Managing Seasonal Weather Risk using Financial Instruments

A report for

By Dylan Hirsch

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Executive Summary

Weather dependant production makes Australian grain farmers one of the most vulnerable businesses to revenue volatility. Traditionally, farmers have managed this by ensuring the business had enough cash and unleveraged assets on hand to cope with successive poor seasons. However, as profit margins come under pressure from increasing investment in agriculture from external sources, the opportunity cost of having unleveraged assets may impede the ability for family farm businesses to compete with larger, diversified, and corporate businesses.

Previous attempts at managing farm production volatility using multi-peril crop insurance products (MPCI) have become victim of moral hazard, adverse selection, and a lack of government support with additional taxes, and no mandate to collect and report farm production data. Programs which have been successful in other countries have not been able to replicate their success in Australia, with many critics highlighting the large subsidies in foreign countries as the obvious point of difference.

In the last 20 years, other global industries such as renewable energy supply, energy distribution and agricultural supply chain companies have developed financial instruments to manage the revenue volatility caused by seasonal weather. All without government subsidy or assistance. These over the counter weather derivatives are now making their way into agriculture, with developing countries including Ukraine, Uzbekistan, India and Brazil all developing weather derivative programs for agricultural producers, rather than using the traditional crop production insurance model implemented in the United States, Canada and European Union.

This report investigates how farmers and the greater agricultural industry in other countries manage seasonal weather risk, and what potential benefits are available for industries which use such instruments. Investment confidence, lending behaviour, land values and profitability are all investigated in several case studies of businesses utilising financial risk management products.

It also looks at how the reinsurance industry is utilising new technology and data to provide solutions for farmers to manage volatility. It provides recommendations for the Australian agricultural industry to best position itself to benefit from these products.

There is an enormous opportunity for growth in the Australian agriculture industry by utilising these products. However, it will require participation from both the Australian farmers and lenders to ensure the products can sustainably meet the needs of the industry and its investors.

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Foreword

Before I returned to work for the family farm, I spent time in other industries, including a grain trading desk, which opened my eyes to the advantages of risk management. How such a small team could manage a billion-dollar exposure to grains price risk using sound application of market futures and options made me realise why farmers are simultaneously respected and considered insane for their willingness to accept such an enormous exposure to unpredictable weather.

As I see it, a large push of external capital from domestic and foreign sources invest in agriculture and I wonder what the future of the family farming business in Australia will be. Will they be managing the same risks we and our parents have always managed by running a family business, will they be employees of a larger corporate entity, or will they have the choice of both? Will the inherent advantage of local knowledge and small-scale efficiency be enough to compete with diversified corporate businesses?

Regardless of what we think is, or should, be the answer, future businesses will need to be both more resilient to drought and other economic shocks caused by climatic events, as well as better able to invest in opportunities to expand and intensify. With so much capital being prepared to be injected into Australian agriculture, I hoped I could find out how family businesses can hedge their exposure in the same way as large corporations, so we can participate and help guide where this capital is invested.

Acknowledgments

I would like to thank Nuffield Australia and the Grains Research and Development Corporation (GRDC) for giving me this opportunity to search the worldwide agricultural and insurance industry for ideas and solutions to bring home to Australia. I am a firm believer in the importance of physical experiences and conversations. There is no way I could have carried out this research without your network and support.

I would like to thank the several WA Nuffield alumni who pushed me to commit to this scholarship. I have a deep respect for the contribution of these individuals to Australian Agriculture and their support was very humbling.

To the wonderful, generous and wise people who taught, challenged, accommodated, pushed and advised me in my world travels, I can't wait to return the favour if you are ever in Australia. To my mentor John G. To my open minded GFP accomplices, Stu, Simon, Steve, Rob, Andre and Jean. To Yolène and Nuffield France who deserve a gold star for their hospitality and dedication to agricultural networking. To my very knowledgeable and experienced hosts and guests who made time for me, Carl W, Richard C, Art B, Marty M, Matt H, Jim H, Grant K, and so many others, I thank you all.

Most of all I would like to thank my fiancé Kirra who did not sign up to the extra workload and challenges my opportunity generated, but which you took on headfirst and with such generosity and nonchalance. I will forever be grateful for the emotional support, therapy and physical workload you embraced which enabled me to complete the scholarship. Somehow throughout this you managed to bring our first child into this world, with our beautiful daughter Darcy giving me extra motivation to find solutions to help our future generations.

And lastly my parents, Joanne and Brad (or Jo and Joe), who's support I continue to take for granted. You are the ones who instilled the desire to find a better way to manage weather risk, and also the ones who picked up the extra workload while I spent months away from the farm business.

Abbreviations

ABARES - Australian Bureau of Agricultural and Resource Economics

ARC – Agricultural Risk Coverage program

ASIC – Australian Securities and Investments Commission

BOM – Australian Bureau of Meteorology

CBH – Cooperative Bulk Handling (Australian supply chain company)

CME – Chicago Mercantile Exchange

EU – European Union

FMDs – Farm management deposits (Australian farm business tax planning tool)

GARS – Global Agricultural Risk Solutions

GSR – Growing season rainfall

LRZ – Low rainfall zone

LVR – Loan to value ratio

MPCI – Multi-peril Crop Insurance

NDVI - Normalized difference vegetation index

OTC – Over the counter products

PLC – Price Loss Coverage program

ROI - Return on investment

SCO – Supplemental Coverage Option

USA – United States of America

USDA – United States Department of Agriculture

WA – Western Australia

WUE – Water use efficiency

Objectives

The aim of this research is to ultimately lift the standard of living for rural communities and businesses by challenging the way the Australian grain industry perceives and manages risk to become more profitable, flexible and ultimately sustainable.

Observations and recommendations are based on meetings with farmers, agricultural lenders, insurers, agricultural and other industry reinsurers and farm lobby groups, exploring concepts and questions around objectives to:

- Challenge the way Australian agricultural businesses manage seasonal weather risk.
- Investigate how businesses in other countries and industries manage weather and crop production risk.
- Investigate costs of insurance products, to identify bottlenecks and inefficiencies within the Australian agriculture industry for improving risk management.
- Provide alternative models for Australian agricultural businesses to manage seasonal weather risk.

Chapter 1: Introduction

Insert one of the many cliché quotes about comparing farming to gambling here. The gambling industry exists not through necessity, but because people find it fun and some might say the uncertainty is what makes farming exciting too. Yet as much as farmers like to innovate, try new technology and grow aesthetically pleasing crops, it's only possible if the farm is a profitable and sustainable business. As margins become tighter as the industry matures, one may question whether Australian farmers can manage or even understand this risk.

In order to remain sustainable, Australian grain farmers have had to become resilient to uncertainty. Two major sources of uncertainty are market prices and seasonal weather conditions. Successful farm businesses are designed to be as profitable long term, whilst being able to survive short term economic shocks, such as drought. Competition within the industry has led to a situation where many farm businesses seek scale and growth for profitability, whilst at the same time ensuring debt levels are controlled so the business can continue after one or more droughts. There are successful farm businesses on each end of this scale. Just as there are businesses who have gone bankrupt from drought after over capitalising, there are farmers who fail to take opportunities to invest and expand, before complaining how high land prices have become. It is debatable about where best a business should be on that scale, but ubiquitously accepted that businesses should look to grow within their means.

"New York City was made possible by the insurers. They are the ones who really built this city. With no insurance there would be no skyscrapers. No investor would finance a building that one cigarette butt could burn to the ground." – Henry Ford

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Just as farming is considered gambling, so too is insurance. Insurance and gambling have been around for millennia. The Babylon Code of Hummurabi from 2000BC was one of the first known products, essentially being a maritime insurance attached to a business loan for merchants. If the merchant's cargo sank at sea, then the clause waived their requirement to pay back the loan (Harford, 2017). Chinese ships had a different risk management strategy. They would instead swap good between ships such that if a ship went down, it would contain a mix of goods from several merchants. However, the shuffling of goods was inefficient and therefore insurance succeeded in allowing specialisation and investment across trade and industry for thousands of years.

In 2019, farmers around the world placed billions of dollars of bets on world commodity exchanges. Most of these are that the market will move against them. Just as in 1687 in Lloyd's

coffee shop of London, merchants and military persons placed bets that their own ships would sink. Neither examples are speculative bets, but hedges which reduce the overall exposure for the business to take on other challenges and opportunities.

Just as businesses have evolved over time, so too has their risks and the insurance products offered. This is no different in agriculture. In the 1940s, a Western Australian (WA) grain or livestock business could be destroyed by fire, however workers compensation claims were not seen as an issue that farmers or their banks thought was worth insuring. Before the deregulation of the Australian Wheat Board (AWB), the uncertainty of grain prices was largely contained. Since then, many businesses have been slow to, or failed to implement grain marketing plans (Critch, 2019), and grain market prices have become a major stress factor in farmer mental health (National Centre for Farmer Health, 2016).

Although risk management isn't is popular conversation amongst farmers in a social situation, compared to new machinery and agronomical practices, perhaps it is just as worthy of innovation such that it can contribute to the success of a modern farmer and rural communities they live in.

Chapter 2: Risk Management in Australian Cropping Businesses

Australian grain farmers deal with an extremely high level of risk, not only compared to other industries, but also to other farmers around the world. As illustrated in Figure 1, production volatility is the major source of this risk.

This volatility is nothing new, handling annual rainfall variability and frost has been challenging Australian grain farmers for a century now. In this time most of industries have dramatically reduced their output volatility, largely through corporate consolidation. Australian agriculture output has defied this trend, however the recent introduction of a number of large scale corporate ventures into grain growing agriculture suggests that the industry may be about to undergo this change (Gannon, 2019).

