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The Potential for Innovative Farm Business Structures in the Australian Grains Sector

A thesis

by

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Thesis Declaration

I certify that this work contains no material which has been accepted for the award of any other degree or diploma in my name, in any university or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text. In addition, I certify that no part of this work will, in the future, be used in a submission in my name, for any other degree or diploma in any university or other tertiary institution without the prior approval of the University of Adelaide and where applicable, any partner institution responsible for the joint-award of this degree. I give consent to this copy of my thesis, when deposited in the University Library, being made available for loan and photocopying, subject to the provisions of the Copyright Act 1968. I also give permission for the digital version of my thesis to be made available on the web, via the University's digital research repository, the Library Search and also through web search engines, unless permission has been granted by the University to restrict access for a period of time. I acknowledge the support I have received for my research through the provision of an Australian Government Research Training Program Scholarship.

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Brendan Charles Clarkin Lynch

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Table of Contents

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Thesis Abstract

Many Australian grain growers face increasing capital, management and scale constraints that limit their ability to adopt productivity-enhancing technical innovations. Organisational innovations in farm business models, such as joint ventures (JVs) may offer opportunities to overcome these constraints and provide new pathways for owner-operator family farms to boost productivity. JVs retain the strengths of family farm models while capturing some of the benefits offered by large-scale corporate farm businesses.

Using a mixed-methods approach, this research addresses gaps in current knowledge regarding the potential of organisational innovations for Australian farmers. Data collected from interviews with agribusiness personnel, as well as two surveys of Australian grain growers, are used to investigate interest in and motivations towards adopting organisational innovations.

A desktop review of the literature and semi-structured interviews with farm managers identified two broad groups of innovative business models: 1) hub-based models and 2) contracting models. Advantages of these models include: efficient scale of farm operations; better access to financial capital; stronger governance and due diligence processes; and increased human capital through labour specialisation.

Analysis of data from a telephone survey of Australian grain growers revealed that 3% of rainfed grain producers were already in a form of JV, and 35% of producers had an interest in hybrid farm structures to help reduce farm costs, increase profitability, improve labour efficiency and capture economies of scale. Adopters of JV structures

were significantly more likely to have larger scale operations; higher cropping intensity; less diverse sources of farm income; agronomists assisting with cropping decisions; and were less reliant on contractors for farm operations. Multinomial logit regressions revealed that famers interested in adopting a JV structure were more likely to be younger, hold a university degree, and believe their business is constrained by a lack of skilled labour.

The analyses of discrete choice data showed that farmers prefer JV farm structures that offer increased income with minimal loss of decision control and no change to annual leave. Significant unobserved heterogeneity of farmer JV attribute preferences was identified using random parameter logit modelling and latent class analysis. Six classes of farmers, each with distinct preferences for JV structure attributes suggest that, although there is no 'one size fits all' model, there are opportunities for compatible JV partnerships.

Our findings suggest that there is significant interest in adoption of JV structures, but adoption will require the identification of potential partners based on attitudinal, business and geographical compatibility. Policy interventions to assist in JV development should focus on: a) supporting research and extension to demonstrate the potential financial benefits; b) providing an enabling business, communication and investment environment to attract compatible farmers, investors, and partners; and c) building a network of trusted advisors to advise and support clients on JV formation and performance. By building the awareness and capacity of the advisor network towards organisational innovation, motivated farmers can be supported to find suitable partners and develop successful JV structures.

Chapter 1 Introduction

1.1 Introduction

As primarily bulk commodity producers, with minimal producer support mechanisms, Australian grain growers must compete fiercely within global commodity markets. Grain growers generate a competitive advantage by increasing productivity through the efficient allocation of resources and lowering their costs per unit of output. With declining returns from food production and the rising costs of many inputs, grain growers have needed to achieve at least 2% per annum productivity improvement just to maintain their current level of enterprise viability (Mullen 2007; ABARES 2008). To capture these continuous improvements, grain growers must consistently invest in the human, financial and natural capital of their business (Nossal and Lim 2011). Productivity gains can be driven through economies of scale, size and scope, but the primary driver is the adoption of innovations like new technologies, crops or management strategies (Carberry et al. 2010; Keating and Carberry 2010; Sheng et al. 2011a; Jackson and Martin 2014).

In the Australian grains sector, research, development and extension have largely focused on innovations related to advancements in farm products (e.g. crop varieties) and production processes (e.g. improved crop seeding practices) to lift the productivity frontier (Knopke et al. 2000; Liao and Martin 2009; Nossal and Lim 2011; Gladigau. 2013). However, minimal attention has been given to the potential productivity benefits offered by organisational innovations in farm structure, like joint venture (JV) structures between family farm businesses, with these types of innovations largely unexplored in the literature. This is despite growing evidence suggesting that many

grain growers are faced with increasing capital, management and scale constraints that limit their ability to adopt technical innovations and capture productivity gains (ABARES 2010; Jackson 2010; Hughes et al. 2011; Jackson and Martin 2014).

The overwhelming majority of farm businesses in the Australian grains sector are owner-operator family farms (Pricewaterhouse Coopers 2011). This business structure has been resilient, despite the vagaries of climate, and been the foundation for the major technical gains in grain production observed over recent decades (Kirkegaard and Hunt 2010). However, as farm enterprises become more complex and capital intensive, the importance of organisational and management innovation grows (Allen and Lueck 1998).

Organisational innovations, like JVs, are widely adopted by firms in the broader economy as a strategy to increase businesses' productivity and profitability (Sheth and Parvatiyar 1992). However, in the Australian grain sector, there has been limited adoption of JV structures between family farm businesses, despite increasing interest by stakeholders across the sector in the potential benefits for farm enterprise viability (Gladigau. 2013). Anecdotally, there have been a small number of successful JVs in the sector, with the most prominent example being Bulla Burra, in South Australia (Gladigau. 2013). Conversely, there have also been a number of less publicised JV failures.

To achieve the potential productivity and profitability benefits a JV may offer, the firms comprising a JV must develop a high degree of trust, integration and strategic alignment, which has obvious benefits, but also generates vulnerabilities (Sheth and Parvatiyar 1992). Given the inherent symbiotic JV relationship, individual firms may

also be exposed to significant financial and operational risk in the event of a JV failure. The balance between risk and reward, and the potential complexity of adopting a JV structure highlights how the attributes of an innovation influence potential adoption and diffusion (Rogers 2003). For example, the human capital and other resources a farm business requires to evaluate and adopt an organisational innovation (like a JV) are significantly different to those necessary when adopting other innovations such as a new crop type, a new crop variety or a new technology. The decision to adopt a JV structure is characterised by large potential consequences and risk, significant informational, legal and analytical requirements, and high complexity, whilst the reversibility of exiting or dissolving a JV may have major consequences for the individual businesses involved (Marra et al. 2003; Gray et al. 2009; Tarrant and Malcolm 2011; Gladigau. 2013). The very nature of an organisational innovation is a significant constraint to the more widespread adoption of JVs, irrespective of the potential relative advantage such an innovation may offer family farm businesses.

Overall, there are significant and wide-ranging knowledge gaps in relation to the potential adoption of organisational innovations, like JVs, in the Australia grains sector. In terms of foundational information, there have been no studies on the current rate of adoption or farmer interest in adoption of JV farm structures within the Australian grains farm sector. Further, it is unknown if current adopters of JV farm structures are different from their non-adopter peers in terms of farmer socio-demographic variables. In thinking about increasing adoption of JV structures within the sector, it is also important to focus research on current non-adopters, the perceived advantages and disadvantages JV structures may offer, and factors that influence farmers' future adoption decisions. Further, are farmer preferences for JV structures

homogenous or heterogeneous, and are such preferences influenced by socio-demographic characteristics?

1.2 Research objectives and questions

Overall, the body of work in this thesis aims to contribute to the agribusiness, extension, agricultural economics and non-market valuation literature by evaluating the potential for the adoption of innovative farm structures in the Australian grains sector. This thesis seeks to provide a better understanding of how owner-operator Australian grain farms ('family farms') may seek to remain competitive through the adoption and integration of organisational innovations, like JVs. In particular, this research focuses on addressing knowledge gaps relating to the adoption of JVs and the relative attractiveness of different JV structure models. The use of a choice experiment survey provides a novel approach to elucidate what JV business structure attributes are most preferred by farmers and to identify what farmer socio-demographics may help to explain attribute preferences. The findings from this research will have implications not only for family farms, but also for rural policymakers and for Australian Research and Development Corporations.

Specifically, this thesis addresses the following nine research questions:

1. What emerging agribusiness models are currently operating at the farm-level of the value chain within the Australian grain sector?
2. Are there benefits or insights from these agribusiness models that can help improve the competitiveness of owner-operator family farms?
3. What is the current level of adoption of JV farm structures within the Australian grain sector?

4. For current non-adopters of JV structures, is there an interest in adopting such structures in the future?
5. What perceived advantages and disadvantages do JV structures have for grain growers?
6. Are there particular socio-demographic variables that can explain farmers' interest in adopting a JV structure in the future?
7. What characteristics of farm JV structure models are most preferred by Australian grain growers?
8. Do socio-demographic and attitudinal variables of Australian grain growers explain JV farm structure preferences?
9. Is there significant heterogeneity in farmer JV structure preferences, and does such heterogeneity provide insights into the potential for JV formation between farmers with complementary preferences?

1.3 Description of datasets

The research presented in the thesis is derived from four primary datasets. The datasets and the associated Chapters where results are presented are outlined below:

a) Data derived from an extensive desktop literature review on innovative farm business models operating in the Australian broadacre grains sector. The results from this review are presented exclusively in Chapter Two of the thesis.

b) Data generated from semi-structured interviews with six agribusiness executives involved in the operation of innovative farm business models in the Australian broadacre grains sector. This data was collected between July and November 2011. A synthesis of these interviews is presented in Chapter Two of the thesis.

c) Data generated from an online choice experiment questionnaire of 340 grain growers across ten southern and western grain growing regions in Australia. Respondents were randomly recruited using a market research firm that had a comprehensive database of Australian grain growers. Results from the questionnaire are presented in Chapters Two, Four and Five. The questionnaire was administered between July and September 2013 and a copy of the questions is provided in Appendix 1.

d) Data generated from a telephone survey of 573 grain growers across 12 southern and western grain growing regions in Australia. Respondents were randomly recruited using a market research firm that had a comprehensive database of Australian grain growers. The telephone survey was administered in August 2012. Results from the survey are presented exclusively within Chapter Three of the thesis. The survey instrument is provided in Appendix 2.

1.4 Structure of the Thesis

The results from the thesis are laid out in Chapters Two through Five, whilst the thesis conclusions are presented in Chapter Six. Chapters Two through Five are currently under review for publication in reputable scientific journals. A brief overview of each chapter is provided below:

Chapter Two

Chapter Two addresses research questions one through five. A literature review on farm ownership structures within the Australian grain sector is presented and the theoretical basis for the predominance of the owner-operator family farm discussed.

An important term used throughout this thesis – 'owner-operator family farm' or 'family farm' – is defined and established based on previous research by Pritchard et al. (2007).

The potential role that organisational innovations can play to increase the productivity and profitability of owner-operator family farms is also outlined. Through the application of qualitative research methods (semi-structured interviews and an extensive desktop review), a typology of innovative farm business models operating in the Australian grains sector is proposed and the possible benefits such structures offer owner-operator family farms synthesised. Further, quantitative data is drawn from a national choice survey of broadacre grain farmers that provides data on farmers' interest to adopt hybrid family-corporate farm models as well as farmer perceptions on the key advantages and disadvantages of such structures.

Chapter Three

Chapter Three builds on the findings of Chapter Two and addresses research questions Three through Six. The Chapter examines farmer perceptions of, interest in, and barriers to participation in JV farm structures. Quantitative and qualitative data was collected from a national telephone survey of Australian grain growers. Statistical analysis, including a multinomial logit regression model, provides important insights on socio-demographics and attitudinal differences between farmer types with varying levels of interest in the adoption of JV farm structures and whether such interest can be predicted.

Chapter Four

Chapter Four builds on the findings identified in the previous chapters and addresses research questions Seven through Nine via a discrete choice experiment. The chapter focuses on identifying the characteristics of JV structures most preferred by Australian grain farmers, and examines observed and unobserved preference heterogeneity. The chapter provides a detailed overview of the choice experiment method, the development of the JV structure choice attributes and levels used in the experiment, and the associated development of the questionnaire instrument used in a national survey of Australian grain growers. Data from the survey is quantitatively analysed using multinomial logit (MNL) and random parameter logit (RPL) models to examine farmer JV structure preferences. Implicit prices are also calculated for different farmer types to estimate their marginal willingness to accept (WTA) for the JV structure choice attributes.

Chapter Five

Chapter Five further explores the unobserved preference heterogeneity identified in Chapter Four, and addresses research questions Seven though Nine. In this chapter, data derived from a national choice experiment farmer survey is analysed using a quantitative methodological approach, which combines a latent class model with *post-hoc* t-tests and probit models. Based on a non-linear latent class model, discrete classes of farmers with similar JV structure preferences are identified. These classes are then analysed *post-hoc* to explore potential socio-demographic and attitudinal differences between classes using t-tests and probit models. Given the underlying JV structure preferences of different farmer classes, a matrix of class pairings is proposed that categorises potential matches between classes for the formation of JV structures. The

matrix provides insights on potential areas of preference complementarity, conflicts between classes and how this may impact the potential pool of compatible JV structure partners.

Chapter Six

The final concluding Chapter Six provides a summary of the thesis' contribution to the agribusiness, extension, agricultural economics and non-market valuation literature. An overall summary of the thesis is provided along with individual summaries for Chapters Two though Five. Implications from this research for policymakers, research and development organisations, and farm business advisors are outlined. Finally, an agenda is proposed for future research on topics related to the adoption and diffusion of organisational innovations in the Australian grains sector.

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Chapter 2 - Statement of authorship

Title of Paper	Do alternative business models present opportunities for family farms?
Publication Status	Unpublished or Un-submitted work written in manuscript style
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Principal Author

Name of Principal Author (Candidate)	Brendan Lynch
Contribution to the Paper	Collected data via a literature review and semi-structured interviews, analysed, interpreted and synthesised data, and wrote manuscript.
Overall percentage (%)	75%
Certification:	This paper reports on original research I conducted during the period of my Higher Degree by Research candidature and is not subject to any obligations or contractual agreements with a third party that would constrain its inclusion in this thesis. I am the primary author of this paper.

Signature Date 26/07/2016

Co-Author Contributions

By signing the Statement of Authorship, each author certifies that:

i. the candidate's stated contribution to the publication is accurate (as detailed above);
ii. permission is granted for the candidate in include the publication in the thesis; and
iii. the sum of all co-author contributions is equal to 100% less the candidate's stated contribution.

Name of Co-Author	Dr. Rick Llewellyn
Contribution to the Paper	Supervised development of work and assisted in data interpretation and manuscript editing and evaluation (10%).
Signature	Date 26/07/2016

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Contribution to the Paper	Supervised the development and conceptualization of the research methods, data interpretation and manuscript editing and evaluation (10%).
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Contribution to the Paper	Assisted with data interpretation and manuscript evaluation (5%).
Signature	Date 26/07/2016

Chapter 2 Do alternative business models present opportunities for family farms

Abstract

The owner-operator family farm is the dominant business structure in the Australian rain-fed grains sector. However, there is evidence to suggest that an increasing number of family farm businesses are encountering difficulties in adapting to the evolving and complex operating environment. This is best typified by the growing productivity gap between the most productive and the average family farm businesses due to constraints that limit the adoption of existing technologies and new innovations. At the same time, we have observed the emergence of a diverse range of innovative farm business models which apply organisational innovations to facilitate the adoption of new technologies and practices that boost productivity. These organisational innovations in the rain-fed grains sector are understudied, even though they may provide new pathways for owner-operator family farms to increase the human, financial and natural capital of their businesses, overcome potential adoption constraints and increase productivity. In this paper we identify and characterise the existing range of innovative farm business models operating in the Australian grains sector. Two broad groups of innovative farm models are identified: hub-based and contracting models. Findings from interviews conducted with personnel from six businesses applying innovative farm models reveal the main advantages these businesses perceive to hold relative to typical owner-operator family farms. These include scale of farm operations; better access to financial capital; stronger governance and due diligence processes; and increased human capital through labour specialisation. To capture these benefits whilst

retaining the inherent advantages of owner-operator family farms, innovative structures like hybrid family-corporate farm business models (e.g. joint ventures) show potential to increase innovation adoption and improve productivity. Findings from a nationwide survey of rain-fed grain producers suggest that 4% are already in a form of joint-venture and 55% of producers have a level of interest in considering hybrid farm structures like joint ventures. However, such models also present farmers with new challenges and trade-offs that must be carefully considered prior to adopting a change in business structure. These trade-offs include a potential loss of farm independence, less control over farm decision-making processes and increased business risk.

2.1 Introduction

The farm business structures we observe in rural communities do not come about by chance. They are a product of the differences in the economic, social and political environment present at a particular time and place (Pfeffer 1983; Gonzalez-Alvarez et al. 2006). These factors intertwine with constraints on labour management imposed by the vagaries of climate and production in rain-fed systems to influence the farm structure and rural community characteristics we witness in a specific region. In Australia, the majority of farm businesses in the rain-fed agriculture sector are owned by families in an owner-operator model (ABARES 2003; Pricewaterhouse Coopers 2011). Despite being bulk commodity producers, with limited scope for product differentiation, this model has had great success, with Australian producers being highly efficient and globally competitive, with minimal government support compared to other comparative nations (Carberry et al. 2010; OECD 2010).

The economic, social and political environment faced by rain-fed farm businesses is constantly changing and there is evidence to suggest that many family farm businesses

are struggling to adapt their business to remain competitive (Pfeffer 1983; Hughes et al. 2011). This is most clearly illustrated by the growing productivity gap between the most productive and the typical (average) family farm (Hughes et al. 2011).

Productivity improvement is critical to retaining enterprise viability as productivity gains of 2% or more (per year) have been necessary to maintain the status quo due to declining returns from food production and the increasing costs of many inputs (Mullen 2007; ABARES 2008). To achieve this necessary productivity growth, the most productive producers consistently adopt a variety of technical, managerial and organisational innovations (Mullen and Crean 2007; Carberry et al. 2010; Hughes et al. 2011; Sheng et al. 2011a). However, studies indicate that while the leading family farms are highly profitable, typical family farms are being increasingly limited in their ability to adopt existing technologies and innovations that may boost productivity because of farm scale, management and/or capital constraints (ABARES 2010; Jackson 2010; Hughes et al. 2011).

Farmers struggling to achieve viability due to an inability to capture the necessary productivity improvements are faced with a stark reality. If farmers want to remain in business in the long-term, then ultimately they will need to embrace changes that address the root cause of lagging productivity and boost competiveness (Vanclay, 2003). Improved productivity at the farm level is ultimately achieved via three channels: 1) changes in farm products (e.g. new crop types and varieties); 2) changes in farm production processes (e.g. improved crop seeding practices); and 3) changes in farm organisation and marketing (e.g. new farm business structures) (Nossal and Lim 2011).

Much of the literature on innovation adoption and productivity improvement in the rain-fed grains sector has focused on changes in farm products, production processes and marketing innovations, with minimal attention paid to potential innovations in farm organisation (Knopke et al. 2000; Liao and Martin 2009; Nossal and Lim 2011; Gladigau. 2013). However, given the nature of the productivity challenge, innovations in farm organisation—like joint ventures between farmers and the development of new structures for owning and operating farms—are increasingly being suggested to farmers as ways to attract the necessary scale, management skills and capital to bridge the productivity gap and increase competitiveness (Gorton and Davidova 2004; Wolfe 2011; Port Jackson Partners 2012; Cawood 2013). Innovations in farm organisation may involve family farms changing their business model; moving from an individual owner-operator model to a model characterised by greater management collaboration with other stakeholders and more formality of business processes, but retaining the basis of family farm land ownership (Sheth and Parvatiyar 1992; Bernard de Raymond 2013; Gladigau. 2013).

Considering these developments, it is important to provide a definition of a 'family farm'. In the context of this research, the terms 'owner-operator family farm' and 'family farm' are used synonymously. There are a wide array of definitions for family farms in the literature (Heady 1953; Lemons 1986; Gasson et al. 1988; Hill 1993; Hoppe and Banker 2010; van Vliet et al. 2015), but the most relevant for this study is the definition of 'family farm entrepreneurs' described by Pritchard et al. (2007):

> *where family units remain at the social and economic heart of farm ownership and operation, but in the context where they relate to their*

land-based assets through legal and financial structures characteristic of the wider economy (Pritchard et al. 2007, p. 76).

Although the owner-operator family farm model is the dominant and enduring farm structure in the rain-fed grains sector, other structures like corporate farm and hybrid family-corporate farm models, such as joint ventures (JVs), are also in existence.

In recent years, the number of non-family owned and operated 'corporate farms' has significantly increased. However, corporate farms still represent less than 5% of all grain-growing farms (Clark 2008; Pricewaterhouse Coopers 2011; Hansen 2012; ABARES 2013; James and Sexton 2013). The increase in corporate interest and investment in the Australian agricultural sector has been driven by a range of investors, including sovereign wealth funds, superannuation funds, and entrepreneurial primary producers (Moir 2011; Hansen 2012)

It is thought that the increased corporate investment in agriculture generally has been motivated by a combination of the following factors: 1) increased global food demand due to a rising global population and changing dietary habits from a growing middle class; 2) historic low levels of world grain stocks; 3) significant crop area being diverted for bio-fuel production; 4) the slowing of yield growth in major food crops; and 5) the limited supply of additional, accessible crop land (Alston et al. 2009; Carberry et al. 2010; Deininger and Byerlee 2012). Together with the influence of the economic, social and political operational environment, these factors have encouraged corporate investment into rain-fed agriculture in Australia and around the world, spawning the development of a diverse range of innovative farm business models (Corish 2010). Such models have the potential to introduce new technical,

organisational and managerial innovations that may boost productivity, yet they have received limited research attention in Australia. Further, these alternative models may provide important insights into the possible strengths, weaknesses and opportunities provided to family farms by adopting innovations in farm organisation to increase their competiveness.

This paper investigates the variety of organisational innovations that are being applied in the rain-fed grains sector presently and identifies possible organisational structures that could be adopted by family farms to boost productivity by overcoming scale, management and/or capital constraints to innovation adoption. In the next section, we provide an overview of the existing literature on potential farm business structures in the rain-fed sector, with particular reference to the advantages and disadvantages of family farms and corporate farm business structures. We then put forward a new conceptual framework for innovation adoption that links farm attributes with organisational structure. In addition, we characterise the different types of corporate farm models and associated sub-models operating in the grains sector in Australia. Interviews are undertaken with managers from corporate and hybrid family-corporate models to gain insights into how family farms may increase productivity and competiveness by adopting organisational innovations. Finally, data from a survey exploring Australian farmers' interest in adopting new farm business structures is presented, along with farmers' perceptions of the key advantages and disadvantages of such structures.

2.2 Farm structure in the Australian rain-fed grains sector

The owner-operator family farm model is the predominant farm structure in the rain-fed grains sector (Pricewaterhouse Coopers 2011). This sector is unlike the majority of production processes in other parts of the economy, which are often dominated by large, corporate enterprises. Broadacre agriculture differs from other sectors because of the inherent seasonality of production and the risk of random production shocks like drought, hail, floods and locusts (Allen and Lueck 1998). The constraint of seasonality limits the productivity benefits derived from specialisation, and reduces the potential for organisational efficiency due to timing issues within agricultural systems (Allen and Lueck 1998). Another difference with the owner-operator model is that family farms retain all of the profit from their work efforts and thus the incentive structure is highly aligned to drive efficient work practices. For corporate businesses, on the other hand, the incentive signal for employees can be skewed and may result in reduced work efficiency. Further, Allen and Lueck (1998) highlight that the unpredictable nature of the aforementioned production shocks and the limited skills and ability of management to compensate and counteract such shocks. Combined, these issues lead to highly volatile farm production, which adversely impacts labour productivity.

Where farm enterprises can emulate factory-like processes, a shift from family-based farming towards more corporate business structures has been observed. This is clearly evidenced in the USA where there has been major corporatisation in the intensive livestock sector for meat production (Furuseth 1997). The development of climate-controlled and factory-type production processes have resulted in a significant replacement of independent producers by either contract growers or corporate production (both vertical and horizontal coordination and integration) (Hefferman and

Constance 1994). This shift is noteworthy in the broiler, egg, pork and dairy industries where over half of production is now undertaken via production or marketing contracts (Hoppe and Banker 2010). In contrast, for field crops like wheat, soybeans and corn where seasonality remains very influential, the use of such contracts and associated vertical integration and coordination strategies by corporate entities is not widespread (Hoppe and Banker 2010).

Farm size is not necessarily an indicator of family versus corporate farming businesses. In the Australian rain-fed grains sector, the four largest family farm businesses (by sown crop area in 2010) were all bigger than the largest corporate farm business involved in crop production (Francis 2010).[1] However, Clark (2008) postulates that a large proportion of Australian farms could be considered a corporate farming enterprise. In Clark's study, a corporate farm was defined as an agricultural enterprise with more than $2 million in revenue per annum. This definition comprised both corporate farms (companies with shareholders and a board structure) and family-corporate farms (large family-owned enterprises). Of the 1,806 agricultural enterprises that met this criteria in 2006, 58% were family-corporate and 42% were corporate farm enterprises (Clark 2008). The family-corporate enterprises were primarily involved in the more climate-exposed sectors, like mixed farming, grain production, pastoral and dairy sectors. The corporate-farm enterprises were generally larger than their family-corporate peers, prevalent in the horticulture, cotton, irrigated grains, hogs and poultry sectors, and located in areas where irrigation is available (Clark 2008).

In the rain-fed grains sector, we have seen increased activity by corporate entities in recent years. Advances in rain-fed agricultural production systems have made these

[1] These large family operations had cropping areas ranging in size from 37,000 ha to over 100,000 ha

systems more resilient to the constraints imposed by seasonality and random production shocks (Carberry et al. 2010), which could partly explain the increase in corporate farming. One large corporate farm business in Australia noted that with improvements in farming systems and technological advances in the size, complexity and swath width of farm machinery, they have been able to expand the crop area managed by two employees from a target size of 2,000 hectares in 1996 to over 10,000 hectares at present (Rural and Regional Committee 2011). Clearly, for smaller family-farms to take advantages of these productivity benefits would require a substantial capital investment in land and new machinery.

As outlined by Allen and Lueck (1998), partnership and corporate structures can attain a competitive advantage because they typically have lower costs of capital, compared to family farm enterprises. This point is highlighted further in a speech by the former chairman of the National Farmers' Federation who indicated that the ability to finance farm investment, via increasing family farm debt, is becoming more expensive and alternative forms of finance from corporate investors in the form of either debt and/or equity will become more prevalent (Corish 2010).

However, as Kingwell (2011a) outlines, even with advancements in farming system technology, yield variance and downside revenue risk have increased significantly across Australian wheat farms in the last 15 years. This suggests that other factors not related to managing seasonality and random production shocks may limit opportunities to adopt more corporate business structures. For example, farmers will need to improve their skills to manage the increased complexity and move from a traditional farmer role into a farm business manager (Cary et al. 2002). This has seen the number of farmers with qualifications beyond school-level rise from 15% to 38% over the three

decades to 2011 (ABS 2012). However, successful farm management requires a diverse skill-set and to a large degree revolves around good decisions about the farm's enterprise mix, machinery replacement, land leasing or purchase, labour hiring and off-farm investments (Kingwell and Pannell 2005). The skill-set required to successfully manage these complex farming systems highlights the potential for management constraints to develop as farm enterprises become or require greater complexity to be competitive.

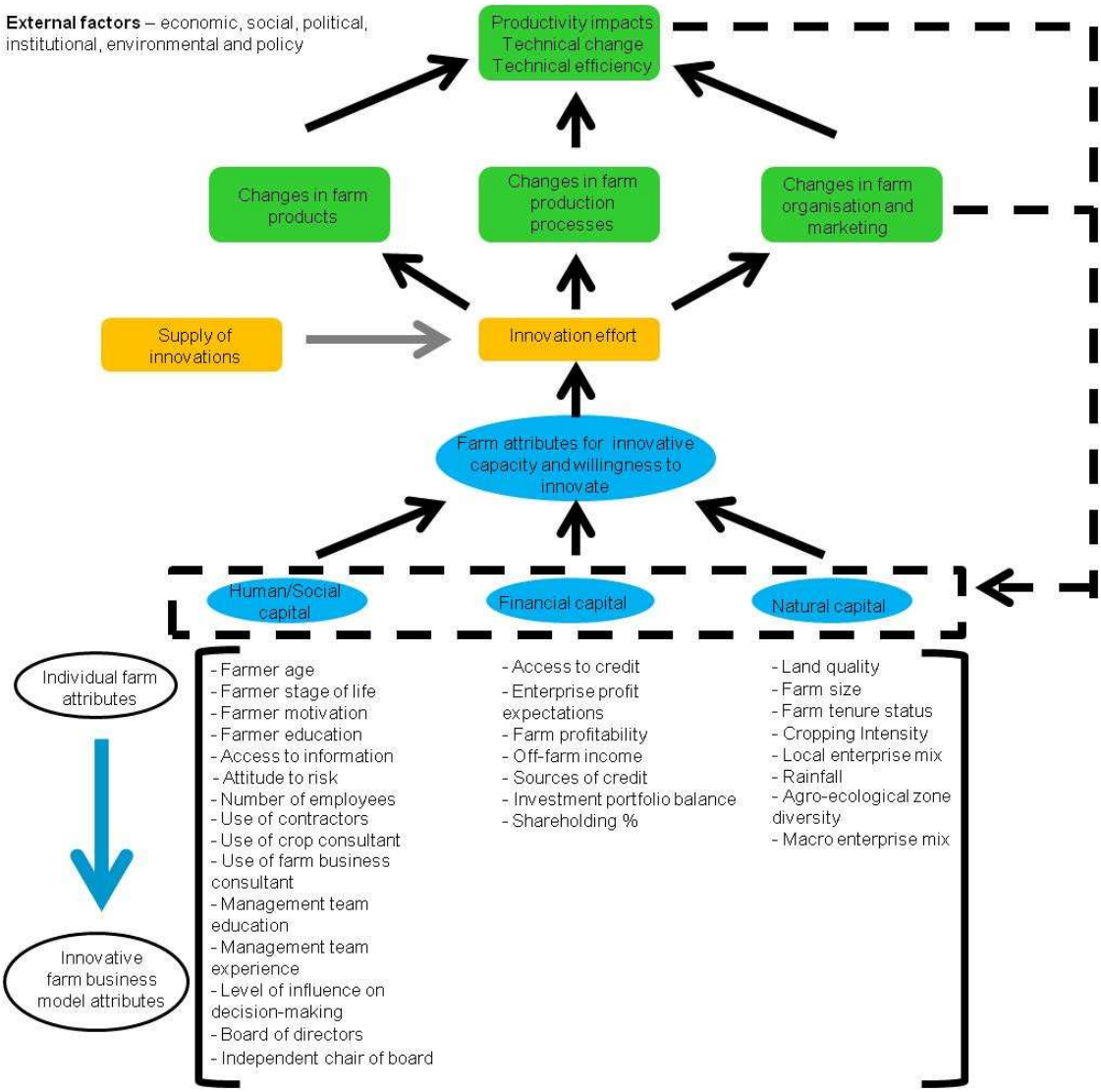
The owner-operator model used by the majority of farm businesses has been resilient and has been the foundation for the major technical gains in grain production observed over recent decades (Kirkegaard and Hunt 2010). However as farm enterprises become more complex and capital intensive, the importance of organisational and management innovation grows. The growing productivity gap between leading and typical farm businesses as a result of farm scale, management and capital constraints demonstrates the need for innovative solutions to boost competiveness. In the next section, we develop a framework for considering productivity improvement that includes factors arising from potential innovative farm business structures.

2.3 Conceptual framework linking farm business structure and productivity improvement

To evaluate innovative farm business models and to gain greater insight into how they may impact innovation and productivity improvement compared to typical owner-operator family farms, a conceptual framework is developed. The framework is based on an in-depth review of the literature. The framework is a way to illustrate, conceptualise and gain a better understanding of the potential differences between a typical owner-operator farm model, large scale family farms and innovative farm

business models in terms of farm attributes that may help to explain differences in innovation adoption and farm productivity.

Figure 1. A conceptual framework linking innovation adoption with farm attributes and associated farm business model complexity



Source: Adapted from (Pfeffer 1983; Pannell et al. 2006; Hughes et al. 2011; Nossal and Lim 2011)

Farm attributes are at the foundation of the conceptual framework in Figure 1, as there is a significant body of literature linking farm attributes with innovation adoption and productivity improvement (Feder et al. 1985; Kokic et al. 2006; Pannell et al. 2006; Nossal and Lim 2011). A number of attributes that are not typically accounted for are proposed within the framework to more readily delineate differences in farm business

structure, alongside attributes that are widely used in previous studies on innovation adoption in agriculture. Farm attributes in the conceptual framework are categorised into three groups based on three types of capital: 1) *human and social capital*; 2) *financial capital*; and 3) *natural capital* (Figure 1).

For *human and social capital*, previous studies have traditionally focused on characteristics of the individual, like age, stage of life, motivation, education, access to information, and attitude to risk; or on attributes associated with the use of non-family labour and expertise like the number of employees, use of contractors, use of a crop consultant, and use of a farm business consultant (D'Emden et al. 2008). These attributes provide a solid foundation, but with the development of larger and more complex farm business structures there is an increasing need to not only capture attributes specific to the individual (e.g. education, age etc), but also that of the broader management team and associated internal governance structures. We propose to include new attributes for management team education and experience, level of influence on decision-making (as influence may vary between farm partners), having a board of directors to aid decision-making, and contracting an independent chairman of the board.

For *financial capital*, previous studies on innovation adoption have looked at attributes like access to credit, enterprise profit expectations, farm profitability and off-farm income (Pannell et al. 2006). But, with the increasing financial complexity and capital requirements of family-farm businesses and innovative farm business models, there is the potential to incorporate a greater range of attributes that may vary with changes in farm structure. Proposed new attributes for financial capital include sources of credit, investment portfolio balance (a measure of investment diversification), and

shareholding percentage of the farm business, which may vary for individuals that may be partners in a joint venture farm business.

Natural capital attributes like land quality, farm size, farm tenure status, cropping intensity, local enterprise mix and climate risk or derivatives of such attributes are commonly captured in studies on innovation adoption (Pannell et al. 2006; D'Emden et al. 2008). However, as farms and associated models increase in scale and complexity they may be able to expand their operations and reduce their production risk by operating in multiple agro-ecological zones and/or achieving a diverse enterprise mix at a district rather than local scale. Attributes that capture these changes may be of increasing interest to studies on innovation adoption in the future.

With the conceptual framework, human/social, financial and natural capital variables impact and interact to determine the *innovative capacity* and *willingness to innovate* of a farm business. Innovative capacity and willingness to innovate are combined with the supply of new innovations from the research, development and extension community, and a range of external drivers influencing farm-level adoption like economic, social, political, institutional, environmental and policy factors, to determine the *innovation effort*. The innovation effort will vary for each farm from innovation to innovation depending on the observable relative advantage of the supplied innovation (Nossal and Lim 2011).

