MSc Thesis at Business Economics Group

Perception and performance of innovative crop insurance in Australia

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Summary

Background

Wheat is Australia's most important crop with a production approximately 4.14 % of the world production. Droughts are likely to cause detrimental effects on Australian agriculture. Conventional insurance seems to struggle to cope with these effects. Extreme weather conditions and the lack of government subsidies in insurance products might prohibit innovations in crop insurance. However, an innovative insurance scheme based on simulated crop yields was introduced recently in Australia, which is called "YieldShield". Although, this "crop simulation insurance" looks promising, the current uptake of the product is still relatively low.

Objectives

The main objective of the study is to investigate the opportunities of innovative crop insurance in Australia. In other words, this research aims to (1) assess the perceived importance of different sources of risk, (2) the current risk management tools of Australian farmers, and (3) elicit the perception of Australian farmers towards crop simulation insurance (applied for YieldShield).

Materials and methods

In order to retrieve data for the research a structured survey was used. Farmers' perception of risk, risk management strategies and towards crop simulation insurance products was measured on Likert-scales. In the period of November 2009 up to February 2010 personal interviews were carried out (n=44). Factor analysis was applied to identify key sources of risk and groups of risk management strategies. Significant difference between groups such as farmers, with positive or negative attitude towards YieldShield, was tested. Conjoint analysis was used to evaluate the perceived importance of crop insurance attributes in order to identify the features of the optimal product.

Results

Average scores of key sources of risk perceived and the price and production risk factor, retrieved from factor analysis revealed the same underlying construct, which is that commodity prices and droughts are perceived to be the most important sources of risk among Australian farmers. Water management, growing different types of crops, and the use of the latest technologies are perceived to be the key risk management strategies. The "on-farm risk management" factor, identified by factor analysis, includes also the same three strategies. Based on the results, property insurance (4^{th}), crop insurance (5^{th}) and personal insurance (6^{th}) are perceived to be relevant risk management strategies as well.

Covered perils, perceived value for money and trust in the broker are perceived to be the most important attributes to be included in crop insurance policies. From the covered perils, conjoint analysis showed that water stress is perceived to be the most important attribute of crop insurance. Furthermore, an alternative product with water stress excluding hail cover is perceived to be more preferred to the currently available YieldShield, which integrates hail and water stress as well.

Crop simulation insurance is likely to be well perceived in Australia, because the majority of farmers indicated that they are either neutral (56.8%) or positive (38.6%) towards the concept. The test for significant difference between positive and neutral farmers revealed that educational background, the quality and source of information is most likely to determine farmers' perception of crop simulation insurance (Table 1). On the other hand, apart from tertiary education from economics, the research failed to reveal any significant differences between groups of farmers with regard to socioeconomic factors. The results showed no significant difference in farm characteristics either.

Correlation coefficients indicate that there is positive correlation between positive attitude towards YieldShield and whether farmer heard about APSRU, uses HowWet, had tertiary education from economics respectively. In other words, farmers, who heard about APSRU, use HowWet and had tertiary education from economics, are likely to well perceive YieldShield. On the other hand, there is a negative correlation between positive attitude and receiving information from the brokers. Therefore, farmers who received information from brokers are likely to be negative towards YieldShield. The research also described a number of government policies available for farmers during droughts. However, the importance and details about the application of drought assistance is not explored by this research.

Conclusions and discussion

As the results showed that water stress is perceived to be a key source of risk, and the most important product attribute of crop insurance, one might conclude that YieldShield, which includes water stress cover, is likely to be a successful product. However, based on the results of conjoint analysis, it might be concluded that excluding hail from the policy is likely to improve the current market position of YieldShield. The three most important risk management strategies perceived by farmers are all on-farm risk management strategies (water management, growing other crops besides wheat and using the latest technologies); meanwhile crop insurance is perceived to be the fifth most important risk management strategy. As a conclusion one might say that farmers are likely to allocate a relatively big part of their resources towards on-farm risk management strategies. Therefore, potential uptake of crop simulation insurance, which carries a relatively high cost factor, is likely to involve major reorganization in farm management.

Australian farmers are likely to be either positive or neutral towards the concept. However, the research revealed that farmers' perception is likely to be determined by the quality and the source of their information about the product. Therefore, one might conclude that putting effort into the marketing of the product is likely to improve the position of YieldShield. The perception of farmers is not likely to be influenced by neither socioeconomic factors nor farm characteristics, but might be influenced by educational background and information availability. Therefore, apart from a potential marketing campaign, it might be advised that the target market of YieldShield should be reconsidered. Since the paper did not examine the effects of government assistance with regard to droughts, it might be advisable to undertake further research to investigate the effect of drought policies on farmers' participation with regard to YieldShield.

Table 1: Difference between positive and negative groups of farmers, average scores (1 – not at all, 5 – completely), Spearman rank-order correlation coefficient: ρ (rho) (n=44).

	YieldShield attitude		
	positive (n=17) average	**negative (n=27) average**	**Spearman rank-order correlation coefficient: ρ (rho)**
Socioeconomic factors			
• Farm size (ha)	5486	5633	-
• Annual average farm turnover/year (3=$500-1000k; 4=more than $1000k)	3.35	3.22	-
• Age group of the farmer (3=36-50 years; 4=over 50 years)	3.24	2.92	-
Sources of risk			
• Drought as a risk factor influencing income	4.18	4.19	-
• Flooding as a risk factor influencing income	2.12	2.11	-
• Hail as a risk factor influencing income	2.53	2.11	-
• Fire as a risk factor influencing income	1.41	1.19	-
Information about YieldShield			
• Familiarity with crop insurance based on modeling***	3.06	2.30	-
• Farmer understands the whole concept of the product***	3.41	2.62	-
• Would like to follow monthly yield simulation via internet	4.00	3.96	-
• Was given negative information about the product	1.59	1.35	-
• Trust the validity of simulated yields***	3.35	2.54	-
• A product that reduces income volatility is worth 5% of the risk value	3.41	3.23	-
Non-parametric variables	***yes***	***no***	
• Farmer heard about APSRU (%)**	52.3	47.7	0.384
• Uses HowWet (%)*	18.2	81.8	0.352
• Had information from broker (%)*	86.4	13.6	-0.365
• Tertiary education of the farmer from economics (%)**	20.9	79.1	0.408

***Significant at the 0.05 level (2-tailed).
**Correlation is significant at the 0.01 level (2-tailed).
*Correlation is significant at the 0.05 level (2-tailed).

Abbreviations

NSW: New South Wales

SA: South Australia

WA: Western Australia

SOI: Southern Oscillation Index

AIC: Agriculture Insurance Company of India Limited

RUA: Reference Unit Area

APSRU: Agricultural Production Systems Research Unit

ACLUMP: Australian Collaborative Land Use Mapping Programme

ENSO: El Niño-Southern Oscillation

DPI: Department of Employment, Economic Development and Innovation, Queensland Primary Industries and Fisheries

SI: Stress index

1. General introduction

1.1 Introduction

Wheat is Australia's most important crop; in 2005-2006, farmers harvested 25.7 million tons which is 4.14 % of the world production (Australian Bureau of Statistics, 2008; International Grains Council, 2009). Crop yields and the amount of rainfall within a given region are highly correlated (Malcolm et al., 1996). In fact, Australia is the second driest continent after Antarctica with average (mean) annual rainfall below 600 millimeters per year over 80 percent of the continent, and below 300 millimeters over 50 percent (Australian Bureau of Statistics, 2008). Droughts are inevitable, frequent and often severe events of the Australian agriculture. For example, the droughts in 1982-1983 and 1993-1994 were each responsible for a drop of about 20 percent in the net value of agricultural production, amounting to a fall of about $4 billion (in 1994 Australian dollars) in annual national income (Malcolm et al., 1996).

Insurance can assist in managing these losses, and crop insurance is especially designed to cover the losses arising from perils beyond the control of growers (Roberts, 2005). Varangis et al. (2002) argue that there is a need for yield insurance. Unfortunately, traditional crop insurances seem no longer sufficient. Both correlation of crop risks and asymmetric information problems are likely to make risk pooling, which is essential for any successful insurance program, ineffective. As a result, the latest innovative crop insurances attempt to overcome the traditional problems of agricultural insurance, such as moral hazard, adverse selection, high transaction costs, and most importantly, the problem of systemic climatic risks (Kang, 2007). New types of insurance have been developed during the last 2 decades. More specifically, much attention has been paid to the design and introduction of derivative insurance products based on among others area yields and rainfall indices (Miranda and Glauber, 1997). Although successful in a number of regions around the world, derivatives also seem to face some problems, from which basis risk and availability of adequate data seem to be the major ones.

In Australia, relatively little traditional and derivative insurance is going on, partly because of the extreme weather conditions and because of governments not subsidizing insurance products, in contrast to e.g. US governments. Recently, however, an innovative insurance scheme based on simulated crop yields was introduced. This “crop simulation insurance” uses simulated crop yields to calculate claims. More specifically, simulated yield values must show a reduction from the forecast value produced at the start of the season to the value produced at the end of the season. Actual indemnities to the farmer depend on (i) evidence of actual loss of yield on property insured, confirmed by an agronomist; and (ii) the residual value of the crop after correcting for the insured field perils. Although the policy design looks quit promising, farmers’ participation is still relatively low.

If farmers do not trade away part of their risks, they cannot move closer to the point of expected profit maximization. The result is less desirable allocation of resources (Myers, 1988) and a likely decrease of the overall efficiency in resource use (Hardaker et al., 1997; Rejda, 1998). Also, farms’ and, ultimately, farm villages’ resilience is likely to decrease (Meuwissen et al., 2001). In this framework this study focuses on the opportunities of innovative crop insurance in Australia. More specifically, the objectives of the study are to elicit Australian farmers’ perceptions on (i) current risk management tools available, and (ii) crop simulation insurance products. Data are gathered through personal interviews with farmers in key wheat-growing areas of Australia.

1.2 Objectives

The two objectives of the study are to:

(1) identify the most important sources of risk perceived by Australian farmers;

(2) assess the current risk management tools of Australian farmers; and

(3) elicit the perception of Australian farmers towards crop simulation insurance (applied for YieldShield).

In order to explore the opportunities of innovative crop insurance in Australia, research is carried out in New South Wales and Queensland states of Australia in the period of November 2009 to February 2010. The objectives of the research are examined through personal interviews with Australian farmers using a questionnaire survey. Similar studies have not been undertaken in Australian context. Therefore, this thesis is set up as an exploratory study. The motivation of this research is to investigate research objectives in a foreign environment, and identify relevant market information for insurers and reinsurers, which has not been studied before.

1.3 Outline of the thesis

After a general introduction and an overview of the Australian agriculture, the thesis follows the order of the objectives presented above. In chapter 2 the major characteristics of the Australian agriculture are discussed. In other words, insight is provided into the risk environment of Australian farmers.

