# Sub-Project 1: Insurance in the agricultural sector

## On-farm Financial Risk Management Project

A confidential Final Report prepared for National Farmers' Federation

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AITHER

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## About Aither

Aither's purpose is to help governments and businesses make better decisions about globally significant issues. Natural systems are increasingly strained and under threat, creating challenges in agriculture, water, infrastructure, cities, and the environment. The future is uncertain and the stakes are high.

We allow our clients to navigate uncertainty and complexity by providing clear, evidence-based analysis, insights and advice. Combining economics, policy and strategy, our advisors help decision-makers to clarify their objectives, address the right problems and opportunities, and continuously improve.

We offer services across four key sectors:

- Resilience and adaptation
- Water markets
- Water policy and management
- Water utilities and infrastructure.

Our senior staff take an active role in project delivery, leading teams with the specific skills required for each project. Experienced, committed and well-grounded in the areas in which we work, we are trusted advisers to leaders making tangible progress towards outcomes that matter.

## Abbreviations

| | |
|---|---|
| **ABARES** | Australian Bureau of Agricultural and Resource Economics and Sciences |
| **ABS** | Australian Bureau of Statistics |
| **ACCC** | Australian Competition and Consumer Commission |
| **AFCA** | Australian Financial Complaints Authority |
| **AFSL** | Australian Financial Services License |
| **APRA** | Australian Prudential Regulation Authority |
| **APSIM** | Agricultural Production Systems Simulator |
| **ARPC** | Australian Reinsurance Pool Corporation |
| **ASIC** | Australian Securities and Investments Commission |
| **AWS** | Automatic weather station |
| **BCG** | Birchip Cropping Group |
| **BoM** | Bureau of Meteorology |
| **CRU** | Crop Risk Underwriting |
| **DPIRD** | Western Australian Department of Primary Industries and Regional Development |
| **GBE** | Government business enterprise |
| **GST** | Goods and Services Tax |
| **IAG** | Insurance Australia Group |
| **ICA** | Insurance Council of Australia |
| **IPART** | Independent Pricing and Regulatory Tribunal of New South Wales |
| **MPCI** | Multi-peril crop insurance |
| **NVDI** | Normalised difference vegetation index |
| **PIRSA** | Primary Industries and Regions South Australia |
| **TPAWS** | Trusted Private Automatic Weather Stations |

## Glossary

| | |
|---|---|
| **Adverse selection** | A market failure that can occur when farmers have more information about their risks than insurers. |
| **Agricultural insurance** | Insurance covering agricultural production, property, machinery and vehicles, and liability claims. |
| **Agricultural weather insurance** | Insurance protecting farmers against weather-related production risks to crops or livestock. Includes indemnity insurance and index insurance products (including derivatives). |
| **Basis risk** | The difference between the amount paid to a farmer as an insurance claim and the actual value of losses incurred. |
| **Bounded rationality** | Caused my limited access to information and limited computational ability to make optimal decisions. |
| **Farmer transaction costs** | The costs to farmers of buying insurance, excluding premiums. Includes the opportunity cost of time and cost of external assistance. |
| **Government distortion** | Occurs when insurance is not produced or consumed efficiently due to government policy, such as taxes or restrictions. |
| **Indemnity insurance** | Agricultural weather insurance which pays a claim based on observed production losses. |
| **Index products** | Agricultural weather insurance which pays a claim based on an index related to production risk, such as a rainfall, temperature, or predicted yield index. Includes index insurance and derivatives. |
| **Information asymmetry** | Occurs when a farmer has more information than an insurer about their exposure to risk or behaviour. This can be exploited by the farmer, leading to adverse selection and moral hazard. |
| **Insurer costs** | The costs incurred by an insurer to negotiate, monitor, and enforce an insurance policy. This includes acquisition costs (including commissions paid to brokers), claims handling, and other general expenses. |
| **Loss ratio** | Total claims paid to farmers divided by total premiums paid to insurers. Does not include taxes or subsidies. |
| **Market failure** | Occurs when insurance is not produced or consumed efficiently. |
| **Moral hazard** | Occurs when a farmer exploits an insurer's lack of knowledge by taking more risk, increasing the expected value of claims. |
| **Natural barrier** | A barrier to uptake agricultural weather insurance which does not represent a problem with the insurance market. Natural barriers include lack of risk exposure and alternative risk management strategies. |

| | |
|---|---|
| **National Survey** | Survey administered by the NFF for the purposes of the on-farm financial risk management project. |
| **Systematic risk** | Systematic risk cannot be removed by diversifying investments within that market. |

# Executive Summary

- Agricultural weather insurance has the potential to enhance resilience and productivity, improving the lives of Australian farmers and contributing to the agricultural sector's goal of generating $100 billion of agricultural production by 2030.
- Agricultural weather insurance helps farmers to manage risk by providing compensation for production losses due to adverse weather. This is particularly important in Australia, where agricultural production is amongst the most volatile in the world. This volatility is expected to increase due to climate change.
- For an agricultural weather insurance market to be sustainable, insurance must be beneficial to both farmers and insurers. Insurance transfers risk from farmers to insurers. Farmers need to receive enough benefits from transferring risk (such as improved resilience and productivity) to cover their insurance premiums. At the same time, the insurance premiums need to be sufficient to compensate insurers for accepting the risk and their expenses.
- This has been a challenge. There has been interest in agricultural weather insurance for decades, and various attempts by insurers to develop an Australian market. However, these attempts have proven largely unsuccessful. There are currently only hundreds of farmers with agricultural weather insurance in Australia. There are agricultural weather insurance markets in other countries, but they generally depend on large and ongoing government subsidies.
- The stakeholders consulted for this project offered different explanations for the lack of uptake in Australia. Some suggested that farmers tended to be unaware of the insurance products available or underestimate the benefits. Others suggested that farmers were generally making reasonable decisions. To these stakeholders, the lack of uptake was better explained by barriers that reduce the benefits or increase the costs of insurance, such that agricultural weather insurance is not worthwhile for most farmers.
- The most important barriers are:
  - **Alternative risk management strategies**. Many farmers already have effective ways of managing weather risk. For example, building equity in good seasons and drawing on equity in bad seasons.
  - **Asymmetric information**. Indemnity insurance can be more attractive to risker farmers and can also motivate farmers to take excessive risks. This increases the costs of providing insurance, leading to higher premiums.
  - **Basis risk**. Index products do not provide farmers with complete protection. For example, insurance policies are often settled based on weather at the nearest Bureau of Meteorology (BoM) weather station. If a farmer experiences drought but there is sufficient rainfall at the nearest BoM weather station, the farmer will not receive an insurance payout.
- This report shows that the barriers are material. For example, we undertook a case study based on 13 farmers in northern NSW between 2016 and 2019. We found that farmers would have missed insurance payouts for drought about 24 per cent of the time, if their policies were based on the nearest BoM weather station.

- This report also provides evidence that the barriers can largely explain the limited uptake. We developed a detailed model of the agricultural weather insurance market that accounts for the most important barriers. While there is substantial uncertainty, our best estimate is that given the barriers, agricultural weather insurance would currently only be worthwhile for about 1,000 farmers. This has important implications. If agricultural weather insurance is to be successful in Australia, we will need to understand and address the barriers – awareness and education alone will not be sufficient.
- This report identifies several worthwhile government interventions that address these barriers and would help to facilitate the development of the agricultural weather insurance market:
  - **Support for on-farm weather data and technology**. For example, the BoM is currently developing a program that could allow farmers to use local private weather stations for index products. This would help to reduce basis risk. Further government investment is required to complete the program. The costs of completing the program would be modest but could generate a benefit to Australians of between $5 million and $60 million per year.
  - **Removing stamp duty on agricultural weather insurance**. Stamp duty is applied to agricultural weather insurance in Queensland, Northern Territory, Tasmania and Western Australia. Our best estimate is that exempting agricultural weather insurance in these jurisdictions would generate net benefits to Australians of about $1 million per year.
  - **Support for a digital insurance platform**. This could involve government investment to develop a website that provides reliable and clear information on agricultural weather insurance products. The functionality of the website could be expanded over time, as the market grows, to include product assessment tools and an insurance exchange. The platform would help to reduce the costs to farmers of getting agricultural weather insurance. We estimate that a platform with the features described above would generate benefits to Australians of between $1 million and $30 million per year. The wide range of possible benefits is consistent with experiences of digital insurance platforms in other contexts, with examples of both successes and failures. This excludes the costs of developing and maintaining the platform, which could be substantial.
- We estimate that the uptake of agricultural weather insurance with these interventions could be between 2,400 and 8,200 farmers. This is an order of magnitude higher than current uptake, however, the upper bound estimate is still just 10 per cent of Australian farmers.
- Government subsidies would likely be needed for there to be widespread uptake of agricultural weather insurance in Australia. This is consistent with international experience – there are no examples of countries with widespread uptake in the absence of subsidies. Our best estimate is that adding a 25 per cent subsidy of premiums would increase uptake to about 23,000 farmers, although there is considerable uncertainty around this estimate. The subsidy would generate large benefits to farmers – potentially in the order of $340 million per year. However, our best estimate of the fiscal cost of the subsidy is $1.2 billion per year. A subsidy targeted to a particular cohort of farmers is also possible and could have a higher benefit cost ratio, although the costs are still likely to exceed the benefits in aggregate. This could be investigated on a standalone basis.
- Given this cost, some stakeholders consulted for this project advocated subsidies as a temporary measure. The subsidies would allow the market to mature, which would lead to reduced costs. The idea being the subsidies could then be withdrawn. This approach has two

key limitations. First, as shown above, the short run costs of subsidies are likely to be substantial. Second, uptake will decrease once the subsidies are removed, although uptake will remain somewhat higher than the alternative where subsidies were never used.

- While the nature and extent of interventions to support agricultural weather insurance is ultimately a matter for governments, this report provides an evidence-based pathway forward. We have identified several targeted interventions (in bold above) that would support ongoing efforts by insurers and farmers to make agricultural weather insurance in Australia a success. These interventions would increase uptake, and the benefits from increased resilience and productivity would likely outweigh the costs.

# 1. About the project

This section introduces this project including a brief overview of the topic, project purpose and scope, and the approach and structure of this report.

## 1.1. Introduction

### *Australian farmers are exposed to many risks and some weather risks may be getting worse*

Australian farmers face many risks to farm income when producing crops or rearing livestock. These risks can affect farmers all parts of the supply chain, from production through to sales and include both weather risks, such as drought, and non-weather-related risks, such as variable input and commodity prices. Managing these risks appropriately can offer benefits to farmers, industry and Australian communities. This project focuses on understanding whether insurance can be viably supplied and beneficially used by farmers to manage weather risks and their impact on farm income.

Weather production risk is a defining characteristic of Australian agriculture and has presented farmers with acute and ongoing challenges throughout the 20th and 21st centuries. Weather production risks specifically effect on-farm production and can include deficient or excess rainfall, temperature, and wind, which when combined can result in drought, heatwaves, frosts, floods, hail and cyclones. In the last twenty years Australian farmers have had to contend with major droughts, floods, heatwaves and fires. The Millennium Drought in south-eastern Australia (2001 to 2009) is notable for its duration and intensity. It was followed by major flooding in many agricultural areas, then again by drought which returned in 2017. This most recent drought was characterised as the worst on record in the Murray-Darling Basin by the Bureau of Meteorology (Farm Online 2019). It was followed by devastating fires in many areas that severely impacted many regional and farming communities.

There are concerns that some weather production risks are becoming more frequent, widespread and severe. Climate change is contributing to southward shifts in weather, particularly the rainfall patterns that have typically brought cool season rainfall to southern Australia. Since the 1970s, late autumn and early winter rainfall has decreased by 15 per cent in southern Australia (Climate Council 2018). Climate change is also increasing the intensity and frequency of higher temperatures and heatwaves, exacerbating drought conditions.

### *Australian farmers and governments have developed ways of mitigating the financial impacts of weather production risks, but they have limitations*

Weather events can have major impacts on farm businesses, reducing both the quantity and quality of agricultural production. This leads to reduced revenues and incomes, with negative financial consequences for farm households and investors, agricultural supply chains and broader regional communities. There can also be health and wellbeing consequences, with drought being associated with high rates of stress in farmers (Austin 2018) and a higher risk of suicide in some cases (Hanigan et al. 2012).

The severity of the impacts depend on how well-placed farmers are to manage weather production risks. Farmers have developed strategies to manage these risks. Some farmers alter their systems to lessen the production impacts, others retain profits or smooth their income via other means. Beyond this, government support programs and farm management deposits can help farmers to manage weather production risks.

However, even with these strategies many farmers are still exposed to significant risk. The costs of these strategies can be substantial to both farmers and governments, including the costs of lost opportunities. For example, to manage the effects of weather production risks a farmer might prioritise keeping their balance sheets healthy rather than investing or expanding their business, such as buying neighbouring land when it comes on the market. Insurance is an avenue for managing weather production risks, especially for managing the financial loss associated with severe weather events.

### *Better approaches for managing weather risks are needed*

The presence of a changing and increasingly volatile climate, combined with the limitations of current approaches, suggest that better approaches are needed to manage weather production risks. From a farmer perspective, there is an opportunity to reduce their exposure to weather production risks, avoid some of the costs associated with current approaches and take advantage of investment opportunities. Doing so can help boost agricultural output and contribute towards the goal of becoming a $100 billion industry by 2030.

### *Insurance might be able to help, but there are significant barriers to overcome*

Despite being relatively widespread internationally and in other sectors such as energy, the provision and uptake of agricultural weather insurance in Australian agriculture is relatively low.

The provision and uptake of agricultural weather insurance has been constrained by both supply and demand-side barriers. Administrative costs, data deficiencies, lack of awareness and insufficient market scale are some of the most commonly cited barriers. For the opportunities associated with agricultural weather insurance to be realised, at least some of these enduring barriers need to be addressed.

## 1.2. Project purpose and scope

The severity of the most recent drought, particularly in New South Wales (NSW), prompted significant policy and investment responses from governments at different levels. The NSW Government committed funding to a range of drought measures in late 2019 and early 2020.

In March 2020, the National Farmers Federation (NFF) announced it was partnering with the NSW Government on a project aimed at improving the financial risk management options available to Australian farmers to assist them to manage drought, natural disasters and a range of other risks. The project is structured as follows:

- Sub-Project 1: Commercial and Government-subsidised insurance options (**this report**)
- Sub-Project 2: Forward contracts, futures, options and swap market options
- Sub-Project 3: Mutuals and Co-operatives
- Sub-Project 4: Financial risk management options – awareness and education
- Sub-Project 5: Off-farm income and assets

- Sub-Project 6: Other government risk management measures including tax, and cyclical income-based stabilisers
- Sub-Project 7: Overall Project coordination, data collection, report summary and recommendations, and communications

Aither and project partners Progressive Agriculture and Finity Consulting were engaged by the NFF to deliver Sub-Project 1. The scope of this project is as follows:

- describe the range of farm financial risk management insurance products, including derivatives and other similar products, currently available to Australian farmers and farmers in other countries
- identify and assess options for improving the effectiveness of existing products and expanding the range of those products
- identify and assess the barriers to implementation and uptake of those options, and
- make recommendations for addressing those barriers.

This project excludes consideration of matters addressed by the other sub-projects.

## 1.3. Report structure

The remainder of this report is structured as follows:

- Section 2 contains an overview agricultural risk of non-insurance approaches to weather production risk management
- Section 3 examines agricultural weather insurance in Australia and internationally
- Section 4 outlines the methods used to address the project aims, including an analytical framework and model for assessing the merits of government interventions in insurance markets, and the approach to gathering evidence for the assessment
- Section 5 explains and analyses demand and supply side barriers that may be preventing greater uptake and provision of agricultural weather insurance
- Section 6 describes the expected future developments in agricultural weather insurance that will occur regardless of additional government intervention
- Section 7 presents a range of potential interventions to improve agricultural weather insurance in Australia and identifies and further explores the five shortlisted interventions for detailed assessment in this project
- Section 8 provides the results of the assessment of the five shortlisted interventions based on the results of quantitative and qualitative analysis
- Section 9 provides a summary of key recommendations and final conclusions
- Appendix A – Evidence of risk in Australian agriculture provides an overview of the magnitude and types of risks in Australian agriculture, with a focus on different types of weather production risk
- Appendix B – Case Study Overview includes the five detailed case studies used to inform the analysis in this report
- Appendix C – Technical documentation provides technical documentation about the insurance market model used to assess the interventions and options in Section 8.

# 2. Risk and non-insurance approaches to weather production risk management

This section provides an overview of the types of agricultural risk faced by farmers and non-insurance-based approaches that are used by Australian farmers to manage weather production risk. Understanding these strategies is important, as this can help inform understanding of the current or potential use and role of insurance, and how insurance products might be further developed and utilised.

### Key findings

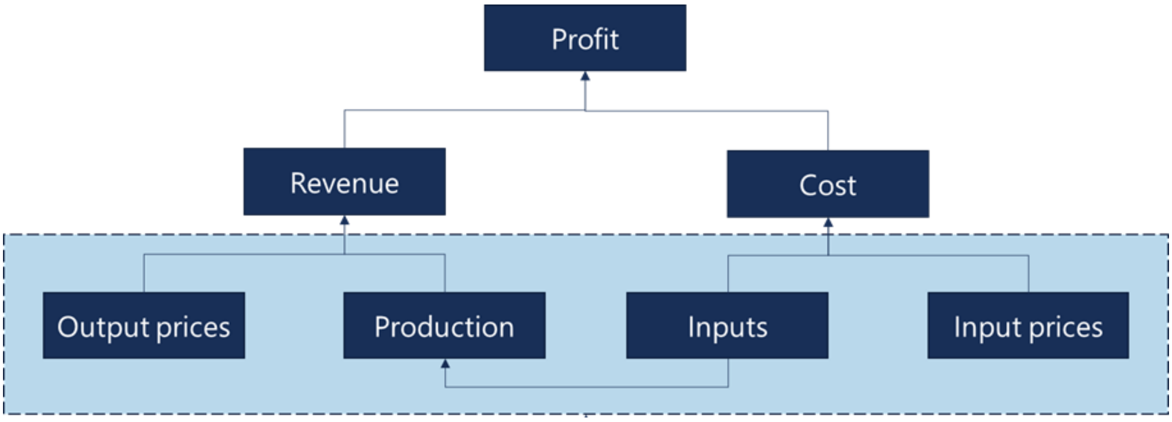
- Farmers have access to several effective non-insurance approaches to risk management. Most farmers adopt a combination of these strategies, which allows them to significantly reduce their exposure to weather production risk.

## 2.1. Types of agricultural risk

The magnitude of risk in Australian agriculture is significant, and there can be marked differences across agricultural activities and regions. Agricultural risks can manifest in different ways and have different impacts suggesting there is benefit in classifying these risks. This subsection briefly summarises the drivers of and types of risk in Australian agriculture.

Figure 1 shows the relationship between farm profit and types of risk. This framework is used throughout the report, including in the modelling. In this simple framework farm profit is the difference between the revenue a farmer receives from production and the costs of their farm inputs.

Revenue is affected by both levels of production and the price a farmer receives for their outputs. Output price risks include, for example, agricultural commodity prices and the exchange rate for internationally traded agricultural commodities. Production risks include non-weather production risks, such as the threat of pests and diseases, and weather production risks, such as drought or frost. Costs are affected by the level of inputs a farmer requires for production, as well as the cost of these inputs. Input price risks include, for example, regulatory risk of mandated increases in wages of farm workers, or the risk of a reduction in irrigation water supply that drives up the price of water.




Source Aither.

Figure 1 Framework for considering risk in agriculture

While Figure 1 is a general framework for considering agricultural risks, it captures a broad range of risks. The framework also shows that multiple risks can influence farm profit at any one time and can mitigate or exacerbate one another. For example, the negative impacts of a weather production risk such as drought could be mitigated by higher output prices (in the case of domestically traded agricultural commodities). As a result, the higher output prices mitigate the negative impact of drought on production and farm profit. In this example, higher output prices provide a natural hedge against drought. This highlights the importance of considering risks simultaneously, rather than in isolation, to account for any negative or positive correlations between risks.

### 2.1.1. Weather production risks

The focus of this project is on weather production risks. Weather production risk materialises when weather occurs outside of expected or manageable bounds of variability, either at a given time or over a period of time. The ways in which weather production risks affect farming activities also depends on farm type and location. In addition to local climate, topography and other geographical characteristics can influence weather production risk. For example, low-ground farms surrounded by sloping terrain in colder areas may be particularly susceptible to frosts, while farms near watercourses or on ephemeral floodplains may experience significant flood risk.

In some cases, weather production risks eventuate when multiple weather events combine. For example, the loss of lambs is often caused by a combination of low temperatures and high winds. Similarly, water stress in crops caused by low rainfall can be exacerbated by high temperature.

This report considers the key weather production risks to important production systems in Australia. These risks are deficient rainfall, excess rainfall, frost, extreme heat and hail. Deficient rainfall was nominated by 81 per cent of National Survey respondents as the primary weather production risk affecting their business[1]. A further 6 per cent nominated frost, with the remainder evenly split between excess rainfall, cyclones and extreme heat. Appendix A sets out the effects of each of these weather production risks in further detail.

There can be significant differences in the importance of weather production risk by location, even within a particular farming activity. Some agricultural activities are also more exposed to weather production risk than others. Understanding how farming activities are exposed to weather production risks can help to understand what approaches can be taken to minimise their effects on production

[1] It should be noted that the National Survey excluded hail from the survey question.

and farmer income. The following sections set out on-farm strategies farmers can use to manage weather production risks depending on their location and farm type.

## 2.2. Non-insurance approaches to weather production risk management

Non-insurance-based approaches can be segmented into two broad categories – production strategies and financial strategies. Production strategies are typically proactive and are undertaken on the farm, prior to a weather event occurring to mitigate its effects on crop or livestock production. Financial strategies can be both proactive and reactive and are an attempt to manage a farmer's income to ensure they have enough money to cover costs.

Which strategies farmers choose to use to manage weather production risk depends on a range of factors, including the type and location of their farm, the relative consequences of the weather production risk, the stage of the business cycle and financial position of the farmer, and their risk appetite.

The following subsections give a summary of the types of production and financial strategies available to farmers, as well as a breakdown of the current application of these strategies on Australian farms.

### 2.2.1. Production strategies

#### *Management practices*

Different farming activities have different management practices available to them to manage weather production risks. Which practices farmers can utilise will also vary for different weather production risks. The management practices available to farmers include agronomic decision making and investment in infrastructure or technology to mitigate weather production risk.

Agronomic decision making involves making strategic decisions about crop and pasture management to maximise soil health, soil moisture retention, and crop and stock nutrition. Improving each of these factors helps to minimise the impacts of weather production risks by ensuring crops and stock are in the best possible health to withstand any adverse weather events.

Farmers also invest in infrastructure and technology to protect crops from weather production risks. This can include purchasing probes and sensors to assist agronomic decision making, using fans or netting to protect high value tree crops, or investing in more efficient water delivery mechanisms.

A range of general production management practices are set out in Table 1 to provide examples of the types of practices farmers use to manage for different weather production risks.

Table 1 Management strategies for various weather production risks and farming activities

| Farming activity | Weather production risk | Production management practices |
|---|---|---|
| **Broadacre cropping** | Extreme heat | Adjusting planting/harvest windows for climate conditions<br>Heat resistant crop varieties |
| | Deficit rainfall | Adjusting planting/harvest windows for climate conditions<br>Calibrating fertiliser applications to rainfall/frost/yield risk<br>Drought resistant crop varieties<br>Fallow weed control<br>Fallowing land<br>Minimal or no till<br>Rotational cropping<br>Switching to irrigated production |
| | Frost | Adjusting planting/harvest windows for climate conditions<br>Calibrating fertiliser applications to rainfall/frost/yield risk<br>Frost resistant crop varieties |
| | Wet harvest | Adjusting planting/harvest windows for climate conditions<br>Aeration and drying of harvested crop |
| **Horticulture** | Frost | Frost fans<br>Irrigation scheduling<br>Planting in low frost-risk areas<br>Planting diverse crop varieties |
| | Low water allocation (Deficit catchment rainfall) | Efficient irrigation scheduling<br>Pruning trees<br>Securing higher reliability water entitlements<br>Temporary water trading |
| **Livestock** | Deficit rainfall | Agistment<br>Alternative feed sources (buying fodder)<br>Destocking |
| | Extreme heat | Adjusting feeding periods<br>Shelter<br>Sprinklers |

Source Adapted from NRAC 2012.

Note Excludes diversification practices such as farming a range of crop or livestock types, or farming at different locations.

While the use of production management strategies can help to minimise the effects of weather production risks, their application does have limitations. Production management strategies are most useful when applied inside the bounds of a reasonable or expected climatic range. These strategies are less useful in managing with extreme adverse weather events. For example, the effects of a 1-in-50 or 1-in-100 year drought on a crop will not be able to be mitigated to a great extent by the application of minimal till prior to the growing season.

Investment in technology and infrastructure can also be capital intensive (e.g. new irrigation infrastructure or frost fans), or may require investments into data or information (e.g. on-farm weather stations, soil moisture probes) so that the benefits of the strategies are realised. These strategies usually also require time, skill and knowledge to implement effectively.

While management strategies are useful in helping to manage the effects of weather production risks, they are not able to do so in all circumstances. Additionally, they may not always be able to be used by farmers, particularly if they require high levels of investment. It is under these circumstances that farmers may need insurance to manage weather production risk instead.

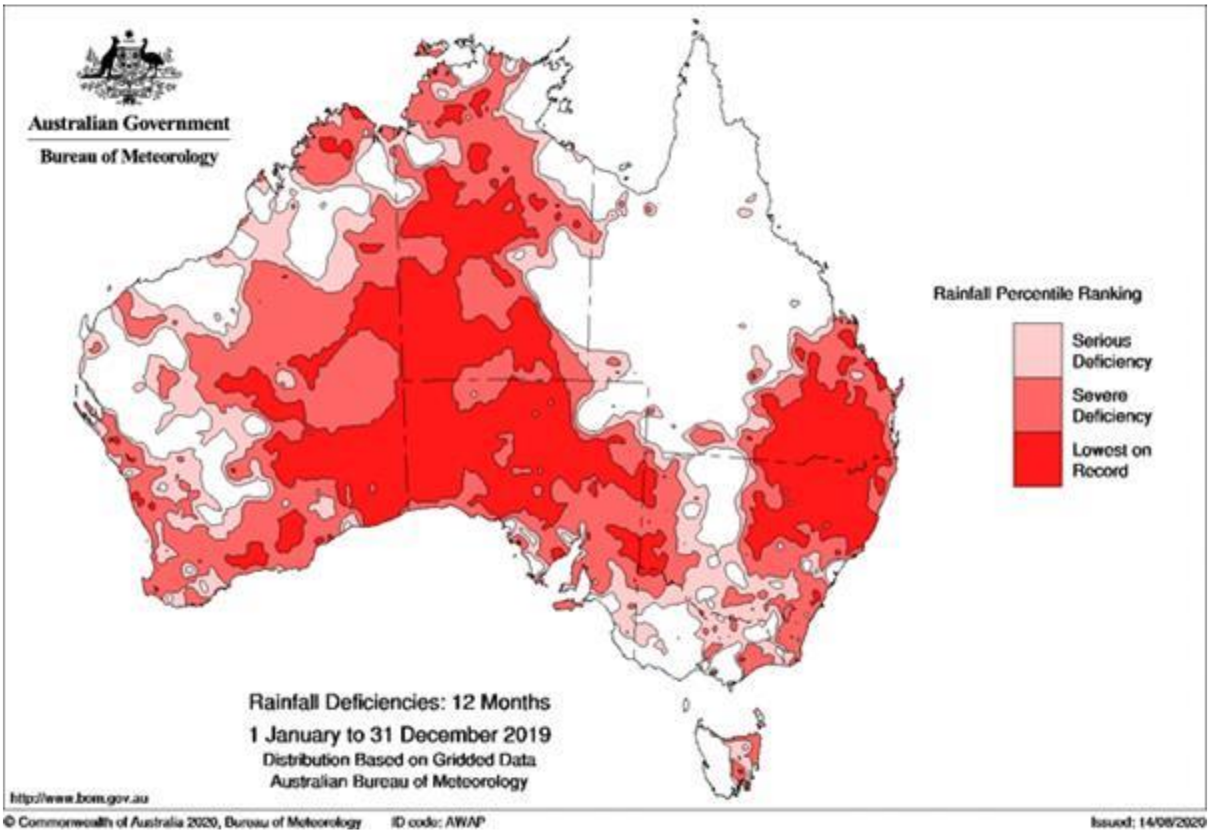
### *Diversification practices*

Diversification practices are used as a production strategy to manage weather production risk. Some farmers manage weather production risk by farming and rearing a range of different crops and livestock at a single farm location. This can include either farming multiple different crops, or a combination of cropping and livestock production. Farming multiple crops or livestock at a single location ensures that not all farming practices will be affected in the same way by a single peril and reduces the effects of weather production risk on a farmer's income. Another practice is to diversify the same farming activity across different geographical locations with different weather production risks. This practice ensures that not all activities are subject to the same weather events. These strategies can offset or disperse the risk of revenue failures associated with any particular production activity at a given time and location.

Bell et al. (2020) outline that risk mitigation to climate variability can be provided through diversification of enterprises, particularly if their annual economic returns are not correlated. In many cases annual farm returns from livestock and crop production are not highly correlated. Crop production is often associated with higher potential profitability but higher risks, while livestock enterprises provide a more consistent cash-flow and often provide needed revenue during dry conditions when crop production is not profitable. Farming a combination of livestock and crops therefor reduces the annual income variability.

While diversification can help manage weather production risk, it is not always an accessible or practical option for farmers. Expanding or modifying an operation to include different locations or farming activities can be capital and time intensive. Diverse farm businesses also require more management skill to run effectively. Geographically dispersed farm locations can also add substantial management costs due to the physical movement of people and equipment that is required.

Another limitation of diversification is that it does not protect against systemic risks. For example, droughts such as that experienced in 2019 (Figure 2) can impact production across many locations and farming activities. Whilst diversification may mitigate some risk, it is difficult to mitigate all weather risk with diversification alone. Under these circumstances farmers may need insurance to manage weather production risk instead.




Source Bureau of Meteorology.

Figure 2 Australian rainfall deficiencies in 2019

### 2.2.2. Financial strategies

#### *Balance sheet management*

When a farm has been affected by an adverse weather event a farmer's income can be impaired. As a result a farmer may need to generate cash to make up for lost income. This can be done by adjusting or managing the farm's balance sheet, either through taking on greater farm debt by drawing down on equity in a farm, use of short-term credit facilities, drawing on savings, selling stored commodities, or selling other assets.

Despite increases in farm debt over the long term, average farm equity for broadacre (including both cropping and grazing) and dairy farms has remained strong because of increases in the value of agricultural land. ABARES (2020) has found that the average equity ratio of broadacre farms at 30 June 2019 was 89 per cent; 63 per cent of all dairy farm businesses at this time had an equity ratio above 80 per cent. This and other data presented by ABARES suggests that most farmers have good levels of equity. As a result, they may be well placed to use balance sheet management as a financial strategy.

While balance sheet management is a strategy that can be used to generate cash, it is not always possible or desirable to have high equity or maintain a significant asset holding. This is particularly the case for farm businesses that are expanding, operate via the use of leased assets, are newly established, or have recently undertaken intergenerational asset transfers. For example, in many instances, in order to meet income and asset distribution requirements for retiring or non-farming family members, it will be necessary for the farm to reduce its nominal debt levels during a period of transition.

A balance sheet strategy may also come with high opportunity cost. In particular, the benefits of having sufficient equity to withstand income volatility will need to be considered against the opportunity cost of forgoing the purchase of additional assets, leasing, or investing in productivity improvements upgrades. A balance sheet strategy can also precipitate the need to prioritise cash flow ahead of rational trading decisions, or may limit the ability to invest in necessary upgrades or maintenance, either of which can have implications for the enterprise at a later time. A balance sheet strategy may also be limited in that in some cases (such as cropping on marginal land), the value of assets might only be worth three times the cost of the financial loss incurred in a bad season. That means even farmers with 100 per cent equity could be significantly impaired after three bad years in a row.

### *Off-farm income*

Off-farm income can be used to supplement and diversify income from farming. This can include income from off-farm employment or investments in off-farm ventures. Off-farm income can decouple income from weather related risks, as these income sources potentially have no exposure to weather risks at all. ABARES (2020) estimated that average off-farm income for broadacre farm businesses was $37,410 in 2018-19, which represented 22 per cent of average farm cash income ($165,680).

The role of off-farm income is further detailed in *Sub-Project 5: Off-farm income and assets*.

### *Government assistance*

The use of government assistance programs or initiatives is another financial strategy that can be used to manage the effects of weather production risk. There are a range of programs available which farmers can use to manage risk, including those posed by adverse weather events such as drought.

There have been various one-off drought assistance packages provided by Australian governments over time. These can take different forms, with assistance sometimes targeted at industry or specific sub sectors, or sometimes more directly in support of households. Households are also able to receive general assistance and farm household payments, while farm businesses can receive access other ongoing or one-off programs (e.g. specific drought assistance such as interest free/low interest loans or fodder subsidies).

While government programs can help farmers manage the effect of weather production risk, a limitation with many of these programs is that they are reactive and are not always able to provide farmers with certainty, given they are often one-off programs. Other financial strategies may offer greater flexibility for farm businesses to manage risk and reduce reliance on government programs.

The role of government policy and programs is further detailed in *Sub-Project 6: Other government risk management measures including tax, and cyclical income-based stabilisers*

## 2.3. Current use of non-insurance approaches for weather production risk management

Evidence from interviews indicates that most farmers use a variety of production strategies to manage adverse weather events. Farmers typically combine these strategies with balance sheet management to maintain sufficient equity to withstand extreme or unexpected weather events. The extent to which farmers rely of these strategies depends on their individual production circumstances, management skills and attitude to risk, and their individual business circumstances.

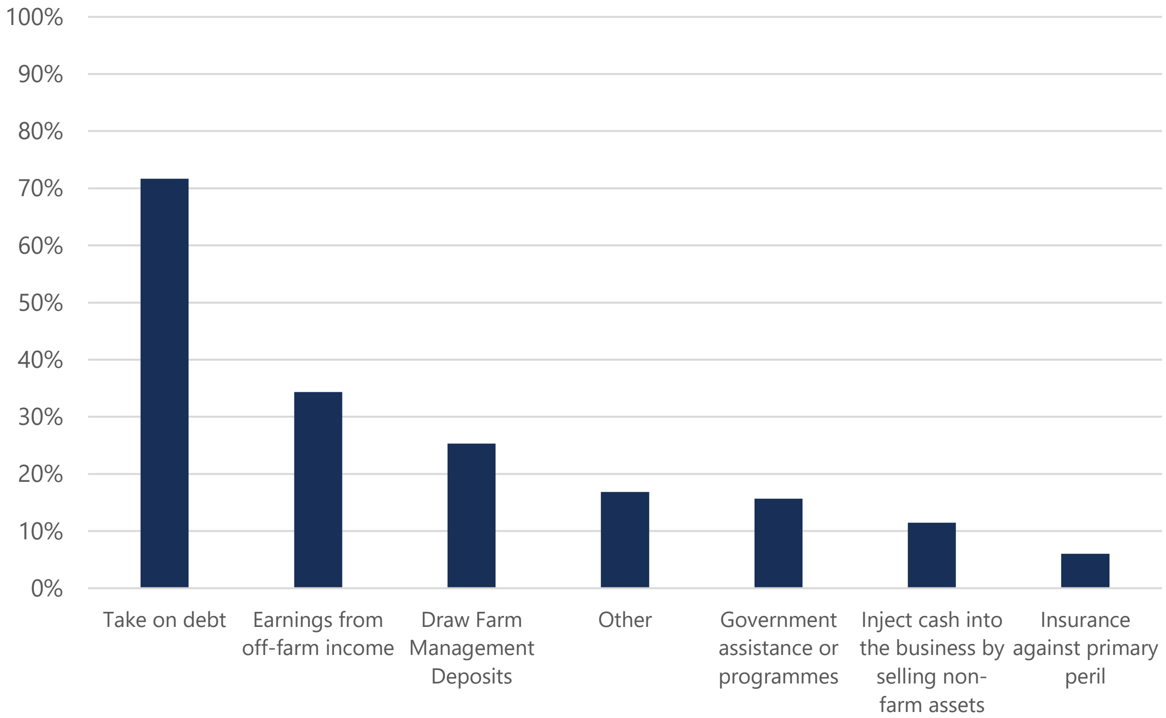
In terms of production management practices, the case studies reveal that farmers across all farm types use a broad range of practices to mitigate weather production risk consistent with the practices set out in Table 1. Many farmers had also invested in on-farm technology to help track weather production risks and assist agronomic decision making. Further detail on specific production management practices for each of the production systems that are addressed by the case studies used in this project are set out in Appendix B.

A significant number of Australian farmers diversify their farming activities to manage risk. Based on an analysis of ABS and ABARES data, Healy et al. (2013) estimated that in 2010-11 there were 21,300 mixed farming enterprises in Australia. About 83 per cent of all cropping farms were mixed farms. This is supported by anecdotal evidence from the case studies. Almost all farmers interviewed used some form of diversification strategy to manage risk, whether it was owning farms in multiple location, farming a combination of crop or livestock types, or even diversifying into a range of cultivars within one specific commodity.

The case studies also show that on-farm storage of commodities and other assets is common across farm businesses, particularly in cropping. This is a form of balance sheet management as it stores value in the assets which can be converted to cash at a later date, as required. Freeth (2017) estimates that in 2015-16, the on-farm storage capacity of Australian broadacre cropping farms was 35 per cent of total summer and winter crop production.

The National Survey provides further insight about the use of financial strategies. The most common financial strategy used by survey respondents to mitigate weather production risk was debt (Figure 3). Seventy-two per cent of respondents indicated that they take on debt in the worst 10 per cent of years for their primary weather production risk. These figures are consistent with anecdotal evidence, which suggests family farms in Australia rely on maintaining high farm equity to meet their cash flow needs during periods of reduced farm income.

The data also suggests that earnings from off-farm income was the second most used financial strategy, followed by drawing from farm management deposits. Insurance against a farmer's primary weather production risk was the least used strategy – the use of insurance is further explored in detail in Section 3.




Source National Survey.

Note Strategies specified within 'Other' included drawing down on cash reserves, drawing down on stored commodities, and reducing non-essential costs.

Figure 3 Proportion of survey respondents using different financial risk management strategies

# 3. Agricultural weather insurance in Australia and internationally

This section introduces how insurance works and the range of agricultural weather insurance policy arrangements and products available and emerging in Australia and internationally. An overview of the Australian insurance market, including legislative and regulatory arrangements, key market players, and product availability and uptake is provided. This section also sets out how insurance markets and policy arrangements work in other countries, and the new products and market arrangements that are emerging to meet the demand for agricultural weather insurance.

### Key findings

- Uptake of agricultural weather insurance in Australia is extremely low (excluding named-peril insurance).
- Several other countries, including the United States, Canada and Turkey, have higher uptake of agricultural weather insurance, particularly multi-peril crop insurance. Unlike Australia, these countries provide ongoing subsidies to the agricultural weather insurance market, as well as other forms of government support.

Agricultural weather insurance can be used as an additional option to assist farmers manage the financial effect of weather production risks. While there are a range of on-farm and off-farm strategies farmers can use to manage weather production risks, as set out in Section 2, the variability of weather and frequency of adverse weather events in Australia mean that weather production risks can remain a problem for many farmers. However, insurance options that help manage these risks are not well established in Australia and uptake remains low. The National Survey indicated that very few farmers used insurance as a primary financial strategy to manage the key weather production risks affecting their farms.

Understanding how insurance works and the current state of agricultural weather insurance in Australia and internationally is an important step to understanding the barriers to the creation of a successful agricultural weather insurance market in Australia, and the interventions that can be used to overcome them.

## 3.1. How insurance works

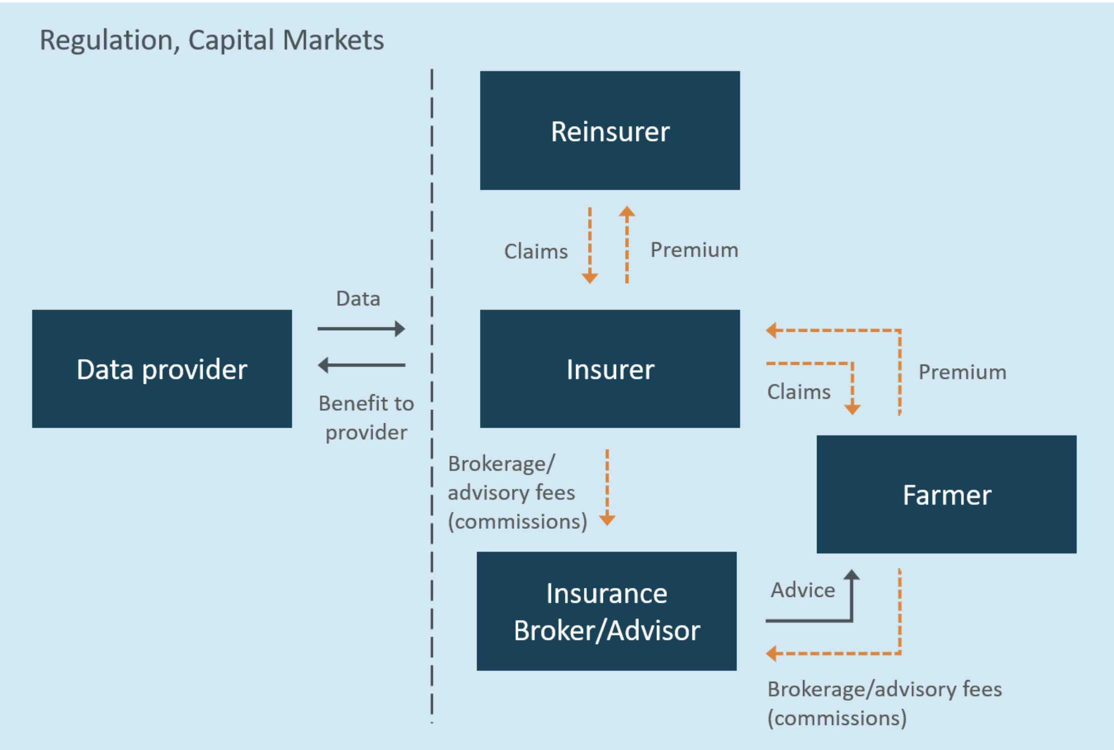
Insurance is used to provide a guarantee of compensation for a loss due to a specified event in return for a premium (ICA 2020). Insurance is generally used to help protect a policyholder from infrequent low probability events that have large consequences. For example, agricultural weather insurance is used by farmers to compensate for financial losses due to reductions in yield (including complete loss) for weather events. In this way, agricultural weather insurance can help to manage the financial impact of extreme or unexpected weather.

## Clarifying terminology

Throughout this report a range of different groupings of insurance products are referred to. The following terms and their definitions have been included below to provide clarity on the terminology used throughout this section and the remainder of the report:

- Agricultural insurance: insurance that provides cover for agricultural production, property, machinery and vehicles, and liability.
- Agricultural weather insurance: Insurance protecting farmers against weather-related production risks to crops or livestock.

The key market actors for the purposes of this project and the relationships between them are presented at a high-level in Figure 4 and further explained below. A policyholder, such as a farmer, may choose to cede some portion of their risk to an insurer. In exchange for this protection, the insurer requires a premium payment, and potentially a deductible, from the policyholder. The exact terms of the settlement for any claim are set out in the policy, or contract, between the insurer and the policyholder. Generally, the contractual arrangements (such as risk type and settlement terms) are grouped into standardised product categories by insurers. For example, agricultural insurance is a general term used to describe a range of products, including farm pack policies and multi-peril crop insurance.




Source Aither.

Figure 4 Overview of the insurance market

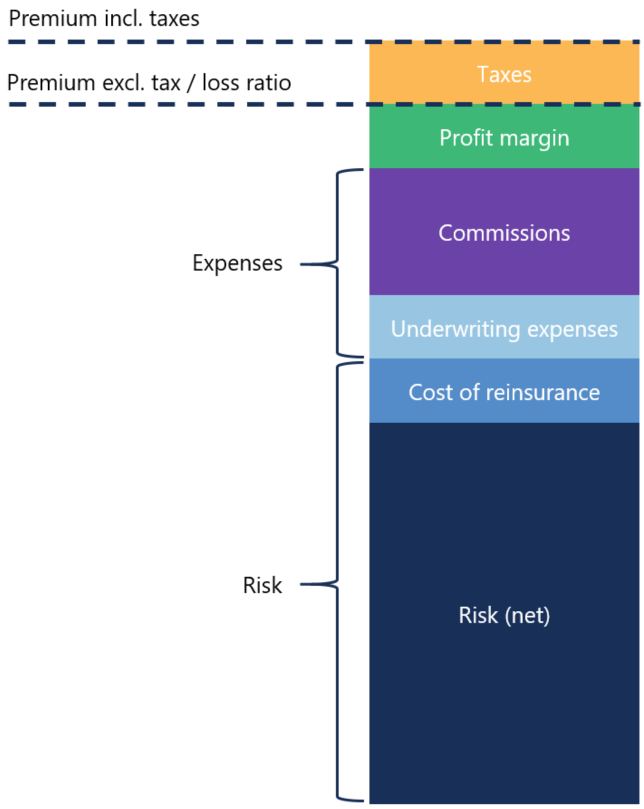
A viable insurance market works largely because insurers pool risk from many policyholders for a range of different events that are typically localised (or otherwise imperfectly correlated). This risk diversification means that only some policyholders are likely to make claims in any year. The costs to insurers of these claims can be (at least partly) covered by the premiums from policyholders who do not make claims. Insurers may also engage a reinsurance company to further cede risk. Reinsurance acts as insurance for insurance companies. It limits insurers' loss exposure, which helps to limit their liabilities for specific risks, stabilise their profit and loss margins, protect against catastrophes and increase their capacity (Reinsurance Association of America 2020b). For example, if many claims are made simultaneously for drought, an insurance company may be able to recover part of the claims from the reinsurance company. Similar to insurers, reinsurance companies typically pool risk from different insurers from different regions and sectors across the world to optimise their risk exposure.

The insurance market also includes insurance brokers or advisors. Brokers have specialist expertise and provide advice to their clients about how they can manage their risk profile with various types of insurance, in exchange for a fee. Brokers also help to arrange insurance cover once a product is chosen and assist clients in understanding the terms and conditions of their selected cover. In addition to charging a fee for their services, brokers can also receive commissions from selling insurance (ICA 2020b).

The insurance market is subject to regulation, which typically involves governments setting industry standards insurers must abide by, such as the level of capital an insurer must have in reserve to pay claims, as well as adhering to consumer protections and privacy laws (APRA 2020). Both reinsurers and insurers also cede risk to the capital markets, who provide the capital for their businesses to operate. Insurance is also reliant on access to adequate data and information for farmers, insurers and reinsurers to understand and price risk, which is often provided by third-party data providers.

### *An introduction to insurance pricing – determining the premium*

For insurance to be viable, at a minimum, a premium must cover the cost of risk, underwriting expenses and commissions, as well as an adequate profit margin (NRAC 2012). The process of determining each of these costs and establishing the required insurance premium is known as underwriting. Figure 5 provides an overview these costs, which are further explained below.




Source Finity Consulting.

Note Proportions represented in the figure are indicative only.

Figure 5 Breakdown of costs that comprise the calculation of a policyholder's premium.

The cost of risk is the cost of expected payouts plus the cost of reinsurance minus reimbursements from reinsurance. Pricing the cost of risk can be complex and typically relies on the availability of adequate historical data to model the risk being insured and therefore what the insurer expects they may have to pay policyholders over time. The insurer will also decide how much of that risk is ceded to reinsurers and in what way, such as a stop loss or a quota-share arrangement. The cost of reinsurance varies year-to-year and consequently is generally agreed on a yearly basis. This is one driver that can lead to variations in the cost of insurance over time.

Underwriting expenses cover the insurer's operating costs including an apportionment of the costs used to develop the product, transaction costs and other administrative costs. Commissions for brokers and agents are also included as an expense that needs to be priced into the premium. The proportion of the total premium (less the value of any taxes) that is comprised of underwriting expenses and commissions is known as the expense ratio.

The final component that is priced into a premium is the insurer's profit margin. The profit margin includes the minimum required return on capital for the insurer and their shareholders, which will depend on the risk the insurer and their shareholders are exposed to. If the profit margin is greater (less) than the minimum required return on capital, the insurer and their shareholder will receive an additional profit (loss), known in economics as a rent. The final premiums paid by policyholders include each of the aforementioned components, as well as any taxes that are required under state or federal law, such as GST and Stamp Duty.

Anecdotal evidence from the insurance industry indicates that a typical premium breakdown for agricultural weather insurance products using a traditional insurance and reinsurance model is approximately 15-20 per cent profit margin, 20-30 per cent expenses, including commissions, and the remainder the cost of risk. These costs however are dependent upon a number of factors and are indicative.

## Loss ratio

We define the loss ratio of an insurance product as the proportion of total premiums (excluding taxes) paid to insurers which is paid back to farmers through insurance claims. For example, if an insurance product paid $50 in claims for every $100 collected in premiums, the loss ratio for that product would be 0.5. A loss ratio of greater than 1.0 indicates that an insurer would not be collecting enough revenue to cover the cost of payouts (ABARES, 2012).

Traditionally, the definition of loss ratio may account for taxes and subsidies. However, our definition excludes taxes and subsidies incurred/received by insurers.

Anecdotal evidence from interviews revealed that insurers typically require an average loss ratio (excluding taxes) of approximately 0.65 or less to provide agricultural weather insurance products in Australia.

## 3.2. Types of agricultural weather insurance

Agricultural weather insurance is used by farmers to protect against revenue losses due to weather events such as drought, flood, extreme temperature, fire and hail. The provision of agricultural weather insurance includes two broad categories of insurance products – indemnity or 'traditional' products, and index products.

### *Indemnity insurance products*

Indemnity products include named peril and multi-peril products. These products protect against actual yield losses on a farm (ABARES 2012). Payouts for indemnity products are based on actual yield losses, which need to be assessed for each claim. Named peril products indemnify against yield loss due to a pre-specified peril, with fire and hail being the most common. Multi-peril products allow for protection against all yield loss events, including weather-related events and pests and diseases.

### *Index products (index insurance products and derivatives)*

Index products use a proxy (in the form of an index) for yield or stock losses on a farm (ABARES 2012). The most used index product is a weather index, such as rainfall deficit or extreme temperature, however yield-based indexes also exist. For example, a weather index product uses one or multiple weather variables, with a payout occurring if the chosen variable falls above or below a pre-specified trigger within a pre-specified period. Under this system, farmers do not need to submit a claim and have their claim assessed each time they experience a production loss. Payouts are automatic based on the trigger occurring.

Index products may be classified as either insurance products or as derivatives, with anecdotal evidence demonstrating that derivatives are currently more common. While derivatives are used by farmers to hedge risk in a similar way to agricultural weather insurance products, there are several key differences between them. Most notably, a derivative is classified as a financial instrument because, unlike insurance, it can be intentionally used by farmers to speculatively generate profits (payouts in excess of the losses actually incurred) and can be traded. This means that derivatives are regulated as financial instruments, whereas insurance is not and has different regulatory requirements.

Industry sources have highlighted that the distinction between derivatives and index insurance is not always clear. While index insurance products contain contractual clauses that define them as insurance, the structure of these products is very similar. As a result, weather derivatives are often used as index insurance despite falling under different regulatory arrangements.

Weather derivates (and derivates used for price risk management) are discussed in further detail in *Sub-Project 2: Forward contracts, futures, options and swap market options*.

Table 3 provides an overview of the indemnity and index products, including derivatives, that are currently available in various countries including Australia.

Note: The following example is for illustrative purposes only. The value of the quote is not taken from any existing index product provider. Index insurance quotes will vary and may be lower or higher than the amount quoted in the example below.

The following indicative example sets out each of the factors a farmer must consider when shopping for an insurance quote. In this example the farmer is seeking index insurance cover for frost.

Index insurance for frost provides cover when daily minimum temperatures fall below a specified trigger value for a specific period at a specific location. Table 2 sets out the parameters of the quote. Some of these parameters must be decided on by the farmer seeking the quote. These parameters are highlighted in **bold** in the table.

