis for around 100 years" (Commonwealth of Australia, 2011a p. 63).

One determinant of the long-term success of community-based natural resource management interventions is the degree to which the distribution of costs and benefits is perceived to be fair by the local people (Sommerville et al., 2010). Sustained positive social benefits are required. While PES may not be strictly a community based approach, it could be possible that eligibility criteria perceived as unfair may impact negatively on social cohesion and the success of the program.

9.3.3 Outsider threat

There was also a concern that signing up to a PES scheme would result in outsiders or 'external people' from government coming to the farm, and essentially a loss of control over access and privacy. It was interesting that even farmers who are innovative and implementing practices that have environmental benefits are nervous of outsider influence. Several farmers in this study were also nervous of endangered species identification, even though at the same time they were working to increase the number of species and diversity on the farm. They did not want further regulations or constraints on their decision making ability.

This reluctance for outside interference and distrust of government is not unique to NSW farmers. In a study of sheep and cattle producers in Western Australia, Palmer et al. (2009) found farmers hesitant to trust government sources on biosecurity and animal health, with the impact that scientific institutions linked to the government also suffered from lack of trust and credibility. In a survey on environmental regulation, farmers from across Australia

were found to "prefer fewer incursions into on-farm management" indicating an area where governments "may lack legitimacy and trust" and the need for strategies to reduce this distrust (Bartel and Barclay, 2011 p. in press). This distrust is not only an Australian phenomenon. Ahnstrom et al. (2008) found that in the United States, there was a fear among farmers of losing control over the land though regulation, and as a result of this fear, 56% of US farmers would not allow a biological survey of their land. Likewise, there was concern about the potential for official identification of endangered species on their land that may limit decisions in management.

As Bartel and Barclay (2011) explain, such attitudes may reflect a tendency for property rights in agriculture to be interpreted as being absolute. Therefore, any impediments to land management imposed by regulation may be viewed as an incursion on the property right itself. While many of the innovative farmers interviewed in this research seemed more comfortable reaching out for expert advice and engaging with government agencies, there still seemed reluctance for that to translate from an advisory service into something more like interference on the farm itself. It could also relate to what is often referred to as the urban-rural divide - where farmers can tend to view 'city people' in a negative light (Witt et al., 2009). Botterill (2009) describes the pervasive belief in the goodness of country life as a result of "residual agrarianism in Australian culture" (Botterill, 2009 p. 60). Agrarianism dates back hundreds of years and is a characteristic of many developed countries. Without going into too much detail, in essence the belief is that agricultural life is good and natural and agricultural pursuits inherently worthwhile, whereas city life is artificial and corrupt. It was manifested in Australia as "countrymindedness", accompanied by the perception that "the ethos of rural Australia" is "somehow different from city life" (Connell and McManus, 2011 p. 18). While political influence has waned and countrymindedness as a national ideology has declined, it has cultural influence particularly in rural areas, including in NSW and Queensland. It has also retained influence in the core visions of the National Party (a political party that replaced the former Country Party) (Connell and McManus, 2011). The result is that certain areas of rural policy tend not to receive the same scrutiny as that for other sectors. Therefore political parties like the National Party and interest groups like the National Farmers Federation continue to rely on agrarian imagery to promote their agendas. The problem is that this approach can limit critical debate and thoughtful reflection and does not always deliver the best long-term policy outcome for the farming communities these groups purport to represent.

9.3.4 Too many land uses

Resistance to PES can be logical from a landholder's point of view, based on hidden costs that are not immediately apparent in an assessment of opportunity costs, such as knowledge requirements and management challenges of land use change. In regard to the suite of ecosystem services outlined in the model, the common response was that it would not be viable to incorporate so many new enterprises into the farm business. There was a sense that there was not enough time in the day or resources available at present. As previously explained, farmers are seeking to specialise and reduce the complexity and knowledge burden of the enterprises that they currently operate. This could be the reason that renewable energy was viewed the most favourably by participants. Farmers could anticipate that incorporating wind or solar power on their farm would not materially impact on other land management decisions or require learning about a whole new land use. It is difficult to determine the existing uptake of renewable energy in rural areas. According to the ABS, Australia's production of renewable energy is increasing (by 41% between 1975–76 and 2007–08). However, in 2008, renewable energy still only accounted for about 5% of the total energy produced. Of this 2008 amount, 72% came from biomass, 15% from hydro-electricity, and 7% from wind and solar. Electricity generation from solar photovoltaic cells is growing quickly, however, it still starting from a very low base, so energy volumes from this source remain small (ABS, 2010). Also, in May 2011, the NSW Government announced the closure of its popular solar panels rebate scheme (Salusinszky, 2011). By June 2011, due to widespread and organised resistance to this action, the government was forced to back down in a confused stance (Woodburn, 2011). Even the prospect of retrospective changes to legislation that essentially undermine legally binding contracts does not inspire confidence in government commitments.

Biodiversity and carbon were both 'maybes' more than an outright yes, mostly because farmers either felt that this is something that should be done anyway, or that they wouldn't get paid for it because they were already doing it, as discussed above. Water barely rated a mention, not surprising given that water scarcity was a dominant issue. Sustainable timber was not really seen as an option by anyone due to constraining factors such as low rainfall, poor infrastructure and distant markets. It could also be assumed that because agroforestry requires a different set of skills and techniques compared to traditional agricultural land uses, then it would impose a greater management burden on the farmer.

Farm forestry makes up only a small percentage of land use in Australia (Maraseni and Cockfield, 2011). Timber plantations tend to be most profitable in high rainfall areas. Even then, cultivation and pasture can be more profitable land uses. In addition, the costs of establishment are up-front while the benefits may be decades away, leading to heavy discounting. A carbon price of $10 or more would potentially reverse this relative lack of profitability. Where time is a factor, the quicker returns from cropping and livestock keep the balance in their favour (Maraseni and Cockfield, 2011).

Tonts and Black (2003) found that farm plantation forestry could have both positive and negative outcomes, depending on the policy and planning framework. Well planned and managed farm forestry can combat environmental problems and provide a new income stream for farmers. Poorly planned and managed farm forestry can cause the local economy to shrink, population to decline and levels of social interaction to decrease. It is up to rural planning measures at local and regional levels to mitigate these negative impacts and reduce growing community anxiety about farm plantation forestry. Stewart et al. (2011) also explored the contested social landscapes of plantation forestry. They examined the promotion of blue gum plantations at the expense of dairy in Victoria. They study found that such a strategy, of promoting an industry with low potential to value add over one with high potential, did not help with job creation or local economic growth. The community also held negative views, not least the fear of rising land prices, depopulation and the loss of local businesses and services. In another Australian study, farmers did not embrace the concept of growing trees. They saw themselves as producers of food and fibre rather than tree growers. There was also the view that the less land 'locked-up' for native vegetation protection, the better the value of the farm upon selling (Valbuena et al., 2010). Similarly, farmers had concerns over feral animals and kangaroos increasing in numbers due to increased forest shelter.

It may be that other businesses within the conservation industry take up the opportunity to receive payments for ecosystem services. This is already evident in the voluntary carbon market, where Australian companies such as CO2 Australia have established themselves as carbon managers. They now have more than 16,500 hectares of "carbon sink plantings" under management across Australia (CO2 Australia, 2011). Another business, Carbon Conscious, plants Mallee Eucalypt trees to create "large scale carbon estates" in the Australian wheatbelt, for the generation of carbon credits (Carbon Conscious, 2011). This follows what Yang et al., envisage as a "mature conservation industry" – one that

comprises many investors and producers, as well as service providers supported by institutional and regulatory systems (Yang et al., 2010 p. 681).