Chapter 3 is concerned with risks and risk sharing. The assessment of on-farm risk management tools, and risk-sharing methods of farmers are discussed also in this chapter. In details, the pros and cons of various types of insurances are elicited and presented in a table.

Chapter 4 provides insight into the various materials used during the thesis. Phases of the work progress are listed alongside with the description of the farmers' perception survey on crop simulation insurance. There are three sections in chapter 4, namely questionnaire design, data gathering and sample description, and data analysis.

In chapter 5 (results), sources of risk, risk management strategies, perception of crop simulation insurance are discussed respectively. The most important risk factors and risk management strategies of Australian farmers are identified and presented. Conclusion and discussion is the last chapter (6) of the thesis. The results are evaluated in the order of the research objectives of the study.

2. Australian agriculture

2.1 Climate[1]

Rainfall can significantly influence the profitability of agricultural production. Being the second driest continent, Australia can be a risky place for farmers. In addition, natural disasters such as droughts are frequent events of Australian agriculture. Adverse weather events may significantly affect the profitability and viability of many farmers. In Australia most resources, production of goods and services by business enterprises are privately owned. Decisions about what to produce and how much to produce are based on information coming out of free, competitive markets. The climate is a significant determinant of agricultural productivity. Australia is unique with regard to its climate. The average (mean) annual rainfall is below 600 millimeters per year over 80 percent of the continent, and below 300 millimeters over 50 percent, making Australia the second driest continent after Antarctica (Australian Bureau of Statistics, 2008). Throughout the thesis, drought is defined as a situation in which rainfall for a region has been at or below the level occurring in the lowest 10 percent of recorded rainfalls for a period of three or more months (Malcolm et al., 1996). Droughts in the past caused severe damages to the Australian economy, for example, after the droughts in 1982-1983 and 1993-1994, both resulted in approximately 20 percent loss in the net value of agricultural production respectively, which caused a fall of about $4 billion (in 1994 Australian dollars) in annual national income.

Four broad climatic types can be classified regarding Australia's agricultural production areas. Based on the amount of rainfall, the time when it falls, the length of growing season and temperature, Malcolm et al. (1996) defines these climatic types: mediterranean, temperate, sub-tropical (wet and dry) and tropical. Mediterranean climate is characterized by wet, mild winters and hot dry summers. In areas with Mediterranean climates, grain production is widespread and there are mainly legume and grass pastures. On the other hand, areas with temperate climates have a relatively even annual distribution of rainfall and lower winter temperatures. Perennial grass-legume pastures are used in these areas. Sub-tropical climate is the third one.

[1] This section is based Malcolm et al., (1996).

The wet sub-tropical regions have reliable summer rainfall and a winter rainfall which varies markedly. In these regions improved tropical grasses, legumes and winter forage crops can be grown. Crops include cereals, oilseeds and cotton. Native pastures are used for grazing sheep and cattle. Finally, the tropical climatic region is characterized by reliable hot wet summers and mild dry winters. Land uses include sugar, horticulture, and cattle, with some cereal and oilseed production. In general, the summers are hot through almost all parts of the country, with average January maximum temperatures exceeding 30 degrees Celsius over most of the mainland. Winters are warm in the north and cooler in the south, with overnight frosts common in inland areas south of the Tropic of Capricorn.

Both rainfall and temperature can significantly fluctuate in parts of the country. Interannual climate variability is associated with the El Niño-Southern Oscillation phenomenon (ENSO). The ENSO cycle refers to the coherent and occasionally extreme year-to-year fluctuations in sea-surface temperatures, convective rainfall, surface air pressure, and atmospheric circulation that occur across the equatorial Pacific Ocean. El Niño and La Niña are the two opposite extremes in the ENSO cycle (DPI, 2009). El Niño is associated with above-average sea-surface temperatures that periodically develop across the east-central equatorial Pacific, while La Niña, the reverse phase of the system, is an anomalous cooling. El Niño events are the major causes of reduction in winter and spring rainfall across much of eastern, northern and southern Australia. This can lead to widespread and severe drought, particularly in eastern Australia, as well as increased daytime temperatures and bushfire risk. On the other hand, La Niña events are generally associated with wetter-than-normal conditions and have contributed to many of the most severe floods. 'The Southern Oscillation Index (SOI) is designed to measure the strength and phase of the Southern Oscillation (DPI, 2009).' In other words, SOI is an index of the pressure differences between Darwin and Tahiti and has been used as an indicator of El Niño events (Australian Bureau of Statistics, 2008). With modern satellite and floating buoy observations, ocean temperature anomalies, both at and below the surface, can be monitored directly. Proxy measurements, such as the SOI, are increasingly important in crop insurance based on crop simulation technology and as a consequence the new Australian insurance product called 'YieldShield' takes into account the different phases of the El Niño events.

2.2 Land[1]

According to figure 2.1, in 2001/02 the total area of land under primary production (livestock grazing, dryland and irrigated agriculture) was nearly 4.7 million square kilometres or 61% of the Australian continent. Livestock grazing on natural vegetation is the dominant land use in arid and semi-arid regions (4.2 million square kilometres or 55%). Nearly 3% (or 229,000 square kilometres) of land is under grazing on modified pastures. About 529,000 square kilometres or 7% of Australia is nature conservation. Forestry is likely to be located in regions of Australia with higher rainfall and covers nearly 2% of the continent. The most intensive use is the built environment, which covers approximately 14,000 square kilometres, or 0.2% of Australia.

Land use	Area (sq. km)	Percent (%)
Nature conservation	529380	6.89
Other protected areas including Indigenous uses	985749	12.82
Minimal use	1169748	15.21
Grazing natural vegetation	4194721	54.56
Production forestry	133064	1.73
Plantation forestry	16879	0.22
Grazing modified pastures	229349	2.98
Dryland cropping	235931	3.07
Dryland horticulture	1165	0.02
Irrigated pastures and cropping	25992	0.34
Irrigated horticulture	4543	0.06
Rural residential	9442	0.12
Urban intensive uses	14031	0.18
Mining	1366	0.02
Water	134869	1.75
No dat	2274	0.03
Total	**7688503**	**100**

Figure 2.1 Land use in Australia (Based on 2001/02 Land Use of Australia, Version 3, Bureau of Rural Sciences. Source: Australian Collaborative Land Use Mapping Programme)

Considering the entire globe, the amount of land that is available for arable agriculture is very substantial. Compared to other parts of the world, the amount of highly useful agricultural land per person is large due to the relatively small population. In fact, Australia is second in line with 218,972.404 sq. km per 1,000 people (NationMaster, 2009).

[1] This section is based Malcolm et al., (1996).

2.3 Agricultural production[1]

As mentioned in the previous chapter, the amount of land that is available for arable agriculture is a very substantial area from a global perspective. In Australia private ownership is dominant in resource ownership, production of goods and services by business enterprises. Management decisions are based on information coming out of free, competitive markets. Australia's agricultural activities are located in three major zones, namely, high rainfall, wheat-sheep and pastoral zones. There are some additional sectors within these zones. The following groupings were defined by Davidson (1981):

(i) High-rainfall zone

- Sheep-beef sector (high-rainfall sheep)
- Dairy sector

(ii) Wheat-sheep zone

(iii) Pastoral zone

- Northern pastoral sector (beef)
- Southern pastoral sector (sheep-beef)

Within these zones defined above, the following activities are located:

(iv) Sugar cane

(v) Irrigation

- Crops
- Fruit
- Vegetables

(vi) Pigs

(vii) Poultry

(i) The high-rainfall zone receives the highest rainfall of Australia's agricultural areas, with an annual average over 500 millimeters. The coastal lands and adjacent tables in Victoria, New South Wales (NSW) and Queensland, small parts of south-eastern SA and south-western WA, and the whole of Tasmania belong to the high-rainfall zone. This zone is used mainly for grazing based on improved pastures and high stocking rates per hectare, with some broad acre cropping. In each state the dairy industry is located in the high-rainfall zone.

[1] This section is based Malcolm et al., (1996).

(ii) The wheat-sheep zone is the second most important zone of agricultural production. The climatic and topographic conditions suit regular cropping accompanied by sheep or beef grazing. Although, the wheat-sheep zone occupies only 11 % of the total land that is used for cropping or producing sheep and cattle, approximately 33 % of Australia's agricultural output is realized in this region, including almost all the wheat grown. Nearly 75 % of the farmers produce sheep, wheat and barley in crop rotation with grain legumes, pulses, and oilseeds. About half of the Australian sheep flock is located in the wheat-sheep zone.

(iii)The pastoral zone includes the arid and semi-arid areas of Australia. Low rainfall is a characteristic of this zone. The main land is used to graze native pastures at low stocking rates on large areas. There are nearly 5000 pastoral properties in the pastoral zone, producing about 15 % of the gross value of annual cattle production and around 8 % of the gross value of wool production.

Each state has varying climatic and topographic conditions. These conditions determine the types of farming that can be undertaken in different areas. The number of cereal growers is spread fairly evenly between the southern mainland states. Nearly all mixed sheep-cereal growers are in NSW, Victoria, SA and WA, most beef producers are in NSW, Victoria and Queensland. The largest numbers of pig producers are in NSW and Queensland, while the major share of the poultry industry is in NSW. Queensland has the most vegetable producers, though significant vegetable production takes place in every state. The sugar industry is nearly entirely located in Queensland. Cotton is grown in NSW and Queensland. Grain is grown in all Australian states, but primarily in a narrow crescent running through the mainland states, known as the wheat belt. This area stretches in a curve from central Queensland, through NSW, Victoria and southern SA. In WA, the wheat belt continues around the south-west of the state and some way north up to the western side of the continent (Australian Wheat Board, 2009).

2.4 Risks in Australian agriculture

In general, major risky events in agriculture include droughts, market collapses, government rulings, flood, fire disease, plague and pestilence, input shortages or failures, input price rises, mechanical failures, marketing disruptions and product losses, and farm-family accidents and illnesses. Timing of planting, crop yield and quality may be affected by such risks. As a group they are also very sensitive to crop pricing movements because of factors such as currency fluctuations, production in other parts of the world and general demand for crops. Australian farmers need to face a rather competitive market, where the values of their farms and the incomes produced are exposed. A crop insurance providing coverage for additional perils apart from hail and fire could soften these downside issues, increasing the farmers' effectiveness. Such product could contribute to the enhancement of farmers' risk management options (Ernst&Young, 2000).

Hammer et al. (1987) argue that high rainfall variability is the major source of dryland wheat yield fluctuations in several regions in Australia. Wheat production in Australia is dominantly rain-fed, which is likely to increase the importance of water stress throughout the continent. As discussed earlier, droughts can cause severe problems to farmers, for example, in Germany the 2003 drought totaled a 1.3 billion euros loss causing enormous setback to the German agriculture. Natural hedging refers to increased prices of agricultural products in the event of a bad harvest as a result of the negative correlation between supply and demand. This "natural" compensation moderated the extent of damage for many German farmers in 2003. However, according to the development of prices in 2008, a poor harvest is not likely to be compensated by higher product prices as a consequence of scarcer quantities of agricultural production (Schwarz, 2009). It is also important to note that a poor harvest cannot only refer to a reduction in quantity, but also in quality. Depending on the futures contracts, a farmer has to deliver certain quality in order to get the price previously agreed on. In severe times, the farmer might need to buy wheat for spot price, because the farmer is obliged to deliver the contracted amount of wheat of a certain quality. Therefore, single-handedly increased agricultural product price is unlikely to tackle the severe losses arising from a poor harvest.