Table 2 The parameters and costs for an index insurance quote for frost cover

| Quote parameters | Specified values | Example: Farmer insures 100 hectares |
|---|---|---|
| Index | Spring frost cover (known as Cumulative Heating Degree Days) | --- |
| **Period** | **15 August - 15 September** | --- |
| **Location** | **Beechworth, Victoria BOM grid point (36.36S, 146.69E)** | --- |
| **Trigger** | **-0.5°C** | --- |
| **Payout per 1°C per hectare for each night below the trigger value** | **$75** | **$7,500** |
| **Maximum payout per hectare** | **$375** | **$37,500** |
| Indicative premium per hectare | $45 | $4,500 |
| Average payout per hectare | $32 | $3,200 |
| Estimated net cost per hectare | $13 | $1,300 |

Note All dates, locations and values are indicative only.

The value that the farmer specifies for each of the parameters of the quote will change the indicative premium. In the above example, the farmer has obtained a quote for spring frost cover in Beechworth, Victoria. If the farmer wanted to insure 100 hectares of land against spring frost, the index insurance premium would be $4,500 per hectare. On average the payout per hectare is around $3,200 for 100 hectares. This means that the net cost to the farmer of taking out insurance for 100 hectares in $1,300.

The trigger is set at -0.5°C. When temperatures below this value occur during the specified date range (15 August - 15 September) the insurance claim is triggered. The claim pays $75 per 1°C for each hectare for each night temperatures fall below -0.5°C. This means that if the farmer has insured 100 hectares, and temperatures only drop below -0.5°C for one night of the insured period, the payout the farmer receives will be $7,500. If temperatures drop below -0.5°C for two nights in the specified period, the farmer receives $15,000. The value of the payout increases in this way until a maximum payout value of $37,500 is reached. The farmer is able to specify the maximum payout value per hectare.

Table 3 Types of indemnity and index products

| Type | Product | Description | Benefits of the product to farmers | Countries / regions available (non-exhaustive list) | Examples |
| --- | --- | --- | --- | --- | --- |
| **Indemnity** | Named peril insurance | • Covers losses that occur due to pre-specified perils like frost, fire, hail<br>• Payout is equal to the loss of insured value, minus an agreed deductible | • Relatively low premiums<br>• Allows farmers to target perils with high probability and/or consequence<br>• Low basis risk – based on actual yields | Australia, Czech Republic, Germany, Hungary, India, Ireland, Malaysia, Netherlands, New Zealand, Portugal, Sweden, Switzerland, United Kingdom, United States | Primacy Broadacre Crop Insurance to cover hail and fire damage (Australia) |
| | Multi-peril crop insurance – yield insurance | • Payout occurs if actual farm-level yields fall below a pre-specified trigger yield.<br>• The trigger yield is typically 50 to 75% of expected yield<br>• Payout structures vary but typically will be equal to the difference between the trigger yield and actual yield multiplied by a pre-agreed price ($/tonne)<br>• As the yield itself is insured, allows for protection against all weather-related events, pests and diseases | • Comprehensive coverage of perils<br>• Low basis risk – based on actual yields | Australia (limited after 2019), Austria, Canada, China, Cyprus, Czech Republic, France, India, Israel, Italy, Japan, Philippines, Portugal, Slovenia, Korea, Spain, Switzerland, United States | Ausure (renewals in 2019 to existing clients only), Insurance Facilitators MPCI (Australia), ProAg Yield Protection (United States) |

| | | | | | |
|---|---|---|---|---|---|
| | | • Losses from some events are typically excluded, however the burden of proof is on the insurer | | | |
| | Multi-peril crop insurance – revenue insurance | • Payout occurs if actual revenue falls below a pre-specified level<br>• The pre-specified level is typically defined as a percentage of average revenue<br>• Payout structure may vary but will generally be equal to the difference between actual revenue and the pre-agreed level | • Allows for comprehensive protection from production risk<br>• Unlike yield insurance, accounts for price risk<br>• Low basis risk – based on actual revenue | Australia, United States, Italy | SureSeason Revenue MPCI Broadacre Winter Crop Protection (Australia) |
| | Multi-peril crop insurance – profit margin insurance | • Payout occurs if actual profit falls below a pre-specified trigger margin<br>• The trigger margin will typically be equal to the expected margin minus a deductible. This deductible can be expressed as a percentage of expected margin, a percentage of expected revenue, or a flat sum<br>• Payout structure may vary but typically will be equal to the difference between actual profit and the pre-specified trigger margin | • Allows for comprehensive protection from both yield and price risk<br>• Unlike revenue insurance, accounts for cost risk<br>• Low basis risk – based on actual profit margin | Canada, United States, France<br><br>Not available in Australia. | ProAg Margin Protection Plan (United States) |

| | | | | | |
|---|---|---|---|---|---|
| **Index** | Weather index products | • Based on an index derived from one or multiple weather variables, such as rainfall or temperature<br>• Weather data can be collected from the nearest weather station or synthetic estimates of weather based on interpolation between multiple nearby weather stations and other data sources<br>• Payout occurs if the index falls below (or rises above) a pre-specified trigger index over a pre-specified period<br>• Payout structure varies: in one example, a payout may be equal to (trigger index value -observed index value) / trigger index value * sum insured | • Lower premiums due to minimal risk of information asymmetry and lower administrative costs<br>• Faster payout processes than indemnity insurance products | Australia, India, Mexico, Africa, South America, Austria, Canada, Germany, Switzerland, United States<br>Note: Weather derivatives are also used in other industries across the US and EU. For example, Chicago Mercantile Exchange offers weather index products for the energy industry | CelciusPro Weather Certificates (Australia), Weather Index Solutions Excessive Rainfall Wet Harvest Cover (Australia) |
| | Yield index products | • Based on an index derived from multiple variables (e.g. shire-level yields, weather variables, and crop specific factors like management practices) that predicts yield for an individual farm<br>• A model provides a yield forecast at the start of the season. At the end of the season the forecast is updated with actual conditions<br>• Payout occurs if post-season modelled yields fall below a trigger yield. The trigger yield may be equal to the pre- | • Lower premiums due to minimal risk of information asymmetry and lower administrative costs<br>• Faster payout processes than indemnity insurance products | Australia, Sweden, India, United States | National Agricultural Insurance Scheme (NAIS) (India), Agriculture and Climate Risk Enterprise (formerly Kilimo Salama) (Kenya, Rwanda, Tanzania) |

| | | | | | |
|---|---|---|---|---|---|
| | | season modelled yield or the pre-season modelled yield minus a deductible<br>• Payout structure may vary but typically will be equal to the difference between the trigger yield and post-season modelled yields, multiplied by an agreed price | • Potential for lower basis risk than weather index products | | |
| | Normalised difference vegetative index (NDVI)/satellite index products | • Similar to weather index products but based on an index of pasture greenness on an individual farm, collected via satellite. Pasture greenness is used as a proxy for feed availability<br>• Payout occurs if the actual index falls below a pre-specified trigger over a pre-specified period<br>• Payout structure may vary: in one example, a payout may be equal to (trigger index value-observed index value) / trigger index value * sum insured | • Lower premiums due to minimal risk of information asymmetry and lower administrative costs<br>• Faster payout processes than indemnity insurance products<br>• Potential for lower basis risk than weather index products | Australia, Mexico, Uruguay, Spain, Canada, USA, Kenya, Argentina | CelsiusPro Australia Livestock Solutions cover (Australia) |
| | Area yield index products | • Payout occurs if actual average regional yields fall below a pre-specified trigger yield | • Lower premiums due to minimal risk of information | Sweden, India, United States, Canada, Spain | Federal Crop Insurance Program Group |

| | | | | | |
|---|---|---|---|---|---|
| | | • The trigger yield is typically equal to a proportion of the average expected regional yield (between 50 – 90 per cent)<br>• Payout structure may vary but typically will be equal to the difference between the trigger yield and actual average regional yields, multiplied by an agreed price<br>• Requires historical area yield data to establish the normal average yield and insured yield<br>• Can also be classified as a hybrid indemnity-index insurance product | asymmetry and lower administrative costs<br>• Potential for lower basis risk than weather index products | | Risk Plan (United States) |

Source ABARES 2012, Hirsch 2020, NRAC 2012, GIIF 2020, CCAFS 2015, Vroege et al, 2019.

## 3.3. Agricultural weather insurance in Australia

### 3.3.1. Legislative and regulatory arrangements in Australia

The Australian insurance sector is governed by several federal and state laws. Key federal legislation includes the *Insurance Act 1973* (Cwth), the *Insurance Contracts Act 1984* (Cwth) and the *Corporations Act 2001* (Cwth). These laws govern the entire insurance industry and aim to ensure financial integrity and that the conduct of the insurance industry is upheld to a high standard.

In addition to the legislation there is also a General Insurance Code of Practice, which is a voluntary code that helps to protect the rights of policyholders. Compliance with the Code of Practice is monitored by the Australian Financial Complaints Authority's (AFCA) Code Compliance and Monitoring team (ICA 2020). AFCA is a not-for-profit that is governed by industry and consumer representatives that provides independent assistance in resolving complaints related to the financial industry (AFCA 2018).

The two key industry regulators are the Australian Prudential Regulation Authority (APRA) and the Australian Securities and Investments Commission (ASIC). APRA is an independent statutory authority that supervises the financial industry, sets standards for industry to abide by, and promotes financial system stability in Australia (APRA 2020; ICA 2020). APRA's mandate is to protect the Australian community through establishing and enforcing industry standards and practices to help ensure that financial institutions can meet their obligations to their clients within a stable, efficient and competitive financial system (APRA 2020). APRA works closely with ASIC, as well as the Australian Treasury and Reserve Bank of Australia.

ASIC is responsible for licencing financial service providers, which includes insurance providers and insurance brokers and agents, and regulating insurers and insurance brokers and agents to ensure compliance with financial services laws (ICA 2020, ASIC 2020). A key difference between ASIC and APRA in terms of legislative arrangements is that while APRA manage insurance products, derivatives fall under the governance of ASIC as they can only be offered by licenced providers (Hirsch 2020).

Insurance products are also subject to various taxes and levies. Insurance is subject to GST and State governments may apply stamp duty or other levies to the premiums.

### 3.3.2. Agricultural weather insurance uptake in Australia

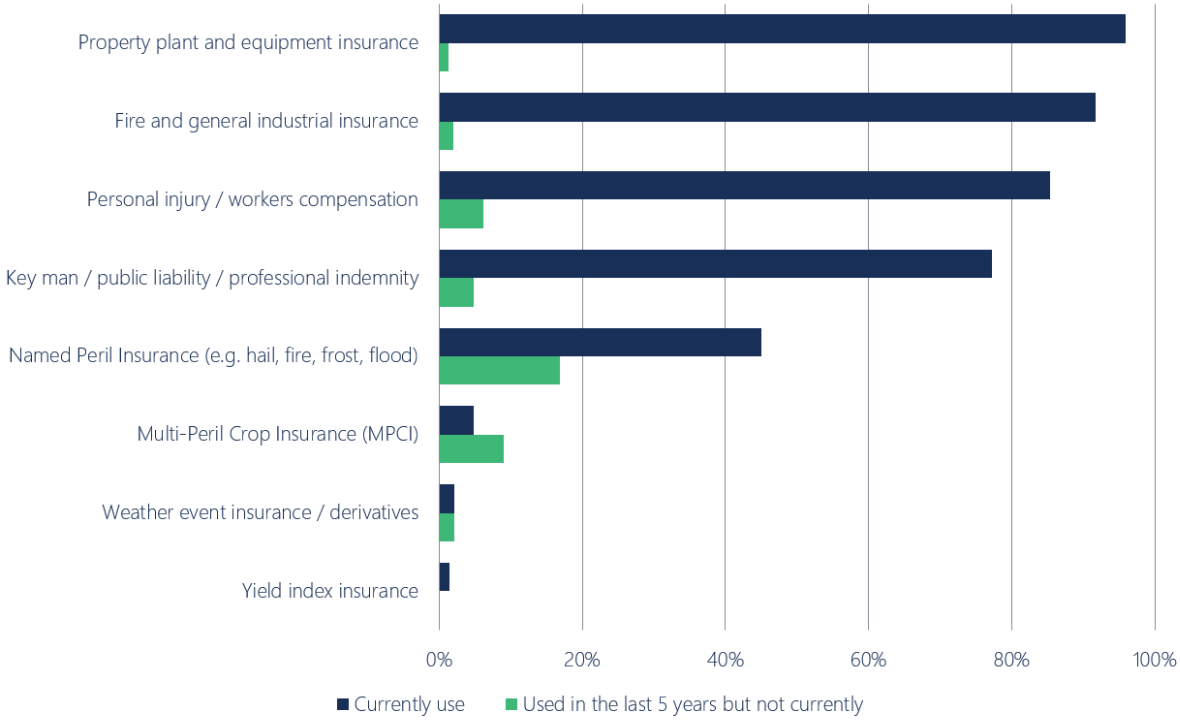
A range of indemnity and index products are available in Australia to help farmers manage weather production risk. Available products include named-peril insurance for localised weather-related risks like hail, fire and frost, multi-peril crop insurance (limited availability from 2019), and a range of index insurance products and derivatives. Of these products named-peril insurance is the most common. Insurers have found it difficult to establish multi-peril crop insurance which has led to limited availability, and index products are relatively new and unknown to many farmers.

Insurance is provided by a range of companies, which continues to change as new products are offered. Providers of insurance products in Australia include All State, Crop Risk Underwriting (CRU), Elders, Latevo Farmers Mutual, Primacy, Rural Affinity and SureSeason. CelsiusPro and Weather Index Solutions are key providers of weather derivatives in Australia.

To help contextualise the uptake of agricultural weather insurance, it is useful to first consider uptake of general farm pack insurance. Farm pack insurance provides comprehensive cover for multiple aspects of a farm business, including insurance for farm and general property, machinery and motor vehicles, public and product liability, business interruption and home and contents. Many insurers also allow for additional products to be added to the insurance bundle, providing a bespoke package that is tailored to each farmer's needs. Farm pack insurance is widely used by farmers. Data from the National Survey show that current use of insurance for non-weather production risks is between 77 per cent for public liability / professional indemnity insurance to 96 per cent for property, plant and equipment insurance (Figure 6). This data is broadly representative of the anecdotal evidence from consultations with farmers and the insurance industry.

The uptake of agricultural weather insurance is starkly lower than that for general farm pack insurance. Data from the National Survey shows that farmer uptake of agricultural weather insurance is between 1 to 45 per cent, depending on the product (Figure 6). Uptake of the most utilised agricultural weather insurance product – named-peril insurance – is only around half that of products offered under farm pack insurance. The next most used according to the National Survey is multi-peril crop insurance at 5 per cent, although this appears high compared to anecdotal evidence. Weather index insurance is the next lowest at 2 per cent, followed by yield index insurance at 1 per cent.

Compared to international examples of named-peril insurance uptake, the uptake numbers from the National Survey are slightly above average. The World Bank (2010) found that for high income countries without premium subsidy support, the percentage of farmers that had named-peril crop insurance was an average of 42 per cent.




Source National Survey.

Figure 6 Farmers' current and historic use of insurance to manage on-farm risk

The following subsections explore Australian agricultural weather insurance uptake in further detail.

### *Indemnity product uptake (named-peril, multi-peril crop insurance)*

Named-peril insurance products are available for a range of commodity types in Australia and cover perils such as hail, fire and frost. This is currently the primary type of insurance used to manage weather production risk in Australia and is offered by most major insurance companies. The National Survey revealed that named-peril insurance was currently used by 45 per cent of survey respondents (Figure 6). This data is representative of anecdotal evidence from farmers and the insurance industry, and similar to named-peril insurance uptake rates estimated by Deloitte (2017).

Multi-peril crop insurance saw an increase in product offerings from 2014, with various providers entering and leaving the market between 2014 and 2018. There was some limited government support of the emerging market, with the Victorian, South Australian and New South Wales governments attempting to encourage uptake by exempting multi-peril crop insurance and other agricultural weather insurance products from stamp duty. In 2016, the Commonwealth government funded the Managing Farm Risk Program to partially rebate farmers for the cost of obtaining advice and assessments to help farmers prepare and apply for new insurance policies. The rebate, of up to $2,500, was for advice on taking out either a new or additional policy covering a peril the farm business had not insured against within the last five years. However, the program was stopped due to low farmer uptake. Over the first two years of the program only 69 farmers participated, primarily for activities related to multi-peril products.

While no conclusive data on historical product uptake was available from industry sources, our discussions with the insurance industry have suggested that multi-peril crop insurance uptake in 2018 and in previous years was in the order of low hundreds of active policies per year across Australia.

Since 2019, the availability of multi-peril crop insurance has become extremely limited, as evidenced by GrainGrowers' report into multi-peril crop insurance (GrainGrowers 2019). The National Survey suggests that multi-peril crop insurance could have a 5 per cent current uptake rate, however this may not be representative of actual farmer uptake due to selection bias of farmers that completed the survey. Industry sources and farmers have suggested that the uptake rate is much lower than 5 per cent. Anecdotal evidence from industry sources, supported by the GrainGrowers' report, shows that since 2019, products were not offered by insurers as there was limited uptake by farmers and products were not considered to be financially viable by insurers. Barriers to uptake of multi-peril crop insurance have been discussed extensively in Australian literature (ABARES 2012, NRAC 2012, IPART 2015, GrainGrowers 2019) and are discussed in more detail in Section 5.

### *Index product uptake (weather index, yield index, other)*

Index products are an emerging weather production risk management offering in the Australian market. No conclusive evidence of uptake is available, however anecdotal evidence from industry sources suggests that uptake of index products is low and in the order of tens of active policies per year. This was reflected in data from the National Survey which indicated that very few survey respondents have used or currently use index insurance or derivatives, however the National Survey results may not be fully representative of all farmers use of index products given the small number of survey respondents. Anecdotal evidence from the industry suggests that while uptake remains low in absolute terms, uptake has grown year-on-year and particularly over the last 12 months.

### 3.3.3. Recent and emerging products in the Australian agricultural weather insurance market

Established and emerging insurance providers have recently been trialling a range of different agricultural weather insurance products and product-delivery strategies for the Australian market. These products and strategies draw on lessons from international markets and past experiences in the Australian market, including an understanding of the preferences of Australian farmers.

The following subsections provide examples of these products and strategies, and demonstrate the continued interest from insurance providers and farmers to identify innovative solutions to address gaps in the market. While the role of new technology is often looked to address gaps in the insurance market, many of the examples below show that gaps can also be addressed by looking at insurance product structure and how insurance is delivered.

#### *Multi-year and lower cost multi-peril crop insurance*

Many providers are developing indemnity insurance products which aim to address key barriers to uptake (discussed in Section 5). Discussions with industry suggested that there remains ongoing interest in different methods to enable the viable supply of multi-peril crop insurance. For example, existing work continues to assess whether multi-year contracts would be mutually beneficial to farmers and insurers. Multi-year contracts may be beneficial to the providers of insurance because they ensure revenue in years with no payouts. This revenue allows capital to be retained and used to pay farmers in other years. Currently, insurance contracts are typically provided on a yearly basis.

Several providers are attempting to reduce the premiums of multi-peril crop insurance by incorporating more nuanced data into their product pricing or payout structure. For example, satellite data may be used to better understand the risk profile of individual farmers or their regions, allowing providers to segment the market and better incentivise effective on-farm risk management. Weather data and yield modelling such as APSIM[2] or Yield Prophet may also be used to verify on-farm yield data, reducing loss assessment costs and lowering moral hazard risks. Similarly, the use of drones and other technology to undertake loss assessments has also been trialled in Australia. These methods aim to reduce costs due to information asymmetry or administrative tasks whilst retaining the desirable characteristics of traditional multi-peril crop insurance, such as comprehensive cover and ease of use.

Alternative delivery mechanisms for insurance, such as the provision of insurance through a mutual fund have also recently been attempted. These funds offer discretionary protection to members as an alternative to insurance with claims paid on a proportional basis depending on the available pool of capital and volume of claims made in any given year. The use of cooperatives and mutual funds to manage on-farm risk is dealt with in greater depth in *Sub-Project 3: Mutuals and Cooperatives*.

#### *Long-term derivative contracts and bundled insurance*

Options for large agricultural supply chain participants to hedge weather production risk, or perform a role of product aggregator are also starting to emerge in the Australian market. In 2019, GrainCorp entered a 10-year insurance contract with Aon-owned White Rock Insurance to manage GrainCorp's weather production risk. The derivative based contract, developed specifically for the Australian market, operates to smooth revenue across the duration of the contract. In bad years White Rock pay GrainCorp a fixed fee of $15 per tonne up to a maximum of $80 million a year when production falls

[2] The Agricultural Production Systems sIMulator (APSIM) is internationally recognised as a highly advanced platform for modelling and simulation of agricultural systems

below 15.3 million tonnes. In good years, White Rock will be paid a maximum of $70 million a year when production exceeds 19.3 million tonnes. The contract also sets a cap on payments from either party of $270 million over the duration of the contract (GrainCorp 2019). The premium for the product is approximately $6 million a year, and has already yielded a payout of $57.9 million in early 2020 as a result of the severe drought gripping south-eastern Australia (Farm Online 2020). An interview with GrainCorp revealed that the insurance contract has benefited the organisation by facilitating long-term planning. Prior to the contract, high volatility in revenue made long-term planning risky, causing the company to make plans on shorter timeframes. The 10-year contract has now allowed GrainCorp to plan strategies and investments as far out as a decade with a greater amount of certainty.

Some providers are also looking into bundling insurance products with other farm products to share risk and improve the value to farmers purchasing high cost farm inputs. For example, between October 2018 and September 2019, Syngenta offered the AgriClime program to customers who spent $15,000 or more on Syngenta inputs. The program provided a rebate on Syngenta inputs based on a growing season rainfall deficit trigger (set at a 1-in-5 year rainfall deficit event). The rebate from Syngenta scaled incrementally with the magnitude of the deficit below the trigger point, up to a cap of 30 per cent of the cost of product (Syngenta 2020). Monsanto / Bayer is currently providing a similar rebate on Bayer products through their DecilePro program for 2020.

## 3.4. International examples of agricultural weather insurance

### 3.4.1. International agricultural weather insurance products

A World Bank (2010) survey from 2008 found that half of all countries offered some form of agricultural weather insurance. This figure includes both publicly and privately provided insurance in developed and developing countries. High-income countries and emerging markets like China are the dominant providers of agricultural weather insurance. In 2008 almost 90 per cent of agricultural weather insurance premiums were underwritten in these countries. Most of this insurance is for crops, making up 91 per cent of the market by the volume of insurance premiums.

Table 4 sets out some international examples of agricultural weather insurance and government policies and arrangements in place to support farmers. The countries and regions included in Table 4 represent a range of insurance products, government policies and levels of development. The following sections explore these examples in further detail.

Table 4 Summary of country arrangements

| Country/Region | Agricultural weather insurance policy arrangements and products |
|---|---|
| United States of America | Government provided and subsidised multi-peril crop insurance and revenue protection programs are a large part of agricultural risk management in the USA. These programs are complemented by market instruments and on farm risk management strategies.<br>The main government provided agricultural weather insurance program is Federal Crop Insurance. This program provides several multi-peril crop insurance policies delivered through public-private partnerships, including:<br>• Actual production history – insures against yield losses due to natural causes (weather, pest or disease related). Payouts are made at a pre-agreed price when harvested yield is less than insured yield.<br>• Area risk protection – insures a farmer based on the performance of a local area (county) rather than their farm. Payouts are made when the area's yield or revenue index falls below a pre-agreed level.<br>• Catastrophic risk protection endorsement – coverage for a 50% loss in yield, indemnified at 55% of the expected market price. Premiums are subsidised, with farmers only paying a $300 fee.<br>In 2015, 90% of crops were insured under the Federal Crop Insurance Program. It is estimated that the government subsidises over 60% of the premiums of these products.<br>Private sector products include crop-hail insurance, named peril insurance for wind and fire damage and index insurance. These products are not a part of the Federal Insurance Program and are not subsidised. |
| Canada | Agricultural weather insurance in Canada is primarily provided through a suite of federal and provincial government programs that include natural hazard insurance (AgriInsurance), natural disaster relief (AgriRecovery), whole of farm margin protection (AgriStability), and savings accounts with 1% of deposits matched by government (AgriInvest).<br>AgriInsurance is a multi-peril insurance product that can be used to insure field crops, horticulture production and forage production against losses and downgraded product quality caused by drought, flood, frost, hail, pests and diseases, snow, wind and wet harvest.<br>AgriInsurance is subsidised by around 60% by Canadian governments. Governments also cover the administration costs in addition to premium subsidisation. Product uptake was estimated to be around 75% in 2014/15.<br>There are some privately provided named peril policies for hail and fire damage and index insurance, however no privately provided multi-peril crop insurance products. |

| | |
|---|---|
| European Union | The European Union has a comprehensive agricultural risk management policy. The Common Agricultural Policy is comprised of two pillars:<br>1. Market and Price Support Policy - provides farmers with direct payments to stabilise their income (accounting for about 43% of farm income)<br>2. Rural Policy - a package of risk management tools for rural development that offers:<br>a. subsidisation of insurance premiums by up to 65%,<br>b. access to mutual funds to compensate for losses,<br>c. income stabilisation through mutual fund-like arrangements (>30%).<br>The insurance scheme is the most developed of the three options under the Rural Policy pillar.<br>Private sector insurance is available, however is heavily subsidised by the EU policy (32 to 65% subsidisation depending on the country). Types of insurance include named peril products for hail, pests, theft, fire, storms, and death or emergency slaughter for livestock, and multi-peril crop insurance (limited to a few countries only). The insurance market is dominated by a few key insurers. |
| New Zealand | New Zealand does not have any major risk assistance programs that are supported by government. Government programs primarily focus on macro-economic stability, prevention of pests and diseases and catastrophic risk. These include funding preventative on-farm measures, welfare benefits and an income deposit scheme.<br>There are a few privately provided insurance schemes in place for wheat and kiwifruit, with insurance offered through mutual schemes or cooperatives. Farmers Mutual Group is the dominant mutual fund insurance provider and provides multi-peril cover for livestock, horticulture, viticulture, and crops, as well as farm pack insurance. |
| Turkey | The insurance market in Turkey operates via a public-private partnership. There are 22 private insurance providers that provide multi-peril and index insurance for crops, greenhouses, cattle, sheep and goats, poultry, aquaculture and beehives against a range of weather production risks, pests and diseases.<br>The insurance market is underpinned by a risk pool. Each insurance provider must place the entire value of their premiums into the pool. The pool can then be drawn on for claims against all insurance policies. Insurance premiums are also subsidised through the pool by the Turkish government. Subsidisation ranges from between 50 - 65% depending on the farming sector and risks covered by the insurance. |

| | |
|---|---|
| Kenya | The main form of government provided insurance in Kenya is the Kenya National Agriculture Insurance Program. The program is a public-private partnership which acts as a substitute for natural disaster relief. It includes both:<br>• Kenya Livestock Insurance Program – triggers payouts to pastoralists when pasture coverage drops below a certain level (NDVI measured by satellite).<br>• Kenya Agricultural Insurance and Risk management Program for maize and wheat – payouts are based on changes to area yield.<br>There are a few government programs that aim to complement the Kenya National Agriculture Insurance Program that focus on disaster risk reduction and climate change action.<br>Privately provided products are limited due to issues with moral hazard and adverse selection. |

Source AFI 2019, Bora 2010, TARSIM 2020, World Bank 2010, Congressional Research Service 2018, GIZ 2016.

### *Indemnity insurance product availability and uptake*

Named-peril and multi-peril crop insurance policies are the two most common types of agricultural weather insurance offered globally (World Bank 2010). Named-peril insurance was offered in 69 per cent of the 65 surveyed countries in 2008. It is more common in high income countries (offered in 100 per cent of countries), rather than lower-middle income (45 per cent) or low income (50 per cent) countries.

Multi-peril crop insurance was available in 63 per cent of the 65 surveyed countries in 2008. It was more common in lower-middle (85 per cent) and upper-middle income (72 per cent) countries than high income (48 per cent) countries (World Bank 2010). Of the surveyed countries, multi-peril crop insurance policies were most common in North and South America, with almost double the availability in these regions compared to Europe, Asia, Africa, and Oceania.

Indemnity insurance uptake varies depending on the level of a country's development and whether they offer premium subsidies or not. The highest levels of uptake are in high income countries that offer premium subsidies such as the United States and Canada, followed by high- and upper-middle income countries that do not offer subsidies.

In comparison to the global uptake of indemnity insurance, the World Bank (2010) reports that Australian uptake of crop insurance is around 50 per cent of farmers, which is higher than the average for high income countries with no premium subsidies. This figure is in line with data from the National Survey, that shows around 45 per cent of surveyed farmers use named-peril insurance, and 5 per cent use multi-peril crop insurance.

### *Index insurance product availability and uptake*

Index insurance products are available for both crop and livestock insurance. The World Bank's 2008 survey found that area yield index insurance was available in 15 per cent of countries, and crop weather index insurance was available in 22 per cent of countries. Many of these policies were available on a pilot basis, primarily in low income countries. The availability of index insurance was the lowest in high income countries. This may be due to index insurance being the focus of international development agencies and donors, as index products have been developed to complement indemnity products and fill a gap in the insurance market in low to middle income countries.

A more recent GIZ (2016) study found that these figures had increased as index insurance gains popularity. However, the study also found that the only countries in which index insurance have been adopted at a large scale are China (area-yield insurance) and India (weather index insurance). Index insurance in these countries is heavily subsidised, and in the case of India, compulsory and linked to government provided agricultural loans. The study found that globally, index insurance has similar barriers to uptake as those found for Australian farmers in this project. Section 5 sets out the barriers to insurance uptake in further detail.

## 3.4.2. Prevalence of subsidies in international insurance markets

The most common form of public intervention in agricultural weather insurance is the provision of crop premium subsidies. The World Bank (2010) survey found that 63 per cent of surveyed countries provided crop premium subsidies in 2008. The value of upfront premium subsidies is around 44 per cent of the premium. Subsidisation at this level was common across all regions and countries (excluding Oceania), with the exception of low-income countries, where only 40 per cent of low-income countries provided crop premium subsidies. Subsidies are mainly offered for multi-peril crop insurance and area-yield insurance. Subsidies for named peril products are not as common.

Government subsidisation of insurance markets can occur in a range of different ways in addition to direct premium subsidies. Subsidisation can include:

- financing administrative and operational costs
- financing loss assessments undertaken by insurers
- the provision of public sector reinsurance
- funding for research and development
- funding for education and awareness programs
- training for farmers or the insurance sector.

When accounting for these forms of subsidisation the global cost of subsidisation rises to around 68 per cent of the value of the premium. Given the differing levels of subsidisation across countries this value will be higher in some countries and lower in others.

Canada, the United States of America, and the European Union are all example of countries or regions that have well developed insurance markets with high levels of direct premium subsidisation for multi-peril crop insurance. The Canadian government provides a mix of direct premium subsidies (up to 60 per cent), administrative and operational rebates to insurance companies, and pays for research and development. Premium subsidisation in the USA also sits at around 60 per cent for multi-peril crop insurance, which amounts to around $7 billion a year. Countries in the European Union also provide direct subsidies that are between 32 to 65 per cent of the value of the premium. This is in addition to providing income stabilisation payments that account for around 43 per cent of farm income (World Bank 2010; AFI 2019). While subsidies and income stabilisation can provide benefits for farmers and the agricultural sector, there are also risks that these comprehensive government policies have reduced the ability of the market to provide new risk management solutions, and have reduced incentives for farmers to take ownership of on-farm risk management (AFI 2019).

These levels of premium subsidisation are in stark contrast to the Australian market, which operates without any subsidies. There are no examples that were found when researching this report of countries that have a large-scale agricultural weather insurance market (excluding named peril insurance) that operates without subsidisation. There are also no examples that were found countries that successfully removed premium subsidies once they were established.

### 3.4.3. Recent and emerging products in the international agricultural weather insurance market

#### *Normalised Difference Vegetation Index livestock insurance*

The global availability and uptake of index insurance products has grown over the past decade, particularly in low- and middle-income countries. Over the last two decades improvements to remote sensing and crop modelling have advanced the global use of index insurance products.

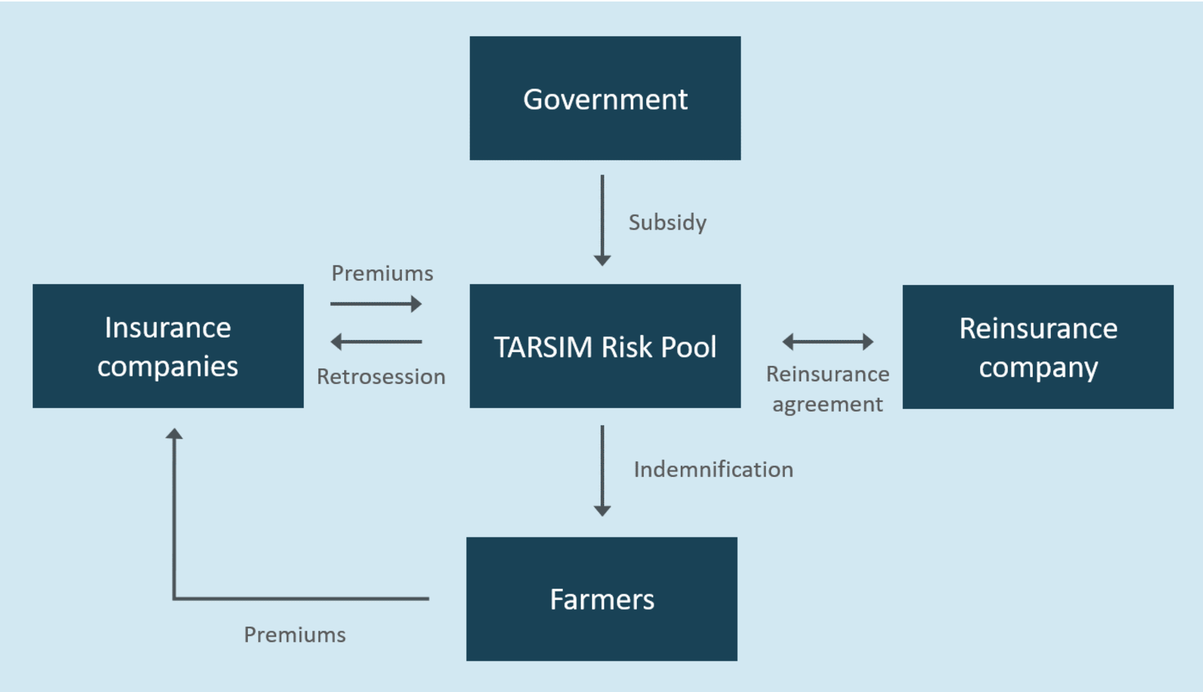
The most recent index insurance product trialled in a range of countries is Normalised Difference Vegetation Index (NDVI) livestock insurance. NDVI insurance uses data from satellites to approximate plant cover and health. This data can then be used to determine changes in the availability of pasture for grazing. In years when pasture cover or health drops below a pre-determined level, livestock farmers receive a payout that can help cover costs for fodder. The 2010 Index-based Livestock Insurance Program in Kenya was the first index insurance program to use NDVI data. It has since been adopted by the Kenyan government as the Kenya Livestock Insurance Program.

NDVI livestock index products have since been trialled in a range of countries and are available in Uruguay, Mexico, Spain, Canada, the United States of America and Argentina. Index products have also recently become available as a new product offering in Australia however, are not yet widely used by livestock farmers.

### *Risk pooling - the Turkish TARSIM system*

The TARSIM program in Turkey is another example of a new approach to insurance provision. Prior to the TARSIM program, Turkey had a private insurance market however only 0.5 per cent of agricultural areas were insured. Insurers tended to insure very specific or low probability risks and did not offer affordable pricing. The system also suffered from a lack of data and transparency and was under-funded. The Turkish government sought to establish a public-private partnership in 2005 to overcome these issues and encourage participation in the insurance market, resulting in the TARSIM program.

The TARSIM system is a subsidised risk transfer program (Figure 7). Under the system, private insurance companies issues policies under their own name. Premiums are collected from farmers by the 22 private insurance companies that operate under the system. The collected premiums and their associated risk are transferred to TARSIM's risk pool. Insurance companies can take money from the pool when required, known as retrosession. Payouts to farmers are taken from the risk pool. The pool is underwritten by a reinsurance company in case retrosession or payouts are not possible due to a high number of claims. If reinsurance cover is insufficient the government also provides Catastrophe Stop Loss cover as a last resort (Bora 2010; TARSIM 2020).




Source Modified from Bora 2010.

Figure 7 The Turkish TARSIM risk pool system

The TARSIM program has been successful in increasing the availability and uptake of insurance over time. In 2007 the insured value of agriculture was around ₺764,340,000 (Turkish lira) for 113,413 policies (Bora 2010). In 2018 this figure had grown to ₺42,217,541,073 for 1,756,428 policies - a 15-fold increase in the number of premiums (TARSIM 2018).

The Turkish government subsidises between 50 to 65 per cent of the premium value across all insurance lines. In 2018 this amounted to just over ₺1 billion (approximately $177 million AUD[3]). As shown in Table 5 below, the value of the premium paid by farmers has not covered the value of paid losses in any of the past four years. This shows that in the past four years the risk pool would have operated at a loss without government subsidies.

Table 5 The value of premiums, subsidies and losses for the TARSIM risk pool from 2015 – 2018

| Insurance parameters | 2015 value (Turkish lira ₺) | 2016 value (Turkish lira ₺) | 2017 value (Turkish lira ₺) | 2018 value (Turkish lira ₺) |
|---|---|---|---|---|
| Total premium value* | 965,772,197 | 1,299,986,302 | 1,628,553,789 | 2,050,635,088 |
| Government premium subsidy* | 524,215,392 | 694,983,646 | 864,417,852 | 1,072,036,127 |
| Premium paid by farmers | 441,556,805 | 605,002,656 | 764,135,937 | 978,598,961 |
| Paid losses* | 724,802,873 | 840,963,512 | 833,085,483 | 1,065,106,035 |
| **Paid losses not covered by the premium value paid by farmers** | **283,246,068** | **235,960,856** | **68,949,546** | **86,507,074** |

Source Values denoted with an asterisk* are taken from the TARSIM 2018 Annual Report, all other values are calculated by Aither.

Note Premiums values are across all insurance lines, including crops, greenhouses, cattle, sheep and goats, poultry, aquaculture and bee hives. As at October 2020 $1 AUD = ₺5.6 Turkish lira.

While the TARSIM risk pool has been able to increase the number of insured farmers across Turkey, it relies on government subsidisation to operate. If government subsidies were removed the premium value for farmers would almost double, which may have implications for the viability of the insurance market.

[3] Converted at the October 2020 exchange rate where $1 AUD = ₺5.6 Turkish lira

# 4. Method

This section describes the analytical framework used for this project and our approach to gathering evidence.

## 4.1. Analytical framework

An objective of this report is to identify worthwhile government interventions to support the agricultural weather insurance market in Australia. To start, we identified the barriers to the uptake of agricultural weather insurance based on a review of the literature and conversations with farmers, insurers and other insurance market participants. The barriers were categorised as demand-side or supply-side barriers, depending on whether they affect farmers' willingness to pay for insurance or insurers' willingness to provide insurance. To help identify the most important barriers, we explored the following questions for each barrier:

- How does the barrier affect the uptake or provision of insurance?
- How large is the impact of the barrier on the uptake or provision of insurance?
- Is the barrier a problem? That is, would farmers be better off if the barrier was removed?

The barriers that are both material and problematic for farmers were carried forward (Section 5).

Some of these barriers will be addressed over time, even in the absence of government intervention. Aither drew on conversations with leaders in the insurance market to understand what future developments are either likely or possible, and what these developments would mean for the barriers (Section 6).

As a result of market failures and government distortions, private action is unlikely to be sufficient to address all of the barriers, even when the benefits would exceed the costs in aggregate (that is, from the perspective of all Australians). Aither developed a comprehensive longlist of possible government interventions. The interventions were shortlisted based on whether they could reasonably:

- provide a material benefit to farmers and
- address a material market failure or government distortion (Section 7).

Decisions around government interventions should be informed by the consequences. As part of this project, Aither built an economic model of the agricultural weather insurance market. The model simulates hundreds of representative farmers on the demand side and insurers on the supply side, capturing the key barriers to insurance. The model is based on dryland winter cropping (Case Study 1), with the results being extrapolated to Australian farmers in general. See Appendix C – Technical documentation for technical documentation.

The agricultural weather insurance market model was used to run virtual experiments, simulating the market with and without the shortlisted government interventions. The model reported on several insurance market outcomes (loss ratio, uptake and premiums paid) as well as the benefits and costs. The benefits and costs are disaggregated by farmers, insurers and the direct fiscal impacts (Figure 8).

We recommended government interventions where the benefits are likely to exceed the costs in aggregate. This is consistent with welfare economics from a theoretical perspective and government business cases processes from a practical perspective. However, people may have other criteria for assessing the merits of government interventions. The consequences outlined in this report should be valuable for informing those assessments as well (Section 8). Our analytical framework is summarised in Figure 9.

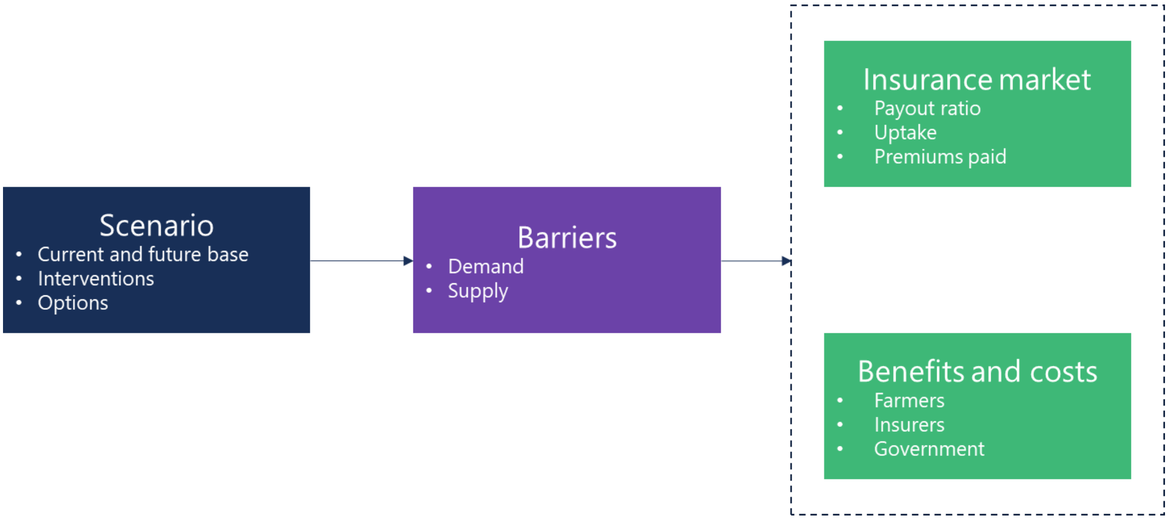



Figure 8 Agricultural weather insurance market model

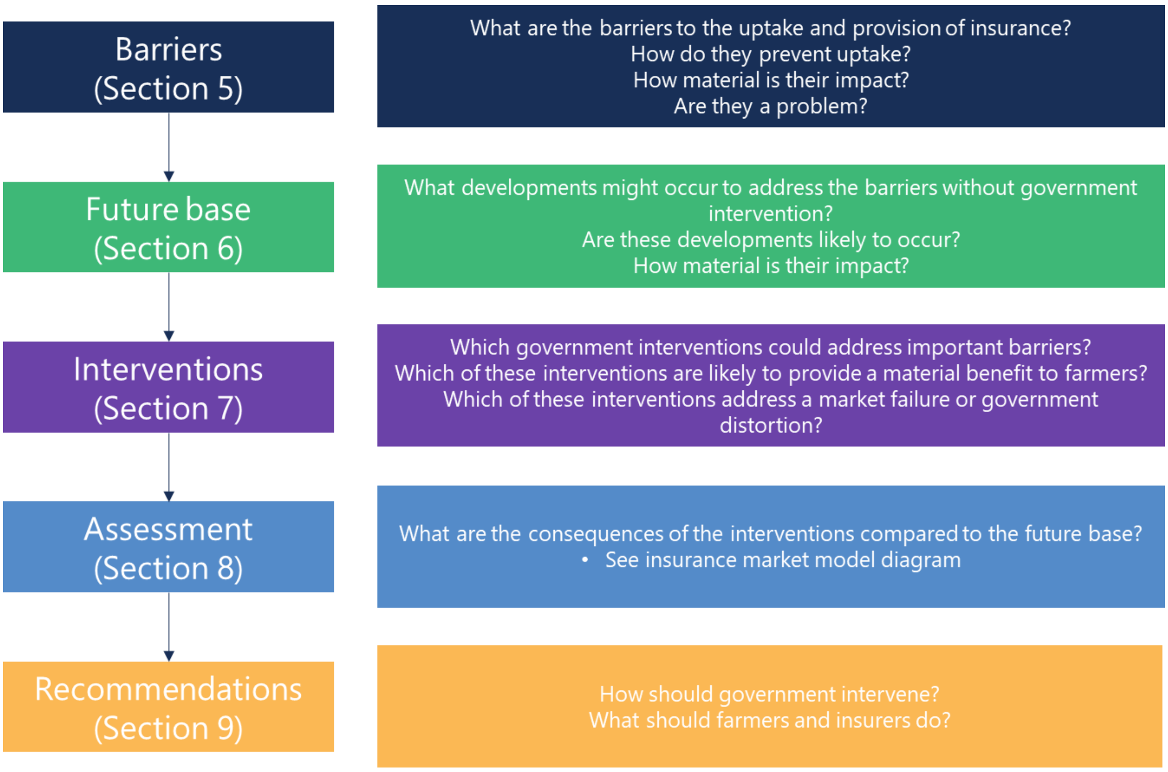



Figure 9 Summary of analytical framework

## 4.2. Approach to gathering evidence

This project focused on collecting multiple lines of data and information to inform the analysis. This was particularly important for this project given the complex nature and scale of the issues being investigated, including the different factors that affect the decision-making of farmers, insurers and government.

Our approach to gathering evidence included undertaking a desktop review, a farmer survey, and stakeholder consultation with relevant industry and government stakeholders, farmers, and farm advisors. Each of these components of our method is set out in further detail below.

### 4.2.1. Desktop review

The initial stage of desktop review was used to clearly identify and refine key barriers to uptake and potential options to overcome them. The desktop review involved collating existing data and information from prior studies, academic papers, and sourcing information directly from the insurance sector and key government agencies. The desktop review involved a review of both Australian and international experience. The data and information collected from the desktop review were used to inform the development of the farmer survey and consultation questions, as well as to support the subsequent quantitative and qualitative analysis of options.

### 4.2.2. Farmer survey

A national stakeholder survey was conducted as a part of the broader On-farm financial risk management project, covering all six approaches to risk management (National Survey). This sub-project contributed 17 questions to the survey to collect quantitative data to support the analysis of barriers to insurance uptake and options to increase insurance uptake.

The survey received 311 responses from individuals and organisations across the agriculture, insurance and finance sectors and government bodies. The responses to the survey were tested through subsequent consultations with farmers, corporate agribusinesses and farm advisors.

### 4.2.3. Consultations

Stakeholder consultation formed an important part of this project and was fundamental to the collection of data and information, and in testing and refining the findings and emerging recommendations. Our approach to stakeholder consultation focused on:

- One-on-one and group consultations with relevant industry and government stakeholders to inform early stages of the project, gather evidence and data for the case studies, and test early findings and recommendations
- One-on-one consultations with farmers, farm advisors, and insurance and finance sector specialists to gather evidence and data for the five case studies
- Group and one-on-one discussions with a Farmer Reference Group, comprising 13 farmers from across Australia with a range of experience across different commodities, farm sizes and structures to inform the initial direction of the project, evidence for the case studies and early findings.

In addition, the project involved substantive inter-project collaboration and engagement with the Working Group and Steering Committee which were established for the overarching project.

### *Consultation with relevant industry and government stakeholders*

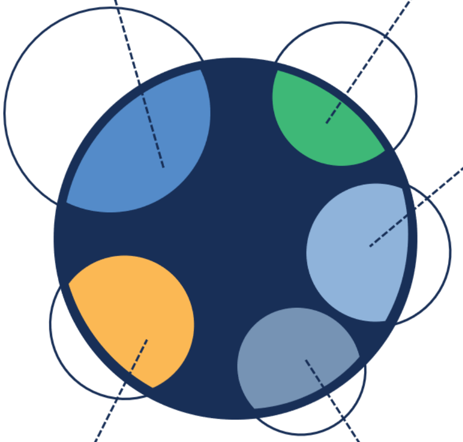
Extensive consultation was undertaken with relevant industry and government stakeholders to gather key data and information at each stage of the project as well as test early findings and recommendations. The one-on-one and group consultations are summarised Figure 10. Our consultations with industry and government stakeholders were invaluable in collating qualitative information to identify and describe key barriers and inform our understanding of the feasibility of options. They were also used to collect additional quantitative data to support the data gathered through the survey and case study interviews.

**Insurance and finance sector**

- AgriRisk
- AgroInsurance
- Allianz
- Celsius Pro
- Commonwealth Bank of Australia
- Gallagher
- Hillridge Technologies
- Insurance Australia Group
- Insurance Council of Australia
- Latevo Farmers Mutual
- Modern Risk Solutions
- QBE Insurance
- Rural Affinity
- SureSeason
- Weather Index Solutions
- Willis Towers Watson

**Data specialists**

- Geosys
- Goanna Ag
- Speedwell Settlement Services



**Government and academia**

- Agriculture Victoria
- ABARES
- Australian National University
- Bureau of Meteorology
- CSIRO
- Queensland Rural and Industry Development Authority
- University of Southern Queensland

**Industry Associations**

- Birchip Cropping Group
- GrainGrowers
- Meat & Livestock Australia
- NSW Farmers
- Queensland Farmers' Federation
- Victorian Farmers' Federation
- WA Farmers

**Supply chain participants**

- Custom Harvesters
- GrainCorp
- Syngenta

Source Aither.

Figure 10 Summary of stakeholder consulted across relevant industry and government bodies

### *Case study consultation*

Five case studies were selected to help focus the scope of the project. The case studies were selected to ensure they covered critical areas for assessment and a range of production systems and perils across Australia. The purpose of the case studies was to undertake detailed analysis to understand the benefits of selected options to increase insurance uptake. The spread of production systems and locations was also selected with the intention to allow generalised findings to be able to be extrapolated to the agriculture sector more broadly. Table 6 below, summarises the case study production systems and locations.

Consultation for the case studies was focussed on discussions with farmers, corporate agribusiness, and farm advisors. The consultations tested findings from the National Survey as well as additional topics. Twenty-five case study specific consultations were carried out. Key lines of questioning included:

- the primary perils affecting their or their clients' production system
- their or their clients' use of financial and on-farm production risk management strategies

- their or their clients' historic and current use of insurance and perspectives on the insurance market
- the key barriers to insurance uptake for their production system
- their willingness to pay for insurance products to target the primary perils that affect their production system
- their perspectives on options to increase the uptake on insurance, including investment in weather and climate data collection and use, the introduction of a central exchange, and government provision of insurance and reinsurance.

Detailed findings for each case study can be found in Appendix B – Case Study Overview.

Table 6 A summary of production systems, primary perils and locations covered by the five case studies

| Production system | Primary Perils | Focus locations |
|---|---|---|
| Dryland winter cropping | Establishment rainfall deficit, finishing (spring) rainfall deficit, frost at flowering, and wet harvest. | Western and south-eastern Australia |
| Annual irrigated broadacre cropping (Cotton) | Sustained catchment rainfall deficit (24 months), wet cotton harvest (April/May), and deficient day degrees during establishment (late Sep-early Nov). | New South Wales Murrumbidgee |
| Dryland summer and winter (double) cropping | Rainfall deficit (long term, fallow, and in-season), spring frost, spring heat, wet harvest (November-December or March-April), and sustained extreme heat (summer) | Northern New South Wales and southern Queensland |
| Permanent irrigated horticulture (Almonds) | Sustained catchment rainfall deficit (24 months), frost (mid-August – early Oct), and spring heat (October-November). | Northwest Victoria (Sunraysia) |
| Livestock production (Beef Cattle) | Deficient rainfall for the November to February pasture growth period. | New England, New South Wales |

### *Farmer Reference Group consultation*

Consultation was undertaken with a Farmer Reference Group comprised of 13 farmers distributed across the key production systems and locations that formed the basis of the case studies, as shown below in Figure 12. Consultation with the Farmer Reference Group was used to help guide the project direction, test key assumptions and assist with filling data and information gaps as the project progressed.