The challenge to multiple land uses does not necessarily spell the end for aspirations of mulitfunctionality. Multifunctionality can occur at both macro and micro scales. It is not defined by scale but by the interactions and synergies between the level of farm, landscape and region (Renting et al., 2009). The issues described above may warrant consideration of a catchment rather than farm scale approach to multifunctionality. The suite of land uses could be incorporated across a larger scale, while individual farms focus on doing one land use well. Likewise, set-asides or reserves may be more successful across several properties, with management requirements shared between a pool of farmers. Indeed, if agriculture becomes increasingly intensified, such an approach may be essential (Dorrough et al., 2007). As previously identified, an important policy challenge is that payments for services such as carbon sequestration are not likely to alone be able to transform unsustainable systems into sustainable ones. Like most payment for ecosystem services, they are more likely to have a positive impact in an enabling economic and institutional context (Antle and Stoorvogel, 2008).

9.4 What do farmers want to see in the future?

Given the mixed responses by farmers to existing funding programs and the hypothetical PES scheme, the question that follows is what do farmers actually want to see happen in the future? As reported in Chapter Seven, responses related to four key themes: environment, economics, knowledge and resources.

In terms of what farmers wanted to see from an environmental point of view, issues such as ground cover, the better use of biology and native species were raised. It was interesting that only farmers from the Central West area mentioned composting, pasture cropping and other environmental innovations. Non-Central West farmers raised issues such as finance, efficiency and precision. One reason for this could be the season and the timing of the interviews. They were in the lead up to harvest, during the crucial months of August and September, when rain can make or break a winter crop. During 2009, for many areas in southern NSW, the rain was not coming and farmers were facing the prospect of having nothing to harvest come November. Most parts of the state, including the central western slopes, around Dubbo, Wellington and Forbes and the central western plains, around Nyngan and Coonamble, were all receiving average rainfall for winter in 2009. Other parts of the state were receiving below average rainfall. In addition, winter 2009 was

the second warmest winter on record for average maximum temperatures (Bureau of Meteorology, 2009b). Come Spring, many parts of the state were again receiving below average rainfall, including the Central Tablelands, around Cowra and Orange, the central western slopes, around Parkes and the southwest slopes around Grenfell. In the Riverina, Griffith was also receiving below average rainfall. It was the 10th consecutive spring in NSW with above average maximum temperatures and the 3rd warmest on record for average maximum temperatures (Bureau of Meteorology, 2009a). The Central West was having a slightly better season, hence farmers may have been less preoccupied with financial worries.

In terms of knowledge, there was a desire for better scientific advice on natural systems and environmental factors such as those raised above. The desire for increased opportunities for learning and transition to new management practices was also identified in Blay-Palmer's (2005) study of the organics industry in Ontario. Learning opportunities were one of the key actions identified as necessary to foster innovation. The environmental and knowledge related issues that farmers raised match the recommendations of the IAASTD (2008) assessment, which included more diverse funding mechanisms for agricultural research and development and associated knowledge systems, such as:

- Public investments to promote interactive knowledge networks (farmers, scientists, industry, and actors in other knowledge areas); and,
- Improved access to a range of sciences, including ecological and complex systems' sciences.

Economic proposals revolved around getting more consistency in income and reducing some of the risk and variability that comes with unpredictable seasons. This was similar to the views of participants in a study by Cocklin et al. (2007) where participants expressed a preference for improved economic conditions rather than government payments for delivery ecosystem services This is similar to the results of this study, where top of the wish list was "rain" and "a couple of good seasons" to allow farmers to "get ahead". Financial incentives were not the most popular suggestion, which differs from the findings of a survey conducted in three regions of northern Australia (where lack of rain is less of a problem, especially in the wet season). In this study, Greiner and Gregg (2011) found that financial incentives were considered the most useful by farmers for removing constraints to the adoption of conservation practices on-farm. This was followed by recognition, planning instruments and research and extension. What these findings have in common

with the northern Australia study is the low ranking given to government regulation. Greiner and Gregg (2011) found that while regulation was recognised as necessary, it was rated as the least effective practice.

In terms of resources, more water was on everyone's list, as well as resources like fence posts to make change happen more quickly. Again this was similar to the findings of Cocklin et al. (2007), where it was reiterated that sometimes the best help is funding for simple things such as fencing off watercourses, shelterbelts and small pockets of endangered trees. The variety of knowledge, environmental, economic and resource related suggestions from farmers demonstrate that they are not simply looking for "silver bullets", as AS2 said, but rather are taking a more pragmatic approach.

9.5 Creating opportunities for sustainability

The desire for more sustainable agricultural production systems has a long history, pre-dating many other areas where sustainability has become an issue in recent decades (Rigby and Bown, 2003). However, sustainability won't just come from innovations in technologies or practices. It also comes from innovations in processes, and in organisational capacity and policy development (IAASTD, 2008). In other words, it also comes from the institutions that govern human behaviour. In the 1960s, Myrdal (1969) explored how the egalitarian principle was framed in such an abstract way that it allowed society to adopt the ideal but turn a blind eye to the reality (Myrdal, 1969). Unless we find practical ways to articulate and embed the principles of sustainability, we risk doing the same thing in this generation. This is no small task – it requires nothing less than bringing "sustainability to a species that has not known it since it manufactured its first tool" (Flannery, 2008 p. 64). A wider transition towards a more sustainable agriculture will not occur without more explicit external institutions and financial support (Pretty, 2008). We need more practical policy actions and greater applicable knowledge on agro-ecological systems (Dorrough et al., 2007). As has become clear in this research, there are farmers who are seeking such knowledge, finding answers that science alone can't give them, that can only be delivered through application, experimentation and observation at the farm level. Such actions should be fostered, not frustrated by government interventions.

9.5.1 Rethinking intervention – enabling innovation

Chapter Two explained that a central factor in the theory of planned behaviour is the individual's intention to perform a given behaviour (Ajzen, 1991). Another key factor is the level to which the intended behaviour is under an individual's control and their perception

of this control. The theory also recognises that control is limited by non-motivational factors such as the availability of requisite opportunities and resources (e.g., time, money, skills and cooperation of others). To the extent that a person has the required opportunities and resources, and intends to perform the behaviour, he or she should succeed in doing so (Ajzen, 1991). These factors could be described by what Sarver referred to as "the context of opportunity" (Sarver Jr, 1983). Such a context is crucial and yet poorly understood. Similarly, within the innovation systems literature, there is recognition of the importance of an appropriate enabling environment for innovation (Douthwaite, 2006 ; Hall, 2007 ; Klerkx and Leeuwis, 2008b ; Spielman *et al.*, 2008). As Douthwaite (2006) writes, enabling innovation requires "building on peoples' ingenuity and motivations, rather than working against them" (Douthwaite, 2006 p. 93). In the context of rural development and agricultural innovation systems, Hall (2007 p. 8) laments that there is still a "large gap between what is known about enabling innovation for development and what is evident in mainstream policies and practices".