Furthermore, others argue that crop variability is chiefly affected by climate variability for both temporal (Nix, 1975) and spatial (Potgieter et al., 2002) dimensions in Australia. Both rainfall and temperature can significantly fluctuate in parts of the country. Interannual climate variability is associated with the El Niño-Southern Oscillation phenomenon. Yields from grain crops can be influenced by several factors. The interaction of a set of limiting factors may affect the final outcome of crops. Genetic factors, environmental factors, and crop management factors are likely to be significant determinants of crop productivity. Genetic factors include ears per square meter, spikelets per ear, grains per spikelet, weight of individual grains. Environmental factors are mainly water availability, nutrients, temperature, and light. Fertilizers, irrigation availability, weed management, and pest management form the third group of limiting factors, namely, the crop management factors. Water deficiency detains the development of different yield components. For example, at the time of spikelet development water deficiency can reduce spikelet number and size, which in severe conditions can lead to significant reduction in grain yield. Water stress and/or high temperature can seriously reduce floret production and survival before anthesis (period crop is fully in flower) in a 2-3 weeks critical period. This can greatly reduce the grain numbers per spikelet. Another problem is soil moisture stress, which during anthesis and grain growth leads to fast leaf senescence, slow photosynthesis and often reduced grain size. Excessive water can also cause crop loss by the depletion of oxygen, which brings after reduced root respiration and the failure of some vital plant processes. The combination of these factors can cause significant yield losses, which is likely to indicate the development of insurance products covering a combination of perils.

2.5 Government policies

According to the severity and frequency of drought events the Australian Government offers drought assistance for farmers, their families, rural communities and certain small businesses. Table 2.1 integrates several types of exceptional circumstance assistance measures provided by the Australian Government and other organizations. Exit grants up to $150,000 are available for farmers, who suffered drought conditions for several years and intend to give up farming. Personal income support and interest rate subsidies are also offered. Irrigators and dryland farmers in the Murray-Darling Basin can apply for support if their water allocations reduced. Professional advice is available for drought affected farmers, which is supported by grants of up to $5500. Tax relief is also a possibility to help farmers affected by droughts. Apart from the listed measure, other financial, personal, and business assistance measures are available for farmers to provide support for farming families during droughts. This can include supplying information about support and assistance available (Department of Agriculture, Fisheries and Forestry of the Australian Government, 2010).

Table 2.1: Exceptional Circumstances assistance measures[1]

	Explanation
Exit Grants	Assist farmers, who have endured severe drought conditions for several years and are considering their options outside farming up to $150,000
Income Support	Offers personal income support payments
Interest Rate Subsidies	Supports farms and small business
Support for farmers in the Murray-Darling Basin	Supports irrigators and dryland farmers in the Murray-Darling Basin that have been affected by reduced water allocations
Support for Small Businesses	Income and business support for eligible small businesses in exceptional circumstances
Professional Advice and Planning Grants	Supports drought affected farm businesses with grants of up to $5500 (GST inclusive) to access professional business and financial planning advice
Farm Management Deposits	Offers a financial risk management tool for farmers to help smooth the uneven income streams that are common in agriculture due to climate and market variability
Tax Relief	Special taxation measures and concessions available to farmers affected by drought

[1]Retrieved from the Department of Agriculture, Fisheries and Forestry of the Australian Government, 2010.

3. RISK MANAGEMENT

3.1 Introduction to sources of risk

Weather variability and natural disasters can lead to high variability in crop yields. Insurance can be an efficient risk management tool to cover the losses arising from yield variability (Roberts, 2005). The primary target of innovative crop insurances is to tackle the traditional problems of agricultural insurance, namely moral hazard, adverse selection, high transaction costs, and the problem of systemic climatic risks (Kang, 2007). Throughout the thesis, risk is defined as exposure to the chance of loss, particularly the degree of likelihood of such loss (Dictionary.com, 2010). Farmers face different types of risks. In agricultural production farmers expect a potential yield, with which they could achieve their financial goals. Variability in outcome according to the unpredictable nature of the weather and the uncertainty about the performance of crops or livestock makes production uncertain. This uncertainty in production is called production risk (Crop insurance education for Wyoming's beginning producers, 2010). Furthermore, price risks refer to the probability of loss from the unpredictable movement in the market price of inputs and outputs. Institutional risk integrates uncertain effects of legislation and market regulation imposed by governments. Farmers may themselves be a source of risk depending on their health status and management competence concerning crop cultivation, rearing of livestock and maintenance of machinery. These risks may be called human risks. Business risk, as an aggregate term, incorporates production, price, institutional and personal risk. Financial risk refers to the risk coming from uncertain consequences as a result of unpredictable effects of how a farm is financed. Income risk refers to unpredicted income fluctuations. In agriculture any unforeseen changes are likely to influence foreseeable income fluctuations, which means that in practice income risk might be identified as income variability (Bardsley et al., 1987).

3.2 Risk management strategies

On-farm risk management strategies[1]

On-farm management strategies can be used to avoid or moderate the impact of undesirable events (downside risk). Risk avoidance and risk mitigation are two important strategies. Risk avoidance refers to reducing or eliminating the possibility of events, which may have unfavorable consequences. Many accidents can be avoided by using preventive measures. When using risk avoidance strategy, one needs to assess the potential risks faced and outline measures to avoid or minimize their occurrence. Risk mitigation is concerned with salvage, and measures dealing with negative outcomes when they occur. With regard to risks which can be foreseen, it is preferred to have contingency plans in place and the means for implementing those plans. Risk mitigation can be closely related to quality control. Both risk avoidance and risk mitigation are based on the proposition that major risks can be defined and prepared for. However, undesirable events can occur at any time. Planning itself seems insufficient to face these risks. Precautionary strategies may be used if the information about a risk is incomplete. Collecting information can be considered an investment, which may reduce downside risk. In agriculture collecting information about more productive technology options and about marketing opportunities and market trends can have substantial playoff. Selecting less risky technologies is another tool of the farmers to increase utility. Some farming activities realize more and stable incomes over time than others. To illustrate, intensive livestock production seems more stable than extensive grazing in terms of levels of production achieved. The same commodity can be produced either relatively more or less risky ways, and farmers can decide which way they want to produce. The concept of diversification is to reduce the variability of the overall return by undertaking a set of activities that have net returns with low or negative correlations. A higher degree of risk aversion brings after a higher level of diversification. Unfortunately, the advantages of specialization are decreasing as the farmers diversify more. Flexibility is concerned with the way how the farming business can adjust to changes.

[1]This chapter is based on Hardaker et al., 1997.

Greater flexibility refers to better possibilities to respond to undesirable events and to take advantage of potential opportunities that occur. Flexibility can be further specified into asset, product, market, cost and time flexibility. Asset flexibility means investing in assets that have more than one use. Similarly, product flexibility refers to products that have more than one use. Market flexibility is related to product flexibility, and means that a product can be sold in different markets that may not be subject to the same risk. Cost flexibility means organizing production in a way that fixed costs are kept low, and incurring higher variable costs as necessary. Finally, time flexibility reflects the speed with which adjustments to the farming operations can be made. Further strategies may include producing at lowest possible costs, increasing solvency ratio, off-farm investment, and off-farm employment.

Risk sharing

Risk sharing is based on the principle that in return for sharing part of the risk, a risk-taker receives a premium paid by the other party who wants to trade away part its risk. Pooling is the key concept behind risk sharing, whereby combining independent (uncorrelated) losses in a pool, the expected amount of losses stays the same, but variance decreases. The amount of risk that can be reduced through pooling arrangements increases with the growing number of participants, all other factors being held constant. In contrast if the correlation in losses across participants increases, the amount of risk that can be reduced decreases, all other factors being held constant (Harrington and Niehaus, 1999). Furthermore, sharing risks in the form of insurance can increase a farmer's utility. If farmers do not trade away part of their risks, they cannot move closer to the point of expected profit maximization, the result is less desirable allocation of resources (Myers, 1988). Similarly, if farmers need to maintain putting a certain level of effort into on-farm methods of avoiding risks, the overall efficiency in resource use may decrease (Rejda, 1998).

Examples of risk sharing strategies:

There can significant differences between different risk sharing tools with regard to the types of risk shared. Examples of major risk sharing strategies for farmers are the following:

(i) Marketing contracts. In terms of a marketing contract, a buyer and a producer set a price and/or outlet for a commodity before harvest or before the commodity is ready to be marketed in a form of an agreement. The producer takes responsibility for management decisions during the production process entirely. Fixed forward price contract is the most commonly used marketing contract, with which farmers can fully eliminate the price risk. However, other types of marketing contracts also contribute to sharing the price risk between the buyer and the seller of the contract (Harwood et al., 1999).

(ii) Financial leverage. Financial leverage is the use of credit and other fixed obligation financing relative to the use of equity capital (Robison and Barry, 1987). Financial businesses that are lending their money pool the risk of loan defaults over many clients.

(iii) Trading in commodity derivatives. With regard to trading derivatives, the price risks for both future inputs and future outputs can be reduced. Hedging on the futures market is rather similar to forward selling on contract, but there are a number of differences. Futures contracts are standardized, widely traded contracts. Therefore, prices are more competitively determined than for a specific contract between a single farmer and a single merchant. The other type of strategy is option trading to reduce price risk. An option is a contract giving the buyer the right, but not the obligation to buy or sell the underlying asset at a specific price on or before a certain date.

(iv) External equity financing. Investors receive a share of the returns of the firm in which they invested equity (Lowenberg-DeBoer et al., 1989). Equity investors pool the risk of low or negative returns over a diversified portfolio.

(v) Insurance. The principle of insurance as a risk sharing tool is that, by receiving appropriate premiums from a significant amount of clients, the insurer is able to pool the risks. The insurer aims to set such premiums that will enable the company to pay all indemnities from the aggregate contributed premiums, and still leave a margin for operating costs and profit.

3.3 Farmers' perception

Table 3.1 shows an overview of farmers' perception of risk management strategies in different countries. Three studies were carried out in Spain, in the Netherlands and in Norway respectively. In the table several types of strategies are listed; the numbers show the ranks of the risk management tools based on farmers' perception. Insurance in general is perceived to be important when managing farming risk. Business and personal insurance are likely to be key risk management strategies; avoiding credit seems to be a significant tool as well. Farmers indicated that holding financial reserves is more preferred to diversification.

Table 3.1: Rank of risk management strategies perceived by farmers[1], 1 (the most preferred), 5 (the least preferred).