Source Aither.

Figure 11 Farmer reference group composition, including production systems and locations across Australia.

# 5. Barriers to the uptake of agricultural weather insurance in Australia

This section explores barriers to the uptake and provision of insurance to cover weather production risk. It identifies and assesses the materiality to uptake of a range of barriers that affect farmers' willingness to pay for insurance and insurers' willingness to provide insurance. Proper consideration of barriers is important to ensure that interventions address the right problems.

## Key findings and recommendations

**Findings**

- Many farmers experience natural barriers to insurance uptake. Natural barriers reduce insurance uptake, however do not represent a problem for farmers. Attempts to address these barriers would leave farmers worse off. The largest natural barriers include a lack of underlying risk exposure, availability of effective production risk management strategies, and availability of effective financial risk management strategies.
- The significance of natural barriers suggests that agricultural weather insurance is unlikely to have universal farmer uptake without subsidisation.
- Insurance-specific barriers to insurance uptake are also relevant. Unlike natural barriers, addressing insurance-specific barriers is likely to benefit farmers. Large insurance-specific barriers include high cost of risk to insurers, high expenses to insurers, and ineffectiveness of insurance at mitigating risk (basis risk).
- We found that there are many insurance-specific barriers, and a significant portion have a moderate to large effect on insurance uptake.
- Individual farmers have characteristics that determine whether they are more or less likely to want insurance. Farmers that are untrusting of financial instruments, time poor, or have high equity are less likely to want insurance. This supports our analysis which suggests that without significant premium subsidy, insurance is likely to remain a niche market.

**Recommendations**

- Insurers are likely to benefit by targeting products towards specific segments of farmers, rather than attempting to appeal to a broader cohort. This will assist insurers to reduce expenses, which are a significant supply-side barrier to insurance uptake.

## 5.1. Definitions and approach

### *Barriers reduce the uptake of insurance*

In this report, we define a barrier as **anything that reduces the uptake of agricultural weather insurance by farmers or the provision of insurance by insurers**. While the term 'barriers' might sound negative, we are defining the term in a neutral way. There are some barriers that are negative for farmers. However, this is not always the case. For example, some farmers are less exposed to weather production risk than others. This reduces their uptake of insurance, but it is beneficial for farmers to be less exposed to risk.

### *Barriers can be classified as demand or supply side*

Barriers can affect the demand or supply side of the insurance market:

- A **demand** side barrier affects farmers' willingness to pay for insurance. For example, the availability alternative production strategies for farmers to manage weather production risk tends to reduce farmers' demand for insurance.
- A **supply** side barrier affects insurers' willingness to provide insurance. For example, insurance product development costs tend to reduce insurers' supply of insurance.

### *We have not included the price of insurance as a barrier*

As discussed in Section 3, the price of insurance is determined by the interaction of demand and supply across many farmers and insurers. In particular, supply side barriers tend to increase the price of insurance. Since the price of insurance is a consequence of the barriers discussed below, we have not included it separately in this section.

There are other problems with classifying the price of insurance as a barrier. For example, while higher prices are a barrier to farmers, higher prices also incentivise insurers to provide additional insurance. As a result, higher prices could lead to more or less insurance, and so describing higher insurance prices as a barrier, overall, would be potentially misleading.

### *The barriers are assessed in relation to three key questions*

Through the course of this project a comprehensive list of potential barriers was identified through literature reviews as well as consultations with farmers and insurers. This section aims to identify which of these barriers are the most important. To help identify the most important barriers, we explore the following questions for each barrier (or group of barriers):

- How does the barrier affect the uptake or provision of insurance?
- How large is the impact of the barrier on the uptake or provision of insurance?
- Is the barrier a problem? That is, would farmers be better off if the barrier was removed?[4]

[4] The barriers can be related. For example, less risk averse farmers are less likely to adopt production risk management strategies. To isolate the direct effects of the barriers, each barrier is assessed holding all other barriers constant. For example, the effect of risk aversion is assessed for a given production risk management strategy.

The barriers that are both material and problematic for farmers are carried forward to Section 7 and Section 8, where they are used to help identify and assess possible interventions to improve agricultural weather insurance in Australia.

## 5.2. Demand side barriers

The demand side barriers focus on farmers. Understanding the barriers that farmers face can help to explain why some farmers want insurance and others do not, and what issues need to be addressed to help farmers better manage weather production risk.

There are two main categories of demand side barriers. **Natural barriers** relate to internal business circumstances that reduce farmers' willingness to pay for insurance. These include:

- Lack of underlying risk exposure
- Cost effective production risk management strategies
- Cost effective financial risk management strategies
- Lack of risk aversion

Together, these barriers capture the extent of underlying weather production risk farmers are exposed to, the availability of options other than insurance to manage weather production risk, and how concerned farmers are about weather production risk.

**Insurance-specific barriers** cover limitations associated with insurance products and farmers' use of insurance products that decrease farmers' willingness to pay for insurance. These include:

- Ineffectiveness of insurance at mitigating risk (basis risk)
- Insurance taxes
- Farmer transaction costs
- Insurance product complexity (bounded rationality)

These barriers capture the extent to which insurance is effective at mitigating weather production risk, the costs to farmers of insurance (beyond premiums), and the extent to which farmers are aware of and able to apply the insurance products available to them.

### *Other demand side barriers*

There are several relevant demand side barriers that are not discussed further:

- **Lack of insurance product awareness**. Some farmers are not aware of the availability of weather insurance, or the specific types of insurance products that are relevant to their circumstances, especially if those products are new to the market. This knowledge deficit occurs for several reasons, including: ad hoc insurance company engagement; limited co-ordinated product education; a reliance of word of mouth or verbal discussions to elicit uptake; and a lack of engagement via common pathways to market such as banks and farm business advisors. Issues around awareness are explored further in *Sub-Project 4: Financial risk management options – awareness and education*.
- **Lack of trust that insurers will pay valid claims**. Some farmers may have experienced or heard of incidences of disputed claims under indemnity insurance policies. Previous disputes may affect trust in both indemnity insurance and index products.

- **Lack of cashflow to pay insurance premiums**. Some farmers may have insufficient cashflow to pay for insurance given competing expenditure obligations. Cashflow problems can arise for several reasons, including: the lumpy revenue streams from particular commodities; high upfront input costs; and previous seasonal deficits.
- **Government drought assistance**. As discussed in Section 2 there are several forms of government programs and assistance available, although not all farmers qualify. Government drought assistance reduces the downside risk of drought, effectively crowding out private insurance against drought. Sub-Project 6 examines the public policy implications of government drought assistance in detail.

Most of the demand side barriers apply to both index and indemnity insurance. The exception is basis risk, which is mostly a problem for index products.

### 5.2.1. Natural barriers

#### *Lack of underlying risk exposure*

Underlying risk exposure is the magnitude of weather production risk in the absence of production risk management strategies. For example, without implementing production risk management strategies, a farmer might experience an 80 per cent reduction in income in typical drought years. This is a measure of their underlying risk exposure.

##### How does a lack of underlying risk exposure affect the uptake of insurance?

As discussed in Section 3, the benefits from insurance depend on the extent to which it reduces the cost of risk. If follows that if the cost of risk is low, the potential benefits of insurance will also be low. This will be reflected in lower willingness to pay for insurance and reduced uptake. All of the natural barriers discussed in this subsection affect the uptake of insurance by decreasing the costs of weather production risk to farm households (and investors in farm businesses).

## Cost of risk

In the context of insurance, the cost of risk has two components. In this case, the first component is the **expected cost** of weather perils. For example, income might fall from $1,000 to $0 per hectare as a result of drought every tenth year (on average). The expected cost is the consequence multiplied by the likelihood, which equals $100 per hectare ($1,000 multiplied by 10 per cent).

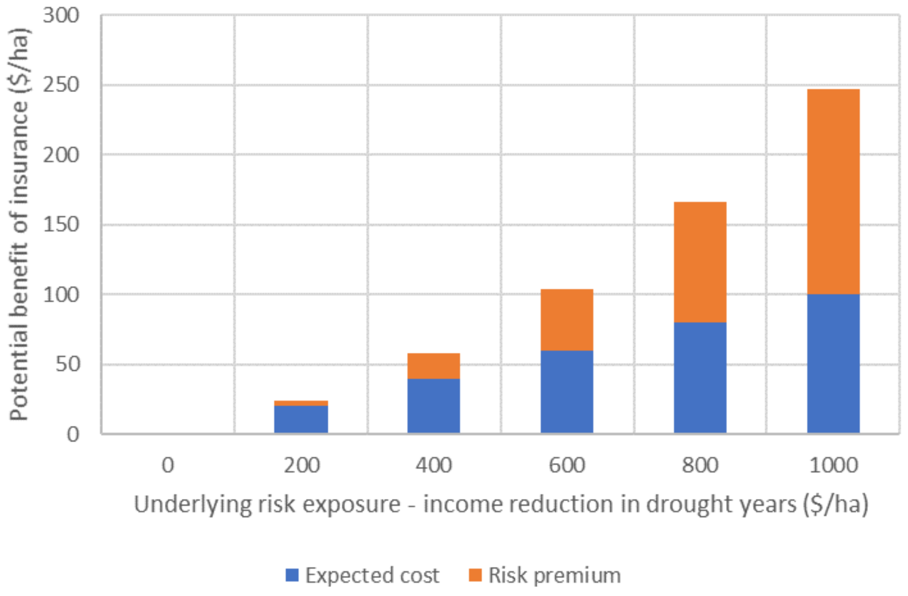
The second component is the **risk premium** from weather perils. This is the cost to risk averse farmers from effectively gambling on the weather. The risk premium is additional to the expected cost and is best demonstrated by a coin toss example. If the coin lands on heads the player wins $1,000, whereas if the coin lands on tails the player loses $1,000. The expected cost is zero, but risk averse people would prefer not to participate. In fact, they would have to be paid to participate. This cost reflects the risk premium. As the level of risk decreases, the risk premium demanded by a player also decreases. For example, suppose that risk exposure in the previous coin toss example was reduced by an order of magnitude, so that if the coin lands on heads the player wins $100, whereas if the coin lands on tails the player loses $100. Risk averse people would be much less uncomfortable playing the game, and the risk premium would generally be far lower. The cost of risk is the expected cost plus the risk premium.

Underlying risk exposure can have a large effect on the cost of risk (and hence the potential benefits and uptake of insurance). To illustrate, Figure 12 shows the cost of risk at different levels of underlying risk exposure for a hypothetical farmer. The greater the underlying risk exposure, the greater the cost of risk. The blue columns show that the expected costs increase linearly with underlying risk exposure. The orange columns show that the risk premiums increase at an increasing rate with underlying risk exposure. This means that doubling underlying risk exposure more than doubles the cost of risk.

## Hypothetical farmer

Some barriers to uptake of insurance are explored in this section through a hypothetical farmer who is affected by drought. The hypothetical farmer has the following characteristics (unless otherwise indicated):

- Generates $1,000 income per hectare in non-drought years
- Generates zero income in drought years without a risk drought management strategy
- Incurs costs of $100 per hectare per year to implement a drought risk management strategy
- Is quite risk averse – risk preferences are given by a negative exponential utility function with constant absolute risk aversion of 2.




Source Aither.

Note Assumes that hypothetical farmer does not implement a drought risk management strategy.

Figure 12 Illustrative relationship between underlying risk exposure and the potential benefit of insurance

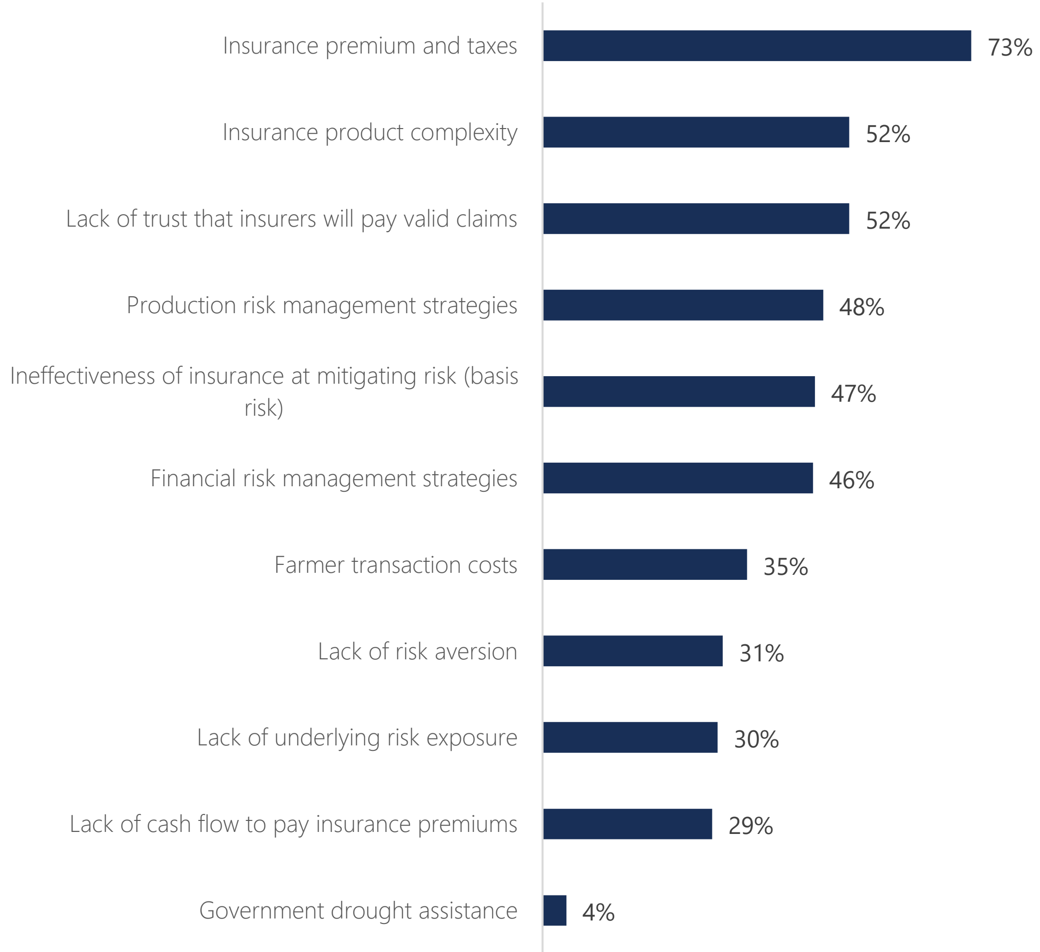
The implication is that the cost of risk tends to be small for farmers who are not exposed to significant weather production risk. This holds even when farmers implement no risk management options and are quite risk averse. Hence, a lack of underlying risk exposure could be a significant barrier to the uptake of insurance.

This is consistent with observed decision making by insurance customers more generally. For example, people are more likely to buy insurance if they perceive their exposure to an insured risk to be high (Shanteau 1992).

### How large is the impact of a lack of underlying risk exposure on the uptake of insurance?

Appendix A demonstrates that many farmers face substantial weather production risk from drought and to a lesser extent excess rainfall, frost, extreme heat and hail. But this is not universal. Each farmer has different circumstances, with their exposure to weather production risk depending on their location and production system, as well as other factors. About 12 per cent of respondents to the National Survey said that their reduction in income in years with significant weather perils was less than 50 per cent. While there is uncertainty of the exact numbers, this suggests that there is a small but material proportion of farmers who are not exposed to substantial weather risk[5], and are therefore unlikely to want insurance. This conclusion is supported by the views of respondents to the National Survey, with about 30 per cent identifying lack of risk exposure as a 'relevant' or 'very relevant' reason for not insuring against weather production risk (Figure 13). At the same time, a lack of risk exposure is not a barrier for most farmers. **Conclusion: Moderate barrier.**

5 This may also reflect the availability of effective production risk management strategies.




Source National Survey.

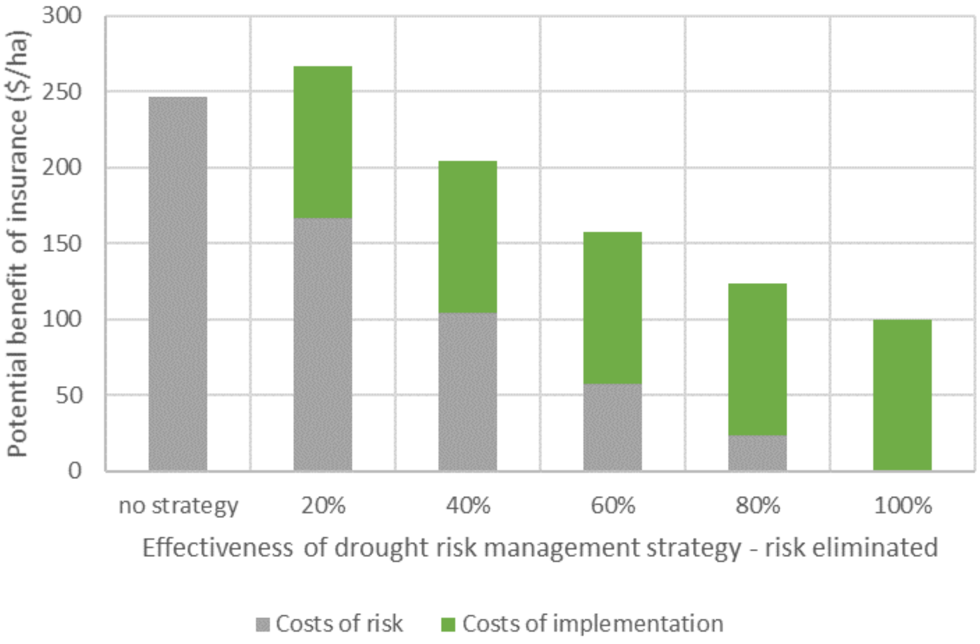
Figure 13 Proportion of survey respondents considering demand-side barriers to be relevant or very relevant

### *Production risk management strategies*

The discussion in the previous subsection takes risk exposure as given, but there are ways for farmers to mitigate their risk exposure through production risk management. Production risk management strategies increase income in years with significant weather perils. Examples of production risk management strategies include production diversification, such as a mix of cropping and livestock production or a mix of locations with different weather risks. Other examples include storing feed from good seasons and selecting crop varieties that are less susceptible to adverse weather events. Production risk management strategies are discussed in Section 2.

#### How do production risk management strategies affect the uptake of insurance?

As mentioned above, natural barriers, such as production risk management strategies, affect the uptake of insurance by decreasing the costs of weather production risk to farmers. Figure 14 illustrates the cost of risk for different production risk management strategies based on the same hypothetical farmer. The grey columns show that the cost of risk falls with increases in the effectiveness of production risk management strategies. In this case, effectiveness is the percentage of drought risk eliminated. This means that effective production risk management strategies are a potential barrier to the uptake of insurance.




Source Aither.

Figure 14 Illustrative relationship between risk management strategies and the potential benefit of insurance

However, to understand the potential benefits from insurance, it is also necessary to account for the costs of implementing production risk management strategies. This is because insurance can replace production risk management strategies[6], meaning that farmers avoid the cost of risk and the costs of implementation. In the hypothetical example, the costs of implementing production risk management strategies are assumed to be $100 per year, as shown by the green columns. This demonstrates how implementation costs can increase the potential benefits from insurance, and diminish the relevance of production risk management strategies as a barrier. For production risk management strategies to be a significant barrier, they must be both (i) **effective** at reducing production risk and (ii) **inexpensive** to implement.

### How large is the impact of production risk management strategies on the uptake of insurance?

As discussed in Section 2, there is considerable variation across farmers in the production risk management strategies available, as well as their cost effectiveness. The variation is due to differences in location and production system, and other factors such as management ability. All farmers have access to, and have been using, cost effective production risk management strategies. Depending on the production system and the business circumstances, these may represent better value than weather insurance options as they are currently priced in the market. For only a small proportion of farmers, in either heavily geared circumstances and/or a high risk production system, will weather risk transfer at current prices be a better option than current reliance on in-paddock management.

6 Insurance can also be used in conjunction with production risk management strategies.

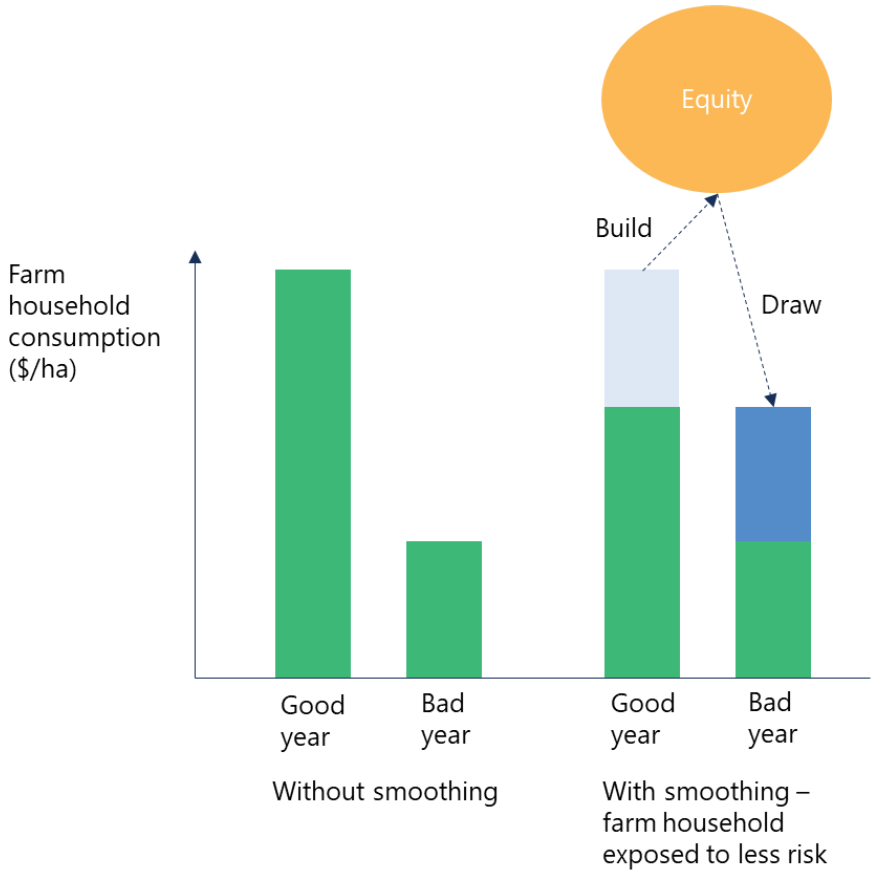
This conclusion is supported by the views of respondents to the National Survey, with about 48 per cent identifying the availability of production risk management strategies as a 'relevant' or 'very relevant' reason for not insuring against weather production risk. **Conclusion: Large barrier.**

### *Financial risk management strategies*

Farmers can mitigate the consequences of their risk exposure through financial strategies. As discussed in in Section 2, the most common financial strategies in relation to significant weather perils are balance sheet management and off-farm income. Balance sheet management involves building equity in good years while drawing on equity in bad years through debt or the sale of assets.

#### How do financial risk management strategies affect the uptake of insurance?

Like production risk management strategies, financial strategies affect the uptake of insurance by decreasing the costs of weather production risk to farm households. However, while production risk management strategies reduce production risk, financial strategies address the consequences of production risk. For example, balance sheet management can be used to smooth the consumption of farm households, despite production risk (Figure 15). This reduces the cost of risk (and hence the potential benefits of insurance). As a result, financial strategies, such as balance sheet management, are a potential barrier to the uptake of insurance.




Source Aither.

Figure 15 How balance sheet management smooths farm household consumption

However, for financial risk management strategies to be a significant barrier, they must be (i) effective at reducing the cost of risk and (ii) inexpensive to implement. As discussed in Section 2, balance sheet management will be less effective for farmers who have not accumulated sufficient equity to withstand years with significant weather perils. In terms of costs, farmers implementing balance sheet management may need to give up profitable opportunities to invest in their businesses, where such investments would compromise their ability to obtain cash as required.

For example, suppose it would be profitable for a farmer to purchase breeding stock and that the purchase would be made with cash. While cash can be used as required, the farmer might be unable to borrow against the full value of the breeding stock or sell the breeding stock at short notice without a substantial discount. Hence, the purchase could leave the farmer exposed to significant weather perils. If the farmer gives up the opportunity to purchase breeding stock, the loss of profits is an opportunity cost associated with the balance sheet management strategy.

#### How large is the impact of financial risk management strategies on the uptake of insurance?

Consultations with farmers suggested that maintaining a strong equity position is the primary method used by farmers to reduce their susceptibility to weather perils. As of 2018-19, the average Australian farmer had $4.9 million of equity. This compares very favourably to annual cash costs of $380,000 (ABARES 2020). Hence, the average Australian farmer has substantial financial capacity to withstand bad years. However, this is not universal. For example, Northern Western Australian grain producers interviewed for this project said that annual cash costs are one third of land values in some cases. Hence, even if the land was initially owned outright without debt and banks were prepared to lend against the full value of the land, these farmers could go broke in just bad three years.

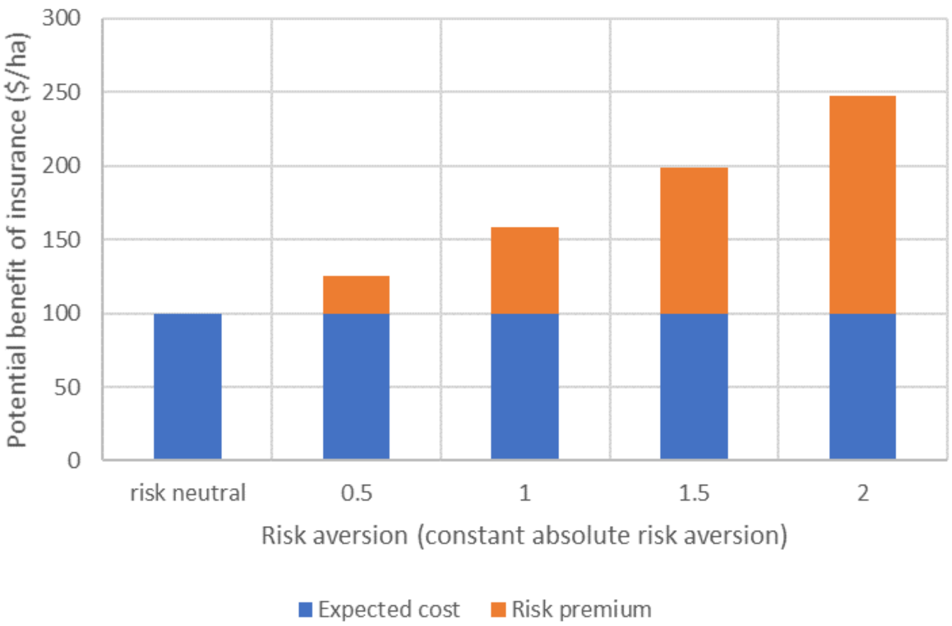
Overall, a substantial proportion of farmers appear to have access to cost effective financial risk management strategies, and are therefore unlikely to want insurance. This conclusion is supported by the views of respondents to the National Survey, with about 46 per cent identifying the availability of financial risk management strategies as a 'relevant' or 'very relevant' reason for not insuring against weather production risk. **Conclusion: large barrier.**

### *Lack of risk aversion*

The previous barriers determine the extent to which farmers are exposed to weather production risk, based on their underlying risk exposure and use of production and financial risk management strategies. The cost of risk also depends on how concerned farmers are about weather production risk. Risk averse farmers dislike risk. By contrast, risk neutral farmers are indifferent to risk. Differences in risk aversion can reflect differences in personality (Filbeck et al. 2005) family situation (Gorlitz and Tamm 2015), and numerous other idiosyncratic factors. The extent to which farmers are exposed to other risks, such as price risk, is also an important determinant of risk aversion.

#### How does a lack of risk aversion affect the uptake of insurance?

A lack of risk aversion affects the uptake of insurance by decreasing the costs of weather production risk to farm households. Figure 16 shows the cost of risk at different levels of risk aversion, again based on the same hypothetical farmer. The greater the risk aversion, the greater the cost of risk. The blue columns show that the extent of risk aversion does not influence the expected costs. Instead, the relationship is driven entirely by the risk premium, as shown by the orange columns.




Source Aither.

Figure 16 Illustrative relationship between risk aversion and the potential benefit of insurance

The implication is that the cost of risk, and in particular the risk premium, tends to be small for farmers who are not risk averse. This holds even when farmers are exposed to significant underlying weather production risk and have no risk management options. Hence, a lack of risk aversion could be a significant barrier to the uptake of insurance.

### How large is the impact of a lack of risk aversion on the uptake of insurance?

Farmers differ markedly in terms of their risk preferences. As part of the National Survey, farmers were asked a hypothetical question about their risk preferences, specifically their willingness to pay in good years to receive additional income in bad years. The higher the willingness to pay, the greater the risk aversion.[7] An analysis of their responses showed that about 57 per cent of respondents were not materially risk averse. This suggests that a significant proportion of farmers are not especially concerned about weather production risk, and are therefore unlikely to want insurance. This conclusion is supported by the views of respondents to the National Survey, with about 31 per cent identifying lack of risk aversion as a 'relevant' or 'very relevant' reason for not insuring against weather production risk (Figure 13). At the same time, it is clear that many farmers are quite risk averse, and so a lack of risk aversion will not be a barrier for all farmers. **Conclusion: Moderate barrier.**

## *Are natural barriers to insurance a problem?*

This subsection has outlined several natural barriers to insurance. These barriers reduce the uptake of insurance, but they do not represent a problem. As discussed in Section 1, the objective motivating this project is not to increase the uptake of insurance, rather to ensure that farmers are well placed to manage risk. Where farmers can manage risk effectively without insurance (for example, through risk management strategies), insurance is not needed. Attempts to address natural barriers (for example,

[7] This may also reflect the availability of effective financial risk management strategies.

banning farmers from implementing risk management strategies) would increase the uptake of insurance, but would conflict with the objective motivating this project and leave farmers worse off.

### 5.2.2. Insurance specific barriers

#### *Ineffectiveness of insurance at mitigating risk (basis risk)*

Insurance does not necessarily provide farmers with complete protection against weather production risk. For example, a farmer with index insurance against drought might not receive an insurance payout in the event of drought or the payout might not cover their losses.[8] This is known as **basis risk**, and has two principal sources:

1. **Measurement risk** – the measured weather used as the basis for settlement differs from the weather experienced by farmers. For example, suppose an insured farmer receives a $100,000 payout if rainfall over a specified period is less than 50mm at the nearest BOM weather station. If rainfall at the farm is 40mm but rainfall at the nearest weather station is 60mm, the farmer will not receive an insurance payout despite the adverse weather event and associated losses (Figure 17).
2. **Index risk** – the insurance payout differs from the losses experienced by farmers, given weather events. For example, suppose the insured farmer in the previous example incurs a $150,000 loss if rainfall is 40mm. In this case, even if there was no measurement risk, there would still be gap (albeit reduced) between the losses experienced by farmers and the insurance payout. Index risk is related to the rules used to determine the insurance payout under different weather events (Figure 18).

Index products are more susceptible to basis risk than indemnity insurance because they use an index as a proxy for losses, whereas indemnity insurance provides payouts on the basis of actual losses. However, even with indemnity insurance farmers can disagree with the assessment of yield from the loss assessor. In that case it is also a reduction in the effectiveness of insurance.

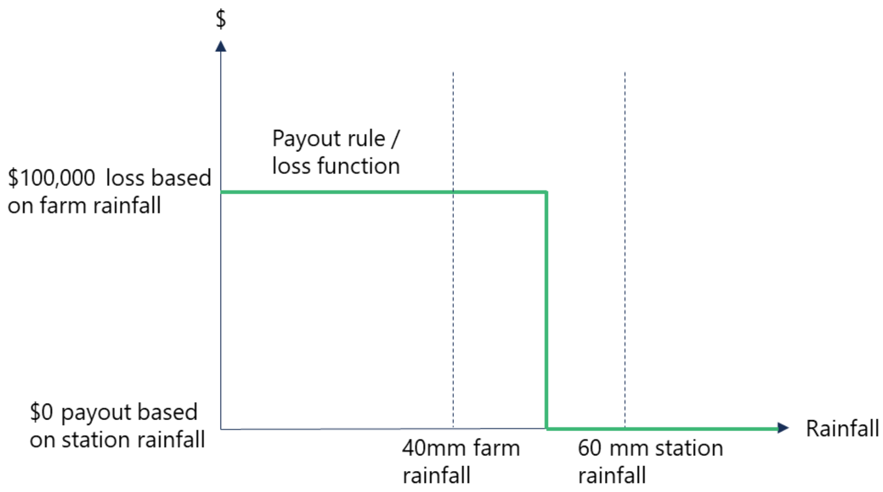



Figure 17 Illustration of measurement risk

8 This explanation of basis risk assumes that farmers are seeking to insure against all of their losses. Given the costs of insurance, many farmers only insure against a proportion of losses.

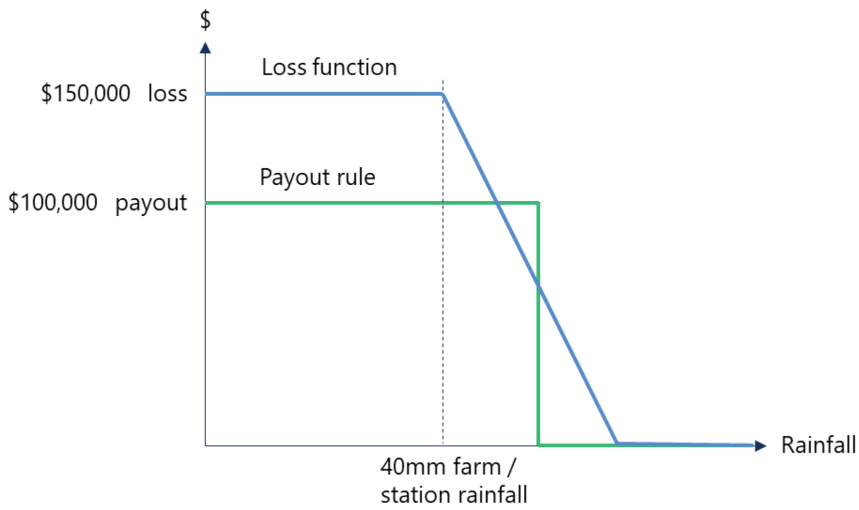
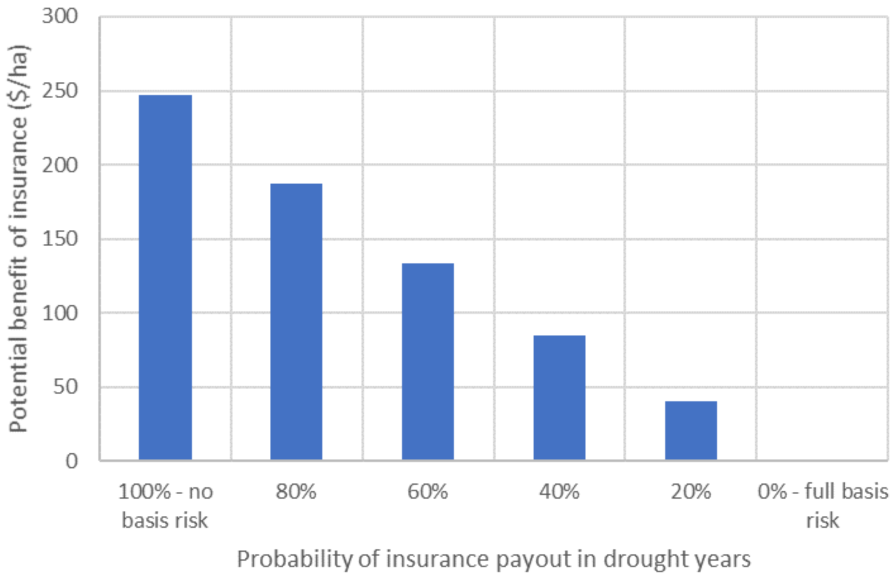



Figure 18 Illustration of index risk

### How does basis risk affect the uptake of insurance?

Notwithstanding the previous barriers, the costs of weather production risk to farm households can be substantial. Insurance has the potential to eliminate these costs, but the insurance payouts need to cover the agreed portion farmer losses. This is undermined by basis risk, which drives a wedge between insurance payouts and farmer losses, meaning that the costs of weather production risk cannot be eliminated. Hence, basis risk reduces the effectiveness of insurance. This reduces the benefits of insurance, and translates into lower willingness to pay for insurance and reduced uptake.

Figure 19 shows the potential benefit of index products at different levels of basis risk, for the hypothetical farmer introduced in the previous subsection. In this case, the magnitude of basis risk is defined by the probability of receiving an insurance payout in a drought year. Where the probability is 100 per cent there is no basis risk. The greater the basis risk, the lower the potential benefits of insurance. The result is that basis risk could be a significant barrier to the uptake of insurance.




Source Aither.

Figure 19 Illustrative relationship between basis risk and the potential benefit of index products

The discussion so far has focused on the case where insurance payouts do not cover farmer losses. However, basis risk can lead to the opposite case, where insurance payouts exceed farmer losses. For example, suppose there is sufficient rain at the farm but the rain misses the nearest weather station. While this increases the potential benefits to farmers, the increase tends to be small (relative to the associated cost to insurers which is factored into premiums). This is because the insurance payouts are received in good seasons when the value of an additional dollar to risk averse farmers tends to be lower.

### How large is the impact of basis risk on the uptake of insurance?

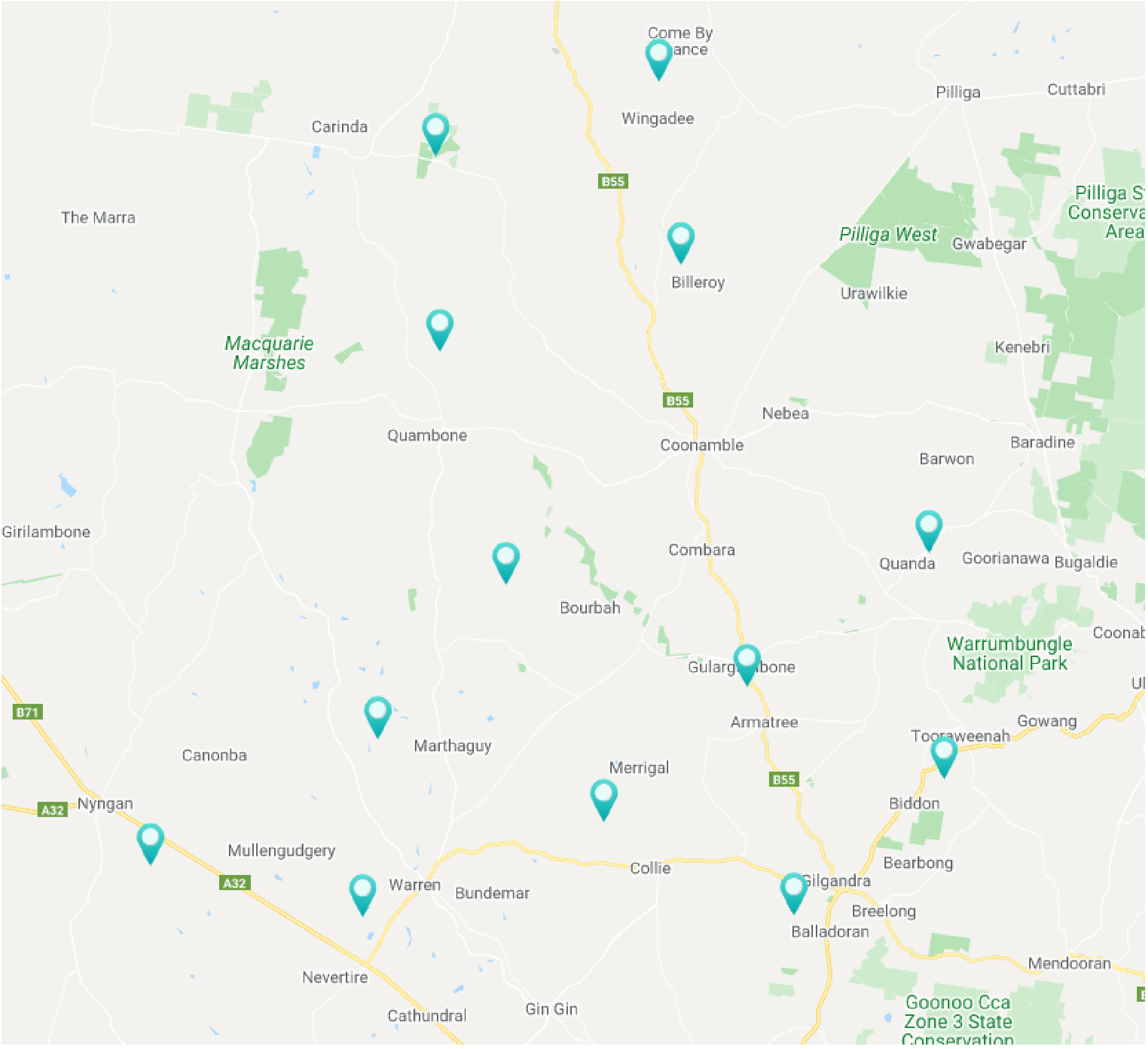
The magnitude of basis risk associated with index products varies. This depends on the location, the adverse weather event being insured against, and the rules used to determine the insurance payout under different weather events.

Some farmers are located near BoM weather stations, and hence weather experienced at the farm is likely to be similar to weather measured at the station (with the possible exception of frost). However, some farmers are located many kilometres from their nearest station. Some of the farmers consulted for this project cited large differences in weather readings between on-farm measurements and their nearest stations. One farmer recalled experiencing a 60mm rain event that was not picked up at their nearest station.

To quantify the magnitude of basis risk, we undertook a case study based on 13 farm locations in northern NSW (Figure 20). Each farmer was assumed to have index insurance against both deficit rainfall (<30mm total between 1 September and 15 October) and frost (<-1 degrees at any time between 1 September and 1 October). Goanna Ag provided four years of data (2016 to 2019) at each location drawing on their network of private weather stations. This allowed us to identify whether each farmer would have experienced these adverse weather events in each year. Overall, there were 17 instances of deficit rainfall and 3 instances of frost. In the absence of basis risk, this would give the number of insurance payouts for deficit rainfall and frost.

To account for basis risk, we assume that the insurance policies are based on the nearest BoM automatic weather station. In one case, the nearest station was about 70 kilometres away. We then repeated the previous analysis based on measured weather at the nearest BoM automatic weather station. We found that farmers would have received insurance payouts for 13 of 17 deficit rainfall events (76 per cent) and 0 of 3 frost events (0 per cent).[9] This analysis is based on a small non-random sample of farm locations and adverse weather events, but it does support anecdotal evidence from consultations that the magnitude of basis risk can be significant.

[9] Farmers would also have received insurance payouts on several occasions without having experienced adverse weather events, with 2 unnecessary payouts for both deficit rainfall and frost events.




Source Goanna Ag.

Figure 20 Northern NSW farm locations used for basis risk case study

Some insurers allow settlement based on synthetic gridded data. These data typically draw on multiple information sources, including measurements at local weather stations, to estimate the weather for 5km (or smaller) grids across Australia. Some farmers suggested that the gridded data did not eliminate basis risk, with discrepancies between their on-farm measurements and the gridded data. This is consistent with advice from the BoM who say that the precision associated with the interpolation process used to create the gridded data varies by location.

The extent of basis risk also depends on the adverse weather event being insured against. Rainfall and frost have patchy spatial distributions across the landscape. In the case of rainfall, this is often caused by storms or summer rain. In the case of frost, this is often driven by topographical factors. In contrast, basis risk tends to be lower for extreme heat, which is more spatially consistent.

The way adverse weather events are specified also matters. For example, longer term indexes tend to have less statistical volatility. As a result, a drought index based on cumulative rainfall over a 36-month period will generally have lower basis risk than a drought index that only covers one month.

The focus of this subsection has been measurement risk. However, even if the measured weather used as the basis for settlement is consistent with the weather experienced by farmers, there is still the potential for index risk. As illustrated in Figure 18, index risk is caused by a discrepancy between the insurance payout (green curve) and losses experienced by farmers (blue curve) under different weather events. In principle, index risk could be eliminated by setting the insurance payout equal to the losses. However, this requires farmers to have a good understanding of the potentially complex relationships between weather and losses.

Many farmers indicated that they do not have sufficient agronomic knowledge to reliably predict how their production would change in response to weather perils of different severities. This was evident in the effects of frost on almond yields and spring heat on winter cereals. However, it was less of a factor for rainfall deficits in winter cereal production, where rainfall within season is the primary driver of yield and the relationship between rainfall and yield is well understood. That said, winter cereal croppers still raised concerns that important factors, such as rainfall intensity and the timing of rainfall within a seasonal window, were not captured by standard aggregate rainfall indexes.

Yield indexes have been canvassed as an alternative to weather indexes. As discussed in Section 3, yield indexes are based on an index derived from multiple variables, including weather, that predicts yield for an individual farm. In practice, yield indexes can be developed using APSIM or similar crop modelling tools. While yield indexes have the potential to reduce index risk by better reflecting the relationships between weather and yield, there are significant limitations. For example, currently available modelling tools do not capture complexities (such as waterlogging, acidity, and soil and nutrition interactions) that are important for predicting yields. One farm adviser suggested that APSIM typically predicted yields 20 to 30 per cent over actual yields.

The previous discussion suggests that basis risk is often significant in the context of index products. Farmers generally expressed strong concerns about basis risk during consultations. These concerns were shared by farmers across all production systems, but appears to be particularly acute for some perils. This is consistent with the views of respondents to the National Survey, with about 47 per cent identifying lack of basis risk as a 'relevant' or 'very relevant' reason for not insuring against weather production risk. Overall, there is strong evidence to suggest that basis risk is an important barrier to the uptake of index products. **Conclusion: Large barrier.**

### *Farmer transaction costs*

The transaction costs to farmers are the costs, in time and money, required to buy insurance. In practical terms, potential customers will need to invest their time and money in undertaking the assessment and adoption process summarised by Figure 21.

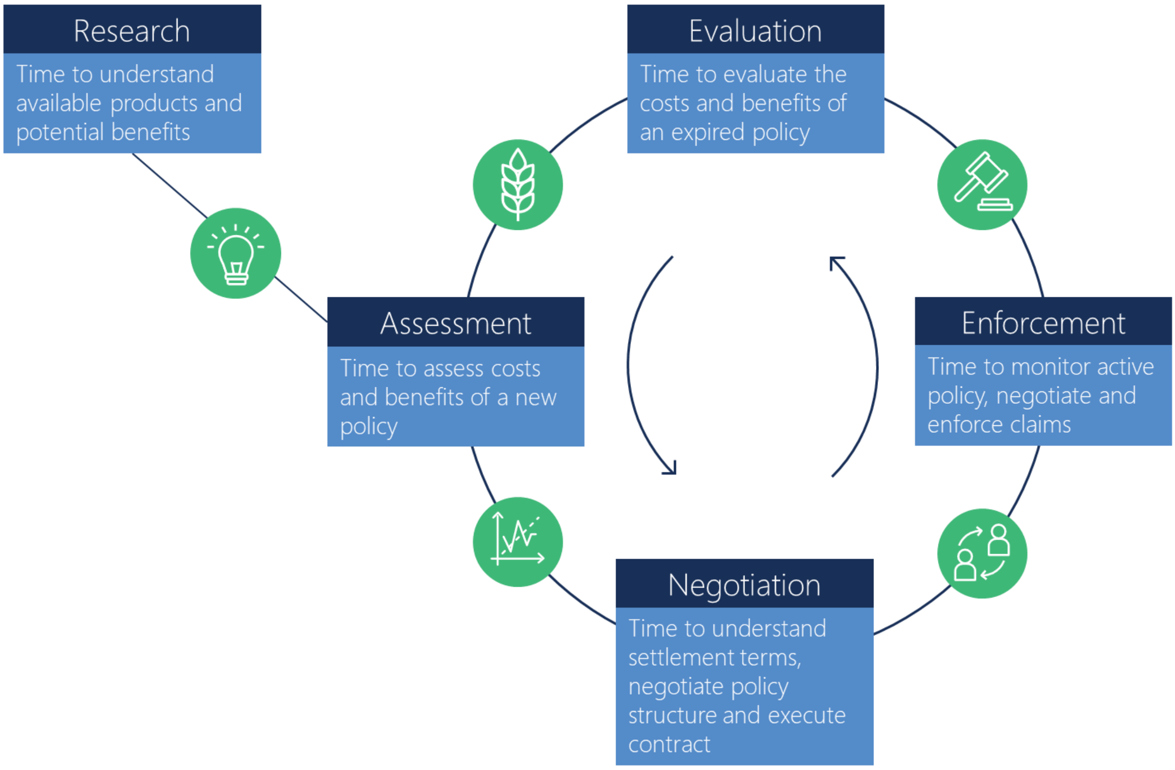



Figure 21 Transaction costs to farmers associated with buying insurance

### How do farmer transaction costs affect the uptake of insurance?

The mechanism by which the transaction costs to farmers affect the uptake of insurance is straightforward – the transaction costs to farmers reduce the (net) benefits of insurance. For example, if the benefit of insurance without transaction costs was $250 per hectare, and the transaction costs were $30 per hectare, the benefit of insurance would be $220 per hectare. This translates into lower willingness to pay for insurance and reduced uptake.

Farmers also noted that the extensive time required to purchase insurance could be a barrier for other reasons. For example, it is common practice for providers of index products to require that farmers purchase policies in a restricted window – often at least thirty days prior to the commencement of the policy. While there are sound reasons for this practice, some farmers indicated that they were unable to complete their research, assessment and negotiation within the window, causing them to miss out on buying insurance.

### How large is the impact of farmer transaction costs on the uptake of insurance?

The extent of transactions costs varies across farmers. To illustrate, the following example shows how two hypothetical farmers approach the assessment of insurance policies. These examples are based on the circumstances of farmers interviewed for this project.

- Farmer 1 is a double cropper looking for index insurance. Farmer 1's production system is subject to a large range of perils, so it is difficult to determine which perils to cover and the most effective timeframe for cover. Therefore, Farmer 1 would prefer to assess a variety of products simultaneously. Farmer 1 is skilled and risk averse, and would prefer to undertake scenario analysis to compare past financial outcomes with and without different insurance products. They would also prefer to account for changing climate conditions and business characteristics to understand how findings from the scenario analysis could be extrapolated to future outcomes. Farmer 1 is

30km away from the nearest weather station and is sceptical of gridded data. They would prefer to calibrate settlement data with on-farm weather readings to understand the extent of basis risk issues.

- Farmer 2 is a winter cropper also looking for index insurance. Farmer 2 is subject to a narrower range of perils and their yields have high correlation with growing season rainfall. Therefore, they see no need to assess any products other than deficit rainfall index insurance. Farmer 2 is time-poor and less risk averse as Farmer 1, and is happy to assess past payout history based on a simple analysis. They are close to their nearest weather station and see no need to assess the magnitude of basis risk.

In this example, the scope and complexity of the assessment undertaken by Farmer 1 is substantially greater than for Farmer 2, leading to higher transaction costs.

Notwithstanding differences between farmers at the extremes, some common themes emerged from the interviews. Most farmers suggested that they would require a significant amount of time for research, assessment and negotiation for both index and indemnity insurance. Challenges include requesting and receiving quotes from brokers, which can take days of time, and gathering the information required to for assessment. One farmer who actively uses index products stated that they assess their past, current and future policies throughout the year, resulting in significant ongoing time commitments. The opportunity cost of these time requirements is high for most farmers. Time spent buying insurance is no longer available for pressing operational priorities, which if neglected can prove very costly.

The interviews with farmers were used, along with other data sources, to estimate the transaction costs of buying insurance for a typical farmer (Table 7 and Table 8). We estimate transaction costs in year one, assuming no prior experience with weather production insurance, to be about $5,700. With experience, we estimate transaction costs to halve in subsequent years to about $2,900.