Traditionally, intervention in the agricultural and environmental policy context has meant seeking to change the motivations and behaviour of farmers to ensure they deliver outcomes desired by the policy makers. It follows that understanding of decisions and motivations is sought to inform "outreach programs" (Brodt et al., 2006 p. 90) and "overcome some of the barriers identified by change agents" (Rodriguez et al., 2008 p. 90), in order for agricultural extension to "be effective in addressing natural resource management issues" (Vanclay, 2004 p. 213). Nationally, the Landcare Program had a philosophy of intervention based upon awareness raising and education. Voluntary approaches were built around the government taking a lead role in research and development of conservation practices and then encouraging farmers to adopt them (Marshall, 2008). As natural resource management become increasingly regionalised and responsibility delegated to catchment based organisations, interventions have been built around grant-based financial incentive systems (Greiner and Gregg, 2011).

Internationally, interventions are just as popular, as seen in the World Bank's report on agricultural innovation, where 'principles for intervention' are given (World Bank, 2006). Even from a systems approach, intervention is a key focus. For example, Midgley (2000) writes about the philosophy, methodology and practice for systemic intervention as does Dodgson et al. (2010), who decry the lack of focus on systemic failures and the "dynamic, emergent, and evolving nature of systems" in policy interventions (Dodgson et al., 2010 p. 4). It is much harder to find notions of intervention that seek to allow the better

expression and embedding of existing behaviours. Perhaps this situation has arisen because the focus has been on the point of change itself as the end goal. From the point of view of farmers adopting technological change, the emphasis has generally been on:

- One technology at a time – which doesn't help when the innovation is not a technology, but a group of technologies, not information, but a way of thinking, nor where farmers are working on the edge of what is "known" or seeking to introduce system wide changes incompatible with existing practices;
- Adoption as a singular event rather than an ongoing process of change and continuous adoption – though the literature acknowledges adoption as a continuous process rather than unique to a point in time, more often than not, decision and behaviours are represented as a linear one-way action; and,
- Obstacles to the action, prior to it being made – expending a lot of effort understanding motivation, at the expense of finding out about the obstacles that occur after the action, post-adoption, in the lead up to further refinement. We cannot assume that opportunities persist or that, where progress is being made, a transition to sustainability is locked in.

Rather than focus on interventions, more thought is needed into how to bring to fruition enabling environments for effective expression of behaviours and effective interactions. Creating an enabling environmental requires targeted agricultural and fiscal policies that shift the incentive structure towards stronger sustainable agriculture systems (UNCTAD, 2010). Chapter Two examined the literature on innovation and the fact that innovation capacity is evolutionary (Hall, 2006). Hall (2009) suggests a shift in focus from the supply of knowledge and technology to the capacity and conditions for innovation. Interventions to strengthen innovation capacity include creating stronger "patterns of interaction across the whole range of actors involved in innovation" (Hall, 2009 p. 36). This requires creating the space for a diversity of interactions to occur. This is a challenge for policy and institutional design, which too often stifles rather than fosters heterogeneity. As a general rule, it is well known that a single policy instrument should be used to target a single (not multiple) objectives (Commonwealth of Australia, 2010a). Yet, policy support of innovation is not the outcome of a single policy but of a set of policies that work together to shape innovative behaviour (World Bank, 2006). The challenge for policy makers is to take a broader perspective in evaluating impacts if they wish to create a policy environment that facilitates innovation. This is typical of long-term policy problems, which pose a difficult class of challenges beyond the scope of single parliaments, political tenures and even

generations (Sprinz, 2009) Yet, by their very nature, sustainable development problems display characteristics of fundamental complexity and uncertainty (Hector et al., 2009).

Innovation frameworks need to enable the continuous adjustment of institutional arrangements and patterns of partnership in response to ongoing learning and changing circumstances (Hall, 2006). A dynamic system of innovation would be the result of an "opportunity-driven system" where a high degree of public and private interaction and collaboration would occur. The system would be "agile, responding quickly to emerging challenges and opportunities" (World Bank, 2006 p. x). According to Spielman (2005), the role of public policy should be to enable an innovation system to remain flexible and diverse enough to avoid becoming locked into a single trajectory. It should create incentives for innovative activity, and create institutions that respond to and learn from the innovative process. As has been shown by this research, flexibility in both government policy and funding has been a common concern for farmers. Like one farmers concern, reported in Chapter 7, "my worry about innovation is that you have got to be flexible enough" (CW1).

Government funding frameworks and advice could become one component in a broader strategy to facilitate opportunities, rather than create or dictate process. Such interventions that build on success or nurture success are more likely to deliver a stronger system (World Bank, 2006). Given this research and the literature above, it would appear that policy interventions are likely to be more successful if they:

- Reward innovators rather than penalise innovators
- Facilitate knowledge networks
- Deliver appropriate resources
- Are based on outcomes rather than processes
- Seek to create opportunities for those who are motivated, rather than seek to change those who don't want to change

9.5.2 New partnerships for new knowledge frontiers

The 2008 International Assessment of Agricultural Science and Technology for Development (IAASTD) concluded that innovation is more than invention. Success is not based on technological performance in isolation, but rather how technology builds knowledge, networks and capacity (IAASTD, 2008). When considering new approaches to

coordination, collaboration and partnerships, it is important that the "partnership" doesn't become an end in itself (Sumberg, 2005 p. 31). Sumberg (2005 p. 38) suggests that:

> Perhaps it is time to leave the blueprints – for farmers groups, stakeholder platforms, competitive research funds and so on behind, and allow local characteristics, differences and anomalies to flourish.

It is also important to pay heed to calls to emphasise the building and maintaining of trust among partners as a key element of a successful partnership (Killough, 2009). Building trust has been found to be increasingly important the more partners involved and the less like-minded the partners (Hall, 2006 ; Killough, 2009). It is also important to ensure that over time farmers' priorities are not "elbowed aside" by researchers' own agendas (Richards, 2009 p. 233). Innovation demands sophisticated integration with local partners (Kiers et al., 2008). Such partnerships should consider the things that farmers have identified would be useful to them, as outlined in 7.4.1. They could address environmental considerations such as improving groundcover through the use of perennial species, knowledge services such as providing access to independent advisors as well as experienced conservation farmers, economic solutions such as new types of insurance that better address climate variability and, the provision of resources such as skilled labour, fencing materials and other farm investments at the right time in the right season.

Partnerships should promote innovation - not only frontier research and technology, but also incremental problem solving. As outlined in Section 9.2, future partnerships for landscape management need to be built upon greater linkages to technically relevant information, longer term funding cycles, flexibility in approach and process and feedback over time to learn from mistakes. These conditions may not result in radical reforms or news headlines that are sought in politics, but they will result in incremental learning and change that builds capacity rather than continuously reinvents it. As shown in previous chapters and discussed above, farmers' experiences with collaborative research in the past have not always been positive. There is a lot of scope for improvement, not least in basic communication.