Innovation effort can lead to changes in farm products (e.g. new crop varieties), production processes (e.g. seeding systems), organisation (e.g. establishing joint venture relationships) and marketing. These changes ultimately have productivity impacts leading to *technical change* (innovation adoption) and *technical efficiency* (innovation diffusion) and/or impact other performance indicators like profitability,

natural resource condition or quality of life. For *organisational* innovations the productivity impact can often be indirect, as the organisational change may have transformative affect on the farm businesses involved by boosting the various forms of farm capital. This can then more readily facilitate the adoption of farm products and production process innovations that directly drive productivity improvements.

2.4 Farmer interviews and surveys

An in-depth review of the literature from journals and industry publications was undertaken to identify and characterise a typology of innovative farm businesses models currently operating in the Australian grains sector. This review was supplemented by qualitative data drawn from semi-structured interviews conducted with key management personnel from five corporate farm businesses and one hybrid family-corporate farm business. The interview questions were designed based on the conceptual framework described in the previous section, with questions focused on identifying perceived differences in human, financial and natural capital attributes between operators of innovative farm business models and those of typical family farms operating in respective regions. The interview questions were pre-tested with an agribusiness consultant that was familiar with corporate and family-corporate farm businesses. Interviews were summarised individually then synthesised as a group to draw out the main conclusions from the qualitative questions.

Given the limited number of large scale corporate farm businesses in operation in Australia, a limited number of potential interviewees could be recruited through direct contact. The interviewees were all involved in the operation of a variety of innovative farm business models and included some of the largest grain cropping enterprises in

Australia (Francis 2011). Interviews were conducted on-farm or at an off-site office of the respondent.

The aim of the semi-structured interviews was to elicit the opinions and perceptions of managers involved with the operation of innovative farm business models. In particular, the interviews focused on the key operational and managerial differences as perceived by managers' of innovative farm models between their operations and a typical owner-operator family farm. Using a set of interview questions (outlined below), respondents were asked to describe the advantages and disadvantages of their innovative farm business models and associated management, as well as the main barriers they thought would prevent typical family farms from capturing some of these advantages. Further, to assess the potential for typical family farms to gain from the experiences of these innovative entities, respondents were asked to identify the key features that typical family farms could adapt or adopt to improve their relative farm productivity and profitability. Specifically, the questions used in interviews with key personnel from innovative farm business models were:

1. In your opinion, what are the key advantages and disadvantages of this farm business compared to typical family farms in the region?
2. What do you think are the main barriers that typical family farms must overcome to begin capturing some of the advantages identified in question 1?
3. What are the key features or aspects of this farm business that typical family farms could potentially emulate or adapt to improve their enterprise productivity and profitability?

4. Can you highlight examples where large-scale has given this farm business a competitive advantage?

In addition to the interviews, we conducted a survey of rain-fed grain producers to gain insights into the current level of adoption and future potential interest in hybrid family-corporate farm models. The survey was conducted online in late 2013. Respondents were primary cropping decision-makers from 340 rain-fed grain farms across ten southern and western grain-growing regions in Australia. Farmers in each region were randomly selected from a comprehensive database of grain growers until the target number of respondents for each region was reached.

In addition to gaining insight into the current level of farmers' interest in hybrid family-corporate farm business models (including joint venture arrangements), the survey collected data on farmer perceptions of the advantages and disadvantages of joint venture farm business structures. The questions respondents were asked included "*Would you consider forming a joint venture arrangement with another farm business that involves putting land and/or major cropping machinery into a company arrangement?*" ('yes', 'maybe', 'no', 'already in one'). If the respondent indicated that they were interested (yes or maybe), they were asked the following open-ended question: "*What are the two main characteristic of a joint venture that makes it attractive to you*"? Respondents who indicated no interest in considering a joint venture structure were asked to answer the following open-ended question: "*What are the two main reasons for not considering a formal joint venture arrangement*"? The responses from these follow-up questions were coded to fit into a range of broad categories to assist with analysis.

2.5 Results and discussion

2.5.1 Typology of innovative farm business models

From a synthesis of the interviews with personnel involved in the management of innovative farm business models and an extensive review of the literature looking at farm business models in the Australian grains sector, a typology of innovative farm business models is proposed. When conducting the literature review we specifically focused on unique differences in innovative capacity and capital, including human, financial and natural capital. A summarised characterisation of these models is presented in Table 1.

Although diverse, innovative farm businesses operating in the Australian grains sector can be assigned to one of two broad typology groups: 1) hub-based models; and 2) contracting models. A hub-based model aims to have sufficient farm scale to optimise human, financial and natural capital at a district-level and thus maximise utilisation rates of machinery, labour and infrastructure to drive productivity. A contracting model involves a contractual arrangement between two or more parties that results in a transfer of risk between the respective parties. Given the nature of contracts, this model is highly flexible and encompasses a broad range of situational relationships and structures. It should be noted that the boundaries between these typologies are fuzzy and a firm may apply multiple models or sub-models depending on their investment objectives

Table 1. Typology of innovative farm models operating in the Australian rainfed grains sector

Business Model	**Business Sub-Models**	**Key Characteristics of Farm Business Models**
Hub-based models	Localised hub	• Aims to optimise economies of scale as well as human, financial and natural capital at a local scale. • Provides opportunities to facilitate labour specialisation as well as drive cost synergies and flexible business arrangements up and down the supply chain. • Primary typology model for both current and potential JV structures between sub-scale family farm businesses in the Australian grains sector.
	Geographically diversified hub	• All of the above, plus mitigation of production and price risk via a variety of strategies including crop, sector and geographical diversification. • Greater human and financial capital requirements due to the broader scope and complexity of operations compared to a localised hub model. • Primary typology model for both current and potential JV structures between optimal scale family farm businesses seeking geographic or sector diversification to manage risk.
Contracting models	Crop co-production model	• The farmer is the primary decision-maker but makes key crop management decisions in consultation with agronomist and other representatives of co-investors. • Volatility of farm revenue is reduced with the transfer of production risks to external investors. • The low risk, low reward farm business environment can possibly promote the testing of new innovations and can assist highly indebted or cash poor farmers with input costs on a short- and/or long term basis.

Table 1 (Cont.). Typology of innovative farm models operating in the Australian rainfed grains sector

Business Model	**Business Sub-Models**	**Key Characteristics of Farm Business Models**
	Farmer service provider model	• An innovative farm business model that relies primarily on farmer contractors for farm labour and operations on land the business it either owns or leases. • A farmer becomes a service provider of labour and/or equipment on land either owned/leased by the innovative entity. On land a farmer leases to the entity, farmer input and autonomy into decision-making is highly variable and can range from significant to limited depending on the contractual arrangement between the parties. • In some circumstances, a farmer can benefit via the reduction of production risk and providing flexibility for the degree of management involvement. In other circumstances, a farmer can expand crop area by leasing corporate owned land, thus allowing them to capture economies of scale.
	Management services provider model	• An innovative farm business model that is a service provider to other farm businesses requiring specialised management support. • This support can be provided to both family farm operations or corporate farm owners with payment structures designed to align the interest of both the land owner and the service provider. • For absent or retiring farm owners, it may provide flexibility for stage of life decision-making considerations (e.g. a break from farming, retirement, etc.), whilst promoting labour specialisation and highly-skilled farm management • May allow existing farmers to specialise their operation and skill-sets whilst diversifying their farm business through the outsourcing of non-core activities (e.g. contract grazing services)

A *hub* (or aggregation) is usually developed via the purchase of a number of smaller-sized, contiguous or nearby farms to ensure sufficient scale. The farms are then managed as one unit or 'hub' to facilitate farm efficiencies. Hub-based models can be classified into two sub-groups - *localised hubs* and *geographically diversified hubs*. A *localised hub* model has all of its production within a local area. This has management and logistical benefits, although climate and associated production risk are magnified, due to a lack of geographical diversification. The large scale of farm operations at a localised hub, and the efficiencies resulting from such scale, may create opportunities for greater use of specialised skilled labour within the business, and potentially reduce the relative unit cost paid to upstream and downstream supply chain partners.

It is hypothesised that family farm businesses with a sufficient combination of the three forms of capital (human and social capital; financial capital; and natural capital) often replicate this hub-strategy to a degree by steadily expanding their scale of operations over time by acquiring nearby land in the local district. Clearly, this type of model is not new, but there is a potential for typical family farms to mimic such a model and gain the associated benefits so long as they have a sufficient combination of the three forms of capital within their business.

The *geographically diversified hub* model has several localised hubs in locations across a geographically diversified system. This model has greater human and financial capital requirements at an organizational level due to the scale of operations across multiple hubs, and the additional complexity generated by the replication of such hubs across diverse geographical locations, agricultural products, production systems and in some cases agricultural sectors. This model has more intensive requirements for the three forms of capital as a result of the broader scope of

operations, but this operational diversity can also reduce exposure to production risk through geographical and climatic diversification and to price risk through the diversification of commodities within and between hubs. This model has been adopted by both corporate farm entities and large-scale family farm businesses. However, it is hypothesised that for typical family farms, the high overall capital requirements of this model make it an unlikely option to emulate, unless farm alliances or similar forms of collaboration between geographically diverse farmers are considered.

Hybrid family-corporate farm models, like joint venture structures between family farm businesses are likely to take the form of either a *localised hub* or *geographically diversified hub* model, depending on individual farmer circumstances and preferences. It is hypothesised that a localised hub model would be most advantageous for farmers currently operating grain farms at sub-optimal scale within a specific district. This would enable JV partners to capture economies of scale and operational efficiencies. Whist, it is hypothesised that a *geographically diversified hub* would be most advantageous for farmers currently operating at optimal scale, but seeking geographic or sector diversification to minimise risk for JV partners.

The other broad category of innovative farm business models is contracting models. Contracting models are not new to agriculture, what is new, however, is their increasing use by innovative farm business entities in the Australian grains sector and the diversity of contracting options available. Contracting models involve binding agreements between two or more parties that can transfer risk between the respective parties. Contracting models are classified into three sub-groups based on the control each party has over the decision-making process and the roles performed by each party

within the specified contract. We distinguish the *crop co-production model*, the *farmer service provider model* and the *management services provider model*.

The *crop co-production* model establishes a contractual relationship between investors and existing farmers, which results in an outsourcing of production risk via a payment transfer system from farmers to investors. In essence, variable costs of production like fertilizer, seed and chemicals are paid for by investors, with the farmer supplying labour, machinery and expertise to plant, manage and harvest the crop. Any profits resulting from the crop are then shared between the farmers and investors based on contract specifications. Such a model reduces downside risk for the producer in poor seasons but constrains farm returns in good seasons (due to the profit/cost-sharing arrangement). It is hypothesised that such a model could be attractive to farmers with a high debt load or employed strategically on a short- or long-term basis by farmers wanting to operate within a lower risk operating environment.

The *farmer service* - and the *management services provider models* are delineated by the agents functioning as the service providers in the agreement. The farmer service provider model, within a cropping context, involves a farmer providing varying levels of capital and input into decision-making, depending on the agreed contractual arrangement. A farmer could enter this contractual service arrangement on land owned and managed passively by another entity (e.g. corporate land owner), or on their own land through a lease arrangement with a corporate farm entity. For example, a farmer may own the land used for growing the crop and also provide the farm equipment and labour, but the farmer leases their land to a corporate entity for a 3-5 year period. As a result, the farmer receives a land lease payment and is paid for their labour and equipment but the resultant crop is owned and marketed by the corporate entity.

Further, the farmer may also need to adhere to specific field and crop management instructions prescribed by the corporation. It is hypothesised that such contractual arrangements have the potential to provide farmers with a range of options from increasing the farm operating size by leasing corporate-owned land to reduced production risk and less income volatility via leasing their land and forgoing management decisions through an arrangement with a corporate farm business.

The *management services provider model* is an innovative farm business model designed to assist farms requiring management support or farmers wanting to specialise their operation and skill-sets whilst diversifying their business by outsourcing non-core activities (e.g. contract grazing services).

Such arrangements may be fee-for-service, but often operate using a profit-sharing remuneration structure so that the long-term interests of both the farm owner and the management services provider are aligned to drive improvements in productivity and profitability. The service provider can employ a skilled farm operator to handle day-to-day management and operational activities. The farm operator is partnered with a specialist farm manager who can leverage their management skills over potentially a portfolio of properties operated by the innovative entity to help direct and drive productivity improvements. It is hypothesised that such a model may be of interest to absentee landowners or farmers considering a transition to retirement as the arrangement may allow the farmer to step back from day-to-day management and operation activities.

2.5.2 Advantages and disadvantages of innovative farm models: interview responses

The conceptual framework described in Section 2.3 forms the basis for the questions used in semi-structured interviews with management personnel from a range of farm operations utilising innovative farm business models. In these interviews, farmers identified the advantages and disadvantages they associate with innovative farm business models.

Advantages

Farmers and farm managers identified the following potential advantages:

- Increased scale of farm operations
- Better access to financial capital
- Improved governance and due diligence processes
- Human capital benefits

The large scale of farm operations: Respondents highlighted the importance of scale in delivering a range of benefits and gaining a competitive advantage over typical family farms. Across the six interviews, a number of key themes appeared repeatedly in relation to scale. Firstly, the large scale of operations significantly enhanced utilisation rates of labour and often machinery, which led to reduced production costs per unit of output. Secondly, many of the large-scale farm businesses reported ability to achieve reduced input costs for seeds, fertiliser and chemicals due to their increased bargaining power with suppliers. Thirdly, supply chain relationships with contractors (e.g. harvesting and trucking contractors) were strong, as relationships were often mutually beneficial with ongoing large scale contracts. In addition, because of their scale, interviewees reported being able to secure contracting services as a priority,

high-value customer and at a lower per-unit price than typical family farms. Further, for the interviewees working in geographically-diverse farm business models, scale combined with geographical diversity was associated with reduced market risk due to production being spread across a variety of climate zones. Interviewees also highlighted that scale facilitated the development of direct-selling of commodity products to major end-users, thus reducing supply chain costs and improving profitability.

Access to financial capital: The majority of interviewees expressed an opinion that they had greater access to financial capital compared to typical family farms and that this provided their business with a competitive advantage. In particular, investment decisions did not have to be cash-flow driven (as they can be for typical family farms). Therefore, highly profitable investment decisions with initial negative cash-flows could be more readily justified. Further, given the inherent volatility of the agriculture-sector, having greater access to capital was seen to allow the farm businesses to ride out market, climate and economic fluctuations and take advantage of opportunities when they arise. For example, land and other assets can be purchased at favourable times during the economic cycle or in response to an immediate or emerging operational need, like the purchase of new farm machinery. Interviewees also believed that farm inputs like fertilizer and herbicide were more likely to be applied at optimal rates as capital was more likely to be sufficient to fund such input rates.

Strong governance and due diligence processes: Interviewees suggested that their robust governance and due diligence processes provided a competitive advantage over typical family farms by increasing investment discipline. All respondents had a farm business structure that included a board of directors. Respondents noted a range of

benefits from having such a structure in place. Firstly, an independent forum is created in which decisions can be openly discussed, and day to day management can be integrated with strategic long-term objectives of the business. Secondly, farm management is accountable to the board and hence creates a mechanism for greater transparency in decision-making to drive continuous improvements in farm management. Thirdly, boards are generally comprised of a number of individuals who are less involved in the day-to-day operations of the farm business and can thus bring fresh eyes and different perspectives to the decision-making process. It was noted that board members can often bring in outside expertise that can assist the performance of the farm business, for example, accountancy, legal or business management skills.

Human capital benefits including increased labour specialization: A variety of issues around human capital were highlighted by interviewees. Human capital includes internal sources, like management and farm employees, and external sources, like consultants and contractors. Interviewees emphasised the importance of skilled and specialized labour to drive improvements in farm performance. Particularly interesting is that all interviewed businesses employed a farm business manager and used an agronomist to advise on crop management decisions and a grain marketing specialist to assist with marketing and managing price risk. There was also a significant emphasis by most interviewees on the use of contractors for harvesting, spraying, and sowing. Advantages that were mentioned included: reduced capital costs associated with farm machinery; contractors being highly skilled and efficient, and staffing levels that could be kept at a minimum.

Interviewees also highlighted the advantages of specialized labour: personnel could focus on their particular roles in the farm business and leverage that expertise over a

larger area of land. For example, it was reported that personnel with high-level skills in farm management were able to focus the majority of their time on management rather than day-to-day operational tasks, thereby generating a greater return for the farm business. This was thought to be in contrast to many typical family farms where the owner/manager may need to split their time between a variety of management and operational tasks on a day-to-day basis. Further, interviewees were of the opinion that their business entities have other human capital advantages over typical family farms in the recruitment and retention of high quality staff. There was a belief that in the majority of circumstances, a family farm would inevitably be managed by a family member, rather than an employee, which ultimately limits the opportunities for career progression of their employees. Other farm business models, on the other hand, could offer prospective employees a career path with resources dedicated to staff development and training. In addition, there may be a greater ability to provide better work-life balance for employees, as generally there are more staff and contractors on-hand to help out at critical periods during the production cycle.

Disadvantages

A range of disadvantages related to human capital and governance issues were also identified by the interviewees of innovative farm models when comparing their operations to that of typical owner-operator family farms. These included designing salary packages that incentivise efficient behaviour whilst keeping labour costs competitive, the difficulty in sourcing appropriately skilled farm staff, decreased short-term farm productivity due to turnover of key staff, and remaining cost competitive despite incurring additional overhead costs from governance processes, and extra layers of management and administrative staff.

Other disadvantages included the potential for conflict between investors and farm management on enterprise decisions, which may lead to sub-optimal farm business performance. An example given was that investors may prefer to grow only crops rather than having a mixed farming system that integrates livestock. This was seen to have potential implications for the flexibility of farm management and may limit the ability to manage risk and respond to various climate and market signals, which can impact farm profitability and competitiveness. It was also reported that strict occupational health and safety management policies meant that the farm labour force could be less flexible compared to that of a typical family farm.

Finally, for the majority of interviewees in hub-based models, a potential tension was reported between the scale of the farm operation and the planning horizon. A large scale farm operation can reduce the ability to be nimble and flexible when making short-term tactical management decisions. Major farm operations like planting and harvesting have to be planned and scheduled strategically, over a longer planning horizon, and on a larger scale compared to typical family farms to ensure operations are performed in an efficient and timely manner. This bias towards reduced operational flexibility and a longer planning horizon is further reinforced if tactical decisions need to be discussed and approved through a decision-making hierarchy within the business. Ultimately, the reduced ability of management to execute short-term tactical decisions could result in missed opportunities to increase profitability, which a smaller and more flexible owner-operator farm model can potentially take advantage of.

2.5.3 What measures could typical family farms adapt from innovative farm models improve productivity?

Respondents were asked how they thought a typical family farm could start to capture some of the benefits experienced as a result of operating an innovative farm business

models. While not all respondents had direct experience within an owner-operator family farm business, the question aimed to elicit what the respondents thought were feasible measures that family farms could implement to improve their productivity

All respondents highlighted the importance of increasing farm scale to improve the productivity of typical family farms. This scale could be acquired via the purchase or lease of more land, or by the use of joint venture arrangements with other farmers in the region, especially in circumstances where financial capital is limited. Scale was viewed by respondents as a vehicle to lower the cost of production and bring in specialised labour to increase the human capital of the business, whilst reducing the per hectare costs of adopting the latest technologies.

In addition, the over-allocation of time and resources by owner-operators on day-to-day operational tasks instead of management tasks was identified by interviewees as a potential barrier that may limit the long-run success and productivity of some typical family farms. To address this, contracting was identified as an opportunity, with farmers being able to improve efficiency by contracting themselves and their machinery out to other farm businesses in the region, or allowing owner-operators to specialise in the tasks they excel at by hiring employees or contractors to perform other specific tasks, for example, machinery or livestock contractors. Respondents also felt that many owner-operator farm businesses suffer knowledge and skill deficits that may adversely impact farm performance. To overcome these deficits and improve on-farm decision-making, the acceptance and wider use of external experts and specialised labour, like farm business and agronomic consultants were seen as possible solutions. However, respondents recognised that such services come with an upfront financial cost, which may place a significant burden on smaller farm operations.

Improving governance and due diligence processes within owner-operator family farm businesses was seen as a critical element that may improve productivity related farm investment decisions. Among respondents there was a general consensus that many owner-operator family farms needed to increase their professionalism and operate like other businesses that are typical of the wider economy if they are to remain productive and competitive. It was recognised that farming had changed dramatically in the preceding decades; from 'a way of life' to a complex and capital intensive business. However, it was thought that many owner-operator farmers had not evolved their internal governance processes to meet the challenges of the new business environment. In particular, respondents highlighted the need to limit the impact of emotion on decision-making as this can often lead to inefficient capital allocation through the pursuit of misguided investment priorities. The importance of using independent and external sources of advice to assist with investment decisions was identified as an important governance measure that many owner-operator farms could adopt to improve their competitiveness.

2.5.4 An alternative farm business model: a hybrid family-corporate farm model

One of the respondents interviewed had recently changed farm structure from an owner-operator model to a hybrid family-corporate farm model using a localised hub. The JV model was designed to capture and combine the inherent advantages of family and corporate farms within a corporate-style farm business structure, while maintaining the family-based ownership of farm land. The structure was formed as a result of two owner-operator family farm businesses entering a joint venture arrangement that involved leasing their land to a new company (formed by them) that

is jointly managed under the oversight of a board of directors. The board is comprised of both landholders and an independent chairman to help facilitate and promote good governance and due diligence processes. Such models are not prevalent in the Australian rainfed grains sector at present and hence an insight from their experience is valuable.

Based on the experience of the respondent it would appear that hybrid structures have the potential to enhance the three forms of capital (human/social, financial, and natural) of owner-operator farm models, take advantages of scale efficiencies by combining multiple properties into one management unit, and facilitate the process of labour specialisation. In particular, the respondent noted that the change in business structure increased farm profitability significantly in a good season, whilst in a poor season downside risk for each individual farmer barely changed. Therefore, in purely financial terms, both farmers, given their individual circumstances, were better off in the hybrid structure than as individual owner-operators. In addition, the hybrid structure facilitated the use of a no-tillage farming systems and other productivity enhancing technologies where capital and scale constraints had previously limited their use. Economies of scale and efficiency benefits had been achieved by combining the land area of both farms and acquiring additional crop land through lease and sharecropping arrangements to form an 8,000 hectare hub. As a consequence of increased bargaining power with suppliers, the relative price paid for inputs and other services was reduced. Further, the scale of operations has led to the consolidation, modernisation and more efficient use of the farm machinery fleet and made it feasible for the business to contract an agronomic consultant. For the individual farmers involved in the hybrid structure, it has also allowed them to specialise their work tasks, as each individual has a defined role and can focus on their individual responsibilities.

This respondent cautioned that hybrid family-corporate farm models may introduce new risks into the farm business and that they challenge the existing notion of what it means to own and manage a family farm. Besides experiencing many of the disadvantages mentioned in Section 5.2.2, this hybrid model has other unique issues that need to be managed. This includes accepting and adapting to change in relation to decision-making processes as a consequence of merging the two owner-operator farms into a hybrid family-corporate farm model. Despite both farmers still owning their underlying land assets, each farmer has had to accept a loss of independence in decision-making and ultimately reduced control of the new hybrid farm business. With a board comprising the respective farm owners and an independent chairman, major business decisions are made via a board voting process instead of the individual farm owner. Furthermore, with labour specialisation and the allocation of roles based on skills and experience, the scope of management and decision-making for each individual is clearly defined and more limited than that of the typical owner-operator. In addition, the implications for succession planning, which is already a complex task for most farm businesses, needs to be considered.

2.5.5 The interest of the farming community in hybrid family-corporate business models

The survey with 340 rainfed grain producers (Section 2.4) revealed that approximately 4% of producers are currently involved in a joint venture farm structure, which is a form of hybrid family-corporate farm model. While the application of joint venture farm structures is not widespread 11% of respondents said they were interested in considering a joint venture structure, whilst 44% of respondents answered that they

were ‘maybe’ interested. A large proportion of respondents (41%) indicated that they were not interested in considering a joint venture structure at all.

Farmers who answered that they were definitely or maybe interested in considering a joint venture structure were asked to indicate their main reasons for this interest. As presented in Table 2, reducing cost was highlighted by the majority of farmers (54%) as the main reason for considering a JV structure. Machinery costs in particular were an important driver (44%). Besides costs, the availability and more efficient use of labour (42%), improved farm efficiency and economics of scale (32%), improved utilisation of capital and greater profitability (19%) and access to the latest machinery and technology (19%) were major reasons highlighted by respondents that make a JV structure attractive.

Farmers who answered that they were not interested in considering a JV structure were asked to identify the major reasons for their answer (Table 3). Major drawbacks of JV structures that were identified related to adverse impact on independence and control of farm decision-making (35%) and the potential for conflict and/or finding suitable JV partners (32%). 21% of farmers were not interested in considering a JV structure as they were satisfied with their current farm business arrangements, and 12% were not interested as they already had sufficient farm scale. Increased farm business risk (17%), the potential for conflict over sharing machinery (16%) and issues related to family tradition, farm succession and the ability to exit a JV structure (10%) were also named as reasons for not considering a JV structure.

Table 2. Factors that make a JV structure attractive to rainfed grain producers who expressed an interest (yes and maybe) in considering a JV

Reasons for considering a JV	% of respondents		
	All (n=187)	**Yes (n=39)**	**Maybe (n=148)**
Reduce cost – all	54	49	55
Reduce cost – machinery	44	31	48
Labour efficiency and/or availability	42	41	42
Economies of scale and/or improve farm efficiency	32	38	30
Improved utilisation of capital and/or greater profitability	19	23	18
Access to new/bigger/better machinery and/or technology	19	15	20
Management capacity (access to expert skills and working in teams)	12	15	11
Reduce and/or diversify risk	9	13	8
Potential for farm and/or business scale expansion	7	10	6
Less stress and/or less workload/more leisure time	7	5	7
Other	4	5	4
Improve farm viability	2	5	1
Geographical and land type diversification	2	3	2
No comment	1	0	1

Table 3. Factors that make JV structures unattractive to rainfed grain producers (stated by respondents who were not interested in considering a JV, n = 139)

Reasons for not considering a JV	**% of respondents**
Adverse impact on independence and control of farm decision-making	35
Potential for conflict between JV partners and/or difficulties finding compatible partners	32
Satisfied with current farm business arrangements	21
Increased farm business risk	17
Potential for conflicts related to sharing machinery between JV partners	16
Already have sufficient scale	12
Family tradition and issues associated with JV reversibility and farm succession	10
Too close to retirement to consider a JV	8
Increased complexity of farm management and operational processes	8
Farm scale too small or inadequate levels of capital to effectively participate in a JV	4
Other	3
No comment	1

We now compare the responses from farmers interested in a JV structure to the interviewees' suggestions to improve family farm productivity. Both groups clearly recognise the importance of increasing farm scale and how this can be a driver to increase competiveness by reducing farm production and machinery costs.

There appear to be some differences of opinion when it comes to issues relating to farm labour and specialisation. Farmers interested in considering a JV structure identified the availability and more efficient use of labour as a positive feature, more so than benefits to management capacity. Interviewees, on the other hand, focussed largely on boosting the management capacity of farm businesses by focusing on strategic planning instead of day-to-day operational tasks. A possible reason for this

difference could be that the survey respondents believe they already have the management skills necessary and therefore do not see management capabilities as an issue. Interviewees also highlighted the importance of improved governance and due diligence processes to enhance productivity related farm investment decisions. However, it appears that this issue received minimal consideration by the farmer survey respondents.

Conversely, many of the major reasons for farmers not interested in considering a JV match the constraints mentioned by the operator of the hybrid family-corporate joint venture farm model (Section 2.5.4). In particular, issues around farmer independence, decision-making processes, potential for conflict between JV partners, increased business risk and the implications for farm succession were commonly cited. Clearly, these issues go to the core of what it means to be an owner-operator farm business and highlight the complex socio-economic and cultural trade-offs involved with adopting organisational innovations like a joint venture structures.

2.6 Conclusions

The owner-operator farm model remains a very successful farm structure in the Australian rainfed grains sector. However, an increasing productivity gap between the most productive and the average family farm due to farm scale, management and capital constraints suggests that some family farms are struggling to adapt and evolve their businesses to remain competitive. Alternatives to the owner-operator model are becoming more widespread in the sector and a typology of innovative farm models operating in the grain sector was proposed.

Interviewees operating innovative farm business models suggested that typical owner-operator family farms could potentially boost productivity by: expanding farm scale, increasing the use of contractors and specialised labour to allow the operator to concentrate on management tasks, and improving governance and due diligence processes, especially for capital intensive investment decisions. However, implementing such initiatives requires appropriate levels of human, financial and natural capital, which for some owner-operator firms is insufficient.

A hybrid family-corporate farm model, like a joint venture between family farm businesses, combines some of the beneficial features of innovative farm models with those typified by owner-operator family farms. Benefits of joint venture structures like reduced costs, economies of scale, labour efficiency and improved farm profitability need to be weighed against the implications for farmer independence, control of decision-making processes and increased business risk. The changes required to shift from an owner-operator farm model to a joint venture structure challenges the notion of what a family farm is. For family farms to adopt such a structure, they will most likely need to take steps to accept new forms of business risk, address human, financial and natural capital constraints and overcome various barriers to change within their business. For a substantial number of rainfed grain producers, this is trade-off they are currently willing to consider.

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Chapter 3 Farmer interest in joint venture structures in the Australian broadacre grains sector

Abstract

There is a growing productivity gap between leading and average grain farms in Australia, driven by a combination of constraints that limit the adoption of innovations. Such constraints may be reduced by the adoption of organisational innovations, including collaborative structures such as joint venture (JV) arrangements. Given the predominance of the owner-operator family farm model in the Australian grains sector, organisational innovations have largely been overlooked by the research and extension community. This paper examines business alliance formation in agriculture and farmers' perceptions of, interest in, and barriers to participation in JV structures. A telephone survey of 573 Australian grain growers revealed that 3% of farmers had adopted a JV structure and that such farms were significantly more likely to have a larger crop area and be less diversified compared to non-adopters. Another 21% of farmers expressed an interest in adopting a JV structure in the future, particularly to reduce costs and improve productivity. A multinomial logit model showed that such farmers were significantly different for a number of socio-demographic variables including age and education, when compared to farmers not interested in adopting JV structures. To build on this basis of interest and motivation for innovative farm business structures, further understanding of perceived trade-offs and preferences is needed to identify the most attractive JV designs.

3.1 Introduction

In Australia, the majority of farm businesses in the broadacre grain sector are owned by families utilising an owner-operator model (ABARES 2003). These family farms operate in an increasingly complex, challenging and competitive operating environment (Keating and Carberry 2010). Over time, estimates suggest that farm productivity gains of 2% or more are required to retain farm enterprise viability due to declining relative returns from food production and the increasing costs of many inputs (Mullen 2007; ABARES 2008). To achieve the necessary productivity growth, farmers have adopted new technologies, like improved farming practices and high performing crop varieties (Angus 2001).

Farm amalgamations, driven by structural change in the sector, have also allowed farmers to expand their operations and potentially capture economies of scale (Boehlje 1992; Kingwell and Pannell 2005). Increasing scale typically leads to higher levels of output and income per hectare, thus improving productivity and ultimately profitability (Davis et al. 2013). However, there is evidence of an increasing productivity gap between the average farm and farms on the productivity frontier (ABARES 2010; Jackson 2010; Hughes et al. 2011). Studies suggest that 'average farms' are often limited in their ability to adopt new technologies and other innovations that can boost productivity because of limited farm scale, management and capital constraints.

A study of the adoption habits of broadacre grain producers showed that productivity improvements in the grains sector have predominately focused on changes in farm products, production processes and marketing innovations (Nossal and Lim 2011). Productivity improvement via innovations in farm organisation has been limited in the sector (Litzenberg and Schneider 1986; Knopke et al. 2000; Liao and Martin 2009;

Gladigau. 2013). Greater collaboration between farmers and the development of new structures for owning and operating farms are increasingly being suggested as ways to attract the necessary scale, management skills and capital to bridge the productivity gap and increase competitiveness (Gorton and Davidova 2004; Wolfe 2011; Port Jackson Partners 2012; Cawood 2013).

One way to achieve this is through the application of different business alliance forms (Lyons 1991; Sheth and Parvatiyar 1992). Traditionally, many agricultural producers have used alliance structures like cooperatives to increase competitiveness (Ortmann and King 2007). However, other collaborative structures are of increasing interest to producers and policymakers as a means to address the productivity challenge (Gladigau 2013). An example of such alliance structures are joint ventures (JV). A JV is a form of collaborative structure that results in the creation of a new organisation that is formally independent of the parents (Section 2.2). Control and responsibility for the venture vary depending on each individual JV agreement (Borys and Jemison 1989). Compared to cooperatives, these structures have a far more limited history in agriculture with minimal associated literature, even though such structures are widely used by firms in the broader economy (Ingram and Kirwan 2011).

The primary objective of this paper is to quantify, for the first time, the current prevalence of JV structure adoption by Australian broadacre grain producers, and to reveal differences between these farm businesses and farmers with a typical owner-operator farm structure. We identify which producers are most interested in JV structures. We also explore reasons for producers' interest in JV structures. Based on a thorough review of the literature and the conceptual model of farm attributes outlined Chapter 2, we hypothesise that farmers with the highest likelihood of interest in

adopting a JV structure are more likely to be younger, have a university degree and farm a smaller area than other farmers in the sample. Using a logit model populated with socio-demographic farm variables, we aim to predict what type of producer may be interested in adopting such structures in the future. A cluster model is also used to identify producer segments and their related interest in JVs.

The next section provides an overview of the existing literature on alliance formation in agriculture to achieve productivity improvements, with a specific focus on co-operatives and collaborative structures like JVs. Section 3 describes the data collection and analytical approach, with survey and analytical results presented in Section 4. The results are discussed in the fifth section. A final section summarises the main implications of the research and concludes the paper.

3.2 Typology of business alliances in agriculture

The formation of business alliances is common throughout most industries and sectors of the economy. Sheth and Parvatiyar (1992) define a business alliance as an "ongoing, formal, business relationship between two or more independent organisations to achieve a common goal". Such relationships are characterised by being more than a typical transactional business relationship but does not extend to outright takeovers or mergers. Firm relationships can focus on operational tasks that rely on factors like resource efficiency and asset utilisation, while strategic firm relationships rely on deeper firm integration at both a managerial and operational level to achieve a competitive advantage.

Sheth and Parvatiyar (1992) postulate that the type and form of alliance relationship is driven by differences in the level of uncertainty in the business operating environment,

and the level of trust between firms—firms may perceive each other as competitors (low trust) or non-competitors (high trust). A typology of four alliance types is outlined by Sheth and Parvatiyar, who state that 1) *competitive alliances* are likely to be formed when uncertainty is high but partner trust is low; 2) *cartels* are likely to be formed when uncertainty is low but partner trust is low to medium; 3) *cooperatives* are likely to be formed when uncertainty is low and partner trust is high; and 4) *collaborative ventures* are likely to be formed when uncertainty is high and trust between partners is high.

Based on the typology above, cooperatives and collaborative venture alliances have a common foundation built on a relatively higher degree of trust between partners. As both structures are comprised of non-competitors, there should be a free-flow of information and cooperation between partners, and shared learning across the organisation (Sheth and Parvatiyar 1992). However, compared to cooperatives, collaborative ventures can have a higher level of uncertainty, as the alliance focuses on not only operational issues (like a cooperative) but also integrates deeper strategic managerial issues. As a result, entry barriers can be higher in collaborative structures compared to cooperatives as strategic goals between firms may differ or may be difficult to align. Collaborative structures also demand higher asset specificity with partners exercising greater control over management decisions, which ultimately leads to a higher level of commitment to ensure the alliances' success.