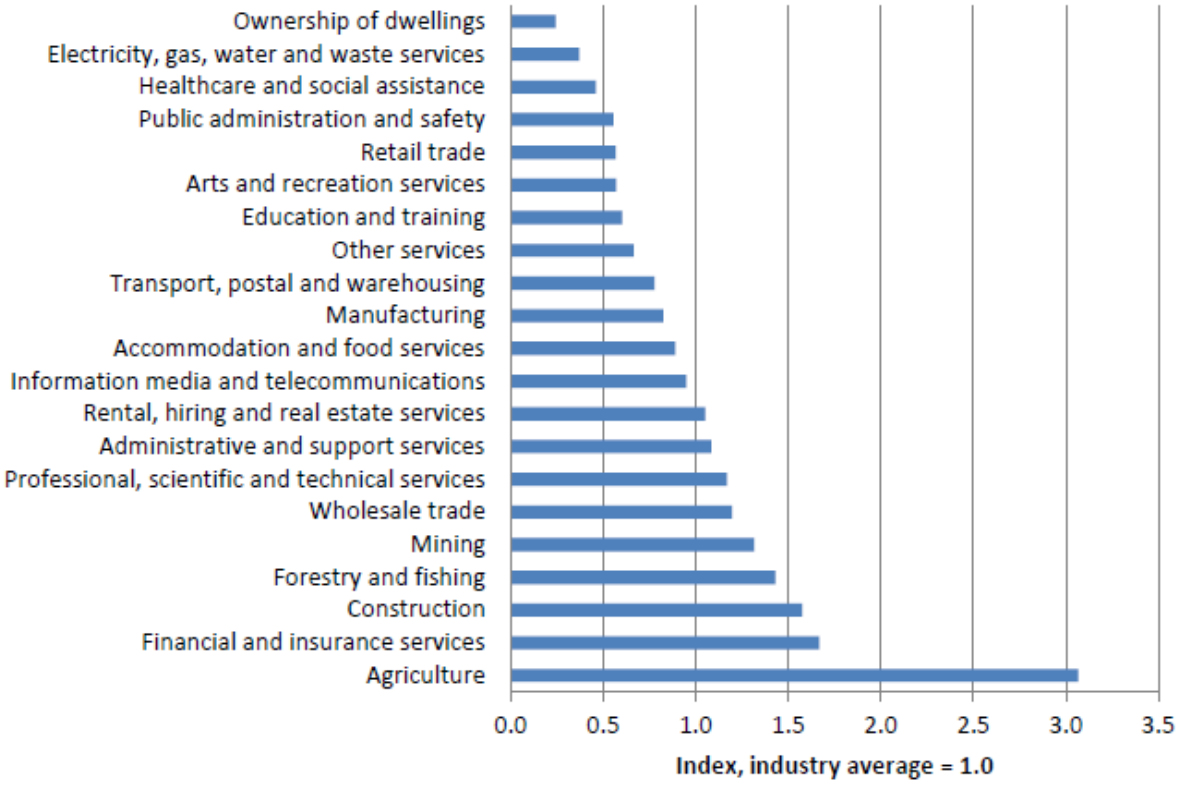

Figure 1: Australian industry output volatility index, 1975-2011 (Marco Hatt, 2012). While commodity pricing is also a major source of volatility, other industries with similar exposures to commodity prices such as mining, forestry and fishing have a much lower output volatility index due to less reliance on weather

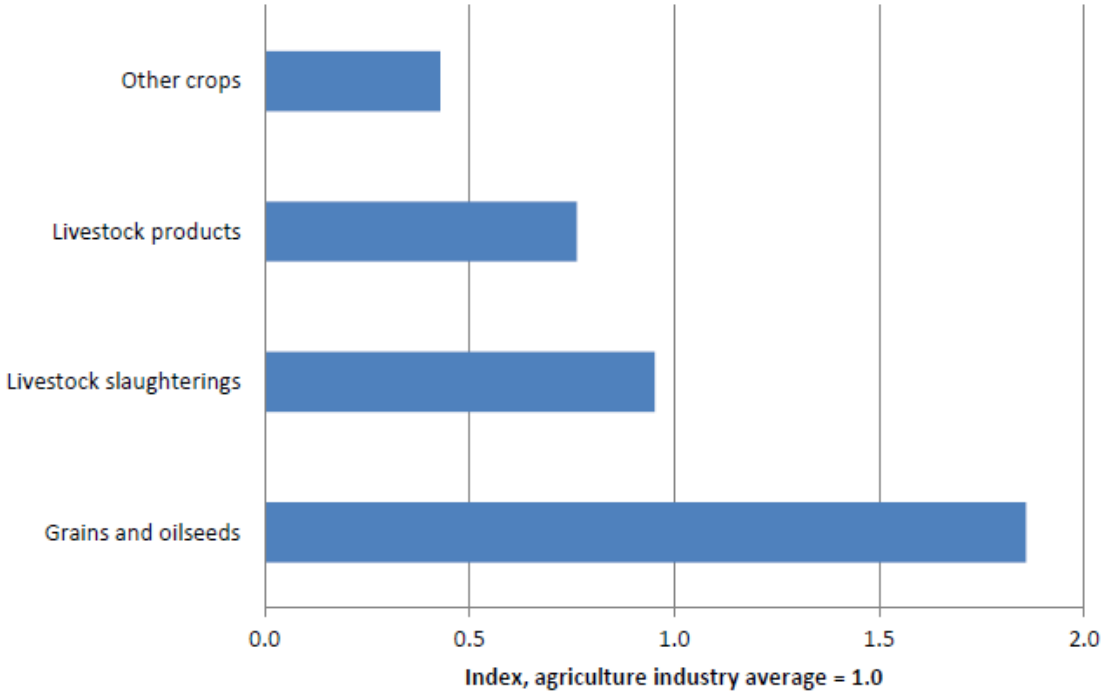

Figure 2 : Volatility across the Australian agricultural industry (Marco Hatt, 2012).

2.1 Impacts of drought shock

Drought shock is arguably the biggest risk for any business or individual working on the Australian grains industry. Drought shocks can impact a business, individual and community in several ways:

- Non-recoverable loss of immediate farm income for the business;
- Reduction in business activity from farming for local services and suppliers;
- Momentary increase in subsequent farm foreclosures;
- Simultaneous decrease in demand for land;
- Decrease in liquefiable land values (unless external investors can take up some of the land oversupply);
- Major business investments require larger Return on Investments (ROI) and faster payback periods due to their increased pressure on business drought exposure;
- Investments may be focussed on short term results rather than longer term due to this pressure;
- Businesses look for causal and seasonal labour to offset risk of drought shock;
- Affected labour may move to other areas looking for work, and may not return;
- Seasonal labour uncertainty attracts single males rather than couples and families, resulting in a demographic imbalance;

- Civic services focussed on family services such as schools, child health and sporting facilities receive reduced patronage in addition to the overall rural population decline; and
- Agricultural university graduates and farmer's children may look to move into other careers, through lack of jobs or perception of a lack of prosperity within the industry.

Whilst the occurrence of drought does provide challenges, it also presents an opportunity for some:

- Farm businesses who can better withstand the economic shock (higher equity) of drought may be able to purchase cheaper land in these years; and
- Farmland investors can achieve good rental yields (4-7%) from cropping leases due to leases attracting greater demand than sales.

Many argue that the discount in land prices creates an opportunity for younger or new farmers. Compared to many other grain growing regions, this didn't seem to be the case, with younger farmers able to access a variety of different avenues for land acquisitions despite high land prices. In the United States of America (USA) and Canada, land leases were more common and available to younger farmers, with flexible profit and risk sharing structures in place between land asset owner and farmer. In the EU, the low interest rate and long loan payback period has forced capital providers to seek younger farmers for their invested capital. One explanation for this perceived paradox is that the greater proportion of upfront capital required as deposit for land purchases in Australia offsets the opportunity of cheaper land arising from production volatility. This is discussed further in section 7.3.

2.2 Traditional risk management strategies

In order to manage the risk of drought and other production perils, many Australian grain farmers have purposely adopted strategies to protect their business. These have changed over time but essentially revolve around operation diversity and protecting the equity level within the business. Like insurance, these strategies often come with their own costs, however they can be utilised to make the business more resilient and profitable.

2.2.1 Geographic spread

More WA farmers are intentionally purchasing properties in different rainfall zones or a significant distance away to hedge against localised drought or frost. Sometimes this benefit may be unintentional but is usually part of an overall business strategy. This strategy often requires initial capital to purchase the secondary property and may require significant

expansion or selling existing assets in order to achieve an effective geographic spread. Transport equipment or duplicate plant and staff may also be required.

Benefits	Costs
• Provides exposure reduction in from all weather risks • Benefit may increase with climate change • Excess inputs from a drought on one property may be utilised by the other	• Less suitable for smaller businesses who may not have the capability to purchase another farm • Machinery transport costs • Greater resources to monitor all properties • New areas may require alternative agronomy

Table 1: Costs and benefits of geographic spread

2.2.2 Production diversity

Although still impacted by drought, livestock and hay business units can provide a meaningful diversification to grains businesses (Fletcher, 2018). However, like many strategies they require initial upfront investment to pursue at a profitable level, which may or may not be available to the already cash strapped business. In addition, it may require external expertise in early years until it can be managed profitably in house. These two costs may be why grain farmers in Australia choose to instead specialise in grain, rather than diversify in order to reduce risk.

Benefits	Costs
• Partially reduced drought exposure • Weed management in hay phase • Feed grain utilisation by livestock • Low ongoing costs once implemented	• Initial equipment/livestock costs • Cropping program may be compromised in timing/area • Knowledge required to setup new business unit • Greater reliance on labour or contractors

Table 2: Livestock and hay diversification cost benefit analysis

2.2.3 Equity protection

The most common tool used by farmers to protect against drought and other production risks is to maintain enough equity to absorb losses resulting from poor years. By ensuring the business still has additional borrowing capacity in the form of unleveraged assets following one or more drought years, the business can continue. Whilst widely accepted and used, this system is not without cost. In WA, the top 25% of farmers have achieved a ROI of 10.6% over

ten years (Planfarm, 2018), approximately double the interest rates available to agriculture businesses. This represents a large opportunity cost for businesses which are not fully leveraged.

Benefits	Costs
• Strategy widely understood by farmers and consultants • Encourages careful planning for major investments • Can be used by all businesses	• Opportunity cost of unleveraged equity • Farm operating businesses are tied to land assets • Strategy can be difficult for younger and new farmers with low asset base • Can be undermined by family succession • Strategy still vulnerable to successive droughts

Table 3: Costs and benefits of farm equity protection

2.2.4 Low input agronomic system

Many grain businesses in the low rainfall zone (LRZ) of WA have adopted a low input agronomic system in order to protect against losses in poor years. While a low input cereal system can be profitable in many areas (Liebe Group, 2018; Nixon, 2017), it is widely accepted that there are huge opportunity costs and yield penalties across WA grain businesses due to lack of inputs, in particularly nitrogen (Planfarm, 2018). Whilst the low input system may succeed in partially protecting the primary production business from drought, reduced production and inputs result in lower economic activity within broader industry and local communities.