In this context, contributions by Howells (2006) and Klerkz and Leeuwis (2008a) on the role of innovation intermediaries are useful. They view intermediaries more as enablers or brokers of knowledge within a network that facilitates change, rather than agents setting out with a predetermined agenda to invoke change. Klerkx and Leeuwis (2008a) suggest

that public funding should be directed towards supporting tasks such as foresight, problem diagnosing and needs articulation, scoping and filtering (selection of collaborative partners), and network brokerage roles. Innovation intermediation is not only about offering one-off intermediary services, but also involves offering longer term, relational innovation capabilities (Klerkx and Leeuwis, 2008a). This means maintaining good relationships and trust within the network. The World Bank has recommended that research systems become more open to other key actors within the innovation system (World Bank, 2006). This should apply to a greater acceptance of the role that farmers play in both innovation and research networks. This is not to say that partnerships should be an end in themselves – this is in fact when problems will arise (Sumberg, 2005). Genuine interaction rather than simply intervention is needed, where farmers are recognised as generators of knowledge, in addition to be adopters and receivers of knowledge.

9.5.3 Flexible approaches for healthy landscapes

Farmer driven innovations have the potential to attain sustainability, but only if the institutions put in place are appropriate to the specific socio-economic conditions of the community in question as well as the capability of the institutions and stakeholders involved (Chikozho, 2005 ; Cocklin *et al.*, 2007). The challenge is how to actually design institutions that achieve this. Government action and policy are one of the drivers that contribute to the opportunities that agents may take up. While sustainable development and environmental policies have traditionally been driven by international agreements and global problems, "innovation policy in most countries is very much driven by national concerns" (OECD, 2005 p. 55). The OCED recognised that while sustainable development as a concept was pitched at the global level, the reality of achieving sustainable development required locally based work. For environmental policy, current design tends to focus on farm-level interventions (van der Horst, 2011). If we are to create flexible and enabling policy environments for innovation, we may need to think beyond the farm system – to conceptualise agricultural systems on a larger scale, as a mosaic of farms across a landscape. This would allow for a greater focus on the overall impacts at a landscape scale, for systems based on outcomes rather than process, cooperation between individuals and a common space for knowledge flows. It is easy enough to talk about flexibility and adaptability to local conditions, but the challenge is defining this in any meaningful way for decision makers and individuals.

None of this is to deny that there remains a case for continued government intervention to promote ecosystem health within landscapes, not only through farm level regulations

and incentives, but through the governance of markets and the setting of property rights (Lockie and Carpenter, 2010). In addition, greater attention also needs to be paid to how other actors in the value chain, such as agribusiness firms and food retailers, influence on-farm environmental management (Lockie and Carpenter, 2010 p. 3). They too are part of the 'opportunity context'. In order to create an enabling environment and change the incentive structure as part of targeted agricultural and fiscal policies that strengthen sustainable agriculture practices. UNCTAD (2010) suggests that policy measures at the international level could include more diversified international supply chains with reduced reliance on a small number of agro-companies; and reformed international trade policies that are supportive of ecological agriculture. Nor does this thesis suggest that all farmers have the means or inclination to be innovators. There is still a wide scope for advisory and extension services – reformed to better build on existing networks and farmer efforts (Leeuwis, 2004). The move away from one-on-one or individual assistance on-farm, should be reversed, as should the shrinking of public advisory services (Cocklin et al., 2007). Where extension efforts do continue, there is a need for a greater focus on credibility as well as reliability (Pannell et al., 2006).

If we are to see the urgent changes needed in landscape management, we must learn from those that are already at the leading edge, fringe dwellers 'outside the tent' of traditional agriculture (Williams and McKenzie, 2008). We should start focusing on the best farmers, the ones who are already motivated but constrained by opportunity. Finding the answers are crucial, otherwise we may seek to find sustainability, but won't know how. Though it is not possible to generalise from the small sample of farmers in this study, it is possible to propose some examples of 'what works' with the hope that these examples inform and inspire more detailed research and consideration in the future. The following table (Table 6) draws on the research findings and analysis described in previous chapters to summarise key elements of 'what works'.

Table 6. 'What works' in enabling farmer-driven innovation

Knowledge	- Challenging the science and accepted wisdom - Getting independent advice and evaluation - Specialising, or reducing the number of land uses on farm - Training that provides new 'mental models' for decision making, rather than just new information - Access to pragmatic scientific advice on natural systems, the use of biology and native species and other ecosystem synergies

Networks	- Having an interactive and broad knowledge network, beyond the local district - Finding "like-minded" people to maintain enthusiasm - Interstate and overseas study tours as a means of mobility and interaction - Having someone else to discuss day-to-day decisions and ideas - Involvement in farmer groups - Participation in farmer driven research programs
Resources	- Being more opportunistic and flexible to respond to the resources available - Treat the farm as a professional business, not a lifestyle - Find new ways to manage risk and better capture opportunities (in lieu of diversification) - Access to resources to speed up and scale up on-farm changes

The following chapter draws the final conclusions of the thesis and summarises the new insights this research provides.

9.6 Summary

This chapter has called for a rethink of interventions into land management on-farm. It is proposed that opportunity creation and interactions based on effective partnerships provide a new way forward. It is emphasised that enabling innovation requires finding a balance between the individual and the system, between formal and informal mechanisms and between knowledge supply and demand. The following chapter concludes the thesis.

10. Conclusion

10.1 Introduction

It has been the purpose of this thesis to better understand farmer-driven innovation by exploring the experiences of farmers in implementing land management change and the implications that this has for interventions that seek the same change. In contrast to the many studies of agricultural innovation in a developing context in developing countries, the focus has been on understanding innovation in developed country agriculture. Through a grounded theory research method, the findings draw on the experiences and perspectives of the participant farmers themselves to inform the theory and concepts of the thesis. These findings, related to concepts of decision making, knowledge and innovation systems, have helped to provide new insights into innovation and knowledge generation in agriculture. It has been my intention to bridge the gap between the theoretical and the practical by providing a deeper understanding of the external and internal forces of farm system change. The research highlights the changing nature of modern agriculture, including the blurring of the line between science and practice. It challenges distinctions between what is local knowledge and what is scientific, and the generators of that knowledge, and reveals the potential role that 'opportunity' plays in theoretical and policy approaches to the decision making of farmers and in creating enabling environments for innovation, given the reality that is modern farming in the 21st century.

10.2 Theoretical Implications

As discussed in Chapter One, there is an urgent need for the transformation of high-input industrial agricultural systems into knowledge intensive regenerative agricultural systems that are more sustainable (UNCTAD, 2010). Major international and intergovernmental organisations such as IAASTD and the OECD are calling for investments in "agricultural knowledge systems" (IAASTD, 2008) and more innovation focused environmental policies - and environmentally focussed innovation policies (OECD, 2005). They propose that such policies will achieve environmental and economic outcomes. The challenge is to understand what knowledge intensive agricultural systems look like. Changes in land management require application and experimentation at the farm level and an understanding of how actions at that level integrate into the ecological and hydrological function of the landscape (Williams and McKenzie, 2008). This is something that requires

the involvement of land managers at the farm scale. As the primary actor in farm level implementation, it therefore follows that it is crucial to understand the nature of farmer driven innovation.

As this thesis has shown, farmer-driven innovation can be emergent, experimental and evolutionary. It is entrepreneurial, complex, uncertain and ongoing. Knowledge is being exchanged through a range of both formal and informal processes, with multiple pathways and diverse networks. The relationship between knowledge, decision making and innovation is multifaceted and interconnected. Knowledge generation, exchange and application inform decisions and allow decisions to be realised. It is based on networks with multiple actors, and particularly thrives on farmer-to-farmer knowledge exchange. However, it does not necessarily reflect traditional 'transfer of technology' models, nor the idea of neighbours learning from 'progressive farmers' as traditional innovation diffusion models proposed. Rather, networks are becoming less bound by geography and more international, facilitated by new forms of telecommunication as well as greater international travel and experience of farmers themselves. In addition, farmers are being proactive in forming their own networks, including making direct contact with the researchers they choose for their purposes, whether they be located in Australia or abroad.