Table 7 Illustrative transaction costs for a typical farmer

| Variable | Value |
| --- | --- |
| **Initial year** | |
| **- farmer time required** | 27 hours |
| **- advisor time required** | 3 hours |
| **- cost** | **$3,813** |
| **Subsequent years** | |
| **- farmer time required** | 13 hours |
| **- advisor time required** | 1 hour |
| **- cost** | **$1,907** |

Table 8 Key assumptions in estimating transaction costs for a typical farmer

| Assumption | Source | Discussion |
| --- | --- | --- |
| The average time requirement for farmers to research, assess, negotiate and evaluate an insurance policy for the first time is 27 hours | Aither analysis based on farmer interviews | Based on a scenario where transaction occurs over a long period. Farmer interviews suggest that this is the most common scenario due to delays in quote generation and availability of information at different points in time. |
| The average time requirement for farmers to engage with an insurance policy given prior experience is 13 hours | Aither analysis based on farmer interviews | Familiarity with insurance is likely to result in significant reductions in time requirements. However, inefficiencies still occur due to time lags during negotiation and long assessment periods. |
| The opportunity cost of farmer time is $128 per hour | ABARES farm survey data – broadacre industries | Likely to be an underestimate of the cost of farmer time. Farmers who typically engage with insurance are likely to be skilled and have a higher opportunity cost of time than other farmers. |
| Farmers incur no enforcement costs | By assumption | Likely to result in underestimation of transaction costs for indemnity insurance however enforcement costs are minimal for index products. |

The previous discussion shows that the transaction costs to farmers can be material. In terms of the extent to which transaction costs represent a barrier to the uptake of insurance, about 35 per cent of respondents to the National Survey identified transaction costs as a 'relevant' or 'very relevant' reason for not insuring against weather production risk. **Conclusion: Moderate barrier.**

### *Insurance taxes*

Several state governments impose stamp duty on agricultural weather insurance premiums (Table 9). Stamp duty is calculated on the base premium (plus GST and other applicable levies). Since 2016, the Australian Capital Territory, Victoria, New South Wales and South Australia have all exempted agricultural weather insurance products from stamp duty. In 2019, the Queensland Government commissioned KPMG to investigate the feasibility of abolishing stamp duty on agricultural weather insurance in Queensland, following advocacy from the Queensland Farmers' Federation. We understand that stamp duty exemption for agricultural weather insurance products in Queensland is currently being considered.

Table 9 Summary of stamp duty arrangements in Australia

| State / Territory | Stamp Duty | Details |
|---|---|---|
| Australia Capital Territory | 0% | Phased out stamp duty on all insurance premiums starting from 2012. Stamp duty abolished 1 July 2016. |
| New South Wales | 0% | Exempted 1 January 2018 in response to IPART's review of multi-peril crop insurance incentive measures. |
| Northern Territory | 10% | Abolition of all insurance duties briefly discussed in 2017 Revenue Discussion Paper. No follow-up observed. |
| Queensland | 9% | Stamp duty exemption for agricultural weather insurance products is currently being considered. |
| South Australia | 0% | Exempted from late 2018, with refunds claimable for policies held after 1 January 2018. |
| Tasmania | 10% | No government action observed. |
| Victoria | 0% | Exempted 1 July 2017. |
| Western Australia | 10% | Stamp duty exemption was sought in 2013 by industry however no action was taken. |

Agricultural weather insurance premiums are subject to levies in some states. For example, fire and hail insurance for crops and livestock is subject to a 1 per cent Emergency Services Levy in New South Wales. Agricultural weather insurance premiums are also subject to a 10 per cent Goods and Services Tax (GST). However, ATO-registered business can claim GST credits and offset this cost.

As discussed in Section 3, some index products can be classified as derivatives. Unlike insurance, derivatives are not subject to stamp duties, levies or GST. However, derivatives are subject to either Capital Gains Tax (CGT) or Taxation of Financial Arrangements (TOFA)[10]. Under CGT, net gains are added to assessable income and taxed at the income tax rate of the individual or business. Net losses can be used to offset other capital gains.

### How do insurance taxes affect the uptake of insurance?

Like transaction costs, insurance taxes reduce the (net) benefits of insurance to farmers. For example, if the benefit of insurance without insurance taxes was $250 per hectare, and insurance taxes were $30 per hectare, the benefit of insurance would be $220 per hectare. This translates into lower willingness to pay for insurance and reduced uptake.

### How large is the impact of insurance taxes on the uptake of insurance?

As shown above, insurance taxes are material in some jurisdictions. Respondents to the National Survey were not asked about insurance taxes specifically. Instead, respondents were asked about the cost of insurance, considering both premiums and insurance taxes. The cost of insurance was identified by 73 per cent of respondents as a 'relevant' or 'very relevant' reason for not insuring

10 TOFA only applies to large entities with turnover above $100 million, assets above $300 million, or financial assets above $100 million. Treatment of capital gains and losses are equivalent under TOFA where the requirements of legislation are met.

against weather production risk, making it the most common barrier. However, insurance taxes are only a small proportion of the cost of insurance. As further evidence, farmers in jurisdictions with stamp duty were about 8 percent more likely to say that the cost of insurance is an important barrier than other farmers. However, due to the small sample size, this difference is not statistically significant. **Conclusion: Moderate barrier.**

### *Insurance product complexity (bounded rationality)*

The complexity of insurance products and their application has already been discussed in the context of transaction costs. The greater the complexity, the larger the transaction costs. However, complexity also has broader implications for farmers' decision making. Often decisions around whether to buy insurance are quite complex, as are related decisions around what insurance product to buy and what policy parameters and settlement terms to select (such as, the best cumulative rainfall threshold for some index products). Even after incurring the transaction costs noted above, the complexity means that farmers' decisions will not always be perfect. Farmers, like everyone else, have limited access to information and limited computational ability to optimise decisions. This is known as bounded rationality.

#### How does bounded rationality affect the uptake of insurance?

Bounded rationality can affect the uptake of insurance it two ways. First, bounded rationality can mean that farmers are unable to maximise the benefits of insurance. For example, they might not select the insurance product that best meets their needs. This will tend to reduce the uptake of insurance. Second, bounded rationality can mean that farmers underestimate or overestimate the benefits from insurance. If farmers have a tendency to underestimate the benefits from insurance, this will reduce the uptake of insurance. However, if farmers have a tendency to overestimate, this will have the opposite effect.

#### How large is the impact of bounded rationality on the uptake of insurance?

As discussed above, bounded rationality is linked to complexity. People tend to make consistency good decisions for simple problems, but this is much harder for complex problems. Weather insurance can involve highly complex contractual agreements for both indemnity and indemnity products. The policy parameters and settlement terms of policies are often complex and difficult to understand. Most of the farmers consulted for this project found evaluating the value proposition of different insurance options, in the context of their individual circumstances, to be a challenging task. About 52 per cent of respondents to the National Survey identified complexity as a 'relevant' or 'very relevant' reason for not insuring against weather production risk. Even sophisticated farmers can be challenged by the complexity of calibrating a weather peril to revenue or yield impact when using index products, calculating relative costs of insurance versus other strategies, understanding insurance policy parameters, or applying these concepts to hedging production risk.

There is evidence of bounded rationality in relation to weather index products. Mußhoff et al. (2018) found that some German farmers use 'rules of thumb' instead of cost benefit analysis to simplify decision making. Relatedly, decisions were sometimes influenced by factors that are unrelated to the benefits and costs of insurance. That said, their analysis was based on hypothetical experiments so there was less at stake for farmers than when making real world decisions. In an Australian context, some farmers consulted for this project also use 'rules of thumb' to decide whether to use buy insurance. These include:

- Sticker price assessment – farmers compare the annual dollar or dollar per hectare premium with other insurance products, such as fire and hail insurance.
- Comparison of the payout probability (for example, 10 per cent of years) with the payout ratio (for example, premiums 20 per cent of payouts).

There is clear evidence that bounded rationality affects the uptake of insurance. However, there is less evidence on the likely magnitude of impact. To estimate the magnitude of impact we would need to compare farmers' observed insurance decisions with optimal insurance decisions. Just as farmers can struggle to identify the optimal decisions, it is difficult (perhaps more difficult) for external observers to identify the optimal decisions on their behalf. Hence, unlike the other barriers, we are not drawing a strong conclusion around the extent to which bounded rationality is a barrier to uptake.

### 5.2.3. Summary

Based on the demand side barriers discussed above, we can broadly segment the insurance market for weather production risk into the following categories. Individual farmers may fall into several categories. The farmers in the higher listed categories are less likely to want insurance.

1. **Untrusting of financial instruments**. Many operators will not trust insurance companies to treat claims fairly and pay out when terms stipulate. This could be based on perception or experience (e.g. they have had this experience before or know someone who has).

2. **Uncertain and time poor**. Many operators will decline to engage with the difficult process of assessing weather insurance products, either because their complexity precludes it or would take too much time away from operational priorities.

3. **Cost averse**. This may relate to attitudes to fiscal conservativeness or cashflow concerns. These operators may understand the benefits of insurance, but are uncomfortable with premium to payout ratios that are perceived to provide too much benefit to the insurer.

4. **High equity**. Operators with significant equity relative to potential losses may prefer to effectively insure themselves. building equity in good seasons and drawing on equity in bad seasons. This strategy can be more cost effective than buying insurance, as long as farmers can maintain their equity without sacrificing too many opportunities.

5. **Conservative production**. Operators with access to effective production risk management strategies may prefer a conservative production approach to insurance. A conservative production approach reduces losses from adverse climatic events. This strategy can be more cost effective than buying insurance as long as production windfalls given up in return for greater risk protection are not too great.

6. **Basis risk averse.** Most operators are concerned about basis risk; the possibility that insurance settlement payouts do not reflect the real world production effects of adverse weather events. While farmers in this category are sceptical of insurance, they can potentially be swayed if insurers (or others) can demonstrate that basis risk will not be a substantial problem for them.

7. **Preference for low stress**. Some farmers may purchase insurance to minimise the personal stress of revenue volatility, even where equity is relatively high. Concerns about the family conflict implications of succession planning may also drive them to seek insurance cover. However, it should be recognised that assessing and negotiating weather insurance can be a stressful exercise itself.

8. **Ambitious and risk adept**. This group are highly skilled operators who can use production and financial risk management skills to mitigate against all but extreme tail risks. They will be more likely

to consider the full value of weather insurance, including using insurance as a hedge to complement and facilitate acquisition strategies and investments to upgrade production systems. On the other hand, skilled risk managers may feel more comfortable managing complex weather risks without insurance. As a result, skilled risk managers will be more likely to target insurance cover to severe perils where alternative risk management options fail.

## 5.3. Supply side barriers

The supply side barriers focus on insurers' willingness to provide insurance. Understanding the barriers that insurers face can help to explain why the provision of insurance has been limited, and what issues need to be addressed to facilitate the provision of weather insurance in the future.

The main supply side barriers are:

- Product development costs
- Insurer transaction costs (expenses)
- Cost of risk

These barriers affect provision in the same way, by increasing the cost of supplying insurance. The greater the cost of supplying insurance, the lower the provision of insurance, all else equal. The supply side barriers apply to both index and indemnity insurance, though not necessarily to the same extent.

### *Product development costs*

Product development costs include: product appraisal; product design; collection of historical data; establishment or access to claim settlement data; and establishment or access to distribution channels.

#### How large is the impact of product development costs on the provision of insurance?

Establishing a new product line is a significant cost burden for both established players and start-ups alike. There are many functions and processes that require development before any product can be released to the market and these costs will generally be borne by the underwriter or the underwriting agency.

The costs of establishing a new product add to the capital required to be allocated to the product and this capital needs to generate a return, and eventually be repaid, similar to the underwriting capital. These upfront costs can place a significant burden on the performance of a new product and contribute to the relatively long periods of time before a new product can be expected to 'break-even'. It would not be unrealistic to assume that it might take 3-5 years (or more) before the costs of bringing a product to market could be repaid. **Conclusion: Moderate barrier.**

### *Insurer costs (expenses)*

Insurer transaction costs are the expenses associated with customer acquisition, claims handling and general administration. They include: marketing; brokerage; quoting for services; customer onboarding; and loss adjustment.

### How large is the impact of insurer's expenses on the provision of insurance?

The best way to quantify the magnitude of insurer transaction costs would be to analyse insurance company data. Due to the immature state of the agricultural weather insurance market in Australia and the commercially sensitive nature of any benchmarks to existing participants, the companies we spoke to were only prepared to discuss their costs in broad terms. To supplement the broad benchmarks provided through our interviews with stakeholders, we also worked with our project partners Finity Consulting to assist with an indicative breakdown of typical insurance premiums into risk premiums, expenses and profit margins.

This breakdown was aligned, approximately, with a number of reference points provided through the interviews conducted during the consultation phase, however, these we not calibrated to current market conditions for MPCI or rainfall-index products either here or overseas.

As such these premium breakdowns should be considered as a 'stylised' starting position to assist in estimating the impact of potential market interventions rather than providing an absolute level for any of the individual components of the premium or the profitability of the potential products overall.

From this starting ('base') position, we then applied a number of adjustments to arrive at our 'future base' position that anticipates a number of enhancements to the market that are currently underway. It is from this 'future base' position that we then estimated the potential impact from the range of market interventions investigated.

The benchmarking exercise, explained above, shows that insurer transaction costs are substantial. Insurer transaction costs are estimated to be higher for indemnity insurance (32.5 per cent of premiums) than index products (16.5 percent of premiums). This is largely a result of differences in the acquisition, underwriting and claims handling expenses between the two product styles.

The main expense was customer acquisition, accounting for almost two thirds of the insurer's expenses. This includes the cost of commission paid to brokers. The costs of acquisition are high due to the relatively complicated nature of these products and the individual treatment and assessment that is required to provide these types of coverage to farmers. Each farm is different and each has its own particular risk-profiles, making the acquisition of customers more involved. There are only limited digital platforms available for agricultural weather insurance products and the majority of policies are acquired with a manual, 'bricks-and-mortar' approach.

Table 10 Indicative insurance transaction costs as a percentage of premiums

| Expenses | Indemnity insurance | Index products |
|---|---|---|
| **Acquisition (including commission)** | 20% | 15% |
| **Claims handling** | 8% | 4% |
| **Other** | 6% | 5% |
| **Total** | 34% | 24% |

Given the substantial expenses described above, insurance costs represent a substantial barrier to the provision of insurance. **Conclusion: Large barrier.**

## *Cost of risk*

The cost of risk was defined in Section 5.2.1 from the perspective of the risks that farmers are exposed to without insurance. As a result of insurance, at least some of these risks are transferred to insurers. While the cost of transferred risks may differ between insurers and farmers, the fundamental concepts introduced in Section 5.2.1 still apply. From an insurer perspective, the expected cost of risk is the long run average insurance payout. The risk premium is the additional cost associated with bearing the risk, either by the insurer themselves or through reinsurance. The risk premium is particularly important because the cost differential between farmers and insurers associated with bearing the risk is the fundamental necessary driver for insurance markets. That is, if the cost of bearing the risk for farmers (e.g. the opportunity cost of self-insuring plus the expected cost of risk) is higher than the cost of insurance, they would benefit from using insurance.

Adverse selection and moral hazard can occur when farmers have better information about their risks and actions than insurers. Both have the potential to increase the cost of risk for indemnity insurance. For example, as a result of adverse selection, insurers may be unable to differentiate between high and low risk farmers. This means that insurers would need to offer high and low risk farmers the same price. This will tend to be more attractive to high risk farmers, who stand to gain more from insurance. Hence, the insurance pool is likely to be biased towards high risk farmers, which drives up the cost of risk. Adverse selection and moral hazard are less relevant for index products, since insurers have access to the same information as farmers (for example, historical data for the weather station used as the basis for settlement).

### How large is the impact of the cost of risk on the provision of insurance?

The cost of risk accounts for the majority of costs for both indemnity insurance and index products. In the case of indemnity insurance, the cost of risk is increased by adverse selection and moral hazard, to the extent that the provision of indemnity insurance is generally not profitable without government subsidies.

The benchmarking approach introduced in the earlier section - *Insurer costs (expenses)* - was also used to estimate indicative risk premiums. The estimated risk premiums were material – about 11 per cent of insurance premiums for indemnity insurance and 9 per cent of insurance premiums for index products (Table 11). This reflects the costs to insurers associated with bearing risk themselves. It also reflects the costs associated with reinsurance, which include the transaction costs to insurers and reinsurers in negotiating and enforcing policies.

Table 11 Indicative insurer risk premium as a percentage of premiums

| | Indemnity insurance | Index products |
|---|---|---|
| **Risk premium** | 11.0% | 8.8% |

Given the substantial costs described above, the cost of risk represents a substantial barrier to the provision of insurance. **Conclusion: Large barrier.**

# 6. Future developments in the agricultural weather insurance market

Although the barriers discussed in Section 5 are significant, they are not likely to remain static over time. Private sector actors are well aware of these challenges, and many are taking steps to overcome them without government intervention.

In this section, we summarise future developments and assess whether they are likely to occur. It is important to understand these developments so that we can understand how uptake may change over time without government intervention. This will then help to inform which government interventions may be the most effective, and at what scale.

## Key findings and recommendations

**Findings**

- Insurers, researchers, and other market participants are actively undertaking research and development into new indemnity insurance products and index products. We expect that some of these products will be commercially available in the future, and will reduce barriers to insurance uptake such as the cost of risk, insurer costs and basis risk.
- Private product assessment tools have recently been released by several index product providers. These product assessment tools are likely to reduce farmer transaction costs.
- Existing government investment into climate and weather data collection and use will allow some farmers to reduce basis risk associated with index products. However, in isolation, this investment is unlikely to result in a material increase in uptake of agricultural weather insurance.
- We expect education and awareness of agricultural weather insurance, particularly index products, to increase over time.
- Banks, industry bodies and supply chain participants have some interest in further involvement in the agricultural weather insurance market. However, this is unlikely to occur without a market with proven viability and longevity.

**Recommendations**

- Insurers should investigate the benefits of the formation of a risk pool.
- Banks should assess the feasibility and potential benefits of linking lending rates and requirements to have agricultural weather insurance.
- Supply chain participants should assess the feasibility and potential benefits of facilitating insurance delivery.
- Industry bodies should invest in additional information provision and promotion of the potential benefits of agricultural insurance.

## 6.1. Expected insurance market developments

Consultations with industry found that several developments are likely in the absence of further government intervention. We consider expected developments to be part of the future base case. Expected developments must:

- be feasible
- have demonstrated interest from relevant parties
- have minimal dependence on other developments which are uncertain, or unlikely to occur.

Section 8 assesses the impact of these developments on insurance uptake.

### *Emerging insurance products*

Several insurers are undertaking research and development into new products, particularly indemnity products. These products may reduce transaction costs for insurers and reduce the cost of risk. Some of these products are described in Section 3.

There is also potential for index products, such as NVDI and yield index insurance, to become available as remote sensing and other technologies continue to advance. These products can reduce basis risk for farmers where new indices are more correlated with production than indices in existing products. Index products are still relatively new in the Australian market and it is expected that insurers will enhance product design and delivery in the future. This is evidenced by the recent launch of Crop Risk Underwriting's index products and Syngenta's 2019 AgriClime program.

Given existing interest in the Australian agricultural weather insurance market by several relevant stakeholders, we expect at least some new products to become commercially available in Australia in the future.

### *Private product assessment tools*

In 2020, several index product providers have begun hosting digital platforms with private product assessment tools. These tools aim to make index products more accessible for farmers and reduce transaction costs associated with assessment and negotiation of insurance. The availability of tools to help assess index products has been limited in Australia until recently.

Hillridge Technology, in partnership with Crop Risk Underwriting, released the Hillridge platform in September 2020. The tool allows farmers to customise a variety of parameters for index products, including the contract window, peril insured, settlement data type and location, and trigger points for payment. Currently, the Hillridge platform is only available for brokers, with plans to make the platform available to farmers in the future.

Index product provider CelsiusPro recently released the Weather Certificate Pricing Calculator, a simple product assessment tool, to the public. Similar to the Hillridge platform, the Weather Certificate Pricing Calculator allows users to enter and modify key policy parameters to receive an indicative quote for weather event insurance products. CelsiusPro also offers a product assessment tool, GeoQuote, to existing clients.

### *Trusted Private Automatic Weather Station (TPAWS) Program*

The Bureau of Meteorology (BoM) is currently undertaking the TPAWS program, funded by the Australian Government. The program seeks to encourage use of private weather stations for index product settlement and pricing. The TPAWS program will allow BoM to review the quality of private weather stations and sensors placed around more than 5,000 sites, managed by a selection of established private network owners (BoM 2020). BoM will also continually monitor data quality and send alerts to farmers, private network owners and relevant stakeholders if weather stations become inaccurate and require maintenance. The initial TPAWS program is considered in the future base case, discussed further in Section 7 and 8.

Quality assurance and alert services will increase insurer confidence in data from private weather stations. Where the initial TPAWS program facilitates insurance settled through private weather stations, it can significantly reduce basis risk for farmers. This is because on-farm private weather stations are more likely to provide accurate data about on-farm weather than a distant BoM station or gridded data.

However, the initial TPAWS program may not encourage material uptake of private weather stations for insurance in isolation. To price and settle insurance, most insurers prefer to have a dataset spanning 10 to 20 years. Interviews with industry sources suggested that most private weather stations have not been established for this long, or have inconsistent or inaccurate historical data.

For this reason, BoM is seeking to improve the granular accuracy of gridded data sets by integrating data from private weather stations into public gridded weather datasets. Currently, these datasets only include data from publicly owned weather stations and sensors. Integration of private weather stations would allow weather history reconstructions for private weather station, enabling insurers to have more confidence to efficiently price risk. However, no funding has been acquired for TPAWS program extension. Because TPAWS program extension would require government intervention, it is not considered in the future base case.

### *Education and awareness*

It is expected that education and awareness about insurance, particularly index products, will increase over time in the absence of government intervention. This would be due to several factors. Firstly, a natural increase in awareness is likely to be caused by other developments, such as emerging products or facilitated insurance delivery. Additionally, organisations with an interest in farm risk management (industry bodies, supply chain participants) are likely to continue to play an active role in education and awareness.

In recent years, industry bodies have been active in educating and advocating for insurance amongst their farmer networks. Notable examples include the Queensland Farmers' Federation's Insurance Data Project, which included educational presentations about index products for farmers and industry organisations, and GrainGrowers' advocacy of multi-peril crop insurance. Other industry bodies including the Victorian Farmers' Federation and NSW Farmers have also advocated for agricultural weather insurance. When interviewed, these organisations were interested in playing an education and awareness role into the future. However, this was conditional on the existence of viable products with proven longevity.

## 6.2. Potential insurance market developments

Potential developments are developments that are possible but do not meet the criteria listed in Section 6.1 to be consider expected. Consequently, we do not assume that they are part of the future base case for the purposes of the assessment in subsequent sections. However, in this section we have briefly assessed their impact on insurance uptake if they were to occur.

### *Facilitated insurance delivery*

Insurance transactions may be facilitated by a third party with established channels to farmers. Facilitated insurance delivery may occur through several arrangements. Facilitators may play a similar role to brokers, with the additional benefit of being able to bundle insurance with existing products or services. Alternatively, facilitators may design their own farm-level insurance product and reinsure these policies in aggregate through an established insurer. Facilitators may include industry bodies and commercial supply chain participants.

Facilitated insurance delivery is not considered part of the future base case. Unlike an educational or advocacy role, an organisation playing a facilitatory role has direct commercial involvement in the insurance market. This means facilitation comes with a higher level of reputational, legal, and financial risk than advocacy, which means facilitators would be highly dependent on both the existence and success of a future product.

Supply chain participants are the most likely to engage in this type of arrangement. Supply chain participants have commercial interest in farmer risk management as their business relies on farms producing optimal yields and remaining operational. Supply chain participants also have existing expertise to manage the risks of facilitating insurance cover for farmers. They can either facilitate direct arrangements between a pool of farmers and a provider/s, or take out an insurance policy on behalf of suppliers and pass on the benefits.

Industry bodies, such as state farming organisations, industry-specific associations, and farming systems groups, are less likely to be involved in facilitating insurance delivery. This is due to potential reputation, legal and financial risks to these organisations. However, with strong commitment from industry leaders, these organisations may still play a facilitatory role.

### *Tying insurance to lending rates and requirements*

Financial incentives for producers to encourage insurance uptake, particularly through lending rates and requirements, is considered to be a development which would result in a material increase in insurance uptake. Currently, Australian institutions offering agricultural loans do not typically account for agricultural weather insurance when assessing a farmer's credit risk. In consultations, some stakeholders argued that accounting for this factor would benefit farmers via reduced financing costs (or increased access to finance), whilst benefiting creditors by allowing them to determine the risk profile of farmers more accurately.

Despite potential benefits, we do not consider changes to lending rates and requirements to be imminent, and have excluded this development from the future base case. Interest in implementation from the Australian finance sector is relatively low. This has been suggested to be the case for several reasons. In the wake of the Royal Commission into Misconduct in the Banking, Superannuation and Financial Services Industry, offering financial incentives may come with significant compliance risks if financial advice is also offered. Additionally, some creditors may believe that benefits from financial incentives (primarily increased demand for loans) are unlikely to be worth the cost of implementation and the lower revenue received due to lower rates.

### *Formation of a private risk pool*

Industry sources have suggested the potential for the formation of a private risk pool between insurers. The risk pool would help insurers reduce the cost of risk by removing non-systematic risk associated with poorly diversified individual portfolios. The risk pool may also result in lower reinsurance costs if a reinsurer is able to reduce costs by interacting with a single, large counterparty, rather than multiple smaller ones.

Formation of a private risk pool would require significant coordination and strategic alignment between multiple insurers. Implementation would likely be difficult due to this counterparty risk, as well as regulatory risks that may arise from anti-competitive behaviour. The risk pool is also dependant on several insurers having viable products on the agricultural weather insurance market to be sustainable. Therefore, we do not consider this development to be part of the future base case.

# 7. Government interventions to improve agricultural weather insurance in Australia

This section provides an overview of the interventions identified to increase insurance uptake and establish a viable insurance market in Australia. An intervention may overcome one or several of the barriers identified in Section 5. However, not all interventions will lead to a material increase in uptake or be suitable for government investment. As a result, only a subset of all interventions identified are subject to further, detailed assessment. This section provides an overview of all interventions that were identified as part of the project and a detailed description of the interventions short-listed for further assessment.

## 7.1. Long list of interventions

Aither has identified a long list of potential government interventions that could increase insurance uptake (Table 12). The long list has been generated from prior work that identified recommendations for further assessment, stakeholder interviews, current work occurring internationally and our own ideas. It is intended to include a wide range of measures which may increase insurance uptake in Australia.

Only government interventions have been included in Table 12. There are a number of developments that are not suitable to government intervention, but may occur without it or as a result of it. For example, financial institutions may build insurance into lending rates or loan requirements, providing financial incentives to farmers to buy insurance. These developments have been captured in Section 6.

To limit the scope of the assessment, a shortlist of interventions was generated from the long list. This was necessary to assess chosen interventions with adequate rigour. Shortlisting does not necessarily suggest that the interventions that do not progress are not worthwhile or would not be worthwhile in the future.

Shortlisting was guided by expert input and high-level assessment criteria. Shortlisted interventions must **be likely to result in material benefit for a broad range of farmers.** This rules out interventions which might increase uptake but do not benefit farmers, such as removing access to other risk management strategies. It also ensures that shortlisted interventions are broadly beneficial and do not target a small subset of farmers. This eliminates interventions which are confined to specific locations or products. Shortlisted interventions should ideally **address a market failure or government distortion**, although we were not prescriptive about this. For example, we shortlisted government subsidies even though they do not directly address a market failure or government distortion. This allows us to do a thorough assessment of government subsidies, which were proposed by several stakeholders in consultations and are common globally. Where a government intervention does not address a market failure or government distortion, it is unlikely to be efficient and may result in net costs.

## Market failure and government distortions

**Market failure** occurs when a good or service, such as insurance, is not produced or consumed efficiently. This may occur because market participants do not have access to the same information, or because a good or service has public good characteristics.

Adverse selection and moral hazard can occur when farmers have better information about their risks and actions than insurers. Both have the potential to increase the cost of risk for indemnity insurance. For example, as a result of adverse selection, insurers may be unable to differentiate between high and low risk farmers. This means that insurers would need to offer high and low risk farmers the same price. This will tend to be more attractive to high risk farmers, who stand to gain more from insurance. Hence, the insurance pool is likely to be biased towards high risk farmers, which drives up the cost of risk.

Market failure may also occur where a good or service has public good characteristics. For example, some insurance information is non-rival, meaning that once produced it can often be shared at close to zero cost. In this case, if information providers were to charge for information, there is the potential for some mutually beneficial deals to fall through. That is, the distribution of information could be inefficient.

Similar to market failures, **government distortions** are policies which discourage efficient production or consumption of a good or service. For example, taxes on insurance premiums may discourage some farmers from buying insurance, even though it would be mutually beneficial for farmers and insurers.

Table 12 Summary of intervention long list and shortlisting assessment

| Government intervention | Description | Potential barriers addressed | Shortlisting assessment |
|---|---|---|---|
| Removal of taxes | Removal of stamp duties applicable to agricultural weather insurance.<br>Stamp Duty exemptions for insurance exist in some states. | • Insurance taxes | Shortlisted. Could provide material benefits to farmers by reducing the costs of insurance. Removes a government distortion which discourages efficient uptake. |
| Digital insurance platform | A digital insurance platform which raises awareness of insurance options and supports farmer decision making. The platform may include information about types of agricultural weather insurance and product assessment tools accounting for farmers' specific circumstances. The platform may also include a central exchange, allowing farmers to compare and buy products from different providers.<br>Private product assessment tools exist for some insurance products in Australia. | • Farmer transaction costs<br>• Insurance product complexity<br>• Insurer transaction costs | Shortlisted. Could provide material benefits to farmers by raising awareness of insurance products and helping farmers make purchasing decisions. The platform is likely to have public good characteristics, potentially addressing a market failure. |
| Climate and weather data collection and use | Collecting more accurate weather data for the purposes of insurance. May include additional weather stations and radars, remote sensing investments, and integration of different datasets. | • Basis risk<br>• Farmer transaction costs<br>• Insurance product complexity | Shortlisted. Could provide material benefits to farmers by reducing basis risk and transaction costs. The provision of data is likely to have public good characteristics, potentially addressing a market failure. |
| Government provision of insurance or reinsurance | Provision of either insurance or reinsurance, likely through a standalone trading enterprise or similar arms-length | • Cost of risk<br>• Insurer transaction costs | Shortlisted. Could provide material benefits to farmers if the government is able to provide insurance or reinsurance at lower cost than private providers. |

| Government intervention | Description | Potential barriers addressed | Shortlisting assessment |
|---|---|---|---|
| | structure. This could be joint or direct provision.<br>Government provides large scale insurance and reinsurance in non-agricultural industries. | | |
| Subsidies | Provision of a premium subsidy directly to farmers who take insurance, or subsidy to insurers. The subsidy could be targeted to specific farmers dependent on location, production systems, or other factors affecting risk and risk exposure.<br>Agricultural weather insurance is not currently subsidised. | • Does not explicitly address barriers to uptake, but decreases the cost of insurance. | Shortlisted. Could provide material benefits for farmers by reducing insurance premiums. Does not directly address market failures or government distortions. |
| Development of products | May include research, design of new products and indices, processing existing data, and setting up infrastructure for product delivery and administration.<br>Government has previously invested in development of yield modelling (APSIM) that may be used for insurance purposes. | • Product development costs | Not shortlisted. While many products are mature, there could be benefits to farmers from further developing some products, particularly to take advantage of new technology and data. However, insurers generally have adequate incentives to develop these products themselves, where worthwhile, without government intervention. (Some further product development in the absence of government intervention is reflected in the future base.) |
| Insurer aggregation | Formation of a risk pool comprised of private insurers. The risk pool may be reinsured by a private reinsurer or self- | • Insurer transaction costs<br>• Cost of risk | Not shortlisted. Could reduce the cost of risk and potentially insurance premiums, which would benefit farmers. However, beyond |

| Government intervention | Description | Potential barriers addressed | Shortlisting assessment |
|---|---|---|---|
| | sustained and may or may not have government involvement in its administration. | | addressing any unwarranted regulatory barriers, there is no clear role for government. If aggregation helps to reduce the cost of risk, insurers can develop and administer the risk pool themselves. |
| Awareness and education | Provision of educational and awareness raising campaigns for farmers. May include workshops with farmers and industry, online resources and advertisements. | • Farmer transaction costs<br>• Insurance product complexity<br>• Insurer transaction costs | Not shortlisted. Dedicated focus of Sub-Project 4. |
| Compulsory insurance program | Government enforces use of agricultural weather insurance across all Australian farmers, or a large subset. | • Indirectly addresses all demand side barriers<br>• Cost of risk | Not shortlisted. Could reduce the cost of risk by addressing adverse selection and increasing the scale of the market. This would benefit some farmers by reducing insurance premiums. However, as discussed in Section 8, insurance is not worthwhile for many farmers. Compelling these farmers to buy insurance would leave them worse off. |
| Regulatory reform | Altering licensing arrangements for the provision of derivatives that are used for the purposes of insurance-like transactions.<br>Providers of weather derivatives require an Australian Financial Services Licence (AFSL). | • Farmer transaction costs<br>• Insurance product complexity<br>• Insurer transaction costs | Not shortlisted. Potential benefits of regulatory reform not expected to be as material as shortlisted government interventions above. Could warrant further attention though, especially if the market grows. |

## 7.2. Shortlist of interventions

Shortlisted interventions chosen for further assessment were:

- Removal of stamp duty on agricultural weather insurance
- Digital insurance platform
- Climate and weather data collection and use
- Government provision of insurance or reinsurance
- Premium subsidies.

The shortlisted interventions cover a wide range of transactions across the insurance market (Figure 22). This allows us to assess which parts of the insurance market may be the most amenable for government intervention, in addition to assessing the materiality of each intervention specifically.

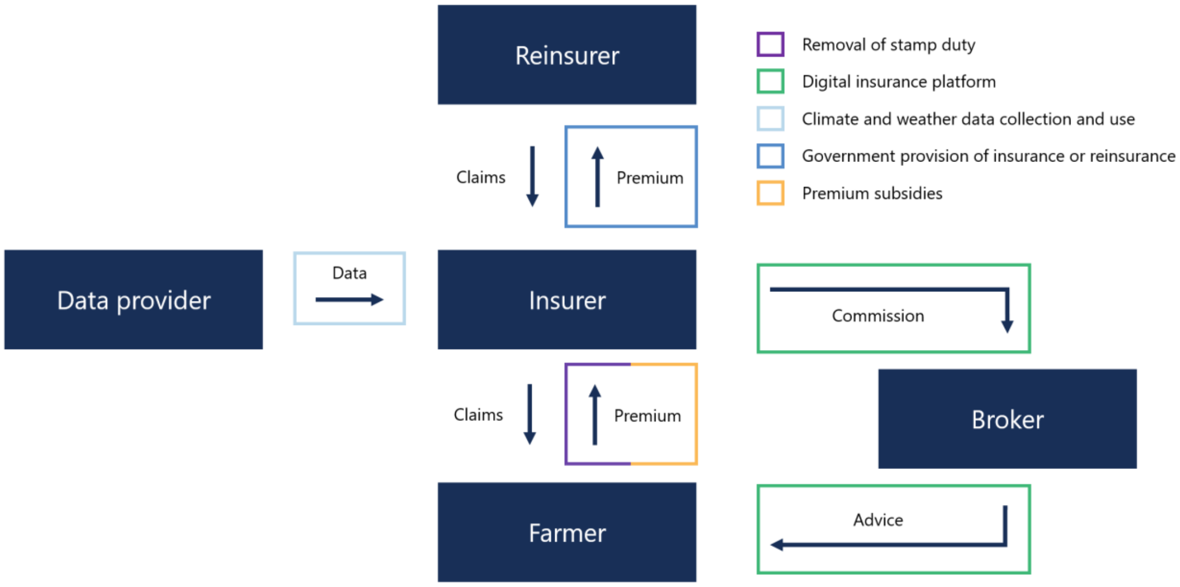



Figure 22 Short-listed interventions and how they interact with the insurance market

### 7.2.1. Removal of stamp duty on agricultural weather insurances

Stamp duty is a state tax applied to agricultural weather insurance premiums, including commissions, GST and levies (where applicable). Stamp duty does not apply to derivative products. As discussed in Section 5, the exemption of stamp duty for agricultural weather insurance products has occurred in the Australian Capital Territory, Victoria, New South Wales and South Australia. However, stamp duty remains applicable in Queensland, Northern Territory, Tasmania and Western Australia. The removal of stamp duty is likely to reduce the effect of government distortions on insurance purchasing decisions.

#### *The proposed intervention*

The government intervention that was assessed was the effect of removing stamp duty. In some states (Table 13), stamp duty is a large amount of the overall insurance premium cost, being 9-10 per cent of the total cost of insurance. In some states this may include GST and levies on top of the base premium.

Table 13 Summary of current and proposed Stamp Duty arrangements for assessment

| State / Territory | Stamp Duty (base) | Stamp Duty (intervention) |
|---|---|---|
| Australia Capital Territory | 0% | No change |
| New South Wales | 0% | No change |
| Northern Territory | 10% | 0% |
| Queensland | 9% | 0% |
| South Australia | 0% | No change |
| Tasmania | 10% | 0% |
| Victoria | 0% | No change |
| Western Australia | 10% | 0% |

*Examples*

Since 2013, most Australian states have considered exempting agricultural weather insurance from stamp duty, or abolishing stamp duty entirely. This is consistent with a broader consideration of the removal of stamp duty for other products. The Australian Capital Territory was the first jurisdiction to phase out stamp duty on insurance as part of its 20-year plan for broad tax reforms. Victoria, New South Wales and South Australia have all exempted agricultural weather insurance products from stamp duty.

Prior to its exemption, stamp duty on agricultural weather insurance in New South Wales was 2.5 per cent. IPART's 2016 *Review of multi-peril crop insurance incentive measures* did not recommend a stamp duty waiver for crop insurance in New South Wales, on the basis that the "reduction in costs would be too small to materially change uptake rates of multi-peril crop insurance". Despite this, the New South Wales government announced an exemption of stamp duty for crop and livestock insurance in the 2017-18 state budget, indicating alternative policy drivers were considered in making this decision.

Stamp duties in South Australia (11 per cent) and Victoria (10 per cent) were higher than New South Wales prior to exemption. South Australia's 2017-18 *Mid-Year Budget Review* estimated that a stamp duty exemption would reduce state revenue by $138,000.

Internationally, agricultural weather insurance is heavily subsidised by many countries and through a variety of channels. Australia is one of a few countries that impose net costs on agricultural weather insurance through taxes.

### 7.2.2. Digital insurance platform

The use of digital platforms to market and distribute insurance is common for many retail insurance products. Digital insurance platforms can be used by consumers who wish to identify options, develop product quotes for their specific circumstances, compare options from different providers and buy their preferred option.

A digital insurance platform is likely to allow farmers to better understand the range of available products, and the potential costs and benefits that they may incur and receive for their use. A digital platform may also lower transaction costs for farmers as it makes it easier for them to assess products, and lower transaction costs for insurers due to efficiencies created by the platform.

We consider whether a digital platform that provides some or all these functions would be beneficial for the agricultural weather insurance market.

### *The proposed intervention*

A digital insurance platform could have a range of functions. At the most basic level, the platform could function as a centralised information source which farmers can used to identify and understand a wide range of available insurance products. Additional features could also be included that add varying degrees of complexity.

Three different digital insurance options are specified for the assessment (Table 14), ranging from simple (information and awareness focus) to more complex (insurance exchange).

Table 14 Specification of digital insurance platform options

| | **Information and awareness** | ***Plus:* Product assessment tool** | ***Plus:* Insurance exchange** |
|---|---|---|---|
| **Description** | Provision of educational materials that provide an objective overview of available products, how each product works, their potential beneficial use via a range of hypothetical scenarios and a list of insurance brokers and providers. | Provision of online tools for a farmer to assess the potential costs and benefits of products to their individual circumstances. Prices would by indicative, based on a calibration of quotes from different providers in each year. A list of insurance brokers and providers for a preferred option is provided to generate real quotes for preferred products. | Insurance providers offer insurance policies for specified parameters enabling the user to purchase or apply for products directly through the platform. |
| **Primary use** | Farmers can identify a range of products that are most relevant to their business circumstances | Farmers can assess products that are most relevant and compare different insurance policies to a 'no insurance' scenario | Farmers can buy or apply for insurance through the platform. |

### *Examples*

The following subsections set out examples of information and awareness tools, product assessment tool and insurance exchanges that are currently operating both in Australia and abroad.

#### Information and awareness in Australia

Broker and provider websites are currently the most accessible and reliable source of information for Australian farmers interested in crop and livestock insurance. Some brokers and providers have information packs that provide to varying levels of information on different insurance products. The available information about different products, how they work and how they could be used by farmers is fragmented.

The Insurance Council of Australia offers multiple information and awareness platforms for the insurance sector. Understand Insurance is a website offering information on insurance terms and concepts, types of insurance, purchasing policies, and more. Information is presented in text form with some use of illustrations and infographics. Find an Insurer directs users to insurers who offer specific insurance products, although no specific information about product offerings or pricing is given on the website. Crop and livestock insurance providers are included on the platform.

### Australian product assessment tools

As discussed in Section 6, several product assessment tools for index products exist in Australia, with one currently being available for public use.

### Australian insurance exchanges

Insurance exchange platforms (also known as aggregation platforms) are common in Australia for most insurance products, including business insurance. These platforms are run by private insurance aggregators such as Choosi, iSelect, Canstar, and Compare The Market. The platforms provide end-to-end support for users to research, compare, and purchase insurance products.

Exchange platforms exist for a variety of insurance products, however the user interface is different depending on the product. For example, interfaces for business insurance allow for a high level of customisation and user input regarding their circumstances and choice of cover. Most exchange platforms tend to be privately owned and operated. Exchange platform owners make money in several ways, however commissions from insurers are typically their primary income stream.

### International insurance platforms

In countries with government insurance/reinsurance provision, information about crop and livestock insurance tends to be more centralised and accessible. For example, The United States Department of Agriculture's website includes information and tools such as:

- Information about the policy structure of different crop and livestock products, including yield protection, revenue protection, margin protection, and rainfall index products.
- An insurance agent locator tool, which allows producers to find and contact insurance agents near to them who offer specific products
- An indicative cost estimation tool for producers. Producers are able to enter farm details and adjust settlement terms to view an indicative quote for a specified product.

The information and tools provided are detailed, freely accessible, and easy to find.

A similar platform that objectively provides comprehensive information on agricultural weather insurance is not available in Australia.

### Non-agricultural government supported exchange platforms in Australia and internationally

Privatehealth.gov.au is a private health insurance comparison platform run by the Private Health Insurance Ombudsmen. Users can specify basic personal details which are used to obtain a list of suitable policies. The website had 1.2 million unique visits in 2015-16.

Finansportalen is a Norwegian insurance comparison platform managed by the Consumer Council of Norway, a government agency. The platform operates similarly to Australia's private aggregation platforms, assisting with research, comparison, and distribution of a wide range of general insurance products (APH 2017). All Norwegian insurers are required to disclose product information and pricing to Finansportalen.

The California Department of Insurance (CDI) manages a comparison platform for general insurance. The platform launched in 2015 (APH 2017). Insurance providers are required to disclose product information and pricing to the CDI. The platform can be used to compare products but users cannot buy products directly from the website.

### 7.2.3. Climate and weather data collection and use

Governments can invest in activities that increase the scale and accuracy of data used in insurance policies. This can include making data more accessible and standardised for insurers to use. Interventions focused on data collection and use are frequently cited by relevant literature as an effective pathway for increased product uptake (ABARES 2012, IPART 2016, NRAC 2012, Hirsch 2020).

Government investment in data has the potential to reduce the presence of several key barriers to insurance uptake. One of these is basis risk, as data collection closer to the area that is insured can reduce the likelihood of incorrect payouts. More reliable data may also lead to increased farmer trust in products, leading to lower transaction costs due to the need for less rigorous assessment of data accuracy. Insurers may also benefit from better data if it allows them to price policies more efficiently and reduce portfolio volatility.

#### *The proposed intervention*

Three options for climate and weather data interventions are presented for assessment. These options (Table 15) are not mutually exclusive and may be implemented in isolation or in combined sets.

Table 15 Specification of climate and weather data collection and use options

| | Trusted Private Automatic Weather Stations integration | Automatic Weather Station network extension | Remote sensing integration and network extension |
|---|---|---|---|
| **Description** | Integration of trusted private automatic weather stations (TPAWS) into gridded datasets. This includes history reconstructions for TPAWS by bias correcting historical gridded data, using TPAWS data. | Establishment of additional Bureau of Meteorology owned automatic weather stations (AWS). This includes integration of new stations into gridded datasets and historical bias corrections for gridded data. | Further integration of radar and satellite data with gridded datasets to enable higher accuracy settlement data. This option may also include the establishment of high resolution doppler radars in agricultural hotspots. |
| **Primary use** | Increases the accuracy of gridded data and creates more options for pricing and settlement data | Increases the accuracy of gridded data and creates more options for pricing and settlement data | Allows for calibration of local weather data using satellite and radar imagery, increasing accuracy. |

The options for assessment do not include research and development activities into new insurance products and indices. Interviews with industry sources, including insurance providers and settlement data providers, have found that there is sufficient private incentive and capability to undertake these activities. This is evidenced by the emergence of new products and product delivery mechanisms, discussed in Section 3.

## *Examples*

The following subsections set out examples of private weather stations and remote sensing tools that have been established and used throughout Australia that align with the proposed intervention.

### Private automatic weather stations – network extension and integration

In 2017, Birchip Cropping Group began installing a network of private network stations on sites owned by participating farmers. Currently, the network includes approximately 90 to 100 weather stations. The primary focus of the network was to provide more accurate weather data for participating farmers, to help them make more effective agronomic decisions.

The Mid North Mesonet is a pilot project that commenced in 2019 and is funded by the South Australian Department of Primary Industries and Regions (PIRSA) and delivered by the Ag Excellence Alliance. The pilot established a network of 40 weather stations across the Mid North, northern Adelaide Plains and northern Yorke Peninsula of South Australia. These weather stations were installed to provide spray applicators with accurate local weather information to reduce the risk of spray drift caused by inversions.

The Western Australian Department of Primary Industries and Regional Development (DPIRD) weather network is comprised of 175 stations connected to the Telstra mobile network and linked to a central database run by DPIRD. Farmers use the information to help plan spraying operations, hay cutting and harvest, and monitoring weather conditions across the region. The data feeds into the Bureau of Meteorology (BoM) and supports rainfall estimates from BoM radar stations over south-western Western Australia. The DPIRD network has been supplemented by the installation of three new Doppler radars as part the Wheatbelt Radars project.

There are also established private automatic weather station network owners across Australia. Goanna Ag is an example of one network owner. Goanna Ag weather stations are used in dryland and irrigated winter cereal and cotton production by farmers to help them make improved agronomic decisions.

### Remote sensing

The Rural Intelligence Platform, developed by Digital Agriculture Services, integrates data from government owned weather stations, public satellite imagery and other sources to enable users to access property reports on past production, climate history and risks, carrying capacity and potential crop yields. The focus of the platform is to use on-ground weather data in tandem with biomass and other data generated from raw satellite data. Use of satellite data to calibrate on-ground weather data appears to be limited.

Private data providers/processors such as Speedwell Settlement Services, Geosys, and MeteoBlue use a range of weather data sources including public weather station networks, radar networks, and satellite imagery. Interviews with industry sources suggest these providers have some ability to integrate weather data from on-ground and remote sources using proprietary models, but are not as well placed to do so as data owners.

The Western Australian government recently invested $28 million to establish three high resolution doppler radars in the WA wheatbelt. A report by the University of Western Australia estimated that the radars would result in $3.3 million in benefits per year. The increased accuracy of weather data will help farmers make better agronomic decisions. It is expected that use of this data for insurance purposes (assisted by integration into gridded datasets) could result in further benefits.

Several other countries own large and technologically advanced radar networks. For example, NEXRAD is a US Government owned network of 159 high resolution doppler radars spread across the US.

### 7.2.4. Government provision of insurance or reinsurance

Government provision of insurance or reinsurance is common in many countries and is frequently subsidised. Government provision of insurance or reinsurance can take many forms. Government may provide insurance directly, competing with private providers, or form a partnership with one or more providers (Figure 23). Provision arrangements can get exponentially more complex than the examples below, as evidenced by arrangements in other counties.

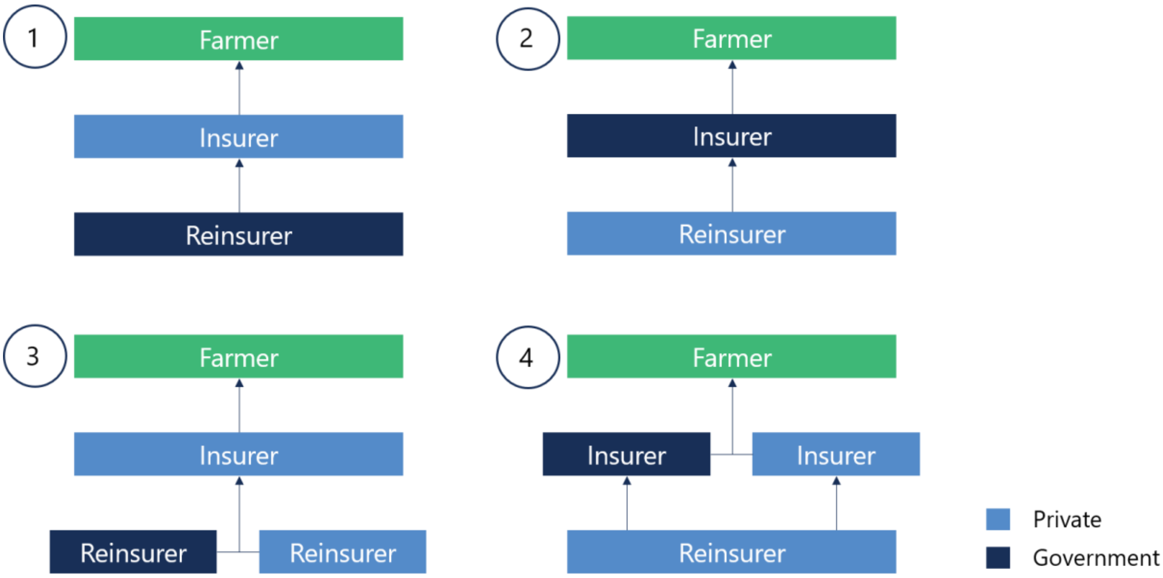



Figure 23 High-level options for government provision of insurance or reinsurance

Governments may choose to be selective in their provision. For example, they may choose to only provide insurance or reinsurance for specific perils, at specific levels of loss, or for specific farmers/insurers. Governments may cover all loss after a certain threshold, or only a proportion of loss. Provision may also be undertaken at different levels of government.

Government provision may be more efficient than private provision if it is lower cost. Factors which may affect the cost of providing insurance are the cost of capital and the cost of other expenses incurred, such as acquisition costs and claims handling.

#### *The proposed intervention*

While there are near infinite options for government provision, we focus on two characteristics which differentiate these options from private provision:

- **Expenses**: government may be able to provide insurance or reinsurance with lower expenses than private providers
- **Cost of capital:** access to capital may be cheaper for government than private providers.

It is important to note that the inverse may be true for both characteristics. Government may have higher expenses and higher cost of capital than private providers. The focus of this intervention is on these characteristics, rather than changes in the design of provision arrangements.

We focus on government provision of reinsurance in our assessment. Discussions with industry experts have suggested that government are likely to have higher expenses than private insurers when providing insurance. This is due to a lack of experience and infrastructure necessary to administer policies for individual farmers at low cost. This is likely to be less of an issue with reinsurance provision.

This intervention does not include subsidisation. This allows us to assess whether government provision of reinsurance would be beneficial through other means.

### *Examples*

#### International government provision

Internationally, government provision of insurance and reinsurance is typically achieved through a government monopoly or jointly with private providers. Government provision is also often accompanied by subsidisation. Despite these common characteristics, government provision arrangements differ greatly between countries. Some examples of provision arrangements are provided in Table 16.