Benefits	Costs
• Reduced exposure to drought (lower breakeven yield) • Efficient prioritisation of resources • Lower costs can make it easier to scale up	• Higher chance of opportunity costs, particularly in high yield potential years • Lower production, reduction in downstream economic activity • Lower inputs used, reduction in upstream economic activity • Cropping business still vulnerable to drought

Table 4: Costs and benefits of a low input agronomic system

2.2.5 Currently available MPCI

Although there have been a range of risk management products launched in Australia in the last 40 years, the period from 2015-2018 saw several competitors bring products to the Australian market. These products are similar in design to Multi-Peril Crop Insurance (MPCI)

products offered in the USA and Canada. All products are based on yield or revenue history of a grain farmer; therefore they require significant administrative appraisal of business performance and often charge initial fees to quote products of $4,000-5,000k (Grain Growers Limited, 2018) to cover this. There are subtle differences between products but can largely be broken down into two systems: revenue, and production insurance.

Revenue insurance products assess median gross revenue of an operation over a 5-10 year history to assess coverage level (usually 70% of mean/median gross revenue in $/ha) and premium which is a function of the coverage level, revenue volatility and other risk factors. Some products offer increased coverage (75-80%) in circumstances where a business satisfies criteria such as sufficient soil moisture at the time of quoting, or if they are in a reliable rainfall area. Revenue products cover both yield and price risk which suits farmers with assertive marketing programs who may be subject to washout fees in drought years, as well as farmers who do not have a marketing plan and are exposed to losses from declining market prices.

Production or yield insurance MPCI products will assign each commodity an agreed price (usually at the time of the quote based on an estimated price), then calculate an insured yield level based on the historical production history of the operation. Administrative costs for this product are generally slightly cheaper than revenue products as they do not need to consider grain marketing information. The coverage level is often ~70% of the mean historical yield over 5-10 years. Production insurance will better suit farmers who undertake conservative grain marketing plans, which should be regularly updated to insure they align to the insured yields.

Both products face issues as they look to secure a long-term foothold in the Australian market:

- Australian farmers are not educated on how best to utilise MPCI products to leverage their business. This dramatically increases risk of adverse selection and moral hazard from farmers participating in the program due to the misconception that the only way to benefit from the product is by making claims;
- Agricultural lenders do not yet incorporate the effect of these products on farm business revenue volatility in their credit risk assessment and therefore are unable to incentivise their use as done in other countries where MPCI products are widely used;
- Data used to quote and assess insurance products is not collected by government data agencies, creating extra administrative costs during quotes and claims;
- With no regional benchmark yield data being collected by Australian Bureau of Agricultural and Resource Economics (ABARES), insurers cannot provide a yield adjustment for farmers who are improving their water use efficiencies (WUE) as done

in countries which collect farm data. This further amplifies risk of adverse selection as better, faster improving farmers may not be adequately covered by a coverage level based on decade old production data.

- Australian farmers record keeping is largely based on cashflow taxation accounting rather than production or gross revenue accruals which products are based on;
- Many Australian State Governments apply additional stamp duty to insurance premiums. As MPCI insurance is designed to claim frequently compared to traditional catastrophic insurance products, this ~10% tax raises the effective insurance price by 20-50%, which can often make the insurance too costly to utilise.

Benefits	Costs (Problems)
• Complete control of exposure to drought • Negates need for fire and hail insurance in poor years	• Premiums have been inflated by growers delaying quotes until Autumn • Administration costs are significant • No government support for program • Education programs for MPCI use have been late and underutilised • Products are marketed on costs rather than benefits • Benefits of MPCI unclear/intangible

Table 5: Summary costs and benefits of traditional MPCI in Australia

2.3 Measurement of financial risk in Australian grain businesses

Due to exposure to drought and other perils, the borrowing capacity of Australian grain businesses is often a function of their loan to value ratio (or equity %) and historical production volatility. Businesses in higher production risk areas may only have a borrowing capacity of 30% LVR. This ensures that the secured asset (e.g. land) can be liquidated, even after successive poor seasons, which may result in a reduction in asset value. In lower risk areas, and for businesses with more diversified income streams, their borrowing capacity may be 50% or greater. However, this is still a long way off the borrowing capacity for 'safer' investments such as Australian residential property, which can enable a an LVR of over 80%.

Farm businesses that take on too much debt can therefore become unable to respond to opportunities to invest by borrowing further, as their ability to further borrow is prevented because of their exposure to a poor production year (Planfarm, 2018).

2.4 Rural communities

Rural Australian communities and businesses are also impacted by seasonal weather events which impact farmers with many of these businesses relying on patronage from surrounding farmers. Consequently, many support businesses and their families must also have management strategies to deal with factors of economic shock e.g. drought.

In Perenjori, WA, some local civil businesses have moved to larger regional centres to provide a wider customer base which may be less prone to localised drought and flood impacts. Mechanical businesses have opted to switch to fixed term and casual employees to be able to respond quickly to quieter and busier seasons, with farmers reducing their maintenance budgets during and following poor seasons. Many employees are on drive-in drive-out rosters, as short-term contracts do not warrant them moving permanently into town. Farming businesses have also become increasingly reliant on foreign seasonal staff, as it gives the business more flexibility to adapt to labour requirements and cashflow of different seasons. The transient nature of farm and rural employment has had big flow on effects to community services and organisations.

Chapter 3: Grain Production Risk Management in Other Countries

While other countries are not subject to seasonal production volatility experienced by Australian grain producers, the principles of risk and business management are similar. Successful businesses are focussing on small production increases in order to increase profit margins. Leading producers also heavily rely on finance in order to make productivity and efficiency gains, and investments are made where the ROI heavily outweighs the interest rate for finance used.

During the research, over 15 grain producers and six agricultural bank managers were interviewed throughout the USA, Canada and European Union (EU) about the keys to business success, risk management and growth. Commonly suggested similarities and differences to typical Australian businesses are:

Similarities:

- Two major profit drivers are production and price;
- Successful businesses are most profitable in the long term but may still encounter loss making years;
- Family succession can be a primary driver behind land expansion and subsequent business leverage;
- While farmers express concerns in high land values and are worried about a price bubble, most are actively seeking new land and few are looking to sell land assets;
- The price of arable land is a function of the potential gross margin of the area and the production volatility (stable production areas are valued higher);
- Arable land lease rates, in combination with the average land appreciation, makes it an increasingly sought after investment;
- Farmers are increasingly using futures and options to hedge price risk;
- There are concerns that the industry is too difficult for newer/younger farmers to enter; and
- Agricultural banks are very willing to finance businesses with good financial records and low risk of default.

Differences:

- Losses are often driven by poorer prices rather than poor production;

- Annual losses are frequent but generally much smaller relative to the asset base of the business (compared to the low and medium rainfall cropping zones of WA);
- Expected or average profit return on capital by top farmers is much lower than in WA, however still above available interest rates, which are also lower;
- There are several financial products available to manage production and price risk;
- Decisions are made using well managed and standardised profit margin data rather than annual budgets;
- Farmers are more willing to invest in opportunities with lower ROI (4-8%), and therefore a longer payback period;
- Farm planning and infrastructure building is done with a long term view, as it can be depreciated and paid off over a longer period of time;
- Government recognises farm investment confidence and output as a contributor to the greater economy and has policy to support it.

3.1 USA – Farm Safety Net

The USA farm safety net is undoubtably the most extensive and complex insurance system in global agriculture. It has been developed over several decades in order to protect the domestic agricultural economy from economic shocks associated with poor seasonal weather, as well as reducing the reliance on ad hoc government disaster relief funding. There is debate about whether or not the program contravenes free trade principles of the World Trade Organisation (Smith, 2018) (Packard, 2017), however it is widely accepted that the primary function of the program is to improve industry confidence by reducing risk of environmental perils rather than economic subsidisation (Ashley Craft, 2015).

There are two major components of the Farm Safety Net; the major being the grain farmers revenue protection 'Federal Crop Insurance' which protects revenue and with premiums which are subsidised by 65% from the government to encourage universal coverage. The second is the Agricultural Risk Coverage (ARC) and Price Loss Coverage (PLC) program, which is supplementary commodity price insurance.

In addition, many grain farmers also take out additional hail insurance on crops, which is very similar to fire and hail insurance available to Australian grain farmers. This is purchased from private companies and is not subsidised by government. Policies provide coverage for the exposed deductible production between federal crop insurance (75-86% of the average yield) and expected yield for that year. This indicates that farm businesses are not only looking to protect against losses but also see value in additional insurance to protect potential profit. Hailstorm frequency and risk is extremely variable across the USA, with some regions paying up to 9% premiums for hail insurance (most of Australian farms pay 1-2%).

3.1.1 Why is the program so complex?

The complexity of the program is regarded as necessary to accommodate the diverse range of producers wanting to participate in the program (Harper, 2019). The Farm Bill has been consistently updated to include more specialty crops including horticulture, yet outdated poorer performing programs have not been removed as it is too politically difficult to change or remove established programs pertaining to traditional grain crops (Newton, 2019).

As this program insures performance of individual farmers it has been prone to fraud / moral hazard events. Therefore, elements of the program have become increasingly complex in order to close loopholes for farmers trying to manipulate claims, or 'farm insurance' as referred to by USA and Canadian farmers. According to them, incidences of fraud are now rare, however it has left a heavy administrative and compliance burden on the program (Mattson, 2018) (Ashley Craft, 2015).

3.1.2 Why does the USA continue to subsidise it?

While expensive, there are several reasons the USA continues to subsidise their Farm Safety Net. These are debated by political fractions and economists, sometimes with different conclusions, and include:

- Reduction of risk from primary industry stimulates spending and production which supports the wider agriculture industry and USA economy (Sumner & Zulauf, 2012);
- Increase in economic activity increases tax revenue by an amount which at least partially offsets the US$15.6b in annual subsidies (Smith, 2018) and at most are net positive for taxation revenue; and
- Premium subsidies are already built into land values. Removing them could destabilise land values which at worst could cause economic shock, and at best would be extremely politically unpopular given the wide range of USA population who farm or invest in agricultural land (Newton, 2019).

3.2 Canada - Profit margin insurance

Despite the Canadian government supporting several crop insurance programs, two private companies have recently formed to provide unsubsidised crop insurance which is competing with the 60% subsidised government products. This was extremely surprising, given that farmers were very price sensitive when selecting their crop insurance product. However, there were several competitive advantages the private products had over the government products allowing them to succeed:

- Private insurance companies could compliment government insurance products where required. In some cases, a farmer would have their 0-60% yield insured covered through government, where the private insurance product would provide a top-up deductable product to cover the farmer up to 80% of their average profit margin.
- Both farmers and lenders preferred to cover profit margin insurance rather than gross revenue or yield as it provided greater financial certainty that a business could cover costs.
- Private insurance companies were able to cherry pick low risk clients, whereas the government products were designed for almost universal participation, including higher risk farmers.
- Canadian farmers have collected data on inputs and production for a long time in order to comply with government insurance requirements. Therefore, minimal administrative costs are required in order to execute quotes and claims by the private insurers.