Farmer-driven innovation in the Australian context has often been in response to the need to reconcile sustainability and productivity, such as through the enhancement of soil health or the management of water scarcity. The programs of trialling and implementation across the participants' farms provide lessons for those seeking to create more ecologically resilient agricultural systems. Activities to promote perennial species, both in grazing and cropping systems, as a response to the need to improve both soil and water management deserve particular attention in terms of their suitability for more widespread application, given the growing challenges of climate change and food security. This brings to the fore another point – that scientists and extension agents often learn from farmers themselves of the latest in best management practices. Rather than being a linear transfer of information from the lab to the farm, it is more circular, where scientists learn and test ideas from one set of farmers, before re-packaging those ideas for extension efforts to another set of farmers. There is a need for greater recognition of the role of farmers as innovators, as well as greater incentives and rewards for doing so. The issue of 'latercomer' advantage, as discussed in Chapter 8 (8.2.1) is pertinent. Those who come late to a new innovation can be rewarded because greater scale and lower cost are possible - while those who innovate can be penalised for taking the risk.

Innovation is itself both an opportunity and a means to realise opportunities. Having made the case that innovation is not just the domain of researchers, but rather at the core of many farmers' enterprises, it becomes clear that more needs to be done to create opportunities for innovation. Greater recognition is needed of the skill and sophistication involved in on-farm innovation – and of the opportunities that these skills provide.

This also requires the better conceptualisation of opportunity, as a means of facilitating decision and action by those who are motivated. In studies of farmer decision making, this would mean a move away from simply focusing on barriers to change and motivations behind the adoption of single technologies and practices. Instead of duplicating the many studies that have asked why actions have not occurred, this thesis has focused on innovative farmers, looking at processes, challenges and outcomes (what has and hasn't worked). In innovation systems studies, this would mean going beyond the focus on innovation and innovation intermediaries at the macro scale, to the workings and requirements of effective knowledge networks and institutions at the micro scale. Interventions that seek to enhance both innovation and sustainability in agriculture can also benefit from greater emphasis on the opportunities required to realise knowledge generation and innovation on-farm. While the research is focused on a specific geographic area – central and western NSW - the perspectives, principles and policy implications that result from this work have application beyond the original context of this study.

10.3 Policy Implications

This research provides evidence that farmers can indeed be innovators. It is also clear that their land management innovations have the potential to contribute to the creation of more ecologically resilient agricultural systems. By considering the point of view of the farmer as innovator, public policy interventions to change farmer behaviour can be seen in a new light. As introduced in Chapters Two and Three, there have been a mix of approaches aimed at changing farmers' behaviour. These include advisory based practices such as agricultural extension, as well as the hybrid approaches of neoliberal governance, of both market deregulation and regulation roll-back, combined with the roll-out of MBIs for ecosystem services and increased environmental regulation.

Farmers in this research were not as supportive of MBIs as would have been anticipated. Given the risks they take to innovate, the current lack of financial reward (at least in the short term) for innovation and the financial difficulties facing farmers in the sector, it was assumed that the potential to gain economic benefits from ecosystem services would be

welcomed. However, this was generally not the case. Given a hypothetical PES scenario, farmers did not see this as a potential funding source. Rather, it would benefit other farmers, their competitors. As has been the case with other funding programs in the past, they assumed that approaches such as PES would come too little too late for the innovators and early-adopters and that they will not be eligible. Additional resistance to the idea of PES was based on the added burden that new land uses create for farm managers. Farmers are already seeking to specialise and reduce the complexity and knowledge burden of the enterprises that they currently operate. This could be the reason that renewable energy was viewed the most favourably by participants, as a low maintenance activity while more demanding activities such as agroforestry were met with the most opposition. The challenge to multiple land uses does not necessarily spell the end for aspirations of a mosaic of land uses across landscapes. However, such a mix may be more realistic at the catchment rather than farm scale.

There were also concerns with the direction that existing grant based funding was taking. In particular, there were concerns that, where funding was available, inappropriate conditions constrained the farmers' ability to manage the farm flexibly. Fears over lack of flexibility was not just a reaction to the perceived impingement on private property rights, but also revealed an economic reality - where fluctuating costs, commodity prices and the Australian dollar all required flexible and rapid responses in order for the farm business to survive.

Unless MBIs such as PES schemes are redefined to have more differentiated and targeted ways of calculating the acceptable baseline, beyond which activities are considered 'additional' and therefore eligible, then farmers who are already working to improve the ecosystem services on their properties will be excluded. And until funding programs emphasise outcomes rather than dictate processes, then they will continue to have only limited impacts. The problem is that system-wide change on farmers can already take decades to implement and even longer to deliver outcomes. It does not make sense to effectively penalise those who are the most advanced in this change, and in doing so, slow down the overall transformation towards sustainable and knowledge intensive regenerative agricultural systems.

New market based instruments for ecosystem services alone will not transform unsustainable systems into sustainable ones. Government funding and incentive frameworks need to be components of a more consistent strategy to encourage

innovative and sustainable land management. There is a need to move away from traditional intervention towards the creating of enabling environments for innovation, not least through knowledge networks where farmers' traditional boundaries between knowledge supply and demand are eroding. Government interventions have had some adverse impacts on innovation, but can be improved if they begin to address the gap that is 'opportunity' – what is required to foster change where there is motivation. The challenge as always is to define what such an enabling environment may look like. As quoted in Chapter Nine, enabling innovation requires "building on peoples' ingenuity and motivations, rather than working against them" (Douthwaite, 2006 p. 93). It requires an "opportunity-driven system" that is "agile, responding quickly to emerging challenges and opportunities" (World Bank, 2006 p. x). But how can public policy create the conditions for such a system? The first step is clearly shifting focus from the supply of knowledge and technology to the capacity and conditions for innovation. Subsequent steps (based both on the literature reviewed, particularly in Chapter Nine, and the results of this research) would include policy approaches that are focused on:

- Delivering appropriate resources, including rewarding innovators rather than penalising them and providing opportunities for those who are motivated, rather than seek to change those who don't want to change
- Facilitating knowledge networks through the creation of space for stronger interaction across the whole range of actors involved in innovation
- Encouraging farmer groups of "like-minded" people, as well as interstate and overseas study tours as a means of mobility and interaction
- Enabling an innovation system to remain flexible and diverse enough to avoid becoming locked into a single trajectory
- Enabling the continuous adjustment of institutional arrangements and patterns of partnership in response to ongoing learning and changing circumstances
- Creating incentives for innovative activity, and create institutions that respond to and learn from the innovative process
- Providing knowledge brokerage services by innovation intermediaries, so that independent advice and evaluation is easily accessible
- More sophisticated training that provides new 'mental models' for decision making, rather than just new information

The farmers who participated in this current research are not always represented by the mainstream agendas of the peak industry bodies. They are not the farmers who will appear

in the local newspaper. They are quietly pushing the agricultural frontier forward, seeking solutions to land management challenges through innovation and changing practices. Ignoring or worse, penalising, the farmers who are seeking to improve the sustainability of their practices risks the discontinuation of innovations and continued degradation of the natural resource base at the expense of both agricultural and ecological assets. The shift from linear 'transfer of technology' approaches to more participatory research will not necessarily solve the problem. What is needed are truly new ways of engaging, with partnerships based on the concept of multiple pathways for knowledge flows and the flexibility required for emergent networks. Such future partnerships must be built upon greater linkages to technically relevant information, longer term funding cycles, flexibility in approach and process and feedback over time to learn from mistakes. While there are ways to establish policies that reward outcomes, it remains to be seen if there is commitment to modify publicly funded approaches so that extension services become one component in a broader strategy to facilitate opportunities for innovation, rather than a means to initiate change.