Table 16 International examples of arrangements for government provision of insurance or reinsurance

| Country | Details |
| --- | --- |
| **Mauritius** | Government owned compulsory insurance fund for sugar cane (SIF). Private reinsurance up to 300 per cent loss ratio, after which losses are borne by the SIF. No subsidisation. |
| **Poland** | Government reinsures for drought risk – all other perils reinsured privately. Insurance is subsidised. |
| **Portugal** | Government provides voluntary reinsurance to insurance providers through the System for the Protection of Climactic Risks (SIPAC). The SIPAC pays 85 per cent of claims above a loss ratio threshold. The threshold decreases and premiums increase in higher risk zones. Insurance is subsidised. |
| **South Korea** | Government reinsures all losses above 180 per cent loss ratio. Operating costs of crop insurance subsidised by government. |

#### Australian government provision

The Australian Reinsurance Pool Corporation (ARPC) is public financial corporation administering the terrorism reinsurance scheme. It provides primary insurers with reinsurance for losses arising from a terrorism incident. The ARPC was founded in 2003 in response to the widespread withdrawal of insurance for terrorism incidents due to the September 11 attacks (APRC 2020). The terrorism reinsurance scheme is comprised of a pool of private reinsurers and a Commonwealth guarantee. The Scheme’s retained earnings and private reinsurers pay claims up to a threshold of $3.75 billion, after which claims up to $10 billion are guaranteed by the Commonwealth (APRC 2020).

The Western Australian Agricultural Produce Commission administers a voluntary insurance scheme for Carnarvon banana producers. The insurance scheme, operated since 1961, compensates farmers for production losses resulting from pests or diseases in return for a yearly levy (APC 2017). The applicability of this experience to government provision of insurance covering a larger range of farmers and perils is likely to be minimal.

Another example of government provided insurance is GIO general (founded as the Government Insurance Office). GIO was a general insurance provider founded by the NSW government in 1927. GIO offered workers compensation insurance, life insurance and other products before becoming majority owned by AMP in 1999. Similarly, WA SGIO and QLD SGIO (founded as the State Government Insurance Offices) were founded by the WA and QLD governments around the same time and sold to private parties in the 1980s-90s. They are now owned by or merged with IAG and Suncorp respectively.

### 7.2.5. Premium subsidies

Premium subsidies are the most direct way to encourage uptake of agricultural weather insurance and are common around the world. The Australian government has been reluctant to subsidise agricultural weather insurance due to high costs to taxpayers and uncertainty about likely benefits (ABARES 2012, IPART 2016).

Compared to other shortlisted interventions, premium subsidies are a less targeted method of addressing market failures. However, several arguments can be made for their implementation, including enabling economies of scale and adjustments for positive side effects created by insurance (Hazell et al. 2017).

#### *The proposed intervention*

Premium subsidies are provided to farmers when buying insurance. Typically, premium subsidies will be set to a proportion of the total premium which would have otherwise been paid by the farmer.

Premium subsidies can vary significantly. These subsidies can be fixed across farmer risk profiles and products, or can vary depending on these factors. Subsidies may also be fixed or variable over time. A common example of a time-variable premium subsidy is a temporary subsidy which is phased out over several years.

This intervention focuses on a subsidy provided directly to farmers. This intervention does not include subsidies which may be delivered through other mechanisms, such as subsidies to insurers to cover expenses, subsidising development of farmer resources (such as digital platforms), or subsidised reinsurance.

#### *Examples*

The value of subsidies provided to farmers varies significantly across countries. A World Bank survey conducted in 2008 found that agricultural weather insurance premiums are heavily subsidised in Italy (73 per cent), Spain (70 per cent) and Japan (51 per cent). As set out in Section 3 the USA, Canada and other countries throughout the European Union also heavily subsidise agricultural weather insurance. Other countries such as India have comparably low premium subsidies (6 per cent of total premiums subsidised) but apply large subsidies to costs incurred by insurers. Several countries including Australia, Germany, Argentina and Romania do not subsidise agricultural weather insurance premiums. The World Bank (2010) found that the proportion of agricultural land insured is higher on average in countries with premium subsidies (Table 17).

Table 17 Proportion of land insured in countries with and without premium subsidies, by development status of country

| Development status of country | Proportion of land insured (with premium subsidies) | Proportion of land insured (without premium subsidies) |
|---|---|---|
| **High-income** | 48% | 39% |
| **Upper-middle-income** | 27% | 27% |
| **Lower-middle-income** | 10% | 2% |

Source World Bank 2010

# 8. Consequence assessment of interventions and options

This section draws on the agricultural weather insurance market model to estimate the consequences of different interventions and response options. This includes estimating the impacts on the insurance market (loss ratio, uptake and premiums paid) and the benefits and costs to farmers and governments.

## Key findings and recommendations

**Findings**

- The insurance market is likely to remain small in the absence of further government intervention.
- Removal of stamp duty on agricultural weather insurance is estimated to result in an increase in uptake of index products of about 300 farmers. The benefits of stamp duty removal exceed costs to government from lost tax revenue.
- Private weather station integration with gridded datasets (TPAWS integration) is estimated to increase uptake of index products from 1,400 farmers without intervention to 1,400 to 2,700 farmers with TPAWS integration. Our best estimate of benefit to farmers from TPAWS integration is $21 million per year. The benefits of TPAWS integration are very likely to exceed the costs.
- A digital insurance platform including an insurance exchange, product assessment tools, and educational resources is estimated to provide between $10 million per year in benefit to farmers. At low levels of uptake, the benefits of a platform with these functions are unlikely to exceed the costs of implementation.
- We estimate that government provision of reinsurance could provide up to $5 million in farmer benefits per year, relative to the future base. However, this is an upper bound estimate, and government provision of reinsurance may result in net costs.
- A targeted response option including removal of stamp duty, TPAWS integration, and a digital insurance platform would increase farmer uptake of index products by an estimated 3,800 farmers. Our best estimate of farmer benefits relative to the future base is about $50 million per year.
- We estimate that adding a permanent 25 per cent premium subsidy to the target response option would increase uptake of index products to about 23,000 farmers. This option corresponds with about $340 million in farmer benefits per year, but a fiscal cost to government of about $1.2 billion.

**Recommendations**

- State governments should consider removing stamp duty and other insurance taxes on agricultural weather insurance.
- Government should continue to make investments into weather and climate data collection and use, through integration of private weather stations into gridded datasets and by other means.
- Government should not consider a digital insurance platform with full functionality at this time, but should revisit the intervention once agricultural weather insurance uptake increases. Provision of simple educational resources is still likely to be worthwhile.
- Government should not consider provision of insurance or reinsurance at this time, but should revisit the intervention if agricultural weather insurance uptake increases.

## 8.1. Index products versus indemnity insurance

The focus of this section are index products since they appear to be more likely to achieve significant uptake than indemnity insurance at the moment. As discussed in Section 5, while indemnity insurance is less affected by basis risk, it is subject to adverse selection and moral hazard. The expenses to insurance companies are also substantially higher. To assess the effect of these and other barriers, we ran an indemnity insurance scenario using the agricultural weather insurance market model (Section 4). There where were no products that were attractive to both farmers and insurers. Hence, the estimated uptake and provision of insurance was zero.

This is consistent with the empirical evidence. There have been repeated attempts to introduce indemnity insurance in Australia, without success. We are not aware of any international examples where there has been significant uptake of indemnity insurance without substantial ongoing government subsidies. However, our focus on index products in this section is not intended to dismiss the longer-term potential of indemnity insurance, especially if information asymmetries can be addressed and expenses reduced through new technologies and products.

## 8.2. Assessment of future base case for index products

Before assessing the consequences of the shortlisted interventions, it is important to understand what might happen in the medium term in the absence of these interventions. This provides a future base case against which the consequences of the interventions can be evaluated. For example, it might be that uptake would increase in the future under an intervention, but some of this increase would happen anyway without the intervention. In this case, a comparison of outcomes before and after the intervention would overstate the impact of the intervention. Instead we need to compare outcomes with and without the intervention, using the future base case.

As discussed in Section 7, the future base includes the following likely developments:

- emerging insurance products
- private product assessment tools
- initial TPAWS program
- improved awareness and understanding.

### *Impact on barriers*

#### Emerging insurance products

The impact of emerging insurance products depends on which products become commercially available, and the characteristics of these products. For example, new index products taking advantage of yield modelling may reduce basis risk for farmers. It is difficult to estimate the impact of new products on barriers to uptake because most are still at a formative stage. Conservatively, our model assumes that emerging insurance products do not affect the barriers.

#### Private product assessment tools

Similar to the digital insurance platform discussed in Section 7, private product assessment tools allow farmers to better understand and assess index products in less time. This enables them to reduce their transaction costs. To the extent that these tools also reduce the costs to brokers, there could be reductions in commissions over time. This would be beneficial for insurers and increase the loss ratio. Despite high potential benefits, interviews with assessment tool providers have suggested that private tools are likely to have less visibility than those hosted by industry bodies or governments. This is because private providers typically do not have access to the same distribution channels and rely heavily on word-of-mouth and low-cost marketing. Interviews with farmers have also suggested that many would have difficulty effectively engaging with product assessment tools without additional education, due to the inherent complexity of the products offered. Our model assumes that private product assessment tools lead to a small reduction in transaction costs and a small increase in the loss ratio.

#### Initial TPAWS program

In principle, the initial TPAWS program will allow farmers to use settlement data from a nearby private weather station for index products. An index product settled from a nearby private weather station will be significantly less prone to basis risk when compared to products using other settlement data sources, such as distant BoM weather stations or gridded data.

Despite these potential benefits, it is unlikely that the initial TPAWS program will be adopted by insurers. Most insurers require approximately 20 years of historical data to be available (dependent on their level of risk aversion) to comfortably price an index product. However, industry sources suggest that a large proportion of private weather stations have not been operational for this long. The initial TPAWS program does not include history reconstructions for private weather stations. Therefore, our model assumes that the initial TPAWS program does not affect the barriers.

#### Improved awareness and understanding

Awareness and understanding of insurance products will tend to increase over time, even in the absence of government interventions, through both experience and education and awareness programs by industry bodies. This could have similar effects to the private product assessment tools discussed above, since both contribute to more efficient decision making. Again, there is considerable uncertainty over the magnitude of the impacts, which also depend on the future scale of the market. Conservatively, our model assumes that improved awareness and understanding leads to a small reduction in transaction costs and a small increase in the loss ratio.

The second column of Table 18 shows the assumptions for the future base, covering several key barriers to insurance as well as subsidies. The third column shows the differences in assumptions between the future base and the current base (where we are now, as detailed in Section 5). The differences reflect the impacts of the likely developments, specifically, private product assessment tools and improved awareness and understanding.

Table 18  Assumptions for the future base scenario (index products)

| Parameter | Value | Difference from current base |
|---|---|---|
| **Farmer transaction costs** | $2,060 per year | -228 per year |
| **Probability of payout in drought year** | 85 per cent[11] | No change |
| **Probability of payout in rain year** | 4 per cent | No change |
| **Loss ratio** | 0.675 | +0.025 |
| **Stamp duty** | 3 per cent | No change |
| **Subsidy** | 0 per cent | No change |

Source  Aither analysis.

### *Impact on insurance market*

The future base was simulated using the agricultural weather insurance market model (Section 4). This provides evidence that in the absence of further government interventions, the insurance market is likely to remain small. While there is substantial uncertainty, our best estimate is that around 1,400 farmers would take out index products and that annual premiums paid would be around $130 million per year (Table 19).[12] While this is an order of magnitude increase from the current market size (Section 3), it still represents only about 2 per cent of farmers.

These results are driven by demand and supply side barriers. While each barrier would not be an issue individually, the collective effect is to reduce farmers' wiliness to pay and increase insurers' premiums to the extent that insurance is not worthwhile for most farmers. This suggests that even with the likely developments described above, the barriers to insurance will remain a substantial deterrent.

11 The estimates of basis risk were informed by the analysis in Section 5. However, the extent of basis risk in the current and future base is less severe as the estimates in Section 5 are likely to be upper bound estimates.

12 The farmers in the agricultural weather insurance market model are based on farmers in the survey, and tend to be larger than average in terms of income. As a result, the estimates of premiums paid as well as benefits and costs could be somewhat overstated.

Table 19  Estimated insurance market outcomes for the future base (index products)

| | | Future base |
|---|---|---|
| Payout ratio | $ claims/dollar of premiums | 0.66 |
| Uptake | number of farmers | 1,368 |
| Premiums paid | $ million/year | 127 |

Source	Aither modelling.

### *Benefits and costs*

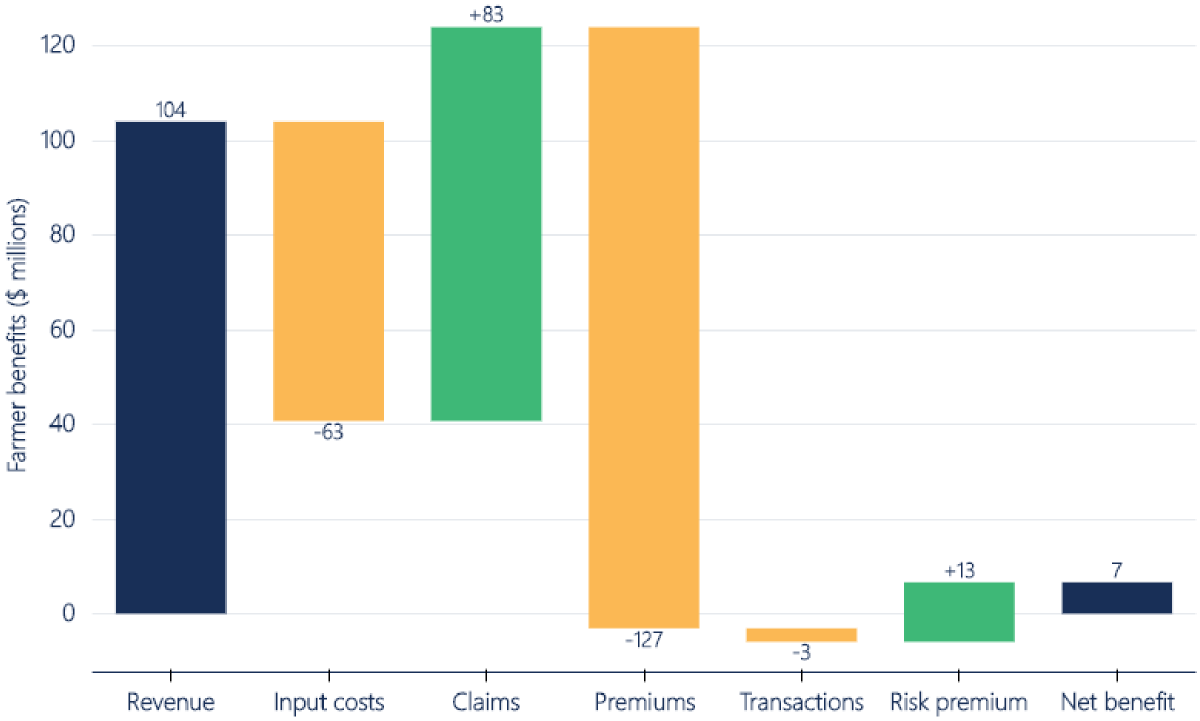
Our best estimate is that in the absence of further government interventions, the insurance market will generate around $7 million per year of benefits to farmers and $4 million per year of government revenue through stamp duty on insurance (Table 20). Adding these estimates together gives an estimated overall benefit to Australians of $10 million per year (after rounding).

Table 20  Estimated benefits relative to no insurance for the future base (index products)

| | | Future base |
|---|---|---|
| Farmer benefit | $ million/year | 7 |
| Net tax revenue | $ million/year | 4 |
| Total | $ million/year | 10 |

Source	Aither modelling.

The benefits to farmers can be disaggregated (Figure 24 to Figure 29). Agricultural weather insurance allows farmers to take on more production risk, including investments to increase production. As a result, there an estimated increase in revenue of about $100 million per year (on average) under the future base. The cost of additional inputs used to make this increase in production possible of about $60 million per year need to be subtracted. Farmers are estimated to receive about $80 million per year of claims from insurers in return for about $130 million of premiums. The claims need to be added and premiums subtracted. It is also necessary to subtract the transaction costs to farmers associated with insurance of about $3 million per year. Finally, insurance means that farmers are exposed to less financial risk, even after accounting for the increase in production risk. The benefit associated with reduced exposure to financial risk is estimated to be about $13 million per year, and needs to be added. The end result of these additions and subtractions is the estimated benefits to farmers.




Source Aither modelling.

Figure 24 Disaggregation of estimated farmer benefits for the future base (relative to no insurance)

## 8.3. Assessment of interventions for index products

The analysis above provides evidence that, as a result of multiple substantial barriers, insurance is not worthwhile for most farmers and is unlikely to be in the future without additional government intervention. Section 7 shortlisted five of the most promising government interventions to mitigate the barriers. This subsection uses the agricultural weather insurance market model and other sources of quantitative and qualitative evidence to assess the consequences of four of these interventions. The final intervention, government subsidies, is covered in the next subsection.

### 8.3.1. Removal of stamp duty on agricultural insurance

#### *Summary*

Removing stamp duty on agricultural weather insurance would be a small but worthwhile step, as long as the administrative costs of removing stamp duty are minimal. We estimate that removing stamp duty would generate a net benefit to Australians of around $1 million per year. This accounts for the benefits to farmers and the loss of tax revenue to governments. It does not account for the costs to governments and farmers in administering or removing stamp duty.

### *Impact on barriers*

The impact of removing stamp duty in all states and territories on the barriers would be straightforward, with the weighted average stamp duty falling by three percentage points to zero (Table 21).[13]

Table 21 Assumptions for the removal of stamp duty scenario (index insurance)

| Parameter | Value | Difference from future base |
|---|---|---|
| **Farmer transaction costs** | $2,060 per year | No change |
| **Probability of payout in drought year** | 85% | No change |
| **Probability of payout in rain year** | 4% | No change |
| **Loss ratio** | 0.675 | No change |
| **Stamp duty** | 0% | -3 points |
| **Subsidy** | 0% | No change |

Source Aither analysis.

### *Impact on insurance market*

Like other taxes, stamp duty on agricultural weather insurance effectively increases prices to buyers and reduces prices to sellers. On the demand side, this means that fewer farmers will want to purchase insurance (than without stamp duty). Where farmers do purchase insurance, they will often want to purchase less insurance. On the supply side, this means that insurers will be less willing to supply insurance. As a result, stamp duty reduces the uptake of insurance, even when insurance would otherwise be mutually beneficial to farmers and insurers.

Aither modelled the agricultural weather insurance market with and without stamp duty (Table 22). Removing stamp duty means that insurance is more attractive to farmers, which leads to an estimated increase in uptake from about 1,400 farmers with stamp duty to about 1,700 farmers without stamp duty (a 25 per cent increase). The magnitude depends on the number of farmers who are swayed by the price change. That is, the number of farmers who have a willingness to pay somewhere in between the two prices (with and without stamp duty). The model estimates that there are about 300 such farmers.

Our estimates of the potential impact on uptake are substantially larger than IPART's estimates from its 2016 review of agricultural weather insurance in NSW. IPART estimated that a temporary stamp duty waiver would increase uptake by 5 or 6 farmers, relative to the base case. However, IPART's estimates are not directly comparable since they relate to multi-peril crop insurance (rather than index products) and are limited to NSW.

The elimination of stamp duty can also lead to an increase in the amount of insurance wanted by farmers who would purchase some insurance in any case (even with stamp duty). Combined with the increase in the number of farmers insured, this leads to an increase in the premiums paid by farmers

13 Stamp duty is not charged on derivatives. In the absence of data on the share of index products sold as derivatives or insurance, we have assumed that all products are sold as insurance. This provides an upper bound estimate.

from about $130 million with stamp duty to $170 million per year without stamp duty (a 32 per cent increase).

Table 22 Estimated insurance market outcomes for the removal of stamp duty (index products)

| | | Future base | No stamp duty | Difference |
|---|---|---|---|---|
| Payout ratio | $ claims/dollar of premiums | 0.66 | 0.67 | 2% |
| Uptake | number of farmers | 1,368 | 1,710 | 25% |
| Premiums paid | $ million/year | 127 | 168 | 32% |

Source Aither modelling.

### *Benefits and costs*

The reduction in the price of insurance benefits farmers (Table 23). We estimate that the benefits of removing stamp duty to farmers would be about $4 million per year. As discussed above, this is calculated as the difference between the benefits with and without removing stamp duty (the fourth column minus the third column). The main source of benefit is that the insurance that farmers would have in any case (that is, even with stamp duty) is less expensive, so they keep the money they would otherwise pay in tax. However, there is also an increase in the number of farmers insured and the extent of insurance. As discussed above, insurance helps farmers reduce financial risk and costs associated with alternative risk management strategies. On the other hand, removing stamp duty is estimated to decrease tax revenue. The overall effect, summed over all affected parties, is a net benefit of $1 million per year.[14]

This differs from the cost benefit analysis undertaken by CIE for the IPART review of agricultural weather insurance in NSW. CIE correctly argued that because their estimated impact on uptake was small, the net benefits were likely to be close to zero. However, this logic does not apply to our analysis, given we estimate increases in the number of farmers insured.[15]

14 We assume that the value of an additional dollar of government revenue is worth the same as an additional dollar to farmers. It could be higher or lower depending on how the government revenue is used. For example, the value would be higher if used to reduce distortionary taxes or lower if used to make investments with a benefit cost ratio less than one. From a utilitarian perspective, it could also differ based on variation between people in the marginal utility of income.

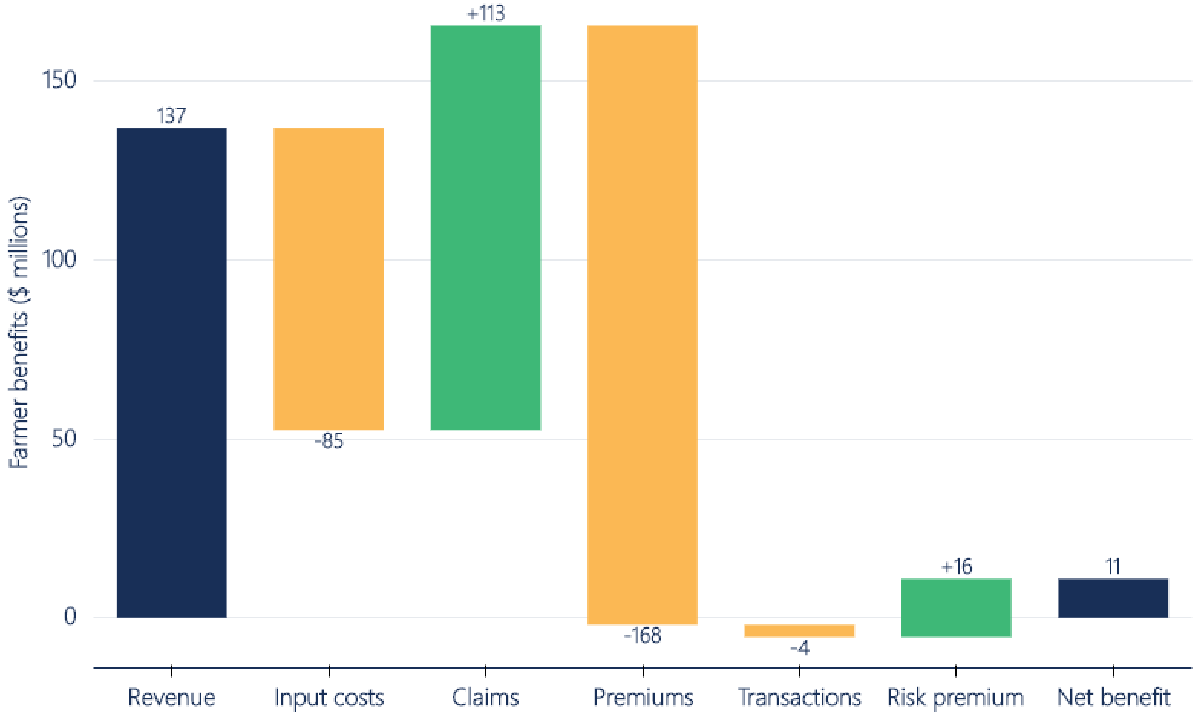
15 Our estimates do not account for the extent to which there are likely to be increases in farm incomes that incur taxes. In this case, the estimates may overstate the reduction in tax revenue. However, any indirect tax revenue increases would need to be subtracted from the benefits to farmers. Hence, accounting for indirect tax revenue increases would alter the estimated distribution of benefits between farmers and governments but not the total benefits, potential incentive effects notwithstanding. Also, our estimates do not account for the costs to governments and farmers in administering or removing stamp duty.

Table 23 Estimated benefits relative to no insurance for the removal of stamp duty (index products)

| | | Future base | No stamp duty | Difference |
|---|---|---|---|---|
| Farmer benefit | $ million/year | 7 | 11 | 63% |
| Net tax revenue | $ million/year | 4 | 0 | -100% |
| Total | $ million/year | 10 | 11 | 5% |

Source Aither modelling.

Note Dollar values are rounded to the nearest million.




Source Aither modelling.

Figure 25 Disaggregation of estimated farmer benefits for the removal of stamp duty (relative to no insurance)

### 8.3.2. Climate and weather data and use

#### *Summary*

Further government investment in climate and weather data would be worthwhile, particularly funding to integrate trusted private automatic weather stations into gridded datasets to allow for historical reconstructions. This is fundamental to the facilitating the use of private weather stations for settlement, which will help to reduce basis risk. We estimate that integrating the trusted private automatic weather stations would generate a benefit to Australians of between $5 million and $60 million per year. This excludes the potential benefits from having more granular weather data, such as improved community safety from better flood modelling. Over time, the benefits are very likely to exceed the upfront costs of integration and installing reliable private weather stations, which account for the bulk of costs.

### *Impact on barriers*

The shortlisted intervention options for climate and weather data and use have the potential to address several barriers to the uptake and provision of insurance, especially basis risk and farmer transaction costs (Table 24). The specific impacts depend on the shortlisted intervention option.

Aither modelled the integration of trusted private automatic weather stations. The intervention is assumed to reduce farmer transaction costs by $270 per year (to $1,787 per year) (Table 25). It is also assumed to have a large impact on basis risk, with the probability of receiving an insurance payout in a drought year increasing by 7.5 percentage points (to 92.5 per cent). The probability of receiving an insurance payout in a rain year is assumed to fall by 2 percentage points (to 2 per cent).

Given uncertainty over these assumptions we have included lower and upper bound scenarios as defined by the values in the square brackets in Table 25. For example, the farmer transaction costs could be as high as $1,923 per year or as low as $1,650 per year. These values correspond to 50 per cent and 150 per cent of the assumed change from the future base case under our best estimate (above).

Table 24 Degree to which barriers are overcome for each data intervention option

| | TPAWS integration | AWS network extension | Remote sensing integration and network extension |
|---|---|---|---|
| **Basis risk (index products)** | Expected to decrease basis risk as settlement is based on readings from on-farm weather stations. Magnitude depends on the peril and location, as well as how well the technology works for detecting problems with the data. If the technology sometimes fails to detect problems or reports problems that do not exist, some basis risk will remain. Also does not address index basis risk. | Expected to decrease basis risk. Similar to TPAWS except that data from the weather stations will likely be more reliable and made available more widely. | Expected to reduce basis risk, but magnitude uncertain. |
| **Farmer transaction costs (index products)** | Expected to materially decrease for farmers who have an on-farm weather station. Many farmers interviewed stated that they currently need to spend several hours calibrating settlement data with readings from on-farm weather stations when assessing index products. Using data from on-farm weather stations would avoid this cost. | Not expected to materially decrease farmer transaction costs as most farmers will still want to calibrate. | Not expected to materially decrease farmer transaction costs as most farmers will still want to calibrate. |
| **Insurer cost of risk (index and indemnity products)** | Ambiguous. All options increase the overall availability of data, which can help insurers to better understand the risks being insured. This can reduce the cost of risk to insurers. On the other hand, TPAWS integration and AWS network extension can mean that policies are written based on new weather stations that have less data than existing stations. This has the opposite effect, especially in the short run before the new datasets have covered a sufficient historical time period. | | |

Table 25 Assumptions for the TPAWS integration scenario (index products)

| Parameter | Value | Difference from future base |
|---|---|---|
| **Farmer transaction costs** | $1,787 per year<br>[$1,923, $1,650] | -$273 per year |
| **Probability of payout in drought year** | 92.5%<br>[88.8%, 96.3%] | +7.5 points |
| **Probability of payout in rain year** | 2%<br>[3%, 1%] | -2 points |
| **Loss ratio** | 0.675<br>[0.658, 0.693] | No change |
| **Stamp duty** | 3% | No change |
| **Subsidy** | 0% | No change |

Source Aither analysis.

Note Square brackets show values for lower and upper bound scenarios.

### *Impact on insurance market*

Aither modelled the agricultural weather insurance market with and without the integration of trusted private automatic weather stations (Table 26). By reducing farmer transaction costs and basis risk, the integration of trusted private automatic weather stations increases the benefits of insurance to farmers (Section 5). This is estimated to increase uptake from about 1,400 farmers without integration to between 1,400 and 2,700 farmers with integration.[16] We also estimate an increase in premiums paid by farmers from about $130 million per year without integration to between $150 million and $420 million per year with integration.

[16] This range of estimates only account for the range of assumptions underpinning the model scenarios. There are further uncertainties associated with the model itself which are not reflected here, but are addressed in the sensitivity analysis subsection.

Table 26 Estimated insurance market outcomes for TPAWS integration (index products)

| | | Future base | Climate and weather data | Difference |
|---|---|---|---|---|
| Payout ratio | $ claims/dollar of premiums | 0.66 | 0.66 [0.64, 0.67] | 0% |
| Uptake | number of farmers | 1,368 | 2,735 [1,368, 2,735] | 100% |
| Premiums paid | $ million/year | 127 | 302 [151, 417] | 137% |

Source Aither modelling.

Note Square brackets show values for lower and upper bound scenarios.

### *Benefits and costs*

The reductions in farmer transaction costs and basis risk benefit farmers (Table 27). We estimate that the benefits of integration to farmers are between $3 million and $51 million per year. There is also an increase in net tax revenue as a result of stamp duty on increased premiums paid. Overall, we estimate that integrating the trusted private automatic weather stations would generate a benefit to Australians of between $5 and $60 million per year. This excludes the potential benefits from having more granular weather data, such as improved community safety from better flood modelling.

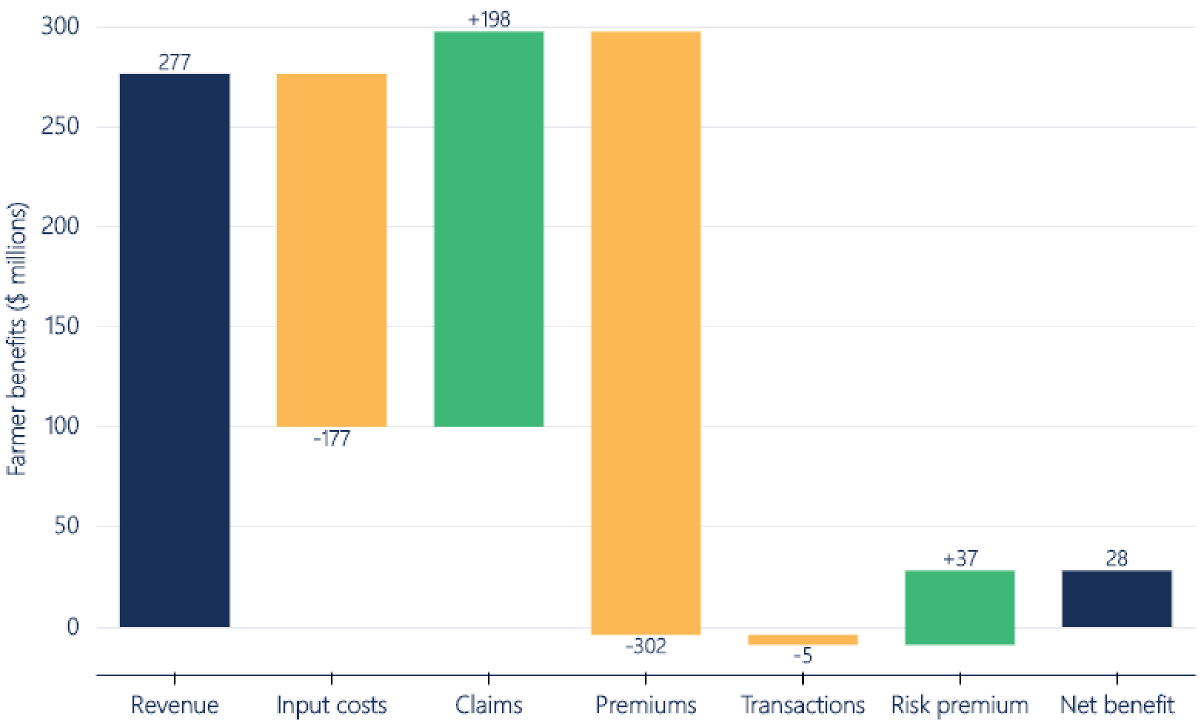
Even under the lower bound scenario, the benefits of integration are likely to outweigh the costs. The estimated upfront costs of integration are about $1.2 million (BoM 2018), with a further $6.8 million to install reliable private weather stations under the lower bound scenario. This assumes that half of insured farmers install a weather station at an upfront cost of $10,000 per station. Hence, with any plausible discount rate the upfront costs ($8 million), which account for the bulk of costs, are likely to be paid back within two years.

Table 27 Estimated benefits relative to no insurance for TPAWS integration (index products)

| | | Future base | Climate and weather data | Difference |
|---|---|---|---|---|
| Farmer benefit | $ million/year | 7 | 28 [10, 58] | 320% |
| Net tax revenue | $ million/year | 4 | 9 [ 4, 12] | 137% |
| Total | $ million/year | 10 | 37 [15, 70] | 255% |

Source Aither modelling.

Note Square brackets show values for lower and upper bound scenarios. Dollar values are rounded to the nearest million.




Source Aither modelling.

Figure 26 Disaggregation of estimated farmer benefits for TPAWS integration (relative to no insurance)

### 8.3.3. Digital insurance platform

#### *Summary*

There might be a case for government investment in a digital insurance platform. Initially this could involve a website that provides reliable and clear information on agricultural weather insurance products. While not warranted initially, there is a possibility that this could be expanded over time, as the insurance market grows, to include a product assessment tool and insurance exchange. We estimate that a digital insurance platform with all of the features described above would generate a benefit to Australians of between $1 million and $30 million per year. The wide range of possible benefits is consistent with experiences of digital insurance platforms in other contexts, with examples of both large successes and large failures. This excludes the costs of developing and maintaining the platform, which could be substantial.

#### *Impact on barriers*

The shortlisted intervention options for a digital insurance platform have the potential to address several barriers to the uptake and provision of insurance, especially farmer transaction costs, a lack of product awareness, and insurer transaction costs (expenses). Our assessment of the specific impacts of the shortlisted intervention options is summarised in Table 28, and further explored in the subsections that follow.

Table 28 Degree to which barriers are overcome for each digital insurance platform option

| | Information and awareness | *Plus:* Product assessment tool | *Plus:* Insurance exchange |
|---|---|---|---|
| Farmer transaction costs | Provides static information on insurance products. Reduces time required for initial research into products but is limited in its ability to help farmers assess the value of products. | Reduces time required for research and assessment by providing information about different products and bespoke application to farmer circumstances. | Allows farmers to request quotes from insurers based on preferred scenario. Significantly reduces time required to receive and compare quotes for products and enables cost savings through identification of the lowest cost provider. |
| Lack of product awareness | Likely to increase awareness of different insurance products and their suitability, conditional on high visibility and accessibility of the platform. | May increase awareness incidentally through increasing visibility of the platform. | May increase awareness incidentally through increasing visibility of the platform. |
| Insurer costs (expenses) | May be some reduction in marketing component of transaction costs. | Likely to be a reduction in time required by insurers and brokers, with potential for reduced commission costs over time. | Likely to be a reduction in time required develop quotes, however each insurance policy would still need to be approval. Potential for costs associated with participating in the insurance exchange. |

### Farmer transaction costs

A digital insurance platform with information and awareness functionality is likely to reduce transaction costs to farmers by providing a learning pathway which is comprehensive, independent, and freely accessible. Accessible information from an independent source about insurance products and their benefits in different scenarios is currently limited in Australia. Current learning pathways are either costly (brokers, advisers, educational programs), reliant on the knowledge of a third party (brokers, advisers, word-of mouth), or potentially incomplete. This can contribute to high transaction costs.

The addition of product assessment tools would significantly reduce the time required for assessment. First, provision of information including historical settlement data (such as local rainfall), hypothetical historical payouts, independent ratings and tips for assessment (for example, tips on how to assess insurance by comparing past cash flows with and without insurance) would help farmers understand what assessment process they could undertake and increase the efficiency of the process. Second, these options are likely to significantly decrease time required to arrange quotes. The time required for a skilled user to generate quotes using existing product assessment tools (such as the Hillridge platform) is typically around 10 to 15 minutes. In contrast, quote generation and policy structuring through a broker may take 1 to 2 hours per quote, and the full process is more likely to stretch across multiple days or weeks.

The addition of an insurance exchange would allow farmers to efficiently identify a provider that could offer the best policy for their circumstances (of those on the exchange). Our consultations revealed that different insurers can offer vastly different prices for the same policy (peril, location, season, and so on). These differences can be driven by various factors, such as insurers' assessment of risk. An insurance exchange could help to reduce the time required to identify the best policy.

Hence, a digital insurance platform with all of the functionality described above could significantly reduce time required by farmers to research, assess, and purchase insurance products. The platform may also result in lower requirements for external assistance from advisers. However, farmer transaction costs will not be eliminated.

A digital insurance platform will not be able to provide all of the information required for farmers to assess the value of insurance products. For example, in context of index products, the platform may be limited in its ability to help farmers understand the relationship between weather perils and yields for their specific farm. For example, many almond producers interviewed were unsure about the implications of frost events on yields and revenue, and were therefore hesitant to purchase an index product. A digital insurance platform, as defined in this report, would not be able to materially help to address this issue.

In addition, many farmers were uncertain about the best way to assess the merits of various products. As a result, most farmers interviewed stated that they prefer face-to-face engagement on important issues, such as insurance, which require significant investment and detailed assessment. This is currently provided by brokers, and to some extent farm advisers, who help farmers to understand the application of insurance for their specific circumstances, given the complexity of the products. It is also critical that settlement terms are understood, which often requires third-party advice. For these reasons, it is unlikely that a digital platform would eliminate dependence on brokers and advisers, especially in the short term.

The impact on farmer transaction costs, and the barriers covered below, also depends on the extent to which the platform is used by farmers and insurers. During consultations, some insurers stated that they would not participate in a platform that allowed farmers to compare insurers.

### Awareness of insurance products

The impact of the digital insurance platform on farmer awareness of insurance products is likely to depend on the success of the platform. This will be influenced by the marketing of the platform. Additionally, a platform that includes interactive elements such as a product assessment tool or insurance exchange is more likely to attract visitors and increase product awareness. This is supported by the views of interviewed farmers, who expressed interest in using tools which allow them to assess of different insurance products.

The platform could also have a material impact on advisors' awareness of insurance products. Industry sources have stated that advisors generally have had limited involvement in the advocacy of agricultural weather insurance. Through the National Survey, Sub-Project 4 found that only 13 per cent of farm financial advisors surveyed provide clients with advice on agricultural weather insurance.

#### Insurer costs (expenses)

A digital insurance platform could reduce insurer transaction costs. Lower transaction costs for insurers largely depends on whether the platform allows farmers make insurance decisions with less support from insurers and brokers, who are paid by insurers through commissions.[17] It is expected that an insurance platform with information and awareness functionality alone would not materially decrease farmers' need for external assistance. However, there may be some reduction in marketing costs. As discussed above, an insurance platform with full functionality could reduce the need for external assistance, but it would not eliminate it. This could be partially offset by the costs of participating in an insurance exchange.

#### Modelling assumptions

Aither modelled the digital insurance platform with full functionality. The intervention is assumed to reduce farmer transaction costs by $922 per year (to $1,138 per year) (Table 29). It is also assumed to increase the loss ratio, through reduced insurer and broker costs, by 0.035 (to 0.71). As per the previous intervention, we have included lower and upper bound scenarios as defined by the values in the square brackets in Table 29.

Table 29 Assumptions for the digital insurance platform scenario (index products)

| Parameter | Value | Difference from future base |
|---|---|---|
| **Farmer transaction costs** | $1,138 per year<br>[$1,830, $447] | -$922 per year |
| **Probability of payout in drought year** | 85% | No change |
| **Probability of payout in rain year** | 4% | No change |
| **Loss ratio** | 0.710<br>[0.675, 0.745] | +0.035 |
| **Stamp duty** | 3% | No change |
| **Subsidy** | 0% | No change |

Source Aither analysis.

Note Square brackets show values for lower and upper bound scenarios.

### *Impact on insurance market*

Aither modelled the agricultural weather insurance market with and without a digital insurance platform with full functionality (Table 30). By reducing farmer transaction costs, the digital insurance platform increases the benefits of insurance to farmers (Section 5). At the same time, the digital

17 Anecdotal evidence suggests that brokers may be unwilling to reduce their commission even in circumstances where their involvement is reduced. However, if the market develops, longer term competitive pressures could drive down commissions.

platform reduces the costs to insurers (as reflected in the loss ratio), which reduces the price of insurance.[18] This is estimated to increase uptake from about 1,400 farmers without the digital insurance platform to between 1,400 and 2,700 farmers with the platform. We also estimate an increase in premiums paid by farmers from about $130 million per year without the digital insurance platform to between $130 million and $290 million per year with the platform.

Table 30 Estimated insurance market outcomes for the digital insurance platform (index products)

| | | Future base | Digital insurance platform | Difference |
|---|---|---|---|---|
| Payout ratio | $ claims/dollar of premiums | 0.66 | 0.69 [0.66, 0.72] | 5% |
| Uptake | number of farmers | 1,368 | 2,394 [1368, 2735] | 75% |
| Premiums paid | $ million/year | 127 | 216 [127, 290] | 70% |

Source Aither modelling.

Note Square brackets show values for lower and upper bound scenarios.

### *Benefits and costs*

The reductions in farmer transaction costs and the price of insurance benefit farmers (Table 31). We estimate that the benefits of a digital insurance platform with full functionality to farmers are between $0 million (after rounding) and $24 million per year. There is also an increase in net tax revenue as a result of stamp duty on increased premiums paid. Overall, we estimate that the digital insurance platform would generate a benefit to Australians of between $1 and $30 million per year. The wide range of possible benefits is consistent with experiences of digital insurance platforms in other contexts, with examples of both successes and failures.

The cost to develop and maintain a digital platform would vary greatly depending on functionality. The development and maintenance of information and awareness functionality is not expected to be particularly complex or costly. As a result, the benefits of a website that provides reliable and clear information on agricultural weather insurance products are reasonably likely to outweigh the costs, even given the current scale of the agricultural weather insurance market.

At the other end of the spectrum, the development and maintenance of an insurance exchange could be expensive. For example, insurers will often have different policy structures and terms and conditions, resulting in variability of insurance product offerings. This introduces substantive complexity into the creation of a platform that can adequately capture this level of detail. A digital insurance platform would be less complex to implement if insurance contracts were standardised in some way. This is common, often regulated, for retail insurance products in order to allow the consumer to accurately compare policies. However, standardisation can make it more difficult for farmers to get insurance products that meet their specific needs. In our view, the costs of additional

[18] The extent to which changes in insurer costs are passed on farmers depends on several factors, including the market structure. These estimates assume a competitive market structure, but the sensitivity analysis below repeats the analysis under the other extreme case – a monopoly insurer or several colluding insurers.

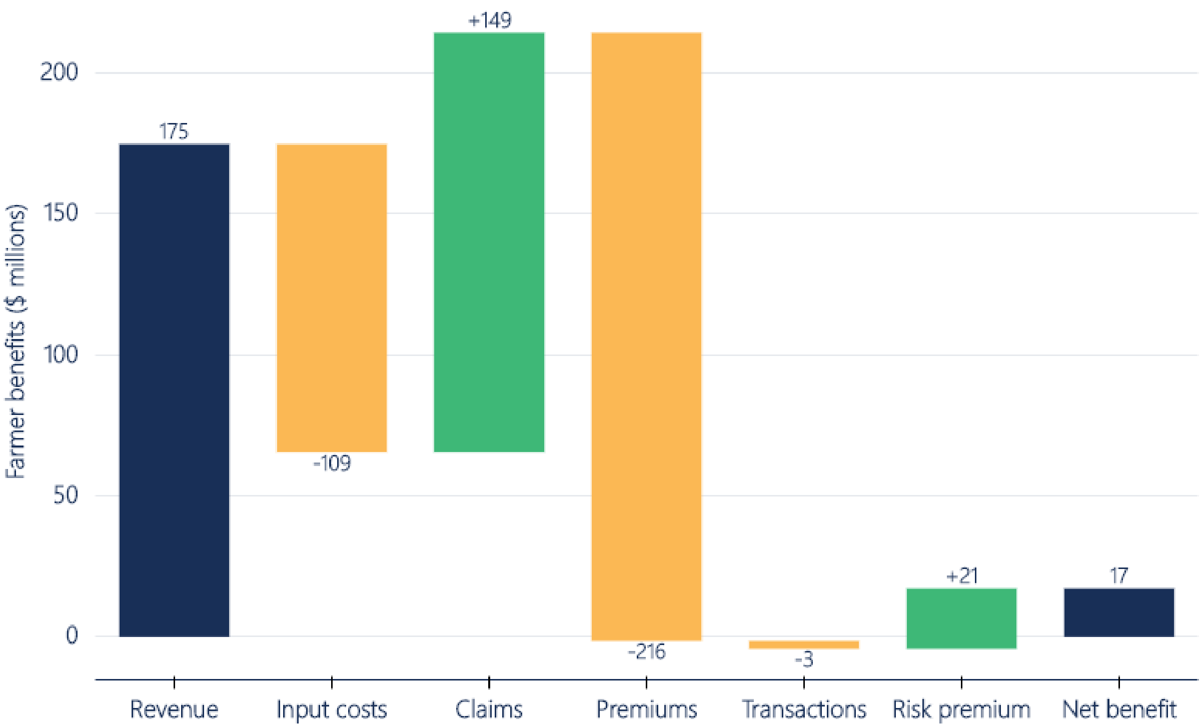
functionality, either assessment tools or an insurance exchange, are very likely to outweigh the benefits. However, this could change if the scale of the agricultural weather insurance market increases.

Table 31 Estimated benefits relative to no insurance for the digital insurance platform (index products)

| | | Future base | Digital insurance platform | Difference |
|---|---|---|---|---|
| Farmer benefit | $ million/year | 7 | 17 [7, 31] | 155% |
| Net tax revenue | $ million/year | 4 | 6 [4, 8] | 70% |
| Total | $ million/year | 10 | 23 [11, 40] | 125% |

Source Aither modelling.

Note Square brackets show values for lower and upper bound scenarios. Dollar values are rounded to the nearest million.




Source Aither modelling.

Figure 27 Disaggregation of estimated farmer benefits for the digital insurance platform (relative to no insurance)

### 8.3.4. Government provision of reinsurance

#### *Summary*

The merits of government provision of reinsurance without subsidies are unclear. Further research would be required to understand several issues, including the extent of risk that Australians would be exposed to as a result of government reinsurance and the cost of that risk. We estimate that government reinsurance could generate a benefit to Australians of up to $8 million per year. However, the benefits are likely to be smaller and could be negative (that is, costs). In our view, these results are not promising enough to warrant further investigation at this stage, especially given the complexity and risks associated with developing a government reinsurance scheme. This should be reconsidered if the agricultural weather insurance market grows substantially.

#### *Impact on barriers*

Government provision of reinsurance without subsidies has the potential to affect the costs of reinsurance, which accounts for a significant proportion of the most insurers' cost of risk. The provision of reinsurance requires capital and governments may be able to access capital at lower cost than private reinsurers. This is because governments may be less likely to default. This is evident in differences between yields at the time of writing for Australian Government bonds (1.2 per cent for 15-year bonds) and equivalent bonds issued by reinsurers (for example, 2.75 per cent for QBE 16-year bonds).

However, as discussed by Quiggin (1997), this is only one piece of the puzzle. Governments' ability to access capital at lower cost than private reinsurers is primarily a consequence of its ability meet its obligations, if required, through measures such as raising taxes. As a result, the government provision of reinsurance exposes Australians to additional risk. The cost of this additional risk needs to be taken into account. Also, there is more to reinsurance than just supplying capital. Even if governments have a lower cost of capital, they may be less efficient at the provision of reinsurance for several reasons, including the absence of a profit motive. The relative efficiency of provision would also need to be considered.

Addressing these issues definitively would require a detailed investigation. As an alternative, we have undertaken a threshold analysis, where we have applied the largest plausible reduction in the costs of reinsurance, 50 per cent. The benchmarking reported in Section 5 indicates that reinsurance costs are generally about 5 per cent of premiums for index products. Hence, the upper bound scenario for the threshold analysis is a 0.025 increase in the loss ratio (to 0.700) (Table 32).

Table 32 Assumptions for the government reinsurance threshold analysis (index products)

| Parameter | Value (upper bond) | Difference from future base (upper bound) |
|---|---|---|
| **Farmer transaction costs** | $2,060 per year | No change |
| **Probability of payout in drought year** | 85% | No change |
| **Probability of payout in rain year** | 4% | No change |
| **Loss ratio** | 0.700 | +0.025 |
| **Stamp duty** | 3% | No change |
| **Subsidy** | 0% | No change |

Source Aither analysis.

### *Impact on insurance market*

Aither modelled the agricultural weather insurance market with and without government provision of reinsurance without subsidies based on an upper bound scenario (Table 33). Under this scenario, the costs to insurers decrease (as reflected in the loss ratio), which reduces the price of insurance. This is estimated to increase uptake from about 1,400 farmers without government provision to about 2,100 farmers with government provision. We also estimate an increase in premiums paid by farmers from about $130 million per year without government provision to $190 million per year with government provision.

Table 33 Estimated insurance market outcomes for the government reinsurance threshold analysis (index products)

| | | Future base | Government reinsurance (upper bound) | Difference (upper bound) |
|---|---|---|---|---|
| Payout ratio | $ claims/dollar of premiums | 0.66 | 0.68 | 3% |
| Uptake | number of farmers | 1,368 | 2,052 | 50% |
| Premiums paid | $ million/year | 127 | 191 | 50% |

Source Aither modelling.

### *Benefits and costs*

The reduction in the price of insurance under the upper bound scenario benefits farmers (Table 34). Under this scenario, we estimate that the benefits of government provision of reinsurance without subsidies to farmers are $5 million per year. There is also an increase in net tax revenue as a result of stamp duty on increased premiums paid. Overall, we estimate that government provision would generate a benefit to Australians of $8 million per year.

However, as discussed above, these are upper bound estimates. The benefits are likely to be smaller and could be negative (that is, costs). In our view, these results are not promising enough to warrant further investigation at this stage, especially given the complexity and risks associated with developing a government reinsurance scheme. This should be reconsidered if the agricultural weather insurance market grows substantially.

Table 34 Estimated benefits relative to no insurance for the government reinsurance threshold analysis (index products)

| | | Future base | Government reinsurance (upper bound) | Difference (upper bound) |
|---|---|---|---|---|
| Farmer benefit | $ million/year | 7 | 12 | 80% |
| Net tax revenue | $ million/year | 4 | 6 | 50% |
| Total | $ million/year | 10 | 18 | 70% |

Source Aither modelling.

Note Dollar values are rounded to the nearest million.

## 8.4. Assessment of response options for index products

### 8.4.1. Targeted response option

The previous subsection assessed the consequences of four government interventions. Of these, at least three are likely to be worthwhile in the sense that the overall benefits are likely to exceed the costs. These relate to:

- removal of stamp duty on agriculture
- climate and weather data and use
- digital insurance platform.

Together, these interventions could be bundled into a **targeted response option**.

The agricultural weather insurance market model was used to estimate the combined effects of the interventions that comprise the targeted response option on the insurance market. By addressing several demand and supply side barriers, the targeted response option is estimated to increase uptake from about 1,400 farmers without the option to between 2,400 and 8,200 farmers with the option (Table 35). This is a material increase, especially given the current scale of the market. However, it is still less than 10 per cent of farmers.