Farmers can take out profit margin insurance through an assessment of their (5-10 year) average gross margin of the particular crop being grown, as well as the variable inputs allocated to that crop (fertiliser, chemicals, fuel and seed). The difference between the two figures is the 'nett profit margin', which includes the profit made by the farmer and the fixed costs required to run the business. Many farmers will take out sufficient coverage to cover fixed costs including the premium of insurance. This ensures that they cannot make a loss, allowing them to focus on decisions to make the business more profitable. A hypothetical summary of an insurance product for an Australian farm is detailed in the table below.

5-year average gross margin for wheat	$500/ha
5-year average variable input costs (fertiliser, chemical, seed, fuel)	$260/ha
5-year nett average profit margin on variable costs	$240/ha
Budget minimum fixed costs	$160/ha
Insured profit margin	$190/ha
Insurance Premium	$30/ha

Table 6: Example of how profit insurance might look for an Australian wheat crop

3.2.1 Case Study: Antler Valley Farm, Alberta

Wayne McAllister operates a 5,000-acre cropping enterprise in Red Deer County in conjunction with his sons, many who have recently returned to the farm. Wayne sees their return as an opportunity to expand in preparation for succession. They farm wheat, barley and canola and farm aggressively, using typically more inputs, but achieving greater revenue and gross margins than the district average. More importantly for Wayne, they're improving each year with better agronomic management. Crop insurance is a big part of their decision to expand – as they take on more land they take on more risk.

Figure 3: Antler Valley Farm, Alberta Canada

Wayne had been using the government supported crop insurance program through Alberta Agriculture Financial Services Corporation (AFSC) for many years in conjunction with hail insurance. The issue was that the 70% yield replacement coverage was based on historical agronomic practices, thus increased costs associated with their leading edge agronomy were not fully covered. It was estimated that this historical 70% yield replacement may only represent a 50% cover of production costs using a newer agronomic system.

Wayne's strategy is to insure his cost of production, including all business costs, land payments and depreciation. This covers the downside risk, enabling them to take on land purchase and lease opportunities with confidence, as well as providing full support by their bank to do so. In order to do this, he purchases additional profit margin insurance from either Just Solutions or GARS to cover the ~CA$250/ha difference between the subsidised government cover level and his full production cost.

Wayne also considered taking out full unsubsidised private insurance, as it is more administratively demanding to use two products in conjunction. However, presently it makes most financial sense to use a government subsidised product to cover some risk. Surprisingly, the full private cover product is only marginally more expensive. Having this extra option also means his business will be unaffected by any policy changes to the government product.

Without the extra insurance Wayne wouldn't have farmed the same way, and either would not execute the opportunity to purchase some of the properties or just delayed the decision to put an offer on and possibly missed out on those opportunities. Despite spending more in insurance premiums and rarely making a claim compared to his neighbours, he's very confident he's made more money from having the insurance.

Lessons learnt

- The value of insurance is about what it enables farmers to do, not the balance of claims and premiums paid (loss ratio).
- Insurance is best utilised by more productive and/or aggressive farmers (provided they have a good knowledge of true costs and production capabilities).
- Without full knowledge of costs and realistic long term business performance, it would be difficult to utilise the full potential of insurance to manage business risk and expand it.

3.2.2 Can profit margin work in Australia?

Profit margin insurance is not too dissimilar to the MPCI products available in Australia already. The major differences are:

- Profit margin insurance would require data to be kept and collated on input costs for each crop, as well as the production records required for MPCI; and
- Cover would be the nett margin rather than the gross margin, which would result in better coverage for producers, as it would account for reductions in input costs in dry years, and therefore result in a better distribution of claims when they're needed.

The other small difference is that additional inputs required for better years are going to be covered by insurance. When asked if this presented as a moral hazard risk for insurers as it had the potential to encourage the application of unnecessary inputs, both Canadian insurers responded that in their experience the extra inputs usually increased the profit margin, and therefore reduced their chance of claims. However, it was something they were monitoring and ensured they reviewed agronomy recommendations (Zayak, 2018) (Epp, 2018)

In theory, profit margin insurance should be more suitable than MPCI in Australia, however it may struggle to get initial volume with the number of farmers who have sufficient records for their historical inputs.

3.3 European Union – price index insurance

Price Index Insurance is an over the counter (OTC) product similar to a call or put option for commodity producers, however whereas options require the liquidity from a major exchange with global participation, an OTC product can written as a contract between a producer and an underwriter based on any third party price index. This product is most suited to producers (and purchasers) who do not have access to a local liquid exchange for their commodity. These are being offered in several internationally traded products such as nuts, vegetables, avocados, milk and dairy products. Products are also being developed for farm inputs such as urea, electricity and diesel.

In purchasing OTC price index insurance, a farmer will consult with the provider (insurer) who would need to analyse the price index for the commodity needing to be insured. The farmer can specify a minimum price needed for profit or business continuation, or any price desired for the overall business strategy. The insurance premium will be function of the required floor price and the current price of the particular index.

In the past two years, 2016 Nuffield UK Scholar Richard Counsell has developed an insurance product called Stable, designed to fill major gaps in price risk management, and assist farmers manage price volatility. The product has largely focussed on dairy and other EU traded food products, where there is easily accessible third-party price data. The product has been successful and has been adapted to suit a number of situations (Counsell, 2018).

3.3.1 Case Study – Index insurance incorporated into loans - Ireland

The incorporation of index insurance with agriculture finance is interesting and relevant for Australian conditions. Stable has developed several products in conjunction with agricultural lenders to reduce risk of loan default following poor market prices. One product has been launched in Ireland for dairy farmers where milk price volatility cannot be managed with futures contracts.

3.4 Captives

Captive insurance products are essentially crop insurance for farmers who do not need crop insurance. For many farmers, there is not the capacity to self-insure and/or desire to expand, invest or become more leveraged through debt. Other farmers who use crop insurance may shortly find that they are in this position after a few profitable years. In Australia, farmers use

Farm Management Deposits (FMDs) in order to smooth annual cashflow volatility and minimise tax. Insurance is used by many farmers to execute the same purpose as FMDs. These products are structured similar to MPCI products and referred to as captives.

Captives are essentially self-insurance offered by a separate entity owned by the farmer. The entity acts as an insurance company and is subject to financial and taxation laws applied to other insurance companies. However, as the insurance company only provides insurance for the one farm business entity, it merely acts as an income management tool and does not undertake all physical and administrative functions that a typical insurance company may provide.

Most captives also do not use reinsurance to underwrite their 'insurance product'. Premiums are not consistent. They are often much greater in higher yielding/revenue years in order to manage income as done with FMDs. Claims are made in loss making years and the captive insurance entity usually accumulates wealth and manages this investment on behalf of the farming business.

Given the initial set up cost to establish a captive insurance entity, they are usually only used by medium and large farming operations. The ability to use FMDs, given their associated tax benefits to manage farm income may negate the benefits of using captives, and this report has not assessed if Australian laws would enable or prohibit their use by farmers.

Chapter 4: Production Insurance vs Index Insurance

Across the globe, the most widely understood and purchased form of insurance for grain farmers has been a form of production insurance. This may be referred to as MPCI or crop insurance. This relies on an assessment of the production of each individual farmer in order to provide quotes and when making claims. Like any traditional insurance product, there is an inherent moral hazard and adverse selection for companies offering this product. This inefficiency must be priced into products, increasing the cost of premiums.

Index insurance does not rely on individual assessment in the process of providing quotes and making claims. Instead, the insured parameter is an independent data set which cannot be influenced by the behaviour of the farmer. This almost completely removes the risk of moral hazard and adverse selection (Hertzler, 2004) (Jones, 2007) (Ketchell, 2019) (Richard Oduntan, 2011). This type of product has been in existence for a long time; one example which may be familiar is commodity price swaps via banks. Whilst the price received on farm in Australia can be very different to the price of that crop on the CME, overall their correlation is considered close enough to use it as a hedge. Farmers can hedge on the Australian Securities Exchange (ASX), as the basis risk may be much less. However the liquidity of the CME makes it much easier to participate in. Just like commodity swaps/trading, weather index insurance is not a perfect hedge for farm production but a useful tool and is easier to underwrite than MPCI.

Individual Crop Production Insurance	**Weather Index Insurance**
Requires oversight and regulation to contain adverse selection and moral hazard	No inherent moral hazard or adverse selection
Insurance coverage easy to understand	Requires a good analysis of production/profit and weather index relationship
No basis risk	Some basis risk i.e. exposure to other perils
Claims require assessment	Instant claim payment
Products designed to one size fits all	Products can be designed by farmer
Reinsurance demand develops with performance of product	Very elastic reinsurance demand

Table 7: Comparison of index products with traditional insurance products

4.1 Weather index insurance in other industries

Energy production companies first started using weather derivatives after the El Nino events of 1996-1998 triggered extreme temperature events across the pacific and greater USA (Jones, 2007). This caused companies to seek to hedge their earnings which were based on energy use and seasonal temperatures in major cities. The Chicago Mercantile Exchange (CME) now offers temperature related weather futures and options across many US and European cities (Chicago Mercantile Exchange, 2019).

Industry	Weather Variable	Weather Exposure
Energy	Precipitation, Temperature, Wind, Solar irradiance	Reduced or excessive demand, Reduced or excessive supply
Agriculture	Precipitation, Temperature	Crop yield, handling, storage, pests
On Shore Construction	Wind, Temperature	Budget overruns, Schedule disruption
Sports & Entertainment	Precipitation	Cancellations, Schedule disruption
Retail	Precipitation, Temperature	Reduced product demand
Transportation	Precipitation, Temperature	Budget overruns, delays
Travel	Precipitation, Temperature	Cancellations, schedule disruption
Governments	Precipitation, Temperature	Budget overruns
Off-shore Construction	Wave, Wind	Budget overruns, Schedule disruption

Table 8: Weather risk across industries (Richard Oduntan, 2011)

4.2 Production Index Insurance in major supply chains

Like farmers, supply chain businesses can be vulnerable to seasonal weather and production volatility. Two of Australia's major grain handlers, CBH Group and Graincorp use index products to protect earnings from this volatility.

In April 2019, Graincorp announced a major contract with White Rock Insurance to address earnings volatility. The agreement is a two way derivative, with Graincorp receiving compensation of $15/t in poor production years for each ton below 15.3MT, and having to pay $15/t to White Rock Insurance in a large production year for each ton above 19.3MT.