Risk management strategies	The Netherlands (Meuwissen et al., 2001)	Norway (Lien et al., 2003)	Spain (Palinkas and Szekely, 2008)
Diversification	5	5	5
Off-farm investments	4	-	-
Property insurance	-	-	3
Avoiding credit	-	4	2
Holding financial reserves	3	1	4
Business insurance	1	2	1
Personal insurance	2	3	-

[1]Derived from Meuwissen et al., 2001; Lien et al., 2003; Palinkas and Szekely, 2008.

3.4 Crop insurance

The key principles of conventional insurance are that farmers pay a premium and receive an indemnity after an insured loss occurs (after loss adjustment and correction for deductibles, if any). If provided, conventional insurance seems to be a relatively popular risk management instrument. It however faces several difficulties, such as with *asymmetric information*. If a pool consists of large numbers of independent risks, the party who pools the risk may be able to estimate average losses and so the amount of money (e.g. an insurance premium) needed for dealing with these losses. Asymmetric information between the risk-sharing parties (such as between insurer and insured), however, can lead to established premiums being insufficient to cover the losses (Harrington and Niehaus, 1999). Asymmetric information includes moral hazard and adverse selection. In insurance, adverse selection means that exposure units most at risk buy more insurance than others but the extent to which this happens is not known a priori to the insurer. With moral hazard, insured entities change their behavior after having bought insurance in a manner not predicted by the insurer (e.g. by becoming more careless) (Arrow, 1996). Another difficulty relates to *systemic risks*. Pooling independent risks reduces the variance of losses. But if systemic (i.e. positively correlated) risks are pooled, the variance of losses decreases less. In pooling completely systemic risks, variance does not decrease at all (Harrington and Niehaus, 1999). Risks that are completely systemic, such as prices and interest rates, generally cannot be commercially insured but can be efficiently dealt with on exchange markets, e.g. by use of futures. Risks that are not completely independent nor completely systemic, the so-called ‘in-between risks’, (Skees and Barnett, 1999) are more problematical. Examples include droughts affecting crop yields over a substantial area and widespread epidemics of livestock diseases. Organizations that pool such risks face higher costs of pooling because of the need to hold substantial reserves in case systemic events occur (Doherty, 1997).

In contrast to conventional insurance, index-based products are financial instruments that make payments based on realizations of an underlying index relative to a pre-specified threshold (Barnett et al., 2008). The underlying index is a transparent and objectively measured random variable. Examples include area average crop yields, area average crop revenues, cumulative rainfall, cumulative temperature, flood levels, sustained wind speeds, and Richter-scale measures. Some highly standardized index-based products are actively traded in secondary markets. However they are mostly customized to fit the specific risk management needs of the purchaser. Index-insurance schemes have a number of advantages, but also disadvantages, relative to conventional insurance. These are summarized in Table 3.2.

Crop simulation insurance, such as the one provided in Australia, is a product that is somewhat in between conventional insurance and index-based insurance. For instance, payments are triggered “off-farm”, i.e. by a simulation model, comparable to index schemes. Loss adjustment on the other hand is done on farm, as with conventional insurance. Pros and cons are listed in Table 3.2 as well.

Table 3.2: Pros and cons of various types of insurance.

	Conventional insurance	Index insurance[1]	Crop simulation insurance
Pros	- Applicable to a wider range of situations than index insurance, as it can cover all risks where losses are involved. - Actuarial procedures for indemnity-based schemes are well established and thus schemes should be easy to run. - As claims are paid by assessing losses directly, there is no issue of basis risk.	- No problem of moral hazard as the behavior of the client does not influence the pay-out. - No problem of adverse selection as pay-out is independent of losses. - No need to assess claims so lower transaction/overhead costs. - Pay-outs can be rapid because claims are verified easily through the index rather than assessment of losses. - Policies can be sold as standard packages.	- Lower transaction costs and less problems of asymmetric information compared to conventional insurance because of use of simulation model - Less basis risk in triggering payments compared to index insurance because of ability to capture local heterogeneity
Cons	- Moral hazard is an issue unless there are deductions built into the premium for risk reduction. - Adverse selection can occur with voluntary schemes, in particular if there is asymmetric information and the client knows more about their risk than the insurer. - Transaction costs and overheads are high because of the need to assess losses. - The loss assessment process can be time-consuming, leading to slower pay-out of indemnities. - Difficulties to deal with systemic risks	- Basis risk, where correlation between payouts and losses breaks down and payment occurs without losses, or *vice versa.* - Historical data needed to create the index, but this may not be an accurate predictor of future conditions. - Needs a relatively homogenous area to ensure that losses correlate to the index. - Relatively difficult to understand, therefore low uptake[2]	- Need for continuously updating integrated agrometereological simulation models - Slower pay-outs than with index-insurance because of required farm visit - Relatively new product, therefore not much experience

[1]Derived from among others Skees et al., 1999; Miranda and Vedenov, 2001; Skees et al., 2006; and Angelucci, et al., 2008.

[2]Especially in developing countries. Discontinued index programs can be found in Ethiopia, Marocco and Malawi. Little uptake was not the only reason for discontinuation.

Table 3.2 illustrates that all three types of insurance have some potential problems. As a result, various authors propose combinations of products. For instance, to "combine the best of conventional and index insurance", Skees et al. (2006) suggested to develop "*blended products*" in which (i) the systemic risk is covered by index-products deployed by governments, reinsurers or banks; and (ii) the idiosyncratic part of risk is covered by conventional insurance products sold by local companies. The index-based livestock insurance in Mongolia, covering herders when livestock losses at the regional scale exceed a certain trigger point, is an example of such a blended product (Skees et al., 2008). As crop simulation insurance is a relatively new product, no such experience does yet exist.

3.5 YieldShield

This concept combines traditional hail and fire insurance with waters stress cover. The main difference from conventional insurance is in the loss assessment procedure. The loss assessment of traditional field perils is carried out similarly to conventional crop insurance. Loss, arising from water stress, however, is triggered off-farm, using a crop simulation model. In order to have a claim, the model must show a yield loss, retrieved from the difference of the modeled start of season yield average and the end of season average. Another requirement for a claim is to demonstrate on-farm yield loss as a direct consequence of water stress. An appointed agronomist must confirm the on-farm loss. The simulation model underlying the YieldShield product is called the Oz-Wheat crop simulation model, which was developed by the Agricultural Production System Research Unit (APSRU) (Figure 3.3). ASPRU is a government entity in Australia, which is a joined venture between the Queensland State Government and the Commonwealth Scientific and Industrial Research Organization (CSIRO). APSRU is responsible for administering the crop model and providing the simulated yields.

The Oz-Wheat model integrates (i) a simple agro-climatic wheat stress index (SI) model, which takes into consideration a water deficit or surplus (ii) historical climate data and (iii) broad crop phenology and crop management practices. Model outputs, in other words SI, are generated at point scale which is then aggregated to create a shire scale index. In order to account for the influence of the winter fallow on starting soil moisture conditions, APSRU runs the model from 1 October the year before sowing. For each shire, the model input parameters such as plant available water content, planting rain and stress index period are selected on the best fit of the model when trained against actual shire wheat yields from the Australian Bureau of Statistics (ABS) for the period 1975 - 1999. Model parameters are derived for 253 shires within the main wheat crop producing region of Australia. The shire scale SI value is converted into yield per unit area applying the final optimized regression model for each shire. The model incorporates the main wheat producing shires in Australia. These shires give approximately 90% of total average wheat production within the broad winter cropping region of Australia. There are altogether 253 wheat shires containing 907 long-term unique climate stations within this region (Figure 3.3).

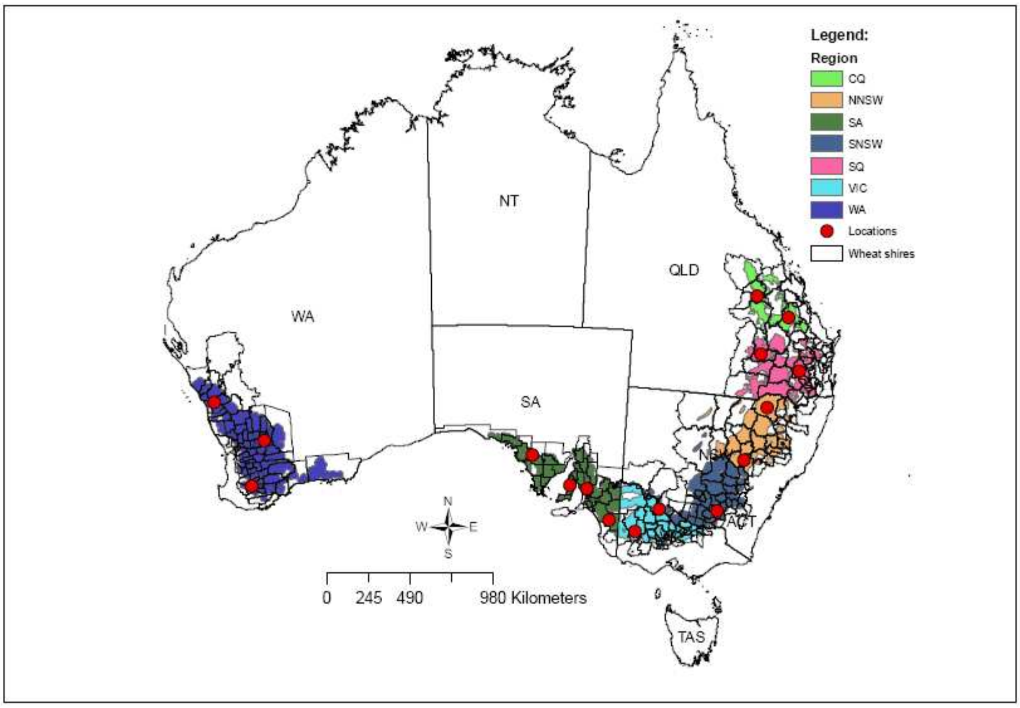

Figure 3.3 The broad winter cropping region of Australia[1]

In other words, Oz-Wheat is a simple agroclimatic model integrating (i) a daily water balance routine during fallow and crop growth periods, (ii) actual climate and (iii) crop specific parameters to come up with a final water limited stress index value. Spatial variability of rainfall, crop cultivar, crop phenology, plant available water and timing of planting rainfall within a shire is selected through a calibration process which optimizes the best linear fit between predicted and observed shire scale wheat yields in the period of 1975 to 1999 period.

[1]The broad winter cropping region of Australia (filled areas), showing distinct agronomic regions (legend classes) and the geographic locations (red dots) used to generate crop coefficients using the APSIM model (Primacy, 2009).

A linear regression fit is applied to transform shire stress index value into a shire wheat yield value (Potgieter et al., 2006). Additional variables which account for technology trend and water logging are also included, and showed significant increase in correlation coefficients across the wheat belt.