3.2.1 Cooperative business alliances in agriculture

Cooperatives in agriculture have a history dating back to the late 19th and early 20th century, and were formed because of a variety of economic, farm organisation and public policy factors (Cook 1995; Ortmann and King 2007). Traditionally, farmers

have used cooperatives to pool their resources and increase their negotiating power with the aim of enhancing the mutual benefits of the cooperative members (farmers) (Cook 1995; Ortmann and King 2007). There are a wide variety of cooperative types in agriculture. Of most relevance to this study are supply cooperatives, production cooperatives and/or machinery-sharing cooperatives, which improve farmers' access to farm inputs and capital which are often directly related to enhancing farm-level productivity (Bijman et al. 2012). However, other cooperative types, like marketing cooperatives that collectively market the output of producers have also been established in the agriculture sector. The primary objective of these latter cooperatives is to increase the collective bargaining power of farmers and the efficiency of relationships between partners in the value chain.

Agricultural production cooperatives acquire total control of the land resources of its members via purchase or lease and/or leasing additional non-members' land (Harris and Fulton 2000). The arguments about the benefits of agricultural production cooperatives historically revolved around the advantages of economies of scale and a greater capacity of such farms to adopt the latest technology and distribute resources more equitably amongst members (Deininger 1995). The limited adoption of production cooperatives by agricultural producers may indicate that the costs of such structures are perceived to generally outweigh the possible productivity benefits. Indeed, Deininger (1995) highlights that scale benefits can often be eroded by agency costs associated with monitoring and motivating labour. Further, investment incentives for members can often be skewed and result in under-investment, with a preference for shorter-term investments that deliver returns during the members' tenure.

Alternatively, machinery-sharing cooperatives have shown some promise for increasing farm productivity (Harris and Fulton 2000; Long and Kenkel 2007). Machinery cooperatives share the costs of buying machinery, fixed costs and operating expenses (Long and Kenkel 2007). Since machinery costs are a major expense for individual producers, the need to share these costs, capture efficiency gains, and benefit from economies of scale has been one of the drivers contributing to machinery cooperatives (Long and Kenkel 2007).

Experience with machinery cooperatives in Saskatchewan, Canada, indicates that such structures allowed grain farmers to jointly purchase larger and more efficient machines that individual members could not afford to purchase alone (Harris and Fulton 2000). Per hectare machinery costs for some cooperative members were reduced by 30-65%, depending on individual circumstances.

Simulations of machinery cooperatives on the southern plains of the USA also noted total machinery savings of 14-31% for members (Long and Kenkel 2007). However, despite their success, machinery cooperatives still have limited broad appeal as farmers fear that they will need particular machinery at the same time, which is particularly critical for seasonal machinery like seeders and harvesters (Harris and Fulton 2000; Long and Kenkel 2007). Nevertheless, evidence from Saskatchewan machinery cooperatives suggests that none of the cooperative members experienced such potential conflicts, either by agreeing to an (in)formal set of rules around scheduling or by adopting a more integrated cooperative business structure that pools income as well as machinery (Harris and Fulton 2000).

Machinery-sharing cooperatives where both machinery and income is pooled among all members of the co-op could overcome the scheduling and decision-making constraints (Harris and Fulton 2000). This level of integration often results in some loss of independence as operational decision-making moves from the individual to the group. The cooperative manages all field operations and coordinates labour inputs by its members (Harris and Fulton 2000). Cooperative structures where machinery as well as income is shared among members have many common characteristics with the collaborative business structures, described in the next section.

3.2.2 Collaborative business alliances in agriculture

Collaborative alliance structures have a far more limited history in agriculture (Ingram and Kirwan 2011). The focus of this study is on joint venture (JV) business structures. We define a JV as "the bringing together of land, capital and skilled management in an agreement between two or more parties, each running their own underlying business" (ADAS 2007). In sharing machinery costs, operating expenses, labour, land and income, JV structures are similar to what Harris and Fulton (2000 p.2) call "co-operative farms". While JV structures are potentially beneficial to farmers and rural communities, the benefits of such structures, and the resources and skills required to make them work effectively are presently not well understood (Grande 2011). At the foundation of all successful JVs is the premise that all partners gain from the structure (Lynch 1989). However, a view expressed regarding JVs is that they are a fallback or compromise solution for firms that are unable to grow and compete independently due to their individual circumstances (Lyons 1991). Even if this pessimistic analysis is the case, a JV may still present partners with the most cost-effective way forward.

The literature on JVs within the agriculture sector is scarce. Ingram and Kirwan (2011) looked at matching new farm entrants with retiring farmers in the United Kingdom through JV partnerships. Such JV agreements offer new farmers the chance to enter an established business without significant capital expenditure; to learn from the knowledge and experience of the older farmer; and build upon their established business networks, whilst allowing an older farmer to progressively step away from the farm operation into semi-retirement and ultimately lead to the successful transfer of the farm business to the new partner. Despite the benefits of such arrangements, participants expressed a deep-rooted reluctance to enter formal long-term JVs due to differing motivations, expectations, and concerns about their respective responsibilities in the working relationship (Ingram and Kirwan 2011). This reluctance to commit to formalising a JV agreement was only overcome when there was an existing informal relationship between the parties.

In the Australian broadacre agriculture sector there is some research looking at the potential for JV structures to improve the viability of small family farms via the concept of “cross boundary farming” (Williamson et al. 2003; Muenstermann 2009). When farmers are interested in establishing such structures, the importance of developing and enforcing strict rules through mutual agreement is highlighted as a critical step to minimise potential disputes between JV partners and address issues like free-riding (Williamson et al. 2003). Williamson et al. (2003) also highlights potential threats to the long-term longevity to such structures, including a change in farm ownership, difficulties related to succession planning and individuals accepting a loss of independence in decision-making.

Despite these threats, JV structures may have the potential to address the productivity challenge faced by many broadacre producers by overcoming scale, management, and capital constraints that currently limit efficiency and adoption of technologies that boost productivity (ABARES 2010; Jackson 2010; Hughes et al. 2011; Gladigau. 2013).

Although there are no empirical studies, anecdotal evidence suggests that JV structures can improve the competitiveness of family farm businesses (Brunckhorst and Coop 2003; Gladigau. 2013). JV structures can take a variety of forms but could potentially involve structures where existing farm(s) collaborate with other farmers or with passive investors. A well-known example is a JV operated and promoted by two farmers in the Mallee region of South Australia. This JV structure was formed by two families who had known each other for a number years and had trialled the arrangement at a smaller scale before establishing a formal collaborative structure (Gladigau. 2013). The two farms are now managed as one operating business resulting in a range of scale, management, and capital benefits. Specifically, the management unit has more than doubled in size, the farm machinery fleet has been modernised and consolidated, and the relative price of procured inputs and services has been significantly reduced (Lynch et al. 2012; Gladigau. 2013). Further, the change in business structure has facilitated greater specialisation of labour units and has helped overcome previous innovation constraints, which led to the adoption of a no-tillage farming system, precision agriculture and other technologies that improve productivity (Lynch et al. 2012; Gladigau. 2013).

Although the aforementioned literature identifies four business alliance types, the lines of differentiation between types can be quite blurry in some aspects. For example, with

respect to risk, production cooperatives that share machinery and income, and collaborative business alliances both require high levels of trust and strategic integration across multiple farm businesses. Although this deep integration is likely to generate significant operational and financial advantages, it also creates significant reversibility risk, as dissolving or exiting such an alliance may have major negative financial implications for the individual farm business involved.

Overall, the literature indicates that JV structures have the potential to overcome some of the constraints associated with production and machinery cooperatives but also require a greater commitment by participants by aligning both operational and strategic objectives (Sheth and Parvatiyar 1992; Deininger 1995; Harris and Fulton 2000). A number of knowledge gaps have been identified concerning the use and potential adoption of JV structures by broadacre grain producers, and these will be addressed in this paper. As a first step, we collect information about the current level of adoption of JV structures and how these businesses may differ across a range of socio-demographic variables compared with traditional owner-operator farm businesses. Further, we capture data on the level of interest in adopting JV structures by current non-adopters, and aim to explain how interest is influenced by farmers' demographic characteristics.

3.3 Methods

3.3.1 Data collection

A telephone survey was conducted in August 2012 with 573 primary cropping decision-makers from broadacre grain farms across twelve southern and western grain growing regions in Australia. Farmers in each region were randomly selected from a

comprehensive database of grain growers until the target number of respondents for each region was reached. Only those growing more than 500ha of grain were selected. Of those contacted, 45% of farm businesses elected not to take part and 31% agreed to take part but the primary cropping decision-maker was not available to complete the questionnaire at the time of the initial call and the regional respondent quota had been filled before a call back was made. In total, 573 respondents completed the survey, which is 24% of all of the farm businesses contacted.

To gain insight into the current level of interest farmers had in JV structures, we asked: "*Would you consider forming a joint venture arrangement with another farm business that involves putting land or major cropping machinery into a company arrangement?*". The respondent could answer 'yes', 'maybe', 'no' or 'already in one'. Respondents who answered yes, maybe, or already in one were then asked their main reasons for considering a JV arrangement.

Of the 573 producers participated in the survey, there was good representation from each of the major southern and western grain growing regions. Table 1 summarises the regional sample sizes, locations and interest in JV structures.

Table 1. Number of responses and joint venture preferences by production region across Australia

State	Region	Number of responses	Would you ever consider a Joint Venture arrangement?			
			Already in one (%)	Yes (%)	Maybe (%)	No (%)
New South Wales	*Central West*	53	2	25	11	62
	Riverine Plains	50	8	20	14	58
Victoria	*Vic Mallee*	52	4	17	17	62
	Wimmera	51	4	24	16	57
	Loddon	50	0	14	8	78
	SA Mallee	50	2	28	8	62
South Australia	*Central*	52	4	19	13	63
	Upper Eyre Peninsula	51	6	29	24	41
	Lower Eyre Peninsula	36	6	33	8	53
Western Australia	*North-Central*	36	6	11	25	58
	South-Central	47	2	26	21	51
	Southern	45	2	4	16	78
Australia	All	573	3	21	14	62

Overall, 21% of broadacre grain producers would consider adopting a JV, with another 14% classed as ‘maybe’, while 62% expressed no interest in adopting a JV structure. Only 3% of farmers indicated that they were already involved in a JV structure of some form. At a regional level, the Lower Eyre Peninsula in South Australia demonstrated the greatest interest in JV structures with 33% of farmers answering ‘yes’, whilst the Loddon region of Victoria and the Southern region of Western Australia had the greatest percentage of farmers indicating no interest in considering a JV (78%). The Riverine Plains region of NSW had the greatest percentage of farmers already in a JV (8%) (See Figure 1 below).

In addition to the adoption and interest in JVs, the survey also collected data on respondents' adoption of a range of farming practices including autosteer, yield mapping, tillage practices, soil testing and use of farm advisers. Finally, general data was collected about farm size, enterprise mix, and farmer demographics, attitudes and perceptions. Table 2 provides an overview of the different data collected and summary statistics.

For the initial analysis, descriptive statistics of the four unique respondent groups (yes, maybe, no, already in one) were compared. We also assessed the differences between adopters of JVs (already in one) and current non-adopters (Table 3). Given the number of respondents in each category were unbalanced, group means were compared for significance using Tukey's t-test for continuous variables and chi squares tests for other variables types (binary, categorical, ordinal, etc.). Differences in the groups are discussed in section 3.4.

3.3.2 Predicting farmer interest in joint venture structures

A multinomial logit regression model was used in a parametric analysis to assess if interest in adopting a JV structure could be predicted for farmer respondents using a number of independent socio-demographic variables (explained in Table 2). Similar logit models have been used in a number of innovation adoption studies in the agriculture sector (Sheikh et al. 2003; D'Emden et al. 2008).

Given the low level of current adoption of JV farm business structures and the study's focus on the potential for greater uptake in the future, the potential adoption of the innovation in the future by current non-adopters was used as the dependent variable. The dependent variable *jvinterest* was coded as follows:

- *jvinterest* = 2 for farmers who expressed a definite interest (yes)
- *jvinterest* = 1 for farmers who were uncertain (maybe)
- *jvinterest* = 0 for farmers who were not interested (no)

The last group (*jvinterest* = 0) was used as the base case to which the other two categories of farmers are compared. Given that this analysis focussed on non-adopters of JVs, the farmers who were already in a JV were excluded. A range of models including different independent socio-demographic variables captured in the survey (Table 2) were evaluated before a final, best-fitting model was selected.

3.3.3 Characterising farmers by interest in joint venture structures

Cluster analysis was undertaken to identify different segments of producers and their interest in JV structures. Cluster analysis is a statistical technique that makes no distinction between dependent and independent variables. It is used to group or 'cluster' respondents with comparatively homogeneous characteristics within the cluster but with heterogeneous characteristics relative to respondents in other clusters (Ziehl et al. 2005). The cluster models were estimated in the STATA 12.1 software package (StataCorp 2011). The Calinski test was applied to identify the optimum number of clusters for the analysis combined with the k-means clustering technique (Caliński and Harabasz 1974). Clusters included a wide range of socio-demographic farm attribute variables. Respondents' interest in a JV structure was included as a variable.

3.4 Results

3.4.1 Characteristics associated with interest in joint ventures

Descriptive statistics comparing farmers' socio-demographic characteristics and their interest in JV structures are presented in Table 2. A number of significant differences were identified between groups. Farmers who are already in a JV were more reliant on cropping income (*cropincome*) and farmed on a larger scale: They had a greater average past, current and expected crop area (*3yrcroparea*, *avcroparea*, and *futurecroparea* respectively) compared to farmers not involved in JVs. When compared to farmers who expressed no interest in JVs, those who were already in a JV were more likely to pay for agronomy advice (*paidadvice*) and for that advice to be provided by an independent crop consultant (*cropconsultant*). There were no significant differences between the 'maybe' and 'already in one' farmers and between the 'maybe' and 'no' farmers for any variables. Farmers who were definitely interested in a JV agreed more readily that skilled labour was one of the biggest constraints for their farm operation (*labourconstraint*) and were also more likely to have someone managing the farm with a university degree (*education*) than farmers who had no interest in a JV.

Table 2. Variable descriptions and descriptive statistics (means) of variables by joint venture preference

Variable	Description	n	mean	st. dev.	yes (n=118) A	maybe (n=79) B	no (n=357) C	already in one (n=19) D
Lowrain	1=Rainfall below 350mm; 0 = Rainfall above 350mm	573	0.42	0.49	0.47	0.44	0.41	0.26
Cropincome	% of gross property income derived from broadacre cropping over the past 3 years	573	73.7	22.73	72	74	74	83
Cropspecialist	1=75% or more of gross property income derived from broadacre cropping over the past 3 years (0=No)	573	0.56	0.5	**0.51^{d*}**	0.59	0.56	**0.79^{a*}**
Sheepincome	% of gross property income derived from sheep production over the past 3 years	573	22.1	19.78	24	22	22	14
Totalarea	Total farm area (ha)	572	3078	3885	2893	3964	2914	3616
Avcroparea	Average crop area in a normal season (ha)	571	1805	1605	**1643^{d**}**	2034	**1760^{d*}**	**2695^{a**c*}**
Cropintensity	Average crop area in a normal season / total farm area (%)	570	64.01	25.41	63	64	64	75
Prefcrop	1=Prefer cropping only enterprise; 0=Prefer livestock only enterprise	573	0.71	0.45	0.72	0.67	0.71	0.89
Totalarable	Total arable land currently managed (ha)	572	2541	2111	**2314^{b*}**	**3023^{a*}**	2463	3407
Arableexpand	1=You or a family member will be managing more arable land in 5 yrs time (0=No)	573	0.3	0.46	0.33	0.28	0.29	0.47
3yrcroparea	Average crop area over the past 3 yrs (ha)	572	1801	1649	**1548^{b*d**}**	**2120^{a*}**	**1762^{d**}**	**2771a^{**c**}**
Futurecroparea	Expected crop area in 5 yrs time (ha)	530	1855	1751	**1546^{b**d***}**	**2238^{a**}**	**1819^{d**}**	**2945^{c**}**
Ageseeder	Age of seeder machinery (yrs)	567	11,2	8.5	12	10.6	11.2	9.8
Ageheader ≤ 10yrs	1=Header age 10yrs or less; 0 = Header age greater than 10yrs	553	0.61	0.49	0.57	0.69	0.6	0.84
Notill	1=Use or have used no-till for cropping (0=No)	573	0.85	0.36	0.86	0.84	0.85	0.89
Group	1=Yes – Member of a group that looks at cropping issues (0=No)	573	0.55	0.5	0.55	0.54	0.56	0.53

Variable	Description	n	mean	st. dev.	yes (n=118) A	maybe (n=79) B	no (n=357) C	already in one (n=19) D
Paidadvice	1=Yes – Currently pay for a consultant, advisor or agronomist for cropping advice (0=No)	573	0.52	0.5	0.53	0.59	**0.49^{d*}**	**0.79^{c*}**
Futurepaidadvice	1=Yes – Expect to be paying for a consultant, advisor or agronomist for cropping advice within 5 years (0=No)	573	0.63	0.48	0.67	0.7	0.6	0.79
Cropconsultant	1=Use of paid independent crop consultant (0=No)	573	0.4	0.49	0.42	0.49	**0.36^{d**}**	**0.68^{c**}**
Autosteer	1=Yes – currently using autosteer on farm machinery (0=No)	573	0.77	0.42	0.83	0.75	0.75	0.84
Yieldmap	1=Yes – collecting yield maps this year (0=No)	573	0.4	0.49	0.41	0.46	0.39	0.42
Soiltest	% of paddocks soil tested in the last 3 years	573	44	38	42	48	43	46
Prefsimple	1=Strongly agree / Agree with statement "*I prefer to keep my farming operations very simple*" (0=No)	573	0.82	0.39	0.79	0.8	0.84	0.74
Labourconstraint	1=Strongly agree / Agree with statement "*A lack of skilled labour is one of the biggest constraints to my farm operations*" (0=No)	573	0.46	0.5	**0.55^{c*}**	0.44	**0.43^{a*}**	0.53
Computerskills	1=Strongly agree / Agree with statement "*there is someone involved in the farm business who has strong computer technology skills*" (0=No)	573	0.61	0.49	0.63	0.58	0.61	0.63
Relycontractor	A sliding scale from 3-9 that indicates an increasing reliance on contractors for seeding, spreading and harvesting	573	3.99	1.41	4.09	3.96	3.98	3.84
Age	Age categories:1 = 18-24yrs; 2 = 25-34yrs; 3 = 35-44yrs; 4 = 45-54yrs; 5 = 55-64yrs; 6 = 65yrs +	573	4.39	1.05	4.32	4.34	4.41	4.58
Education	1=Someone managing the farm has a degree/diploma from a university (0=No)	573	0.32	0.47	**0.41^{c*}**	0.29	**0.29^{a*}**	0.32
Futureyears	Number of years the respondent expects to be actively farming into the future (yrs)	568	13	9.25	12	13	13	16
Familysuccession	1=Family succession is likely or very likely (0=Other)	573	0.54	0.5	0.49	0.49	0.56	0.53

* P < 0.1; ** P < 0.05; *** P < 0.001 (Different letters indicate significant differences between variables); ^{A} = significant difference between response group and respondents who answered YES to interest in considering a joint venture; ^{B} = significant difference between response group and respondents who answered MAYBE to interest in considering a joint venture; ^{C} = significant difference between response group and respondents who answered NO to interest in considering a joint venture; ^{D} = significant difference between response group and respondents who answered ALREADY IN ONE to interest in considering a joint venture

3.4.2 Characteristics associated with adoption of joint ventures

The characteristics of adopters ('already in one') and non-adopters are compared in Table 3. Although there were only 19 farmers that were already in a JV structure, several variables were significantly different between the two groups.

Table 3. Descriptive statistics of variables by adopters and non-adopters of farm joint venture structures

Variable	n	mean	st. dev.	Adopters (n=19)	Non-adopters (n=554)
Lowrain	573	0.42	0.49	0.26	0.43
Cropincome (%)	573	73.7	22.73	**83***	73
Cropspecialist	573	0.56	0.5	**0.79****	0.56
Sheepincome (%)	573	22.1	19.78	**14***	22
Totalarea	572	3078	3885	3616	3059
Avcroparea	571	1805	1605	**2695****	1775
Cropintensity	570	64.01	25.41	**75***	64
Prefcrop	573	0.71	0.45	**0.89***	0.71
Totalarable	572	2541	2111	**3407***	2511
Arableexpand	573	0.3	0.46	0.47	0.3
3yrcroparea	572	1801	1649	**2771*****	1768
Futurecroparea	530	1855	1751	**2945*****	1816
Ageheader ≤ 10yrs	553	0.61	0.49	**0.84****	0.61
Notill	573	0.85	0.36	0.89	0.85
Group	573	0.55	0.5	0.53	0.55
Paidadvice	573	0.52	0.5	**0.79****	0.51
Futurepaidadvice	573	0.63	0.48	0.79	0.63
Cropconsultant	573	0.4	0.49	**0.68****	0.4
Autosteer	573	0.77	0.42	0.84	0.77
Yieldmap	573	0.4	0.49	0.42	0.4
Soiltest (%)	573	44	38	46	44
Prefsimple	573	0.82	0.39	0.74	0.82
Labourconstraint	573	0.46	0.5	0.53	0.46
Relycontractor	573	3.99	1.41	**3.84****	4
Age	573	4.39	1.05	4.58	4.38
Education	573	0.32	0.47	0.32	0.32
Futureyears	568	13	9.25	16	13
Familysuccession	573	0.54	0.5	0.53	0.54

* P < 0.1; ** P < 0.05; *** P < 0.01

From a human capital perspective, the adopters had a greater preference for a cropping only enterprise (*prefcrop*), were more likely to use a paid agronomist (*paidadvice*), and for that agronomist to be an independent crop consultant (*cropconsultant*). Contrary to expectations, adopters were less likely to use contractors for machinery operations (*relycontractor*). In terms of adopting modern farming innovations like no-tillage, autosteer, yield mapping and soil testing, there were no significant differences between adopters and non-adopters.

For natural capital, adopters were more likely to have a higher cropping intensity (*cropintensity*), matched with a larger total arable land area (*totalarable*) and a larger crop area across time (*3yrcroparea*, *avcroparea*, *futurecroparea*). For financial capital variables, adopters were more likely to derive a greater proportion of gross farm income from broadacre cropping activities (*cropincome*) and significantly less income from sheep production (*sheepincome*). Finally, from a farm equipment perspective, adopters were more likely than non-adopters to have a header that was ten years old or less (*ageheader* $\leq$ 10yrs).

3.4.3 Farmers' interest in JV structures

Farmers who expressed an interest in JV structures (yes, maybe) or who were already in one were asked to indicate their main reason for considering, or for being involved in, such structures. As shown in Table 4, reducing costs was highlighted by a majority of farmers (55%) as a reason for interest in JV structures, with 29% identifying general operational cost, 28% machinery costs and 6% costs associated with economies of scale. Other reasons identified included general benefits associated with economies of scale and/or improved efficiency (17%), improved utilisation of capital and/or greater profitability (15%), and advantages related to labour availability and efficiency (10%).

Table 4. Reason to consider a joint venture structure as identified by farmer respondents

Reason for considering a joint venture	% of respondents			
	All (n=216)	**Yes (n=118)**	**Maybe (n=79)**	**Already in one (n=19)**
Reduced cost - all	55	58	52	47
- Reduce cost - general	29	31	27	26
- Reduce cost - machinery	28	30	28	21
- Reduce cost - economies of scale	6	8	3	0
Economies of scale and/or improved efficiency	17	20	13	11
Improved utilisation of capital and/or greater profitability	15	13	20	11
Labour availability, labour efficiency, and labour age,	10	12	8	11
Access to new/bigger/better machinery and/or technology	9	10	5	21
Management capacity (access to expert skills and working in teams)	5	6	4	5
Reduce Risk	2	3	1	0
Trust People	1	0	4	0
Other	13	11	15	21
No Comment	9	9	9	5

Results of the parametric analysis of non-adopters of farm JV structures are shown in Table 5. The multinominal logit regression model has farmers not interested ('no') in considering a JV structure as the base case to allow comparisons between farmers uncertain of interest ('maybe') and those definitely interested ('yes') in considering a JV structure. When comparing 'not interested' and 'uncertain' farmers, there were no significant differences, other than 'uncertain' farmers having had a larger average crop area over the past 3 years (*avcroparea*).

There were a greater number of significant differences observed when comparing 'not interested' and 'definitely interested' farmers. Farmers who were 'definitely interested' in considering a JV structure were more likely to (1) agree that their business is constrained by a lack of skilled labour (*labourconstraint* = 0); (2) have someone involved in managing their farm that has a university degree (*education* = 0); (3) be younger in age (*age*); and (4) expect to have slightly less years actively farming into the future (*futureyears*) compared to farmers who were not interested in considering a JV structure.

The model has a low R^2 (0.023) and could not accurately predict farmer interest in JV structures. Thus, it is clear that the factors influencing a farmers' interest in a JV structure cannot be adequately explained by the observable socio-demographic variables collected in the survey.

Table 5. Multinomial logit regression estimates of coefficients associated with interest in adopting a JV structure

Interest in a JV	**Variable**	**Coefficient**	**(std. error)**	**P-value**
No	(base outcome)			
Maybe	Avcroparea	0.000	(0.000)	**0.063***
	Labourconstraint	0.151	(0.256)	0.557
	Age	-0.105	(0.158)	0.505
	Education	-0.031	(0.281)	0.911
	Futureyears	-0.007	(0.018)	0.686
	Constant	-1.283	(0.901)	0.155
Yes	Avcroparea	-0.000	(0.000)	0.196
	Labourconstraint	0.494	(0.217)	**0.023****
	Age	-0.251	(0.136)	**0.064***
	Education	0.523	(0.224)	**0.020****
	Futureyears	-0.030	(0.016)	**0.067***
	Constant	0.117	(0.775)	0.880
	n	547		
	Model chi-square	21.90		
	Pseudo R^2	0.0226		

3.4.4 Identifying producer segments with cluster analysis

Cluster analysis was used to explore whether producer segments could be identified from the survey data. The analysis used a wide variety of farm variables from the producer survey to identify eight distinct groups (clusters A to H) amongst farmer respondents (Table 6). A brief description of each cluster is provided below:

- Cluster A – Large cropping specialists with low contractor and advisor reliance
- Cluster B – Small croppers
- Cluster C – Croppers who prefer simple operations and contractors
- Cluster D – Highly educated soil testers
- Cluster E – Very large cropping specialists
- Cluster F – Croppers who prefer paid agronomists and contractors
- Cluster G – Livestock orientated small croppers
- Cluster H – Medium sized croppers who use paid agronomy service and don't mind complexity

Overall, Cluster G (livestock orientated small croppers) and Cluster D (highly educated soil testers) were the largest; collectively accounting for approximately 35% of the sample. Cluster E (very large cropping enterprises) had the least number of farmers (2.8%). The cluster means for farm scale variables like average crop area (*avcroparea*) and 3-year crop area average (*3yrcroparea*) were all significantly different between the clusters groups. Other variables had mixed significance between cluster groups. Farmers categorised as being of medium size with a lower aversion to complexity and using agronomic consultants (cluster H) were most likely to be involved in, or express some level of interest in, a JV.

Table 6. Cluster analysis output

Variable	Sample Mean	Cluster means								
		Cluster A (n=37)	Cluster B (n=88)	Cluster C (n=82)	Cluster D (n=100)	Cluster E (n=16)	Cluster F (n=61)	Cluster G (n=102)	Cluster H (n=72)	F-statistic
Natural capital variables										
LOWRAIN	0.42	0.54	0.38	0.44	0.41	0.56	**0.56^{g}**	**0.31^{f}**	0.47	**2.09****
AVCROPAREA	1805	**4745^{bcdefgh}**	**772.5^{acdefgh}**	**1611^{abdefgh}**	**1167^{abcefgh}**	**7856^{abcdfgh}**	**3104^{abcdegh}**	**385.7^{abcdefh}**	**2349^{abcdefg}**	**1254.21*****
3YRCROPAREA	1801	**4584^{bcdefgh}**	**756^{acdefgh}**	**1578^{abdefgh}**	**1139^{abcefgh}**	**8081^{abcdfgh}**	**3361^{abcdegh}**	**363^{abcdefh}**	**2212^{abcdefg}**	**1255.99*****
CROPINTENSITY	0.64	**0.78^{bdg}**	**0.57^{acefgh}**	**0.71^{bg}**	**0.65^{aeg}**	**0.86^{bdg}**	**0.73^{bg}**	**0.45^{abcdefh}**	**0.73^{bg}**	**20.39*****
Financial capital variables										
CROPINCOME (%)	73.7	**90.51^{bcdgh}**	**71.32^{aefg}**	**78.66^{ag}**	**73.75^{aefg}**	**90^{bdg}**	**84.41^{bdg}**	**54.17^{abcdefh}**	**77.6^{ag}**	**22.5*****
SHEEPINCOME (%)	22.05	**7.19^{bcdgh}**	**26.24^{acefgh}**	**17.98^{abg}**	**22.08^{afg}**	**9.63^{bg}**	**13.74^{bdg}**	**38.4^{abcdefh}**	**17.43^{abg}**	**21.07*****
Human capital and perception variables										
PREFCROP	0.71	**0.87^{g}**	**0.71^{g}**	**0.83^{g}**	**0.7^{g}**	**0.94^{g}**	**0.82^{g}**	**0.48^{abcdefh}**	**0.75^{g}**	**6.86*****
ARABLEEXPAND	0.30	0.38	0.23	0.35	0.31	0.25	0.41	0.21	0.39	2.14**
GROUP	0.55	0.51	0.56	0.62	0.54	0.50	0.59	0.49	0.63	0.78
PAIDADVICE	0.52	**0.43^{h}**	0.55	0.54	0.52	0.38	**0.48^{h}**	**0.45^{h}**	**0.72^{afg}**	**2.47****
FUTUREPAIDADVICE	0.63	**0.49^{h}**	0.64	0.72	0.66	0.56	0.61	**0.53^{h}**	**0.79^{ag}**	**2.84*****
RELYCONTRACTOR	4.00	**3.46^{cf}**	3.98	**4.38^{ag}**	4.04	4.50	**4.28^{a}**	**3.68^{c}**	3.88	**3.17*****
AGE	4.39	4.43	4.43	4.44	4.32	4.50	4.39	4.35	4.56	0.39
EDUCATION	0.32	0.27	0.34	0.37	**0.42^{g}**	0.38	0.26	**0.19^{d}**	0.36	**2.33****
FUTUREYEARS	12.99	11.54	12.34	12.90	13.09	13.38	13.52	13.32	12.60	0.26
FAMILYSUCCESSION	0.54	0.54	0.57	0.57	0.57	0.56	0.41	0.52	0.56	0.77
COMPUTERSKILLS	3.37	3.24	3.25	3.35	3.59	3.50	3.15	3.38	3.43	1.31
PREFSIMPLE	3.93	3.78	3.84	**4.11^{h}**	3.93	4.06	3.98	3.97	**3.69^{c}**	1.59
LABOURCONSTRAINT	3.12	2.92	3.36	3.18	3.06	2.63	3.26	3.10	3.06	1.31

Table 6 (Cont.). Cluster analysis output

Variable	Sample Mean	Cluster means								
		Cluster A (n=37)	Cluster B (n=88)	Cluster C (n=82)	Cluster D (n=100)	Cluster E (n=16)	Cluster F (n=61)	Cluster G (n=102)	Cluster H (n=72)	F-statistic
Farming equipment and practices variables										
AGESEEDER	11.22	**6.24**^{bdg}	**13.64**^{acefgh}	**9.60**^{bg}	**11.43**^{aefgh}	**4.56**^{bdg}	**7.43**^{bdg}	**18.26**^{abcdefh}	**6.89**^{bdg}	**25.03*****
NOTILL	0.85	0.92	0.85	**0.90**^{g}	0.84	1.00	**0.92**^{g}	**0.75**^{cf}	0.83	**2.52****
AUTOSTEER	0.77	0.92	0.76	0.72	0.84	0.75	0.74	0.72	0.79	1.57
YIELDMAP	0.41	0.46	0.46	0.39	0.48	0.63	0.33	0.32	0.40	1.61
SOILTEST (%)	43.65	36.73	**47.51**^{g}	40.9	**50.16**^{g}	40.94	**49.52**^{g}	**30.61**^{bdfh}	**49.56**^{g}	**3.14*****
Joint venture variables										
Interest in joint venture - yes	0.21	0.16	0.24	0.16	0.23	0.06	0.20	0.20	0.28	0.97
Interest in joint venture - maybe	0.14	0.14	0.18	0.12	0.11	0.25	0.18	0.09	0.14	1.01
Interest in joint venture - no	0.62	0.65	0.56	0.71	0.65	0.63	0.56	0.70	0.50	**1.81***
Interest in joint venture - already in one	0.03	0.05	0.02	0.01	0.01	0.06	0.07	0.02	0.08	1.72
Joint venture variables as a % of respondents		**% of respondents by cluster**								
Interest in joint venture - yes %		5.2	18.1	11.2	**19.8**	**0.9**	10.3	17.2	17.2	
Interest in joint venture - maybe %		6.6	**21.1**	13.2	14.5	**5.3**	14.5	11.8	13.2	
Interest in joint venture - no %		6.9	14.1	16.7	18.7	**2.9**	9.8	**20.5**	10.4	
Interest in joint venture - already in one %		10.5	10.5	5.3	5.3	5.3	21.1	10.5	**31.6**	

Note: *** p<0.01, ** p<0.05, * p<0.1; abcdefgh = Different letters indicate significant mean differences (alpha=0.10, Turkey's test)

3.5 Discussion

This is one of the first studies to provide insight into farmers' current participation and future interest in JV structures in the broadacre grains sector. Geographically, JV structures were identified in all but one of the twelve major growing regions sampled in the survey. However, it was clear that the current rate of adoption is small (3% of the sample). This confirms that organisational innovations like JV structures are in the early stages of the innovation diffusion curve, and predominantly within the domain of farmer innovators (Rogers 2003). For JV adopters, reducing operational and machinery costs, gaining access to new technology and more efficient machinery, and deriving benefits from economies of scale were highlighted as important benefits resulting from their JV. These benefits would likely boost farm productivity and competitiveness for participating farmers (ABARES 2010; Jackson 2010; Hughes et al. 2011).

A descriptive statistical analysis of adopters and non-adopters of JV structures revealed some interesting differences between the two groups. Although there is no significant difference in the total area operated by the two groups, there was a significant difference in the amount of cropping land utilised. Adopters on average had a higher cropping intensity and cropped an additional 900 hectares compared to non-adopters. This highlights the potential for JVs to derive significant scale benefits for cropping activities, including improved utilisation rates of machinery and labour assets.

Scale benefits may also arise when negotiating with upstream and downstream value chain partners like machinery contractors or input suppliers. However, the study did not produce evidence that the advantage of scale led to greater capacity to adopt

technical innovations including no-till, autosteer, yield mapping and soil testing compared to non-adopters of JVs. This was possibly affected by the small number of JV adopters in the sample population.

Nevertheless, adopters were significantly more likely than non-adopters to have a grain harvester less than 10 years old and to be more willing to use a paid agronomist to aid crop management decisions. It is not surprising that adopters operate a younger grain harvester, given that such machinery is usually replaced based on the number of hours operated and thus harvesting a significantly larger crop area may require adopters to update equipment more often. Of more interest is the greater use of a paid agronomist. This may reflect a greater capacity to be able to pay for such advice compared to non-adopters, and/or adopters valuing external advice more than non-adopters.