Table 35 Estimated insurance market outcomes for the targeted response option (index products)

| | | Future base | Targeted response | Difference |
|---|---|---|---|---|
| Payout ratio | $ claims/dollar of premiums | 0.66 | 0.71 [0.66, 0.76] | 8% |
| Uptake | number of farmers | 1,368 | 3,761 [2,394, 8,206] | 175% |
| Premiums paid | $ million/year | 127 | 446 [222, 833] | 251% |

Source Aither modelling.

Note Square brackets show values for lower and upper bound scenarios.

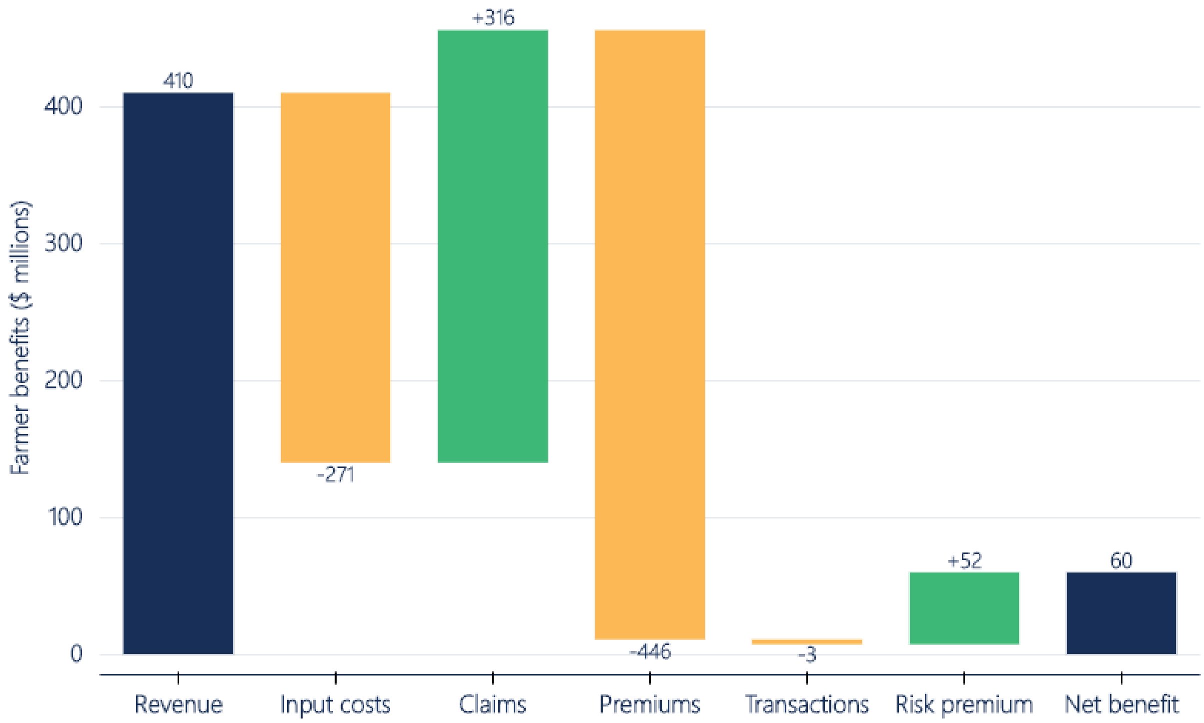
Table 36 shows that the potential benefits are also material. However, as discussed above these estimates are not comprehensive and exclude some relevant benefits and costs.

Table 36 Estimated benefits relative to no insurance for the targeted response option (index products)

| | | Future base | Targeted response | Difference |
|---|---|---|---|---|
| Farmer benefit | $ million/year | 7 | 60 [16, 140] | 794% |
| Net tax revenue | $ million/year | 4 | 0 [0, 0] | -100% |
| Total | $ million/year | 10 | 60 [16, 140] | 475% |

Source Aither modelling.

Note Square brackets show values for lower and upper bound scenarios. Dollar values are rounded to the nearest million.




Source Aither modelling.

Figure 28 Disaggregation of estimated farmer benefits for the targeted response option (relative to no insurance)

### 8.4.2. Government subsidies

Our analysis suggests that a large subsidy would likely be needed for there to be widespread uptake of agricultural weather insurance in Australia. This is consistent with international experience – there are no examples of countries with widespread uptake in the absence of subsidies. To explore this issue, we added a 25 per cent subsidy on premiums to the targeted response option.

The subsidy reduces the price of insurance to farmers, which increases uptake. This increase is the scale of the agricultural weather insurance market is estimated to be large enough to reduce the costs of insurance.[19] Our best estimate is that adding a 25 per cent subsidy of premiums to the target response option would increase uptake from about 3,800 farmers to about 23,000 farmers, although there is considerable uncertainty around this estimate (Table 37).

19 Estimated uptake with the subsidy is about an order of magnitude greater than the future base. Praetz and Beattie (1980) estimate that an order of magnitude increase in the scale of an insurance market reduces costs by about 17 per cent. In the absence of more recent Australian evidence, we have assumed a 17 per cent reduction in the costs of insurance in this instance.

Table 37 Estimated insurance market outcomes for the targeted response option plus government subsidies (index products)

| | | Targeted response | Plus subsidies | Difference |
|---|---|---|---|---|
| Payout ratio | $ claims/dollar of premiums | 0.71<br>[0.66, 0.76] | 0.95<br>[0.88, 1.02] | 34% |
| Uptake | number of farmers | 3,761<br>[2,394, 8,206] | 23,251<br>[9,574, 83,773] | 518% |
| Premiums paid | $ million/year | 446<br>[222, 833] | 3,558<br>[1,096, 28,164] | 698% |

Source Aither modelling.

Note Square brackets show values for lower and upper bound scenarios.

The addition of a subsidy to the targeted response option would generate large benefits to farmers – potentially in the order of $340 million per year. However, this is dwarfed by the fiscal costs to government. Our best estimate of the fiscal cost of the subsidy is $1.2 billion per year (Table 38). As a result, there would be a significant net cost to Australians from subsidising agricultural weather insurance.[20]

The intuition behind this result is similar to the case of stamp duty. As discussed above, the imposition of taxes on insurance mean that some deals between farmers and insurers that otherwise would have been mutually beneficial do not proceed. The costs of taxes are the unrealised gains from trade. Subsidies are the opposite of taxes. With subsidies, some deals between farmers and insurers that otherwise would *not* have been mutually beneficial proceed. In this case, the costs of subsidies on insurance are the losses from trade, where the costs to insurers exceed the benefits to farmers.

Some stakeholders suggested subsidies as a temporary measure to allow the market to mature, and costs to decrease, before withdrawing the subsidy. We are not aware of any cases where this has happened in other countries, potentially highlighting the political challenge of removing established subsidies. There is also a practical challenge. As the subsidy is removed, the price of insurance will increase, and uptake will fall. The final equilibrium depends on the extent to which the reduction in costs brought about through increased scale are retained. If half of the reduction in costs are retained, based on our estimates, the sustained reduction in costs from this strategy would be about 8.5 per cent. This would generate ongoing benefits. However, they are likely to be small relative to the short run costs of using subsidies for a number of years to establish the market.

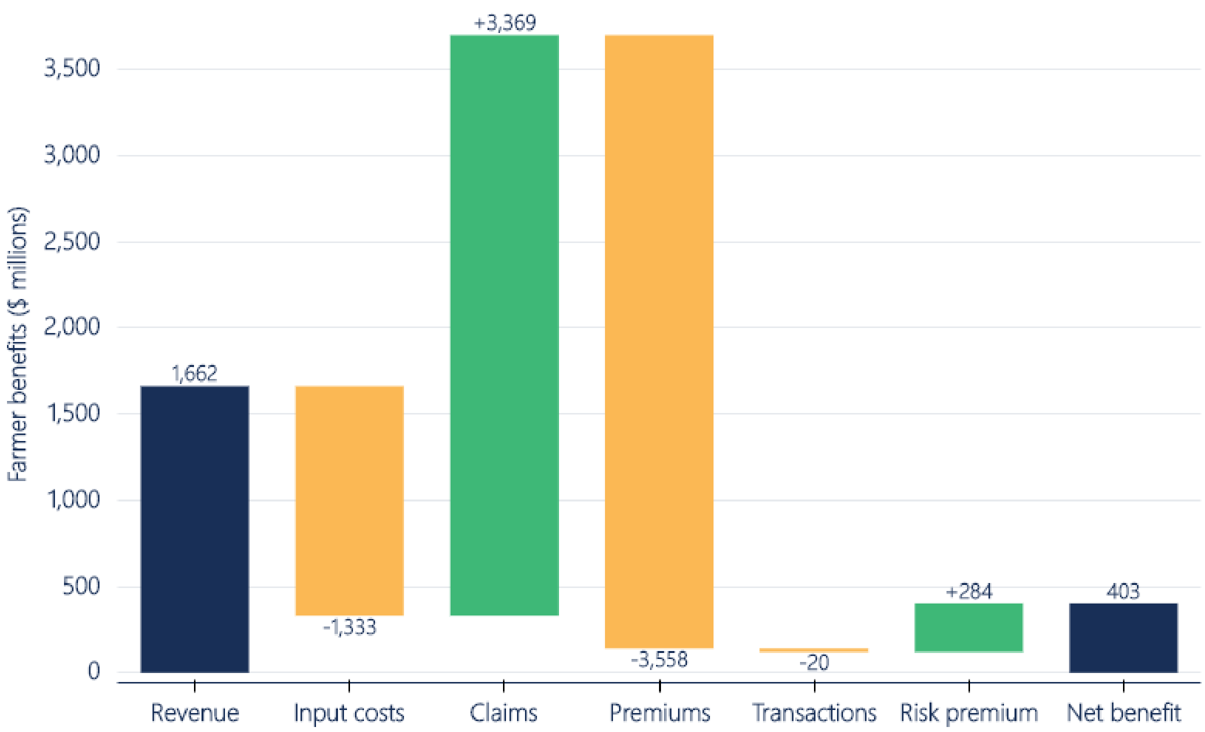
[20] These estimates account for the fact that other countries subsidise their agricultural sectors via the impact on commodity prices.

Table 38 Estimated benefits relative to no insurance for the targeted response option plus government subsidies (index products)

| | | Targeted response | Plus subsidies | Difference |
|---|---|---|---|---|
| Farmer benefit | $ million/year | 60<br>[16, 140] | 403<br>[172, 1,327] | 572% |
| Net tax revenue | $ million/year | 0<br>[0, 0] | -1,186<br>[-365, -9,388] | Not defined |
| Total | $ million/year | 60<br>[16, 140] | -783<br>[-193, -8,061] | -1405% |

Source Aither modelling.

Note Square brackets show values for lower and upper bound scenarios. Dollar values are rounded to the nearest million.




Source Aither modelling.

Figure 29 Disaggregation of estimated farmer benefits for the targeted response option plus government subsidies (relative to no insurance)

## 8.5. Further sensitivity analysis for index products

The previous subsections include sensitivity analysis around the scenarios run through the agricultural weather insurance market model. In particular, the extent to which the scenarios reduce the barriers to the uptake and provision of insurance. This subsection briefly explores the sensitivity of key results to more fundamental changes to the model.

The sensitivities tested in this subsection are:

- **High risk aversion**. As discussed in Section 5, farmers' risk aversion can affect the uptake of insurance. The model includes a parameter which controls average risk aversion. This parameter is estimated based on analysis of data from the National Survey. To explore the sensitivity of the results to high risk aversion, the value of this parameter was doubled.
- **Monopoly.** The extent of competition in the insurance market can affect insurance premiums and hence the uptake of insurance. The model includes the option to select different market structures. The previous runs assume a perfectly competitive insurance market. To explore sensitivity of the results to different market structures, the monopoly market structure was selected. This assumes that there is a single insurer or several colluding insurers. This is intended to be an extreme scenario to demonstrate the possible effects of different market structures – we are not aware of any evidence that insurers are colluding on pricing.

### *Sensitivity analysis results*

High risk aversion increases uptake by a factor of three in both the future base and targeted response option (Table 39 and Table 40). This is because farmers with greater risk aversion tend to benefit more from insurance. High risk aversion also increases the premiums paid.

Monopoly leads to a small increase in the price of insurance in the future base scenario and a large increase in the targeted response scenario (as indicated by the payout ratio). As a result, uptake is lower in both scenarios. Premiums paid are also lower, with the reduction in uptake outweighing the increase in price.

While these assumptions clearly affect the results, they are unlikely to fundamentally shift the conclusions of our analysis presented above. For example, in the targeted response scenario, there is a small but viable insurance market under all of the sensitivities tested.

Table 39 Estimated insurance market outcomes for the future base under high risk aversion and monopoly (index products)

| | | Central | High risk aversion | Monopoly |
|---|---|---|---|---|
| Payout ratio | $ claims/dollar of premiums | 0.66 | 0.66 | 0.63 |
| Uptake | number of farmers | 1,368 | 4,787 | 684 |
| Premiums paid | $ million/year | 127 | 267 | 44 |

Source Aither modelling.

Table 40 Estimated insurance market outcomes for the targeted response option under high risk aversion and monopoly (index products)

| | | Central | High risk aversion | Monopoly |
|---|---|---|---|---|
| Payout ratio | $ claims/dollar of premiums | 0.71 | 0.71 | 0.61 |
| Uptake | number of farmers | 3,761 | 10,600 | 2,394 |
| Premiums paid | $ million/year | 446 | 837 | 197 |

Source Aither modelling.

As discussed above, high risk aversion increases the benefits of insurance to farmers, whereas monopoly reduces the benefits to farmers due to increases in the price of insurance (Table 41 and Table 42). Under monopoly, insurers are estimated to receive profits (in excess of their risk adjusted cost of capital) of about $2 million per year under the future base and $27 million per year under the targeted response option. The aggregate benefits of insurance are greatest for the high risk aversion scenario and lowest for the monopoly scenario.

Table 41 Estimated benefits relative to no insurance for the future base under high risk aversion and monopoly (index products)

| | | Central | High risk aversion | Monopoly |
|---|---|---|---|---|
| Farmer benefit | $ million/year | 7 | 24 | 2 |
| Net tax revenue | $ million/year | 4 | 8 | 1 |
| Insurer benefit | $ million/year | 0 | 0 | 2 |
| Total | $ million/year | 10 | 32 | 5 |

Source Aither modelling.

Note Dollar values are rounded to the nearest million.

Table 42 Estimated benefits relative to no insurance for the targeted response option under high risk aversion and monopoly (index products)

| | | Central | High risk aversion | Monopoly |
|---|---|---|---|---|
| Farmer benefit | $ million/year | 60 | 137 | 14 |
| Net tax revenue | $ million/year | 0 | 0 | 0 |
| Insurer benefit | $ million/year | 0 | 0 | 27 |
| Total | $ million/year | 60 | 137 | 41 |

Source Aither modelling.

Note Dollar values are rounded to the nearest million.

# 9. Recommendations and conclusions

This section provides a summary of recommendations from prior sections along with final conclusions

Weather production risk is a defining characteristic of Australian agriculture and has presented farmers with acute and ongoing challenges. Managing this risk is inherent to farming in Australia and farmers have a range of production and financial risk management strategies available to them. Agricultural weather insurance is a potentially beneficial financial risk management strategy. While common in numerous countries and despite various attempts by insurers to develop a sustainable Australian market, agricultural weather insurance has had limited uptake in Australia. This project sought to identify and assess worthwhile government interventions to support the uptake of agricultural weather insurance in Australia.

Our assessment commenced with the identification and assessment of the key barriers to agricultural weather insurance uptake, including those that affect farmers' willingness to pay for insurance and insurers' willingness to provide insurance. The assessment demonstrated that there are material barriers to the uptake and provision of agricultural weather insurance. While there is substantial uncertainty, our best estimate is that given the barriers, agricultural weather insurance would currently only be worthwhile for about 1,000 farmers. While low compared to international standards, this is substantively higher than our best estimate of the current number of farmers using insurance in Australia.

We identified possible government interventions that could address the most material barriers, and shortlisted and analysed the interventions that were the most likely to provide material benefits for farmers and address a market failure or government distortion. Our assessment was evidenced by the development of an economic model of the agricultural weather insurance market that was used to simulate the market with and without the shortlisted government interventions. The model was driven by data gathered from the literature, a farmer survey and extensive consultation with relevant industry and government stakeholders, farmers, farm advisors and insurance and finance sector specialists. Using the model, we were able to determine the costs and benefits of each intervention and insurance market outcomes as evidenced by the change in loss ratio, uptake and premiums.

Based on our analysis we have identified several evidence-based targeted interventions that would support the uptake of agricultural weather insurance in Australia. Together, these interventions could be bundled into a targeted response option. Implemented together, we estimate that the uptake of agricultural weather insurance with these interventions could be between 2,400 and 8,200 farmers. This is an order of magnitude higher than current uptake, however, the upper bound estimate is still just 10 per cent of Australian farmers. As a result of this analysis, we recommend that:

- State governments should consider removing stamp duty and other insurance taxes on agricultural weather insurance.
- Government should continue to make investments into weather and climate data collection and use, through integration of private weather stations into gridded datasets and by other means.

- Government should not consider a digital insurance platform with full functionality at this time, but should revisit the intervention once agricultural weather insurance uptake increases. Provision of simple educational resources is still likely to be worthwhile.
- Government should not consider provision of insurance or reinsurance at this time, but should revisit the intervention if agricultural weather insurance uptake increases.

The only intervention we found would result in widespread uptake of agricultural weather insurance, beyond 10 per cent of Australian farmers, was the provision of a premium subsidy. Our best estimate is that adding a 25 per cent subsidy of premiums would increase uptake to about 23,000 farmers, although there is considerable uncertainty around this estimate. The subsidy would generate large benefits to farmers – potentially in the order of $340 million per year. However, our best estimate of the cost of the subsidy is $1.2 billion per year.

In addition to these findings and recommendations for government investment, several other important recommendations for farmers and industry were identified for consideration:

- As there are some farmers that could benefit from insurance under the current market, farmers and farm advisors should further investigate the benefits of agricultural weather insurance is they have not already done so. Government and industry bodies could also invest in additional information provision and promotion of the potential benefits of agricultural insurance.
- There are certain characteristics that determine whether a farmer is more of less likely to want insurance. Farmers that are untrusting of financial instruments, time poor, cost averse or that have high equity are less likely to want insurance. The insurance industry should focus on developing and targeting their products to specific segments of farmers, rather than trying to appeal to all farmers. This will assist insurers to reduce expenses, which are a significant supply-side barrier to insurance uptake.
- Banks and supply chain participants can influence agricultural weather insurance uptake and doing so may be beneficial to them. Banks should assess the feasibility and potential benefits of linking lending rates and requirements to have agricultural weather insurance. Supply chain participants should assess the feasibility and potential benefits of facilitating agricultural weather insurance delivery.
- The cost of risk is a large barrier to the provision of insurance in Australia, accounting for the majority of costs for both indemnity and index insurance. Industry sources have suggested the potential for the formation of a private risk pool between insurers to derive the benefits of a diversified insurance portfolio. The insurance industry could investigate the actual expected benefits of the formation of a risk pool to help reduce the cost of risk associated with a lack of diversification.
- Our assessment of the barriers found that there are lower barriers to uptake for index insurance products than indemnity insurance products, and a greater potential for index insurance products to benefit farmers. Consequently, we recommend that the insurance industry focus on the development of index insurance products.

This project has identified several targeted interventions and other recommendations for farmers, industry and governments. The nature and extent of the interventions and recommendations that are implemented are ultimately a matter for each of these stakeholders. For governments, increasing the uptake of agricultural weather insurance is not expected to be the primary objective and there may be other interventions and policies that governments could consider. Governments should, for example, consider the interventions and policy measures recommended in the other sub-projects for the *On-*

*farm financial risk management project*. An assessment of all potential options will support governments to develop a comprehensive strategy for investing to support the resilience and productivity of Australia's agricultural sector.

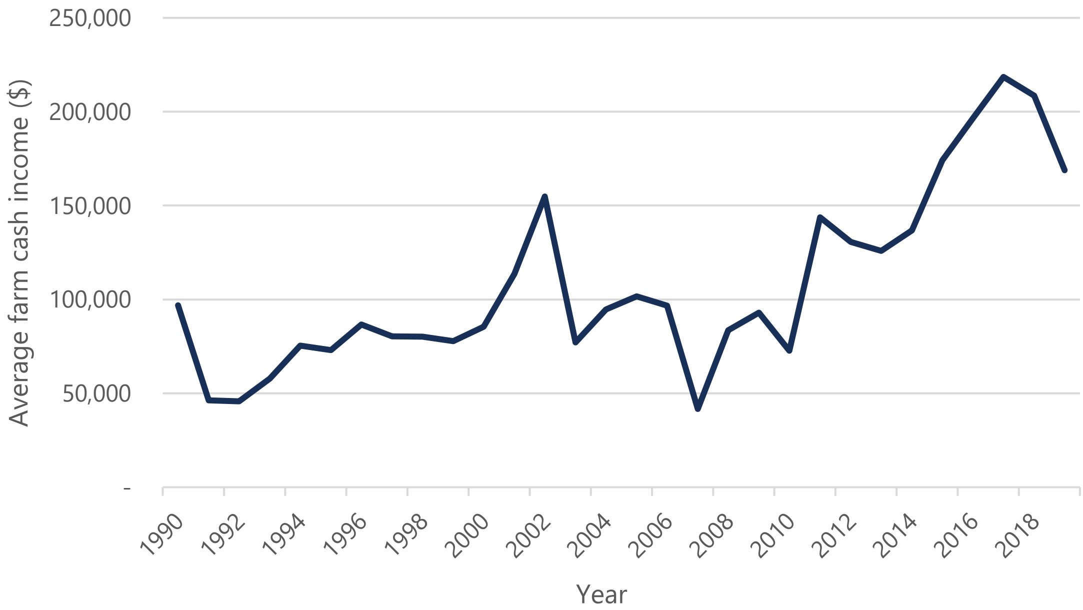
# Appendix A – Evidence of risk in Australian agriculture

This Appendix provides an overview of the overall magnitude and types of risks in Australian agriculture, with a focus on different types of weather production risks. This is important for understanding the challenges to Australian farmers in managing risk and hence the potential opportunities for expanding agricultural weather insurance.

## Australian agriculture is inherently volatile

### *Australian farmers are exposed to substantial risk*

Australian agriculture is characterised by a relatively high degree of risk, with substantial production and income volatility over time (Figure 30). ABARES farm survey data suggests that Australia wide, average annual farm cash income from 1990 to 2019 ranged from $42,000 to $219,000 with an average year-on-year swing of $22,000 (or 24 per cent) (ABARES 2020).




Source ABARES, 2020.

Figure 30 Average annual cash income for Australian farmers from 1990 to 2019

These estimates understate the true magnitude of risk faced by most Australian farmers. In particular, the farm income estimates presented above are aggregated for all Australian farmers. As discussed by Kimura et al (2010) and the United States Department of Agriculture (2017), aggregate statistics can mask considerable variation at the farm level. For example, in any one year, producers in one region might be thriving while producers in another might be incurring losses from local drought.

### *Agriculture has the greatest risk of all Australian industries*

The value of output for Australian agriculture is substantially more volatile than for other Australian industries (Productivity Commission 2005). In the four decades to 2012, agriculture recorded the greatest output volatility all industries – almost two and a half times the average of all Australian industries (Table 43) (Keogh 2012).

Table 43 Index of relative volatility in the value of output for Australian industries

| Industry | Whole period 1975-2011 | 1975-84 | 1985-94 | 1995-04 | 2004-11 |
|---|---|---|---|---|---|
| **Health care** | 46 | 56 | 48 | 34 | 29 |
| **Electricity, gas and waste** | 47 | 59 | 35 | 31 | 60 |
| **Public administration** | 49 | 53 | 51 | 50 | 45 |
| **Education and training** | 54 | 75 | 43 | 27 | 42 |
| **Transport** | 72 | 90 | 72 | 45 | 83 |
| **Rental and real estate services** | 73 | 64 | 88 | 77 | 102 |
| **Manufacturing** | 75 | 79 | 91 | 63 | 76 |
| **Retail trade** | 75 | 62 | 95 | 59 | 107 |
| **Professional services** | 97 | 67 | 132 | 116 | 83 |
| **Accommodation and food services** | 103 | 85 | 118 | 112 | 150 |
| **Administrative services** | 115 | 122 | 104 | 161 | 111 |
| **Wholesale trade** | 120 | 106 | 172 | 76 | 65 |
| **IT, media and telecommunications** | 120 | 167 | 53 | 64 | 65 |
| **Mining** | 128 | 159 | 108 | 124 | 122 |
| **Construction** | 134 | 94 | 162 | 200 | 116 |
| **Finance and insurance** | 157 | 106 | 208 | 87 | 153 |
| **Agriculture** | **234** | **257** | **120** | **374** | **293** |

Source Keogh 2012.

Note Index value set to 100 for industry average.

### *Australian agriculture is risky by international standards*

The value of output for Australian agriculture is also volatile by international standards. Keogh (2012) reported that in the four decades to 2012, Australian agriculture recorded output volatility of almost twice the international average for agriculture (Table 44). This suggests that Australian farmers have faced a more volatile operating environment than farmers in almost all other economically or agriculturally comparable nations.

Table 44 Index of relative volatility in the value of agricultural output across countries

| Country | Index value |
|---|---|
| Argentina | 135 |
| Australia | 186 |
| Brazil | 73 |
| Canada | 86 |
| Chile | 82 |
| Denmark | 43 |
| France | 74 |
| India | 89 |
| Mexico | 72 |
| Netherlands | 123 |
| New Zealand | 76 |
| Poland | 102 |
| South Africa | 98 |
| USA | 65 |
| Uruguay | 201 |

Source Keogh 2012.

Note Index value set to 100 for country average.

### *Some agricultural activities and regions are riskier than others*

There are differences in how risk plays out depending on farm type, outputs and systems. The Australian Farm Institute (2019) compared production volatility across a range of agricultural activities from 2001 to 2016. Grains and sheep meat consistently experienced much higher production volatility than other activities. Dairy farming was the least volatile activity, followed by pork and wool production (Table 45).

Table 45 Index of relative volatility in production for Australian agricultural activities 2001 to 2016

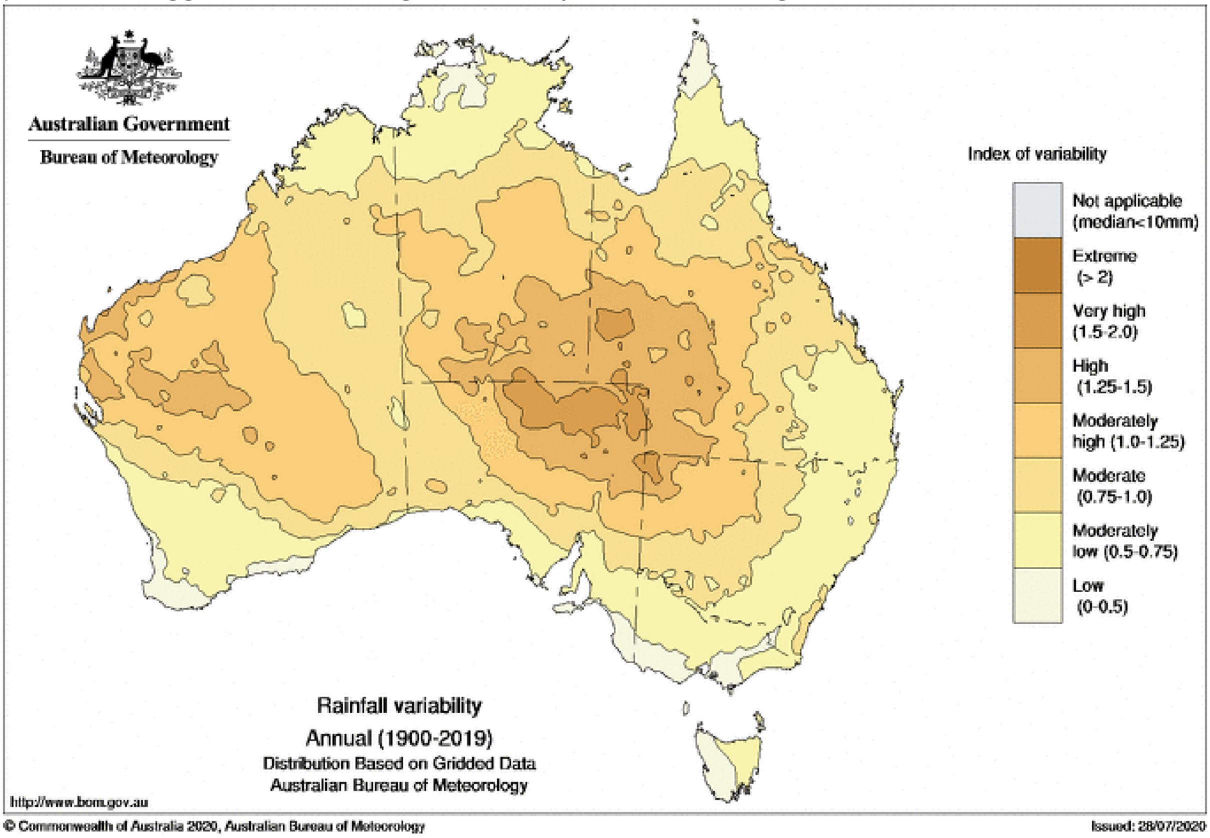
| Activity | Whole period 2001-16 | 2001-09 | 2010-16 |
|---|---|---|---|
| **Beef cattle** | 97 | 104 | 85 |
| **Sheep meat** | 215 | 202 | 248 |
| **Wool** | 43 | 46 | 39 |
| **Grains (wheat)** | 296 | 323 | 224 |
| **Cotton** | 115 | 78 | 173 |
| **Sugar** | 62 | 57 | 72 |
| **Dairy** | 34 | 27 | 46 |
| **Pork** | 39 | 46 | 30 |
| **Poultry (eggs)** | 55 | 81 | 35 |

Source AFI 2019.

Note Index value set to 100 for activity average.

Source Varying climate volatility across regions is also likely to contribute to differences in production volatility across regions. Bureau of Meteorology 2020.

Figure 31 shows that there are significant differences in the long-run variability of annual rainfall across Australia. Variability in the volatility of other climate factors, such as temperature or wind, also occurs across regions (CSIRO 2015). The importance of these climate factors for agricultural production suggests that some regions are likely to be risker for agricultural activities.




Source Bureau of Meteorology 2020.

Figure 31 Annual rainfall variability in Australia, 1900-2019

## Weather production risk in Australian agriculture

This subsection examines different types of weather production risks and their impacts on Australian farmers.

### Deficient rainfall

Deficient rainfall affects almost all production systems. The cost of consecutive failed crops or leaving land fallow for multiple seasons can be crippling to farm businesses, especially when the cost of seasonal inputs is high in relation to asset value. Livestock enterprises are generally less susceptible to individual rainfall events than crop production, however they can be vulnerable to missing rainfall events in some circumstances. Irrigated production systems are capital intensive businesses that highly susceptible to sustained rainfall deficits in storage catchment areas, which manifest as deficient inflow and water allocation outcomes.

### Excess rainfall

Excess rainfall can affect crop production in several ways. Winter cereal crops can suffer adverse yield or quality consequences through wet harvests, or the anaerobic environment caused by waterlogging. Excess rainfall during the grain filling period and throughout the harvest can result in pre-harvest sprouting, leading to price downgrades due to poor grain quality (BCG 2014). Excess rainfall can also affect cotton crops. Heavy or prolonged rainfall events are known to negatively affect lint colour and cause downgrades (The Australian Cottongrower 2017). High rainfall can also result in flooding of lowlands, which is common in parts of Queensland and can result in loss of livestock.

### Frost

Frost occurs when the ground and ambient air cools down through the loss of heat to the atmosphere. This commonly occurs under clear skies with little or no wind. Radiation frost begins at ground level and gradually rises to higher objects (BoM 2014). Frost injures plants by causing ice crystals to form in plant cells, making water unavailable to plant tissues and disrupting the movement of fluids (UC 2003). Plants can be susceptible to frost at different stages of their growth cycle. Different plants are also impacted in different ways. For example, cereal crops are most susceptible to frost damage during flowering and are also susceptible at the early booting and grain filling stages (GRDC, 2018). Nut trees such as almonds are most susceptible to frost during flowering and crop maturation. Frost damage from one year is also able to impact nut trees over multiple growing seasons. Citrus fruit harvests are also susceptible to frost damage, with frost able to rupture the citrus fruit from within, causing damage to the fruit (UC 2003).

### Extreme heat

Extreme heat has a range of effects on crop and livestock production. High temperatures can affect crops by decreasing a plants ability to photosynthesise, causing leaf senescence, decreasing pollen production and pollen viability, inducing seed abortion, and lowering grain number and gain weight (Siebert and Ewert 2014). These effects can be exacerbated when combined with windy conditions. Winter cereals during spring, summer crops such as cotton and sorghum, and summer fruit growth are all adversely affected by heatwaves. Extreme heat can also contribute to excessive heat load in livestock, which can lead to lethargy and lower production due to reduced food intake. In extreme cases, heat stress can result in livestock death (MLA 2020).

### Hail

Hail can cause enormous physical damage in agriculture, often resulting in widespread, sudden loss in harvestable produce, and at times entire loss of mature orchards. Falling hailstones and strong winds bend and break plants and strip them of leaves and bark. Hail can impact most crop production and can have significant impacts on horticulture. Cherry growing regions are highly affected by hail events, as well as many other fruit production systems.

The relative effect of these production risks on Australian farmers was assessed through a National Survey of farmers undertaken for this project (see Section 4 for detail on our methodology).

## *Deficient rainfall is the most important weather risk for most Australian farmers*

As part of the National Survey farmers were asked to nominate the most important weather production risk for their business. Of the weather production risks listed above (excluding hail), deficient rainfall was nominated by 81 per cent of survey respondents as the primary weather production risk affecting their business. A further 6 per cent nominated frost, with the remainder evenly split between excess rainfall, cyclones and extreme heat.

In interpreting the National Survey results it should be noted that there can be significant differences in the importance of weather production risk by location, even within a particular farming activity. For example, a northern Queensland cattle producer may be most concerned about floods, while a cattle producer in New England may consider low cumulative rainfall to be their most significant weather risk. Another example is the difference between winter cereal production in different locations. Winter cereal production in the north-east wheatbelt in Western Australia are typically reliant on growing season rainfall and are vulnerable to rainfall deficits during this period. Winter cereal production in higher rainfall zones in south-eastern Australia have much less exposure to rainfall deficit as south-east Australia has longer or wetter growing seasons and a higher likelihood of a full or partial moisture profile before sowing.

### *Weather production risks have a substantial impact on the incomes of Australian farmers*

The National Survey asked farmers what impact their primary weather production risk had on farm income (in the worst 10 per cent of years for that specific weather risk). The median reported impact was a 91 per cent decrease for all farmers (Table 46). While substantial, the reported decreases are smaller than that reported by ABARES (2020), who estimated a 154 per cent decrease for cropping farmers (with a profit of around $230,000 in a 'typical year' and a loss of around $125,000 in a 'dry year').

Table 46  Median income changes due to primary weather risk by activity

| Activity | Annual change per hectare | Percentage change |
|---|---|---|
| **Wheat** | -350 | -98% |
| **Barley** | -120 | -50% |
| **Cotton** | -700 | -96% |
| **Other broadacre** | -200 | -86% |
| **Beef cattle** | -150 | -96% |
| **Sheep** | -192 | -100% |
| **Wool** | -40 | -67% |
| **Other** | -300 | -90% |
| **All** | **-300** | **-91%** |

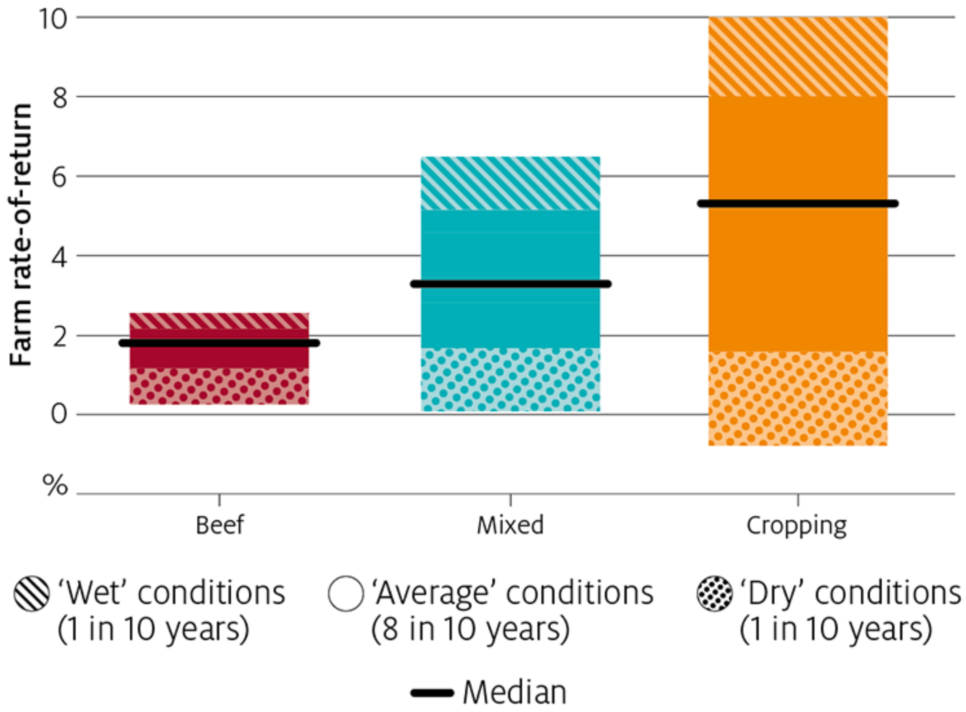
Source	National Survey results.

Note	Table includes all activities with at least five valid responses. 'All' covers valid survey responses for these activities.

### *Some agricultural activities are more exposed to weather production risk than others*

The National Survey also reveals differences between activities. The reported impact on farm income was highest for sheep (100 per cent decrease) and lowest for barley (26 per cent decrease). This result may be misleading due to a small sample size. The large impact for cotton (91 per cent decrease) mostly reflects the increasing costs of water allocations in years of low irrigation water availability.

The impact on some activities such as sheep production was higher than expected, given our case study interviews and the findings from ABARES (2020), which indicate that cropping enterprises are generally more exposed to climate risk than livestock enterprises. Figure 32 demonstrates the higher profit volatility (expressed by rate-of-return) for cropping compared to beef or mixed farming enterprises.



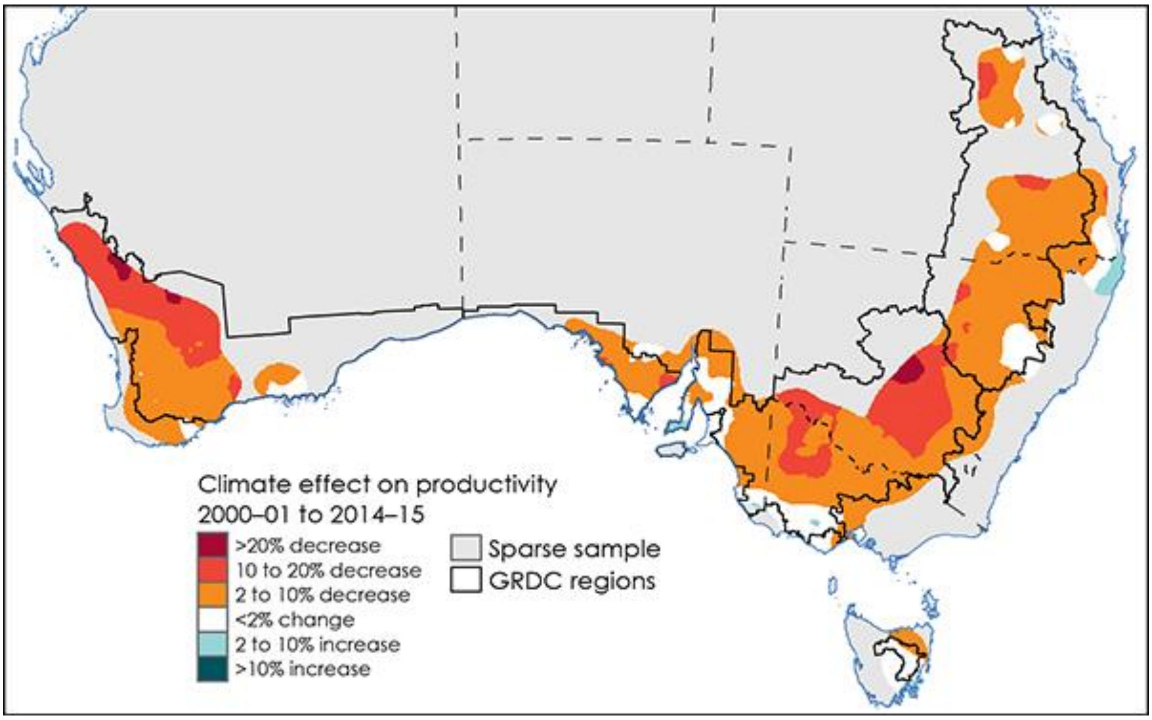

Source ABARES 2020.

Figure 32 Effect of climate variability on rates-of-return for Australian beef, mixed and cropping farms

### *Weather production risks are likely to increase due to climate change*

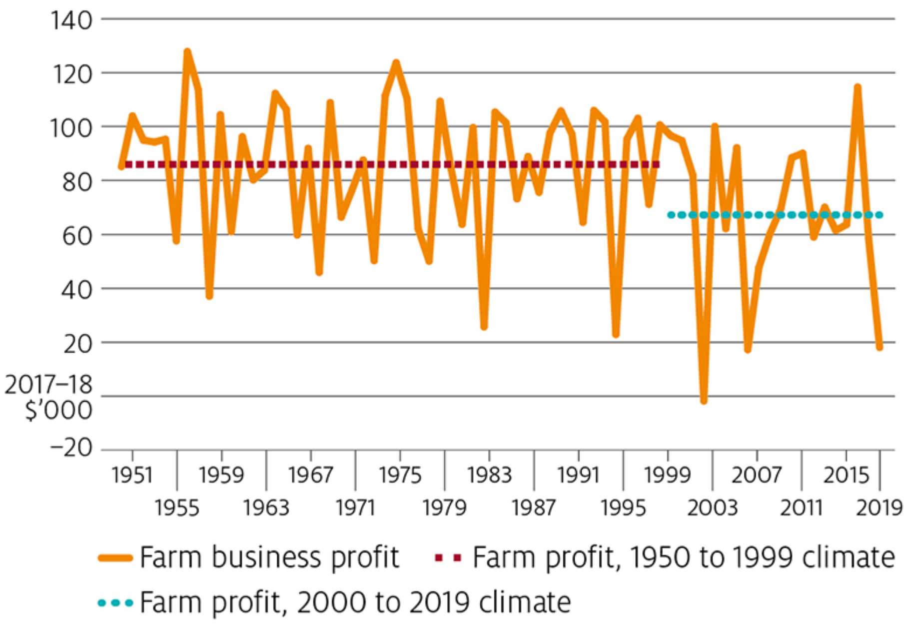
Climate change is predicted to increase the volatility of weather systems globally, which will increase weather production risks for Australian agriculture into the future. CSIRO (2018) estimates that April to October rainfall has decreased by around 20 per cent in south-west Australia since 1970. CSIRO also estimates a decline of around 11 per cent in April to October rainfall in south-east Australia since the late 1990s. CSIRO (2018) suggest Australia can expect to experience decreases in rainfall across southern Australia with an increase in droughts, as well as an increase in intense heavy rainfall throughout Australia. Increases in sea and air temperatures, with more hot days and marine heatwaves and fewer cool extremes, are also predicted.

These estimates are reflected in reduced agricultural productivity (relative to a baseline with no climate change) across most of south-west and south-east Australia (Figure 33). This change in productivity has implications for farm profits. ABARES (2020) suggest that changes in the climate since 2000 have reduced average annual broadacre (cropping and livestock) farm profits by 22 per cent, or around $18,600 per farm (Figure 34).




Source ABARES 2019.

Figure 33 Effect of climate on cropping productivity between 2001 and 2015 (relative to average conditions between 1915 and 2015)




Source ABARES 2020.

Figure 34 Effect of climate on average farm business profit from 1950 to 2019

# Appendix B – Case Study Overview

The following case studies (Table 47) have been selected for detailed analysis to understand the benefits of selected options to increase insurance uptake. These case studies have been selected to ensure they cover the most critical areas for assessment and include a range of different production systems and perils. They also represent a geographic spread of high value commodities across Australia, to allow the case study specific and generalised findings to be able to be extrapolated to the agriculture sector more broadly.

Table 47 High level summary of selected case studies and key characteristics

| Production system | Primary Perils | Focus locations | Key characteristics | Estimated commodity value* |
|---|---|---|---|---|
| Dryland winter cropping (wheat/barley) | Establishment rainfall deficit, finishing (spring) rainfall deficit, frost at flowering, and wet harvest. | Western Australia, SE Australia | Dryland, broadacre cropping | $10 billion (wheat / barley / canola) |
| Annual irrigated broadacre cropping (Cotton) | Sustained catchment rainfall deficit (24 months), wet cotton harvest (April/May), and deficient day degrees during establishment (late Sep-early Nov). | NSW Murrumbidgee | Irrigated, annual horticulture | $1 billion (cotton / rice) |
| Dryland summer and winter (double) cropping | Rainfall deficit (long term, fallow, and in-season), spring frost, spring heat, wet harvest (November-December or March-April), and sustained extreme heat (summer) | Northern NSW | Dryland, broadacre cropping | $10 billion (wheat / barley / canola) |
| Permanent irrigated horticulture (Almonds) | Sustained catchment rainfall deficit (24 months), frost (mid-August – early Oct), and spring heat (October-November). | North West Victoria | Irrigated, permanent horticulture | $5.5 billion (fruit and nuts) |
| Livestock production (Beef Cattle) | Deficient rainfall for the November to February pasture growth period. | New England | Livestock | $13 billion (cattle and calves) |

Note * ABS Gross Value of Agricultural Products 2018/19 for Australia

# Case Study 1: Dryland winter crop production – western and south-east Australia

Case study 1 focuses on the effects of deficient rainfall, frost and wet harvest on dryland winter crop production in the Western Australian wheatbelt and the south-east Australian wheat and sheep belt, including the Victorian Mallee and Wimmera, and New South Wales Riverina and Central West farming districts. While the focus of this study is on western and south-eastern Australia, components of the study are also applicable to South Australian and Tasmanian production. The primary crops of interest are of wheat, barley and canola, while oats, pulses, legumes and other crops may also be evident in these production systems.


Figure 35 The dryland winter crop production zone across western and south-east Australia.

## Introduction

Crop production in Australia is split into several major cropping regions that are dictated by climate and weather patterns – winter cereal cropping in SE Australia and WA, and doubling cropping systems (summer and winter cropping) in northern NSW and Southern Queensland.

Dryland winter crop production occurs across the Riverina and Central West regions of New South Wales, the Victorian Wimmera and Mallee regions and northern Victoria, the various cropping regions of South Australia, and the Western Australian wheatbelt. Crops produced include wheat, barley, oats, rye, triticale, canola, mustard, safflower and various pulses. Sheep and beef cattle grazing of both winter cereals and pasture is often included in these systems.

The area planted to winter crops in southern Australia in 2020-21 is forecast to be close to 22.5 million hectares producing a projected 44.5 million tonnes. Major crops include wheat, barley and canola, with close to 13 million hectares of wheat projected to be planted, 4.4 million hectares of barley and 2.4 million hectares of canola. Australian exports of winter cereal crops typically make up between 10 – 30 per cent of the global market, depending on crop type.

Recent production of dryland winter crops across southern Australia has been variable, with some areas affected by drought seeing reduced crop areas and yield, and other areas benefiting from favourable seasonal conditions that have resulted in significantly increased winter crop production.

### *Dryland winter crop production*

Dryland winter crop production occurs across southern Australia in regions that have traditionally been in winter dominant rainfall zones. Planting occurs between April – June, with crops sown into dry ground on the prospect of autumn and winter rain. Harvest can begin in late October through to early January, depending on the location.

Farmers may also incorporate a range of additional crops, such as legumes and pulses, or change their crop rotations from year to year to maximise on-farm agronomic benefit and revenue (GDRC 2009, Gan et al 2015, GDRC 2018). For example, the incorporation of lucerne in a cereal crop rotation has been found to increase what production and protein levels, and has benefits for soil health and fertilizer costs (NSW DPI, 2003). Similarly, producers may also incorporate livestock into their farming mix. Farming livestock in addition to winter cereal crops can provide farmers with an enterprise hedge against climate or price volatility, allow them to utilise land that is unsuitable for cropping, and increase farm profitability (Grain and Graze 2020).

Following harvest the supply chain for winter cereals includes storage and handling, freight and shipping. Storage and transport for cereals is dominated by a small number of bulk handlers, with a growing trend towards on-farm storage. The supply chain structure for wheat can vary considerably, and can include transport of outputs from farms to receival sites, from farms to port and on-farm storage.

Most winter cereal farms are family owned, however there is an increasing corporate presence. Corporate entities typically operate as asset owning landlords with operator tenants paying fixed leases, however there are also are corporate owner-operators. An increasing corporate presence is emerging as scale efficiencies are becoming increasingly important, resulting in many family run operations becoming unviable. As a result, many family businesses are seeking opportunities to increase the scale of their operations and are establishing family-corporate business systems, scale and operations. Doing so assists with labour and machinery efficiency.

Winter cereal production areas have also undergone significant capital growth in land values over the past decade, with the average annual growth in farmland median prices over the last 20 years ranging from between 5 to 7.7 per cent across Australia. Increased land values can impact the expansion opportunities available to smaller producers that do not have high equity, making it difficult to scale operations (GRDC 2019).

## Risk and risk management

### *Weather production risks*

The key perils for dryland winter crops include rainfall deficit both during crop establishment, finishing (in spring) and growing season rainfall, frost at flowering, spring heat and wet harvest. Crop germination and establishment can be restricted at the start of the growing season by rainfall deficit. Growth can also be affected at the end of the season by rainfall deficit, which may be further exacerbated by high temperatures. The yield effects of finishing rainfall deficit can be amplified when good autumn and winter rainfall has set a crop up for strong yield potential and encouraged grower investment in crop nutrition. Grain receivers are particularly exposed to substantial, regional scale rainfall deficits.

Dryland winter crop production flourishes in areas with predictable winter-spring rainfall patterns. The predictability of such rainfall patterns is changing, with rainfall becoming less winter-dominant and autumn and spring rainfall deficits becoming more common (CSIRO 2018), increasing farmers' reliance on capturing fallow soil moisture via rainfall from increasingly erratic summer storm activity. This is particularly concerning given climate conditions is one of the most dominant drivers of broadacre farm performance in Australia (ABARES 2019), compounding effects of recent drought across southern Australia. Climate change projections suggest that there will be an increasing likelihood of these events occurring.

Increasing dry periods also affect the likelihood of frost, including frost that occurs later in the production cycle. Frosts that occur during flowering can have an immediate and catastrophic effect on yield, particularly when a crop has high yield potential and high rates of fertiliser have been applied.

Wet harvest is another peril that affects dryland winter crop production as some crops are sensitive to waterlogging. Wet harvest is an issue from early November to December, and can impacts crops by decreasing the grain quality, decreasing yield and creating difficulties for harvesting with heavy machinery. The effect of wet harvest on grain quality is further magnified when the difference between grain and feed prices is large – if the quality of the grain is downgraded due to wet harvest it may only be able to be sold as feed.

### *Production strategies*

The key weather production risks that are the focus of this case study are rainfall deficit, frost, wet harvest and spring heat. There are several production strategies that farmers can use to mitigate the effects of these perils on their crop.

Production strategies that winter cereal producers use to deal with rainfall deficit include; soil and weed management practices that can conserve soil moisture from summer rainfall events, increasing yield, grain quality and soil health by utilising nutritionally beneficial crop rotations such as legumes, lupins and field peas, occasionally leaving land fallow, withholding planting until an establishing rainfall event arrives, incorporating low intensity livestock production systems to act as an enterprise hedge during drought, and planting more resilient (often lower value) crop varietals.

Production strategies that can help manage frost risk include; using a diverse spread of crop varieties that have a spread of planting windows, conservatively applying fertiliser and other crop inputs, planning more resilient (often lower value) crop varietals, and selecting planting windows to ensure critical periods of crop development are matched typical weather patterns to minimise yield loss.