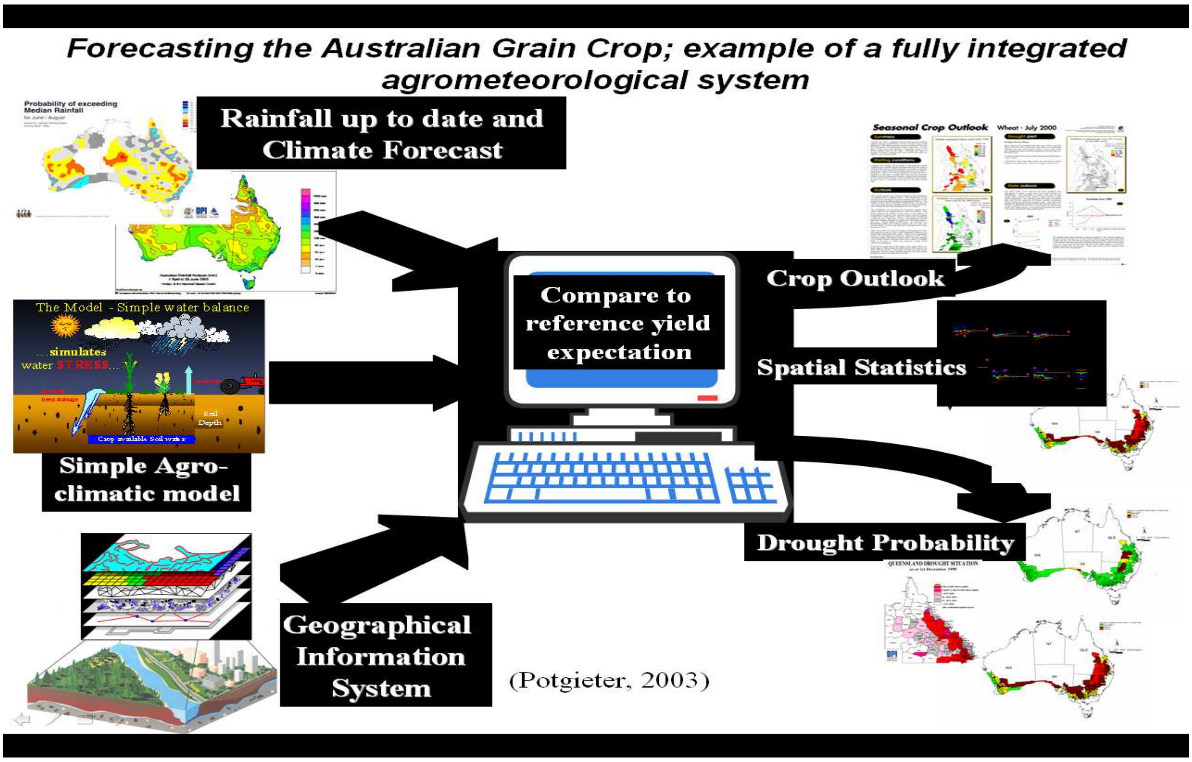

Figure 3.3: Example of a fully integrated agrometeorological system (source: Potgieter et al., 2003)

During the interviews crop simulation insurance was well perceived by farmers in the aspect that it aims to assist farmers to cope with waters stress, one of the greatest sources of risk in Australian farming. Farmers showed interest in receiving more information about the product and the ability to follow monthly yield simulations via internet. Respondents indicated that the product is likely to be complicated, especially the modeling component. The distance between particular weather stations and the particular location of farms seemed to be one of the biggest concerns, which shows a general misunderstanding about how the model works, confusing point scale and shire scale modeling. Price was perceived to be relatively high compared to conventional insurance.

4. Materials and methods

4.1 Questionnaire design

The goal of the questionnaire was to assess sources of risk, risk management tools applied on-farm and off-farm, and elicit the perception of farmers towards crop simulation insurance. There are four sections in the questionnaire, and the issues addressed are the following: structural characteristics of the farms, currently used on-farm and risk-sharing management tools, general knowledge and potential up-take of crop simulation insurance products, and a number of personal questions. Most questions were closed questions, the questionnaire included 31 questions.

Farmers' perception of sources of risk, risk management strategies and crop simulation insurance products is measured on Likert-scales ranging from 1 to 5. Motivating factors, on which farmers base their decisions when buying crop insurance, were ranked from 1 (most important) to 12 (least important). Likert-scale is a type of composite measure. It uses standardized response categories (e.g. 1 to 5) in survey questionnaires. In general to construct a composite measure a group of questions with response categories such as strongly agree, agree, disagree, and strongly disagree are applied (Bureau of Justice Assistance, 2010).

Question 25 offers 7 product profiles to farmers, farmers' preference is measured on a 1 to 7 Likert-scale, where 1 means the most preferred and 7 refers to the least preferred profile. The profiles are combinations of different attribute levels, which are presented in Table 4.1. In the first column of the table the 3 attributes are shown, the second column contains the different levels of attribute levels. To preserve orthogonality there can be no correlation among the levels of an attribute (Hair et al., 1992). From the 7 attribute levels 12 possible combinations (3x2x2=12) were generated in the orthogonal design by SPSS. Each profile contains one level form each attribute. 5 profiles were ruled out because these were regarded not viable by Primacy, the owner of YieldShield. The remaining 7 profiles can be found in the questionnaire (Appendix).

Table 4.1: Attributes and levels of attributes to design product profiles

Attributes	Attribute levels
Risks covered	· Hail
	· Water stress excluding hail
	· Hail and water stress
Premium based on	· Historical data
	· Yield simulation model
Loss assessment method	· Detailed farm visit
	· Modelling outcomes and quick farm visit

4.2 Data gathering procedure and sample description

In the period November 2009 up to February 2010 a structured survey was undertaken in the form of personal interviews. 60 farmers, all of them engaged in dryland wheat production, were contacted by email, with which a YieldShield brochure was sent in order to ensure that farmers have an adequate level of knowledge about crop simulation insurance. These farmers are clients of Agririsk Services, a licensed company for broking YieldShield. Later, farmers received a phone call and an appointment was made for the interview. Farmers were selected from the New South Wales and Queensland wheat-growing areas. Two farmers from Western Australia and one from Victoria were interviewed, which is likely to make the research more representative. Sophisticated, large scale farmers were targeted, which is in line with the target group of crop simulation insurance identified by Primacy, the owner of YieldShield. In other words, results were retrieved from mostly well educated, large scale farmers, who represent the target group of farmers for Primacy, who are expected to understand and purchase the product. Therefore, the sample is not completely representative for an average Australian broadacre farmer, but it is likely to be adequate with regard to this research. Before visiting the farmers, the questionnaire was discussed with insurers, reinsurers and insurance brokers in a period of two weeks. After each discussion, the questions were rephrased and improved based on the suggestions. During the research period 44 personal interviews were carried out from the contacted 60 farmers.

Table 4.2 shows that the average land size of farmers is 5576 hectares compared to the Australian average broadacre farmer having 4100 hectares. Farmers in the research indicated that they use 46.24% of their land for dryland wheat production, while an average broadacre farmer produces dryland wheat on 9.21% of the total land capacity. Respondents seem to have bigger farms, and utilize a bigger share of their lands for wheat production than an average broadacre farmer. Yield averages also differ; respondents are likely to have higher yield averages compared to the overall Australian average. According to the table, from the 44 interviewed farmers, more than 52% of them have a turnover exceeding $1 million. On average, risk involved in farming is perceived to be medium or relatively high.

Table 4.2: Farm characteristics, organizational form, socioeconomic factors of farmers, years, mean, standard deviation, percentages (n=43).

	Mean or percent	**Standard deviation**
Farm characteristics		
• Average broadacre farm size (ha)	4100	-
• Farm size (ha)	5576.31	6185.77
• Land Area owned (%)	82.46	28.51
• Dryland Wheat Growing Area/ average broadacre farm (%)	9.21	-
• Dryland Wheat Growing Area/farm (%)	46.24	26.47
• Perceived risk of farming (1 - low; 5 - high risk)	3.52	0.93
• Average yield (t/ha)	1.6	-
• 0 - 1 ton/ha in 10 years (number of years)	1.66	1.87
• 1 - 2 ton/ha in 10 years (number of years)	3.3	2
• 2 - 3 ton/ha in 10 years (number of years)	3.55	2.53
• 3 - 4 ton/ha in 10 years (number of years)	0.8	1.34
• Yield fluctuation in the last 3 years (3 refers to 40%)	2.89	1.13
Organizational form		
• Family farm/broadacre farms in Australia (%)	95.6	-
• Farmers with more than $501k annual turnover (%)	81.8	-
• Corporation (%)	4.5	-
• Partnership (%)	20.5	-
• Privately owned (%)	63.6	-
• Share farmer (%)	2.3	-
• Other (%)	9.1	-
Socioeconomic factors		
• Broadacre farmers average age (years)	50.3	-
• Less than 20 years (%)	2.3	-
• 21-35 years (%)	25.6	-
• 36-50 years (%)	37.2	-
• Over 50 years (%)	34.9	-
• Male (%)	93	-
• Female (%)	7	-
• Tertiary education among broadacre farmers (%)	8.8	-
• Tertiary education of the farmer from agronomics (%)	14	-
• Tertiary education of the farmer from agriculture (%)	56	-
• Tertiary education of the farmer from economics (%)	21	-
• Tertiary education of the farmer from science (%)	9	-
• 2 or less persons (%) in household	44.2	-
• 3 to 5 persons (%) in household	53.5	-
• over 5 persons (%) in household	2.3	-

Retrieved from ABARE conference paper 02.12 and 09.16, ABS Year Book of Australia, 2006 - 1301.0.

With regard to farm organizational forms, 95.6% of broadacre farms are family farms in Australia, farmers interviewed during the research indicated that 63.6% privately own their, which can also be considered as family farms. 20.5% of respondents in the research work in partnership; 4.5% of the farms are corporations.

Socioeconomic factors of farmers are also presented in the table. An average broadacre farmer is approximately 50.3 years old, meanwhile the majority of farmers in the research are either between 36 to 50 or over 50 years old; 25.6% of them are between the 21 to 36 age category. The majority of respondents are male (93%). There were only a few farmers in the research who had no tertiary education; on the other hand some farmers had tertiary education in more than one field. There seems to be a significant difference in tertiary education between respondents and average broadacre farmers (8.8%). It might be concluded that farmers in the research generally younger, better educated than the average broadacre farmer with relatively high farm turnover, and higher average yields. This supports the statement that the research is not completely representative for an average farmer, but can help insurers and reinsurers understand the perception of farmers, who they intend to target with crop simulation insurance.