For the 97% of the farmer sample not involved in a JV structure, we aimed to learn more about the characteristics of farmers who may be interested in JV structures in the future. Overall, 21% of farmers indicated a definite interest in considering the adoption of a JV structure, whilst 14% were uncertain and 62% not interested. The high level of ‘uncertain’ and ‘no interest’ in JV structures by farmers isn’t surprising when considering the characteristics of business structure innovation. The five attributes of innovations that are critical drivers of adoption and diffusion identified by Rogers (2003) (i.e. relative advantage, compatibility, complexity, trialability and observability) are not necessarily evident when considering organisational business structures. By its very nature, an adoption decision about a JV structure is highly complex, with limited trialability and hard to quantify costs and benefits, which will partly explain low current adoption rates and limited definite future interest.

Nevertheless, over one-third of farmers in the survey agreed that there is a potential for JV structures to improve their farm business performance in some way. The major reasons for farmers having a level of interest in adopting a JV structure revolved around improving farm productivity and competitiveness by reducing costs, increasing scale and efficiency, and enhancing farm profitability and capital utilisation. These results align with the literature on the growing productivity gap in the broadacre grains sector, which highlights that average farms are often limited in their ability to adopt productivity enhancing innovations because of limited farm scale, management and capital constraints (ABARES 2010; Jackson 2010; Hughes et al. 2011).

A multinomial logit model demonstrated limited ability to predict farmers' interest in JV structures. However, there are still a number of significant results. Farmers who were interested ('yes') in considering a JV structure were more likely to have a university degree, to agree with the statement that "*a lack of skilled labour is one of the biggest constraints to my farm operations*", to be younger in age, and curiously, to have a shorter expected future in farming compared to farmers 'not interested' in JV structures. Past research has also linked higher education with greater levels of adoption (Pannell et al. 2006; Llewellyn et al. 2007). Younger farmers may be more interested in JV structures for a number of reasons. As they are more likely to have started farming recently, they may be carrying higher relative debt loads, which could constrain their ambitions for productivity enhancing investments. Being younger and more educated, they may also see a JV structure as one way to increase their income and stay involved in farming, beyond what otherwise is a shorter than average expected future in farming.

Although not conclusive, cluster analysis identified a category of farmers with medium-sized farms, relatively high use of consultant advice and lower aversion to complexity as the most open to considering a JV (Cluster H). Conversely, Cluster C (Croppers who prefer simple operations and contractors) and Cluster G (Livestock orientated small croppers) appear the least interested in considering the adoption of a JV structure. However, JV interest was not significantly different between any of the eight clusters identified

Overall, the results for the multinomial logit model and the cluster analysis demonstrate how difficult it is to predict or identify, respectively, producer interest in considering a JV structure. Unlike a number of other studies that successfully use similar socio-demographic variables to assess innovation adoption (Sheikh et al. 2003; D'Emden et al. 2008), predicting future adoption of a complex innovation like a JV structure appears more challenging, most likely due to the highly personal nature of managing the human relationships and relinquishing some level of individual control when entering into a JV.

The adoption of a JV structure impacts all aspects of a farm business including ownership, lifestyle, decision-making processes, personnel roles, asset ownership and utilisation, supply chain relationships and farming practices. These are trade-offs that must be considered before an adoption decision can be reached. Such a decision is characterised by large potential consequences and risk, significant informational and analytical requirements, and high complexity, whilst the reversibility of exiting or dissolving a JV may have major consequences for the individual businesses involved (Marra et al. 2003; Gray et al. 2009; Tarrant and Malcolm 2011; Gladigau. 2013).

Given the inherent complex nature of the innovation and the heterogeneity of the producer population, the benefits and costs of adopting a business structure innovation are likely to be highly variable depending on the individual circumstances and attitudes towards risk and collaboration held by each farmer. To address this complexity and to inform the design of attractive JV models for practitioners and policy makers, future studies will need to move beyond broad socio-demographic variables to capture individual preferences, especially concerning risk and collaboration, and other farm-specific data on business performance and profitability.

3.6 Summary and conclusions

While top family farms have achieved strong gains in profitability and wealth, the average broadacre grain producer faces a significant productivity challenge. Farm scale, management and capital constraints are likely factors that limit the ability to adopt existing technologies and new innovations. The use of strategic business alliance structures including production cooperatives and collaborative structures like JV structures is one strategy that can reduce some of these constraints. We conducted a nation-wide farmers' survey, which indicates a small level of existing JV activity. Overall, adopters of JV structures operate on a larger scale compared to their peers; have less diversified enterprises with a strong focus on cropping activities and high cropping intensity; use a paid agronomist to assist with crop nutrition decisions; and have less reliance on contractors for farm operations.

Survey results showed that 35% of broadacre farmers are interested in considering adopting a JV structure in the future. The major reasons for this interest are related to improving farm productivity and competitiveness, largely through cost-reducing

efficiencies. A multinomial logit model found that farmers who were 'definitely interested' in considering a JV structure were more likely to be younger, have a university degree, identify skilled labour as a significant farm constraint, and currently expect to have a shorter future in farming compared to farmers who are not interested in JV structures. Given the complexity of adopting a business structure innovation, future work will need to examine farmers' personal attitudes towards sharing decision-making, collaboration, and risk, as well as what features of a JV structure would be most attractive to individual farmers who wish to achieve productivity gains through business structure innovation.

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Principal Author

Name of Principal Author (Candidate)	Brendan Lynch		
Contribution to the Paper	Leading the design, development and analysis of the discrete choice experiment survey and wrote the manuscript.		
Overall percentage (%)	65%		
Certification:	This paper reports on original research I conducted during the period of my Higher Degree by Research candidature and is not subject to any obligations or contractual agreements with a third party that would constrain its inclusion in this thesis. I am the primary author of this paper.		
Signature		Date	26/07/2016

Co-Author Contributions

By signing the Statement of Authorship, each author certifies that:

i. the candidate's stated contribution to the publication is accurate (as detailed above);
ii. permission is granted for the candidate in include the publication in the thesis; and
iii. the sum of all co-author contributions is equal to 100% less the candidate's stated contribution.

Name of Co-Author	Dr. Marit Kragt		
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Chapter 4 Farmer preferences for joint venture farm business structures

Abstract

Joint venture (JV) farm structures combine the assets, infrastructure and human resources of two or more farm businesses, and have the potential to increase farm productivity. The potential benefits of JVs to family farm businesses are increasingly recognised but there are still few examples of JV structures operating in the Australian grains sector. Improved understanding of what characteristics of JVs are attractive to farmers could assist with the design of JV structures and boost their uptake. To address this issue, we conducted a choice experiment with broadacre grain growers in Australia. Results from the discrete choice models showed that farmers consistently had a strong preference for JV structures that offer greater control of operational decisions and no change to existing annual leave arrangements. The number of partners in a JV structure, and the opportunity to use new machinery within a JV, appear less influential on farmers' preferences. Socio-demographic variables were interacted with the JV choice attributes to explore heterogeneity in preferences across respondents. Further, random parameter logit modelling revealed significant unobserved preference heterogeneity, indicating that farmers' observable characteristics cannot necessarily predict the JV structure preferences of respondents.

4.1 Introduction

Organisational innovations in the agribusiness sector, may allow farmers to increase scale, improve utilisation rates of machinery and labour and potentially increase profitability (ADAS 2007; Lynch et al. 2012; Gladigau 2013; Lynch et al. 2015). Yet, alternative business structures, like joint venture (JV) farm business structures, are not yet widely applied in the Australian grain farming sector. Current knowledge is limited with respect to the relative attractiveness of different JV structures, farmer characteristics that may influence decision-making regarding JVs, and how preferences for these structures may vary between individuals. This gap in the literature is despite the demonstrably growing interest in alternative farm structures (Gorton and Davidova 2004; Wolfe 2011; Port Jackson Partners 2012; Cawood 2013).

As price-takers, producers of dryland (non-irrigated) field crops are under constant pressure to increase productivity to remain competitive. Traditionally, productivity growth in the Australian grain sector has been driven by changes in farm products (e.g. improved crop types and varieties), production processes (e.g. improved crop seeding practices) and marketing innovations (e.g. hedging strategies) (Nossal and Lim 2011). However, further productivity improvement via innovations in farm organisation like JVs has been limited (Knopke et al. 2000; Liao and Martin 2009; Gladigau. 2013). This is despite evidence that combinations of scale, management, and/or capital constraints are limiting the adoption of productivity boosting innovations (ABARES 2010; Jackson 2010; Hughes et al. 2011). To overcome these constraints and increase competiveness, adopting organisational innovations like joint venture (JV) structures between family farm businesses may be an option (Gladigau. 2013).

Business alliance structures like JVs are commonly used in the broader economy to increase firm competiveness by gaining strategic and operational advantages that

otherwise would be difficult to obtain as a standalone entity (Sheth and Parvatiyar 1992). Adoption of JV structures by Australian broadacre grain growers is currently less than 5% (See Chapter 3). The owner-operator family farm remains the predominant farm structure, although corporate farm ownership is increasing (Clark 2008; Pricewaterhouse Coopers 2011). However, as the scale, complexity, and capital requirements of Australian grain farms continue to grow (Kingwell 2011a; Kingwell 2011b), the nature of the family farm must evolve and meet the challenges of the new operating environment (Allen and Lueck 1998). Farmers adopting a JV structure may be able to reduce their operating costs, increase scale, and gain access to technical innovations to drive farm productivity improvements.

The adoption of a JV structure is multi-faceted and likely to impact all parts of a farm business including asset ownership, decision-making processes, personnel roles, and lifestyle (Lynch et al. 2012; Gladigau. 2013). The decision environment is characterised by significant risk, considerable reversibility costs, and thus large consequences for the farm businesses involved (Marra et al. 2003; Gray et al. 2009; Tarrant and Malcolm 2011; Gladigau. 2013). In such circumstances, the learning and management capacity of an individual farmer are particularly important to successfully adopt a complex innovation (Rogers 2003; Pannell et al. 2006; Llewellyn 2007; Llewellyn et al. 2012). Given this complexity, and the heterogeneity of the producer population, the benefits and costs of adopting a business structure innovation are likely to be highly variable depending on a farmer's individual circumstances and attitudes towards risk and collaboration. This highlights that both observable and unobservable personal characteristics are likely to influence farmers' adoption decisions. (Heckman J. J. 2001; Kragt and Bennett 2011; Koutchade et al. 2014).

In this paper, we use a choice experiment (CE) to identify the characteristics of JV structures that are most preferred by Australian grain farmers. In particular, we explore how observed and unobserved heterogeneity between farmer characteristics may affect their preferences. Farmer attributes explored, include a range of human, financial and natural capital socio-demographic variables identified in the innovation adoption conceptual model, as described in Chapter 2. We also estimate the implicit prices of each of the JV characteristics. This work will assist with the design and development of novel organisational innovations, like JV structures, that may boost the competiveness of Australian grain growers.

The CE method and modelling approach are detailed in the next section. This is followed by a description of the CE questionnaire in Section 3. Results of the questionnaire and the discrete choice models are presented in Section 4. The paper concludes with a discussion of the challenges and implications for the future adoption and diffusion of organisational innovations by farmers in the Australian grain sector.

4.2 The choice experiment method

A stated preference survey, such as a CE, is well-suited for this study because JV structures' are not yet widely adopted nor are they traded in markets, thus revealed preference techniques are not applicable in this case. Using a stated preference approach allows us to study farmer preferences for hypothetical scenarios. The CE method has been applied within a diverse variety of fields, including consumer research (e.g. Swait and Adamowicz 2001), transport choices (e.g. Hensher and Rose 2007), and environmental management (e.g. Kragt and Bennett 2011), but has not been widely applied in agribusiness (Kragt and Llewellyn 2014).

The theoretical underpinning of CEs comes from random utility theory (McFadden 1986) and Lancaster's theory of value (Lancaster 1966). Random utility theory is based on a model where the utility U_{ijt} an individual i obtains from possible choice j in situation t is described as a latent variable which is observed indirectly via the choices made by respondents. Utility is comprised of an observed 'systematic' utility element $V_{ijt,}$ and a random unobserved error term ε (Louviere et al. 2000). The foundation of Lancaster's theory of value is that a good can be described in terms of its multiple characteristics (called 'attributes'), which impact utility as components of $\boldsymbol{x_{ijt}}$:

$$U_{ijt} = V_{ijt} + \varepsilon = \beta' X_{ijt} + \varepsilon \qquad i=0,1,\ldots,N;\ j=0,1,\ldots,J;\ t=1,2,\ldots,T \qquad (1)$$

The observed element of utility V_{ijt} is assumed to be a function of a vector of explanatory variables that includes attributes of the good under valuation, and may also include socio-demographic and attitudinal characteristics, and features of the choice task itself (Hensher and Greene 2003). The CE allows us to infer individuals' values for the different attributes of a good. In the survey, respondents are shown multiple options for JV structures, which vary in their level of attributes (Section 3). The choices respondents make between attributes of different levels allows the practitioner to deduce the trade-offs respondents make when choosing between alternatives (Bennett and Blamey 2001).

4.2.1 Modelling approach

We first estimate a series of multinomial logit (MNL) models; the 'work-horse' of discrete choice analysis (Hensher et al. 2005). Farmers' socio-demographic characteristics are included in the utility expression to analyse what variables may influence preferences for JV farm structures. In the MNL model, it is often assumed

that the error term is independently and identically distributed (IID) (Gumbel distributed) over individuals and alternatives (Cameron and Trivedi 2005). This leads to the, behaviourally implausible, assumption that the ratio of the choice probabilities of any pair of alternatives is independent of the presence or absence of any other alternative in the choice set (Hensher et al. 2005). The MNL model can account for observed heterogeneity in preferences by interacting farmers' socio-demographic variables with the attributes of hypothetical JV structures (Birol et al. 2006). This allows us to develop a deeper understanding of how farmer socio-demographics influence farmer JV structure preferences.

We also estimate a random parameter logit (RPL) model (McFadden and Train 2000). The RPL model overcomes the constraints imposed on standard logit models through relaxing the IID condition. Specifically, RPL models permit random preference variation across individuals, unrestricted substitution patterns, and correlation in unobserved factors within individuals, by including an individual specific error term that is correlated across the series of choices made by each respondent (Train 2003). In a RPL model, the utility of person *i* from choice alternative *j* is:

$$U_{ijt} = \beta_i' X_{ijt} + \varepsilon_{ijt} \qquad i=0,1,\ldots,N;\ j=0,1,\ldots,J;\ t=1,2,\ldots,T \qquad (2)$$

where X_{ijt} are observed characteristics of the choice set and respondent, and β_i is a vector of coefficients for person *i* (thus reflecting individual taste parameters). The coefficients vary across the population with density $f(\beta)$, the functional form of which has to be specified by the analyst. The unconditional choice probability for the RPL model is given by:

$$P_{ijt} = \int \frac{e^{\beta' X_{ijt}}}{\sum e^{\beta' X_{ikt}}} f(\beta)\, d\beta \qquad (3)$$

$$P_{i\tau} = \int \prod_{t=1}^{T} \left[\frac{e^{\beta_i' X_{ijt}}}{\sum e^{\beta_i' X_{ikt}}} \right] f(\beta)\, d\beta \quad (4)$$

In a situation where respondents answer multiple choice sets $\tau = \{j_1,\ldots,j_T\}$, the RPL model needs to estimate the probability of observing a sequence of individual choices. The unconditional probability of this panel RPL model is given in Equation 4. Because the RPL model formula does not have a closed-form solution, the model is estimated using simulated maximum likelihood methods (Train 2003). We estimate RPL models to explore observed and unobserved preference heterogeneity in farmers' preferences for JV farm structures. All choice models were estimated in Nlogit v.5 (Econometric Software 2012).

In this CE, we include an attribute that is measured in monetary units: change in annual net farm income. Due to the trade-offs respondents make between changes in income and changes in the other, non-market, attributes, we are able to estimate the marginal attribute values by way of the marginal "willingness to accept" (WTA) for each attribute (Bateman et al. 2006). The marginal WTA (or 'implicit price') is expressed as the implicit change in income that the respondent is willing to accept to achieve a unit change in an attribute:

$$Marginal\ WTA = \frac{\beta_{attribute}}{\beta_{income}} \quad (5)$$

Where $\beta_{attribute}$ is the estimated attribute coefficient; and β_{income} is the estimated coefficient of the monetary attribute. In this study, the marginal WTA is used, rather than the more commonly used willingness to pay (WTP), as it is likely that the income coefficient parameter will have a positive parameter estimate. Specifically, respondents are expected to require an increase in income to accept some form of JV structure for their farm business that will result in a lower level of utility for the

individual. This marginal rate of substitution between income and attribute can be interpreted as a WTA measure.

The implicit prices were calculated using a parametric bootstrapping technique with 10,000 replications drawn from the estimated mean coefficients and their standard error (S.E.). To calculate the WTA MNL2 in a model with interaction variables, all interaction variables were set to the average value of the underlying socio-demographic or attitudinal variable to give a sample-average WTA.

4.3 Questionnaire development

The CE questionnaire was developed and designed following best-practice guidelines (Louviere et al. 2000; Bennett and Adamowicz 2001; Hensher et al. 2005). A team of experts was consulted during the survey development phase, encompassing farm extension, farm business and environmental valuation experts, as well as farm joint venture practitioners and farm business consultants. Pre-testing of the survey was undertaken through one-on-one interviews with farmers and discussions with groups of farmers, before an online pilot survey was launched and tested. Minor changes were made to the survey design before the final online survey was launched in July 2013. The survey started with general questions about JV farm structures and other forms of farmer collaboration. We then explained the choice task and relevant choice attributes to respondents, followed by the choice questions. The final section contained socio-demographic and attitudinal questions.

Before commencing the choice tasks, respondents were given a definition of a farm JV structure and its basic operating principles. A JV structure was defined as “a business structure that combines the assets, infrastructure and staff of two or more farm

businesses". The JV operating conditions were based on a combination of expert opinion and from the experience of practitioners' currently involved in similar JV structures (Gladigau. 2013). The operating conditions of the JV structure were described in the survey as follows:

- Individual farm businesses retain ownership of their underlying land asset
- Cropping land is leased to the JV on a 3-year rolling lease basis
- Livestock is not included in the JV and is managed independently at the individual farm level
- Each JV is managed by a board that is responsible for major business decisions and headed by an independent chairman
- Each farm business in the JV will have an equal shareholding and a representative on the board
- Machinery is procured and managed by the JV
- Crop area of the JV will be sufficient to optimise economies of scale, and more crop land can be leased or share farmed if required
- An independent crop consultant is contracted by the JV to provide advice and support in relation to crop management decisions
- Farm income is derived from a combination of land lease payments, a role-based salary and a dividend from the profit/loss of the JV structure

The JV scenarios in the CE included five attributes that varied in levels between choice sets. Table 1 provides a detailed explanation of the attributes and associated attribute levels included in the CE. Attribute levels were based on feedback from experts and farmers involved in the design and pre-testing phases. The attributes are: 1) the number of farm businesses in the JV structure; 2) control of operational decisions; 3) farming with the latest machinery; 4) leave arrangements; and 5) change in annual net farm

income. The levels of the 'change in net farm income' attribute was also informed by an analysis of farm financial performance data at the national scale (ABARES 2010), and financial performance benchmarks at the agro-ecological zone scale across the southern and western grain growing regions of Australia (Hooper and Levantis 2011).

Table 1. Attributes and levels used in the farmer JV choice experiment

Attribute	**Attribute description**	**Attribute levels**
Number of farm businesses in the JV structure	A JV will be comprised of a number of individual farm businesses that will be equal shareholders in the new JV business structure.	2, 3, or 4 farm businesses
Control of operational decisions	Despite equal shareholdings and representation on the board, individual farm families may have varying levels of direct influence/control over farm operational decisions for the whole JV.	Sole decision-maker (coded +3), Final decision-maker, in consultation with other partners (+1), Shared decision-making with other partners (0), Not the final decision-maker, but input into decisions (-1), No operational decisions (-3)
Farming with the latest machinery	The JV farm structure may increase the feasibility that JV partners can procure the latest machinery.	New machinery, older machinery (initially 5 yrs plus)
Leave arrangements	The extra workforce in a JV may allow farm families to take more leave (holidays) away from the farm.	Extra 2 weeks leave, no change
Change in annual net farm income	Adopting a JV structure will likely result in a change to a farm family's average annual net farm income. This change in income will be relative to the family's average net farm income over the past 5 years.	-15k, no change, 15k, 30k, 50k, 75k

Figure 1. Example choice set in the farmer JV choice experiment questionnaire

Carefully consider each of the following options for formal JV structures. If options A, B, C and D were the only ones available, which option would be most attractive to you?

Characteristics	Option A	Option B	Option C	Option D
Number of farm businesses in the JV structure	2	3	4	4
Control of operational decisions (non-board decisions)	Sole decision-maker	Shared decision-making with other partners	Not the final decision-maker, but input into decisions	No operational decisions
Farming with the latest machinery	Older machinery (initially 5 yrs plus)	New machinery	New machinery	New machinery
Leave arrangements	Extra 2 weeks of flexible leave	No change	No change	Extra 2 weeks of flexible leave
Change in annual net farm income (compared to current 5yr average)	+ $30k	No Change	+ $50k	+ $15k
Most attractive option	☐	☐	☐	☐

The choice sets were constructed using a Bayesian D-efficient design (Sándor and Wedel 2001), with a total of 20 choice sets divided into four blocks. These blocks were evenly distributed at the regional and national scale. Each respondent was allocated to a block and completed five choice sets. Respondents were asked to identify their most preferred structure from four alternatives. An example of one of the choice sets is provided in Figure 1.

4.3.1 Survey administration

The survey was administered online with broadacre grain producers between July and September 2013. A sample of 340 farm owner-managers was randomly recruited by telephone using a market research firm that had a comprehensive database of Australian grain growers.[2] Farmers were recruited until the target number of respondents for each region was reached to ensure balanced regional samples across Australia's major grain growing regions Farm managers were first contacted via telephone, and those who agreed to participate were sent a secure web-link via email that they could use to complete the survey. A follow-up phone call was made shortly after each email was sent to confirm the respondent had received the web-link. Out of the 4,137 farm businesses contacted, 47.9% did not qualify due to land size, farm type, lack of internet connection, or because the primary cropping decision-maker was not available. Of the 2,155 eligible farmers, 340 completed surveys were collected: a response rate of 15.7%.

[2] The firm KG2 recruited survey participants and managed the online farm survey.

4.4 Results

A summary of the respondents' geographic locations are provided in Table 2. The sample of 340 respondents covered 10 major grain farming regions of Australia across New South Wales, Victoria, South Australia and Western Australia. Summary statistics for the sample are provided in Table 3. The majority of respondents were male with an average age of 53 years. On average, respondents had an annual net farm income over the past five years of $162,900, with approximately three-quarters of income (74%) derived from broadacre grain production. In terms of scale, respondents had an average grain crop area of 1,626 hectares, with 51% expanding their crop area via purchase or lease over the past 5 years.

Table 2. Geographic location of respondents

State and regions	Number of respondents	% of respondents*
New South Wales	**56**	**16%**
Central west	28	8%
Riverine plains	28	8%
Victoria	**84**	**25%**
Vic Mallee	28	8%
Wimmera	28	8%
Loddon	28	8%
South Australia	**120**	**35%**
SA Mallee	28	8%
Central	36	11%
Upper Eyre Peninsula	28	8%
Lower Eyre Peninsula	28	8%
Western Australia	**80**	**23%**
Central and midlands	80	23%
TOTAL	**340**	**100%**

* Due to rounding, percentages may not always appear to add up to 100%

Table 3. Sociodemographic statistics of sample respondents

Characteristic	Description	Mean	Std. Dev	Min	Max
Gender	1= Male; 0= Female	0.96	0.21	0	1
Age	Farmer age (yrs)	52.54	10.19	21	70
Age_dif	Farmer age as a standard deviation	0	10.19	-32	17
University degree	1= University degree; 0= No university degree	0.12	0.33	0	1
Area of grain	Current grain crop area (ha)	1,626	1,461	324	18,500
Current net farm income	Average net farm income over the past 5 yrs (in '000 AU$)	162.9	175.3	0	1,000
Current net farm income_dif	Average net farm income over the past 5 yrs (in '000 AU$) as a standard deviation	0	175.3	-163	837
Grain income	% of farm income derived from broadacre grain production	74.06	19.98	0	100
Financial health	Respondent's perception of farm business financial health: 1= Healthy; 0= Stable; -1= Strained	0.29	0.81	-1	1
No crop area expansion	1= No crop area expansion in the last 5 yrs via purchase or lease; 0= Yes	0.49	0.50	0	1
Current annual leave	1= Greater than 4 weeks; 0= 3-4 weeks leave; -1= 2 weeks or less	-0.31	0.65	-1	1
Joint machinery purchase	1= Experience to jointly purchase/lease machinery; 0= No	0.44	0.50	0	1
Know of JV	1= familiar or aware of grain farmers that have entered a JV; 0= No	0.42	0.49	0	1
Early adopter	Consider themselves an early adopter compared to other farmers in their region: 1= Agree; 0= Neither agree or disagree; -1= disagree	0.22	0.77	-1	1
Mind farm	1= Someone to mind the farm when absent; 0= No	0.82	0.39	0	1

Table 4 outlines the results of respondents' interest in farm JV structures. Approximately 4% of respondents were currently part of a JV farm structure. Of the remaining 96%, 11% said that they would consider adopting a JV structure in the future and 44% were 'maybe interested' in such structures.

Table 4. Respondents' interest in considering a JV structure in the future

Already in one	Yes interested	Maybe interested	No, not interested
14 (4%)	39 (11%)	148 (44%)	139 (41%)

4.4.1 Multinomial model results

Data from the CE were analysed using the model specifications discussed earlier and the results are presented in Table 5. The first model (MNL1) was estimated using only the attributes of the JV structures as explanatory variables. Utility was specified as a linear function of income, partners, decision control, machinery and leave. In this model, all attributes were significant. Farmers prefer JV structures that offer an increase in net farm income, greater control of operational decisions, and use new farm machinery. The partners and leave attributes are negative and significant. The negative sign means that farmers have a preference for JV structures that offer fewer partners and result in no change to existing leave arrangements.

Table 5. Results of multinomial logit (MNL) and random parameter logit models (RPL)

Variable	MNL1 Coeff.	MNL1 S.E.	MNL2 Coeff.	MNL2 S.E.	RPL 1 Coeff.†	RPL 1 Coeff. Stdev.†
Attributes of the JV choice experiment						
Income ($)	0.023***	0.001	0.029***	0.002	0.038*** (0.002)	0.038*** (0.002)
JV partners (range from 2-4)	- 0.057*	0.032	-0.049	0.035	0.007 (0.064)	0.664*** (0.087)
Decisions (range from -3 to 3)	0.176***	0.013	0.163***	0.035	0.287*** (0.036)	0.486*** (0.044)
Machinery (new machinery = 1)	0.335***	0.056	-0.066	0.130	0.554*** (0.123)	1.513*** (0.155)
Leave (two weeks additional leave = 1)	- 0.257***	0.058	-0.379***	0.067	-1.071*** (0.141)	1.366*** (0.160)
Farmer socio-demographic interaction variables						
Income x current net farm income_dif			0.000***	0.000		
Income x university degree			0.010***	0.003		
Income x age_dif			- 0.000***	0.001		
Income x current leave			0.004***	0.001		
Income x financial health			- 0.002**	0.001		
Income x joint machinery purchase experience			0.004**	0.002		
Income x no crop area expansion in past 5 yrs			- 0.009***	0.002		
JV partners x current net farm income_dif			- 0.000**	0.000		
JV partners x university degree			- 0.187*	0.104		
Decisions x know of JV			- 0.074***	0.026		
Decisions x university degree			0.109**	0.045		
Decisions x age_dif			- 0.003**	0.001		
Decisions x mind farm			0.085**	0.033		
Decisions x nocrop area expansion in past 5 yrs			- 0.618**	0.027		
Machinery x age_dif			- 0.012**	0.006		
Machinery x mind farm			0.437***	0.145		
Machinery x early adopter			0.292***	0.074		
Leave x income_dif			0.001***	0.000		
Leave x age_dif			- 0.009*	0.006		
Leave x current leave			- 0.285***	0.088		
Log-likelihood	-1881.3		-1809.7			-1698.7
AIC/n	2.219		2.158			2.009

Notes: †Standard errors (S.E) in parentheses; ***, **, * denote significance at the 1%, 5% and 10% levels, respectively; n=370.

To investigate how socio-demographic characteristics influence preferences, we estimated a second model that included socio-demographic indicators (MNL2). In the MNL2 model, utility is specified as a linear function of the JV structure attributes and interactions between JV structure attributes and various socio-demographic and attitudinal characteristics of respondents. For the continuous variables in the model (age and current net farm income), new variables were generated (*age_dif* and *current net farm income_dif*) that capture the deviation of a respondent's age and farm income from the sample mean (e.g. mean value = 0). Therefore, these interaction terms can be interpreted as the differences in preferences for an attribute if a respondent is older/younger or has a higher/lower average income than the sample average.

Results from the MNL2 model (Table 5) show that the income and decision attributes are positive and significant and the leave attribute is negative and significant. Interestingly, the partners and machinery attributes are not significant in the MNL2 model. This is because a number of significant interaction variables now pick up the preference heterogeneity for partners and machinery.

Looking at the interaction variables, farmers were more likely to prefer JV structures that offered higher incomes when: their existing income was higher; they held a university degree; were younger; took more leave; perceived their financial health to be poorer; had previous experience with the joint purchase of machinery; and/or had expanded their crop area within the past five years. For the partners attribute, farmers with higher existing income and/or farmers with a university degree preferred fewer partners. Farmers were more likely to prefer JV structures with greater operational control when: they were unaware of other JVs; held a university degree; were younger; had someone to mind their farm when absent and/or; had expanded crop area in the

last five years. JV structures offering new machinery were more likely to be preferred by farmers who were younger, had someone to mind their farm when absent, and/or considered themselves to be early adopters of innovations compared to other farmers in their district. Finally, for the leave attribute, farmers were more likely to prefer JV structures offering two weeks of additional leave when they had a higher current income, were younger and/or currently had less leave.

4.4.2 Random Parameter Logit model results

The data was also analysed using an RPL model with 500 Halton draws to gain insights into unobserved heterogeneity related to farmer JV preferences. The model was specified to account for the panel nature of the choice data, thus controlling for error correlation across the choices made by an individual respondent. The RPL model was estimated with a normal distribution on all attributes, except for the income attribute, which was estimated with a constrained triangular distribution. Although the constrained distribution generated a moderately less efficient model fit compared to a normal distribution, it generates behaviourally more plausible results.

The estimated coefficients of the variables are similar in direction and significance to results obtained with the MNL1 and MNL2 models. Specifically, the income, decisions and machinery attribute are positive and significant. This means that farmers have a preference for JV structures that offer an increase in net farm income, greater control of operational decisions, and offer opportunities to utilise new farm machinery. The standard deviation for the random parameters in the RPL model show significant heterogeneity in preferences for these attributes. Although the partner coefficient is not significant in the model, the significant standard deviation on this attribute shows that individual preferences for the number of partners varies significantly across the

population (from positive to negative preferences). The leave attribute is negative and significant, indicating that farmers have a preference for JV structures that result in no change to their existing leave arrangements.

When comparing the log-likelihoods between models, it is clear that an attribute-only RPL model provides a better fit than an extended MNL model comprising a large array of significant socio-demographic interaction variables. This indicates that there is significant preference heterogeneity that cannot be explained by any of the observable variables collected in the survey. The RPL model also accounts for the correlation between the sequence of choices made by the same individual, which improves model fit.

4.4.3 Implicit prices

The attribute 'change in annual net farm income' was expressed in monetary units, which allows us to estimate the marginal values respondents hold for the partners, decisions, machinery and leave attributes. In this study, the marginal WTA represents the amount of income that a farmer is willing to forego to gain an improvement in another attribute of the JV structure.

The results for MNL2-average include socio-demographic and attitudinal interaction variables. This shows, for an average respondent in the sample, that WTA estimates for the decisions and leave attributes are significant at the 1% level. On average, the WTA estimates were of a similar magnitude to the estimates calculated in MNL1. Farmers were willing to accept a $7,393 decrease in annual net farm income for each additional level of decision control and $11,604 of net farm income to accept a JV structure offering two weeks of additional annual leave (Table 6).

The use of socio-demographic interaction variables also allows us to compare WTA estimates for different farmer scenario types. This is done by generating different farm typologies, whose socio-demographic characteristics were adjusted for particular interaction terms to generate type-specific WTA estimates. Three farmer types that were representative and observed in the real world were designed to explore differences in WTA. These farmer types are:

- Farmer Type 1 (T1) – High income (100k above average), expansion farmer with good financial health and someone to mind the farm whilst absent (*Expansion=1*, *Financial health=1*, *Mind farm=1*)
- Farmer Type 2 (T2) – Low income (100k below average), no expansion farmer with strained financial health and no one to mind the farm whilst absent (*expansion=0*, *Financial health=-1*, *Mind farm=0*)
- Farmer Type 3 (T3) – Younger (15yrs younger than average), university educated farmer with early adopter tendencies but has not expanded the farm crop area within the last 5 years (*Age_dif=-15*; *University=1*; *Early adopter=1*; *Expansion=0*)

Table 6. Willingness to accept estimates

	Partners (per partner)	**Decisions (per operational control level)**	**Machinery (for new machinery)**	**Leave (for 2 weeks additional leave)**
MNL1				
Average WTA	$ 2,458**	$ - 7,511***	$ -14,310***	$ 10,986***
	(182 – 4,748)	(- 8,574 – - 6,487)	(- 18,402 – - 10,283)	(6,882 – 15,174)
MNL2				
Average WTA	(NS)	$ - 7,393***	(NS)	$11,604***
		(- 9,945 – - 4,954)		(7,078 – 16,356)
RPL1				
Average WTA	(NS)	$ - 10,311	$ - 20,238	$39,072
		(- 43,351 – 16,132)	(- 116,781 – 64,064)	(- 35,433 – 137,886)
Median WTA	(NS)	$ - 7,502	$ - 14,496	$28,057
Farmer Type 1 (**T1**)	$3,700***	$ - 7,817***	-14,788***	$6,638***
	(1722 – 5,720)	(- 9,989 – - 5,727)	(-22,324 – -7,417)	(2,865 – 10,495)
Farmer Type 2 (**T2**)	(NS)	$ - 3,842***	(NS)	$17,714***
		(- 6,632 – - 1,132)		(12,275 – 23,529)
Farmer Type 3 (**T3**)	$7,278***	$ - 9,151***	$ - 23,764***	$4,612**
	(5,418 – 9,213)	(- 11,165 – - 7,219)	(-30,845 – -16,904)	(1,198 – 8,082)

Notes: 95% confidence intervals in parentheses below mean WTA estimates; ***, **, * denote significance at the 1%, 5% and 10% levels, respectively.

For the partners attribute, T1 and T3 had significant WTA estimates. For each additional JV partner, T1 required an additional $3,700 of net farm income, whilst T3 required almost twice that amount $7,278. All three farmer types had a highly significant WTA for the decisions attribute. On average, T3 were willing to accept the greatest decrease in net farm income per annum for each additional level of decision control over farm operational decisions (WTA = $ - 9,151). Conversely, T2 were more sensitive to changes in net farm income and were less willing to forgo income for each additional level of decision control (WTA = $ - 3,842).