More general strategies also include managing the geographic diversity of crop locations, to ensure that not all crops are likely to be affected by the same peril. On-farm storage of grain and feed is also commonly used for cropping enterprises to protect against price risk. At least one of the farmer's interviewed stores close to 20,000 tonnes of grain a year to smooth his income. Grains that are affected by frost or other perils can also be used as fodder for livestock. This strategy is also used is grain is performing poorly on the market.

### *Financial strategies*

There are a range of financial strategies farmers use to help mitigate the financial effects of production risk. Managing financial risk with a comfortable debt to equity ratio is one such strategy, and was found to be relatively common amongst farmers interviewed. Many family farms rely on maintaining high farm equity to allow them to borrow money to meet cash flow needs during times of low farm income, and when they need to make new investments. While farm debt has been increasing over the long-term, average farm equity for broadacre farmers remains strong due to increases in agricultural land value. ABARES (2020) reports that the average equity ratio for broadacre farms (including cropping and grazing) as at 30 June 2019 was estimated to be 89 per cent. Of all broadacre farm businesses at that time 84 per cent had an equity ratio above 80 per cent. The average equity ratio of farmers interviewed for this case study was slightly lower than that reported by ABARES. Farmers estimated their equity ratios as being between 65 to 80 per cent, with one farmer stating they actively begin to seek out new investment when their equity is close to 80 per cent.

Interviews revealed that another financial strategy used by some winter cereal farmers is on-farm storage. These farmers store a portion of their harvests, particularly in surplus years, and then sell in poor years or mid-season to reduce income volatility across and within years. For mixed farms, this strategy also mitigates production risk as stored fodder crops can be used to feed livestock in poor pasture years. One farmer interviewed commented that they were able to store up to two years of grain harvests on-farm.

Winter cereal farmers are also able to utilise crop marketing options such as forward production contracts to manage risk, however some farmers avoid forward contracts to minimise the risk of committing to a contract and then having to deal with crop failure. Forward production contracts allow farmers to utilise price hedging opportunities.

Winter cereal farmers also manage financial risk by diversifying their income stream using off-farm income and investments and making use of government assistance programs such as farm management deposits (FMDs).

# Insurance product use and uptake

## Indemnity products

Both named-peril and multi-peril crop insurance products are available for dryland winter cereal farmers to use to manage yield risk, however access to multi-peril crop insurance products is limited in 2020 (refer to Section 3.3 for further detail).

Evidence from the interviews on the uptake of indemnity insurance products broadly supports findings of low uptake from the National Survey, with multiple farmers commenting on low uptake due to cost, availability, and poor word of mouth amongst their communities. Most of the farmers interviewed had a range of views about multi-peril crop insurance. Some farmers expressed an interested in multi-peril crop insurance and had investigated getting it only to find it wasn’t available in their region, despite multi-peril crop insurance having been mainly targeted at winter cereal cropping and dryland double cropping regions when it was initially introduced. Other farmers thought multi-peril crop insurance was too expensive and complex for their needs.

A number of the interviewed farmers stated they did not see insurance as worth pursuing, with several expressing a lack of trust even in named-peril products. One farmer predicted he was losing money on named-peril insurance over the long-term due to high-premium levels, and was considering abandoning it, despite having received payouts in recent years. Most interviewed farmers did not currently have any form of insurance to manage risk on their farm, with the exception of farm pack insurance. This is consistent with data from the National Survey.

Despite these views, some interviewed farmers who had purchased multi-peril crop insurance and expressed contentment with past offerings, and indicated interest in purchasing multi-peril crop insurance products if they were to be widely available again. These farmers commented on the advantages of multi-peril crop insurance in enabling them to comprehensively cover risk with an easy to understand policy, and the benefits of increased confidence and investment capacity in poor years. One farmer commented that a significant payout in a poor year from multi-peril crop insurance allowed them to buy a sprayer and begin a sprayer business, increasing their diversification and resilience against weather risk in future years. Interestingly, some of these farmers have since looked at or purchased weather-index insurance or derivatives. These views indicate that niche appeal, rather than broad interest, still exists for multi-peril crop insurance products across dryland croppers.

### Index insurance products

Index insurance products are available for dryland winter cereal cropping and are able to cover the following options:

- total season rainfall from autumn to spring that is taken out early in the year
- spring deficit cover taken out in winter
- a 'multi' of establishment rainfall into spring rainfall, where growers take a position on establishment rainfall, the outcome of which determines their spring rainfall cover or a payout on failed establishment
- frost events, where low temperature can be used as a proxy
- extreme heat days
- wet harvest.

At a minimum, rainfall and temperature policies must be taken out approximately a month before the policy cover starts, with decisions on whether to take out insurance or not based on intra-seasonal factors such as yield potential, grain price dynamics, stored fallow moisture and frost risk. However, it should be noted that the number of products of the market is currently limited, and many have only been recently developed.

In terms of product uptake, the case study interviews revealed that current use of index insurance products by winter cereal farmers is low, which supports the findings from the National Survey on the low numbers of uptake of index products by farmers more generally.

The interviews revealed that some winter cereal farmers had investigated using index products, with some even going so far as to get quotes. However, most did not think that the cover was worthwhile in consideration of the price of the premium that was offered when compared to their view on risk of the peril. One farmer that had investigated index products stated that he found it difficult to determine what time period and perils he would be best placed to take out the insurance for – for example, whether it would be best to insure for growing season rainfall deficit versus inter-season rainfall deficit.

One farm advisor provided feedback that he had advised several winter cereal farmers about taking out index insurance, but that many of his clients found it difficult to link the indexed weather event to the effect it would have on their yield. Even after providing his clients with an analysis of the timing of rainfall and its correlation to yield, many of them still did not understand the product.

## Barriers to uptake

### Demand side barriers to insurance uptake

There are a range of demand-side barriers to insurance uptake that are common across production systems, and that are applicable to dryland winter cereal production. These barriers include:

- high costs (high premiums for both major product types and in some cases transaction costs for index products),
- a high appetite for risk,
- a lack of farmer understanding or awareness of available insurance products, and
- a distrust of products and insurers.

Dryland winter cereal producers are highly exposed to adverse weather risks relative to other production systems. Producers experience a high correlation between growing season rainfall and yield, particularly for producers in Western Australia, where crops are often sown into dry soil on the expectation of autumn-winter rainfall, and the financial consequences of crop failure can be significant. The low rainfall zones of SE Australia face a similar risk profile. Frost, wet harvest, and extreme heat in spring can also result in yield or quality losses. As a result, a lack of risk exposure is not seen to be significant barrier to insurance uptake.

Alternative production risk management strategies are not as extensive for dryland winter cereal producers compared with other sectors. The production system excludes capital-intensive risk management strategies such as irrigation, the de-stocking or feeding option available in livestock enterprises, or producing two crops in one year as occurs in rain producing areas of northern New South Wales. Competing financial risk management strategies are also more limited compared with other sectors. Despite dryland winter cereal producers maintaining high equity ratios, many still spend a significant portion of their total equity value annually on seasonal inputs. A failed crop can therefore put these businesses into a precarious position where they are unable to draw down on cash or other assets if consecutive poor years were to occur.

The barrier of complexity, while still relevant, is also not as pronounced in this system, as rainfall is better correlated with financial outcomes on these farms than other locations with different production outputs and systems.

Basis risk is a major barrier to insurance uptake for winter cereal producers. Their location is typically a large distance from Bureau of Meteorology weather stations and, as with other producers, there is a lack of farmer trust in settling index products using gridded data. In low rainfall production zones the thresholds for required rainfall will be low to avoid prohibitive premium prices, so small discrepancies can be costly, and little comfort is gained from errors in the farmers' favour – payments are required in the years when the event occurs. The mitigating effect on covering growing season rainfall is that cooler season rainfall tends to be less erratically distributed across the landscape.

### Supply-side barriers to insurance uptake

Supply-side barriers to insurance uptake for dryland winter cropping are similar to those in other agricultural sectors. The costs to develop products that are tailored to the industry are high, which has resulted in a lack of bespoke products that meet farmers' needs. Similarly, transaction costs in marketing and brokering policies to farmers, negotiating agreements and monitoring and enforcing contacts are high due to the dispersed locations of farms, and time it takes to assess claims.

However, anecdotal evidence from the insurance industry suggests that the inclusion of farmers form the Western Australian wheatbelt would be advantageous for the viability of offering insurance. This is primarily because this region offers an important diversification benefit on policies held on the east coast of Australia.

## Options to increase insurance uptake

The case studies explored several options to improve the effectiveness of insurance with farmers across each agricultural sector. These options included:

- The removal of stamp duty on agricultural insurance
- The development of a digital insurance platform, or central exchange
- Investment in climate and weather data collection and use
- Government provision of insurance or reinsurance, and
- Premium subsidies.

A number of these interventions are likely to have similar effects on insurance uptake regardless of the agricultural sector to which they are applied. For example, the government provision of premium subsidies would lower the cost of current insurance products, thereby increasing insurance uptake. The government provision of insurance or reinsurance, and the removal of stamp duty are also likely to have similar effects on insurance uptake agnostic of commodity type, as they directly change the cost of insurance.

Unlike the options described above, the development of a central exchange and investment in climate and weather data collection and use are two options that would not result in a direct change in the cost of insurance. The effectiveness of these options are more likely to be specific to commodity type, which is what was found through the case study interviews.

In terms of investment in climate and weather data collection and use, farmers generally agreed that more investment would be beneficial, however it was unclear to what extent investment would result in an increase in insurance uptake. Some farmers were clearly confident using gridded data sets, and reported calibrating gridded data against weather gauges on their own farms. Others expressed a strong preference for on-farm data and a distrust of gridded data, particularly in relation to localised rainfall events. However, one farmer offered that they would be happy to use the data if there were the ability to contest the data in inaccurate years, thereby increasing the accuracy and granularity of the historic dataset over time. Given the scale of any these cropping properties basis risk will remain a factor even with on-farm measurement of settlement data, because rainfall variability across a single farm can by high.

Farmers were generally positive about using a central exchange to help them analyse options and understand and make rational decisions about insurance uptake. From a cost-benefit perspective farmers stated that an exchange would be most useful if it resulted in lower costs and also provided a significant value add for farmers. A product that only lowers costs but makes the process more difficult, or a product that results in higher costs for farmers (including transaction costs) would not be beneficial. Multiple farmers stated they would likely use a central exchange in addition to their broker, as they still valued having someone provide them with advice and to be able to test their thinking.

# Case Study 2: Annual irrigated cropping (cotton) - NSW Murrumbidgee

Case Study 2 focuses on annual irrigated cotton cropping in the New South Wales Murrumbidgee catchment, affected by sustained catchment rainfall deficit, wet harvest, deficient temperatures (day degrees) during plant establishment and hail. While the primary crop of interest is cotton, this case study will have relevance to other forms of irrigated annual cropping, such as rice.


Figure 36 The Murrumbidgee cotton production zone in New South Wales.

## Introduction

Cotton production in the Murray-Darling Basin accounts for approximately 91% of Australia's total cotton farms. There are close to 900 cotton growers on up to 1500 farms in Queensland, New South Wales and northern Victoria. Cotton production in the Basin contributed around 18% of the total gross value of the Basin's irrigated agricultural production between 2006-07 and 2014-15. In total, the Australia cotton crop generates an average of $1.9 billion in export revenue annually, as close to 100% of the national crop is exported.

Recent improvements in technology and research and development of cotton genetics have increased cotton yield in cooler climates, and opened up more summer cropping cotton production areas. Cotton production has recently expanded in the Murrumbidgee valley, with the area planted to irrigated cotton increasing from less than 5,000 hectares prior to 2010-11, to around 35,000 hectares in 2015-16. Cotton crop expansion has continued, with estimates that the area planted to cotton in the Murrumbidgee is now upwards of 44,000 hectares, however figures fluctuate from year to year depending on the availability of water and the profitability of growing cotton relative to other crops (ABARES, 2019; Grain Central, 2018). Declining water allocations have contributed to cotton expansion, with farmers looking to improve their return on their crop per megalitre (ML). Cotton uses approximately 8ML/hectare, compared to 12ML/hectare for rice, which is a key irrigated commodity grown in the area.

In addition to cotton and rice, other key irrigated commodities grown in the Murrumbidgee catchment include wine grapes, citrus, vegetables, nut tree crops, winter cereals, and annual pastures. Dryland grazing and cereal-based cropping account for more than 75% of land use in the area.

### *Cotton production*

The cotton supply chain operates in four key stages, beginning with on-farm production through to the cotton being processed in a cotton gin, then from the gin to a warehouse or processor, and finally from the warehouse to domestic or export manufacturers.

Cotton production in the Murrumbidgee begins with field preparation from July to September. Cotton seeds are then planted in spring (October – November) after which the plant grows into a bushy shrub over the summer months (November – March). Once the plants' flowers are pollinated, they drop off and are replaced with fruit (cotton bolls). In autumn (April – June) after the plants have been defoliated and the bolls crack open, the cotton is picked using large mechanical harvesters. The harvested cotton is sent to a cotton gin for processing.

The ginning process separates that cotton lint and seeds and presses the lint into cotton bales which weigh approximately 227kg each. One pressed that bales are transported to warehouses in shipping ports, ready to be exported overseas for manufacturing.

The majority of cotton producers in the Murrumbidgee valley operate under family farming structures, though there are several large corporate agribusinesses growing cotton there, complemented by the emergence of large 'family corporate' aggregations.  Land values have more than doubled in irrigation areas of the Murrumbidgee valley over the past decade.

The emergence of cotton as a summer cropping option has opened up new production areas where the soil wasn't suitable for rice production, or replaced previous rice growing areas where soil water use was high and has become uneconomic, Cotton production expansion has also made groundwater a more valuable resource, as cotton is more tolerant of water that may be too saline for rice production.

## Risk and risk management

### *Weather production risks*

The key perils that affect irrigated cotton production include sustained catchment rainfall deficit (i.e. of 24 months or greater), wet cotton harvest (April to May), deficient day degrees during plant establishment(from later September to early November), and hail. Catchment rainfall deficit presents as a risk to crop planting, and may result in farmers being unable to meet fixed costs or forward contract obligations, rather than resulting in overall crop failure.

Irrigated cotton production per hectare yields are relatively predictable when water is available to enable a planting commitment, however within growing season production issues such as damage from pests and disease can occur. Lower temperatures across spring months can also impact production, as described in further detail below.

Sustained catchment rainfall deficit can will result in low water allocations to farmers against their water entitlement licences, and cotton grown under irrigation is reliant on allocations against entitlement. Murrumbidgee General Security water entitlement is often supplemented by purchases on the annual market, the price of which is driven by allocation volumes. Depending on the amount of water held in storage, allocations against General Security entitlements can be anywhere between 100% to 0% of the volume of a held licence.

The frequency and duration of sustained catchment rainfall deficit is increasing in south-east Australia, which has led to low to zero water allocations against General Security licences in the Murrumbidgee in the last two years, and occurred regularly during the Millennium drought between 2002-2010. As a result, irrigated cotton production in the Murrumbidgee is heavily exposed to drought. The risk of rainfall deficit and low water allocations is expected to continue to increase over time, which will impact the ability of cotton producers to manage this production risk via existing water risk management options, such as carryover, to grow crops.

Successful plant establishment is an important driver of the yield success of a cotton crop,. Sufficient day degrees are critical to successful plant establishment, with cooler temperatures diminishing root and shoot growth, reducing water and nutrient uptake and increasing plant susceptibility to disease and pests. Overall, higher temperatures at planting are correlated with greater seedling emergence and survival. Studies have shown that a 4 degree difference in soil temperature (measured at 10cm deep at 8am), can result in around a 17 per cent difference in seeling emergence and survival (Cotton Seed Distributors, 2014).

Wet harvest can result in downgrades in cotton fibre quality, and can create issues for harvesting, given that the use of large picking equipment can result in soil compaction or preclude paddock access in wet conditions (Cotton Seed Distributors, 2014).

### *Production strategies*

There are several production strategies that irrigated cotton producers are able to use in response to catchment rainfall deficit and consequent low water allocations and high water costs. These risk management options include:

- Choice of crop configuration – irrigators can plant a reduced crop area (resulting in a production shortfall), choose to plant another crop that requires less irrigation, or adjust the mix or diversity of their crops or agricultural enterprises. These changes are common on farms that grow annual crops such as cotton. The relatively large cropping areas of these farms gives cotton farmers scope to grow a mix of crops depending on market and seasonal conditions (including water availability).
- Utilisation of carryover water – most irrigators choose to retain a portion of their water allocation each year as a risk mitigation measure for subsequent years. If allocation is too low, (announced and/or budgeted at the time of planting) carryover water can be drawn on to supplement annual allocation
- Buying water on the market – irrigators are able to buy and sell water allocations on the water market. If available or budgeted allocation is too low, they can either buy additional water, or choose to sell their water for income instead of planting a crop. In years with low water availability the price of water may be too high to justify buying additional water for a crop. At

water prices above $250/ML cotton growers are typically priced out of the market to buy water and will be sellers of their allocation above $250-300/ML. While water sales of available allocation can cover fixed business costs, zero or minimal allocations over successive years will limit this possibility.

- Taking out forward or leased water products – these options allow predictable water prices to be secured ahead of planting and crop marketing decisions.
- Owning high security water entitlements – high security entitlements are guaranteed allocation prior to General Security entitlements, and hence are a more secure option to guarantee water availability when there is sustained catchment rainfall deficit. However, there is an opportunity cost of holding this form of water entitlement, as the entitlement yields a lower volume of water per dollar of invested asset.
- Owning a groundwater licence – groundwater licences can be used to supplement water availability, however access is dependent on the location and depth of local aquifers. Groundwater use may also pose water quality issues for irrigators, as groundwater can often be far more saline than surface water.

Several on-farm management practices can also be utilised that help increase crop yield and profit margins, even under circumstances when water is abundant. These include soil management practices, and more effective water management practices. For example, regular monitoring and maintenance of storages and channels to increase storage efficiency and monitoring soil water and evapotranspiration to optimise irrigation.

There are currently limited options available to cotton producers to manage deficient temperatures during crop establishment, or the risk of wet harvest or hail. Currently, managing the crop planting window is the primary strategy available to manage temperature risks, however this can come with a substantial yield penalty if optimal planting windows are compromised for the purpose of managing this risk.

### *Financial strategies*

Cotton production is a relatively high risk, high return farming system. Many cotton growers in the Murrumbidgee have allocated substantial capital to upgrading irrigation layouts and equipment, and may not yet be financially resilient to successive low or non-producing years as a result of zero to low water allocations. There are a number of financial strategies available to cotton farmers to combat financial difficulties that occur due to production risk. These strategies include managing financial risk with comfortable debt to equity ratios, and only undertaking expansion opportunities when a comfortable debt to equity ratio is able to be maintained.

Given the input costs for cotton are high, most farmers that were interviewed stated that a strong balance sheet was a requirement of farming cotton.

Interviewed farmers reported that compared to other farming enterprises cotton production is more heavily geared than other systems and required higher levels of capital invested. Some farmers reported that equity levels could decline by around 5 per cent from a production hit, and cash flow is challenging if recovering from a difficult season, or series of years.

Corporate cotton producers are likely to be much better able to maintain a strong balance sheet and self-insure, given the breadth of their assets, and access to alternative sources of capital via equity partners.

Irrigators are also able to make use of government tax-based income smoothing arrangements such as farm management deposits (FMDs).

Farmers also reported using crop marketing options such as forward production contracts and speciality contracts to increase the value of and returns received for their crops. Forward contracts are to enable growers to secure a price for some or all of their crop prior to harvest. Typical forward contracts can be for three to five years of forward production. Farmers can utilise this option with greater confidence if they are able to manage water availability over time, for example by using carryover water or through utilising water trade. Without the option to managed water availability, forward production contracts can present a risk if a farmer is not able to meet their contracted production targets.

Farmers also seek to diversify their income stream through off-farm investments and income.

## Insurance product use and uptake

### Indemnity products

Both named-peril and multi-peril crop insurance products have been available for cotton producers to manage yield risk, however as is the case for other commodities, access to multi-peril crop insurance is limited in 2020 (refer to Section 3.3 for further detail).

Cotton hail insurance is one type of named peril insurance available to cotton producers. The policies provide cover for yield loss caused by hail damage, and can typically be tailored to a farmers financial requirements (including specified yield, bale prices, excess, additional options and cost structures) and can include cover for a decrease in crop quality. The payout is calculated by comparing the harvested yield with potential crop yield and indemnified based on specific coverage parameters agreed by the farmer (CRDC, 2020). Evidence from the interviews revealed that around 50 per cent of cotton producers tend to insure their crops for hail damage, as damage can vary from moderate to the complete destruction of a crop. While hail is a low frequency event, it can have high consequences.

Named-peril insurance for fire risk was also mentioned as being used. Once farmer gave an example of a recent payout he had received for fire damage that had destroyed 12 modules of cotton, valued at $1.375 million. The insurance premium had only cost around $12,000. While the cover was stated to be slightly more expensive than other types of named-peril insurance for other commodities the farmer produced, he found the level of cover was worth it, given the size of the payout.

Other cotton producers did not use any form of insurance, other than legislated motor vehicle insurance, as they find the premiums to be too high. These farmers reported self-insuring instead, by utilising a range of production and financial risk management strategies, such as a robust water allocation portfolio. These farmers reported that they found it difficult to understand what the value proposition of some forms of insurance are, and that it can be difficult to know which perils they should be seeking to insure against.

A farm advisor reported that multi-peril crop insurance  is not popular among irrigated enterprises, as farmers tend to use the water market as their main means of managing production risk.

### Index insurance products

Index insurance products are available for irrigated cotton production, with products available to mitigate against prolonged (24 to 36 month) catchment rainfall deficit as a proxy for water allocation and price risk, in addition to more conventional location-based index cover for wet harvest risk, and day degree deficits. Many of these products are new to the market, and as such there is little evidence for their use to date by Murrumbidgee broadacre irrigators.

Weather index insurance products can be used to protect farmers against rainfall deficit that has the cumulative effect of reducing water available for allocation. Growers can elect to have settlement based on a basket of BOM rainfall observations (weighted if necessary), or use a gridded data set across the catchment area.

Growers using this cover would need to assess the level of catchment rainfall that correlates with zero or very low allocation events. Lining up retrospective index observations against historic allocations in this way can assist them with managing basis risk. Following this, developing an understanding of allocation scenarios relative to water prices can help to inform the policy parameters and payout they should be seeking from their insurance. There is better correlation between catchment rainfall and allocation in the Murrumbidgee system than in the Murray, for example, where regulatory intervention in water sharing arrangements reduces the inflow-allocation nexus.

From a pricing efficiency perspective, the lower levels of implied volatility from pricing a long term (24-36 month) deficit should, in theory, reduce the price of cover relative to covering events within a shorter window of time, where statistical volatility is high.

In terms of product uptake, some interviewed farmers reported that the complexity of this type of product would impede them from seeking to purchase it. However, there was interest in this option as a hedge for allocation risk, subject to better understanding its strategic application to their business and the terms on which policies would be settled.

Index insurance to cover quality downgrades from excessive harvest rain would typically be taken out for the April to May period (CRDC, 2020). Excessive rainfall cover would need to be taken out well in advance of the insured period (up to one month prior), and pricing will be influenced by long term weather outlooks if taken out on an intra-seasonal basis. Day degree cover insurance products are also slowly becoming available.

Some irrigators interviewed commented that index insurance products appear to be too expensive for the cover they provide. A farm advisor also commented that the lack of continuity of index insurance products was a barrier to their uptake by farmers, with farmers preferring to self-insure when managing these types of production risks.

## Barriers to uptake

### Demand side barriers to insurance uptake

There are a range of demand-side barriers to insurance uptake that are common across production systems. Some of these barriers include:

- high costs (high premiums for both major product types and in some cases transaction costs for index insurance products),
- a high appetite for risk, (for cotton farmers this is particularly evident in their high levels of investment in water entitlements, layouts and machinery),
- lack of farmer understanding or awareness of available insurance products, and
- a distrust of products.

Demand side barriers to insurance uptake that were found to be prevalent among cotton producers include the presence of competing production and financial risk management strategies. There are many options that are available to cotton producers to manage catchment rainfall deficit. Most interviewed farmers pointed to their use of available water market options to manage low allocation risk. Farmers are also able to utilise forward contracts of up to five years to mitigate the impacts of low allocations. It is only when catchment rainfall deficit becomes prolonged that farmers may not have to option to utilise the water market or that the use of forward contracts becomes risky. However, farmers are always able to choose to avoid planting or to reduce the number of crops planted to reduce input costs and make money back by selling water allocations (where water has been allocated to them).

Product complexity was also mentioned as a barrier by some of the interviewed farmers., This complexity may be further compounded by understanding the basis risk implications of a given set of policy parameters. Index insurance products that address catchment rainfall deficit must use a catchment rainfall index, which farmers would then have to assess against their understanding of water allocations and water prices. The complexity of this assessment, and a lack of trust in gridded data may be a concern for some farmers.

### Supply-side barriers to insurance uptake

Supply-side barriers to insurance uptake for cotton producers are similar to those in other agricultural sectors. The costs to develop insurance products that are tailored to the industry are high, as there are a range of perils that affect cotton production that are highly specific to the production system, especially the requirement to hedge against weather events that occur at a location separate to the farm (storage catchments). As a result, there has been a lack of product development tailored to irrigators' needs.

Transaction costs associated with marketing and brokering policies to farmers, negotiating agreements and monitoring and enforcing contracts are also high due to the dispersed locations of farms and the time it takes to assess claims. This is particularly true of indemnity products that require an assessment of loss prior to a payout occurring.

The cost of risk to an insurer, cost of portfolio volatility, and bounded rationality are also relevant supply-side barriers, particularly in the context of the increasing timing and magnitude of sustained catchment rainfall deficit in southern Australia.

## Options to increase insurance uptake

The case studies explored several options to improve the effectiveness of insurance with farmers across each agricultural sector. These options included:

- The removal of stamp duty on agricultural insurance
- The development of a digital insurance platform, or central exchange
- Investment in climate and weather data collection and use
- Government provision of insurance or reinsurance, and
- Premium subsidies.

A number of these interventions are likely to have similar effects on insurance uptake regardless of the agricultural sector to which they are applied. For example, the government provision of premium subsidies would lower the cost of current insurance products, thereby increasing insurance uptake. The government provision of insurance or reinsurance, and the removal of stamp duty are also likely to have similar effects on insurance uptake agnostic of commodity type, as they directly change the cost of insurance.

Unlike the options described above, the development of a central exchange and investment in climate and weather data collection and use are two options that would not result in a direct change in the cost of insurance. The effectiveness of these options are more likely to be specific to commodity type, which is what was found through the case study interviews.

Cotton producers had mixed feedback about the efficacy of a central exchange in increasing insurance uptake. Some farmers thought it was a good idea that would help provide product transparency to assist decision making, however felt that even if they would use a platform they would still prefer or need to maintain a relationship with their broker to understand product use, policy parameter options, and settlement terms. One farmer suggested that a platform with accompanying educational tools would be useful, to smooth the transition from using a broker to using a platform. Other farmers were not as receptive to the idea of a central exchange as, in addition to being too time poor to use it, did not trust that the savings that might come about from eliminating the role of a broker would be passed down to consumers.

As with other cropping producers, interviewed farmers expressed concerns about the basis risk associated with the distance between their location-specific peril and the closest Bureau of Meteorology (BoM) weather stations, as well as scepticism about the reliability and credibility of gridded data.. The idea of gridded data being owned by an independent authority was viewed favourably.

For farm specific index cover, farmers expressed a preference for localised data being used, whether it would be data taken from private weather stations, or data calibrated to each farm location. Hence, investment in climate and weather data collection and use may increase farmer trust in insurance products, leading to an increase in use over time.

However, the most potentially useful index cover for cotton producers is a catchment wide rainfall across the catchment inflow area. The primary form of basis risk here is low correlation between rainfall, resultant storage inflows, and subsequent allocation announcements. A lack of rainfall data granularity is less a concern in this circumstance, as a basket of BoM measurements or gridded data points are used to determine the index, and the index would cover an extended 24 month or longer deficit. Both these aspects of a storage rainfall index would serve to smooth any short term or location specific discrepancies that arise from covering on-farm intra-seasonal perils.

# Case Study 3: Dryland summer and winter (double) cropping – Northern NSW

Case Study 3 focuses on the effects of long-term, fallow (pre-planting) and in-season rainfall deficit, spring frost, spring heat, wet harvest, and sustained extreme heat during summer months on dryland summer and winter cropping, also known as double cropping, in northern New South Wales and southern Queensland.

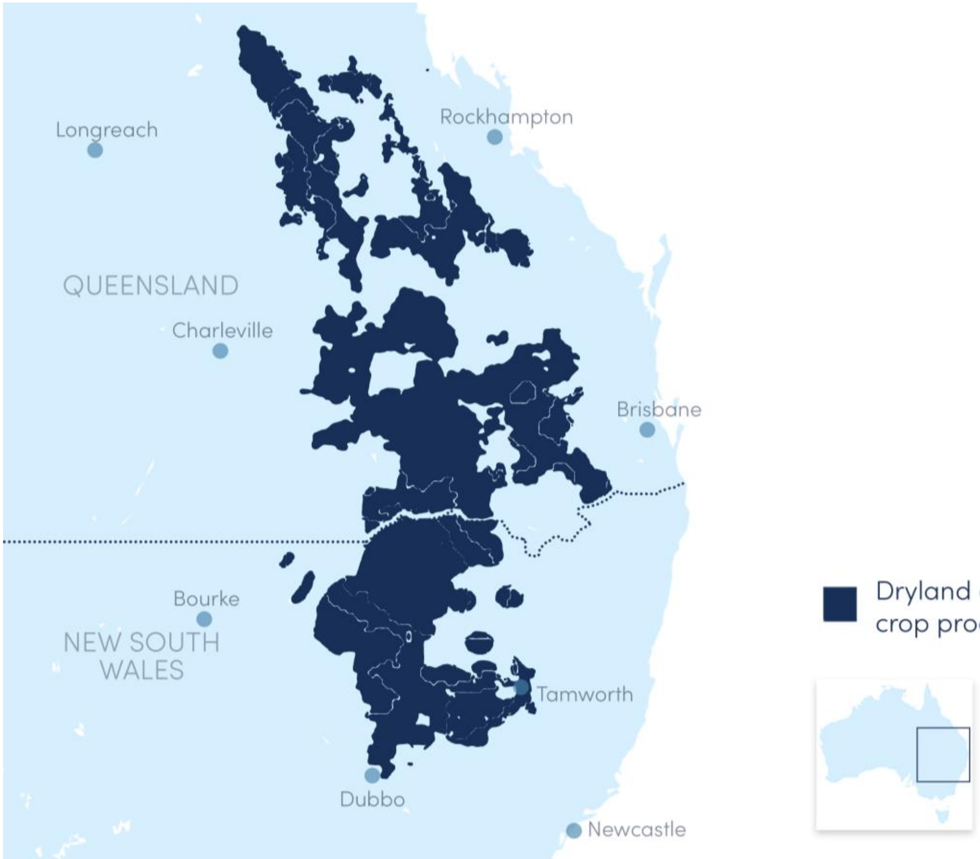



Figure 37 Dryland double crop production zones in southern Queensland and northern New South Wales

## Introduction

Dryland double cropping production systems have rainfall patterns that enable the planting of two crops in one year. This production system includes winter crops such as wheat, barley, canola, pulses and legumes, and summer crops such as cotton, sorghum and corn. Dryland double cropping is common in the summer rainfall zone around northern New South Wales and southern Queensland, where summers are adequately wet to sustain the summer crop. This region stretches from the NSW Central West and Liverpool Plains up to the Queensland Darling Downs. In north-west New South Wales and the Northern Tablelands, 21% of cultivated land uses a double cropping production system.

Australia wide, in 2016-17 double cropping production was undertaken on approximately 1.7 million hectares of land (inclusive of irrigated operations), an area that comprises approximately 9 per cent of Australia's cultivated agricultural land. Compared to dryland single cropping, double cropping can stabilise farm income in single years by spreading income and risk across the entire year. This is especially relevant considering the increasing volatility of rainfall in the region and shifting rainfall zones.

Dryland double cropping is undertaken by a range of agricultural businesses, although the presence of large scale operations, corporates and family-corporates is significant. Corporates are generally landlords with tenants paying fixed leases and corporate owner-operators.

### *Dryland double crop production*

Dryland double crop production consists of farmers sowing multiple crops in the same paddocks within an annual cropping cycle. Planting occurs on two intra-seasonal cycles, with the timing for planting dependent on the type of crop sown and local weather conditions. Winter crops are typically sown between April and June, with harvest occurring around November to December. Summer crops are sown from December to January, and harvested between April and June.

Summer crops are a valuable rotational option, particularly in summer-rainfall dominated areas, as they offer the potential to improve the resilience of cropping systems. They assist in reducing balance sheet vulnerability affected by crop revenue-asset value ratios. In a double cropping system individual short term climatic events are of lower consequence to farmers than one crop per year systems, particularly in high rainfall regions of the double cropping zone.

The supply chain and farm composition for dryland double crop production is similar to that of dryland winter cereal crop production, as set out in Case Study 1. Notably, producers in these regions have also experienced strong land asset value increases to protect equity during adverse climatic events in recent years.

## Risk and risk management

### *Weather production risks*

Given the range of enterprises and perils that occur over both summer and winter, there are multiple key perils for double cropping systems. Weather perils in this system are complex to assess in discrete terms, being interrelated, consecutive and contingent on previous weather outcomes.

Key perils include long-term, fallow (pre-planting) and in-season rainfall deficit, spring frost, spring heat, wet harvest, and sustained extreme heat during summer months. It is difficult to single out a specific time of year or related peril as being the most critical for double cropping production revenue. The timing of each peril at different stages of the production cycle and the sequence in which they occur can alter the impacts of each subsequent peril on farm revenue.

Of the range of discrete short-term rainfall perils that affect double cropping, summer rainfall deficits can be particularly destructive due to their effect on high value summer crop yields. Despite this, these events occurring singularly may be mitigated by other rainfall related perils not occurring, due to a greater spread of risk/income across the year.

Rainfall patterns in recent years have been unpredictable, with areas such as the Liverpool Plains missing what have been historically predictable key rainfall events. This volatility is creating a higher degree of uncertainty in areas which have historically been 'safer' rainfall areas.

Double cropping is also vulnerable to sustained rainfall deficits (multi-year droughts). Drought can significantly reduce soil moisture across consecutive planned cropping rotations. Sustained deficits both precipitate non-planting decisions and, where planted, affect yields of both winter and summer crops., This will result in a larger impact on revenue than may be experienced by a single cropping production system.

Increasing dry periods also affect the likelihood of frost, including frost that occurs later in the production cycle. Frosts that occur during spring flowering can have an immediate and catastrophic effect on yield, particularly when a crop has high yield potential and high rates of fertiliser have been applied.

Wet harvest is another peril that affects double crop production, potentially causing quality and price downgrades or preventing timely access to paddocks for harvest. Wet harvest is an issue from late October to December for winter crops, and March to April for summer crops. The effect of wet harvest on grain quality is exacerbated when the difference between grain and feed prices is large – if the quality of the grain is downgraded due to wet harvest it may only be able to be sold as feed.

### *Production strategies*

There are a number of production strategies that producers can employ to mitigate the effects of deficit rainfall.

- Fallowing – farmers may choose to fallow paddocks to allow for moisture accumulation. If soil moisture in an area of land is not sufficient for crop sowing, the crop may be withheld and the paddock used for a subsequent crop once the soil profile has been replenished.
- Crop rotation/switching – Combinations of crops that allow for effective nutrient cycling can combat soil nutrition and moisture issues that may arise from a lack of rainfall and overworking land.
- Dry sowing – dry sowing may occur if long range outlook is positive or prices justify the risk. This option is more likely for lower input cost winter cereal crop than summer cotton, where input costs are high. The predictability of rainfall patterns in any specific location, balanced against price outlooks, will guide dry sowing decisions.
- Sowing resilient crop varieties – Crop varieties that can tolerate low rainfall and/or soil moisture may be planted to hedge against deficits. This strategy may come at the expense of lower yields and/or less valuable production options.
- Weed and input control – effective weed control can help to conserve moisture. The use of precision agriculture can also help to mitigate financial losses by more efficient management of input costs.
- Enterprise and geographic diversification – farmers may choose to diversify the crops or stock they farm, or the locations in which they farm then to diversify their income streams and spread out their exposure to perils. Yields from livestock activities are typically less volatile and less exposed to rainfall deficits than dryland cropping. Pasture loss due to deficient rainfall can be combated with alternative feed sources such as hay and grain on a seasonal basis. Farmers may choose to convert some cultivated land to pasture.

Production strategies that can help manage frost risk include; using a diverse spread of crop varieties that have a spread of planting windows, conservatively applying fertiliser and other crop inputs, planning more resilient (often lower value) crop varietals, and selecting planting windows to ensure critical periods of crop development are matched typical weather patterns to minimise yield loss.

### *Financial strategies*

Financial strategies for double cropping are similar to those employed by winter cereal producers, and set out in Case Study 1. Key amongst these are:

- managing financial risk with a comfortable debt to equity ratio, as maintaining high equity allows farmers to borrow money to meet cash flow needs during times of low farm income, and when they need to make new investments
- on-farm storage of a portion of production in high yielding and/or lower grain price years, to offset lower yields in poor years, capitalise on later, higher grain prices, and reduce income volatility. For mixed farms, this strategy also mitigates production risk as stored grain or fodder crops can be used to feed livestock in poor pasture years.
- Utilising crop marketing options such as forward production contracts. However, forward contracts carry some risk if farmers are not able to meet contracted yield targets.
- Income diversification via off-farm income and investments.
- Government assistance programs such as farm management deposits (FMDs).

# Insurance product use and uptake

## Indemnity products

Indemnity insurance products that are available to double cropping farmers are similar to those for winter cereal producers outlined in Case Study 1.

As with other farm businesses, insurance for double cropping production systems is more likely to present value to operating businesses that require revenue stability, such as those with high gearing ratios or undergoing intergenerational asset transfer. Insurance may also be taken out by businesses seeking to enter leasing commitments or which require cover for debt funded expansion of the asset base.

Multi-peril crop insurance is well suited to this production system, compared with systems where a single peril is the dominant driver of yield outcomes.

Several farmers reported having used multi-peril crop insurance in the last few years, or that they were currently using one of the few multi-peril crop insurance products available to them, and stated that multi-peril crop insurance is ideal for their type of production. Others found it to be too expensive or had not looked into it as an option.

Most approached multi-peril crop insurance use as a defensive strategy (to limit losses or cover costs), while some viewed the benefits as being able to support more confident agronomic decisions within the cropping cycle, thus better capitalising on good seasons.

Multi-peril crop insurance  in this system certainly has the potential to lead farmers to make riskier agronomic decisions, such as incentivising dry sowing. Some interviewees conceded that they had undertaken more aggressive strategies as a consequence of having cover, though it should be acknowledged that these may have been rational decisions, with insurance cover providing the confidence to avoid overly cautious planting and management strategies. Other farmers raised concerns that the tendency of their peers to alter management practices would raise the level of claims and inevitably lead to insurers to exit provision, or lead to unsupportable pricing arrangements.

Farmer attitudes towards named-peril insurance were varied. Some farmers currently held named-peril insurance for fire and hail, and were happy with the products due to recent payouts (some in the order of approximately 10 years' worth of premium). Others had held fire and hail insurance previously, however had lost trust in the product due to failed claims and felt the premiums were not priced according to individual farm risk. In line with the findings from the National Survey, these farmers typically only held farm pack insurance.

### Index insurance products

Index insurance products that are available to double cropping farmers are similar to those for winter cereal producers, set out in Case Study 1.

In terms of product uptake, few farmers reported having recently used or thought about using weather derivatives. The complex and interrelated nature of weather perils and their effect on production across seasons makes weather index insurance products difficult to assess for their relationship with production outcomes, and present real value for money challenge if multiple perils are covered across the season.

Farmers stated that while they were aware of the products, they were not comfortable with the level of basis risk involved. This related both to the variation between observed weather on farms and at Bureau of Meteorology weather stations, as well as the difficulty of correlating events with production outcomes. In general, interviewees did not think that index insurance in its current format was comprehensive enough, and that it was too expensive.

There was general consensus among doble cropping farmers that their preference is for yield or revenue protection that covers multiple perils. In order to compete with farmers' preference for multi-peril crop insurance, index-products may need to be offer more complex bespoke cover that accounts for contingent triggers and is reflective of the production system. Yield index products may also be favourably viewed within this production system.

## Barriers to uptake

### Demand side barriers to insurance uptake

There are a range of demand-side barriers to insurance uptake that are common across production systems. Some of these barriers include:

- high costs (high premiums for both major product types and in some cases transaction costs for index insurance products),
- a high appetite for risk (double cropping in a dryland environment, at large scale, indicates a relatively high appetite for risk),
- a lack of farmer understanding or awareness of available insurance products, and
- a distrust of products and insurers.

Product complexity is a barrier to insurance uptake issue with this production system, given the many and varied perils affecting yield and the contingent nature of any climate triggers using an index approach. These factors mean double cropping farmers require complex bespoke solutions to ensure insurance is priced efficiently and basis risk is minimised. Additionally, basis risk is a dominant barrier to insurance uptake, given the large distances from Bureau of Meteorology weather stations and a lack of farmer trust in gridded data and index insurance products. Summer rainfall perils in this system can also act to amplify basis risk given the sporadic nature of rainfall patterns at that time of year.

While high asset values in the east of Australia and double cropping options available to farmers provide some production system insulation from one-off climatic peril risks, producers are increasingly exposed to climatic volatility, hence a lack of risk exposure is not seen as a dominant barrier to insurance uptake.

The double cropping production system, with a complex interplay between multiple cropping and managing soils moisture across cropping cycles allows for very skilful management to mitigate against weather perils and maintain profitably across seasons. This capacity for farmers to manage their way through seasonal difficulties creates value for money threshold that works against insurance solutions, compared with other farming operations subject to uncontrollable and high consequence events.

### Supply-side barriers to insurance uptake

Supply-side barriers to insurance uptake for double cropping are similar to those in other agricultural sectors. The costs to develop products that are tailored to the industry are high, which has resulted in a lack of bespoke products that meet farmers' needs. Similarly, transaction costs in marketing and brokering policies to farmers, negotiating agreements and monitoring and enforcing contacts are high due to the dispersed locations of farms, and time it takes to assess claims.

## Options to increase insurance uptake

The case studies explored several options to improve the effectiveness of insurance with farmers across each agricultural sector. These options included:

- The removal of stamp duty on agricultural insurance
- The development of a digital insurance platform, or central exchange
- Investment in climate and weather data collection and use
- Government provision of insurance or reinsurance, and
- Premium subsidies.

A number of these interventions are likely to have similar effects on insurance uptake regardless of the agricultural sector to which they are applied. For example, the government provision of premium subsidies would lower the cost of current insurance products, thereby increasing insurance uptake. The government provision of insurance or reinsurance, and the removal of stamp duty are also likely to have similar effects on insurance uptake agnostic of commodity type, as they directly change the cost of insurance.

Unlike the options described above, the development of a central exchange and investment in climate and weather data collection and use are two options that would not result in a direct change in the cost of insurance. The effectiveness of these options are more likely to be specific to commodity type, which is what was found through the case study interviews.

Double cropping farmers had mixed responses towards climate and weather data collection and use. Some farmers were confident using gridded data sets and reported calibrating gridded data against weather gauges on their own farms. Others expressed a strong preference for on-farm data and a distrust of gridded data, particularly in relation to localised rainfall events. However, one farmer offered that they would be happy to use the data if there were the ability to contest the data in inaccurate years, thereby increasing the accuracy and granularity of the historic dataset over time. Overall farmers seemed to agree that more investment in data would be beneficial, however it was unclear to what extent more accurate or granular data would increase their uptake of insurance products.

Double cropping farmers were fairly positive about using a central exchange to help them analyse options and understand and make rational decisions about insurance uptake. From a cost-benefit perspective, farmers stated that an exchange would be most useful if it resulted in lower costs and also provided a significant value add for farmers. A product that only lowers costs but makes the process more difficult, or a product that results in higher costs for farmers (including transaction costs) would not be beneficial. Multiple farmers stated they would likely use a central exchange in addition to their broker, rather than in their stead.

# Case Study 4: Permanent irrigated horticulture (almonds) – north-west Victoria

Case study 4 focuses on permanent irrigated horticulture in north-west Victoria. Whilst findings may be applicable to horticultural activities in a broad sense, the focus of the case study is on almonds. Almonds are a high value crop that is prone to yield risks from frost and the business implications of adverse availability and price of water allocations.


Figure 38 The north-west Victorian almond production zone in the Sunraysia district.

## Introduction

Almond production in Australia was worth $725 million in 2018-19, up from $345 million in 2014-15. This occurred, in part, due to a substantial rise in newly maturing plantings in northwest (NW) Victoria in that period. NW Victoria accounts for 69 per cent of Australia's almond production by value and contains around 183 almond growing businesses as of 2018-19. The area is also a major production region for other horticultural crops including citrus, olives, and grapes.

The main driver for high growth in the Australian almond market is export demand. Exports have consistently accounted for a large portion of overall sales, with around 61,000 tonnes of almonds (63 per cent of total almond production) being shipped overseas in 2018-19. Increased exports to China and Hong Kong have accounted for a significant portion of export growth in recent years.

The majority of almond production in NW Victoria occurs in and around the Sunraysia region, which stretches north into southern NSW. The Victorian portion of the growing region borders lower Murray and resides largely within the Mildura local government area.

Despite recent growth in production, almond growers face considerable risks. Water availability and price is the primary risk for growers. Recent modelling by Aither (2020) has determined that, in an extreme dry climate scenario, the water use requirements of existing permanent plantings in the lower Murray may outstrip allocated water supply within the entitlement zone by two and a half times in extreme dry years, leaving the region dependent on trading in and carryover. Inter-valley trade arrangements establish current trade parameters, but future water trade opportunities from the Murrumbidgee and Goulburn river systems are uncertain, as both systems have been put under considerable strain in recent years.

In addition to water risks, frost during almond flowering can also be very harmful to yields in severe frost years.

### *Almond production*

The almond supply chain operates in three key stages, beginning with on-farm production (including establishment of plantings) through to almond processing, and then from the facility to domestic or export wholesale and retail sellers.

After planting, almond trees require around three years to begin bearing fruit. Yields steadily increase in sequential years with full yields expected around seven years after planting.

Unlike annual crops, almond trees require a fixed water supply each year, in the order of 10 to 15 megalitres per hectare, to produce yields and survive into future years. For this reason, almond trees in this region are irrigated and rely on a mixture of some in crop rainfall, and seasonal water determination allocations from the Murray, Murrumbidgee and Goulburn river systems.

The almond production cycle begins with a dormancy period in cold winter months (May – June). Depending on the variety, almond trees will blossom between late July and early September. Nuts are allowed to mature (September – December), and split (January – February) before harvest occurs in February, March and April. The timing of harvest is dependent on the moisture content of the almond - dry almonds are preferred to inhibit growth of microorganisms. Almonds are typically harvested using mechanical shakers. Fallen almonds are then left to dry before being collected.

Once harvested, almonds are transported to a processing facility, which is usually separate from the farm. Once processed, almonds are distributed in domestic and international markets. Production, processing, and distribution must be performed with diligence and care to ensure that food safety standards are met.

Almond farms are typically corporate-owned and managed enterprises. For example, almond farms in NW Victoria are often run by corporate managers for private investors or investment funds.

## Risk and risk management

### *Weather production risks*

The key perils faced by almond growers are sustained catchment rainfall deficit (of 24 months or greater), frost occurring from mid-August to early-October, and spring heat occurring from October to November. Unlike annual cropping activities, almond production is also subject to the risk of almond tree inter-season damage or tree death, which can have a crippling effect on farm income and profit for years after a peril has occurred.

Water deficit can occur due to a combination of low storage catchment rainfall and low water allocations against held entitlement licences in the southern connected system, particularly the Murray. Where water from these sources is insufficient for optimal yields and/or tree survival, almond growers are required to obtain additional allocations from the temporary water market, which can increase input costs when the price of water is high. In the case where water allocations are prohibitively expensive or there is limited trade opportunity, almond growers may not obtain required water, resulting in lost yields and/or tree death.

Average annual inflows into Murray storage catchments have decreased by one third over the past 20 years. This has increased risks associated with water availability and excessive demand (IIG MDBWR, 2020).

Spring frosts at flowering can result in significantly reduced yields, as almond buds are particularly vulnerable to frost damage at this time. The effect of subzero temperatures increases from mid-August to late September. Topography is also a major driver of frost occurrence and damage, with lower areas subject to trapped cold air amassing being the most prone. Additionally, frost damage in one year can impact the crop for the following year. Despite a warming climate, spring frosts have become more common in NW Victoria in recent decades and tend to be likely to occur for a longer period of time.

Other perils that impact almond farms include hail damage or harvest rains in autumn that cause quality downgrades and can impact pollination due to continuous wet and cloudy weather. Spring day degree deficits can also impact crop pollination due to its effects on bee activity.

### *Production strategies*

There are several production strategies that almond growers are able to use in response to frost events or sustained rainfall deficit.

A number of practices are available to reduce the likelihood and/or consequence of a frost event. These practices include:

- Strategic planting placement – where farmers can plant almond trees in areas with low frost risk, or plant different varieties of almonds on the same farm with different frost tolerance, to spread the impacts of frost damage out on the crop.
- Frost fans and helicopters – farmers can install frost fans which allow for increased airflow around almond buds. The fans prevent still, cold air from pooling and causing damage to almond buds. Other methods which create air flow and prevent cold air from pooling, such as the use of helicopters, fulfill a similar role.
- Sprinkler irrigation – when temperatures are low, sprinklers can be used to increase soil moisture and increase the temperature of surrounding air. This reduces frost risk to almond buds. Consecutive days of frost can create over watering problems if applying water is relied on to manage frost risk.
- Use of frost sensors – farmers may also use frost sensors throughout their orchards to trigger the above amelioration practices.

Similarly, there are several practices growers can employ to reduce the likelihood or consequence of sustained rainfall deficit. These practices include:

- Buying temporary water – almond growers are able to buy and sell water allocations on the water market to manage any shortfall in allocations against entitlement, or leasing, forward or carryover water. Years of low water availability and high costs of additional water may exceed per ML returns on its use.
- Utilisation of carryover water – almond growers will choose to save allocation or acquire water at the end of each year as a risk mitigation measure for subsequent years. If allocations are low they will typically hold carryover water they can draw on to supplement annual allocation.
- Owning high security water entitlements – high security entitlements are guaranteed allocation prior to lower security entitlements, and are a more secure option to guarantee water availability when there is sustained catchment rainfall deficit. In the Sunraysia region most almond producers own a proportion of Victorian below choke High reliability Share. However, there is an opportunity cost of holding this form of water entitlement as a drought hedge, as high reliability entitlement yields a lower volume of water per dollar invested in water access.
- Owning a groundwater licence – groundwater licences can be used to supplement water availability, however access may not be possible for all irrigators as it is dependent on the location and depth of local aquifers. Additionally groundwater use may also pose water quality issues for farmers, as groundwater can often be far more saline than surface water.
- Sacrificing yields – if it is not feasible to buy water on the temporary market, a farmer may choose to forego yields and provide almond trees with the minimum amount of water required for survival.
- Geographic diversity – producers may opt to own almond farms in varying locations, or include a range of topography on the farm.

Several production practices can also be utilised that help increase crop yield and profit margins, even under circumstances when perils do not occur. These include soil management practices like reduced tillage and the application of organic matter to soils, and more effective water management practices like regular monitoring and maintenance of storages and channels to increase storage efficiency and monitoring soil water and evapotranspiration to optimise irrigation.

### *Financial strategies*

There are a number of financial strategies available to almond growers to combat financial difficulties that occur due to frost or low allocations. As is the case for other agricultural sectors, one such strategy is managing financial risk with comfortable debt to equity ratios, and only undertaking expansion opportunities when they are able to maintain a comfortable debt to equity ratio. One approach to maintaining this balance sheet flexibility is opting to lease rather than purchase land, crop and water assets.