4.3 Data analysis

Descriptive analysis was used to study farmers' perception of sources of risk, risk management strategies and crop simulation insurance. The number of risk management strategies and sources of risk was reduced by factor analysis. Perception is a latent variable, because it cannot be measured directly. However, it is possible to measure different aspects of perception, for example attitude, trust and willingness to buy. After the measurements are done, it is necessary to find out whether the measured variables really reflect the underlying variable. Therefore, factor analysis can be used to identify groups of variables. Investigating several variables, the correlation between all variable pairs can be incorporated into an R-matrix, which is a table of correlation coefficients between variables. If there are groups of large correlations between subsets of variables it is likely that those variables could be measuring aspects of the same underlying variable. Such underlying dimensions are called factors (latent variables). By explaining the maximum amount of common variance in a correlation matrix using the smallest number of explanatory concepts it is possible with the use of factor analysis to reduce the data set from a group of interrelated variables into a smaller set of factors. After identifying factors one can measure to what degree variables load onto these factors. Factor loadings might be explained as a type of correlation between the variable and a factor. Taking the square of the factor loading one can measure the substantive importance of a variable to a factor. The eigenvalues of a factor are the indicators of the substantive importance of the underlying factor. Factor rotation can be used to make interpretation of substantive importance less difficult. Orthogonal or oblique rotation is available for the researcher. Varimax rotation is one of the three orthogonal type rotations available in SPSS. Varimax attempts to load a smaller number of variables highly onto each factor to obtain groups of factors, which are easier to interpret (Field, 2005). While conducting the factor analysis it was assumed that standard parametric statistical procedures are appropriate for ordinal variables in the form of Likert-type scales.

One sample t-test was applied to measure the significance between the means of scores with regard to the perception of source of risk, risk management strategies, and motivating factors for buying insurance. Applying one sample t-test it is possible to test whether a sample mean (of a normally distributed interval variable) is significantly different from an expected value (usually the population mean). One can conclude whether there is a significant difference between the sample mean and the hypothesized value (test value) checking the significance value of the output in SPSS. Means are significantly different if the significance value is less than or equal to 0.05.

Conjoint analysis was applied to elicit farmers' perception towards the 7 product profiles, presented in the questionnaire. During the conjoint analysis, utility scores of the attribute levels and the relative importance of the attributes were estimated. Applying conjoint analysis the evaluation of complex products is possible without interfering with the realistic decision context of the respondent. By evaluating only a few product profiles, which are combinations of product levels, the assessment of the importance of attributes as well as the levels of each attribute can be carried out. Having the consumer perception evaluation completed, the results of the conjoint analysis can be used in product design simulators, which demonstrates consumer acceptance for each potential product formulations and help designing the optimal product (Hair et al., 1992).

In order to identify difference between groups of farmers, an independent sample t-test was carried out. The independent t-test investigates the difference between the overall means of the two samples (groups) and compares them to the expected difference.

The equation is the following:

$$t = \frac{(\overline{X}_1 - \overline{X}_2) - (\mu_1 - \mu_2)}{\text{estimate of the standard error}}$$

, where

t = the mean difference of the two groups compared to the expected difference

$\overline{X}_1$ = the mean of the first group

$\overline{X}_2$ = the mean of the second group

μ_1 = the estimated mean of the first group

μ_2 = the estimated mean of the second group

Two groups were generated based on the general attitude towards crop simulation insurance, which was retrieved from the scores given to the question how farmers feel about crop simulation insurance. Farmers with scores 4 and 5 were assumed to be positive and those with score 1, 2 and 3 were assumed to have negative attitude towards the concept. Therefore, the two groups were named positive and negative. ‘0’ was assigned to the positive group and ‘1’ to the negative group to make the interpretation of the groups easier. After running the test, there were 17 farmers in the positive group and 27 in the negative group.

The t-test revealed significant difference with significance values less than 0.05. Equal variances were assumed, where the significance (p value) of Levene's test was greater than 0.05. On the other hand equal variances were not assumed, were the significance (p value) of Levene's test was less than 0.05. Levene's test for equality of variances indicates whether an assumption of the t-test has been met. One of the assumptions of the t-test is that the variability of each group is approximately equal. In those cases when this assumption is not met, a special form of the t-test should be used. When the significance (p value) of Levene's test is less than or equal to the α level for the test (0.05), then one can reject the null hypothesis that the variability of the two groups is equal. Therefore, the variances are unequal, and the bottom row of the output of SPSS ("Equal variances not assumed") should be used. If the p value is greater than the α level, then the middle row of the SPSS output ("Equal variances assumed") should be used (Field, 2005).

Non-parametric test was used to examine the interrelationship between yes or no questions. More specifically, Spearman rank-order correlation coefficient was calculated, which is a method for determining the correlation between two variables, which are reduced to an ordinal scale. ρ (rho) was calculated with the following equation:

$$\rho = 1 - (6\Sigma D2\ )/\ [N(N2 - 1)]$$

, where

D = the difference between the rank position of each case on X and Y.
N = the number of paired observations, cases.

Assumptions:

- The two variables are ordinal or metric variables that have been reduced to an ordinal scale of measurement,
- The correlation between the variables is linear, and
- If a test of significance is applied, the sample has been selected randomly from the population (Sam Houston State University, 2010).

All analysis was undertaken using SPSS for Windows (v 15.0).

5. Results

5.1 Sources of risk

In the beginning 18 sources of risk were examined. 7 were natural, 6 man-made and 5 defined as pest and disease risks. Table 5.1 shows the average scores for risk sources, which are derived from the scores given for the answers regarding the perception of farmers towards each source of risk. The standard deviations for each score are in the second column of the table. According to the table, commodity price and droughts are perceived to be the most important sources of risk. With regard to commodity price, the standard deviation is 0.69 indicating that respondents were consistent. The volatility and competitive nature of the wheat market might be the primary cause for commodity price receiving the highest score from the sources of risk. The second position of droughts is likely to be explained by the fact that Australia is the second driest continent of the globe. The relatively low perceived importance of fire, as a source of risk, which is a traditional element of broadacre crop insurance in Australia, can be regarded as unexpected result.

Factor analysis was carried out to reduce the number of sources of risk, which resulted in 6 factors with eigen values higher than 1 and the total variance explained was 73%. Significant differences between the means of risk factors were investigated using one sample t-test. The mean score of commodity price and droughts as risk factors are significantly different from each other and from all other factors with significance level less than 0.05. On the other hand, pest feeding on crops is significantly different from all factors except fungi (at $\alpha \leq 0.05$). Note that the mean score of hail is not significantly different from the perceived importance of flooding, frost, nutrient deficiency, soil compaction and fungi. Table 5.1 presents the factor loadings (after varimax rotation) of the sources of risks on the 6 factors identified. Interpreting the loadings, the factors 1 to 6 can most accurately be explained as 'human risk', 'field perils', 'pests and disease', 'extraordinary circumstances', 'price and production risk', 'soil problems'. With regard to factor 1, poor education is accompanied by herbicide over application, soil compaction and nutrient deficiency. 'Field perils' are associated with flooding, hail, fire, pest problems and droughts. In factor 3, fungi and viruses have the highest factor loadings. 'Extraordinary circumstances' are mostly described by vandalism and other unspecified risks. In factor 5, commodity prices have the highest loading, followed by bacteria and droughts. Dryland salinity, frost and pollution characterize factor 6.

Table 5.1: Perceived importance of risk factors, measured on a scale from 1 (very little) to 5 (very much), average scores, standard deviation, and varimax rotated factor loadings for sources of risk, (n=44).

	Average (n=44)	Std. Deviation	Most important factors [a]					
			1	2	3	4	5	6
Commodity prices	4.64	0.69	0.07	0.03	0.13	0.08	**0.84**	-0.08
Drought as a risk factor influencing income	4.18	1.15	0.03	**0.48**	-0.16	**0.39**	**0.50**	**0.33**
Pests feeding on crops	2.66	1.06	0.25	**0.70**	**0.37**	0.22	-0.04	-0.04
Frost	2.57	1.13	0.03	**0.27**	**0.46**	0.00	-0.25	**0.58**
Hail	2.27	0.97	-0.02	**0.71**	**0.31**	**0.39**	0.08	-0.10
Fungi	2.27	1.13	-0.02	-0.02	**0.90**	0.05	0.06	0.10
Nutrient deficiency	2.18	1.13	**0.53**	0.27	0.06	**0.43**	0.09	0.05
Flooding as a risk factor influencing income	2.11	1.47	**0.26**	**0.78**	-0.17	-0.13	0.15	-0.01
Soil compaction	2.07	1.04	**0.86**	0.20	-0.02	0.23	-0.01	0.10
Viruses	1.8	1.05	**0.27**	**0.26**	**0.75**	0.00	0.23	-0.03
Poor education and training	1.75	1.14	**0.81**	0.13	0.07	0.10	0.21	-0.10
Bacteria	1.75	0.94	**0.46**	0.18	**0.39**	-0.04	**0.55**	0.21
Herbicide overapplication	1.52	0.93	**0.85**	0.15	0.18	0.00	0.01	0.16
Fire	1.27	0.69	**0.29**	**0.66**	0.17	-0.15	0.01	0.15
Vandalism	1.14	0.67	**0.29**	0.11	0.24	**0.74**	0.01	0.05
Pollution of air and/or soil	1.11	0.62	**0.33**	**0.35**	**0.44**	0.23	0.12	**0.32**
Dryland salinity	1.07	0.59	0.10	-0.10	0.01	-0.12	0.07	**0.86**
Other specified factors	0.5	1.3	0.06	-0.09	-0.10	**0.81**	0.08	-0.16

[a] Factors 1 to 6 are ‘human risk’, ‘field perils’, ‘pests and disease’, ‘extraordinary circumstances’, ‘price and production risk’, ‘soil problems’, loadings of ≥ 0.25 are in bold.

5.2 Risk management

Table 5.2 shows the average scores of farmers’ perception towards risk management strategies, and the standard deviation of each score. Water management, growing different types of crops, and the use of the latest technologies are perceived to be the key risk management strategies. From the first three strategies, water management has a standard deviation of 0.97 indicating high consensus among respondents. The first three items are followed by property insurance, crop insurance and personal insurance. Therefore, insurance in general was perceived to be a relevant risk management strategy as well. In table 5.1 commodity price was indicated to be the greatest source of risk. On the other hand, in Table 5.2, all risk management strategies designed to cope with price risk like producing at the lowest possible cost, off-farm investment, forward contracts, holding financial reserves, other source of income and currency hedging are perceived to be less relevant. Currency hedging is perceived to be a less relevant risk management tool of Australian farmers.

The number of risk management strategies was reduced by using factor analysis, which resulted in 5 factors with eigenvalues greater than 1 and the total variance explained was 73%. The factor loadings after varimax rotation are shown in the table. According to the factor loadings, the factors can be described as 'on-farm risk management', 'risk sharing', 'diversification', 'financial management', 'futures market'. With regard to 'on-farm risk management' (factor 1), property insurance and the implementation of the latest technologies are accompanied by water management, holding financial reserves, and growing different crops. In factor 2, other source of income, working together with other farmers, producing at the lowest possible cost, forward contracts received high factor loadings. 'Diversification' (factor 3) has high loadings of personal insurance, growing other crops than wheat and is accompanied by crop insurance, water management and off-farm investment. Factor 4 seems to reflect financial management with high loadings of holding financial reserves, off-farm investment. Based on the loadings, factor 5 combines currency hedging with forward contracts and off-farm investment. After conducting one sample t-test, it is indicated that the mean score of water management is significantly higher than all of the other strategies (at $\alpha \leq 0.05$) except growing other crops than wheat. The test failed to show any significant difference between the means of crop insurance, personal insurance and property insurance. The relative importance of diversification and the use of latest technologies are not significantly different from each other.