For the machinery attribute, T1 and T3 were both willing to accept a significant decrease in annual net farm income for a JV structure offering new machinery, while the WTA for T2 was not significant. For the leave attribute, T3 had a WTA of an additional $4,612 of net farm income to accept a JV structure offering two weeks additional annual leave, whilst T2 required an additional $17,714 of net farm income. This again, highlights the relative sensitivity of T2 to changes in net farm income.

Finally, the implicit price estimates were calculated for the RPL model. Unlike the MNL models, which use the mean coefficient estimate and its standard error, the RPL model estimates WTA based on the estimated mean coefficients and their random standard deviations. This approach takes into account the full distribution of preferences amongst respondents and thus delivers much wider confidence intervals. The results indicate that farmers were willing to accept, on average, a $10,311 decrease in annual net farm income for each additional level of decision control within the JV; a $20,238 decrease in annual net farm income for JV structures offering new farm machinery; and required an additional $39,072 of net farm income to accept a JV structure offering two weeks of additional annual leave.

4.5 Discussion

The results from the survey show that there is potentially broad general interest (55% of farmers) in JV structures by Australian grain growers, and thus, JV structures should be considered within the range of options available to increase the productivity and competitiveness of family farm businesses. We identify the JV structure attributes most preferred by farmers and reveal socio-demographic and attitudinal characteristics that are shown to influence these preferences.

Results from the MNL2 model with socio-demographic interaction variables showed that, overall, farmers had three main considerations for potential JV partnerships. They indicated preferences for JV structures which delivered an increase in net farm income and minimal loss of control over operational decision-making, whilst leaving existing annual leave arrangements unchanged. Farmers were less concerned about the potential number of partners, even though a greater number of partners may increase the complexity of decision-making processes and the potential for conflict between JV partners. The offer of new machinery also did not appear to affect farmer preferences for JV structures.

Farmer socio-demographic interaction variables in the MNL2 model showed there is significant preference heterogeneity that is influenced by a small-set of farmer socio-demographics. For example, when compared to older farmers, younger farmers were more likely to have a preference for JV structures offering higher incomes, greater operational control, new machinery, and more leave. This suggests that older farmers may be more willing to have less control over the operational decision-making than younger farmers, and thus, there may be complementarities in setting up JV structures between younger and older farmers, rather than amongst a group of younger farmers.

Additionally, although the partners attributes was, on average, not significant in the MNL2 model, interaction variables showed that farmers who had high existing incomes and/or a university degree significantly preferred JV structures with fewer partners

Although the MNL2 model provides useful results regarding observed preference heterogeneity, the RPL model revealed significant *unobserved* heterogeneity across all attributes in the study. Further, when comparing the log-likelihoods between models it was clear that an attribute-only RPL model provides a better fit than the MNL2 model, with its associated interaction variables. This indicates that when modelling farmer preferences for JV farm structures, unobserved preference heterogeneity may be more important than differences in preferences that are caused by any observable characteristics. In the next chapter, we will explore unobserved preference heterogeneity further by estimating latent class models.

A consistent finding across all models is that farmers appear reluctant to give up control of operational decisions or move towards consensus decision-making processes (measured in our survey as consulting or being consulted about decisions or a shared decision-making process). This is obviously problematic for the formation of JV structures, as the number of farmers interested in forgoing significant operational control appears limited, thus greatly reducing the potential JV partner pool.

One way to address this challenge is to consider the potential financial benefits of a successful JV structure. If a JV structure can generate sufficient additional net farm income versus an individual's status quo income, it may encourage individuals to accept less control of operational decisions in exchange for increased income. This

would expand the potential pool of JV partners. The implicit price estimates from our models indicate that farmers are willing to forgo between $7,511 (MNL1) and $10,311 (RPL) of additional net farm income for each level of decision control. For example, farmers are willing to forgo net farm income to be the sole decision-maker rather than be the final decision-maker in consultation with other partners.

However, the implicit price estimates in the MNL2 and RPL models for the decisions attribute show significant heterogeneity. In the MNL2 model, this is due to the underlying influence of various farmer socio-demographics variables. We demonstrate this for three example farmer 'types'. Depending on the type of farmer, an individual may be willing to forgo additional net farm income for each level of decision control in a range from $ 3,842 to $ 9,151. This shows that the size of the trade-offs between income and accepting less operational control varies greatly between different types of farmers. Therefore, it is vital to quantify the potential economic implications of a JV structure for each individual farmer when assessing the feasibility and attractiveness of opting into a JV structure, compared to an individual's baseline status quo situation.

There may be the potential to recognise farmers' preferences for maintaining control and the diversity of interests between farmers. For example, the welfare loss associated with losing some operational control may be reduced if a JV allows an individual farmer in the partnership to focus on the aspect of farm management that is their strength and interest (e.g. crop agronomy, farm management or grain marketing etc.).

This study has provided significant insights into both observed and unobserved JV attribute preference heterogeneity amongst Australian grain growers. However, there

is clearly more work to be done exploring unobserved preference heterogeneity in greater detail. The use of latent class models to explore and identify groups of farmers with unique preferences may be one possible future research avenue. Given the inherent design of the choice attributes and their associated levels, there is also potential to investigate non-linearity in farmer preferences, especially for the attribute related to operational control.

4.6 Conclusions

Organisational farm business innovations like JV structures have the potential to boost the competitiveness and productivity of broadacre family farms. There are, however, a range of trade-offs that must be considered by farmers when assessing the viability of these structures. In this study, we investigate farmers' preferences for different characteristics of JV structures: change in income, number of JV partners, control of operational decision-making, new machinery and amount of leave. We found that approximately 55% of farmers are likely to consider adopting a JV structure in the future and that 4% are already in a form of JV. Farmers' preferences for JV farm structures were partly explained by observed heterogeneity, via farmer socio-demographic interaction terms, but there was significant unobserved preference heterogeneity that could not be explained by any of the observable characteristics collected in this study. All models identified that farmers had strong preferences for JV farm structures that offer increased net farm income, whilst minimising loss of control over operational decisions. The reluctance by farmers to reduce their control of operational decisions and move towards consensus-like decision-making processes clearly reduces the pool of potential JV partners and provides an obvious constraint to the broader adoption of this organisational innovation. Successful JV designs will need

to offer substantial increases in income, involve farmers that place less value on maintaining full operational control and/or provide opportunities for farmers to maintain high levels of operational control over aspects of farm management that they value most highly.

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Name of Principal Author (Candidate)	Brendan Lynch
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Overall percentage (%)	65%
Certification:	This paper reports on original research I conducted during the period of my Higher Degree by Research candidature and is not subject to any obligations or contractual agreements with a third party that would constrain its inclusion in this thesis. I am the primary author of this paper.

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Co-Author Contributions

By signing the Statement of Authorship, each author certifies that:

i. the candidate's stated contribution to the publication is accurate (as detailed above);
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iii. the sum of all co-author contributions is equal to 100% less the candidate's stated contribution.

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Chapter 5 Identifying farmer types most likely to pursue joint venture farm business structures

Abstract

Joint venture (JV) farm structures have the potential to increase the productivity and profitability of family farms. However, such structures are not widely adopted within the farm business community. Furthermore, knowledge on the relative attractiveness of different JV models and how farmer characteristics may influence their interest in JVs is limited. We use a choice experiment to explore what characteristics and JV structures are preferred by farmers, and how socio-demographic and attitudinal variables of farmers influence the type of JV structure preferred. A Latent Class analysis revealed significant unobserved preference heterogeneity amongst farmers. We identify six classes of farmers' preferences. Classes varied in their preferences regarding the number of JV partners, access to new machinery and/or the opportunity for additional annual leave. There was one class where farmers preferred to defer the final responsibility of operational decision-making to another JV partner, while in another class farmers displayed a significant preference for JV structures in which they were the sole decision-maker of operational decisions. The diversity in preferences shows that there is no 'one size fits all' JV design, leaving opportunities for a range of JV decision models. Such flexibility in JV design is likely to have advantages when seeking JV partners, with a significant proportion of the sampled population open to collaborative decision-making models. This information can assist stakeholders and policy-makers in identifying appropriate partnerships with the greatest potential for success.

5.1 Introduction

Organisational innovations, like joint venture (JV) farm structures where two or more farm businesses combine to establish a larger farming enterprise have the potential to increase the productivity and profitability of family farms (ADAS 2007; Lynch et al. 2012; Gladigau 2013; Lynch et al. 2015). Business alliance structures like JVs are commonly used in the broader economy to increase firm competiveness by gaining strategic and operational advantages that would be difficult to obtain as a standalone entity (Sheth and Parvatiyar 1992). However, such structures are not widely adopted within the farm business community, despite the average family farm business facing increasing productivity challenges (ABARES 2010; Jackson 2010; Hughes et al. 2011) and a growing interest in alternative farm structures (Gorton and Davidova 2004; Wolfe 2011; Port Jackson Partners 2012; Cawood 2013). While previous studies have identified a small niche of Australian grain growers interested in adopting JV structures (Lynch et al. 2015) the relative attractiveness of different JV models and how farmer characteristics affect their preferences for different JV models is still unchartered territory.

Adopting a JV farm business structure is inherently complex and entails the consideration of both market and non-market costs and benefits. The adoption decision is also characterised by considerable reversibility costs, which obviously have significant implications for the risk profile of the farm businesses involved (Marra et al. 2003; Gray et al. 2009; Tarrant and Malcolm 2011; Gladigau. 2013). Given the inherent qualities of the innovation, it is likely that farmer preferences for JV structures are heterogeneous, depending on, for example, an individual's circumstances and their attitude to risk and collaboration. To explore preference heterogeneity, latent class models have been widely used in the literature, in a variety of agricultural economics

contexts (Colombo et al. 2009; Ruto and Garrod 2009; Rodríguez-Entrena et al. 2014). This methodological approach will be applied in this paper to explore unobserved heterogeneity of farmer preferences for JV structures.

This study, which is the first of its kind, uses a choice experiment (CE) to explore what JV structures are most attractive to Australian grain farmers, and then uses a latent class analysis to identify what JV structure attributes are most valued by different farmer classes. To better understand the characteristics of each class, we undertake a *post-hoc* analysis to assess potential socio-demographic and attitudinal differences. These specific variables were identified within the innovation adoption conceptual model, as described in Chapter 2. Our aim is to improve understanding of the potential for JV farm business structures, which will assist policy-makers and stakeholders interested in developing innovative farm business structures to boost the competiveness of Australian grain growers.

The CE method and modelling approaches used to identify farmers' preferences for JV characteristics are detailed in the next section, followed by a description of the questionnaire in Section 5.3. Results of the questionnaire and latent class models are presented in Section 5.4. The paper concludes with a discussion of the challenges and implications for policymakers and other stakeholders interested in the future adoption and diffusion of organisational innovations, like JV structures, by farmers in the Australian grain sector.

5.2 The choice experiment method

To deepen our understanding of farmers' preferences for different characteristics of JV structures, a discrete choice experiment (CE) was conducted. A stated preference

questionnaire like a CE is well suited for this study because JV structures are not yet widely adopted nor traded in markets to allow the use of revealed preference techniques. The stated preference approach allows us to study farmer preferences for hypothetical circumstances. The CE method has been applied within a wide range of fields, such as consumer research (e.g. Swait and Adamowicz 2001), transport choices (e.g. Hensher and Rose 2007), and environmental management (e.g. Kragt and Bennett 2011), but it has rarely been used in an agribusiness domain (Kragt and Llewellyn 2014).

The theoretical foundation of CEs comes from random utility theory (McFadden 1986) and Lancaster's theory of value (Lancaster 1966). Random utility theory is based on a model where the utility U_{ijt} an individual *i* obtains from possible choice *j* in situation *t* is described as a latent variable which is observed indirectly via the individual's choices. Utility is comprised of an observed 'systematic' utility element V_{ijt} and a random unobserved error term ε_{ijt} (Louviere et al. 2000). The foundation of Lancaster's theory of value is that a good can be described in terms of its multiple characteristics (called 'attributes'), which impact utility as components of $\boldsymbol{x_{ijt}}$:

$$U_{ijt} = V_{ijt} + \varepsilon_{ijt} = \beta_i' \mathbf{x}_{ijt} + \varepsilon_{ijt} \qquad i=1,2,\ldots,N;\ j=1,2,\ldots,J;\ t=1,2,\ldots,T \qquad (1)$$

The observed element of utility V_{ijt} is assumed to be a function of a vector of explanatory variables that includes attributes of the good under valuation, and may further include socio-demographic characteristics and features of the choice task itself (Hensher and Greene 2003). The CE allows us to infer people's values for the different attributes of a good. In the present study, respondents are shown multiple alternatives for JV structures, which vary in the level of their attributes (Section 5.3). Respondents' choices between attributes of different levels allow the researcher to infer the trade-

offs respondents make when choosing between alternatives (Bennett and Blamey 2001).

5.2.1 Modelling approach

There are a number of modelling approaches used by CE practitioners to explore the heterogeneity between individuals' preferences. While observable characteristics such as socio-demographic variables can be included in the utility function to explain heterogeneity, CE research increasingly shows the need to account for *unobserved* heterogeneity in CE modelling (Hensher et al. 2005). Two commonly used models that can account for unobserved preference heterogeneity are the random parameter logit (RPL) and the latent class (LC) models. The RPL model captures unobserved heterogeneity by assuming a continuous distribution of the preference parameters, which accounts for the fact that preferences vary across the population. LC models, on the other hand, assume a discrete distribute of preference parameters where different preference 'classes' exist within a population, but preferences are homogeneous within each class. An advantage of the LC model over the RPL model is that it does not require any *ex-ante* assumptions on the distribution of preference parameters (Sagebiel 2011). The LC model structure allows us to explore the preferences of different 'market segments' within the sample population. Since we aim to identify broad farmer types with similar preferences, a LC model is appropriate for this study.

5.2.2 Latent class model and post-hoc analysis

The LC model assumes that the population consists of discrete number of classes, in which preferences β_c are homogenous within class c but may vary between classes (Heckman and Singer 1984). One of the strengths of the LC model is that it allows the

analyst to control for any potential systematic, but unobserved, correlations in the repeated choices made by an individual (Revelt and Train 1998). This is achieved by using an individual specific error term that is correlated across the repeated choices made by individual *i*. In this LC model, the probability that an individual *i* chooses alternative *j* in choice situation *t* follows the typical logit formula but is conditional on that individual belonging to class *q* (Greene and Hensher 2003):

$$\Pr_{it|class\ c}(j) = \frac{\exp(\mathbf{x}_{it,j}\beta'_c)}{\sum_{j=1}^{J}\exp(\mathbf{x}_{it,j}\beta'_c)} \tag{2}$$

The unconditional choice probability (unconditional on *c*) is then given by (Hess et al. 2011):

$$\Pr_{it}(j \mid \beta_1,.....,\beta_C) = \sum_{c=1}^{C} \Pr_{ic}\ \Pr_{it}(j \mid \beta_c) \tag{3}$$

The LC logit model specification can account for the repeated choices made by the same respondent, assuming intra-respondent homogeneity as follows (Hess et al. 2011):

$$L_i(j_{i1},...,j_{iT} \mid \beta_1,.....,\beta_C) = \sum_{c=1}^{C} \Pr_{ic}\left(\prod_{t=1}^{T}\Pr_i(j_{it} \mid \beta_c)\right) \tag{4}$$

The analyst specifies the number of classes *C* to be estimated, and decides on the 'optimal' number of classes guided by the AIC and BIC values of the various models, R^2, class sizes, and significance of class membership functions.

In this paper, we undertake a *post-hoc* analysis of the classes identified in the LC model, to explore potential socio-demographic and attitudinal differences between classes. Using a three-step approach (Hibbard et al. 2007; Chang 2012), each

respondent was first assigned to one latent class based on the maximum posterior probability of belonging to that class. Second, we performed a t-test to compare socio-demographic and attitudinal characteristics between farmer classes. Finally, a probit model was estimated to explain farmer classes based on socio-demographical and attitudinal variables.

5.3 Questionnaire development

The CE questionnaire was developed and designed following best-practice guidelines (Louviere et al. 2000; Bennett and Adamowicz 2001; Hensher et al. 2005). In addition to nonmarket valuation experts, a team of farm business experts was consulted during the questionnaire development phase, encompassing farm extension, farm management consultants and farmers, which included farm joint venture practitioners. Pre-testing of the questionnaire was undertaken through one-on-one interviews with farmers and workshops with groups of farmers, before an online pilot questionnaire was launched and tested. Minor changes were made to the questionnaire design before the final questionnaire was launched in July 2013.

The JV scenarios in the CE included five attributes that varied in levels between choice sets. These attributes were: 1) the number of farm businesses in the JV structure; 2) influence on operational decisions; 3) farming with the latest machinery; 4) leave arrangements; and 5) change in annual net farm income (Table 1 below). Attribute levels were based on feedback from experts and farmers involved in pre-testing. The change in net farm income attribute was further based on the analysis of farm financial performance data at the national scale (ABARES 2010), and financial performance

benchmarks at the agro-ecological zone scale across the southern and western grain growing regions of Australia (Hooper and Levantis 2011).

The questionnaire started with general questions about JV farm structures and other forms of farmer collaboration, which aimed to gauge respondents' familiarity with JVs and general interest in collaboration. We then explained the attributes and choice task, followed by the choice questions. The final section contained a broad range of both socio-demographic and attitudinal questions. The choice sets were constructed using a Bayesian D-efficient design (Sándor and Wedel 2001), with a total of 20 choice sets divided into four blocks. These blocks were evenly distributed at the regional and national scale. Each respondent was allocated to a block and completed five choice sets. Respondents were asked to identify their most preferred structure from four alternatives (Figure 1). An opt-out option was not provided in the choice sets because we are most interested in the relative importance of different JV attributes, as opposed to eliciting absolute values for attributes, and to avoid potential non-choices because of the potentially likely low levels of awareness of JV farm structures amongst the target audience. Since we are not investigating the absolute likelihood of adoption, but the preference trade-offs between attributes, not including an opt-out alternative is appropriate in this case.

Table 1. Attributes and levels used in the farmer JV choice experiment

Attribute	**Attribute description**	**Attribute levels**
Number of farm businesses in the JV structure	A JV will be comprised of a number of individual farm businesses that will be equal shareholders in the new JV business structure.	2, 3, or 4 farm businesses
Influence on operational decisions	Despite equal shareholdings and representation on the board, individual farm families may have varying levels of direct influence/control over farm operational decisions for the whole JV.	Sole decision-maker (coded 1); Final decision-maker, in consultation with other partners (2); Shared decision-making with other partners (3); Not the final decision-maker, but input into decisions (4); No operational decisions (5)
Farming with the latest machinery	The JV farm structure may increase the feasibility that JV partners can procure the latest machinery.	New machinery, Older machinery (initially 5 yrs plus)
Leave arrangements	The extra workforce in a JV may allow farm families to take more leave (holidays) away from the farm.	Extra 2 weeks leave, no change
Change in annual net farm income	Adopting a JV structure will likely result in a change to a farm family's average annual net farm income. This change in income will be relative to the family's average net farm income over the past 5 years.	-15k, no change, 15k, 30k, 50k, 75k

Figure 1. Example choice set in the farmer JV choice experiment questionnaire

Carefully consider each of the following options for formal JV structures. If options A, B, C and D were the only ones available, which option would be most attractive to you?

Characteristics	Option A	Option B	Option C	Option D
Number of farm businesses in the JV structure	2	3	4	4
Your influence on operational decisions (non-board decisions)	Sole decision-maker	Shared decision-making with other partners	Not the final decision-maker, but input into decisions	No operational decisions
Farming with the latest machinery	Older machinery (initially 5 yrs plus)	New machinery	New machinery	New machinery
Leave arrangements	Extra 2 weeks of flexible leave	No change	No change	Extra 2 weeks of flexible leave
Change in annual net farm income (compared to current 5yr average)	+ $30k	No Change	+ $50k	+ $15k
Most attractive option	☐	☐	☐	☐

Before commencing the choice tasks, respondents were given a definition of a farm JV structure and its basic operating principles. A JV structure was defined as "a business structure that combines the assets, infrastructure and staff of two or more farm businesses".

The JV operating conditions were based on a combination of expert opinion and from the experience of practitioners' currently involved in similar JV structures (Gladigau. 2013). The operating conditions of the JV structure were described as follows:

- Individual farm businesses retain ownership of their underlying land asset;
- Cropping land is leased to the JV on a 3-year rolling lease basis;
- Livestock is not included in the JV and is managed independently at the individual farm level;
- Each JV is managed by a board that is responsible for major business decisions and headed by an independent chairman;
- Each farm business in the JV will have an equal shareholding and a representative on the board;
- Machinery is procured and managed by the JV;
- Crop area of the JV will be sufficient to optimise economies of scale, and more crop land can be leased or share farmed if required;
- An independent crop consultant is contracted by the JV to provide advice and support in relation to crop management decisions; and
- Farm income is derived from a combination of land lease payments, a role-based salary and a dividend from the profit/loss of the JV structure.

The above description of a JV business should be kept in mind when considering the results of this study, as they will be specific to the context provided in our questionnaire.

The CE questionnaire was administered online with broadacre grain producers between July and September 2013. The market research firm KG2, which maintains a comprehensive database of Australian grain growers, randomly recruited a sample of 340 farm managers. Farmers were recruited until the target number of respondents for each region was reached, ensuring a balanced regional samples across the major growing regions of New South Wales, Victoria, South Australia and Western Australia. Farm managers were contacted by telephone, and those who agreed to participate were sent a secure web link via email through which they could access the questionnaire. A follow-up phone call was made shortly after each email was sent to confirm the respondent had received the web link. Out of the 4,137 farm businesses contacted, 47.9% did not qualify due to land size, farm type, lack of internet connection, or because the primary cropping decision-maker was not available. Of the 2,155 eligible farmers, 340 completed questionnaires were collected: a response rate of 15.7%.

5.4 Results

To explore farmer preferences for JV structure attributes, both linear and non-linear LC models were evaluated. LC models were generated using Nlogit v.5 (Econometric Software 2012). Summary statistics and probit models were generated in Stata 12.1 (StataCorp 2011).

Initially, attribute-only LC models that were linear in attribute levels were evaluated. Several models were estimated, with varying numbers of classes with model selection guided by the AIC and BIC values of the various models, R^2, class sizes, and significance of class membership functions. A four-class model was chosen as the preferred model. This was because there was only a small marginal increase in model performance when the number of latent classes was more than four. Further, a four-class model avoided the very small class sizes, which resulted when models with greater than four classes were modelled.

Post-hoc analysis was then performed to explore potential socio-demographic and attitudinal differences between the four classes identified in the LC model. Respondents were allocated to their dominant class and t-tests were performed on the descriptive statistics. The analysis of farmer classes revealed only one observable socio-demographic variable that helps to explain class membership probability (university degree). All other characteristics were self-reported attitudinal variables (such as JV interest and family history) that are not typically observed amongst the population. Probit models were also estimated on the binary variable that identifies a farmer's dominant class, using the significant variables identified during the t-testing as independent variables. However, the probit models had limited accuracy in explaining class membership for the four-class linear model.

We therefore conducted additional analyses to assess whether heterogeneity in preferences could be explained differently. We estimated a number of LC models where socio-demographic and attitudinal variables were included in the class membership probability function, but these did not provide additional insights. We then estimated LC models that were non-linear in attribute levels, to explore in more

detail the JV structure attributes preferred by different farmers. As explained earlier, these models were estimated with varying numbers of classes, with the final model selection guided by a range of criteria. This process resulted in a preferred model with six latent classes that is non-linear in attributes (Table 2 on next page).

5.4.1 Six-class non-linear latent class model

The six-class model shows that income is significant and positive for all classes. This is not surprising as it suggests that in general, all farmers prefer JV structures that offer opportunities to get higher income. There is significant heterogeneity of preferences for number of JV partners. Classes A, D and E displayed a significant positive preference for JV structures involving two partners instead of the base case of four partners, but did not show significant preferences for three partners over four. Classes B, C and F were indifferent towards the number of partners involved in a JV structure (within the choice context presented).

The non-linear specification of the decisions attribute reveals an array of preference structures. When compared to the base case, Class A, B and E significantly preferred ‘not being the final decision-maker, but having input into the decisions’ over the base case level (‘No operational decisions’). All classes, except A and C had a significant positive utility for ‘shared decision-making with other partners’ and for having ‘final control over operational decision-making in consultation with other partners’, when compared to the base case. Finally, classes B, C and F displayed a significant positive utility for JV structures in which they were the ‘sole decision-maker’, compared to the base case.

Table 2. Latent class model result for the preferred six-class non-linear model

Class	**Class A**		**Class B**		**Class C**		**Class D**		**Class E**		**Class F**	
Latent Class Probabilities	**26.4%**		**27.9%**		**9.2%**		**13.0%**		**13.6%**		**9.9%**	
Choice Attributes	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.
Income	**0.060*****	0.007	**0.035*****	0.004	**0.041*****	0.015	**0.061*****	0.010	**0.012***	0.007	**0.023****	0.009
2 JV partners	**0.678****	0.284	0.320	0.219	0.245	0.458	**0.941*****	0.285	**1.123*****	0.375	-0.330	0.412
3 JV partners	-0.618	0.487	-0.032	0.310	-1.729	1.503	-30.282	0.000	-0.126	0.358	-0.346	0.448
4 JV partners (Base Case)	-	-	-	-	-	-	-	-	-	-	-	-
No operational decisions (Base Case)	-	-	-	-	-	-	-	-	-	-	-	-
Not the final decision-maker, but input into decisions	**1.468****	0.663	**1.496****	0.698	-0.424	1.632	1.164	0.751	**2.622*****	0.680	-0.232	3.182
Shared decision-making with other partners	0.824	0.728	**3.342*****	0.595	1.841	1.307	**2.306*****	0.692	**3.038*****	0.758	**4.740*****	1.244
Final decision-maker, in consultation with other partners	0.246	0.661	**4.163*****	0.592	-0.729	2.221	**1.388***	0.727	**1.631****	0.784	**3.942*****	1.072
Sole decision-maker	0.272	0.425	**4.102*****	0.512	**2.436*****	0.811	0.052	0.389	-0.538	0.594	**1.546***	0.934
Machinery	**2.596*****	0.513	**0.475***	0.252	**-3.435*****	1.309	-0.477	0.307	**-0.812****	0.333	**1.847*****	0.540
Leave	**-1.766*****	0.549	**0.769****	0.368	**-3.468***	1.809	**2.066*****	0.409	-0.235	0.440	0.514	0.566
Log-likelihood	-1538.2											
AIC/n	1.88											

Table 3. Variable descriptions and descriptive statistics for the overall sample and for each of the six latent classes

Variable	Description	Mean	SD (range)	Class A (n=104)	Class B (n=85)	Class C (n=35)	Class D (n=37)	Class E (n=44)	Class F (n=35)	F-Statistic
Gender	1 = Male; 0 = Female	0.96	0.21	0.95	0.95	1.00	0.97	0.98	0.89	0.263
Grain income	% of farm income derived from broadacre grain production	74	20 (0-100)	77[c*]	74	66[a*]	75	74	73	0.177
Area of grain	Current grain crop area (ha)	1,626	1,461 (324-18,500)	1,758	1,600	1,246	1,933	1,272	1,801	0.158
Current net farm income	Average net farm income over the past 5 yrs (in '000 AU$)	163	175 (0-1,000)	172	165	143	200	123	161	0.460
University degree	1 = Has a university degree; 0 = No university degree	0.12	0.33	0.16[e*]	0.19[e**]	0.11	0.03	0.00[a*,b**]	0.11	**0.013**[**]
Age	Farmer age (yrs)	52	10.2 (21-70)	53	52	53	50	55	53	0.287
Annual leave	Current annual leave: 1 = Greater than 4 weeks; 0 = 3-4 weeks leave; -1 = 2 weeks or less	-0.31	0.65	-0.21	-0.39	-0.23	-0.43	-0.34	-0.37	0.328
Financial health	Perception of farm business' financial health: 1 = Healthy; 0 = Stable; -1 = Strained	0.29	0.81	0.23	0.41	0.17	0.32	0.34	0.20	0.561
Farm expansion	1 = Has expanded crop area in the last 5 yrs via purchase or lease; 0 = No expansion	0.51	0.5	0.59[e**]	0.54	0.49	0.51	0.32[a**]	0.51	**0.097**[*]
JV Awareness	1 = Familiar or aware of grain farmers that have entered a JV; 0 = No	0.42	0.49	0.47	0.36	0.43	0.54	0.39	0.34	0.367
Early adopter	Do you consider yourself an early adopter compared to other farmers in your region: 1 = Agree; 0 = Neither agree or disagree; -1 = disagree	0.22	0.77	0.33	0.11	0.17	0.32	0.02	0.34	0.133
Flexible work	Having the flexibility to opt for a reduced workload makes a joint venture structure attractive: 1 = agree; 0 = neither agree or disagree; -1 = disagree	0.30	0.81	0.41[b***]	-0.12[a,d,e,f***]	0.17[d*]	0.65[b***,c*]	0.45[b***]	0.57[b***]	0.000[***]

Table 3 (Cont.). Variable descriptions and descriptive statistics for the overall sample and for each of the six latent classes

Variable	Description	Mean	SD	Class A (n=104)	Class B (n=85)	Class C (n=35)	Class D (n=37)	Class E (n=44)	Class F (n=35)	F-Statistic
Family history	Family history and traditions related to my farm highly influence the major farm business decisions I make presently: 1 = agree; 0 = neither agree or disagree; -1 = disagree	-0.29	0.78	-0.38	-0.21	-0.34	-0.46	-0.16	-0.17	0.282
JV risky	I think the downside risks of a formal joint venture structure outweigh the possible benefits for my farm business: 1 = agree; 0 = neither agree or disagree; -1 = disagree	0.22	0.76	0.10[b**]	0.45[a**,f*]	0.26	0.16	0.23	0.03[b*]	**0.022****
JV interest	I would consider forming a JV: 1 = Yes/Already in one; 0 = Maybe; -1 = No	-0.25	0.71	-0.09[b***]	-0.54[a***,e*]	-0.20	-0.24	-0.18[b*]	-0.20	**0.000*****
Sell Farm	It is likely that I will need to sell the farm to a non-family member to fund my retirement: 1 = agree; 0 = neither agree or disagree; -1 = disagree	-0.48	0.75	-0.55	-0.51	-0.57	-0.22	-0.36	-0.54	0.195
Risk Tolerance	I am willing to take higher financial risks in my farm business in order to realise higher average returns: 1 = agree; 0 = neither agree or disagree; -1 = disagree	0.15	0.83	0.29	0.09	0.09	0.03	-0.09	0.37	**0.059***
More Professional	I would increase farm profitability if I ran my farm business more professionally: 1 = agree; 0 = neither agree or disagree; -1 = disagree	0	0.83	0.13	-0.18	-0.11	0.11	0.05	-0.06	0.149
Rely on experts	I rely on outside experts to help me make farm decisions: 1 = agree; 0 = neither agree or disagree; -1 = disagree	0.21	0.82	0.21	0.16	0.17	0.32	0.25	0.14	0.927

*P < 0.1; ** P < 0.05; *** P < 0.001 (Different letters indicate significant differences between latent classes)
[a] = significant difference between respondents in latent class and respondents in latent Class A
[b] = significant difference between respondents in latent class and respondents in latent Class B
[c] = significant difference between respondents in latent class and respondents in latent Class C
[d] = significant difference between respondents in latent class and respondents in latent Class D
[e] = significant difference between respondents in latent class and respondents in latent Class E
[f] = significant difference between respondents in latent class and respondents in latent Class F

For the machinery attribute, classes A and B displayed a significant positive utility for JV structures offering new machinery, whilst classes C, E and F displayed significant preferences for existing (older) machinery.

Regarding the leave attribute, classes A and C did not value more leave beyond their current leave arrangements, while classes B and D displayed a significant positive utility for two weeks additional annual leave.

5.4.2 Post-hoc analysis of preference classes

Post-hoc analysis was performed to explore potential socio-demographic and attitudinal differences between the classes identified in the six-class non-linear LC model. Respondents were allocated to a class, based on their maximum posterior probability. This resulted in the following class distribution: Class A = 30.6%; Class B = 25.0%; Class C = 10.3%; Class D = 10.9%; Class E = 12.9%; and Class 10.3%. The descriptive statistics, by class, as well as descriptions of the socio-demographic and attitudinal variables collected in the survey are displayed in Table 3 above.

Post-hoc t-tests on descriptive statistics revealed that there are no significant differences for most of the variables, including farm cropping scale (Area of grain), income (Current net farm income), farmer age (Age), the amount of annual leave (Annual leave), perceived farm business health (Financial health), awareness of grain farmers that had entered a JV (JV awareness), perceived as an early adopter (Early adopter), being highly influenced by family history and traditions when making major farm business decision (Family history), succession planning (Sell farm), increased farm business professionalism (More professional), and self-reported reliance on external experts to help make farm decisions (Rely on experts).

Significant differences between at least two classes were observed for six variables only. In terms of enterprise mix (Grain income), farmers in Class C derived a significantly lower proportion of farm income from broadacre grain production than farmers in Class A. Whilst farmers in Class A and B were significantly more likely to be university educated (University degree), compared to farmers in Class E. Further, Class A farmers were significantly more likely to have expanded crop area, via purchase or lease within the last 5 years (Farm expansion) than farmers in Class E. Farmers in Class B showed a significantly lower *a priori* interest in forming a JV in the future (JV interest) compared to farmers in Class A and E. Farmers in Class B were also significantly less attracted to the potential workload flexibility offered by a JV structure (Flexible work), compared to farmers in all other classes, except Class C. Finally, farmers in Class B were also more likely to think that the potential downside risks of JV structures outweigh the benefits for their business (JV risky) than farmers in Class A and F.

5.5 Discussion

In this study, we aim to understand how heterogeneity between farmers affects their preferences for characteristics of JV structures. A six-class LC model that is non-linear in JV structure attributes shows that there is significant unobserved preference heterogeneity, particularly for the different levels of decision control. Apart from Class C, all classes demonstrated significant preferences for options that offered some degree of control or form of collaboration on operational decisions with JV partners, compared to the base case of no control or influence in operational decisions. Classes B and C most strongly preferred having more or complete control in the operational decision-making process relative to the other classes.

Although they still preferred some involvement in operational decision-making, the fact that the majority, roughly 91% of respondents (Classes A, B, D, E, F), indicated a willingness to forgo some degree of operational control is an important finding. This result demonstrates there is potential for a range of JV structures to be developed, with different levels of operational control that align with a broad pool of potential JV partners. Without this pool of potential JV partner candidates, the ability to locate a suitable JV partner is significantly diminished.

Farmers in Class C (9.2%) appear to prefer only JV structures in which they make autonomous operational decisions. This decision control preference is likely to significantly impede their ability to attract a suitable JV partner. However, they may be able to pursue an alternative JV funding solution, like a non-farm passive investor.

Interestingly, Classes B, and C (as well as F) were indifferent to the number of JV partners (2, 3, or 4 partners). However, the remaining three classes significantly preferred JV structure containing two partners instead of four. This result may imply that farmers in Classes A, D and E, while they are willing to relinquish some degree of control in decision-making, they are concerned by the increased number of working relationships, and the associated potential complexities involved with operating, managing or potentially unwinding a JV structure involving a large number of JV partners.