10.4 Further Research

To reiterate, this thesis argues for a greater recognition of and role for farmer driven innovation, particularly on-going innovations. There is still an important role for scientific research, which has made many positive contributions to agriculture in the past, continues to do so today, and will likely do in the future. There are still many challenges facing the sector that require the attention of formal science – not least the need for greater research and guidance on working within nature in agricultural systems, including the use of biology and native species and other ecosystem synergies at the farm level. Likewise, extension and technical advisory services also remain important, particularly where they can assist in applying knowledge to local circumstances. That being said, more research is needed to better understand decisions not simply in terms of barriers to change or how to convince individuals to change, but in terms of why change occurs and what facilitates action. There is scope for further research to explore how governments can encourage innovation without 'picking winners' or being excessively interventionist. The challenge is to create an inherent capacity for ongoing innovation, not to just apply a band aid or short-term interventions in a way that undermines this capacity for long-term gain.

10.5 Summary

This research has highlighted the experiences of a selection of farmers in New South Wales in implementing innovative land management practices and processes. It has shown the

prevalence of independent testing and trialling, the time and resources needed to implement change, and the important ability of observing and responding to the landscape, whether this is through property redesign or management adaptations. This is no small task for farmers working at the interface of production and conservation, trying to balance the demands of both. The implementation of new practices and processes requires an ongoing process of innovation and change – something which is too often ignored when the focus is on the point of 'adoption'. Despite innovation processes being time and resource consuming, and without any guarantee of success, the farmers interviewed were working to implement changes. If researchers and policy makers could contribute to this effort through the creation of new opportunities, not only would an enabling environment for innovation be created, but also opportunities for sustainability. The importance of fostering ongoing innovation that enhances both agricultural productivity and sustainability cannot be overemphasised. With about seven billion people alive today, projections of population increases until approximately 2050, and growing concerns about the amount of, and quality of, land available for agriculture on earth, farmer driven innovation that promotes sustainability is crucial. My thesis is one small step in this critical endeavour.

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Appendices

Appendix One – Interview Information

1. Farmer Interview Guide
2. Non-farmer Agricultural Professionals Interview Guide
3. Letter requesting an interview – Famers
4. Letter requesting an interview – Non-farmers
5. Participant Information Statement
6. Participant Consent Form

FARMER INTERVIEW GUIDE

General topics to discuss

Motivations and opportunities

Farm management practices

System-wide changes and 'post-adoption' or ongoing implementation

What is needed to keep going – opportunities to be created?

Proposed questions (re: on-farm experiences)

What are some of the experiences you've had implementing whole-of-farm change including challenges and opportunities?

What kind of time and resources does it take to implement on-farm change?

What experiences have you had adopting or dis-adopting new technologies or practices?

How do you go about on-farm innovation, decision making and experimentation?

How do you judge success or get feedback?

How is change built into the management process?

Proposed questions (re: off-farm experiences and influences)

What role do markets and institutional settings such as government policy play in the agricultural sector?

What ways would you like to see constraints overcome and opportunities created eg. through government policy?

What role does science and outside expertise play?

Other drivers of farming decisions?

Incentives and Funding

What funding/incentives have been received?

What worked and what didn't?

Duration of funding? Conditions and contracts?

Would they do what they done without the funding?

The image from *Scientific American*

What response does this image trigger?

Would these types of incentives and markets be useful or positive?

NON-FARMER AGRICULTURAL PROFESSIONALS INTERVIEW GUIDE

General topics to discuss

The nature of innovation in Australian agriculture

How best to foster change

The role that current market and institutional settings play.

Proposed questions

How do you see innovation operating in Australian agriculture?

What sort of opportunities are there for innovation in farming?

Is any 'post-adoption' support provided and how could it be improved?

What ways would you like to see constraints overcome and opportunities created eg. through government policy?

How could existing government policy be improved?

What sort of funding programs are needed?

Is there a better role that science and outside expertise could play?

What role do markets and institutional settings such as government policy play in the agricultural sector?

Other drivers of agricultural sector?

The image from *Scientific American*

What response does this image trigger?

Would these types of incentives and markets be useful or positive?

In the future - what is possible?

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Dear Sir or Madam,

I am a PhD student at the University of Sydney, supervised by Associate Professor Phil McManus of the School of Geosciences. I am conducting research in to how to better foster decision and innovation that achieves an agricultural system that maintains or improves the natural resource base on which it relies. To this end, I aim to learn from farmers who are already showing innovation in land management at the whole-of-farm scale, using examples of progressive farming practices and farmers in the NSW Central West as my case studies.

I am writing to you in your capacity as a farmer to invite you to participate in an interview for this research. Please find attached a copy of the Participant Information Statement and Participant Consent Form. I am particularly interested in hearing your views on the nature of decision and innovation in Australian agriculture, how best to foster change and your experiences in implementing new practices and systems across the farm.

The interview would last approximately one (1) to three (3) hours, depending on the time you have available. The research has been approved by the Human Research Ethics Committee of the University of Sydney.

If you are willing to participate in an interview, please sign the Consent Form and return it to me at the above address. Please provide your preferred contact details so I can arrange a suitable interview time at either your farm or an alternative place at your convenience.

Thank you for your consideration of this request for an interview. If you require further information, please don't hesitate to contact me either by phone on 0432 922 652 or by email at f.mckenzie@usyd.edu.au

Yours Sincerely

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<Title> <First Name> <Surname>
<Position>
<Organisation>
<Postal Address>
<Suburb> <State> <Postcode>
<Date>

Dear <Title> <Surname>

I am a PhD student at the University of Sydney, supervised by Associate Professor Phil McManus of the School of Geosciences. I am conducting research in to how to better foster decision and innovation that achieves an agricultural system that maintains or improves the natural resource base on which it relies. To this end, I aim to learn from farmers who are already showing innovation in land management at the whole-of-farm scale, using examples of progressive farming practices and farmers in the NSW Central West as my case studies.

I am writing to you in your capacity as <Position> at <Organisation> to invite you to participate in an interview for this research. Please find attached a copy of the Participant Information Statement and Participant Consent Form. I am particularly interested in hearing your views on the nature of innovation in Australian agriculture, how best to foster change and the role that you think current market and institutional settings play.

The interview would last approximately one (1) hour. The research has been approved by the Human Research Ethics Committee of the University of Sydney. If you are willing to participate in an interview, please sign the Consent Form and return it to me at the above address. Please provide your preferred contact details so I can arrange a suitable interview time and place at your convenience.