Payment in either direction is capped at $270m over ten years, with Graincorp paying an annual premium of less than $10m (Graincorp, 2019).

CBH have had a similar arrangement over time with Sompo International Reinsurance. Initially their cover was based on ABARES production data, however because this data was often not published until 7-8 months after harvest, CBH formed an agreement with Sompo where claims could be paid in accordance with CBH's own production data, and corrections are made if ABARES data is inconsistent for any reason (Maurich, 2018).

4.3 How much does index insurance cost?

Because index insurance is based on a known historical dataset such as rainfall records, it's cost can be easily estimated given a set of key design parameters;

*Premium = (**Y***Average claim + **A***standard deviation of claims) ***B***

Coefficient **Y** accounts for any long-term trends if suspected, or if long term forecasting indicates a greater or less likelihood of the event occurring. In a neutral scenario Y can be assumed as having a value of 1.

Coefficient **A** represents the finance costs for the reinsurer to have funds available for a claim. The more predictable and uniform a dataset is (i.e. a smaller standard deviation of the dataset), thus the less likelihood of a large claim, the smaller this cost is. In the current climate this coefficient may be around 0.25-0.3 depending on the insurer. Should interest rates rise, this value may increase to reflect the extra cost of finance for a claim.

Coefficient **B** represents the brokerage and/or taxes applied to a contract, if applicable. For brokerage coefficient this value may depend on the size of the contract. Smaller contracts may attract a rate of >15% while larger contracts may be <10%. If sold as an insurance contract this may attract an additional stamp duty of ~10%. Brokerage and stamp duty can very quickly reduce the cost effectiveness of any product, particularly products which are designed to pay out more frequently (greater than one in ten years). This is discussed further in the following sections.

Using historical data, the average claimed amount for the designed product can be calculated. For weather events this might be calculated using the previous 20-30 years.

Unlike other insurance products, weather derivatives used to hedge drought and/or frost events are likely designed to provide claims in the medium/long term. Therefore, it may be questionable whether it is appropriate to consider the entire premium as being the cost of the product. For example; a product with a premium of $30/ha, pays out $21/ha on average over

ten years. Is it more appropriate to consider the cost of the product as $30/ha, or the $9/ha/year difference between the premium and the average claim?

4.3.1 Case Study: Hirsch Farms Rainfall Derivatives, 2018

Hirsch Farms operate a wheat, barley and canola cropping enterprise in the low-medium rainfall zone of the WA wheatbelt. Wheat has been the most common crop over history, with a 20-year yield average of 1.7t/ha which has increased up to around 2.0t/ha with recent productivity improvements. Barley and canola generally yield around 110% and 55% of the wheat yield in any given year, however this can vary depending on rainfall timing. The Hirsch's use rainfall to predict wheat yield potential in order to make seasonal business and agronomic decisions. Though canola and barley have overtaken wheat production in recent years, wheat is used as a proxy indicator because of the extensive data history.

The Hirsch's use a modified French & Schulz yield/rainfall relationship to predict their yield. The rainfall index is 50% of the preceding summer (Nov-Mar) rainfall in addition to growing season rainfall (Apr-Oct). This provides a reliable yet simple equation to predict their yield. Yield is calculated according to the following equation;

$$Y = K_{WUE}(x - E)$$

In this equation ***Y*** is the wheat yield in t/ha, ***K*** is the water use efficiency of their agronomic system in kg/ha/mm, ***x*** is the rainfall index according to the formula described above at the nearest BOM station, and ***E*** is the evaporation or rainfall required to produce a minimum yield. The coefficients ***K*** and ***E*** can be calculated by assessing the line of best fit of the historical yields with their associated rainfall indexes.

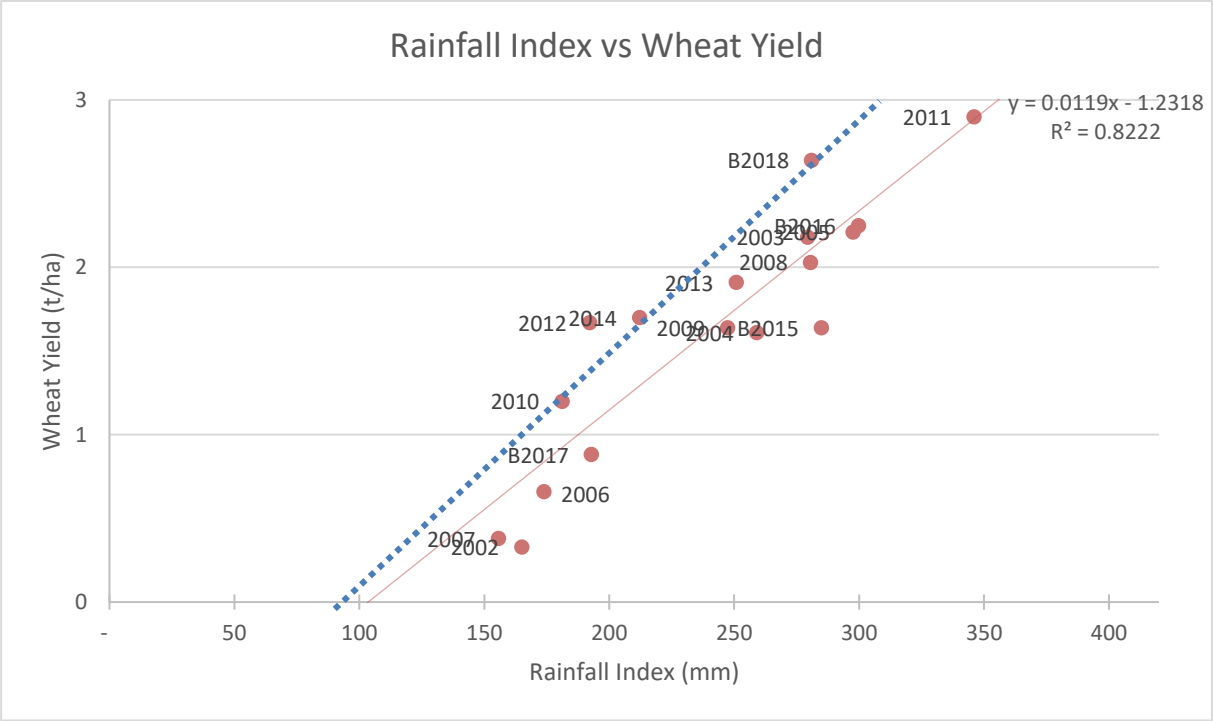

Figure 4: Historical wheat yields of Hirsch Farms vs rainfall index

Using Figure 4, the red line of best fit gives a WUE of 11.9kg/ha/mm and an evaporative loss of 103mm. To account for recent improvements in crop production systems and technology, the Hirsch's have drawn a new line (in blue) through more recent years, with a WUE of 14.3kg/ha/mm and an evaporation loss of 95mm.

Based on this relationship and an average farm gate value of wheat of $245/t, each mm of rainfall received in the growing season is deemed to be worth $3.50/ha to the business's seasonal gross revenue. By taking into account variable costs such as nitrogen and fungicides, Hirsch's estimate the overall profitability of their business has a desired break even at 225mm (1.75t/ha) and is ± $3.00/ha for every mm above or below this index value, making assumptions on grain and input prices.

Due to coming off a major drought and loss year in 2017, the Hirsch's wanted to ensure they would not go backwards in 2018. When finalising weather derivatives system in March, they had already received 100mm of summer rainfall across their enterprise and therefore needed an additional 175mm to achieve their indicative breakeven. They initially looked at insuring 175mm (Decile 2) of growing season rainfall, paying out at $3/mm/ha to a maximum of $133/ha at 130mm (Decile 0.5). This would cost them $34/ha in premium, which they need to incorporate into their breakeven threshold, and therefore increase their required rainfall to 186mm to accommodate for this extra cost.

With the introduction of soil amelioration, the Hirsch's have become increasingly confident of producing a profitable yield if the crop germinates in May or June, with deeper rooting depth allowing a crop to finish better and make use of summer and early season rainfall. They alternatively looked at taking out germinating rainfall cover only, with a critical amount of 55mm (Decile 2) from April to early June enough to get a profitable crop out of the ground to set it up given their summer rainfall. They then look at a germinating season rainfall cover, paying out at $4.5/ha to a maximum of $133/ha at 25mm (Decile 0.5). This would cost them $24/ha in premium, which may also need to be incorporated into their breakeven threshold.

Instead of choosing one product over the other, the Hirsch's took out half of each product. Increasing thresholds of the growing season and germinating rain covers to 186mm and 60mm respectively. At the end of the year they received 60.1mm and 195mm for these periods, indicating slightly above breakeven production conditions. However, crop yields ended up being above average as a result of agronomic improvements, giving confidence to produce a profitable crop on even less rainfall in the future.

Chapter 5: Preparing Australian Agriculture for Risk Management Products

As discussed in Chapter 3, the Australian grain industry is different to the grain industries in developed and even developing countries. This makes it difficult to introduce financial risk management products which may be successfully operating elsewhere to the Australian market. There are several ways in which the industry can prepare itself so that risk management products can be more effective when launched in Australia.

5.1 Working with reinsurers

When taking out insurance, one could easily be forgiven for thinking it is a product for client needs only. Where in fact, insurance is an over the counter contract between the client (the farmer) and the insurer (underwriting reinsurer in many cases). Any products design needs to fulfil the needs of both parties for it to be successful. If the product is too beneficial to the farmer, then it will eventually run out of reinsurers to be able to offer it, and vice versa. If the product can be manipulated and becomes prone to moral hazard, then the reinsurer will either have to increase premiums, or insert complex clauses into the contracts which may reduce the usefulness of the product to the grower (Counsell, 2018) (Malinow, 2019). Therefore, it is very important to design products with input from reinsurers to ensure it can be underwritten. Based on discussions with several major reinsurers in New York, London and Munich, reinsurers are actively seeking new products to launch in Australia, particularly where the following can be met:

a) There is **third party oversight of the underlying data**, preferably by a government agency. Reinsurers are looking for low cost, low risk products where a government or at least private independent agency oversees the data. This might be the Bureau of Meteorology (BOM), ABARES or private remote sensing data. Reinsurers of previous MPCI products in Australia found it difficult that farm production data was not scrutinised or supplied to any third party. Therefore, any relaunch of a production style insurance would likely require ABARES or similar agency to be responsible for overseeing the data collection, as is the case in USA, Canada and EU.
b) **A history of the data** is available. As the industry looks forward to what new innovative insurance products might be based on, questions may include what sort of data should have been collected earlier? If future insurance products will be based on on-farm rainfall recordings rather than the BOM station 40km away, it may be prudent to look at installing an automated weather station on farm now, to build up a dataset for this potential product. The same might be true for profit margin insurance. Whilst farmers

are not required to record production and input data for government reporting requirements in Australia, those who have this available and can produce a history of profit margins across their properties may be able to insure their profit margin.

c) **A counterparty** can share some of that risk. Mature risk products such as grain price futures are extremely efficient because for every producer looking to hedge their risk of low prices, a grain buyer also exists looking to hedge against high prices. Whilst it may be difficult to find direct counterparties who want to protect against 'high rainfall in the Australian wheatbelt' or a 'lack of frost in the Murray Darling Basin', there are many reinsurers and investors around the world who are looking at spreading their risk away from shares and bonds, and diversify their existing weather risk book which may be weighted to Europe, Asia and the Americas.

d) **Credit risk can be managed**. Insurance and option type products are easy to offer to farmers because the farmer is required to pay up front, eliminating risk of buyer default. However, in order to offer any more complex products which may have longer terms, two-way options, or sequential premiums, the reinsurers may not be comfortable with the credit risk of typical Australian grain farmer. In these instances, a third party such as an Australian bank might have to act as the intermediary.