By comparing attribute preferences across farmer classes, a picture begins to emerge regarding potential complimentary and conflicting JV structure preferences between and within classes. At a granular level, when you consider preferences for the operational decisions attribute, it is clear that some classes are likely to have a wider

pool of potential JV candidates (e.g. class A), whilst others classes (such as class C) appear to have a limited potential of finding suitable pool JV partner candidates. However, by drilling down into the individual attribute preferences of each of the 21 possible combinations of latent class relationship pairs, conclusions can be drawn about the suitability or otherwise of potential JV 'pairings' between and within classes (Figure 2).

To create the compatibility matrix shown in Figure 2, the choice attributes were assessed for each possible individual relationship pairing, and rated compatible, neutral or non-compatible. Each attribute within a relationship pair was rated either: 1) compatible, if the JV structure attribute preference between a relationship pair was aligned or complementary; 2) neutral, where one class had a significant attribute preference whilst the other class displayed no significant preference for the same attribute; or 3) non-compatible, where both classes had a significant preference for the same attribute, but that preference was not aligned or complementary. Based on the collective assessments of the five choice attributes, a relationship pair was then allocated a relationship compatibility ranking as a way to assess JV partner potential between classes. Relationship pairs were rated either: 1) Low, when at least one attribute between a pair was rated non-compatible; 2) Medium, when at least one attribute between a pair was rated neutral, with no attributes being rated non-compatible; or 3) High, when all attributed between a pair were rated compatible.

Figure 2. Class pairings and JV structure compatability matrix

Class Relationship		Choice Attributes					JV Structure
Class 1	Class 2	Income	Partners	Decision	Machinery	Leave	Compatability
B	B						High
D	D						High
E	E						High
F	F						High
A	F						Medium
B	D						Medium
B	F						Medium
D	E						Medium
D	F						Medium
A	A						Low
A	B						Low
A	C						Low
A	D						Low
A	E						Low
B	C						Low
B	E						Low
C	C						Low
C	D						Low
C	E						Low
C	F						Low
E	F						Low

Choice Attributes Compabiltity
Compatible
Neutral
Non-Compatible

JV Structure Compataibility
High
Medium
Low

JV Structure Compataibility Matrix						
	Class A	Class B	Class C	Class D	Class E	Class F
Class A	Low					
Class B	Low	High				
Class C	Low	Low	Low			
Class D	Low	Medium	Low	High		
Class E	Low	Low	Low	Medium	High	
Class F	Medium	Medium	Low	Medium	Low	High

The analysis reveals that the majority of pairings (12) had a Low JV structure compatibility rating as they contained at least one attribute preference that was non-compatible. A further five pairings were classed as having a Medium JV structure compatibility at they contained only compatible and/or neutral attributes. Of most interest are the four relationship pairings that had a High JV structure compatibility, with all attribute preferences aligned and compatible. The relationship pairings rated High consisted of pairings with farmers belonging to the same class, with classes that displayed a significant preference for decision control that involves some form of collaboration on operational decisions.

As evidenced by the proposed JV structure compatibility matrix, there are distinct differences between classes in terms of their overall relationship pair compatibility. Farmers in Classes D and F have the most number of class relationships ranked as Medium or High (four each). This is due to their preferences for collaborative decision control and insignificant preference for either the machinery attribute (Class D) or the leave attribute (Class F), which expands the pool of potential relationship pairings with a Medium rating. Conversely, relationship pairs with farmers in Class C are all rated Low for JV structure compatibility. This is because farmers in Class C had a single significant preference for JV structures in which they were the sole-decision-maker. This suggests that farmers in Class C may have difficulty in finding a suitable pool of JV structures partners, unless they are willing to forgo greater operational control.

Interestingly, although farmers in Class A were willing to forgo being the final decision-maker, whilst retaining input into operational decisions, all relationship pairs with this class were rated Low for JV structure compatibility (with the exception of the Medium rating for Class F). It is also noteworthy that Class A was not compatible

with itself, because farmers in this class had a non-compatible decision-control preference; an aversion for being the final decision-maker in a JV structure.

To identify if there were observed socio-demographic and attitudinal characteristics that could be used to predict class membership, we first undertook a *post-hoc* analysis using t-tests (as we discussed above and shown in Table 3). Of the six significant variables identified by the post-hoc analysis, three were observable socio-demographic variables and three were attitudinal / behavioural variables that cannot be directly observed in the population without detailed individual surveys. Two of the significant socio-demographic variables (grain income and farm expansion) were only significant for two out of six classes. The third socio-demographic characteristic (university education) was significant for three classes. While the socio-demographic and attitudinal data captured in the questionnaire are important drivers of farmer preferences, they could not be used to explain class membership probability to a significant predictive degree. The preference heterogeneity predicted in our model remains largely unobserved, which means that we cannot *a priori* predict what type of farmers will belong to which preference class.

From a policy maker's perspective, the inability to accurately identify a farmer's preference for JV structures based on observable socio-demographic characteristics limits the ability to target policy interventions at a particular farmer socio-demographic group. However, the diverse heterogeneity in farmer preferences for JV structure attributes highlights that policymakers should focus on fostering and supporting a range of JV structure models, that meet the broad needs of farmer population segments, rather than a simple one size fits all approach.

5.6 Conclusions

There is growing evidence that a combination of scale, management and/or capital constraints are limiting the adoption of productivity boosting innovations for an increasing number of Australian grain growers (ABARES 2010; Jackson 2010; Hughes et al. 2011). Organisation innovations, like JV farm structures, designed appropriately, may help some farm businesses overcome these constraints and boost their competitiveness (Lynch et al. 2012; Gladigau 2013). The results of the analysis presented in this paper show that there is high variability in farmers' preferences for the attributes of JV structures considered in this study. This highlights the importance of accounting for preference heterogeneity in analyses of farmers' interest in JVs. Understanding what farmer classes exist in the population is important to develop relevant and targeted JV farm business structures. Our findings suggest that the pool of potential JV partners is diverse and interested in a wide array of JV models. Further research should now focus on how to operationally assist farmers in identifying the most appropriate partnerships based on various business preferences and attitudinal differences.

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Chapter 6 Conclusions

6.1 Conclusions and contributions

Farm-level adoption of innovations is a critical lever to drive improvement in farm productivity. Yet, organisational innovations in farm structure to drive productivity improvement have been largely overlooked within the Australian grains sector, as well as globally. Research, development and extension activities to drive productivity improvement have primarily focused on the adoption of technical innovations. However, growing evidence suggests that Australian grain growers, in particular, face increasing capital, management and scale constraints that limit their ability to adopt such technical innovations. Organisational innovations, like joint ventures (JVs) may help overcome these constraints and increase farm competitiveness by combining the collective social, human, financial and natural capital of two or more farm businesses.

Previous research on organisational innovations in the agriculture sector has largely focused on cooperatives, in their various forms. Research on more integrated and tailored collaborative business alliance structures, like JVs, has been very limited. Given the dearth of research on organisational innovations within the Australian grains sector, this thesis contributes a number of knowledge gaps in the agribusiness, extension, agricultural economics and non-market valuation literature. Specifically, this thesis:

- Developed and presented a typology of emerging agribusiness models currently operating at the farm-level in the Australian grain sector, and discussed the main advantages and disadvantages of the models.

- Measured the current rate of adoption of JV farm structures by Australian grain growers, as well as developed an understanding of future interest amongst current non-adopters of JV structures.
- Determined the socio-demographic characteristics of farmers interested in adopting a JV structure.
- Conducted a discrete choice experiment (DCE) within a novel agribusiness context, with a focus on farmer preferences for farm JV structure attributes.
- Identified JV structure attributes most preferred by Australian grain growers and used socio-demographic and attitudinal variables of Australian grain growers to explain preferences for different JV farm structure attributes.
- Determined that there is significant unobserved preference heterogeneity of farmer JV structure preferences and proposed an innovative compatibility matrix that highlights the level of complimentary JV structure preferences between groups of farmers. This tool will allow farmers to engage in the process of identifying the likely pool of suitable JV partners, with reference to their personal JV structure preferences.

6.2 Summary of chapter findings (Chapters 2-5)

6.2.1 Chapter Two

This chapter combined findings from an extensive literature review, as well as qualitative data gathered from 1) semi-structured interviews with executives operating innovative farm business models, and 2) a national survey and choice experiment completed by 340 grain growers in 2013.

The key findings included:

- There are two broad groups of innovative farm models and associated sub-models operating within the Australian grains sector. These models can be classified as either hub-based models or contracting models.
- The main potential benefits that may accrue to owner-operator family farms adopting these type of structures include: efficient scale of farm operations, improved access to financial capital, stronger governance and due diligence processes, and increased human capital through labour specialisation.
- A small number (4%) of surveyed grain growers were already in a form of a JV.
- Over one-half (55%) of producers showed an interest in considering hybrid farm structures like joint ventures.
- Farmers interested in JVs perceived the benefits of joining a JV to be reduced farm costs (particularly machinery costs), improved labour efficiency, and captured economies of scale.
- Farmers not interested in JVs (41%) held concerns about the potential loss of independence and decision-making control as well as the increased farm business risk that may result from the adoption of a JV structure.

6.2.2 Chapter Three

Statistical analysis of quantitative and qualitative data collected from a telephone survey of 573 Australian grain growers showed that:

- The rate of adoption of JV structures was 4% and the potential interest in JV structures of current non-adopters within the Australian grain sector was 35%.
- Australian grain growers' perceived benefits of JV farm structures revolved around reducing operational and machinery costs, increasing efficiency through economies of scale and increasing farm profitability.
- Tukey's t-tests comparing descriptive statistics between farmers with different levels of interest to adopt JV structure identified numerous significant differences for a range of socio-demographic and attitudinal variables.
- When adopters were compared with non-adopters of JV structures, adopters tended to operate on a larger scale, have less diversified enterprises with a strong focus on cropping activities; use a paid agronomist to assist with crop nutrition decisions; and have less reliance on contractors for farm operations when compared to their non-adopter peers.
- A multinomial logit regression model showed that famers interested in adopting a JV structure were significantly more likely to be younger, hold a university and believe their business is constrained by a lack of skilled labour when compared to farmers not interested in adopting JV structures.

6.2.3 Chapter Four

This chapter analysed data collected from a national survey and a discrete choice experiment completed by 340 broadacre farmers. The following are the main highlights:

- A multinomial logit model that included interaction terms between the JV attributes and respondents' socio-demographic characteristics showed that farmers significantly prefer JV structures that offer an increase in net farm income, with minimal loss of control over operational decisions and no change to existing annual leave arrangements. The number of partners in the JV and the offer of new machinery within a JV were not significant in explaining choice of JV.
- The multinomial logit model also showed significant preference heterogeneity influenced by a small set of farmer socio-demographic variables.
- When compared to older farmers, younger farmers were more likely to prefer JV structures offering higher net farm income, greater operational control, access to new machinery and with two weeks of additional annual leave. Thus, older farmers may be more willing to forgo having more control over operational decisions than younger farmers. This finding suggests the potential for complementarities between older and younger farmers.
- Farmer respondents were willing to accept, on average, a $7,393 decrease in annual net farm income for each additional level of decision control within a JV. Differences in willingness to accept values were also observed for designed farmer types with varying socio-demographic profiles.

- A random parameter logit model analysis showed similar preferences for JV structure attributes as the analyses using multinomial logit models, but also revealed significant unobserved preference heterogeneity for all attributes.
- The combined analysis of both multinomial and random parameter logit models indicates farmer preferences for JV structures were partly explained by observed heterogeneity, but there was significant unobserved preference heterogeneity that could not be explained by any of the observable characteristics collected in the study.

6.2.4 Chapter Five

The analyses in this chapter used the data collected from the 340 broadacre farmers discussed in Chapter Four. A latent class model with non-linear attribute preferences confirmed the findings of Chapter Four, namely that farmer preferences for JV structure attributes are heterogeneous. The following are highlights of Chapter Five:

- Latent class analyses showed that farmers could be grouped into one of six classes with distinctly different preferences.
- JV structure preferences were diverse, with significant heterogeneity indicating that there is not a one-size-fits-all approach to JV structure design. Rather, the variety in farmers' preferences increases the opportunities for identifying compatible JV partners amongst the farmer population.
- *Post-hoc* statistical analysis of latent classes revealed that class membership, and thus JV structure preferences, were not strongly explained by socio-demographic variables. This poses a challenge for policymakers wishing to target a specific sub-group of farmers with interventions.

- A JV structure compatibility matrix showed that some latent classes were far more likely to find a significant pool of farmers with compatible JV structure preferences than others. For farmers interested in considering the adoption of a JV structure, this tool could be useful for initial self-assessment and facilitation between groups of interested farmers.

6.3 Summary of thesis findings

This thesis revealed an important set of results that can help to advance the awareness, interest and adoption of organisational innovations in the Australian grains sector. First, it identified two broad groups of innovative farm models that are currently operating within the Australian grains sector. Farm businesses applying these innovative models claim that advantages they have over a typical owner-operator family farms are: efficient scales of farm operations, improved access to financial capital, stronger governance and due diligence processes, and increased human capital through labour specialisation.

Second, although only 4% of rainfed grain producers are already in a form of JV, a further 55% of all surveyed producers may be interested in considering hybrid farm structures like JVs to help reduce farm costs, improve labour efficiency and capture economies of scale. The remaining 41% of farmers who were not interested in JVs were concerned about the potential loss of independence and decision-making control as well as the increased farm business risk that may result from the adoption of a JV structure. This is an important finding as it highlights issues that must be addressed if organisational innovations are to be considered more broadly.

Third, there are significant differences between adopters and non-adopters of JV structures. JV structure adopters were significantly more likely to operate on a larger scale and with a higher cropping intensity, have less diversified sources of farm income, use a paid agronomist to assist with crop nutrition decisions, and have less reliance on contractors for farm operations. A multinomial logit regression model showed that famers interested in adopting a JV structure were significantly more likely to be younger, hold a university degree and believe their business is constrained by a lack of skilled labour, compared to farmers not interested in adopting JV structures.

Fourth, results from the discrete choice models show that farmers prefer JV farm structures that offer increased net farm income and minimise loss of control over operational decisions, with no change to existing annual leave arrangements. There was significant unobserved preference heterogeneity that could not be explained by any observable characteristics measured in the study. Furthermore, random parameter logit modelling and latent class modelling showed farmers' preferences are heterogeneous with respect to all JV attributes. The latent class models revealed that farmers could be grouped into multiple latent classes with distinctly different preferences. An assessment of choice attribute compatibility showed distinct differences between classes in terms of their partner compatibility. Some classes were likely to have a wide pool of partners with compatible preferences, whilst other classes may have difficulties finding a suitable compatible partner, particularly once the likely requirement for geographical proximity is taken into account.

Overall, the results suggest that there is not a one-size fits all approach to designing JV structures. However, the diversity in farmers' preferences increases the opportunities for identifying compatible JV partners amongst the farmer population.

Ultimately, given the complex and multi-faceted nature of adopting a JV, adoption is likely to be limited to a niche of grain growers, with a willingness to tradeoff some level of independence, combined with a strong preference to strategically increase the scale, productivity and profitability of their farm business over the medium to long-term. Within the sector, the owner-operator family farm model is expected to continue to be the dominant farm structure, due to a range of compelling operational, social and lifestyle factors. However, organisational innovations, like JVs, will, over time, become an increasingly important tool in the innovation toolbox given the increasing capital, scale and productivity growth demands on broadacre grain growers in Australia.

6.4 Research implications

There are a number of important implications from this research for agricultural policymakers, Australian Research and Development Corporations (RDCs), farm advisors, and farmers interested in boosting farm-level productivity and competitiveness via the adoption of organisational innovations, like JVs. Firstly, there is a notable level of interest in the potential adoption of JV farm structures by Australian grain growers. Secondly, farmer preferences for these structures are diverse, with farmers having preferences for a wide-array of models. However, farmers' preferences for JV structures cannot be explained purely by commonly available socio-demographic variables (e.g. age, farm size). This finding suggests that policy interventions cannot be targeted at a readily identifiable group of farmers.

In addition, evaluating the potential adoption of an organisational innovation is an inherently complex decision. It may be difficult for an individual to analyse and

evaluate the market and non-market costs and benefits of a JV structure for their farm business because of the multitude of economic and personal uncertainties that are tied in with these farm business models (Lynch et al. 2012; Gladigau. 2013). Furthermore, there may be significant risk, considerable reversibility costs and large consequences for the farm businesses involved (Marra et al. 2003; Gray et al. 2009; Tarrant and Malcolm 2011; Gladigau. 2013).

The complexity of the adoption decision points to the necessity of seeking independent and specialised advice from a range of business, accounting and legal experts to ensure a JV structure is appropriate for the individuals involved and has robust legal and governance structures. Further, farmers may also need assistance in identifying and evaluating the suitability of potential JV partners. This requires a broad assessment of partner compatibility across a range of factors, including financial circumstances, operational, managerial and governance preferences, attitude to risk, long-term goals, personality, farm enterprise alignment, and geographical proximity, amongst others.

Given the limited awareness, knowledge and experience of farm JV formation in the Australian grains sector, among both farmers and the farm advisor community, rural policymakers have an important role in broadening the national innovation agenda beyond technical innovations. Organisational innovations in farm structure, like JVs are of interest to many farmers and may have significant benefits, which boost farm competitiveness. There is a need for investment in awareness-raising and capacity building activities aimed at addressing knowledge gaps and developing the industry architecture, which can support farmers considering the adoption of an organisational innovation. Such activities could be undertaken with a range of key stakeholder groups, like rural financial counsellors, farm business advisors and farmers themselves

Policymakers also have an important role in creating enabling business, communication and investment environments to facilitate the development and wider adoption of farm JV structures. This could include providing a clear information exchange point where interested parties and experts in JV formation could engage with one and other. Policymakers could also enable the social infrastructure to attract farmers who are interested in such structures, so that farmers can find potential JV partners. These partners could be other farmers, but they may also be non-farm passive investors from Australia or from abroad. Such an initiative would allow farmers and future investors to efficiently identify potential partners and setup JV structures.

There are important implications from this thesis for RDCs. Traditionally RDCs have focused on technical innovation to drive improvements in productivity. However, there is increasing recognition that capital constraints are limiting innovation adoption, and thus productivity, for many farmers. Organisational innovations, like JV structures, can be promoted and enabled by RDCs to assist farmers seeking more profitable structures, but this will require RDCs to invest in research and extension activities to inform and influence grain growers.

However, there are a number of barriers that may limit the broader adoption of organisational innovations that need to be considered in the design of research and extension programs. Rogers (2003) identified five attributes of an innovation that were critical drivers of adoption and diffusion: 1) relative advantage; 2) compatibility; 3) complexity; 4) trialability; and 5) observability.

Demonstrating relative advantage is achievable but could be difficult to estimate, due to the mixture of market and non-market costs and benefits. It may be assisted by

existing JVs revealing the benefits being gained, though this is unlikely. The compatibility of the innovation will be highly variable depending on a range of personal, operational and financial factors. There is no doubt that a JV will involve increased business complexity, but this may be reduced as proven effective models emerge for easier implementation. Trialability is unlikely to be possible at the full farm JV scale, but there may be opportunities to encourage trialling of joint business ventures between potential JV partners at a lesser scale, such as machinery JV arrangements, before a full farm JV is introduced. Observability or awareness of JVs may increase if confidence grows in the structure and its benefits, but in general farm business arrangements are not readily visible so growth in adoption will not be immediately apparent.

Studies that evaluate and quantify the financial benefits of potential novel business structure innovations, via a case study approach, would assist in quantifying the potential relative advantage such structures may provide. This research could use a variety of scenario-based farmer types (e.g. with changes in farm size, farmer equity, enterprise alignment, etc.) to quantify the economic impact and change in risk profile for different farmer types.

Further, extension efforts could focus on assisting farmers to assess the compatibility and address complexity inherent to the adoption of an organisational innovation by engaging trusted farm advisors. Given the importance of trusted farm advisors in driving innovation adoption with their clients, RDCs should focus on supporting these existing advisor networks via capacity building opportunities and investing in specialists within this space to form a community of practice. This will ensure that

advisors can better support clients on matters related to the assessment and potential adoption of innovative farm business structures, like JVs.

Given the complexities involved in adopting a JV structure, it is likely that farmers' will need to source independent and specialised advice from a range of business, accounting and legal experts to ensure the JV structure is appropriate for the individuals involved and has robust legal and governance structures. Farmers may also need assistance in identifying and evaluating the suitability of potential JV partners and in assessing how to maximise benefits for all parties involved with consideration of farm spatial proximity and differences between individual farmers in terms personalities, values, management priorities, risk tolerance and current financial status, amongst others. The ideal people to facilitate this process are the existing trusted advisors of farmers like farm business or agronomic consultants, who are key drivers influencing on-farm practice change (Coppin et al. 2010). Although, these individuals are unlikely to possess the full range of skills and expertise required, their knowledge of their clients' circumstances across a region could be a valuable resource, especially if working in conjunction with a JV expert. Farm advisors would need access to specialist accounting, legal, and business experts to help them in their advice to farmers. Advisors could also up-skill (e.g. through workshops provided by RDCs) to expand their knowledge about the possibilities of JV structures for broadacre agriculture.

For famers, the thesis findings suggest that organisational innovations, like JV structures may assist farmers to overcome capital, management and scale constraints that limit adoption of innovation and thus improve farm competiveness. For farmers interested in the adoption of JV structures, the pool of potential JV partners is diverse

and interested in a wide array of JV models. Significant heterogeneity in farmer preferences indicates that the prospect of finding JV partners with compatible preferences may be reasonable for most farmer types identified, but will be highly influenced by the level of geographical proximity required.

The pool of potential JV partners is largest for those farmers who preferred JV structures where operational decisions are made using a shared decision-making model. Conversely, it appears that farmers with a preference for JV structures in which they retain sole control over operational decisions are likely to have difficulty in attracting a pool of potential JV partners, unless they are willing to consider more collaborative operational decision-making models or find passive investor JV partners. However, as outlined earlier, finding a suitable partner will require not just an alignment of JV structure preferences, but compatibility across a range of financial, personal, physical, attitudinal and operational parameters.

6.5 Methodological reflections

A range of quantitative and qualitative methodological approaches were used to address the objectives and key research questions outlined in section 1.2. These methods, included semi-structured interviews, desktop reviews of innovative farm business structures in the Australian grain sector, a national telephone survey of Australian grain growers and a national online survey of Australian grain growers, incorporating a discrete choice experiment. Collectively, these methods provide rich, robust and insightful results regarding the potential for innovative farm business structures in the Australian grain sector.

However, upon reflections there are number of methodological improvements that would significantly enhance the impact and relevance of this research. Firstly, a greater focus on quantifying the potential economic benefit of JV structures, via the use of case studies incorporating bio-economic modelling and simulations would have been a valuable addition to this study. Such analyses could quantify and provide insights on the risk-reward profile of adopting a JV structure for farm businesses, given differences in equity profiles and regional production/climate risk. This insight is highlighted further in section 6.6.

Secondly, although the choice modelling approach delivered insightful results on farmer preferences for JV structures, the method and consequent demands on respondents limits the scope of variables able to be examined. Although JV structure attributes were tested with focus groups and pre-tested prior to the national online choice survey, the ability to more flexibly and comprehensively test a range of JV structure attributes would have been beneficial.

Finally, the results of this research clearly show that farmer interest in, and preferences for, JV structures cannot be explained purely by commonly available socio-demographic variables (e.g. age, farm size). Given the inherent complexity of adopting a JV structure and differences in individual farmer circumstances, this result is not particularly surprising in hindsight. However, given the body of innovation adoption literature, linking farmer attributes with adoption status, this underlying assumption regarding farmer attributes continued to influence our survey design throughout the research project.

6.6 Future research

This research has greatly increased understanding of the potential for adoption of JV structures in Australian broadacre farms. Nevertheless, further farm-level economic modelling of the likely impacts for farm profitability is needed to provide farmers with more confidence when entering into these types of business alliances. One way to move forward with this type of research is to perform analysis (for example using bio-economic modelling and Monte Carlo simulation) to quantify the impact on farm operating return and risk distribution from adopting a JV structure. This analysis could be done on a case study basis for farms with different equity levels and in multiple climatic zones, to understand broad implications for farmers in various scenarios. One could also incorporate business management innovation strategies in farm-level optimisation models, to enable an assessment of the farm business structures that optimise performance for different types of farms.

This research examined joint venture structures set up between farmers. Other joint venture types exist as well, for example, between farmers and passive (corporate) investors. Such partnerships present alternative options for farmers who are interested in setting up a JV structures. Alliances with passive investors are different from JVs with other farmers in that farmers tend to retain control over day-to-day decision-making and there may be less potential personality and relationship conflicts. However, to date, there has been very little research into the possibilities of developing passive JV structures in Australia, nor has there been any modelling of the benefits and risks of passive JV structures in this space. As a result, there is limited understanding of farmers' and investors' needs and their interests in taking on these types of partnerships.

A compatibility matrix for potential JV business partners was presented in Chapter Five. RDCs and farm extension advisors may be able to use the matrix as an initial first-cut guide to connecting specific farmers together to form strong JV structures. Although personalities and other specific relational factors will have to be considered, the use of the matrix as a preliminary sorting tool may save the enabling officers' and the farmers' time in the long run. Despite the potential of the compatibility matrix, real-life testing of the matrix, and its usefulness to help farmers find business partners, is still needed to ground-truth the data and analysis.

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Appendix 1 Online choice experiment questionnaire instrument

CSIRO_Web_Survey_JULY 2013 NEW

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QR1. **Interviewer: Please dial [01phone] Good evening [03title] [05first] [06surname], my name is ____ from KG2.We are conducting a survey with grain and grain/livestock producers on behalf of a PhD student studying with the CSIRO and the University of Adelaide to investigate farmer interest in different types of joint venture structures between family farm operations. This is an area of emerging interest within the grains industry and this survey is the first step to ascertain the level of interest associated with a range of potential joint venture structures. This is strictly a research project and we are not selling anything. All opinions you share will be kept confidential. The survey will be completed in two parts, with a 3 minute qualitfying survey, at which stage we would send you a link to an online survey that takes around 20 minutes. For your time in completing the online study we will send you a cheque for $30 or make a donation to charity on your behalf.Would you be able to help with this study?**

Re-introduce yourself to the relevant person if needed

Yes	1	
No	2	End

QR2. **Thank you for agreeing to do this survey just letting you know that this call is being recorded for training and qaulity assurance purposes. Are you the key decision maker for this farm business?**

Re-introduce yourself to the relevant person if needed

Yes	1	
No	2	End

QR3. Dummy question - LGA - pulled from data base

Do not answer If true

NSW Central West	1	
NSW Riverine Plains	2	
VIC Mallee	3	
VIC Wimmera	4	
VIC Loddon	5	
SA Mallee	6	
SA Central	7	QR3
SA Upper EP	8	
SA Lower EP	9	
WA Northern	10	
WA Midlands	11	
WA Central	12	
WA Southern	13	

QR4b. Which of the following best describe your farm type?

Read out the full definitions to the respondents but stop reading if an answer was given

Grain specialist: That is 75% or more of your gross on farm income comes from grain production	1		
Grain & Livestock: Must have derived at least 25% of your gross farm income from grain production and 25% of your gross income from beef or sheep productions	2		QR4b
Other	4	End	

QR4. So that we can be sure we are interviewing a cross section of rural producers, over the last three financial years, roughly what percentage of your gross property income, that is, only income from your property, came from the following activities?

*READ OUT AND RECORD
CONTRACTING is NOT a source of onfarm income!*

Beef Cattle	1	QR4_1
Sheep including Wool & Prime Lambs	2	QR4_2
Dairy	3	QR4_3
Broadacre cropping	4	QR4_4
Sugar Cane	10	QR4_5
Cotton	11	QR4_6
Rice	12	QR4_7
Horticultural / Vegetable Crops	13	QR4_8

Other Crops	14	QR4_9
Other Livestock	15	QR4_10

QR5. Dummy Farm Type Question QR4x1: [QR4x1] QR4x2: [QR4x2]QR4x3: [QR4x3]QR4x4: [QR4x4]QR4x5: [QR4x5]QR4x6: [QR4x6]QR4x7: [QR4x7]QR4x8: [QR4x8]QR4x9: [QR4x9] QR4x10: [QR4x10] QR4x11: [QR4x11] QR4x12: [QR4x12]QR4sum: [QR4sum] Crops: [xCrops] Livestock: [xLivestock]

Do not answer If true

Grains	1	
Grain/Livestock	2	
Beef and Sheep	4	
Beef	5	
Sheep	6	
Dairy	7	QR5
Sugar Cane	8	
Cotton	50	
Horticulture	70	
QNA	99	

QR6. In a normal season, how many hectares of dryland grain would you crop on average?

CHECK WHETHER THE ANSWER IS HECTARES OR ACRES & RECORD

Hectares	1	
Acres	2	QR6_1

If (([QR6_1] = 1 AND [QR6_2] <= 499) OR ([QR6_1] = 2 AND [QR6_2] <= 749)) go to QR8

QR7. Do you have an email address that I can send you a link to the survey?

Yes	1	
No Email and cannot complete the survey	2	End

If [QR7] = 1 go to QR9

QR8. Thank you for your time but we are actually looking for different types of producers for this survey. We appreciate your offer to provide input and are sorry to have taken your time. Best of luck with the rest of the season.

End

QR9. Could you please advise me of your email address so that a link to this survey can be sent to you?

*SPELL IT BACK TO THEM
SPELL IT BACK TO THEM AGAIN*

QR10. Can I please get your name so that we can address the email to the correct person.

THIS IS REQUIRED

First	1	QR10_1_1
Last	2	QR10_1_2

QR11. Thank you for your time and we appreciate your input and views. Our supervisor will be sending you the survey link shortly and will give you a phone call to confirm that you have received it. Best of luck with the rest of the season.

GENDER - DO NOT ASK

Male	1	
Female	2	QR11

QENDrecruit. THIS IS THE END OF THE RECRUITMENT CATI SURVEY.1) PLEASE RECORD THIS ID# [QD] EMAIL [QR9]and let your supervisor know. 2) AFTER clicking next, you will click on the Quit and Resume later button. which will be at the top of the page. YOU MUST ONLY CLICK QUIT AND CONTINUE ONCE YOU GET TO THE NEXT PAGE!!!! DO NOT CLICK IT YET!! (tell your supervisor straight away if you accidently click it before).

QA. A survey on establishing formal joint venture structures with other farm businesses Introduction We would like to invite you to participate in a study conducted by the University of Adelaide and the CSIRO. This study explores how farmers might feel about different joint venture or collaborative farm business structures. The results of this research will help build a greater understanding of the benefits, costs and associated trade-offs of adopting alternative farm business models. It may also assist with design changes in programs to the farm sector. This survey is comprised of two parts. Part A focuses on how you might feel about different joint venture farm business structures and Part B focuses on gathering farm specific information. You are under no obligation to participate in this study, but it would be most helpful if you

could spare approximately 20 minutes of your time to complete an online survey. Consent is implied by continuing to the next screen. If you would like a copy of this information sheet and the consent form, please click here . All records containing your personal information will remain confidential and no information which could lead to your identification will be released. On completion of the survey, you can opt-in to receive a copy of the final research paper via email.For your time, you can either elect to receive a cheque for $30, or have it donated to charity on your behalf. Kind regards,Brendan Lynch, PhD Candidate, University of Adelaide and CSIRO Email: brendan.lynch@csiro.au Dr. Rick Llewellyn, CSIRO; rick.llewellyn@csiro.auDr Wendy Umberger, University of Adelaide; wendy.umberger@adelaide.edu.au If you have any ethical concerns regarding this study, please contact the Office of Research Ethics, Compliance and Integrity, University of Adelaide; Phone: (08) 8303 5137; Email:hres@adelaide.edu.au

QB. CONSENT FORMResearch Project - Opportunities for collaborative farmer approaches to improve innovation adoption and enhance farm productivity and profitability. Researcher - Brendan Lynch, PhD Candidate, University of Adelaide and CSIROMobile: 0450 344 125 Email: brendan.lynch@csiro.auDear Participant, Please review the information below . I agree to participate in the above project being conducted by the University of Adelaide and CSIRO. I have been provided with information about the project and all questions regarding my participation and any associated risks and benefits have been answered to my satisfaction. I understand that my participation in the research will involve a 20 minute online survey. I have been provided with contact details of the investigating officers and understand that I can contact them at any point during the study. I have also been provided with the contact details of the Office of Research Ethics, Compliance and Integrity, University of Adelaide should I wish to raise any concerns about the conduct of the research.I understand that participating in the study is entirely voluntary and that I am free to withdraw at any time for any reason. I understand that I may ask for the information provided by me to be removed from the study without penalty or explanation. I understand that the information I provide for this research will be used in journal publications and industry reports and will be treated confidentially. Information provided by me will only be accessed by members of the research team and will only be used for the purposes describe above. It will be stored securely by CSIRO and the University of Adelaide and retained for a period of five years after which it will be destroyed.

Do not answer If true

Agree to participate in this survey	1	
Do not agree to participate in this survey	2	End

QC. Hidden Question - pulled from database - Farm Type

Do not answer If true

Grains	1	
Grain / Livestock	2	QC
Cotton	50	

QD. Hidden Question - pulled from database - Region

Do not answer If true

NSW Central West	1	
NSW Riverine Plains	2	
Vic Mallee	3	
Vic Wimmera	4	
Vic Loddon	5	
SA Mallee	6	
SA Central	7	QD
SA Upper EP	8	
SA Lower EP	9	
WA Northern	10	
WA Midlands	11	
WA Central	12	
WA Southern	13	

QIntro. IMPORTANT - PLEASE READ BEFORE STARTING SURVEY Part A – Formal Joint Venture or Collaborative Farming Arrangements For this study, we define a joint venture (JV) or collaborative farming model as a business structure that combines the assets, infrastructure, and staff of two or more farm businesses. The JV has the following characteristics: * A JV increases economies of scale as multiple farms are managed as one unit, improving machinery and labour utilisation rates.* Individual farm businesses retain ownership of underlying land assets, but this land is leased to the JV.* Machinery is procured and managed by the JV.* If required, there is also the option to include additional farmland from third parties via share farm or lease arrangements to achieve an optimal operational area. Two examples of possible JV structures are shown below:

Q1a. Would you consider forming a joint venture arrangement with another farm business that involves putting land and/or major cropping machinery into a company arrangement?

Yes	1
Maybe	2

No	3	Go to Q1d	Q1a
Already in one	4	Go to Q1e	

Q1b. How likely is it that you would investigate the possibility of adopting a formal joint venture arrangement within the next 5 years?

Very unlikely	1	
Unlikely	2	
Unsure	3	Q1b
Likely	4	
Very Likely	5	

Q1c. What are the 2 main characteristics of a joint venture that make it attractive to you?

Please type in below

Go to Q2a

Q1d. What are your 2 main reasons for not considering a formal joint venture arrangement?

Answer If Attribute "No" from Q1a is SELECTED

Please type in below

Go to Q2a

Q1e. Who is the joint venture arrangement with?

Answer If Attribute "Already in one" from Q1a is SELECTED

Please select one answer from below or specify your other

Extended family members	1	
Neighbouring farms	2	
Corporate farm business	3	Q1e
Non-farm financial company	4	

Q1f. What does the joint venture include?

Please select all that apply from below

Machinery	1	Q1f_1
Farm labour	2	Q1f_2
Cropping land	3	Q1f_3

Grazing land	4	Q1f_4
Livestock	5	Q1f_5
Agronomic decisions	6	Q1f_6
Strategic business decisions	7	Q1f_7

Q1g. Would you recommend a formal joint venture structure to other interested farmers in your district?

Yes	1	
Maybe	2	
No	555	Q1g
Unsure	666	

Go to Q3

Q2a. Are you familiar or aware of any grain or mixed farmers that have entered into a formal joint venture arrangement?