Thank you for your consideration of this request for an interview. If you require further information, please don't hesitate to contact me either by phone on 0432 922 652 or by email at f.mckenzie@usyd.edu.au

Yours Sincerely

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PARTICIPANT INFORMATION STATEMENT
Research Project

Title: Fostering decision and innovation: towards sustainable agriculture

(1) What is the study about?

The study is examining how to better foster decision and innovation that achieves an agricultural system that maintains or improves the natural resource base on which it relies. It aims to learn from farmers who are already showing innovation in land management at the whole-of-farm scale.

(2) Who is carrying out the study?

The study is being conducted by Fiona McKenzie (PhD Candidate, School of Geosciences) and will form the basis for the degree of Doctor of Philosophy at The University of Sydney under the supervision of Dr Phil McManus (Associate Professor, School of Geosciences). Phil can be contacted by phone on (02) 9351 4242 or by email at pmcmanus@usyd.edu.au. Fiona grew up on a farm in the Central West and now also works part-time as a Policy Analyst with the Wentworth Group of Concerned Scientists (her research is being conducted independently of this Group).

(3) What does the study involve?

The study involves face-to-face interviews and observations of behaviour. The majority of interviews will be held with farmers, on-farm. Several interviews will also be undertaken with agricultural service providers and decision makers at their place of work. Interviews will be recorded for transcription. In the case of farmer interviews, an informal tour of the farm to observe on-farm activities and management would not be compulsory, but if interviewees have the time, it would help provide further context and understanding of the subject matter discussed during the interview. If permission is granted, photos may also be taken of the farm.

(4) How much time will the study take?

The interviews are part open-ended and part structured. A range of themes will be explored. As a general rule, each interview will take between 1 to 3 hours, but duration will depend on the individual, their depth of answers and the time that they have available. An informal farm tour is optional, ideally undertaken either at the same time as the interview or immediately after its completion.

(5) Can I withdraw from the study?

Being in this study is entirely voluntary: you are not under any obligation to participate and - if you do participate – you can withdraw at any time without prejudice or penalty and without affecting your relationship with the University of Sydney. You may stop the interview at any time you do not wish to continue, the audio recording will be erased and the information provided will not be included in the study.

(6) Where did you obtain my name and details?

Names of details of potential interviewees have been provided to the researcher through consultation with stakeholders in the agricultural sector or through publicly available materials.

(7) Will anyone else know the results?

All aspects of the study, including results, will be strictly confidential and only the researchers will have access to information on participants. A thesis and academic publications will emerge from this study, but individual participants will not be identifiable in such publications.

(8) Will the study benefit me?

The study will not provide you with any direct benefit. However, as indicated above, conclusions and recommendations arising out of the study will be published publicly, with the intention of positively influencing agricultural management in Australia.

(9) Can I tell other people about the study?

Yes. Please feel free to tell others about the study.

(10) What if I require further information?

When you have read this information, Fiona will discuss it with you further and answer any questions you may have. If you would like to know more at any stage, please do not hesitate to contact Fiona McKenzie, PhD Candidate, School of Geosciences on 0432 922 652 (mobile) or f.mckenzie@usyd.edu.au (email).

(11) What if I have a complaint or concerns?

Any person with concerns or complaints about the conduct of a research study can contact the Manager, Ethics Administration, University of Sydney on 02 8627 8175 (telephone) and 02 8627 8180 (facsimile) or gbriody@usyd.edu.au (email).

This information sheet is for you to keep.

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PARTICIPANT CONSENT FORM

I, ... [PRINT NAME], give consent to my participation in the research project.

TITLE: Fostering decision and innovation: towards sustainable agriculture

In giving my consent I acknowledge that:

1. The procedures required for the project and time involved have been explained to me, and any questions I have about the project have been answered to my satisfaction.
2. I have read the Participant Information Statement and have been given the opportunity to discuss the information and my involvement in the project with the researcher/s.
3. I understand that I can withdraw from the study at any time, without affecting my relationship with the researcher(s) or the University of Sydney now or in the future.
4. I understand that my involvement is strictly confidential and no information about me will be used in any way that reveals my identity.
5. I understand that being in this study is completely voluntary – I am under no obligation to consent.
6. I understand that I can stop the interview at any time if I do not wish to continue, the audio recording will be erased and the information provided will not be included in the study.
7. I consent to
   - i. Audio taping YES ☐ NO ☐
   - ii. Receiving feedback YES ☐ NO ☐

   If you answered YES to the "Receiving Feedback Question (iii), please provide your details i.e. mailing address, email address.

   Feedback Option

   Address: .....

   Email: .....

Signed: .....

Name: .....

Date: .....

Appendix Two – Reports to interview participants

Report One - 20 November 2009

Report Two - 8 September 2010

Understanding innovation in agriculture: towards sustainability

Report for Interview Participants

20 November 2009

The Farm Interviews

Between July and September 2009, I hit the road and clocked up many miles visiting farms across the NSW wheat/sheep belt. Targeting farmers with a track record in innovative land management, I visited 22 farms and interviewed 33 farmers overall. I relished the opportunity to see what was happening on the ground and to learn about the experiences of the farmers interviewed. I have to admit, it was a steep learning curve! There was such a wide range of innovations happening on-farm, from alternative methods to maximise biological activity in the soil, through to complete machinery overhaul and system redesign.

The aim of this report to is provide you with a summary of my general impressions and observations as well as some of the issues that arose during the interviews. The report is divided it into three sections:

1. Management practices;
2. Innovation, Science and Experimentation; and,
3. Markets, Money and Incentives.

Management Practices

Many farmers do not use a lot of inputs (especially up front) as a risk management strategy due to unpredictable rainfall. The real breakthrough in reducing risk and increasing flexibility seems to be finding effective ways to manage the landscape for moisture.

In established zero tillage systems, stubble retention over summer can pose a problem, particularly in the north of the state, due to quick breakdown and decomposition.

Options such as cover cropping and pasture cropping are being considered, although there are constraints due to moisture scarcity.

There has been a need to wind back seeding and fertiliser rates – partly in response to drier

seasons, but also because of the way the soil and the crop is responding to zero till.

Some farms have destocked all together or are keeping livestock totally separate from their cropping system. There were mixed views on the role of livestock in causing soil compaction and the tradeoffs of removing stock from the system.

There seemed to be a widespread belief that cropping is 'low labour' compared to livestock. However, there were several farmers who disagreed and felt that this perception was a result of livestock systems not having undergone the same modernisation and scrutiny as cropping.

There has been a mental and actual shift away from traditional fencing. The replacement of barbed wire with two wire and/or 'Weston' fences and the use of electricity was widespread across the farms visited.

Rotational grazing is proving to be applicable to low rainfall zones. However, there appears to be a lack of information, knowledge and science on the effects of rotational grazing on soil health, animal health and overall productivity. This lack of technical supporting information was keenly felt by some farmers.

Drought and dry seasons can interrupt trials and changes occurring on farm. It can also mask the results of change, which can prove frustrating, but seems generally accepted as the way things are.

Grazing paddocks are getting smaller and cropping paddocks are getting bigger.

Time is precious and finding ways to 'save' time is crucial. Finding ways to cut back on the long hours spent working was also a reoccurring theme.