5.2 Data collection and sharing

Data is critical for successful insurance products to function, whether it be the dataset for an index product, or to assess and validate quotes and claims for production insurance. Sufficient data can save the cost of assessors having to visit farms in the case of claims and speeds up response time for transactions.

Several new technologies have recently arisen to give insurers as others better access to data such as the internet, satellite and drone remote sensing, and local grain market pricing tools. However Australian on-farm data remains undisclosed and poorly collected and published by ABARES (Ketchell, 2019), in comparison to on-farm benchmarking and crop insurance data carried out by USDA (Mattson, 2018). Private benchmarking is gaining popularity in Australia, however low level voluntary data does not allow the same level of analysis enabled by universal participation and government oversight (Grenier, 2018).

In the USA, farmers submit on farm production, land value, input and pricing data through several annual surveys for the USDA. While farmers are concerned about data privacy, most find the aggregated regional averages extremely useful for planning and benchmarking purposes, let alone the ability to insure against the datasets. Australian farmers seem to share similar data concerns, however without experiencing the benefits of aggregated data, it may

prove difficult to convince them of the merit of providing on farm data to agencies such as ABARES.

5.3 Syndication and mutual groups

A common criticism of insurance products by farmers is that they are expensive, and that it often involves payment to large foreign entities, representing cash leaving the local economy. One mechanism to reduce the cost of premiums and retain local capital is to syndicate with other growers and even form mutual groups. Whilst not common in Australian agriculture, mutual risk management groups have become very common in other industries and within agriculture in other countries.

In Canadian agriculture, regional mutual's have become the primary provider of most agricultural insurance products, most being over a century old. Several mutual's have even combined funds to create large reinsurance companies which underwrite their member mutual and even invest in foreign insurance products for very competitive investment returns (Ketcheson, 2018). Mutuals provide several benefits over privately provided insurance (Howell, 2019):

- Syndication of several farmers insurance policies reduces overall standard deviation of claims, thus reducing premiums;
- Reduction in moral hazard due to self-policing by members and personal relationship between farmer clients and locally owned and operated mutual;
- Once mature, the mutual can make investments in local property, businesses and infrastructure (provided these are as profitable as external investments);
- The mutual can react quickly to member risks and launch novel products as required; and
- Whilst members cannot sell their share in the mutual for value, the reduction in insurance premiums leads to an increase in profit margins in the area and is therefore reflected in local land prices (in a similar way cooperatives such as CBH impact on land prices in WA (Varischetti & Prendergrast, 2016).

5.4 Regulation and stamp duty

The general insurance industry in Australia is governed by several laws (most importantly the Insurance Act 1973, the Insurance Contracts Act 1984 and the Corporations Act 2001). Insurance duty or stamp duty is applied to the premiums of insurance policies in all states of Australia, however for crop insurance, some states provide duty exemptions as recognition for the need for better risk management.

State	Stamp Duty
New South Wales	0% (exempted)
Northern Territory	10%
Queensland	9%
South Australia	0% (exempted)
Tasmania	10%
Victoria	0% (exempted)
Western Australia	10%

Table 9: Crop insurance stamp duty fees across Australian states (Grain Growers Limited, 2018)

The added cost of stamp duty can become prohibitive, particularly for products designed to pay out frequently such as crop insurance. Using the effective cost analysis as explained in the previous section, for catastrophic event (1 in 100 years) insurance cover of $500,000 such as harvester fire may cost around $15,000 in premium, which an average claim of $5,000 over 100 years. The effective cost of insurance is $10,000 being the gap between premium and average claim. The 10% ($1,500) stamp duty increases the effective cost by 15%.

However, for common event (1 in 5 years) cover of $500,000 such as drought insurance, the premium may be around $144,000, making the effective cost of insurance $44,000 per year. In this case the 10% ($14,400) increases the effective cost of insurance by 33%.

In order to make a risk management product cost effective by avoiding the insurance duty tax, in some states it may be beneficial for farmers to purchase coverage as a derivative as opposed to insurance products. Derivatives fall under different regulations (ASIC) than insurance products and can only be offered by licenced providers. For this reason, many insurance companies are not able to offer competitive weather products in Northern Territory, Tasmania and WA.

By continuing to enforce the insurance duty on high frequency claim products like crop and weather insurance, states are limiting the risk management options for farmers and the ability of professionals to offer advice on it, let alone be able to offer a product. Whilst private industry and larger businesses may be able to navigate around this bottleneck using licenced financial derivatives to offer protection, smaller farms with less experience in trading options may find it more difficult to understand.

Chapter 6: Alternative Systems for Reducing Climate Risk

While it could be argued that the current available financial instruments (weather derivatives and MPCI) is enough to meet risk management requirements of Australian grain growers, and it is their utilisation which needs improvement, alternative product structures may allow a better market uptake as they better meet the needs of farmers looking to reduce risk.

6.1 Coupled index insurance mortgage

While risk management tools are often best used to help leverage a business, there are also additional efficiencies which can be achieved by combining insurance and finance products. As the insurance product has to be structured to cover the requirements of both the farmer and the lender, it may be more efficient for the insurance product to be packaged to the finance of the loan (Malinow, 2019). This type of structure has been offered in Ireland with dairy farmers accessing loans which waive repayments if the milk price drops below a certain value (Counsell, 2018). The structure provides the following advantages:

- The insured term is over the life of the loan (10-15 years), making it more attractive to reinsurers and therefore reducing the premium;
- Less risk of incorrect coverage or emotional decision making as insurance cover is designed specifically for both creditor and debtor;
- It significantly reduces the risk of loan default in the event of poor weather/market conditions, lowering the customer margins applied to the interest rates;
- Reducing short term default risk may allow longer repayment terms and/or reduce the required upfront capital on land or other investments.

6.1.1 Scenario: Rainfall insured mortgage

Farmer A is looking at financing a property purchase. The property has potential however requires some investment in the first five years to reach production potential. Due to maintenance costs, there is a significant risk if Farmer A experiences a drought in the first five years, as well as considerable cashflow limitations on the business because of the extra property maintenance costs.

Banker B recognises the property requires maintenance and that there is potential for property value appreciation if the right improvements are carried out. However, if the district has a drought in the first few years, it may risk having to put back on the market before such improvements can be made and also an issue of poor liquidity after such years.

In normal circumstances the $1m land purchase would require a 50% deposit with the balance financed at 5% over 15 years. Resulting in annual repayments of $48k to cover both interest and principal.

In order to satisfy the needs of both Farmer A and Banker B, a five-year rainfall insurance product is taken out which covers the interest payment in the event of a one in five-year drought (Decile 2 and lower). The cost of this insurance is equivalent to a 1.3% increase in interest rate, however due to reduced risk of the loan they are able to secure an interest rate of 4.1% instead of 5.0%. Additionally, because of the insurance the bank agrees to allow the option of making interest only payments in the first five years.

Year	Rainfall Decile	Traditional Loan Repayment	Insured Loan Repayment (including insurance premium)
1	6	$48,171 (5%)	$27,000 (4.1 + 1.3%)
2	1	$48,171	$6,500 (0 + 1.3%)
3	3	$48,171	$27,000 (4.1 + 1.3%)
4	7	$48,171	$27,000 (4.1 + 1.3%)
5	9	$48,171	$27,000 (4.1 + 1.3%)
6	4	$48,171	$61,953 (4.1%)
7	5	$48,171	$61,953
8	2	$48,171	$61,953
9	8	$48,171	$61,953
10	10	$48,171	$61,953
11	2	$48,171	$61,953
12	5	$48,171	$61,953
13	9	$48,171	$61,953
14	6	$48,171	$61,953
15	5	$48,171	$61,953

Table 10: Example of an insured loan amortisation schedule

In this case the insurance premiums paid to the reinsurer over the first five years equate to an additional $31,000 in loan repayments (with $20,500 returned in claims on average). However, extra flexibility of the finance allows extra cashflow to be committed to the required property maintenance in the first five years.

As well as coupling insurance to loans, similar benefits may be obtained by coupling insurance with long term lease contracts, where the lessor is able to waive lease payments following a poor season in exchange for higher payments. Such a product may/may not have to be underwritten by a reinsurer depending on the lessor's capacity and appetite to participate in risk.

6.2 Weather swaps

A swap type product may be a more effective and palatable structure than a derivative for insuring against seasonal weather effects.

Grain swaps are over the counter (OTC) products offered by banks to grain businesses to hedge price risk, and are becoming widely utilised and accepted because of their low transaction costs and impact on business cashflow requirements (Critch, 2019). Insurance and options products however are perceived by many farmers as being too expensive according to a 2018 survey conducted by the author.

6.2.1 Scenario: Rainfall swap for a grain producer

Farmer B is looking at rainfall derivatives to protect the business against drought as undertaking succession planning which is likely to require more debt and therefore drought exposure of the business. The property receives on average 220mm of growing season rainfall (GSR) and there is a belief the business can breakeven including finance costs with production on 180mm GSR, which statistically is likely to receive in 75% of years. Farmer B calculates that each mm of rain below this amount will cost the business $3/ha so looks at insurance/derivatives which will cover this loss from lack of rainfall.

A rainfall derivative to cover for $3/ha per mm below 180mm GSR (capped at $120/ha maximum) is looking to cost $27/ha. However, with cashflow already constrained because of the extra debt, Farmer B is uneasy about this additional expense. Also, if they only receive 180mm GSR then they might breakeven but would be behind $27/ha with the additional cost. Farmer B knows they should probably insure a higher GSR to cover this cost but knows that this will probably cost even more.