Table 5.2: Perceived importance of risk management strategies, measured on a scale from 1 (very little) to 5 (very much), average scores, standard deviation, and varimax rotated factor loadings for sources of risk (n=44).

	Average (n=44)	Std. Deviation	Most important factors [a]				
			1	2	3	4	5
Water management	4.41	0.97	**0.56**	**0.39**	**0.46**	0.13	0.04
Growing other crops besides wheat	4.20	1.36	**0.31**	0.14	**0.77**	0.17	-0.19
Using the latest technology	4.11	0.95	**0.79**	**0.39**	0.09	0.07	0.11
Property insurance	4.00	0.96	**0.88**	0.16	0.24	0.07	0.12
Crop insurance	3.82	1.24	**0.49**	0.05	**0.58**	-0.16	0.19
Personal insurance	3.48	1.56	-0.05	0.23	**0.83**	**0.26**	**0.28**
Working together with other farmers	3.43	1.19	0.26	**0.69**	0.18	0.17	0.15
Producing at the lowest possible cost	3.36	1.37	0.23	**0.64**	0.06	-0.20	0.20
Off-farm investment	3.34	1.46	0.15	0.02	**0.43**	**0.63**	**0.33**
Forward contracts	3.32	1.38	0.20	**0.52**	0.27	0.22	**0.49**
Holding financial reserves	3.09	1.22	**0.53**	0.14	-0.09	**0.64**	0.08
Other source of income	2.32	1.39	0.09	**0.81**	0.10	**0.27**	-0.17
Currency hedging	1.80	1.05	0.14	0.07	0.04	0.12	**0.91**
Specified other factors	0.86	1.79	-0.06	0.12	0.14	**0.77**	0.03

[a] Factors 1 to 5 are ‘on-farm risk management’, ‘risk sharing’, ‘diversification’, ‘financial management’, ‘futures market’, loadings of ≥ 0.25 are in bold.

Table 5.3 shows the average scores of the factors, which are important when farmers decide to buy a crop insurance policy. Standard deviation for each score can also be found in the table followed by the ranks of the factors. The covered perils, perceived value for money and trust in the broker are perceived to be the key factors. According to the table, ‘level of premium charged is below 5%’ is ranked number 4 by respondents.

One sample t-test was carried out to investigate the significant differences between the mean scores of motivating factors for buying insurance. The test revealed that 4 groups of factors could be generated. Perils covered, perceived value for money and trust in the broker are the highest scoring variables and the means of these factors are significantly different from all the other factors (at $\alpha \leq 0.05$), but not from each other. The second group includes level of premium charged is below 5%, simplicity of insurance product, and easy to understand the product. These variables have approximately the same importance and they are significantly different from all the other factors. Trust in the insurer, time till claim settlement, loyalty to the broker and insurer, information availability of the product and weather predictions for the upcoming season are likely to have about the same importance but they are significantly different from the other variables. ‘Insurance is compulsory to have’ is perceived to be less relevant.

Table 5.3: Important factors when deciding to buy crop insurance, ranked from 1 (highest importance) to 12 (lowest importance), (n=43).

	Mean	Std. Deviation	Rank
Perils covered	4.16	3.37	1
Perceived value for money	4.23	3.06	2
Trust in the broker	4.30	2.79	3
Level of premium charged is below 5%	5.65	3.26	4
Simplicity of the insurance product	5.93	3.42	5
Easy to understand the product	6.28	2.55	6
Trust in the insurer	7.30	3.20	7
Time till claim settlement	7.35	2.63	8
Loyalty to broker and insurer	7.35	2.78	9
Information availability of the product	7.47	2.24	10
Weather predictions for the upcoming season	8.30	3.60	11
Insurance is compulsory to have	9.67	3.54	12

5.3 Perception of crop simulation insurance

Perception of the product

In Table 5.4 statements were used to elicit the perception of farmers towards crop simulation insurance. The statements measure perception of crop simulation insurance. The percentage distribution of farmers' response to each statement is presented as well in the table. The table shows that the majority of respondents indicated that farmers perceive they have a basic understanding of the concept. Trust and willingness to buy the product, trust in the company and in simulated yields are perceived to be relatively positive. The relatively higher price of crop simulation insurance is likely to be well perceived. Farmers indicated that they received a minimum amount of negative information concerning crop simulation insurance, and they are open for more information about the product. An adequate level of Cronbach's alpha of 0.76 indicates that all statements measure the same underlying construct, which is the general perception of crop simulation insurance.

Table 5.4: Perception of crop simulation insurance, measured on a scale from 1 (completely disagree) to 5 (completely agree), (n=43).

	Detailed scores (%)					**Overall**	
	1	2	3	4	5	Mean	SD
I understand the total concept of crop insurance based on simulated yields	16	9	42	30	2	2.93	1.08
I trust the validity of simulated yields	9	19	49	23	-	2.86	0.89
I understand how the premium level is calculated	16	33	28	23	-	2.58	1.03
I understand how the loss assessment is carried out	9	21	40	30	-	2.91	0.95
A product that reduces income volatility is worth 5% of my risk value	5	12	37	42	5	3.3	0.91
I trust the competence of the company providing this product	2	7	44	35	12	3.47	0.88
I would like to follow the monthly yield simulations via the internet	5	5	16	37	37	3.98	1.08
I was given negative information about this product	74	14	7	2	2	1.44	0.91
I would like to know more about this product	5	-	16	47	33	4.02	0.96

Conjoint analysis

Table 5.5 shows the utility scores of attribute levels, the standard error of each score and the importance scores of attributes. Water stress is perceived to be the most important cover to be included in crop insurance. Note that farmers indicated in Table 5.1 that the second most significant source of risk is drought. Hail on the contrary is perceived to be less relevant (-1.869). Hail accompanied by water stress seems to be a more preferred combination to hail only. With regard to the premium attribute, farmers prefer historical data to yield simulation model with high consistency. Farmers indicated that detailed farm visit was preferred to modeling outcomes and quick farm visit. According to the table, crop simulation insurance is likely to receive a higher uptake if hail is detached from water stress cover. Note that in Table 5.3 the “covered perils” is perceived to be the most important attribute of crop insurance and premium level is the fourth in importance. Therefore, farmers are consistent that risks covered by the insurance policy and premium are likely to be the key attributes of crop insurance policies.

Table 5.5: Importance score of attributes, utility scores of attribute levels, (n=44).

	Importance	Attribute levels	Utility Estimate
Risks	43.78	Hail	-1.869
		Water stress	1.881
		Hail and water stress	-0.011
Premium	40.72	Historical data	1.716
		Yield simulation model	-1.716
Assessment	15.5	Detailed farm visit	0.629
		Modeling outcomes and quick farm visit	-0.629

Target market

In order to identify characteristic difference between groups of farmers, an independent sample t-test was carried out (Table 5.6). Two groups were generated based on general feelings about crop simulation insurance and were named positive and negative. The t-test revealed significant difference in the seven underlying variables, listed in Table 5.6. Farmers, who are more familiar with the product, have a better understanding of the concept, and trust the simulated yields are likely to perceive the product better. In general, knowing more about the background of crop simulation and the concept itself, having quality information from multiple sources, tertiary education in economics and trust in the simulated yields are likely to be key factors generating positive perception of YieldShield. Farmers indicated that they would be interested in further information about YieldShield.

Non-parametric test revealed that there is a significant positive correlation between farmers' perception towards crop simulation whether respondents heard about APSRU, and whether they use HowWet (product of APSRU). Farmers, who heard about APSRU and use HowWet, are likely to develop a more positive attitude. According to table, perception of farmers is less likely to be influenced by socioeconomic factors and farm characteristics. Furthermore, the importance of various sources of risk is perceived to relatively similar by the positive and negative groups of farmers. No significant difference was revealed between the perception of the price of crop simulation insurance between the two groups of farmers.

Table 5.6: Difference between positive and negative groups of farmers, average scores (1 – not at all, 5 – completely), Spearman Rank-order correlation coefficient: ρ (rho), (n=44).

	YieldShield attitude		
	positive (n=17) average	**negative (n=27) average**	**Spearman rank-order correlation coefficient: ρ (rho)**
Socioeconomic factors			
• Farm size (ha)	5486	5633	-
• Annual average farm turnover/year (3=$500-1000k; 4=more than $1000k)	3.35	3.22	-
• Age group of the farmer (3=36-50 years; 4=over 50 years)	3.24	2.92	-
Sources of risk			
• Drought as a risk factor influencing income	4.18	4.19	-
• Flooding as a risk factor influencing income	2.12	2.11	-
• Hail as a risk factor influencing income	2.53	2.11	-
• Fire as a risk factor influencing income	1.41	1.19	-
Information about YieldShield			
• Familiarity with crop insurance based on modeling***	3.06	2.30	-
• Farmer understands the whole concept of the product***	3.41	2.62	-
• Would like to follow monthly yield simulation via internet	4.00	3.96	-
• Was given negative information about the product	1.59	1.35	-
• Trust the validity of simulated yields***	3.35	2.54	-
• A product that reduces income volatility is worth 5% of the risk value	3.41	3.23	-
Non-parametric variables	***yes***	***no***	
• Farmer heard about APSRU (%)**	52.3	47.7	0.384
• Uses HowWet (%)*	18.2	81.8	0.352
• Had information from broker (%)*	86.4	13.6	-0.365
• Tertiary education of the farmer from economics (%)**	20.9	79.1	0.408

***Significant at the 0.05 level (2-tailed).

**Correlation is significant at the 0.01 level (2-tailed).

*Correlation is significant at the 0.05 level (2-tailed).

6. Conclusions and discussion

6.1 Conclusions

With regard to the first objective, perceived importance of sources of risk, which were examined together with risk management tools, the paper revealed controversy. Farmers gave the highest importance to price risk, becoming the greatest source of risk, but on the other hand risk management tools designed to confront price risk were perceived to be less important. As the results showed that water stress is perceived to be a key source of risk, and the most important product attribute of crop insurance, one might conclude that YieldShield, which includes water stress cover, is likely to be a successful product. However, based on the results of conjoint analysis, it might be concluded that an alternative product offering water stress cover excluding hail is likely to improve the current market position of YieldShield.

The second objective of the research was to elicit farmers' risk management strategies in Australia. Analyzing the questionnaire survey data, key strategies were identified for 44 farmers. However, based on the results, it is indicated that there is a significant level of variation among respondents. Water management, diversification and the use of the latest technologies were perceived to be the most important strategies, which are all on-farm risk management strategies. Insurance (property, crop, and personal) in general was perceived to be a relevant risk management tool as well. However, one might say that farmers are likely to allocate a relatively big part of their resources towards on-farm risk management strategies, which might negatively influence farmers' participation with regard to YieldShield. On average, currency hedging was perceived to be less relevant.