Yes	1		
No	555	Go to Q3	Q2a

Q2b. In your opinion, have formal "joint venture arrangements" had a positive impact on these respective farm businesses?

Please select one response from below

Yes - Joint venture had a completely positive impact	1	
Yes - Joint venture had mostly a positive impact	2	
Unsure	3	Q2b
No	4	

Q3. Have you or do you intend to implement any of the following arrangements within the next 5 years?

Please select and answer for each attribute below

	Done previously, but unlikely to do so again	Done previously, but likely to do so again	Doing it now, but intending to stop	Doing it now and plan to continue	Never done it, but interested	Never done it and not interested	
Purchasing inputs (seed, fertiliser, herbicide, etc.) in collaboration with other	1	2	3	4	5	6	Q3_1

farmers (e.g. buying group or supply co-operative)							
Joint selling of grain in collaboration with other farmers (e.g. via a marketing cooperative or grain pool operator)	1	2	3	4	5	6	Q3_2
Joint contracting of farm agronomic consulting services with one or more other farm businesses	1	2	3	4	5	6	Q3_3
Joint employment of an additional employee that is shared with one or more other farm businesses	1	2	3	4	5	6	Q3_4
Joint purchase/lease of machinery with one or more other farm businesses	1	2	3	4	5	6	Q3_5
Joint contracting of machinery contractors with one or more other farm businesses	1	2	3	4	5	6	Q3_6
Leasing crop land to another farm business	1	2	3	4	5	6	Q3_7

Supplying land to a sharefarmer	1	2	3	4	5	6	Q3_8
Managing and operating land as a sharefarmer	1	2	3	4	5	6	Q3_9
Joint purchase/lease of additional crop land with one or more other farm businesses	1	2	3	4	5	6	Q3_10
Expanding crop area through a leasing arrangement with another farm business	1	2	3	4	5	6	Q3_11

Q4. Please indicate how strongly you agree or disagree with the following statements.

Please select and answer for each attribute below

	Strongly disagree	Disagree	Neither agree or disagree	Agree	Strongly agree	
I consider my farm to be comprised of a land business and farm operations business	1	2	3	4	5	Q4_1
Being accountable to an independent chairman would improve my strategic farm business decisions	1	2	3	4	5	Q4_2
I would be comfortable being accountable to an independent chairman for strategic business decisions	1	2	3	4	5	Q4_3
Having the flexibility to opt for a reduced workload makes a joint venture structure attractive	1	2	3	4	5	Q4_4
A joint venture farm business structure would be an attractive way to improve the financial performance of my farm business	1	2	3	4	5	Q4_5

Q15_. IT IS IMPORTANT THAT YOU READ ALL THE INFORMATION BELOW BEFORE ATTEMPTING THE NEXT SET OF QUESTIONS CHARACTERISTIC OF A FORMAL JOINT VENTURE STRUCTURE The following set of questions present different options for establishing a formal joint venture (JV) structure. Although you

may not be particularly interested in forming a JV, your responses to the questions are still valuable. For each set of joint venture options presented, please indicate: 1) the JV option that is most attractive to you; 2) the JV option that is least attractive to you; 3) the JV option/s that you would never participate in if they were available to you. It is possible that in some questions, none of the options will be attractive to you. However, we are interested in the relative attractiveness of the options presented in each choice set. Please choose the most and least attractive options in each choice set as if they were the only ones available to you. We will use 5 characteristics to describe each JV structure, as seen in the example question below. Example Question Carefully consider each of the following options for formal JV structures. If options A, B, C and D were the only ones available,
Characteristics Option A Option B Option C Option D Number of farm businesses in the joint venture structure 2 3 2 4 Your influence on operational decisions (non-board decisions) Shared decision-making with other partners No operational decisions Sole decision-maker Final decision-maker in consultation with other partners Farming with the latest machinery Older machinery (initially 5 years plus) Older machinery (initially 5 years plus) New machinery New machinery Leave arrangements No Change No Change Extra 2 weeks of flexible leave Extra 2 weeks of flexible leave Change in your annual net farm income (compared to current 5yr average) + $30k + $50k + $30k + $50k

Q15. Which option would be the most attractive and least attractive to you?

	Option A	Option B	Option C	Option D
Most attractive	1	2	3	4
	Q15_1_1	Q15_2_1	Q15_3_1	Q15_4_1
Least attractive	1	2	3	4
	Q15_1_2	Q15_2_2	Q15_3_2	Q15_4_2

Q15x. Which of these four options would you NEVER participate in?Select all that apply

Option A	1	Q15x_1
Option B	2	Q15x_2
Option C	3	Q15x_3
Option D	4	Q15x_4
I could participate in any of these 4 options	5	Q15x_5

Q15p. IMPORTANT - PLEASE READ Shortly you will be presented with 5 different sets of 4 joint venture (JV) options in a format similar to those you've just seen. In each screen, the set of JV options and their unique 5 characteristics will vary from those in the previous screen. The 5 characteristics are explained in the next 5 screens.

Q15p1. IMPORTANT - PLEASE READ 1. Number of farm businesses in the joint venture structureA JV will be comprised of a number of individual farm businesses that are also equal shareholders in the new JV entity. The 3 options available for this characteristic are:> Each JV option will be comprised of either 2, 3 or 4 farm businesses (including your own)

Q15p2. IMPORTANT - PLEASE READ 2. Your influence on operational decision-making (e.g. agronomic and seasonal land use decisions) Despite equal shareholdings and representation on the board, individual farm families may have varying levels of direct influence/control over farm operational decisions for the whole JV. The 5 options available for operational decision-making are: > Sole decision-maker – You or a member of your family is the ultimate decision maker with no need to consult other JV partners. > Final decision-maker, in consultation with other partners – You or a member of your family is the final decision maker, but other JV partners are consulted on a regular basis for their thoughts and opinions before major operational decisions are made. > Shared decision-making with other partners – Operational decision are made via consultation with other JV partners until a consensus is reached. > Not the final decision maker, but input into decision process – The final decision power is held by another JV partner. You or a member of your family is regularly consulted about operational decisions. > No operational decisions – no operational decisions are made by you or your family

Q15p3. IMPORTANT - PLEASE READ 3. Farming with the latest modern machinery The JV may increase the feasibility of buying the latest machinery. In the case where new machinery is procured, existing machinery is sold by each partner so that capital can be re-invested into the JV to fund or partially fund the purchase of new machinery. In other circumstances, existing machinery from individual farm businesses is retained and either leased or sold on a commercial basis to the new JV structure. The options for farming with the latest modern machinery are: > New machinery – All farm machinery is purchased new and is replaced on a 5 year basis . > Older machinery (initially 5 years plus) - All farm machinery is initially at least 5 years old . Replacement machinery procured later may include a mix of new and used.

Q15p4. IMPORTANT - PLEASE READ4. Leave arrangements The extra workforce in a JV may allow you and your family to take more leave away from the farm, whilst doing so with greater flexibility. The options for leave arrangements are: > Extra 2 weeks of flexible leave – On top of your existing leave arrangements, an extra 2 weeks leave can be taken by you and your family. This leave can be scheduled with great flexibility with key tasks allocated to other personnel within the JV in your absence.

Bear in mind that you will have to reciprocate this arrangement in an equal amount by covering the absence of other JV partners at different times of the year. > No Change – You maintain your current leave arrangements as is.

Q15p5. IMPORTANT - PLEASE READ5. Change in average annual net farm income for your family Each farm family in the JV will receive income via 3 channels: 1) Land lease payments (based on production potential and associated land area); 2) Salary tied to your family's role in the new JV; and 3) A dividend from the profit/loss of the farm structure. Adopting a JV structure may decrease or increase your family's average annual net farm income. NOTE: Net Farm Income = Gross Cash Income - Total Cash Expenses +/- Inventory changes - Depreciation The change in average annual net farm income will be relative to your family's average net farm income over the past 5 years and be a function of the total of the 3 income sources listed above. The options are: * $ 15k p.a. less than current 5-yr average * No change (Same as current 5-yr average) * $ 15k p.a. more than current 5-yr average * $ 30k p.a more than current 5-yr average * $ 50k p.a more than current 5-yr average * $ 75k p.a. more than current 5-yr average

Q15pa. HOW TO ANSWER THE CHOICE QUESTIONSThe next five questions will each show 4 options for establishing a formal JV structure. For each question, please indicate: 1) the JV option that is most attractive to you; 2) the JV option that is least attractive to you; and 3) the JV option/s that you would never participate in if they were available to you. .It is important that you consider each question independently, so only compare the four options A, B, C and D within each separate question. The following factors also apply to all options listed: * Each joint venture is managed by a board that is responsible for major business decisions and headed by an independent chairman * Each farm business that enters the JV will have an equal shareholding and a representative on the board * The JV only includes cropping land, which is leased to the new structure on a 3-year rolling lease basis * Crop area of the JV will be sufficient to optimise economies of scale, and more crop land can be leased or share farmed if required * An independent crop consultant is contracted by the JV to provide advice and support in relation to crop management decisions * Livestock is not included within the JV and will be managed independently at the individual farm level.

Answer If Attribute "Block 1" from Q4a is SELECTED

Q501a. Carefully consider each of the following options for formal JV structures. If options A, B, C and D were the only ones available, Characteristics Option A Option B Option C Option D Number of farm businesses in the joint venture structure42 2 3 Your influence on operational decisions (non-board decisions) No operational

decisions Final decision-maker, in consultation with other partners Sole decision-maker Shared decision-making with other partners Farming with the latest machinery New machinery New machinery Older machinery (initially 5 years plus) Older machinery (initially 5 years plus) Leave arrangements Extra 2 weeks of flexible leave No Change Extra 2 weeks of flexible leave Extra 2 weeks of flexible leave Change in your annual net farm income (compared to current 5yr average) + $75k + $15k - $15k - $15k

Q501a2. Which option would be the most attractive and least attractive to you?

Answer If Attribute "Block 1" from Q4a is SELECTED

	Option A	Option B	Option C	Option D
Most attractive	1	2	3	4
	Q501a2_1_1	Q501a2_2_1	Q501a2_3_1	Q501a2_4_1
Least attractive	1	2	3	4
	Q501a2_1_2	Q501a2_2_2	Q501a2_3_2	Q501a2_4_2

Q501a3. Which of these four options would you NEVER participate in? Select all that apply

Answer If Attribute "Block 1" from Q4a is SELECTED

Option A	1	Q501a3_1
Option B	2	Q501a3_2
Option C	3	Q501a3_3
Option D	4	Q501a3_4
I could participate in any of these 4 options	5	Q501a3_5

Answer If Attribute "Block 1" from Q4a is SELECTED

Q502a. Carefully consider each of the following options for formal JV structures. If options A, B, C and D were the only ones available, Characteristics Option A Option B Option C Option D Number of farm businesses in the joint venture structure 3 4 3 2 Your influence on operational decisions (non-board decisions) Not the final decision-maker, but input into decisions Sole decision-maker Shared decision-making with other partners No operational decisions Farming with the latest machinery Older machinery (initially 5 years plus) New machinery New machinery Older machinery (initially 5 years plus) Leave arrangements No Change Extra 2 weeks of flexible leave No Change Extra 2 weeks of flexible leave Change in your annual net farm income (compared to current 5yr average) + $30k + $50k No Change + $30k

Q502a2. Which option would be the most attractive and least attractive to you?

Answer If Attribute "Block 1" from Q4a is SELECTED

	Option A	Option B	Option C	Option D
Most attractive	1	2	3	4

	Q502a2_1_1	Q502a2_2_1	Q502a2_3_1	Q502a2_4_1
Least attractive	1	2	3	4
	Q502a2_1_2	Q502a2_2_2	Q502a2_3_2	Q502a2_4_2

Q502a3. Which of these four options would you NEVER participate in? Select all that apply

Answer If Attribute "Block 1" from Q4a is SELECTED

Option A	1	Q502a3_1
Option B	2	Q502a3_2
Option C	3	Q502a3_3
Option D	4	Q502a3_4
I could participate in any of these 4 options	5	Q502a3_5

Answer If Attribute "Block 1" from Q4a is SELECTED

Q503a. Carefully consider each of the following options for formal JV structures. If options A, B, C and D were the only ones available, Characteristics Option A Option B Option C Option D Number of farm businesses in the joint venture structure 2 3 4 4 Your influence on operational decisions (non-board decisions) Sole decision-maker Shared decision-making with other partners Not the final decision-maker, but input into decisions No operational decisions Farming with the latest machinery Older machinery (initially 5 years plus) New machinery New machinery New machinery Leave arrangements Extra 2 weeks of flexible leave No Change No Change Extra 2 weeks of flexible leave Change in your annual net farm income (compared to current 5yr average) + $30k No Change + $50k + $15k

Q503a2. Which option would be the most attractive and least attractive to you?

Answer If Attribute "Block 1" from Q4a is SELECTED

	Option A	Option B	Option C	Option D
Most attractive	1	2	3	4
	Q503a2_1_1	Q503a2_2_1	Q503a2_3_1	Q503a2_4_1
Least attractive	1	2	3	4
	Q503a2_1_2	Q503a2_2_2	Q503a2_3_2	Q503a2_4_2

Q503a3. Which of these four options would you NEVER participate in? Select all that apply

Answer If Attribute "Block 1" from Q4a is SELECTED

Option A	1	Q503a3_1
Option B	2	Q503a3_2
Option C	3	Q503a3_3
Option D	4	Q503a3_4
I could participate in any of these 4 options	5	Q503a3_5

Answer If Attribute "Block 1" from Q4a is SELECTED

Q504a. Carefully consider each of the following options for formal JV structures. If options A, B, C and D were the only ones available, Characteristics Option A Option B Option C Option D Number of farm businesses in the joint venture structure 3 2 4 2 Your influence on operational decisions (non-board decisions) Not the final decision-maker, but input into decisions No operational decisions Final decision-maker, in consultation with other partners Sole decision-maker Farming with the latest machinery Older machinery (initially 5 years plus) Older machinery (initially 5 years plus) New machinery New machinery Leave arrangements No Change Extra 2 weeks of flexible leave No Change Extra 2 weeks of flexible leave Change in your annual net farm income (compared to current 5yr average) + $15k + $30k + $75k - $15k

Q504a2. Which option would be the most attractive and least attractive to you?

Answer If Attribute "Block 1" from Q4a is SELECTED

	Option A	Option B	Option C	Option D
Most attractive	1	2	3	4
	Q504a2_1_1	Q504a2_2_1	Q504a2_3_1	Q504a2_4_1
Least attractive	1	2	3	4
	Q504a2_1_2	Q504a2_2_2	Q504a2_3_2	Q504a2_4_2

Q504a3. Which of these four options would you NEVER participate in? Select all that apply

Answer If Attribute "Block 1" from Q4a is SELECTED

Option A	1	Q504a3_1
Option B	2	Q504a3_2
Option C	3	Q504a3_3
Option D	4	Q504a3_4
I could participate in any of these 4 options	5	Q504a3_5

Answer If Attribute "Block 1" from Q4a is SELECTED

Q505a. Carefully consider each of the following options for formal JV structures. If options A, B, C and D were the only ones available, Characteristics Option A Option B Option C Option D Number of farm businesses in the joint venture structure 2 4 3 3 Your influence on operational decisions (non-board decisions) No operational decisions Sole decision-maker Final decision-maker, in consultation with other partners Not the final decision-maker, but input into decisions Farming with the latest machinery New machinery Older machinery (initially 5 years plus) Older machinery (initially 5 years plus) Older machinery (initially 5 years plus) Leave arrangements Extra 2 weeks of flexible leave No Change No Change No Change Change in your annual net farm income (compared to current 5yr average) + $30k + $50k - $15k + $15k

Q505a2. Which option would be the most attractive and least attractive to you?

Answer If Attribute "Block 1" from Q4a is SELECTED

	Option A	Option B	Option C	Option D
Most attractive	1	2	3	4
	Q505a2_1_1	Q505a2_2_1	Q505a2_3_1	Q505a2_4_1
Least attractive	1	2	3	4
	Q505a2_1_2	Q505a2_2_2	Q505a2_3_2	Q505a2_4_2

Q505a3. Which of these four options would you NEVER participate in? Select all that apply

Answer If Attribute "Block 1" from Q4a is SELECTED

Option A	1	Q505a3_1
Option B	2	Q505a3_2
Option C	3	Q505a3_3
Option D	4	Q505a3_4
I could participate in any of these 4 options	5	Q505a3_5

Answer If Attribute "Block 1" from Q4a is SELECTED

Q501b. Carefully consider each of the following options for formal JV structures. If options A, B, C and D were the only ones available, Characteristics Option A Option B Option C Option D Number of farm businesses in the joint venture structure 4 3 2 4 Your influence on operational decisions (non-board decisions) No operational decisions Shared decision-making with other partners Sole decision-maker Shared decision-making with other partners Farming with the latest machinery New machinery New machinery Older machinery (initially 5 years plus) New machinery Leave arrangements Extra 2 weeks of flexible leave No Change Extra 2 weeks of flexible leave No Change Change in your annual net farm income (compared to current 5yr average) + $50k No Change + $30k + $30k

Q501b2. Which option would be the most attractive and least attractive to you?

Answer If Attribute "Block 2" from Q4a is SELECTED

	Option A	Option B	Option C	Option D
Most attractive	1	2	3	4
	Q501b2_1_1	Q501b2_2_1	Q501b2_3_1	Q501b2_4_1
Least attractive	1	2	3	4
	Q501b2_1_2	Q501b2_2_2	Q501b2_3_2	Q501b2_4_2

Q501b3. Which of these four options would you NEVER participate in? Select all that apply

Answer If Attribute "Block 2" from Q4a is SELECTED

Option A	1	Q501b3_1
Option B	2	Q501b3_2
Option C	3	Q501b3_3
Option D	4	Q501b3_4

I could participate in any of these 4 options	5	Q501b3_5

Answer If Attribute "Block 1" from Q4a is SELECTED

Q502b. Carefully consider each of the following options for formal JV structures. If options A, B, C and D were the only ones available, Characteristics Option A Option B Option C Option D Number of farm businesses in the joint venture structure 3 2 3 4 Your influence on operational decisions (non-board decisions) Shared decision-making with other partners No operational decisions Not the final decision-maker, but input into decisions Sole decision-maker Farming with the latest machinery New machinery New machinery Older machinery (initially 5 years plus) Older machinery (initially 5 years plus) Leave arrangements No Change Extra 2 weeks of flexible leave No Change No Change Change in your annual net farm income (compared to current 5yr average) - $15k + $30k No Change + $75k

Q502b2. Which option would be the most attractive and least attractive to you?

Answer If Attribute "Block 2" from Q4a is SELECTED

	Option A	Option B	Option C	Option D
Most attractive	1	2	3	4
	Q502b2_1_1	Q502b2_2_1	Q502b2_3_1	Q502b2_4_1
Least attractive	1	2	3	4
	Q502b2_1_2	Q502b2_2_2	Q502b2_3_2	Q502b2_4_2

Q502b3. Which of these four options would you NEVER participate in? Select all that apply

Answer If Attribute "Block 2" from Q4a is SELECTED

Option A	1	Q502b3_1
Option B	2	Q502b3_2
Option C	3	Q502b3_3
Option D	4	Q502b3_4
I could participate in any of these 4 options	5	Q502b3_5

Answer If Attribute "Block 1" from Q4a is SELECTED

Q503b. Carefully consider each of the following options for formal JV structures. If options A, B, C and D were the only ones available, Characteristics Option A Option B Option C Option D Number of farm businesses in the joint venture structure 4 4 3 2 Your influence on operational decisions (non-board decisions) Final decision-maker, in consultation with other partners No operational decisions Not the final decision-maker, but input into decisions Sole decision-maker Farming with the latest machinery New machinery Older machinery (initially 5 years plus) Older machinery (initially 5 years plus) Older machinery (initially 5 years plus) Leave arrangements No Change Extra 2 weeks of flexible leave No Change No Change

Change in your annual net farm income (compared to current 5yr average) No Change + $50k No Change + $50k

Q503b2. Which option would be the most attractive and least attractive to you?

Answer If Attribute "Block 2" from Q4a is SELECTED

	Option A	Option B	Option C	Option D
Most attractive	1	2	3	4
	Q503b2_1_1	Q503b2_2_1	Q503b2_3_1	Q503b2_4_1
Least attractive	1	2	3	4
	Q503b2_1_2	Q503b2_2_2	Q503b2_3_2	Q503b2_4_2

Q503b3. Which of these four options would you NEVER participate in? Select all that apply

Answer If Attribute "Block 2" from Q4a is SELECTED

Option A	1	Q503b3_1
Option B	2	Q503b3_2
Option C	3	Q503b3_3
Option D	4	Q503b3_4
I could participate in any of these 4 options	5	Q503b3_5

Answer If Attribute "Block 1" from Q4a is SELECTED

Q504b. Carefully consider each of the following options for formal JV structures. If options A, B, C and D were the only ones available, Characteristics Option A Option B Option C Option D Number of farm businesses in the joint venture structure 4 3 2 2 Your influence on operational decisions (non-board decisions) Sole decision-maker Not the final decision-maker, but input into decisions No operational decisions Shared decision-making with other partners Farming with the latest machinery Older machinery (initially 5 years plus) Older machinery (initially 5 years plus) New machinery New machinery Leave arrangements Extra 2 weeks of flexible leave No Change Extra 2 weeks of flexible leave No Change Change in your annual net farm income (compared to current 5yr average) + $50k + $30k No Change + $50k

Q504b2. Which option would be the most attractive and least attractive to you?

Answer If Attribute "Block 2" from Q4a is SELECTED

	Option A	Option B	Option C	Option D
Most attractive	1	2	3	4
	Q504b2_1_1	Q504b2_2_1	Q504b2_3_1	Q504b2_4_1
Least attractive	1	2	3	4
	Q504b2_1_2	Q504b2_2_2	Q504b2_3_2	Q504b2_4_2

Q504b3. Which of these four options would you NEVER participate in? Select all that apply

Answer If Attribute "Block 2" from Q4a is SELECTED

Option A	1	Q504b3_1
Option B	2	Q504b3_2
Option C	3	Q504b3_3

Option D	4	Q504b3_4
I could participate in any of these 4 options	5	Q504b3_5

Answer If Attribute "Block 1" from Q4a is SELECTED

Q505b. Carefully consider each of the following options for formal JV structures. If options A, B, C and D were the only ones available, Characteristics Option A Option B Option C Option D Number of farm businesses in the joint venture structure 3 4 2 3 Your influence on operational decisions (non-board decisions) Final decision-maker, in consultation with other partners Sole decision-maker No operational decisions Not the final decision-maker, but input into decisions Farming with the latest machinery New machinery New machinery Older machinery (initially 5 years plus) Older machinery (initially 5 years plus) Leave arrangements No Change Extra 2 weeks of flexible leave Extra 2 weeks of flexible leave No Change Change in your annual net farm income (compared to current 5yr average) No Change + $15k + $50k + $30k

Q505b2. Which option would be the most attractive and least attractive to you?

Answer If Attribute "Block 2" from Q4a is SELECTED

	Option A	Option B	Option C	Option D
Most attractive	1	2	3	4
	Q505b2_1_1	Q505b2_2_1	Q505b2_3_1	Q505b2_4_1
Least attractive	1	2	3	4
	Q505b2_1_2	Q505b2_2_2	Q505b2_3_2	Q505b2_4_2

Q505b3. Which of these four options would you NEVER participate in? Select all that apply

Answer If Attribute "Block 2" from Q4a is SELECTED

Option A	1	Q505b3_1
Option B	2	Q505b3_2
Option C	3	Q505b3_3
Option D	4	Q505b3_4
I could participate in any of these 4 options	5	Q505b3_5

Answer If Attribute "Block 1" from Q4a is SELECTED

Q501c. Carefully consider each of the following options for formal JV structures. If options A, B, C and D were the only ones available, Characteristics Option A Option B Option C Option D Number of farm businesses in the joint venture structure 2 2 2 4 Your influence on operational decisions (non-board decisions) Final decision-maker, in consultation with other partners Shared decision-making with other partners Not the final decision-maker, but input into decisions Final decision-maker, in consultation with other partners Farming with the latest machinery New machinery New machinery Older machinery (initially 5 years plus) Older machinery (initially 5 years plus) Leave arrangements Extra 2 weeks of flexible leave No Change No Change Extra 2 weeks of flexible leave Change in your annual net farm income (compared to current 5yr average) - $15k + $15k + $30k + $50k

Q501c2. Which option would be the most attractive and least attractive to you?

Answer If Attribute "Block 3" from Q4a is SELECTED

	Option A	Option B	Option C	Option D
Most attractive	1	2	3	4
	Q501c2_1_1	Q501c2_2_1	Q501c2_3_1	Q501c2_4_1
Least attractive	1	2	3	4
	Q501c2_1_2	Q501c2_2_2	Q501c2_3_2	Q501c2_4_2

Q501c3. Which of these four options would you NEVER participate in ?Select all that apply

Answer If Attribute "Block 3" from Q4a is SELECTED

Option A	1	Q501c3_1
Option B	2	Q501c3_2
Option C	3	Q501c3_3
Option D	4	Q501c3_4
I could participate in any of these 4 options	5	Q501c3_5

Answer If Attribute "Block 1" from Q4a is SELECTED

Q502c. Carefully consider each of the following options for formal JV structures. If options A, B, C and D were the only ones available, Characteristics Option A Option B Option C Option D Number of farm businesses in the joint venture structure 3 4 2 2 Your influence on operational decisions (non-board decisions) Shared decision-making with other partners Not the final decision-maker, but input into decisions Shared decision-making with other partners Final decision-maker, in consultation with other partners Farming with the latest machinery Older machinery (initially 5 years plus) Older machinery (initially 5 years plus) New machinery New machinery Leave arrangements Extra 2 weeks of flexible leave Extra 2 weeks of flexible leave Extra 2 weeks of flexible leave No Change Change in your annual net farm income (compared to current 5yr average) - $15k + $50k - $15k + $75k

Q502c2. Which option would be the most attractive and least attractive to you?

Answer If Attribute "Block 3" from Q4a is SELECTED

	Option A	Option B	Option C	Option D
Most attractive	1	2	3	4
	Q502c2_1_1	Q502c2_2_1	Q502c2_3_1	Q502c2_4_1
Least attractive	1	2	3	4
	Q502c2_1_2	Q502c2_2_2	Q502c2_3_2	Q502c2_4_2

Q502c3. Which of these four options would you NEVER participate in? Select all that apply

Answer If Attribute "Block 3" from Q4a is SELECTED

Option A	1	Q502c3_1
Option B	2	Q502c3_2
Option C	3	Q502c3_3
Option D	4	Q502c3_4
I could participate in any of these 4 options	5	Q502c3_5

Answer If Attribute "Block 1" from Q4a is SELECTED

Q503c. Carefully consider each of the following options for formal JV structures. If options A, B, C and D were the only ones available, Characteristics Option A Option B Option C Option D Number of farm businesses in the joint venture structure 2 2 4 3 Your influence on operational decisions (non-board decisions) Not the final decision-maker, but input into decisions Final decision-maker, in consultation with other partners Final decision-maker, in consultation with other partners Not the final decision-maker, but input into decisions Farming with the latest machinery Older machinery (initially 5 years plus) Older machinery (initially 5 years plus) New machinery Older machinery (initially 5 years plus Leave arrangements No Change Extra 2 weeks of flexible leave Extra 2 weeks of flexible leave Extra 2 weeks of flexible leave Change in your annual net farm income (compared to current 5yr average) + $50k - $15k + $75k No Change

Q503c2. Which option would be the most attractive and least attractive to you?

Answer If Attribute "Block 3" from Q4a is SELECTED

	Option A	Option B	Option C	Option D
Most attractive	1	2	3	4
	Q503c2_1_1	Q503c2_2_1	Q503c2_3_1	Q503c2_4_1
Least attractive	1	2	3	4
	Q503c2_1_2	Q503c2_2_2	Q503c2_3_2	Q503c2_4_2

Q503c3. Which of these four options would you NEVER participate in? Select all that apply

Answer If Attribute "Block 3" from Q4a is SELECTED

Option A	1	Q503c3_1
Option B	2	Q503c3_2
Option C	3	Q503c3_3
Option D	4	Q503c3_4
I could participate in any of these 4 options	5	Q503c3_5

Answer If Attribute "Block 1" from Q4a is SELECTED

Q504c. Carefully consider each of the following options for formal JV structures. If options A, B, C and D were the only ones available, Characteristics Option A Option B Option C Option D Number of farm businesses in the joint venture structure 2 3 3 4 Your influence on operational decisions (non-board decisions) Sole decision-maker Not the final decision-maker, but input into decisions No operational decisions

Shared decision-making with other partners Farming with the latest machinery Older machinery (initially 5 years plus) New machinery New machinery New machinery Leave arrangements No Change Extra 2 weeks of flexible leave Extra 2 weeks of flexible leave Extra 2 weeks of flexible leave Change in your annual net farm income (compared to current 5yr average) + $75k - $15k + $15k + $15k

Q504c2. Which option would be the most attractive and least attractive to you?

Answer If Attribute "Block 3" from Q4a is SELECTED

	Option A	Option B	Option C	Option D
Most attractive	1	2	3	4
	Q504c2_1_1	Q504c2_2_1	Q504c2_3_1	Q504c2_4_1
Least attractive	1	2	3	4
	Q504c2_1_2	Q504c2_2_2	Q504c2_3_2	Q504c2_4_2

Q504c3. Which of these four options would you NEVER participate in? Select all that apply

Answer If Attribute "Block 3" from Q4a is SELECTED

Option A	1	Q504c3_1
Option B	2	Q504c3_2
Option C	3	Q504c3_3
Option D	4	Q504c3_4
I could participate in any of these 4 options	5	Q504c3_5

Answer If Attribute "Block 1" from Q4a is SELECTED

Q505c. Carefully consider each of the following options for formal JV structures. If options A, B, C and D were the only ones available, Characteristics Option A Option B Option C Option D Number of farm businesses in the joint venture structure 3 4 4 3 Your influence on operational decisions (non-board decisions) Final decision-maker, in consultation with other partners No operational decisions Sole decision-maker Final decision-maker, in consultation with other partners Farming with the latest machinery New machinery Older machinery (initially 5 years plus) New machinery New machinery Leave arrangements No Change Extra 2 weeks of flexible leave Extra 2 weeks of flexible leave No Change Change in your annual net farm income (compared to current 5yr average) + $15k + $75k + $15k No Change

Q505c2. Which option would be the most attractive and least attractive to you?

Answer If Attribute "Block 3" from Q4a is SELECTED

	Option A	Option B	Option C	Option D
Most attractive	1	2	3	4

	Q505c2_1_1	Q505c2_2_1	Q505c2_3_1	Q505c2_4_1
Least attractive	1	2	3	4
	Q505c2_1_2	Q505c2_2_2	Q505c2_3_2	Q505c2_4_2

Q505c3. Which of these four options would you NEVER participate in? Select all that apply

Answer If Attribute "Block 3" from Q4a is SELECTED

Option A	1	Q505c3_1
Option B	2	Q505c3_2
Option C	3	Q505c3_3
Option D	4	Q505c3_4
I could participate in any of these 4 options	5	Q505c3_5

Answer If Attribute "Block 1" from Q4a is SELECTED

Q501d. Carefully consider each of the following options for formal JV structures. If options A, B, C and D were the only ones available, Characteristics Option A Option B Option C Option D Number of farm businesses in the joint venture structure 3 4 3 2 Your influence on operational decisions (non-board decisions) Not the final decision-maker, but input into decisions No operational decisions Shared decision-making with other partners Sole decision-maker Farming with the latest machinery Older machinery (initially 5 years plus) New machinery Older machinery (initially 5 years plus) Older machinery (initially 5 years plus) Leave arrangements No Change Extra 2 weeks of flexible leave No Change Extra 2 weeks of flexible leave Change in your annual net farm income (compared to current 5yr average) + $15k + $75k + $15k - $15k

Q501d2. Which option would be the most attractive and least attractive to you?

Answer If Attribute "Block 4" from Q4a is SELECTED

	Option A	Option B	Option C	Option D
Most attractive	1	2	3	4
	Q501d2_1_1	Q501d2_2_1	Q501d2_3_1	Q501d2_4_1
Least attractive	1	2	3	4
	Q501d2_1_2	Q501d2_2_2	Q501d2_3_2	Q501d2_4_2

Q501d3. Which of these four options would you NEVER participate in? Select all that apply

Answer If Attribute "Block 4" from Q4a is SELECTED

Option A	1	Q501d3_1
Option B	2	Q501d3_2
Option C	3	Q501d3_3
Option D	4	Q501d3_4
I could participate in any of these 4 options	5	Q501d3_5

Answer If Attribute "Block 1" from Q4a is SELECTED

Q502d. Carefully consider each of the following options for formal JV structures. If options A, B, C and D were the only ones available, Characteristics Option A Option B Option C Option D Number of farm businesses in the joint venture structure 2 3 4 4 Your influence on operational decisions (non-board decisions) No operational decisions Final decision-maker, in consultation with other partners Sole decision-maker Final decision-maker, in consultation with other partners Farming with the latest machinery New machinery New machinery Older machinery (initially 5 years plus) New machinery Leave arrangements No Change No Change Extra 2 weeks of flexible leave No Change Change in your annual net farm income (compared to current 5yr average) + $75k - $15k + $30k - $15k

Q502d2. Which option would be the most attractive and least attractive to you?

Answer If Attribute "Block 4" from Q4a is SELECTED

	Option A	Option B	Option C	Option D
Most attractive	1	2	3	4
	Q502d2_1_1	Q502d2_2_1	Q502d2_3_1	Q502d2_4_1
Least attractive	1	2	3	4
	Q502d2_1_2	Q502d2_2_2	Q502d2_3_2	Q502d2_4_2

Q502d3. Which of these four options would you NEVER participate in? Select all that apply

Answer If Attribute "Block 4" from Q4a is SELECTED

Option A	1	Q502d3_1
Option B	2	Q502d3_2
Option C	3	Q502d3_3
Option D	4	Q502d3_4
I could participate in any of these 4 options	5	Q502d3_5

Answer If Attribute "Block 1" from Q4a is SELECTED

Q503d. Carefully consider each of the following options for formal JV structures. If options A, B, C and D were the only ones available, Characteristics Option A Option B Option C Option D Number of farm businesses in the joint venture structure 4 3 2 4 Your influence on operational decisions (non-board decisions) Shared decision-making with other partners Final decision-maker, in consultation with other partners Not the final decision-maker, but input into decisions Final decision-maker, in consultation with other partners Farming with the latest machinery Older machinery (initially 5 years plus) Older machinery (initially 5 years plus) New machinery Older machinery (initially 5 years plus) Leave arrangements Extra 2 weeks of flexible leave Extra 2 weeks of flexible leave No Change Extra 2 weeks of flexible leave Change in your annual net farm income (compared to current 5yr average) No Change - $15k + $75k No Change

Q503d2. Which option would be the most attractive and least attractive to you?