Corporate owned-farms are also more likely to be able to secure additional capital to ride out any production risk volatility. Corporate owners also have diversified revenue streams from other agricultural enterprises or off-farm investments.

Growers can also manage price risk by locking in forward production contracts and managing currency risk. Effective use of these strategies is varied across producers, even within the corporate sector. Price risk instruments can be used to provide greater confidence to acquire future water access at a profitable margin, by using the water trade and carryover strategies described above.

# Insurance product use and uptake

## Indemnity products

Almond growers have a number of indemnity insurance products available to them to manage the financial consequences of production risks.

Traditional fire and hail insurance, a type of named-peril insurance, is available for almond growers. If a claim is made fire/hail is determined to have occurred, losses are then assessed based on a number of metrics including the impact of the event on yields.

Frost insurance is another type of named-peril insurance for almond growers, although availability is limited and may vary significantly from year to year. If a claim is made and a frost event is determined to have occurred, losses are then assessed based on a number of metrics including the impact of the frost event on yields. Some frost insurance policies may provide discounts for growers who employ effective agronomic practices to reduce frost risk. Access to indemnity frost insurance has been limited or prohibitively expensive for almond growers in this region.

In terms of product uptake, most farmers interviewed had some type of weather-related indemnity insurance. One corporate farm manager, that manages multiple properties for investors, had hail insurance for most of the properties they managed. However, they did not think that this type of insurance offered value for money, as the payout was low in comparison to the premium. While the decision to take out insurance is a matter for their investors, self-insurance (i.e. putting money away in savings to cover future losses) was often put forward as an alternate option.

Most farmers had some type of frost insurance, however around half of interviewed farmers stated that while they held frost insurance they were not happy with the product – there was little competitive pressure in the market and the insurance excess is high. These farmers also stated that they were previously happy with indemnity frost insurance, when they had originally taken it out close to a decade ago.

Some farmers expressed interest in a multi-peril crop insurance option, however are not able to use them as there are so few options currently available.

## Index insurance products

There are a few new and emerging index insurance products on the market to help almond farmers manage for production risk due to frost and spring heat events. Frost insurance typically uses low temperature as a proxy for frost events, although correlation between observed temperature from the nearest weather station and localised frost effects can be poor. The threshold for a frost event is typically between a -2°C and 0°C air temperature, measured from the nearest weather station. The frost event must occur within a specific cover period - this period may change from year-to-year based on weather conditions and the likely window of risk. Index insurance to manage frost risk will only be used where yield/revenue sensitivity to an event justifies an additional crop input cost. Spring heat index-insurance operates in a similar fashion to insurance for frost, however is based on a different temperature range.

Despite these products becoming available, there is a challenge to their uptake in that there is a lack of agronomic understanding of the yield effects of specific frost and spring heat events. Some farmers stated that they did not yet know enough about these products and would like to have a better understanding of them, particularly their value for money. However, farmers stated that there would be a transaction cost in understanding how these products could be applied to their farm, as they would need to first analyse historic on farm data to understand what time periods would be best to insure, and whether insurance would offer value for money as opposed to other practices. For corporate farm managers this extends to needing to be able to present a clear methodology for these calculations to investors to help them understand their return on investment.

Some farmers had not yet considered index insurance products and were not aware of how they could be used to mitigate production risks. Others had considered index insurance products, however felt that it was not a viable option from an affordability standpoint.

One organic farmer that was interviewed mentioned regional yield index insurance, and pointed out that this type of index insurance would not work for their farm, as yields on organic farms are lower than that of conventional growers. As a result the regional index used for payouts does not correlate well with the circumstances of their farm.

## Barriers to uptake

### Demand side barriers to insurance uptake

Given the highly corporatized nature of many almond farms in this region, most of the demand-side barriers to insurance uptake that are common across other production systems are not as applicable for almonds. High premium and transaction costs are not as large an issue, as corporate farm managers have a greater pool of funding available to them to seek out advice on products. Additionally, cash flow is not as much of an issue due to the scale of investments, however rigorous processes would underpin any decisions about the best return on investment on insurance expenditure. These barrier would however, still be an issue for smaller, non-corporatized farms.

In terms of risk appetite, corporate almond operators tend to have an appetite for risk as they have made significant investments in land and farm development, with many having foregone entitlement ownership in favour of allocating capital to greater land and development scale. However, risk appetite may vary depending on the purpose of the farm – evidence from interviews shows that investors are less likely to take out insurance is the balance sheet is in a reasonable position, farms managed on behalf of investment funds are more likely to take out insurance, as they are making decision on behalf of others. However, the interviews revealed that farms managed on behalf of investment funds would still be more likely to select competing production risk management strategies, rather than insurance.

Evidence from interviews shows that competing production and financial risk management strategies are a barrier to insurance uptake, for both corporate and non-corporate farmers. Almond growers have a range of agronomic practices in place for dealing with frost, and for conserving water when there are sustained catchment rainfall deficits, resulting in low allocations and high water prices. Similarly, corporate almond growers have access to external equity to manage production volatility when required.

A lack of understanding or awareness of products was as prevalent a barrier to insurance as in other sectors, despite corporate farms generally having greater internal capacity to take the time to understand the products and assess the return on investment. This may be due to the level of on-farm information required to assess specific frost and hail events over time, given the narrow time frames in which these events occur.

Basis risk and product complexity are also both highly relevant barriers for almond producers uptake of insurance. Basis risk for frost is difficult to manage, as the correlation between objective temperature and frost events is lower than for other perils. Likewise, government decisions, trading rules and allocation rules affect the relationship between catchment rainfall and water ultimately made available for productive use, which proves difficult to account for when developing insurance products. As a result, both frost and water allocations and price risk are two of the most complex risks to build an index for.

### Supply-side barriers to insurance uptake

Supply-side barriers to insurance uptake for almond producers are similar to those in other agricultural sectors. The costs to develop insurance products that are tailored to the industry are high, as there are a range of perils that affect almond production that are highly specific to each growing stage of the plant. Often the window of time in which a peril can affect crop yield is very narrow, but nevertheless can have a high impact on revenue. As a result, there are a lack of cost effective products that are tailored to farmer needs.

Transaction costs associated with marketing and brokering policies to farmers, negotiating agreements and monitoring and enforcing contracts are also high due to the dispersed locations of farms and the time it takes to assess claims, for indemnity products that require an assessment of loss prior to a payout occurring.

The cost of risk to an insurer, cost of portfolio volatility, and bounded rationality are also relevant supply-side barriers, particularly in the context of the increasing high intensity weather events in southern Australia, like hail storms, and the prolonged frost season.

Product distribution barriers are likely to be less pronounced for the almond industry, as most operators are of scale and management capability to assess financial-based risk management tools.

## Options to improve uptake of insurance

The case studies explored several options to improve the effectiveness of insurance with farmers across each agricultural sector. These options included:

- The removal of stamp duty on agricultural insurance
- The development of a digital insurance platform, or central exchange
- Investment in climate and weather data collection and use
- Government provision of insurance or reinsurance, and
- Premium subsidies.

A number of these interventions are likely to have similar effects on insurance uptake regardless of the agricultural sector to which they are applied. For example, the government provision of premium subsidies would lower the cost of current insurance products, thereby increasing insurance uptake. The government provision of insurance or reinsurance, and the removal of stamp duty are also likely to have similar effects on insurance uptake agnostic of commodity type, as they directly change the cost of insurance.

Unlike the options described above, the development of a central exchange and investment in climate and weather data collection and use are two options that would not result in a direct change in the cost of insurance. The effectiveness of these options are more likely to be specific to commodity type, which is what was found through the case study interviews.

Almond farmers were largely positive about using a central exchange to help them analyse various insurance options. One corporate farm manager stated that an exchange would help them be able to compare products for investors, however they would still likely use a broker in conjunction with an exchange, until they had developed a greater understanding of how to use it on their own. Other farmers stated they would happily use a platform independent of a broker, however also reflected it may take some time to properly understand the products.

Responses to the effectiveness of investment in climate and weather data were varied. Common across all farmers was the sentiment that any data used for insurance needed to be accurate and correlate with what was happening on their farms. For some farmers, there already is sufficient correlation between the Bureau of Meteorology's (BoM) weather stations and their farm. For others, this meant having a private weather station on their properties, as they were too far away from the nearest BoM weather station (some were up to 50 km away). Most farmers expressed distrust of or a lack of familiarity with synthetic or gridded data, and felt that it did not offer a level of granularity that was needed for assessing frost events. Many farmers pointed out that they were already in the process of or had recently installed private weather stations or sensors on their farms, however as they did not yet have an historic dataset from them they could not be used for insurance. Overall, there was consensus that more accurate climate and weather data was required, as current data is inaccurate and too loosely correlated with farmers' requirements.

# Case Study 5: Beef cattle production – New England

Case study 5 focuses on beef cattle production in the New England region of northern New South Wales, and analyses the impact of rainfall deficit on pasture grazing. This case study will have relevance to beef cattle pasture grazing in other regions of Australia, including for the dairy industry, however will have more relevance to beef cattle pasture grazing in southern Australian states.

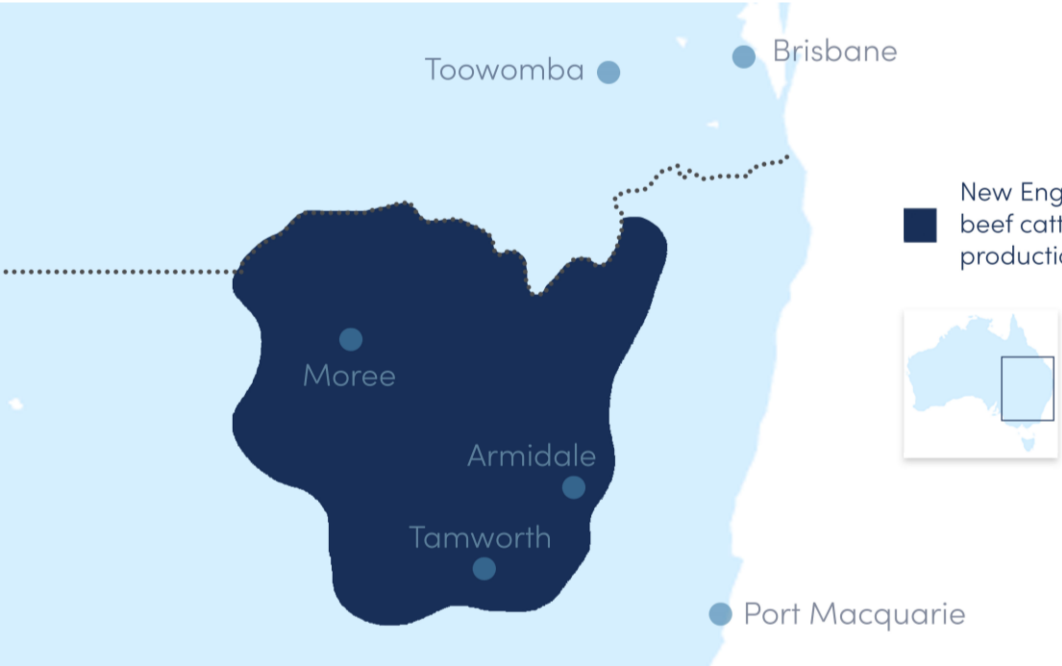



Figure 39 A map showing the New England beef cattle production zone.

## Introduction

Beef cattle production in Australia is the largest contributor to the annual value of Australian agricultural output, with a gross production value of around $10.6 billion in 2019. Cattle producers manage more than 75 per cent of agricultural land across the country, with more than half of all agricultural properties engaged in cattle production. Globally, Australia is one of the top five beef exporting countries, exporting 1.1 million live cattle in 2018.

In 2018–19, the gross value of agricultural production in the New England and North West region was $1.8 billion, which was 15 per cent of the total gross value of agricultural production in New South Wales ($11.7 billion). The region has a diverse agricultural sector - the most important commodities in the region based on the gross value of agricultural production were cattle and calves ($611 million), followed by cotton ($390 million) and wool ($115 million). These commodities together contributed 64 per cent of the total value of agricultural production in the region.

Within New England specialised beef cattle farms (1,617 farms) are the most common type of farm, comprising 41 per cent of farms in the region. These farms also account for 26 per cent of all beef cattle farms in New South Wales, making it the largest cattle and calf producing region in NSW.

Between 2000-01 and 2017-18 there was a decline in the number of cattle farms in Australia of approximately 20 per cent. The majority of the decline (83 per cent) occurred in southern Australia (which includes the New England region), with farms in these regions comprising only 36 per cent of the national herd in 2017-18 (ABARES, 2020). Within North West NSW there was a 20 per cent decline in the cattle herd between 2017-18 and 2018-19 (MLA, 2020). At the start of 2020-21, the Australian beef cattle herd was estimated to be approximately 21.1 million head of cattle, the smallest recorded herd since 1989–90 (ABARES, 2020).

The New England region is a high rainfall area, typically receiving 750mm or mor of annual rainfall spread across the year.

Most beef-producing regions in Australia were severely affected by the past two years of drought. However, since February 2020, widespread and above average rainfall has led to rapid pasture growth, particularly in the south-east. These rapid improvements in production conditions have led many producers to consider restocking, with the sector forecast to move into a period of gradual restocking to reach 21.5 million head by June 2021. At present the smaller breeding herd, combined with strong competition between re-stockers, processors and feed-lotters, will constrain production and exports over the short term.

### *Beef cattle production*

The type and size of production system and end market for beef cattle is dependent on the location of production. In southern Australia beef cattle production is characterised by a large number of relatively small-scale farms, compared to fewer farms with larger herd sizes in northern Australia. The average size of a beef cattle farm in southern Australia in 2014-15 was 412 head of cattle raised on approximately 6,000 hectares (ACCC, 2017).

Most beef cattle producers produce a mix of cattle for both breeding purposes and commercial trade cattle production. These enterprises run cow-calf farms, where a herd of breeding cows and a small number of bulls are maintained to produce calves. The calves that are produced on these farms are either sold at a young age or are grown to slaughter weight and then sold. There are multiple production and sales options for cattle that vary with a cows' weight, including sales to: vealers and weaners, lot feeders, re-stockers, major supermarket chains for slaughter, live exporters and processors Some producers also selectively breed cattle and may sell bulls, cows, calves, stud services or genetic materials. Additionally, producers may also have cattle processed and sell the beef products themselves (ACCC, 2017).

Pasture grazed production in the New England region relies on rainfall fed pasture, typically in high rainfall zones. Rather than relying on natural pasture, some producers plant particular grass types to produce fodder. Cattle can be set-stocked or rotationally grazed. Decisions on grazing and stocking are typically made in autumn, depending on the amount of growth in pasture. In New England cows are typically bred to calve in spring contingent on seasonal rainfall and feed availability. Producers try to align calving with abundant feed to ensure there will be sufficient milk supply for the calves and to maintain the condition of the cows. Calves are typically weaned between 4 – 9 months (200 – 300kg) and fed on pasture (known as the backgrounding phase) –an important phase to ensure that each animal is consuming enough feed to support a strong growth rate. The backgrounding phase is complete when each animal has reached the weight required for the next process in the supply chain – either entering a feedlot or pasture to reach their finishing weight.

The sector has a number of historically large family owned businesses, however is seeing an increasing corporate presence. There are varying degrees of vertical integration, contingent on the size and type of producer. Beef cattle producers typically have strong equity positions, reported to be in the order of 80 to 90 per cent.

ABARES (2019) research has shown the effect of climate variability on the profitability of typical 'small', 'medium' and 'large' beef farms. Smaller farms are less profitable on average, with lower rates of return. They are also more likely to experience low cash income and negative profits during drought years. Smaller farms typically maintain higher equity ratios than large farms and have a larger share of household income coming from off-farm sources (an average of 50 per cent compared to 6 per cent for large farms).

## Risk and risk management

### *Weather production risks*

In a New England cattle production system, there is a complex interaction between short- and long-term climatic perils, primarily based on rainfall deficit. The key peril faced by beef cattle producers in New England is deficient rainfall during the November to February pasture growth period, as pasture growth during this period can sustain the herd during the dormant pasture period during winter. If hand feeding is required or a chosen means of feeding stock during winter then a spring break becomes critically important. Rainfall deficit tends to become problematic when less than 50 millimetres a month is received.

ABARES (2019) estimates that for a typical cattle enterprise, profits can fall from $60,000 in a 'typical year' down to a loss of $5,000 in a 'dry year' Drought has a smaller effect on revenue in the short-term, because in dry years farmers can increase the quantity of livestock they sell. These increased sales help to offset potential reductions in farm prices received for livestock if the effects of drought have had negative effects on livestock quality.

Sustained rainfall deficits across seasons represents a significant revenue peril to cattle producers. In 2019, for example, the New England region received its lowest recorded annual rainfall. In these circumstances, producers are faced with a decision to hand feed cattle for an indeterminate period of time, which may last beyond the period for which that investment could be recouped. Alternatively, de-stocking may preserve cash flow and equity in the short term, but leave producers vulnerable to high cattle prices when feed returns and re-stocking is required.

In extreme events, production fluctuations can have a large effect on sale prices (ACCC, 2017). For example, rapid destocking of properties during a drought can flood the market, and drive down cattle prices.

Destocking can also have cumulative impacts on production. High rates of destocking and slaughter can result in unsustainable slaughter rates of cows (female bovines), meaning that producers will have difficulty rebuilding their herd size in the longer-term. This results in negative profits when the value of the reduced herd size is accounted for, as well as lower farm cash income over the longer-term. The effects of destocking are greater for producers with more valuable breeds or custom herd genetics.

Drought and floods can also impact the availability and cost of supplementary feed or fodder which compounds issues with pasture availability. When pasture and grazing areas are low, supplementary feed is more expensive. This is exacerbated if traditional fodder growing areas are also in drought.

### *Production strategies*

There are a number of production strategies cattle farmers can use in response to rainfall deficit. There strategies include:

- Decision making on the timing of de-stocking and re-stocking the herd, including de-stocking to breeders if entering a period of pasture dormancy with low pasture/feed availability
- Timing calving, weaning and sales to suit pasture cycles
- Pasture management, including the utilisation of rotational or cell grazing strategies
- Production diversification, where farmers combine beef cattle production with other lower input livestock activities
- Geographic diversification, to mitigate the risk of rainfall deficits at one location or vary pasture dormancy periods across landholdings.
- Growing or acquiring fodder during wetter periods to use during dry periods. E.g. supplementary feed such as grains, hay, molasses, silage, cottonseed, lupins etc.

Robust business planning that includes a plan for how to tackle production risk management decision points during periods of low rainfall or drought are essential for cattle producers to effectively manage their herd. This may include valuation of a producers herd, estimating the cost of feeding or agisting the herd, and calculating the cost/benefit of keeping and feeding, or selling and replacing stock, as well as analysing cash flow implications, the peak amount of debt a producer could handle and the security of funding sources (MLA, 2019).

### *Financial strategies*

There are a number of financial strategies available to beef cattle producers that can be utilised to combat financial difficulties from adverse rainfall deficit events. These include:

- Adopting conservative debt to equity ratios, and only taking expansion opportunities when a comfortable debt to equity position can be maintained.
- Seeking higher value markets via improved branding, traceability and sustainability initiatives.
- Maintaining off-farm income through investments and alternative sources of income.

There is a lack of forward pricing mechanisms in the industry, meaning producers have to judge what future prices and returns may be using historical data. This makes it difficult to judge future market trends and doesn't allow producers to mitigate price risk through hedging.

## Insurance product use and uptake

### Indemnity products

Named-peril insurance including fire and theft is available for cattle producers, however its use is limited. Similarly, there is very limited use of insurance to mitigate the effects of flooding in the beef cattle sector, both for stock and other property like fencing, as most basic farm policies do not cover livestock or large runs of fencing. Flood cover is occasionally offered as an extension to basic farm policies or as an opt-in with higher premiums, whereas other basic policies exclude flood altogether.

Indemnity insurance uptake among cattle producers in Australia is low, with the World Bank (2010) estimating that only around 5 per cent of the national herd are insured.

Farmers interviewed for the project revealed that most producers would relying on destocking as a mitigation strategy rather than taking out insurance. Farmers find that the premiums are too expensive relative to other options, and are rising in parts of Australia due to the increased incidence of storms and adverse weather events.

### Index insurance products

Cattle producers currently have the option of taking index cover against rainfall deficit, either at their location, or across a region that provides feed in the event of drought at the farm location. Despite the availability of these products, none of the interviewed farmers or farm advisors reported any New England cattle producers using index insurance. One farm advisor stated that the premiums on offer for his region were too expensive and, as a result, most graziers would not consider using it. Farmers reported that while they were interested in index insurance products to provide a rainfall hedge, the complexity of the product may be a limitation to its use for some farmers, and the relative cost of common production risk management strategies was lower.

A spokesperson for an industry body suggested that NDVI insurance may be attractive to cattle enterprises that have agreements about maintaining their herd in a particular weight class prior to sale. Given the links between pasture health and weight gain, this may be a prospect businesses would consider, however, these types of agreements are predominantly used in northern Australia at present.

## Barriers to uptake

### Demand side barriers to insurance uptake

There are a range of demand-side barriers to insurance uptake that are common across production systems and are applicable to beef cattle production. Some of these barriers include:

- high costs (high premiums for both major product types and in some cases transaction costs for index insurance products),
- a lack of farmer understanding or awareness of available insurance products and their application in that farming system, and
- a distrust of products and insurers.

Unlike the other production systems studied, a lack of risk exposure is a barrier to insurance uptake for cattle producers. Cattle production systems are less exposed to risk due to the ability to de-stock herds and to buy cattle feed during times of rainfall deficit. Additionally, farmers in high rainfall country have less exposure to volatility, because pasture growth is mostly reliable within and across seasons. Pasture management, feed purchase and marketing options also provide more cost effective risk management options than insurance.

Unlike other production systems, cattle producers are generally more risk averse and run conservative balance sheets. Interviews found that a lack of product awareness was also a key barrier to insurance uptake.

### Supply-side barriers to insurance uptake

Supply-side barriers to insurance uptake for beef cattle producers are similar to those in other agricultural sectors. The costs to develop insurance products that are tailored to the industry are high, as the impact of each peril on the production cycle is and farmer decision making is highly specific. As a result, there are a lack of cost effective products that are tailored to farmer needs.

Transaction costs associated with marketing and brokering policies to farmers, negotiating agreements and monitoring and enforcing contracts are also high due to the dispersed locations of farms and the time it takes to assess claims. This is particularly true of indemnity products that require an assessment of loss prior to a payout occurring.

The cost of risk to an insurer, cost of portfolio volatility, and bounded rationality are also relevant supply-side barriers, particularly in the context of the increasing adverse weather events.

## Options to increase insurance uptake

The case studies explored several options to improve the effectiveness of insurance with farmers across each agricultural sector. These options included:

- The removal of stamp duty on agricultural insurance
- The development of a digital insurance platform, or central exchange
- Investment in climate and weather data collection and use
- Government provision of insurance or reinsurance, and
- Premium subsidies.

A number of these interventions are likely to have similar effects on insurance uptake regardless of the agricultural sector to which they are applied. For example, the government provision of premium subsidies would lower the cost of current insurance products, thereby increasing insurance uptake. The government provision of insurance or reinsurance, and the removal of stamp duty are also likely to have similar effects on insurance uptake agnostic of commodity type, as they directly change the cost of insurance.

Unlike the options described above, the development of a central exchange and investment in climate and weather data collection and use are two options that would not result in a direct change in the cost of insurance. The effectiveness of these options is more likely to be specific to commodity type, which is what was found through the case study interviews.

Overall cattle producers expressed an interest in a central exchange as it could provide increased transparency to the insurance market, and could help them understand how index-insurance product work. However, any benefits of a central exchange are predicated on there being a viable market for insuring beef production against adverse weather events.

To the extent that producers in high rainfall cattle production systems will opt to cover longer term rainfall deficits using index insurance, investment in climate and weather data collection and use is not as applicable to cattle production as other farming systems. However, key summer rainfall in the New England region can be spatially volatile, which increases basis risk. Also, where farmers want to cover key, short term rainfall deficit windows (e.g. spring rainfall) that may be volatile in its distribution, more granular data would provide more confidence to farm operators considering parametric coverage.

# Appendix C – Technical documentation

This technical appendix outlines the approach taken to model the insurance market and benefits to farmers and insurers under the different scenarios considered in this report. This includes the formulation of an individual farmer production and insurance model, the overall insurance market model, the approach taken to parameter estimation and simulating farmers.

## Farmer state contingent production model

This section outlines the notation and formulation of the farmer production and insurance model.

### Model notation

Table 48  Set indices

| | |
|---|---|
| $s_d$ | Index of the set of drought states $D$ |
| $s_r$ | Index of pest and disease states $R$ |
| $s_p$ | Index of output price states $P$ |
| $s_w$ | Index of input price states $W$ |
| $s_i$ | Index of insurance trigger states for weather index insurance $I$ |
| $s$ | Index of the set of all states $S = D \times R \times P \times W \times I$ |

Table 49 Model parameters

| | |
|---|---|
| **Agricultural production** | |
| $t$ | Elasticity of transformation |
| $e$ | Farm efficiency |
| $a_s$ | Productivity term in Cobb Douglas production function |
| $b_s$ | Cobb Douglas production function exponent for transformed ex-ante input |
| $c_s$ | Cobb Douglas production function exponent for ex-post input |
| $r_s$ | Yield multiplier for pests and diseases |
| $dc$ | Income from double cropping |
| **Price** | |
| $p_s$ | Output price in state $s$ |
| $w_s$ | Input price in state $s$ |
| **Risk** | |
| $pr_s$ | Probability of state $s$ occuring |
| $ra$ | Farmer risk aversion coefficient |
| **Farm insurance** | |
| $tc$ | Insurance transaction costs |
| $ic$ | Insurance premium unit cost for weather index insurance |
| $y_{thresh}$ | Yield threshold before indemnity insurance payouts are received |
| $ip$ | Insurance premiums for indemnity insurance |
| $vmin_s$ | Minimum allocation of ex-ante inputs in state $s$ for farmers with indemnity insurance |
| $xpmin_s$ | Minimum level of ex-post input in state $s$ for farmers with indemnity insurance |

Table 50  Model variables

| Variable | Description |
|---|---|
| **Agricultural production** | |
| $XA$ | Input committed ex ante |
| $V_s$ | Allocation of ex ante input in state $s$ |
| $XP_s$ | Ex post input after observing state $s$ |
| $Y_s$ | Farm yield in state $s$ |
| $Z_s$ | Agricultural profit in state $s$ |
| **Farm insurance** | |
| $INS$ | Whether insurance is purchased or not |
| $CL_s$ | Insurance claims in state $s$ |
| $DP$ | Payout in drought states |
| $TC$ | Insurance transaction costs |
| $PM$ | Insurance premiums |

## Model formulation

The model is formulated as a constrained non-linear mixed integer optimisation problem of determining the ex-ante and ex-post levels of production inputs, and insurance decisions. The model objective is to maximise farmers expected utility:

$$\max_{XA,XP,INS} E[U_s] = \sum_{S} pr_S\left[1 - e^{-ra[Z_s+INS(CL_s-PM-TC)]}\right]$$

Agricultural production is represented by a nested state contingent production function, motivated by the approach taken by Quiggin and Chambers (2004). A farmer first commits some inputs prior to observing nature. It is possible to direct these inputs towards increasing production in years with weather perils versus years without weather perils (that is, self-insurance) or the opposite. This is constrained by a constant elasticity of transformation function:

$$XA = \left[\sum_{s}\frac{1}{2}{V_s}^{t}\right]^{1/t}$$

A Cobb-Douglas production function then determines the agricultural yield in each state, based on the transformed ex-ante inputs and inputs able to be committed after observing nature:

$$Y_s = e \cdot r_s \cdot a_s \cdot {V_s}^{b_s} \cdot XP_s^{c_s}$$

The profits from agricultural production vary across different states of nature, accounting for both state contingent production and output prices and input costs:

$$Z_s = p_s Y_s - w_s(XA + XP_s) + dc$$

Output prices vary amongst different output price states ($s_p$), while input costs vary under different input cost states ($s_w$). The output price and input cost states are assumed independent of all other states.

The decision to purchase insurance or not is represented through a binary variable:

$$\text{INS} = \begin{cases} 1\ if\ insurance\ purchased \\ 0\ otherwise \end{cases}$$

If insured, a farmer receives claims based on the state of nature and pays a premium and transactions costs regardless of nature:

$$INS \cdot (CL_s - PM - TC)$$

The model considers a single type of insurance product at a time. The form of insurance claims and premiums vary depending on the specified insurance product and are described for weather index insurance and indemnity insurance in the following subsections.

### Weather index insurance

When considering weather index insurance, insured farmers receive a nominated payout in states where weather observations nearby, but not at the farm, are below a threshold level:

$$CL_s = \begin{cases} DP\ if\ s_i =\ drought \\ 0\ otherwise \end{cases}$$

The distinction between weather insurance drought states ($s_i$) and farm drought states ($s_d$) allows for a drought to be experienced on farm, but not recorded at a local weather station and no insurance payout being received. The opposite case is also possible.

Premiums for weather index insurance increase linearly with the nominated payout:

$$PM = ic \cdot DP$$

### Indemnity insurance

When considering indemnity insurance, insured farmers receive compensation for reduced output when their production falls below a certain threshold:

$$CL_s = \begin{cases} p_s(y_{thresh} - Y_s)\ if\ y_{thresh} \geq Y_s \\ 0\ otherwise \end{cases}$$

Premiums for indemnity insurance are assumed equal to fixed constant:

$$PM = ip$$

To account for monitoring and enforcement by insurers, a lower bound is placed on the ex-ante and ex-post inputs of insured farmers:

$$V_s \geq vmin_s \cdot INS$$

$$XP_s \geq xpmin_s \cdot INS$$

## Solving the model

The model is formulated in Pyomo, an open-source optimisation modelling language. Once data have been specified for the parameters, the model is solved using IPOPT for all possible combinations of the binary variables. The solution which maximises the objective function is taken as the optimal solution. IPOPT is an open-source numerical solver for continuous nonlinear optimisation problems.

## Insurance market model

After formulating the model of individual farmer production and insurance decisions, the uptake and market prices of insurance under different market structures can be investigated. For specific set of farm level model parameters, the market equilibrium is solved by:

- estimating supply and demand for insurance from a simulated set of $m$ farmers at $n$ different insurance prices
- numerically determining the equilibrium solution based on the condition for the chosen market structure.

The three market structures considered. Their equilibrium conditions are:

3. **Monopoly:** No competition between insurer suppliers, with the market price maximising insurer profits, $\max_p B_{insurer}(p)$
4. **Competitive:** Perfect competition between insurer suppliers, with the market price resulting in zero insurer profits, $B_{insurer}(p) = 0$
5. **Welfare maximising:** Market prices are set to maximise net benefits to society, $\max_p B_{farmer}(p) + B_{insurer}(p) + taxes(p) - subsidies(p)$.

- Farmer benefits are calculated as the sum of the certainty equivalents across all farmers:
- $B_{farmer}(p) = \sum_i^m \frac{-\ln(1-U_i(p))}{ra_i}$
- Insurer benefits are calculated as the premiums less costs and net taxes:

$$B_{insurer}(\mathrm{p}) = \mathrm{Premiums(p)} - \mathrm{Insurance\ costs(p)} - \mathrm{taxes(p)} + \mathrm{subisides(p)}$$

All costs and revenues are calculated as expectations across all states of nature.

## Parameter estimation

This section outlines the approach to estimating the production function and risk aversion parameters. While not described here, a sample of data collected through surveying farmers and consultations with local farm businesses advisors is used for estimation purposes. Please contact Aither for access to the data underlying the model.

### Farmer production function parameters

The farmer production model uses the following state contingent production function:

$$Y_s = e \cdot a_s \cdot V_s^{b_s} \cdot XP_s^{c_s}$$

$$XA = \left[\sum_s \frac{1}{2}(V_s)^t\right]^{1/t}$$

To estimate the parameters $\boldsymbol{\beta} = (a, b, c, t)$, the efficiency parameter ($e$) is initially fixed to 1 and the following set of simultaneous equations are solved for a typical farmer, over two drought states $s_d \in \{drought, rain\}$.

The typical yield ($Y^{typ}$) produced in each state $s_d$:

$$Y_{s_d}^{typ} = a \cdot \left(\mathrm{V}_{s_d}^{typ}\right)^{b_{s_d}} \cdot XP_s^{c_s}$$

$$XA = \left[\sum_{s_d} \frac{1}{2}\left(V_{s_d}^{typ}\right)^t\right]^{1/t}$$

An alternative yield ($Y^{alt}$) that can be achieved with the same set of inputs ($XA$ and $XP$):

$$Y_{s_d}^{alt} = a \cdot \left(\mathrm{V}_{s_d}^{alt}\right)^{b_{s_d}} \cdot XP_s^{c_s}$$

$$XA = \left[\sum_{s_d} \frac{1}{2}\left(V_{s_d}^{alt}\right)^t\right]^{1/t}$$

The increase in yield ($xpm$) from doubling the ex-post input ($XP$):

$$xpm_{s_d} = \frac{Y(\mathrm{V}_{s_d}^{typ}, 2XP_{s_d})}{Y(\mathrm{V}_{s_d}^{typ}, XP_{s_d})}$$

The increase in yield ($\mathrm{sm}$) from doubling the ex-post input ($XP$) and the transformed ex-ante input in each state:

$$sm_{s_d} = \frac{Y(2\mathrm{V}_{s_d}^{typ}, 2XP_{s_d})}{Y(\mathrm{V}_{s_d}^{typ}, XP_{s_d})}$$

The ratio of transformed ex-ante inputs in each state:

$$\rho = \frac{V_{drought}}{V_{rain}}$$

While the values of $Y^{typ}$, $Y^{alt}$, $XP$, $XA$, $xpm$ and $\mathrm{sm}$ can be obtained from the surveys and consultations, the transformed ex-ante inputs are not explicitly defined and the ratio $\rho$ is unknown. To overcome this, we estimate the parameters for $m$ different values of $\rho$, with the $j^{th}$ value yielding the parameter combination $\boldsymbol{\beta_j}$. The combination of parameters which minimises the sum of squared differences between the modelled and actual yields is then selected:

$$\min_{\boldsymbol{\beta_j}} \sum_{s_d} \left(Y_{model,s_d}(\boldsymbol{\beta_j}) - Y_{s_d}^{typ}\right)^2$$

Where $Y_{modelled,s}$ is calculated based on solving the farmer level optimisation problem for the parameter combination $\boldsymbol{\beta_j}$.

### *Farmer efficiency*

To account for the observed variation in farm efficiency, a farm specific efficiency parameter $e$ is included as a multiplicative factor for each farmer's production function.

The efficiency parameter for each farmer is estimated through a calibration process that determines the minimum efficiency value which equates the modelled and observed income.

The calibration is undertaken by solving a modified version of the model outlined above. The objective is changed to minimise $e$, and an additional constraint included to ensure that the modelled income aligns with the observed income across each drought state.

## Farmer risk aversion

For each farmer in the sample, a risk aversion coefficient ($ra$) is estimated based on equating the expected utility across observed states ($E[U]_{observed}$) and the expected utility based on hypothetical state contingent farm incomes nominated by surveyed farmers as being equivalent ($E[U]_{hypothetical}$):

$$E[U_i]_{observed} = E[U_i]_{hypothetical}$$

$$p(1 - e^{-ra_i \cdot a_i}) + (1 - p)(1 - e^{-ra_i \cdot b_i}) = p\left(1 - e^{-ra_i \cdot (a_i + x_i)}\right) + (1 - p)\left(1 - e^{-ra_i \cdot (b_i - w_i)}\right)$$

Where:

$p$ is the probability that $s_d = drought$

$a_i$ is the observed income for farmer $i$ under state $s_d = drought$

$b_i$ is the observed income for farmer $i$ under state $s_d = wet$

$w_i$ is the stated maximum willingness to pay of farmer $i$ to receive an additional $x_i$ income under state $s_d = drought$.

The risk aversion coefficients for each farmer are solved separately using a standard root finding algorithm.

Due to the small sample of data available for parameter estimation, farmer specific risk aversion coefficients are not used when running the model. The individual risk aversion estimates are pooled together to calculate an average risk aversion coefficient:

$$ara = \frac{1}{N} \sum_{i}^{i=N} ra_i$$

Farmer specific risk aversion coefficients are then assigned through inverse sampling from a chi-squared distribution with a mean equal to $ara$.

# Simulating farms

The farm level model can be run using the estimated parameters and data for each of the $n$ farms in the sample of collected farm data used for parameter estimation. However, the number of farms is relatively small, larger sample of simulated farms is generated when running the insurance market model.

A set of $m$ farmers is constructed by simulating farm efficiency, farm size, and risk aversion for each farm. The following steps are taken to develop a simulated set of m farmers:

- repeating the pairs of farm efficiency and farm size values from the sample $m/n$ times and assigning each simulated farm a farm efficiency and size value
- assigning a risk aversion coefficient to each farm through inverse sampling a chi-squared distribution with an average value equal to $ara$. It is assumed there is no correlation between risk aversion and any other farm properties.
- All other parameters of the model are assumed to not vary between farmers.

# References

Agricultural Produce Commission (WA) (APC). (2020). *APC Carnarvon Banana Producers' Committee*. Retrieved from https://apcwa.org.au/producers-committees/carnarvon-banana

Ashton, D. (2019). *Cotton farms in the Murray-Darling Basin – Department of Agriculture.* Australian Bureau of Agricultural and Resource Economies and Sciences (ABARES). Retrieved from https://www.agriculture.gov.au/abares/research-topics/surveys/irrigation/cotton#cotton--production-in-the-murraydarling-basin

Austin, E., Handley, T., Kiem, A., Rich, J., Lewin, T., & Askland, H. et al. (2018). Drought-related stress among farmers: findings from the Australian Rural Mental Health Study. *Medical Journal Of Australia*, 209(4), 159-165. doi: 10.5694/mja17.01200

Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES). (2019). *Farm performance and climate – Department of Agriculture*. Retrieved from https://www.agriculture.gov.au/abares/research-topics/climate/farm-performance-climate

Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES). (2020). *Australian beef: financial performance of beef farms- Department of Agriculture*. Retrieved from https://www.agriculture.gov.au/abares/research-topics/surveys/beef#data-and-other-resources

Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES). (2020). *Beef and veal: September quarter 2020 – Department of Agriculture*. Retrieved from https://www.agriculture.gov.au/abares/research-topics/agricultural-outlook/beef

Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES). (2020). *Farm survey data – Department of Agriculture.* Retrieved from https://www.agriculture.gov.au/abares/research-topics/surveys/farm-survey-data

Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES). (2020). *The effects of drought and climate variability on Australian farms – Department of Agriculture.* Retrieved from https://www.agriculture.gov.au/abares/publications/insights/effects-of-drought-and-climate-variability-on-Australian-farms

Australian Bureau of Statistics (ABS). (2020). *Value of Agricultural Commodities Produced, Australia (2018-19).* Retrieved from https://www.abs.gov.au/statistics/industry/agriculture/value-agricultural-commodities-produced-australia/latest-release#data-download

Australian Competition and Consumer Commission (ACCC). (2017). *Cattle and beef market study – Final report*. Canberra: Commonwealth of Australia. Retrieved from https://www.accc.gov.au/system/files/ACCC%20Cattle%20and%20beef%20market%20studyFinal%20report.pdf

Australian Financial Complaints Authority. (2020). *About AFCA.* Retrieved from https://www.afca.org.au/about-afca

Australian Prudential Regulation Authority. (2020). *Capital explained | APRA.* Retrieved from https://www.apra.gov.au/capital-explained#:~:text=For%20insurers%2C%20the%20prudential%20capital,buffers%20above%20these%20minimum%20amounts.

Barr, A. (2013). *Government response to Mr Synth's motion regarding analysis undertaken on taxation reform.* ACT Government. Retrieved from https://apps.treasury.act.gov.au/__data/assets/pdf_file/0003/511563/20-Year-Taxation-Reform-Plan.pdf

Birchip Cropping Group (BCG). (2014). *Pre-harvest sprouting in wheat and barley*. Retrieved from https://www.bcg.org.au/pre-harvest-sprouting-in-wheat-and-barley/

Bora, B. (2010). *Subsidised agricultural insurance in Turkey (TARSIM).* Trébol.

NSW Department of Primary Industries (DPI). N.d. *NSW Government response to IPART Report: Review of Multi-peril Crop Insurance Incentive Measures*. Retrieved from https://www.dpi.nsw.gov.au/climate-and-emergencies/droughthub/research-and-development/multi-peril-insurance

Bureau of Meteorology (BoM). (2014). *About potential frost days – Australian Maps*. Retrieved from http://www.bom.gov.au/climate/map/frost/what-is-frost.shtml

Bureau of Meteorology (BoM). (2020). *Australian annual rainfall variability 1900-2019.* Retrieved from http://www.bom.gov.au/jsp/ncc/climate_averages/rainfall-variability/index.jsp

Bureau of Meteorology (BoM). (2020). *Australian rainfall deficiencies 1 January to 31 December 2019*.

Bureau of Meteorology (BoM). (2020). *Trusted Private Automatic Weather Stations (TPAWS) Brief*.

Commonwealth of Australia. (2017). *Australia's general insurance industry: sapping consumers of the will to compare.* Retrieved from https://www.aph.gov.au/Parliamentary_Business/Committees/Senate/Economics/Generalinsurance/Report

Commonwealth Scientific and Industrial Research Organisation (CSIRO). (2015). *Climate change in Australia | Regional Report.* Department for the Environment. Retrieved from https://www.climatechangeinaustralia.gov.au/media/ccia/2.1.6/cms_page_media/168/CCIA_2015_NRM_TechnicalReport_WEB.pdf

Congressional Research Service (CRS). (2018). *Federal Crop Insurance: Program Overview for the 115th Congress*.

Cotton Research & Development Corporation (CRDC). (2020). *Australian Cotton Production Manual 2020*. Monsanto Australia. Retrieved from https://www.crdc.com.au/sites/default/files/pdf/ACPM%202020.pdf

Cotton Seed Distributors. (2014). *Irrigated Cotton Guide*. Monsanto Australia.

Crocker, G., Collett, I. (2003). *Lucerne boosts cereals in crop rotations.* NSW Agriculture. Retrieved from https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0017/146204/Lucerne-boosts-cereals-in-crop-rotations.pdf

Filbeck, G., Hatfield, P., & Horvath, P. (2005). Risk aversion and personality type. *Journal of Behavioral Finance*, 6(4), 170–180.

Freeth, A. (2017). *On Farm Storage and the Grain Supply Chain – Unravelling Logistics and Marketing Puzzle*. Nuffield Australia.

Gan, Y., Hamel, C., Cutforth, H., Zentner, R., Poppy, L., & O'Donovan, J. et al. (2015). Diversifying crop rotations with pulses enhances system productivity. *Crops & Soils*, 49(4), 6-10. doi: 10.2134/cs2016-49-0402

Geisel, P. (2003). *Frost Protection for Citrus and Other Subtropicals*. University of California, Division of Agriculture and Natural Resources. Retrieved from http://homeorchard.ucdavis.edu/8100.pdf

GIO. (2020). *About Us | GIO*. Retrieved from https://www.gio.com.au/about-us.html

Global Index Insurance Facility (GIIF). (2017). *When and How Should Agricultural Insurance Be Subsidized? Issues And Good Practices.* International Labour Organization and International Finance Corporation.

Görlitz, K., & Tamm, M. (2015). Parenthood and Risk Preferences. SSRN Electronic Journal. doi: 10.2139/ssrn.2618442

Government of South Australia. (2017). *Mid-year Budget Review 2017-18*. Retrieved from https://www.treasury.sa.gov.au/__data/assets/pdf_file/0008/38645/2017-18_mid-year_budget_review.pdf

Grains Research & Development Corporation (GRDC). (2018). *Frost Identification Guide for Cereals*. The Western Australian Agriculture Authority. Retrieved from https://grdc.com.au/__data/assets/pdf_file/0020/364205/DPIRD-Frost-Identification-Guide-for-Cereals-2018.pdf

Greatrex, H., Hansen, J., Garvin, S., Diro, R., Blakeley, S., Le Guen, M., Rao, K., Osgood, D. 2015. *Scaling up index insurance for smallholder farmers: Recent evidence and insights*. Copenhagen: CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS). Retrieved from www.ccafs.cgiar.org

GrainCorp. (2019). *GrainCorp enters into 10 year contract to manage eastern Australian grain production risk*.

GrainGrowers. (2019). *Market failure in the crop insurance market*. Syndey. Retrieved from https://www.graingrowers.com.au/graingrowers-2019-multi-peril-crop-insurance-report/

Hanigan, I., Butler, C., Kokic, P., & Hutchinson, M. (2012). Suicide and drought in New South Wales, Australia, 1970-2007. *Proceedings Of The National Academy Of Sciences*, 109(35), 13950-13955. doi: 10.1073/pnas.1112965109

Hatt, M., Heyhoe, E., & Whittle, L. (2012). *Options for insuring Australian agriculture*. Canberra: Australian Bureau of Agricultural and Resource Economics and Sciences.

Hawksford, A. (2018). *Australian Agricultural Insurance Weather Data Options Paper*. Bureau of Meteorology and Insurance Council of Australia.

Healy, D, Gilmour, P, Campbell, J. (2013). Grain and Graze 2 Impact Report. Melbourne: Grains Research and Development Corporation.

Heimoana, S., Wilson, L. (2017). *How much rain is too much? The impact on cotton colour grade*. The Australian Cottongrower.

Hirsch, D. (2020). *Managing Seasonal Weather Risk using Financial Instruments*. Nuffield Australia.

Independent Pricing and Regulatory Tribunal of New South Wales (IPART). (2015). *Review of multi-peril crop insurance incentive measures - Draft Report*. Sydney.

Independent Pricing and Regulatory Tribunal of New South Wales (IPART). (2016). *Review of multi-peril crop insurance incentive measures - Final Report*. Sydney.

Kuhn, S., Hess, U., Hazell, P. (2016). *Innovations and Emerging Trends in Agricultural Insurance*. GIZ. Retrieved from https://www.researchgate.net/publication/306379708_Innovations_and_Emerging_Trends_in_Agricultural_Insurance

Insurance Council of Australia. (2020). *Understand Insurance*. Retrieved from https://understandinsurance.com.au/

Key, N., Prager, D., Burns, C. (2017). *Farm Household Income Volatility: An Analysis Using Panel Data From a National Survey*. U.S. Department of Agriculture, Economic Research Service.

Kimura, S., Antón, J., and LeThi, C. (2010). Farm Level Analysis of Risk and Risk Management Strategies and Policies: Cross Country Analysis. *OECD Food, Agriculture and Fisheries Papers*, No. 26, OECD Publishing, Paris. doi; 10.1787/5kmd6b5rl5kd-en

Kragt, M. & Nery, T. (2019). *Estimating the economic benefits from weather radar investments in the Western Australian wheatbelt*. Report to the Bureau of Meteorology. UWA School of Agriculture and Environment, The University of Western Australia: Perth

Laurie, A., Curtis, M., Heath, R., Darragh, L., & McRobert, K. (2019). *Australian agriculture: an increasingly risky business*. Australian Farm Institute.

Meat & Livestock Australia. (2019). *More Beef from Pastures (MBfP) online manual*. Retrieved from https://mbfp.mla.com.au/#

Meat & Livestock Australia. (2020). *Cattle herd – Population changes: 2018-19 on 2017-18 percentage change.*

Meat & Livestock Australia. (2020). *Heat stress | Meat & Livestock Australia*. Retrieved from https://www.mla.com.au/research-and-development/feeding-finishing-nutrition/Lotfeeding-intensive-finishing/heat-stress/

Mahul, O., & Stutley, C. (2010). *Government Support to Agricultural Insurance – Challenges and Options for Developing Countries.* The World Bank.

Marshall, A. (2020). *GrainCorp banks on $58m insurance boost to drought-hit revenue*. Farm Online. Retrieved from https://www.farmonline.com.au/story/6641075/graincorp-crop-insurance-punt-paying-58m-after-dud-year/

Mußhoff, O., Hirschauer, N., Grüner, S., & Pielsticker, S. (2018). Bounded rationality and the adoption of weather index insurance. Agricultural Finance Review, 78(1), 116-134. doi: 10.1108/afr-02-2017-0008

National Rural Advisory Council. (2012). *Feasibility of agricultural insurance products in Australia for weather-related production risks*.

Productivity Commission. (2005). *Trends in Australian Agriculture*. Canberra. Retrieved from https://www.pc.gov.au/research/completed/agriculture/agriculture.pdf

Queensland Farmers' Federation (QFF). (2020). *Insurance – Queensland Farmers' Federation*. Retrieved from https://www.qff.org.au/projects/insurance/

Quiggin, J. (1997). Altruism and benefit-cost analysis. *Australian Economic Papers*, 36(68), 144-155. doi: 10.1111/j.1467-8454.1997.tb00827.x

Quiggin, J., & Chambers, R. (2004). Drought policy: a graphical analysis. *The Australian Journal Of Agricultural And Resource Economics*, 48(2), 225-251. doi: 10.1111/j.1467-8489.2004.00249.x

RevenueSA. (2018). *2018-19 State Budget – Revenue SA*. Retrieved from http://www.revenuesa.sa.gov.au/generic-pages/news-articles/2018-state-budget

Rochester, I. (2009). *Using rotation crops to improve soil quality.* Grains Research & Development Corporation (GRDC). Retrieved from https://grdc.com.au/resources-and-publications/grdc-update-papers/tab-content/grdc-update-papers/2009/10/using-rotation-crops-to-improve-soil-quality

Shanteau, J. (1992). Decision Making Under Risk - Applications to Insurance Purchasing. *Advances In Consumer Research. Association For Consumer Research (U.S.),* 177-181. Retrieved from https://www.researchgate.net/publication/262840410_Decision_Making_Under_Risk_-_Applications_to_Insurance_Purchasing

Siebert, S., & Ewert, F. (2014). Future crop production threatened by extreme heat. *Environmental Research Letters*, 9(4), 041001. doi: 10.1088/1748-9326/9/4/041001

Steffen, W., Rice, M., Hughes, L., & Dean, A. (2018). *Factsheet: Climate Change and Drought June 2018*. Climate Council of Australia. Retrieved from https://www.climatecouncil.org.au/wp-content/uploads/2018/06/CC_MVSA0146-Fact-Sheet-Drought_V2-FA_High-Res_Single-Pages.pdf

Syngenta. (2020). *Agriclime – confidence to invest in a better crop | Syngenta*. Retrieved from https://www.syngenta.com.au/agriclime

TARSIM. (2018). *2018 Annual Report*. Republic of Turkey.

TARSIM. (2020). *About Corporation*. Retrieved from https://web.tarsim.gov.tr/havuz/subPageEng?_key_=6D7415BE31795E0576A7CE18FEDB4F2E406252491HL36S36S61K2H28ER24062015

Terrill, D., Nguyen, N. (2017). *Multi-peril crop insurance in Australia: barriers and opportunities.* Deloitte Access Economics. Retrieved from https://www2.deloitte.com/au/en/pages/consumer-industrial-products/articles/multi-peril-crop-insurance-australia-barriers-opportunities.html

U.S. Department of Agriculture. (2020). *Crop and Livestock Insurance | USDA*. Retrieved from https://www.usda.gov/topics/farming/crop-and-livestock-insurance

Vroege, W., Dalhaus, T., & Finger, R. (2019). Index insurances for grasslands – A review for Europe and North-America. *Agricultural Systems*, 168, 101-111. doi: 10.1016/j.agsy.2018.10.009

Wells, L. (2018). *Demand for water shrinks central, southern NSW cotton area*. Grain Central. Retrieved from https://www.graincentral.com/cropping/cotton/demand-for-water-shrinks-central-southern-nsw-cotton-area/

Whish, J., Bell, L., Zull, A., DeVoil, P. (2018). *Analysis of risks and returns for different crop sequences. Climate and financial risks associated with rotations of differing types and intensities.* Grains Research & Development Corporation (GRDC). Retrieved from https://grdc.com.au/resources-and-publications/grdc-update-papers/tab-content/grdc-update-papers/2018/02/analysis-of-risks-and-returns-for-different-crop-sequences.-climate-and-financial-risks-associated-with-rotations-of-differing-types-and-intensities

Zillman, J. (2001). *A Hundred Years of Science and Service: Australian Meteorology through the 20th Century*. Retrieved from https://www.austehc.unimelb.edu.au/fam/1595.html

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