There is a lack of skilled labour available. There is also a fear that any labour that has been trained or 'up-skilled' on farm will eventually leave, creating a vacuum and a waste of time spent training. When it came to the crunch, family was still relied upon for "surge capacity" in busy times like harvesting, shearing or fencing.

"Timing" was a reoccurring theme. It was emphasised by various farmers that even a half a day can make all the difference at crucial times such as sowing and harvesting. This has led some farmers to increase their investment in machinery so that they have the control over its availability rather than rely on a contractor. In some cases, the farmers themselves then also undertook off-farm contracting to help recover the costs of machinery investment.

Strong emphasis was placed on creating business structures to manage the planning and financial processes of the farm professionally, accompanied by clearer 'decision making rules'.

Innovation, Science and Experimentation

A common comment was that "this is just the beginning" or "we are just getting started".

It was felt that there was still a lot to learn, test and implement and that the potential for further change and evolution was definitely there. That said, it was mentioned by some that they were worried they would lose the drive to 'change' overtime and not remain innovative as they got older.

It seems that most 'innovators' have someone in their life who helps put the brakes on their curiosity and remind them of the financial realities. Generally, this intervention was acknowledged as important because there also was a widespread belief that it is the innovators who risk going broke.

In terms of management, there was often more than one person involved in planning or at least available for brainstorming ideas. Having someone to bounce ideas off was seen as important. In addition, it seemed that involving other decision makers or partners in any significant training was vital to ensure that they were 'brought along' in the process.

Issues of intellectual property were not seen as paramount. Most farmers supported the idea of continuing to make information freely available between farmers, but did not appreciate ideas being poached and profited from by private companies.

Trials and experiments are continuously conducted on-farm by both the farmers themselves and also external parties. That said, it seemed quite common for farmers not to hear back from researchers who implemented a trial on their place. Leftover trees, soil measurement poles etc were still in the paddock years later, with the farmer not sure whether to just take them out.

There was a scepticism of government staff, although in some cases, respect for the 'old' guard of government advisors who have been around for decades.

There was a sense that lack of follow up was resulting in 'reinventing the wheel' instead of a systematic approach to implementing learning gained through both private and public funded trials, work and experience.

The use of agronomists differed between farms. There was a mix of retail and 'fee for service' agronomists being called upon. Some farmers had a high reliance on an agronomist and saw it as a valid way of outsourcing an area of expertise. Others used agronomists as another tool but would not always take the advice. Some no longer used agronomists at all.

Farmers don't tend to think of "one way" as the "only way". Therefore they will be naturally suspicious of others who advocate a recipe as "the answer".

Markets, Money and Incentives

In terms of incentives or funding from government, no one is asking for a blank cheque. Very few of the farmers interviewed had any real desire or request for financial help or assistance. They just wanted a couple of "good seasons" to get ahead.

Alternative options such increasing the growth of nearby regional centres in order to create demand and value for farm products were suggested as a part of the solution. Commodity prices that better reflected the high cost of growing them would also be welcomed.

Making gains wherever possible should not be underestimated. It was highlighted that every little bit counts and finding that extra 0.5% efficiency gain or increased profitability can be the difference between getting ahead or getting deeper into debt.

It can be frustrating to watch the neighbour who 'flogs' his land still doing well, with a healthy bank balance and a flash car. There is no clear and immediate economic penalty or reward for worse or better land management. Those who seek to manage their land better are driven by considerations other than short term financial gain.

Farmers sell commodities not food. They are largely price takers and are dealing with a volatile commodity market. They recognise that a 'niche' can also be a dead end if market demand changes.

Some felt that promoting what they were doing or being promoted by others as a role model could alienate them within the community. There was also a sense that some people were just waiting for them to fail.

The idea of neighbours going broke, although it would create opportunities for farm expansion, was generally not welcomed at the expense of having a viable local community.

There were mixed views about the idea of bringing in alternative markets for ecosystem services such as water, carbon and biodiversity. While some welcomed the idea, there was also concern that long term contracts would limit flexibility in the future.

In addition, there was an expectation that any payments would go to the farmers who haven't done anything yet and have a long way to go, rather than the farmers who are already increasing their carbon and

biodiversity. In other words, the innovators would miss out again.

While diversifying the types of markets available to farmers could be a good thing, it was also felt that there would not be the time in the day or resources available to incorporate more enterprises into the business. If anything, farmers are having to specialise and focus on one enterprise in order to keep making that 0.5% efficiency gain.

Sustainable timber was not really seen as an option by anyone due to constraining factors such as low rainfall, poor infrastructure and distant markets. Renewable energy was viewed in a more positive light.

Next Steps

It was energising and inspiring to spend time with people who are optimistic about agriculture as an industry and who can see opportunity in adversity. I got the sense that many of you felt a clear sense of mission and achievement in making something work and hopefully also making it pay. I could sense the innate curiosity and was impressed by the proactive approach displayed by many in actively seeking and synthesising information as well as sharing it with other farmers.

I hope that you find this information useful and I welcome any feedback you may have. My next task is to link these findings back to the 'theory' and to figure out what it all means for both policy and innovation in Australian agriculture more broadly.

My one request is please do not distribute or use the findings in this report just yet. I will work to consolidate, publish and disseminate this information more widely as soon as the research has been finalised. I will keep you in the loop on my progress.

Thank you for being so generous with your time. I hope that my research can do justice to the great work you are doing and the rich information you have provided.

Fiona McKenzie

Thank you

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Understanding innovation in agriculture: towards sustainability

A Brief Update

8 September 2010

The work continues……

Well, it has been almost twelve months since I clocked up the miles driving along country roads to visit farms across NSW. Since my November 2009 update, I've been compiling the results of my PhD research, linking it back to innovation theory, and generally trying to figure out what it all means for both policy and innovation in Australian agriculture more broadly.

I have also begun writing my thesis, in which I am aiming to balance an emphasis on theoretical components related to knowledge, networks and decision making with a focus on the on-ground realities of land management as well. I hope to have my thesis completed and ready for submission by June 2011. Once it is officially examined, I will be able to send you an Executive Summary, probably about this time next year (September 2011).

As part of this ongoing process, and as a useful way to get feedback and promote discussion, I've taken up a range of opportunities to talk about my research and to provide evidence of land management innovations that farmers are implementing. Some examples include:

- Participant: *Agriculture and Rural Development Day*, held in Copenhagen, Denmark, on 12 December 2009. This event was hosted by Consultative Group on International agricultural Research, the Global Donor Platform for Rural Development and the University of Copenhagen. It was attended by more than 350 policymakers, farmers and scientists from developed and developing countries across the world.

- Guest Lecturer: *Social and Environmental sustainability - The role of Australian farmers*, presented to students from Hong Kong visiting the Research Institute for Asia and the Pacific, University of Sydney, 22 June 2010.

- Presenter, *Understanding innovations in land management by Australian farmers,* delivered at the NZ Geographical Society (with the Institute of Australian Geographers) Conference 2010, Christchurch, New Zealand, 8 July 2010.

- Guest Lecturer: *A day in the life – Australian agriculture in 2010,* presented to 2nd year students at the School of Environmental & Life Sciences, University of Newcastle, New South Wales. 11 August 2010.

I'm also planning to submit a paper to an international academic journal. It can take over six months for a submission to be reviewed and accepted, but if I do get a paper published I will let you know.

I hope that spring has got off to a good start for you.

Fiona McKenzie

Thank you

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