The broker suggests using a swap type structure to reduce the cost of the derivatives. He works out that by paying the insurer a $2/ha per mm above the average GSR, this would completely offset the price of the derivative which is protection during a drought. The problem is that the large multinational reinsurer does not see them as a secure debtor in the case of an above average year. An agreement is therefore made between Farmer B, the reinsurer and the bank as the third party, who acts as the guarantor for the product. The extra cost of this security is offset by the reduction in the customer lending margin.

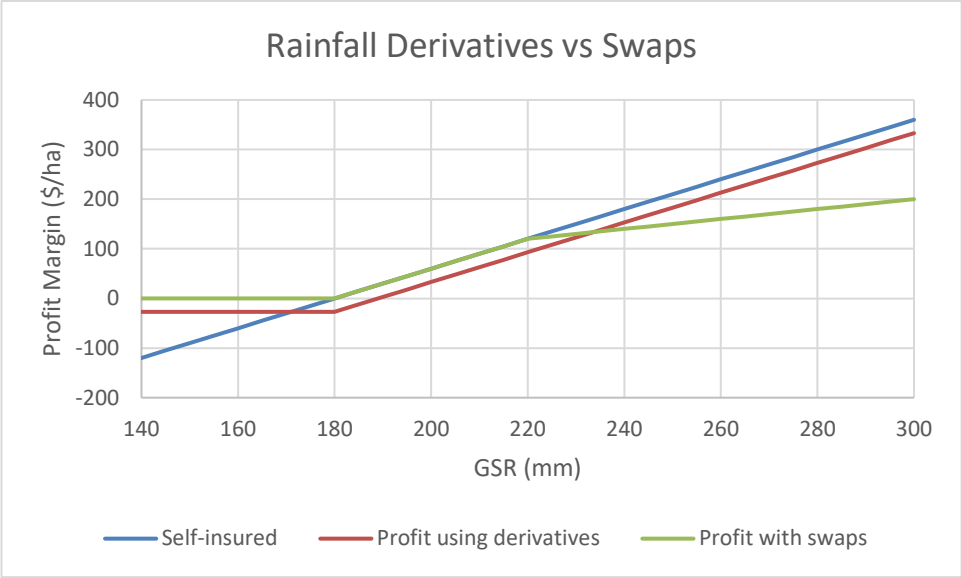

Figure 5: Profit margin analysis for Farmer B under self-insured, weather derivatives, and weather swaps products

Alternatively, Farmer B could opt to forgo only $1/ha per mm in better years, which would cover half of the cost of the protecting derivative, so still costing $13.50/ha in premiums. However, the lessons learnt from grain price swaps in Australia suggest that a 'zero cost' protection product is the most palatable to farm businesses.

6.3 Regional wheat yield index

An insurance product based on a regional wheat yield index could find the middle ground between the moral hazard and adverse selection risk of individual MPCI, and the basis risk of single peril index products such as rainfall insurance. The insurance would require a published history of wheat (or any other crop) yields for a defined region, ideally certified by a government agency such as ABARES. Farmers could use as much or as little of the product as they like, even using the wheat yields as a proxy for other crops where they may have insufficient data to offer insurance for. Farmers on the edge of two or more regions could also purchase insurance for either index.

This type of product would be ideal for regions which experience a diverse range of perils, or perils which are difficult to insure against e.g. frost. The product would however rely on a more detailed reporting of crop production either by ABARES or another government department.

Previous proponents of yield index insurance have proposed a model which transforms an individual variable such as rainfall into a predicted yield (Hertzler, 2004). This is already possible to do with careful structuring of weather derivatives but does not solve the problem of excessive basis risk in areas exposed to a range of perils.

Production information which is currently provided at a state level would likely have to be defined down to a shire or similar level, involving the participation of farmers and bulk handlers. This current data could be extrapolated back using NDVI satellite images to produce a production history for each shire. Due to the time it takes for ABARES to finalise production reports, the product may require an early claims system to allow farmers to recover a portion of the expected claim amount immediately after harvest, before receiving a final correction amount once the data is reviewed and certified.

6.3.1 Scenario: Regional wheat yield index insurance

Farmer C farms wheat, barley and canola in the Shire of Utopia. The Shire's ten year average wheat yield is 1.7t/ha, however due to a combination of being in one of the better areas of the shire, and utilising best practices, Farmer C has averages of 2.2t/ha for wheat, 2.4t/ha for barley and 1.2t/ha for canola. In drier years they drop out canola for full cereals, but generally canola is 40-70% of their wheat yields each year. Drought, frost and heat stress are all major risks in their region.

Farmer C is looking to use the new regional wheat yield index insurance to insure against poor production yields. They believe breakeven in most years is around 1.7t/ha including land repayments but are happy to take a small loss to protect their production below 1.5t/ha. Based on own production data, they are almost always 0.4-0.6t/ha above the shire average for wheat production, so rather than insuring against a Shire Wheat Yield of 1.5t/ha for $65/ha, they take out the insurance at 1.0t/ha on the index for around $12/ha in premium. They take the insurance out in January before they know how much cereals and canola they will put in, so they use the wheat production insurance as a proxy for canola and barley.

In April, Farmer C looks at leasing a block in a cheaper but drier region of the Shire. They expect yields on this block will be closer to the Shire average, so they decide to purchase additional index insurance at around 1.2t/ha to cover the lease and variable inputs of the extra crop. The insurance costs $24/ha, down from $30/ha it would have cost them back in January as the insurer is factoring in the above average summer rainfall received in the last three months.

6.4 Government subsidised insurance

If the lessons learnt from the failures of the USA crop insurance subsidies can be heeded, then it may be possible to use subsidies to improve take up of crop and/or index insurance products in Australia. Australian farmers are not an important political pressure group like the USA or EU. Therefore, it may be possible to introduce a subsidy which has a sunset provision to remove it at a certain time, or when farmer participation levels reach self-sustainable levels. Based on interviews with farmers in the USA and Canada, crop insurance may well be

sustainable without subsidies, given that almost all interviewees indicated they would still participate in crop insurance even at the elevated premiums without the government subsidy.

The priority of any subsidy should be catastrophic level cover to replace the status quo of ad hoc reactive relief funding such as the Australian National Drought Program, Farm Household Allowance and Concessional Loans. This could be done through a variety of ways:

a) Direct subsidisation of the catastrophic level (<1 in 50 year) portions crop or weather insurance for rural businesses. For a typical grain grower in the low to medium rainfall areas of Australia this might be ~$5/ha;
b) Setting up a government-based reinsurance arm to cover catastrophic level portions of crop or weather insurance products (which would be somewhat cheaper but more erratic than option a); or
c) A combination of a) and b).

The system would only be cost effective if the ad hoc relief funding was suspended to recipients who were able to access the relevant catastrophic insurance. This might be difficult if farmers refuse to take up the insurance, experience catastrophic drought conditions, and are able to apply significant political pressure to receive ad hoc disaster relief funding. This occurred through the corn belt of the USA in the early 1990s, however as Australian farmers do not exert the same level of political pressure, there may be less expectation to provide ad hoc assistance in this situation.

6.6 Input and finance risk sharing schemes

One of the biggest beneficiaries of reduced risk and increase in confidence by farmers is input suppliers, particularly those of variable demand inputs such as hybrid seeds, nitrogen fertiliser and fungicides. These inputs are dependent on seasonal weather and local farmer confidence. The uncertainty in demand can lead to production and supply chain inefficiencies including:

- Increased requirement for storage and carryover product to supply high demand seasons;
- Financial losses incurred by suppliers and retailers in poor seasons due to over capitalisation; and
- Opportunity losses in better seasons when products like hybrid canola and nitrogen become sold out or are not available in optimum times.

These inefficiencies have seen companies like Bayer and Syngenta launch risk sharing programs in Australia for input products to increase farmer confidence and stabilise demand for certain inputs. Programs like the DecilePro for RoundupReady canola seed and Agriclime

for crop protection products provide partial refunds in the event of a dry season. These programs are not available in developed countries with existing crop insurance programs like the USA, Canada and EU where product demand may be more consistent, instead focussing on developing agricultural economies in Africa, South America and Australia.

The cost of reinsuring these programs can be significant, so it must be built into the cost of these products. However, where cost of the inefficiencies due to uncertain demand may also be significant, suppliers may be able to absorb the cost of reinsurance within the existing price of the product.

Chapter 7: Implications of Risk Management Instruments in Australian Agriculture

7.1 Increasing capital access by reducing drought exposure

Growers who can reduce their exposure to production volatility will eventually be able to better leverage their businesses if required. This outcome can be seen in the Australian grain industry with the difference in finance requirements and investment behaviour between regions considered more reliable and those which are considered riskier.

In the northern WA wheatbelt, farmers in the H1 and H2 (high rainfall) regions are spending 7.8% on finance costs in comparison to operating costs. Whereas in M1 and M2 areas this drops to 5.7%, and in the L1 and L2 (low rainfall) this drops to 4.4% (Planfarm, 2018). This suggests that:

a) Financiers are more willing to lend to farmers operating in areas with less production risk; and/or
b) Farmers with more reliable production have a bigger appetite to leverage their business.

Visits and interviews with farmers in the USA, Canada and EU further reinforces this observation. Here, production risk is not just a function of geography, but also the insurance products available to farmers. It was not uncommon to see farmers borrowing >75% of land purchases at interest rates below 5%. It was however uncommon to see any farmers achieve >10% ROI on average or even in an individual year (Mattson, 2018) (McAllister, 2018).

In these countries, lending criteria on property purchases seemed to be much more focussed on capacity to generate profit on cropped area, rather than existing business equity. This would seem a much more efficient allocation of capital, however might be difficult to apply in Australia as the practice of recording and benchmarking profit margin data is not yet common.

	WA Medium Rainfall Grain Farmers	Seasonal Risk Managed
Loan Interest Rates	6%	4.5%
Grower ROI target	10%	6%
Minimum Equity	60%	25%
Grain Forward Sold	20%	60%
Land Value	20x lease value	35x lease value

Table 11: Comparison of current financial attitude of agricultural businesses and lenders compared with countries which utilise financial risk management instruments

7.2 Separation of land assets from the operating business

Succession poses a significant challenge to farm businesses in Australia, with many Nuffield reports dedicated to the subject. One of the major challenges facing Australian farmers is the requirement of land assets to finance the operating business. In other industries and in agriculture businesses in other countries, line of credit finance can be obtained on revenue generation of the business. In Australian agriculture, business revenue can be unreliable due to seasonal weather, meaning line of credit is often secured by land assets of the company. Lease only businesses are rare, with initial land ownership seen as one of the first and most critical steps into starting a farm business.