Answer If Attribute "Block 4" from Q4a is SELECTED

	Option A	Option B	Option C	Option D
Most attractive	1	2	3	4
	Q503d2_1_1	Q503d2_2_1	Q503d2_3_1	Q503d2_4_1
Least attractive	1	2	3	4
	Q503d2_1_2	Q503d2_2_2	Q503d2_3_2	Q503d2_4_2

Q503d3. Which of these four options would you NEVER participate in? Select all that apply

Answer If Attribute "Block 4" from Q4a is SELECTED

Option A	1	Q503d3_1
Option B	2	Q503d3_2
Option C	3	Q503d3_3
Option D	4	Q503d3_4
I could participate in any of these 4 options	5	Q503d3_5

Answer If Attribute "Block 1" from Q4a is SELECTED

Q504d. Carefully consider each of the following options for formal JV structures. If options A, B, C and D were the only ones available, Characteristics Option A Option B Option C Option D Number of farm businesses in the joint venture structure 2 4 3 4 Your influence on operational decisions (non-board decisions) Sole decision-maker Shared decision-making with other partners Not the final decision-maker, but input into decisions No operational decisions Farming with the latest machinery New machinery Older machinery (initially 5 years plus) Older machinery (initially 5 years plus) Older machinery (initially 5 years plus) Leave arrangements Extra 2 weeks of flexible leave No Change No Change No Change Change in your annual net farm income (compared to current 5yr average) - $15k No Change - $15k + $75k

Q504d2. Which option would be the most attractive and least attractive to you?

Answer If Attribute "Block 4" from Q4a is SELECTED

	Option A	Option B	Option C	Option D
Most attractive	1	2	3	4
	Q504d2_1_1	Q504d2_2_1	Q504d2_3_1	Q504d2_4_1
Least attractive	1	2	3	4
	Q504d2_1_2	Q504d2_2_2	Q504d2_3_2	Q504d2_4_2

Q504d3. Which of these four options would you NEVER participate in? Select all that apply

Answer If Attribute "Block 4" from Q4a is SELECTED

Option A	1	Q504d3_1
Option B	2	Q504d3_2
Option C	3	Q504d3_3
Option D	4	Q504d3_4

I could participate in any of these 4 options	5	Q504d3_5

Answer If Attribute "Block 1" from Q4a is SELECTED

Q505d. Carefully consider each of the following options for formal JV structures. If options A, B, C and D were the only ones available, Characteristics Option A Option B Option C Option D Number of farm businesses in the joint venture structure 4 2 3 2 Your influence on operational decisions (non-board decisions) Sole decision-maker Shared decision-making with other partners Shared decision-making with other partners No operational decisions Farming with the latest machinery New machinery Older machinery (initially 5 years plus) New machinery New machinery Leave arrangements Extra 2 weeks of flexible leave No Change No Change Extra 2 weeks of flexible leave Change in your annual net farm income (compared to current 5yr average) No Change + $75k No Change No Change

Q505d2. Which option would be the most attractive and least attractive to you?

Answer If Attribute "Block 4" from Q4a is SELECTED

	Option A	Option B	Option C	Option D
Most attractive	1	2	3	4
	Q505d2_1_1	Q505d2_2_1	Q505d2_3_1	Q505d2_4_1
Least attractive	1	2	3	4
	Q505d2_1_2	Q505d2_2_2	Q505d2_3_2	Q505d2_4_2

Q505d3. Which of these four options would you NEVER participate in? Select all that apply

Answer If Attribute "Block 4" from Q4a is SELECTED

Option A	1	Q505d3_1
Option B	2	Q505d3_2
Option C	3	Q505d3_3
Option D	4	Q505d3_4
I could participate in any of these 4 options	5	Q505d3_5

Answer If Attribute "Block 1" from Q4a is SELECTED

Q6. Thank you very much for your input so far. Your opinions provide important information for my PhD research and potential changes in program design. This last part of the survey concerns your farm's specific information. Part B - Farm Specific Information Are you?

Loop by 0 for the following attributes:

Male	1	
Female	2	Q6

Q7. Into which age category do you fall?

18-24	1	

25-34	2	
35-44	3	
45-54	4	Q7
55-64	5	
65 and over	6	

Q8. Please indicate the category that best describes the highest level of education that you have completed .

Year 10 or below	1	
Year 12	2	
Certificate (III or IV)	5	
Diploma level or advanced diploma	6	
Trade apprenticeship	3	
Bachelor degree	4	
Graduate certificate or graduate diploma	7	
Postgraduate degree (masters or PHD)	8	

Q9. Has anyone involved with managing the farm completed a university degree or advanced degree?

Do not answer If Attribute "Bachelor degree" from Q8 is SELECTED OR
Do not answer If Attribute "Graduate certificate or graduate diploma" from Q8 is SELECTED OR
Do not answer If Attribute "Postgraduate degree (masters or PHD)" from Q8 is SELECTED

Yes	1	
No	2	Q9
Don't know	3	

Q10. Are you a member of any local farmer based group in your district?

Yes	1	
No	555	Q10

Q11. Do you employ a non-family farm manager on a full-time basis?

Yes	1	
No	555	Q11

Q12a. Does the farm business employ any non-family labour (excludes work done by a non-family farm manager or contractors)?

Yes	1		
No	555	Go to Q13	Q12a

Q12b. How many non-family employees do you employ directly? Insert 0 where applicable

Do not answer If true

Number of part time employees	1	Q12b_1_1
Number of full time employees	2	Q12b_1_2

Q12b1. How many non-family employees do you employ directly? Insert 0 where applicable

Q12b2

Q13. How often do you use contractors at the relevant time of the year for each of the following farm operations?

	Never	Rarely	Sometimes	Always	
Seeding / Planting	1	2	3	4	Q13_1
Fertiliser Spreading	1	2	3	4	Q13_2
Spraying	1	2	3	4	Q13_3
Harvesting	1	2	3	4	Q13_4

Q14. On average, how many weeks do you spend away from the farm each year on leave/holidays?

Loop by 14 for the following attributes:

Less than 2 weeks	1	
3 or 4 weeks	2	
5 or 6 weeks	3	Q14
7 or 8 weeks	4	
More than 8 weeks	5	

Q15a. Do you have someone to look after the farm if you are absent for an extended period (e.g. on leave for an extended break or overseas holidays, etc.)?

Yes	1		
No	555	Go to Q16	Q15a

Q15b. Who looks after the farm whilst you are away for extended periods?

Other Family	1	
Farm manager	2	
Other employees	3	Q15b
Neighbour / Friend	4	

Q16. Do you directly pay any of the following for advice or support?

	Yes	No	
Farm business consultant	1	555	Q16_1
Crop consultant / agronomist	1	555	Q16_2
Grain marketing specialist	1	555	Q16_3

Q17. Please indicate how strongly you agree or disagree with the following statements:

	Strongly disagree	Disagree	Neither agree or disagree	Agree	Strongly agree	
My farm is too small to be viable in the future	1	2	3	4	5	Q17_1
I would increase farm profitability if I ran my farm business more professionally	1	2	3	4	5	Q17_2
I spend too much time on day to day operational tasks with not enough time available for managing the farm business	1	2	3	4	5	Q17_3
I like working with a team of people to perform tasks and solve problems	1	2	3	4	5	Q17_4
Being my own boss is one of the best things about being a farmer	1	2	3	4	5	Q17_5
I farm with the latest technology	1	2	3	4	5	Q17_6
I rely on outside experts to help me make farm decisions	1	2	3	4	5	Q17_7
Family history and traditions related to my farm highly influence the major farm business decisions I make presently	1	2	3	4	5	Q17_8
It is likely that I will need to sell the farm to a non-family member to fund my retirement	1	2	3	4	5	Q17_9
A greater willingness for farmers to separate land ownership and land management would provide me with additional opportunities for the future (eg. lease, rent, sharefarm etc.)	1	2	3	4	5	Q17_10

Q18a. For the following questions on land area, please choose your preferred unit of measure?

Hectares	1	
Acres	2	Q18a

Q18b. What is the total area of your farm operation by the following land categories (Hectares)? Insert 0 where applicable

Answer If [Q18a] = 1

Hectares

Owned land	1	Q18b_1_1
Land leased from another farm	1	C18b_1_1
Land sharefarmed on another farm	1	Q18b_1_2
Total arable land (owned and leased land only)	1	C18b_1_2
Area sown to crops in a normal season (owned and leased land only)	1	Q18b_1_3
Area sown to crops in 2012 (owned and leased land only)	1	C18b_1_3

Q18c. What is the total area of your farm operation by the following land categories (Acres)?Insert 0 where applicable

Answer If [Q18a] = 2

	Acres	
Owned land	1	Q18c_1_1
Land leased from another farm	1	C18c_1_1
Land sharefarmed on another farm	1	Q18c_1_2
Total arable land (owned and leased land only)	1	C18c_1_2
Area sown to crops in a normal season (owned and leased land only)	1	Q18c_1_3
Area sown to crops in 2012 (owned and leased land only)	1	C18c_1_3

Q19. As at June 30, 2012, how many sheep were stocked? (Total head including lambs)

Insert 0 where applicable

Q20. As at June 30, 2012, how many cattle were stocked? (Total head including calves)

Q21. Thinking of lifestyle and management preferences for this farm operation, if you had to choose between a cropping only or livestock only business, what would you choose?

Cropping only	1	
Livestock only	2	Q21

Q22a. In the last 5 years have you expanded crop area through the purchase and/or long term lease of additional land?

Tick all that are applicable

purchase of additional land	1	Q22a_1
long term lease of additional land?	2	Q22a_2
No	555	Q22a_3

Q22b1. What area of land has been purchased?

Answer If Attribute "purchase of additional land" from Q22a is SELECTED

Hectares	1	
Acres	2	Q22b1_1

Q22b2. What area of land has been leased from others?

Answer If Attribute "long term lease of additional land?" from Q22a is SELECTED

Hectares	1	
Acres	2	Q22b2_1

Q22c. Given your crop area has not increased over the last 5 years, which of the following best describes your farm circumstances?

Answer If Attribute "No" from Q22a is SELECTED

Satisfied with the current farm scale and level of productivity	1	
Aimed to increase productivity but not scale	2	
Aspired to increase scale and/or productivity but significantly constrained by financial limitations	3	
Sufficient financial resources to increase scale but significantly constrained by a lack of available land nearby	4	Q22c
Shifted the focus of the enterprise to non-crop activities like livestock	5	
Phased down farming effort by leasing out, sharefarming and/or selling some land	6	

Q23a. In the next 5 years do you plan to expand farm crop area through the purchase and/or long term lease of additional land?

Yes	1	
No	555	Q23a

Q23b. Is the expansion planned via

Answer If Attribute "Yes" from Q23a is SELECTED

	Yes	Maybe	No	
land purchase	1	2	555	Q23b_1
long-term lease	1	2	555	Q23b_2

Q23c. If you do not intend to increase your crop area via purchase and/or long-term lease, which of the following best describes your intentions for your farm business over the next 5 years?

Answer If ([Q23a] = 555) OR ([Q23b_1] = 555 AND [Q23b_2] = 555)

Satisfied with the current farm scale and level of productivity	1	
Aiming to increase productivity but not scale	2	
Aspiring to increase scale and/or productivity but will be significantly constrained by financial limitations	3	
Shift the focus of the enterprise to non-crop activities like livestock	4	
Phase down farming effort by leasing out, sharefarming and/or selling some land	5	
Expect to sell up and exit farming	6	

Q24a. Does the prospect of retirement concern you?

Yes	1	
No	555	Q24a

Q24b. How many years is it likely to be before you retire?

Already retired	1	
Less than 5 years	2	
Greater than 5 years but less than 10 years	3	Q24b
Greater than 10 years	4	
Don't know	5	

Q25. How likely is it that a family member/s will continue this farming operation after your retirement?

Very unlikely	1	
Unlikely	2	
Unsure	3	
Likely	4	Q25
Very likely	5	
Not applicable	555	

Q26a. You're doing well, only a few questions to go Approximately how much income did you and your partner derive from off-farm employment in 2011-12?

No off-farm employment income	1	Go to Q27	
Less than $25,000	2		
$25,001 - $50,000	3		
$50,001 - $75,000	4		Q26a
Greater than $75,000	5		

Unsure / Refuse to answer	6	

Q26b1. On average, how many hours/week do you work in off-farm paid employment?

Hours of off-farm paid employment per week

None	1	
Up to 8 hours/week	2	
8-16 hours/week	3	Q26b1
16-32 hours/week	4	
More than 32 hours/week	5	

Q26b2. On average, how many hours/week does your partner work in off-farm paid employment?

Hours of off-farm paid employment per week

None	1	
Up to 8 hours/week	2	
8-16 hours/week	3	
16-32 hours/week	4	Q26b2
More than 32 hours/week	5	
Not applicable	555	

Q27. How would you describe the general financial health of this farm business?

Very healthy	1	
Healthy	2	
Stable	3	
Mildly strained	4	Q27
Severely strained	5	
Unsure / Refuse to answer	6	

Q28. Please indicate your level of equity in your farm as a percentage of the total value of farm assets?

Above 95%	1	
Between 76 - 95%	2	
Between 50 - 75%	3	Q28
Below 50%	4	
Unsure / Refuse to answer	5	

Q29. For the past 5 years, what was the average annual gross on-farm income for your farm business?

Less than $100,000	1	

$100,001 to $250,000	2	
$250,001 to $500,000	3	
$500,001 to $1,000,000	4	
$1,000,001 to $2,000,000	5	Q29
$2,000,001 to $3,000,000	6	
More than $3,000,000	7	
Unsure / Refuse to answer	8	

Q30. For the past 5 years, what was the average annual net farm income for your farm business? Net Farm Income = Gross Cash Income – Total Cash Expenses +/- Inventory changes – Depreciation

Less than $0	1	
$0 - $25,000	2	
$25,001 - $50,000	3	
$50,001 - $75,000	4	
$75,000 - $100,000	5	
$100,001 - $175,000	6	Q30
$175,001 - $250,000	7	
$250,001 to $500,000	8	
$500,001 to $1,000,000	9	
More than $1,000,000	10	
Unsure / Refuse to answer	11	

Q31. Please indicate how strongly you agree or disagree with the following statements.

	Strongly disagree	Disagree	Neither agree or disagree	Agree	Strongly agree	
I'm an earlier adopter of the latest farming practices and technologies compared to other farmers in the district	1	2	3	4	5	Q31_1
I never have enough cash on hand or assets than can easily be converted to cash to pay all my bills	1	2	3	4	5	Q31_2
I am willing to take on higher financial risks in my farm business in order to realize higher average returns	1	2	3	4	5	Q31_3
I think the downside risks of a formal joint venture structure outweigh the possible benefits for my farm business	1	2	3	4	5	Q31_4
A joint venture structure would expose my farm business to an unacceptable level of human	1	2	3	4	5	Q31_5

relationship risk between myself and other joint venture partners						
It would be desirable for my farm businesses to have access to alternative forms of funding besides my equity or bank debt, like outside investor equity	1	2	3	4	5	Q31_6
An alternative joint venture structure that involved an equity investment by passive investors would be more attractive than a joint venture structure with others farmers	1	2	3	4	5	Q31_7
I would not be concerned with the nationality of investors so long as they understood the investment parameters/conditions and were of good character	1	2	3	4	5	Q31_8

Q32a. What is the age of your planting tractor?

Don't own one	1	
Less than 3 years	2	
Greater than 3 years but less than 5 years	3	
Greater than 5 years but less than 10 years	4	
More than 10 years but less than 15 years	5	
More than 15 years	6	
Don't know	999	

Q32b. What is the age of your harvester?

Don't own one	1	
Less than 3 years	2	
Greater than 3 years but less than 5 years	3	
Greater than 5 years but less than 10 years	4	Q32b
More than 10 years but less than 15 years	5	
More than 15 years	6	
Don't know	999	

Q60. WARNING - The survey is NOT COMPLETED The survey is only completed once you see the note To complete the survey, please answer the question below and click Next in a few screens time. Would you like your payment directly or indirectly via a donation to a charity?

Cheque	1	
Charity Donation	2	Q60

Q61. Which of the following charities would you like us to make the donation to?

Answer If Attribute "Charity Donation" from Q60 is SELECTED

Royal Flying Doctor Service	1	
Beyond Blue	2	Q61
Salvation Army	3	

Q64. Who would you like [Q60a]?

First Name	1	Q64_1_1
Surname	2	Q64_1_2
Address 1 / Property Name	3	Q64_1_3
Address 2	4	Q64_1_4
Town	5	Q64_1_5
State	6	Q64_1_6
Postcode	7	Q64_1_7

Q65. Thank you very much for your time and effort! To complete the survey, please answer the question below and click Next. If you would like to stay informed about the results of this study, please provide your email address below. This address will not be linked to any of the answers you provided!

Email address	1	
no thanks	2	Q65_1

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Appendix 2 National telephone survey instrument

Q1. **Introduction/permission**

Q2. **Are you a main cropping decision maker on the farm?**

Re-introduce yourself to the relevant person if needed			
Yes	1		
No	2	End	Q2

Q3. **Dummy question - LGA**

Q4. **Thanks for your help; your time is greatly appreciated. Please note that this call may be recorded for quality assurance and training purposes So that we can be sure we are interviewing a cross section of rural producers, over the last three financial years, roughly what percentage of your gross property income, that is, only income from your property, came from the following activities?**

Q5. **Dummy Farm Type Question Q3x1: [Q3x1] Q3x2: [Q3x2]Q3x3: [Q3x3]Q3x4: [Q3x4]Q3x5: [Q3x5]Q3x6: [Q3x6]Q3x7: [Q3x7]Q3x8: [Q3x8]Q3x9: [Q3x9] Q3x10: [Q3x10] Q3x11: [Q3x11] Q3x12: [Q3x12] Crops: [xCrops] Livestock: [xLivestock]**

Do not show If true

Grains	1	
Grain/Livestock	2	
Beef and Sheep	4	
Beef	5	
Sheep	6	
Dairy	7	Q5
Sugar Cane	8	
Cotton	50	
Horticulture	70	
QNA	99	

Q6. **And what is the total area of your property, including all leased land and any unused land?**

CHECK WHETHER THE SHOW IS HECTARES OR ACRES & RECORD		
Hectares	1	
Acres	2	Q6_1

Q7. **Farm Size Groups**

Do not show If true

Under 400ha	1	
400 - 799ha	2	
800 - 1,999ha	3	Q7
2,000ha +	4	

Q8. **In a normal season, how many hectares would you crop on average?**

CHECK WHETHER THE SHOW IS HECTARES OR ACRES & RECORD		
Hectares	1	
Acres	2	Q8_1

If ([Q8_1] = 1 AND [Q8_2] >= 200) OR ([Q8_1] = 2 AND [Q8_2] >= 500) go to Q10

Q9. **Thank you for your time but we are actually looking for different types of producers for this survey. We appreciate your offer to provide input and are sorry to have taken your time. Best of luck with the rest of the season.**

End

Q10. **Thinking of your personal lifestyle and management preference, if you had to choose between cropping only or livestock only, what would you choose?**

Cropping only	1	
Livestock only	2	Q10

Q11. **What is the total area of arable land that you currently manage?**

CHECK WHETHER THE SHOW IS HECTARES OR ACRES & RECORD		
Hectares	1	
Acres	2	Q11_1

Q12. **Do you think the total area of arable land that you or a family member will be managing in 5 years time will be**

READ OUT AND RECORD - SINGLE RESPONSE ONLY		
Less	1	
Same	2	
More	3	Q12
Will not be farming in 5 years	4	

Q13. **What was the total area of arable land that you managed 10 years ago?**

CHECK WHETHER THE SHOW IS HECTARES OR ACRES & RECORD		
Hectares	1	
Acres	2	Q13_1

Q14. **Approximately what proportion or percent of your land did you crop back then?**

If can't estimate percentage, ask area of land (hectares or acres)		
Percent	1	
Hectares	2	
Acres	3	Q14_1
Don't know	999	

Q15. **As an average over the past 3 years, approximately what proportion of your arable land do you crop each year?**

If can't estimate percentage, ask area of land (hectares or acres)		
Percent	1	
Hectares	2	
Acres	3	Q15_1
Don't know	999	

Q16. **What do you expect this figure to be in 4 or 5 years time?**

If can't estimate percentage, ask area of land (hectares or acres)

Percent	1		
Hectares	2		
Acres	3		Q16_1
Don't know	999		

Q17. **How old is your current main seeding machine?**

Months	1		
Years	2		Q17_1
Don't know	999		

Q18. **How old is your current main harvester / header?**

Months	1		
Years	2		Q18_1
Don't know	999		

Q19. **Have you ever used no-till for cropping?**

THAT IS SEEDING WITH NO PRIOR CULTIVATION AND INCLUDES KNIFEPOINTS, ZERO-TILL WITH DISC MACHINES, SUPER-SEEDER, INVERTED-T I.E. NOT FULL-CUT SEEDING

Yes	1		
No	2	Go to Q22	Q19

Q20. **In what year did you first try no-till for cropping?**

Q21. **For the crop area that you have sown this year, what percentage was sown using No Till?**

ie seeding with discs or knife points, including super seeder or inverted T, with no prior cultivation

Q22. **Thinking back, in what year did you first become aware of someone in your district using different fertiliser rates on different soils within paddocks?**

Q23. **Thinking back, in what year did you first become aware of someone in your district using variable rate technology? (That is seeding with GPS, variable rate machinerand prescription maps etc)**

THAT IS SEEDING WITH GPS AND PRES

Q24. **Thinking back, in what year did you first become aware of someone in your district using auto steer?**

Q25. **Thinking back, in what year did you first become aware of someone in your district using yield mapping?**

Q26. **Have you ever been a member of a precision agriculture association or a group with a strong focus on PA?**

Yes	1		
No	2		Q26

Q28. **Are you still a member?**

Show If Attribute "Yes" from Q26 is SELECTED

Yes	1	
No	2	Q28

Q29. **What is the name of the group?**

Show If Attribute "Yes" from Q26 is SELECTED

Q29

_____

Q30. **Are you a member of any local farmer group that looks at cropping issues in your district?**

Yes	1	
No	2	Q30

Q31. **AGRONOMISTS Do you pay a consultant, advisor or agronomist for cropping advice?**

Yes	1	
No	2	Q31

Q32. **Do you expect to be paying a consultant, advisor or agronomist for cropping advice in 5 years time?**

Yes	1	
No	2	Q32

Q33. **In a year, how many visits do they typically make to your farm?**

Show If Attribute "Yes" from Q31 is SELECTED

Q34. **In what year did you start paying for agronomic advice?**

Show If Attribute "Yes" from Q31 is SELECTED

Q35. **How much do you spend each year for your paid agronomic advice?**

Show If Attribute "Yes" from Q31 is SELECTED

$	1	
Refused	888	Q35_1

Q36. **Which of the following are major sources of agronomic advice for your farm?**

READ OUT - MULTIPLE RESPONSE OK

Independent agronomist / consultant - paid	1	Q36_1
Distributor representative agronomist - free of charge	2	Q36_2
Distributor representative agronomist - paid	3	Q36_3
Department of Agriculture agronomist	4	Q36_4
None of the above	555	Q36_5

If [Q36_5] = 555 go to Q45

Q37. **Do any of your major sources of agronomic advice have strong.....?**

READ OUT AND RECORD

	Yes	No	Don't know	
precision agriculture skills	1	2	999	Q37_1
crop nutrition skills	1	2	999	Q37_2

Q38. Have any of your major sources of agronomic advice ever suggested that you should consider using (READ OUT) on your farm?

READ OUT - SINGLE RESPONSE ONLY

	Yes, suggested we consider it	Yes, supported our idea to consider it	Recommended against it	Hasn't been discussed	We were already using it	
varying fertilizer rates on different soils within paddocks	1	2	3	4	5	Q38_1
yield mapping	1	2	3	4	5	Q38_2
other types of paddock mapping data eg EM, NDVI , Gamma etc	1	2	3	4	5	Q38_3
variable rate technology	1	2	3	4	5	Q38_4
soil nutrient testing	1	2	3	4	5	Q38_5

Q39. Do any of your major sources of agronomic advice offer precision agriculture-related services? (if asked: eg soil mapping, prescription maps, paddock zoning maps; managing spatial data from your paddocks; technical services for PA equipment)

Yes	1	
No	2	Q39
Don't know	999	

Q41. How many do you think use different fertilizer rates on different soils within paddocks REMOVED POST PILOT

Do not show If true

Q45. AUTOSTEER I now want to ask you some questions about your adoption of PA. Do you use auto steer using GPS (on any of your machinery)?

Yes	1	
No	2	Q45

Q46. When did you first get auto steer using GPS?

Show If Attribute "Yes" from Q45 is SELECTED

Q47. Do you expect to be using auto steer in 5 years time?

Yes	1	
No	2	Q47

Q48. YIELD MAPPING Do you have a yield monitor on a harvester?

Yes	1	
No	2	Q48

Q49. In what year did you first get a yield monitor?

Show If Attribute "Yes" from Q48 is SELECTED

Q50. Do you have a crop yield map from any of your paddocks?

Yes	1	
No	2	Q50

Q51. Will you be collecting yield maps from crops this year?

Yes	1	
No	2	Q51

Q52. What are YOUR reasons for not collecting yield map data?

Show If Attribute "No" from Q51 is SELECTED

RECORD VERBATIM		
Reason 1	1	Q52_1_1
Reason 2	2	Q52_1_2
Reason 3	3	Q52_1_3

Q54. In what year did you start collecting crop yield map data from any of your paddocks?

Show If Attribute "Yes" from Q50 is SELECTED

Q55. Do you expect to be collecting yield map data from crops in 5 years time?

Yes	1	
No	2	Q55

Q56. EM MAPS Do you have any EM (electromagnetic) or gamma maps of any of your paddocks?

Yes	1	
No	2	Q56
Don't know what they are	3	

Q57. Do you expect to have EM or gamma maps of any of your paddocks in 5 years time?

Show If Attribute "No" from Q56 is SELECTED

Yes	1	
No	2	Q57
Don't know what they are	3	

Q58. NDVI MAPS Do you have any NDVI-based (including satellite vegetation; crop circle ; greenseeker) maps of any of your paddocks?

Yes	1	
No	2	Q58
Don't know what they are	3	

Q59. Do you expect to have NDVI-based maps in 5 years time?

Show If Attribute "No" from Q58 is SELECTED

Yes	1	
No	2	Q59
Don't know what they are	3	

Q60. **FERTILISER VRT Do you use different fertilizer rates on different soils within paddocks?**

CAN INCLUDE EITHER MANUAL EG NO GPS/VRT OR VR TECHNOLOGY

Yes	1	
No	2	Q60

Q61. **What are the reasons for not using different fertilizer rates on different soils within paddocks**

Show If Attribute "No" from Q60 is SELECTED

RECORD VERBATIMS IN FULL

Reason 1	1	Q61_1_1
Reason 2	2	Q61_1_2
Reason 3	3	Q61_1_3

Q62. **What are the reasons for using different fertilizer rates on different soils within paddocks?**

REMOVED POST PILOT

Do not show If true

RECORD VERBATIMS IN FULL

Reason 1	1	Q62_1_1
Reason 2	2	Q62_1_2
Reason 3	3	Q62_1_3

Q63. **In what year did you start using different fertilizer rates on different soils within paddocks?**

Show If Attribute "Yes" from Q60 is SELECTED

Q64. **On average, on what percentage of your cropping paddocks each year do you use different fertilizer rates on different soils within paddocks?**

Show If Attribute "Yes" from Q60 is SELECTED

Q65. **Do you expect to be using different fertilizer rates on different soils within paddocks in 5 years time?**

Yes	1	
No	2	Q65

Q66. **SEEDINGVRT Do you have seeding machinery that is equipped with variable rate technology?**

Yes	1	
No	2	Q66

Q67. **When did you first get seeding machinery that was equipped with variable rate technology?**

Show If Attribute "Yes" from Q66 is SELECTED

Q68. **Do you expect to have seeding machinery that is equipped with variable rate technology in 5 years time?**

Yes	1	
No	2	Q68

If [Q60] = 2 go to Q73

Q69. **Do you use variable rate technology e.g. using prescription maps to apply variable fertiliser rates to identified zones within any of your cropping paddocks?**

Yes	1	
No	2	Q69

Q70. **What are YOUR reasons for not using variable rate technology?**

Show If Attribute "No" from Q69 is SELECTED

RECORD VERBATIMS IN FULL

Reason 1	1	Q70_1_1
Reason 2	2	Q70_1_2
Reason 3	3	Q70_1_3

Q72. **In what year did you first start using variable rate technology?**

Do not show If true

Q73. **Do you expect to use variable rate technology in 5 years time?**

Yes	1	
No	2	Q73

Q74. **SOIL TESTING What proportion of your cropping paddocks have had soil samples taken for nutrient testing in the last 3 years?**

Q75. **In what year did you start taking soil samples for nutrient testing?**

Show If [Q74] > 0

Q76. **What are YOUR reasons for not doing more soil nutrient testing?**

Show If [Q74] < 50

RECORD VERBATIMS IN FULL

Reason 1	1	Q76_1_1
Reason 2	2	Q76_1_2
Reason 3	3	Q76_1_3

Q78. **In 5 years time do you expect to be doing more/less/the same amount of soil sampling for nutrient testing?**

More than currently	1	
Less than currently	2	Q78
Same as currently	3	

Q79. **RECOMMENDATIONS Would you recommend (READ OUT) to other interested farmers in your district? Would you say....**

Do not show If [Q45] = 2 AND [Q51] = 2 AND [Q56] = 2 AND [Q58] = 2 AND [Q60] = 2 AND [Q69] = 2 AND [Q74] = 0

READ OUT AND RECORD

	Yes	No	Unsure	
Show If Attribute "Yes" from Q45 is SELECTED				
Autosteer	1	555	666	Q79_1
Show If Attribute "Yes" from Q51 is SELECTED				
Yield mapping or yield data files from crop	1	555	666	Q79_2
Show If Attribute "Yes" from Q56 is SELECTED				
EM or gamma mapping	1	555	666	Q79_3
Show If Attribute "Yes" from Q58 is SELECTED				
NDVI-based mapping	1	555	666	Q79_4
Show If Attribute "Yes" from Q60 is SELECTED				
Using different fertilizer rates on different soils within a paddock	1	555	666	Q79_5
Show If Attribute "Yes" from Q69 is SELECTED				
Variable rate seed technology	1	555	666	Q79_6
Show If [Q14003d] > 0				
Soil sampling for nutrient testing	1	555	666	Q79_7

Q80. **STATEMENTS For the following statements, please indicate whether you: strongly disagree; disagree; neither disagree nor agree; agree; or strongly agree with them?**

READ OUT AND RECORD

	Strongly disagree	Disagree	Neither	Agree	Strongly agree	
I am not confident in developing new computer skills when I need to	1	2	3	4	5	Q80_1
There is someone involved in the farm business who has strong computer technology skills	1	2	3	4	5	Q80_2
I enjoy analysing data from the crops and/or farm business	1	2	3	4	5	Q80_3
There is someone involved in the farm business that enjoys analysing data from the crops and/or farm business	1	2	3	4	5	Q80_4
I prefer to keep my farming operations very simple	1	2	3	4	5	Q80_5
A lack of skilled labour is one of the biggest constraint to my farm operations	1	2	3	4	5	Q80_6
A major benefit of using different fertilizer rates on different soils within paddocks is reduced input costs	1	2	3	4	5	Q80_7
A major benefit of using different fertilizer rates on different soils within paddocks is more profitable cropping	1	2	3	4	5	Q80_8
Most of my cropping paddocks contain a wide range of different soil types.	1	2	3	4	5	Q80_9

Managing precision agriculture data is very time consuming	1	2	3	4	5	Q80_10
A major benefit of using different fertilizer rates on different soils within a paddock is making investment in applying fertiliser less risky	1	2	3	4	5	Q80_11
Treating paddocks with gypsum or lime is a major cost to my farm business	1	2	3	4	5	Q80_12
Using variable rate technology is very complicated	1	2	3	4	5	Q80_13
Mapping paddock zones is very time consuming	1	2	3	4	5	Q80_14
It is not obvious how to identify paddock zones on my farm	1	2	3	4	5	Q80_15
There isn't enough variability within my paddocks to justify using different fertilizer rates on different soils within paddocks	1	2	3	4	5	Q80_16
There is a lack of technical support available for precision agriculture technology	1	2	3	4	5	Q80_17
I'd be able to fix most problems with precision agriculture technology myself	1	2	3	4	5	Q80_18
A major benefit of using different fertilizer rates on different soils within paddocks is increased crop production.	1	2	3	4	5	Q80_19

Q81. **GENERAL PA QUESTIONS By using different fertilizer rates on different soils within paddocks instead of using a uniform rate I could increase my average wheat crop profitability by what %?**

ENCOURAGE ESTIMATE

%	1	
DK	999	Q81_1

Q82. **From what you have now, how much extra do you think that it would cost you to become equipped to use variable rate technology if you chose to do so (eg seeding machinery; gps; software; yield monitoring)?**

ENCOURAGE ESTIMATE.

$	1	
DK	999	Q82_1

Q83. **What are the2 main changes that you expect to make to improve your farm productivity in the next 5 years?**

RECORD VERBATIM IN FULL

Q83

Q84. **What do you think is the biggest potential benefit from precision agriculture technology on YOUR farm in the future?**

RECORD VERBATIM IN FULL

Q84

Q85. **If technology became available that could control where livestock grazed using electronic collars or ear tags, often called virtual fencing, how beneficial do you think it would be to your farm? Would you say...**

READ OUT AND RECORD

Very beneficial	1	
Moderately beneficial	2	
Slightly beneficial	3	Q85
Not beneficial	4	

Q86. **Would you consider forming a joint venture arrangement with another farm business that involves putting land or major cropping machinery into a company arrangement?**

Yes	1	
Maybe	2	
No	3	Q86
Already in one	4	

Q87a. **What is your main reason for considering a joint venture arrangement?**

Show If Attribute "Yes" from Q86 is SELECTED OR

Show If Attribute "Maybe" from Q86 is SELECTED OR

Show If Attribute "Already in one" from Q86 is SELECTED

RECORD VERBATIM IN FULL

Q87a

Q87. **Are you likely to consider forming a joint venture arrangement with another farm business in the next 5 years or are you already in one?**

Do not show If true

DO NOT READ OUT

Looking to form one	1	
Already in one	2	
Not interested in forming one	3	Q87
Don't know	999	

Q88. **USE OF CONTRACTORS Do you currently use contractors for:**

READ OUT AND RECORD

	Always	Sometimes	Never	
Seeding / Planting	1	2	3	Q88_1
Fertiliser Spreading	1	2	3	Q88_2
Harvesting	1	2	3	Q88_3

Q89. **DEMOGRAPHICS Finally, just a few demographic questions to make sure we have interviewed a representative sample of producers: Could I ask you into which of the following age groups you fall?**

READ OUT AND RECORD

18 - 24	1	
25 - 34	2	
35 - 44	3	
45 - 54	4	Q89
55 - 64	5	
65+	6	
REFUSED (DO NOT READ OUT)	888	

Q91. **What is the age of the [LQ90] person involved in managing the farm?**

Loop by Q90 for the following attributes: youngest

Q92. **Has anyone involved with managing the farm completed a university degree or diploma?**

Yes	1	
No	2	Q92
Don't know	999	

Q93. **How many more years do you expect to be actively farming?**

Q94. **Will any of your family members continue your farm business after you retire?**

READ OUT AND RECORD		
Very unlikely	1	
Unlikely	2	
Not sure	3	
Likely	4	Q94
Very likely	5	
Not applicable	6	

Q95. **Thank you for your time and we appreciate your input and views. As part of our quality control, my supervisor will be re-contacting a percentage of respondents to verify the interview was conducted. For this purpose may I ask your first and last name?**

First	1	Q95_1_1
Last	2	Q95_1_2

Q96. **Thank you for your time and we appreciate your input and views. Best of luck with the rest of the season.**

GENDER - DO NOT ASK		
Male	1	
Female	2	Q96