According to objective 3 of the paper, perception of crop insurance using yield simulation technology was elicited. General understanding of the concept, attitude, trust and willingness to buy were investigated using different analytical methods. The majority of farmers perceived that they have a basic understanding of the concept. Trust and willingness to buy the product were perceived to be adequate, and the general attitude towards crop simulation insurance is neutral or positive. The research supports the statement that water stress is one of the most important field perils of Australian farmers. Farmers proved to be open and positive for the new concept, but conservative buying a completely new product, which applies crop simulation technology to determine crop loss.

As mentioned before, farmers indicated that they are either positive or neutral towards crop simulation insurance. However, farmers' perception is likely to be determined by the quality and the source of their information about the product. Therefore, putting effort into the marketing of the product is likely to improve the position of YieldShield. The perception of farmers is likely to be influenced by educational background and information availability. On the other hand, socioeconomic factors and farm characteristics might have less relevant effects. One might conclude that the target market of YieldShield should be reinvestigated. Further research is likely to explain the effect of drought policies on the current uptake of YieldShield.

6.2 Discussion

Free disaster relief

Several drought assistance measures were described in chapter 2.5. Therefore, financial, personal, and business assistance measures are available for farmers to provide support for farming families under extraordinary circumstances. During the interviews farmers mentioned the drought relief policy but it was perceived as a measure to avoid total bankruptcy and not as a relevant risk management strategy. However, the existence of government support might contribute to the relatively low uptake of crop simulation insurance in Australia.

Complexity of crop simulation insurance

According to farmers, crop simulation insurance is likely to be relatively complicated to conventional insurance. Farmers' attitude towards the modeling feature of the product seems to be a conservative, which might be explained by lack of understanding and trust in the concept. Farmers are used to loss assessment carried out on their farms, and policy wordings, which do not include losses, triggered off farm. Complexity of crop simulation insurance is likely to prevent farmers from potential uptake of the product.

Representativeness of the sample

The research was undertaken only in the form of personal interviews, and altogether 44 interviews were carried out. Triangulation of research methods were not applied, the number of respondents could have been increased by sending the questionnaires via email or interviewing the farmers on the phone. In general, respondents were highly educated, producing on large scale and having relatively high annual turnover. Small scale, lower educated farmers were not included in the survey. During the research, apart from two farmers from Western Australia and one from Victoria, farmers were mainly interviewed from the New South Wales and Queensland wheat-growing areas.

6.3 Recommendations and further research

Based on the results of conjoint analysis, it might be considered that offering water stress cover excluding hail is likely to improve the current market position of YieldShield. Taking the fact that farmers' perception of YieldShield is most likely to be determined by information availability, starting a marketing campaign might be advised. In addition, the target market of YieldShield should also be reexamined. It might also be advised to undertake further research to investigate the effect of drought policies on farmers' participation with regard to YieldShield.

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Appendix - Questionnaire

Section 1. - Structural farm characteristics

1. Shire(s) in which property is located (obtain in advance)

……………...

2. Farmer name (obtain in advance)

……………...

3. Contact number

……………...

4. Property name(s)

Farm 1.................. Farm 2................... Farm 3................. Farm 4.......................

5. What is the size of your farm(s) (in hectares)?

Farm 1.................. Farm 2................... Farm 3................. Farm 4.......................

6. What proportion of the total land area farmed is owned (hectares, or percentage)?

Farm 1.................. Farm 2................... Farm 3................. Farm 4.......................

7. What proportion of the total land area is used for dryland wheat growing (hectares, or percentage)?

Farm 1................. Farm 2................... Farm 3................. Farm 4.......................

8. What is the annual average turnover of the total area farmed for the last three years?
$.................................. or within the following range,

Less than $250k $250k to $500k $501k to 1,000k   More than $1,000k

9. On average what percentage of the total farm turnover comes from dryland wheat?
.... % or within the following range,

Less than 20%   21% to 40%   41% to 60%   61% to 80%   More than 80%

10. What is the ownership structure of your farming business?

- Privately owned
- Share farmer
- Partnership
- Corporation
- Other

11. Are you also engaged in one or more of the following agricultural activities?

- Sorghum Yes No
- Corn Yes No
- Cotton Yes No
- Forestry Yes No
- Beef Yes No
- Sheep Yes No
- Other source of income: …………

Section 2. - Risk management

12. Could you please indicate to which extent the following risk factors in the table influence your income?

	Risk factor	NA	Very little		Some times		Very much
Natural							
1.	Drought		1	2	3	4	5
2.	Flooding		1	2	3	4	5
3.	Frost		1	2	3	4	5
4.	Hail		1	2	3	4	5
5.	Fire		1	2	3	4	5
6.	Dryland salinity		1	2	3	4	5
7.	Nutrient deficiency		1	2	3	4	5
Man-made							
10.	Soil compaction		1	2	3	4	5
11.	Herbicide over-application		1	2	3	4	5
12.	Poor education & training of workers		1	2	3	4	5
13.	Pollution, air and/or soil		1	2	3	4	5
14.	Vandalism		1	2	3	4	5
15.	Commodity prices		1	2	3	4	5
Pest and disease							
17.	Fungi		1	2	3	4	5
18.	Bacteria		1	2	3	4	5
19.	Viruses		1	2	3	4	5
20.	Pests feeding on crops		1	2	3	4	5
21.	Other………..		1	2	3	4	5

13. How many times did your dryland wheat yield reach the following values in the last 10 years?

Yield	Number of years
1 ton/ha or less	
2 ton/ha or less	
3 ton/ha or less	
4 ton/ha or less	

14. To what degree did your dryland wheat yield fluctuate year to year (consider the last 3 years)?

+/- 10% **+/- 25%** **+/- 40%** **+/- 50%** **or above**

15. Could you please put the following factors in order of importance in how much they motivate you when purchasing crop insurance? (1 - Highest; 12 - Lowest)

	Factor	Rank
A	Simplicity of the insurance product	
B	The types of perils that are covered by the insurance	
C	Level of premium charged is below 5% of risk value insured	
D	Trust in the Broker or intermediary for good advice	
E	Its compulsory because of financing arrangement	
F	Perceived value for money i.e. risk reward ratio	
G	How long it take to settlement a loss	
H	Loyalty to the insurance provider/Broker	
I	Availability of Information about the insurance product	
J	Easy to understand coverage and simple processes to apply for the insurance	
k	Security and trust of the insurance company	
L	Weather predictions for the upcoming season	

16. Could you please indicate to which extent you apply risk management strategies?

Risk management strategies	NA	Very little		Some times		Very much
Financial strategies						
1. Personal insurance		1	2	3	4	5
2. Off-farm investment		1	2	3	4	5
3. Crop insurance		1	2	3	4	5
4. Holding financial reserves		1	2	3	4	5
5. Property insurance		1	2	3	4	5
6. Currency hedging		1	2	3	4	5
7. Forward contracts		1	2	3	4	5
8. Other source of income		1	2	3	4	5
Farming strategies						
9. Growing other crops besides wheat		1	2	3	4	5
10. Producing at lowest possible cost		1	2	3	4	5
11. Water management		1	2	3	4	5
12. Using the latest technologies		1	2	3	4	5
13. Working together with other farmers		1	2	3	4	5
14. Other…………………		1	2	3	4	5

Please mention any other factors you think are important.

…………………………………………………………………...

Section 3. - Crop insurance based on simulated yields

17. Have you heard about APSRU (Agricultural Production Systems Research Unit)? (Circle the one applicable).

Yes No

18. Do you use any of the products developed by APSRU (you can select more than one)?

- APSIM Yes No
- Yield Prophet Yes No
- Whopper Cropper Yes No
- HowWet Yes No
- APSoil Yes No

19. Have you heard about the Oz-Wheat model? (Circle the one applicable).

Yes No

20. Do you use the Oz-Wheat model? (Circle the one applicable).

Yes No

21. Are you familiar with crop insurance based on simulated yields?

Not at all familiar		**Somewhat familiar**		**Very familiar**
1	2	3	4	5

22. What kind of feeling do you have when you hear about crop insurance based on simulated yields?

Very negative		**Neutral**		**Very positive**
1	2	3	4	5

23. What is the source of your information (you can select more than one)?

- Insurance broker Yes No
- Other farmer Yes No
- Media Yes No
- Other Yes No

If other, please comment…………………………………………………………………………….

24. Could you please indicate to what extent you agree with the following statements concerning crop insurance based on simulated yields?

	Statement	Disagree		Partially agree		Completely agree
1.	I understand the total concept of crop insurance based on simulated yields	1	2	3	4	5
2.	I trust the validity of simulated yields	1	2	3	4	5
3.	I understand how the premium level is calculated	1	2	3	4	5
4.	I understand how the loss assessment is carried out	1	2	3	4	5
5.	A product that reduces income volatility is worth 5% of my risk value	1	2	3	4	5
6.	I trust the competence of the company providing this product	1	2	3	4	5
7.	I would like to follow the monthly yield simulations via the internet	1	2	3	4	5
8.	I was given negative information about this product	1	2	3	4	5
9.	I would like to know more about this product	1	2	3	4	5

25. In the following section several specifications of crop insurance are represented to you. The specifications differ from each other on the following:

Key product features	Available choices
Risks covered	• Hail • Water stress excluding hail • Hail and water stress
Premium based on	• Historical data • Yield simulation model
Loss assessment method	• Detailed farm visit • Modelling outcomes and quick farm visit

On the next page you will find 7 profiles from A to G, which are different combinations of available choices for each of the three key product features boxes. One available option has been selected from each box to create a profile. Please put the profiles in order of preference on a scale of 1 to 7, where 1 is the Most preferred and 7 being the Least preferred.

Attributes	A	B	C	D
Risks covered	Water stress excluding hail	Water stress excluding hail	Water stress excluding hail	Water stress excluding hail
Premium based on	Yield simulation models	Historical data	Historical data	Yield simulation models
Loss assessment method	Detailed farm visit	Detailed farm visit	Modeling outcomes and quick farm visit	Modeling outcomes and quick farm visit
Rank				

Attributes	E	F	G
Risks covered	Hail	Hail and water stress	Hail and water stress
Premium based on	Historical data	Historical data	Historical data
Loss assessment method	Detailed farm visit	Modeling outcomes and quick farm visit	Detailed farm visit
Rank			

26. Would you have any suggestions to improve crop insurance based on simulated yields?

**……
……
……
……...**

Section 4. - Personal questions

27. What age group do you belong to?

Less than 20 years 21-35 years 36-50 years over 50 years

28. Gender:

Male Female

29. Did you undertake tertiary education in any of the following areas of expertise?

agronomics agriculture economics science

30. What is the size of your household? (Please, count only children living at home, if any)

2 or less person's 3 to 5 persons Over 5 persons

Thank you very much for all your time and assistance it will be of great help to me in my studies!