In the USA and Canada, crop insurance means that a typical grains business is guaranteed to recover the majority of their operating expenses in a given year. Therefore, line of credit finance can be obtained for any business with an insurance policy. It is common for first generation farmers and contractors to have crop operations using leases rather than purchasing land. Even though the lease market is competitive, lease rates are typically still 1.5-3% of land values. Largely because farmland owners are satisfied with the total rate of return from leases and land appreciation which can be 4-7% in total. Further analysis of land value effects is covered in the next section.

The separation of land assets from the operating business due to crop insurance enables:

- Farm businesses to undertake succession without necessarily transferring land ownership;
- Greater capital investment by non-farming investors in agriculture land; and
- Access to land for first generation farmers through greater availability of farm leases.

It must be noted that the outcomes above may take considerable time to realise as the industry reaches an equilibrium following the introduction of risk management instruments.

7.3 Will insurance exaggerate land values, and is this a bad thing?

One of the most common criticisms of the USA crop insurance program is its role in increasing agricultural land prices. This has been voiced by farmers in Australia as well. There are several reasons why crop insurance in the USA has led to higher land prices. Some of which may be considered beneficial whilst others merely artificial.

Increasing access to capital to farmers

As discussed previously, by managing seasonal profitability volatility farmers tend to invest more in their business and agricultural lenders become more willing to finance these investments. Provided the cost of the risk management instrument doesn't overly detract from the overall profitability of the business, this may cause greater demand by farmers for additional land. This will see sustained increase in land values unless the risks management instruments were discontinued, which might risk a subsequent collapse in prices.

Long term subsidies

Initially, subsidies encourage farmers to embrace a product until it can become self-sustaining without the need for further subsidy. Once this happens the subsidy is not required, and only increases the profitability of the farmer who receives it. After time this extra subsidised profitability results in increased land prices. Based on a rate of 5%, a wheat farmer receiving $25/ac in subsidy on crop insurance might be able to pay $600/ac extra for land due to the increase in profitability. This inflation is considered artificial and unsustainable by many critics of the crop insurance program, and some also suggest it may contravene the rules of free trade (Packard, 2017) (Smith, 2018).

Land price stability and liquidity

By curbing the peaks of land supply and demand caused by drought and good production years, land prices can eventually stabilise with the profitability of the land, rather than the ability to finance it. With additional lease liquidity as mentioned previously, and better regional benchmarking on farm profitability, land prices can be more accurately predicted using statistics, rather than relying on speculation.

The stabilisation of agricultural land prices could lead to it becoming a desirable investment for non-farmers, as is the case in USA and Canada. If these investors have a lower ROI expectation than existing businesses, land prices will increase until the lease yield and appreciation of the land value meet the investors reduced ROI expectations.

With the current influx of external capital investment into Australian farmland, land affordability remains a big concern. The introduction or development of any product which manages volatility of farming profitability is likely to eventuate in high land prices eventually, particularly in traditionally riskier climatic areas. However Australian farmers should understand that the widely held belief, that land ownership is required in order to finance a farm business, is only true because of the seasonal production volatility, and is not true in more developed countries that manage this risk effectively.

7.5 Regional benefits from herd immunity

As more farmers in a particular region reduce exposure to seasonal production volatility, businesses and communities may start to experience several flow-on effects from greater investment confidence which many of the local service businesses rely on. This may include:

- More employment opportunities, and full-time positions rather than casual;
- Greater investment in on farm infrastructure;
- Increase use of inputs;
- Increased production; and
- Better population retention and public services through extra economic activity.

Case Study: Chester, Montana USA

Chester is a small town in rural Montana, surrounded by broadacre wheat farms. These typically produce 2t/ha, however range from 1-3t/ha depending on seasonal rainfall which averages 275mm, rent for AU$$77/ha, sell for AU$4500/ha (United States Department of Agriculture, 2016). The nearest city is Great Falls, which is 150km away and has a population of 58,000. In many respects, it seemed very similar to many small towns in the WA wheatbelt, particularly in terms of agricultural output and production risk.

However, walking through the main streets, one might notice the diverse range of small businesses in town. Medical Centres, Art Centres, lawyer, hairdressers, grain traders, and many others which depend on surrounding farm businesses and their population. In many WA towns, these businesses have relocated to large towns and regional cities as the small cities. When asked why some of these businesses didn't pack up and relocate after droughts, local farmer Carl Mattson attributed the federal crop insurance program as the reason local businesses stayed. Mattson suggested that the beneficiaries of crop insurance were rural businesses rather than farmers themselves, because farmers were able to continue to employ and conduct business with them following droughts. While it is difficult to wholly attribute this to crop insurance, it is perhaps feasible to suggest that the decline of many rural wheatbelt towns is because of exposure to risk above all other factors.

Figure 6: Main street business facade of Perenjori (photo by Bahnfrend 2018) and Montana (bigskyfishing.com)

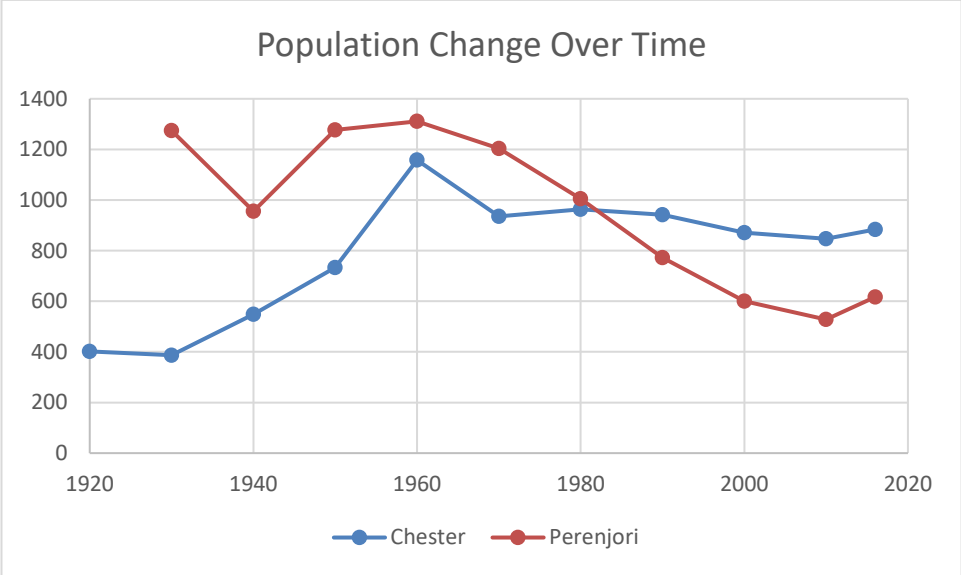

Figure 7: Population over time, Chester, Montana vs Perenjori, WA

Conclusion

MPCI has been transformed and relaunched in Australia several times in the last three decades and more of this may come, if potential improvements from other successful foreign products are applied in Australia. However, the industry lacks the political pressure required to attract government support, which has seen the broadscale implementation of insurance programs across developed agricultural industries in the USA, Canada and the EU.

The new age of 'big data' is enabling developing agricultural industries in Eastern Europe, India and several African and South American nations to implement index insurance programs for farmers, subject to seasonal production risks at a fraction of the cost of traditional crop insurance programs. The last decade has seen development of available datasets on which to base these index insurance programs, such as satellite remote sensing imagery, weather station networks, and government collected industry production data. As a result, index insurance has the potential to not only replace the need for MPCI in these developing countries but surpass it in terms of performance across all agricultural industries.

Based on their implementation in other countries, the biggest beneficiaries of agricultural financial risk management products are not just farmers. The lift in confidence and industry investment presents an excellent opportunity for agriculture services and suppliers, especially regionally based businesses which may be particularly dependent on seasonal farm spending.

The launch of these products in Australia is inevitable, but the present opportunity is for Australian farmers and the broader agricultural industry to shape how these products will function. Engagement with the insurance and finance industries, as well as government, will ensure the benefits of risk management programs are realised collectively.

Recommendations

In order to prepare for and best utilise new financial risk management products:

- The GRDC and other Australian Government agencies should better invest in industry performance data including weather station networks, radars, remote sensing and regional grain production reporting.
- ABARES should adapt surveys to capture data similar to that which is captured by private farm benchmarking groups and by the USDA.
- Australian farmers need to become more focused on quality data recording of all aspects of their production systems.
- Australian farmers should work with agribusiness lenders and reinsurers to develop products which provide benefits to all parties. This will likely see risk management products become symbiotic with agribusiness lending.
- Agronomists and agribusiness consultants should familiarise themselves with index insurance products to fill the void of independent advisors for the design of products for each grower.
- State governments should remove insurance duty on seasonal risk management products to enable the products to be offered by insurers and regulated as an insurance product rather than be limited to financial service providers as a derivative product.
- Agricultural lenders, including banks and finance product providers, should consider and incentivise the reduction in seasonal weather exposure by clients utilising risk management products.
- Australian farmers should use financial risk management products to reduce their risk, make longer term decisions, so that they can leverage and grow their businesses.

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Plain English Compendium Summary

Project Title:	Managing Seasonal Weather Risk using Financial Instruments
Nuffield Australia Project No.:	1819
Scholar:	Dylan Hirsch
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Objectives	• Challenge the way Australian agricultural businesses manage seasonal weather risk; • Investigate how businesses in other countries and industries manage weather and crop production risk; • Investigate the costs of insurance products, to identify bottlenecks and inefficiencies within the Australian agriculture industry for improving risk management; and • Provide alternative models for Australian agricultural businesses to manage seasonal weather risk.
Background	The ability of many Australian farming businesses to invest and take opportunities is often impeded by their exposure to drought and other climate risks.
Research	The use of various financial risk management instruments across agriculture and other industries to explore alternative strategies for use by Australian farmers to manage risk increase access to capital.
Outcomes	Alternative financial risk management instruments will inevitable and continually be introduced to Australian agriculture. However it is up to the Australian farmers and agriculture lenders to collaborate with reinsurers to design products which satisfy the needs of all stakeholders, so that the adaption of these products can become sustainable and they can contribute to industry growth.
Implications	Better management of seasonable production risk will likely lead to increased access to capital, decouple land assets from farming operations, increase land values and provide better outcomes for upstream businesses and rural communities.
Publications	Nuffield Australia National Conference presentation, Brisbane, September 2019