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Australian Agriculture:
An Increasingly Risky Business

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Australian Farm Institute

New thinking about agriculture

Australian agriculture: an increasingly risky business

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Executive summary

Risk is ever-present in Australian agriculture. It is not a new issue for farm businesses and has in fact often been the driver for new ideas, innovation and change. However, the nature of these risks is constantly changing, and so the need to understand the tools available to address and manage these risks, and to ensure that the risk management marketplace matches the needs of farm businesses, is greater than ever.

Good farm business practice has been effective in driving a strong and resilient farm sector economy.

The most practical and effective way to address multiple known risks simultaneously (as well as protect against new, emerging and unknown risks) is through farm business management which strengthens financial resilience and delivers the ability to absorb production, market and institutional shocks. The fact that the Australian farm sector has continued to grow - while exposed to significant risk, and in the absence of both Government support comparable to other nations and a mature income insurance market - is an indicator that good farm business practice has been effective in driving a strong and resilient farm sector economy.

However, for commodity subsectors and on an individual farm business basis there are multiple defined risks specific to industry or location for which more tailored risk mitigation tools can form an important part of the farm business management toolbox. Insurance and weather derivative products, for example, can provide effective and cost-efficient methods for practically eliminating risk for certain events. In many cases though, where these products are available, they remain underutilised or in market failure.

There is a further need to understand how risk appetite interacts with decisions of cost/benefit before forecasts of likely uptake can be made.

Improved financial literacy and understanding how insurance and derivative products work would raise awareness for farm businesses of the potential utilisation of these products. However, even with better understanding of the functional specifics of risk mitigation products there is a further need to understand how risk appetite interacts with decisions of cost/benefit before forecasts of likely uptake can be made. Risk appetite is individual, cultural and differs between subsectors and regions. Industry advocacy and

other promotion of risk management products needs to take these cultural factors into account when communicating the potential benefits.

The threat of new and emerging institutional risk factors is quickly becoming a major concern for industry. Institutional risk will play a significant role in the future viability of the sector. Institutional risks associated with competition and supply chain dynamics may be accelerating but are nonetheless familiar to most agricultural supply chain actors. New and emerging institutional factors (e.g. community trust issues such as animal welfare and potential glyphosate regulation) have created the greatest uncertainty and increased risk for producers - and indeed the entire agricultural value chain - in recent times. These risks are unlikely to diminish, as they are the product of an increasingly active and engaged consumer base.

The threat of new and emerging institutional risk factors is quickly becoming a major concern for industry.

An appropriate industry response to institutional risk is complex and perhaps one of the more difficult tasks for industry going forward. There is no easy or quick fix as there is unlikely to be an institutional risk mitigation 'product' developed. Building financial resilience via farm business practice is the most effective way to mitigate institutional risk, as this resilience provides time to recover from unanticipated shocks. However, unlike production and market risks, some institutional risk factors can potentially be avoided altogether through industry action to avert the hazard before it becomes a risk.

Recommendations:

1. New and developing institutional risks are a multi-faceted and significant threat to many agricultural sectors. Industry bodies and advocacy groups should **coordinate to monitor sector-specific and cross-sectoral institutional risks** and proactively develop effective responses.
2. Government and industry should collaborate on a **consistent and cooperative education approach** to:
    a. raise the sector's level of financial literacy

   b. increase awareness of types and levels of risk, and
   c. provide resources to develop diverse approaches to ameliorating risks.
3. Given their applicability and cost-effectiveness as a general risk management tool, **barriers to the use of FMDs should be investigated and removed**.
4. **Behavioural economics filters** (e.g. perceptions of cost related to risk appetite) **should be applied in the development of risk managements products** such as insurance and derivatives to expediate uptake.
5. **Weather derivative products** competing in the agricultural insurance market place **should be licensed** in the same manner as other agricultural insurance products.
6. Government and official statistics agencies (i.e. ABS, ABARES) should support and **enable the supply of appropriate industry data** to enable better risk assessment.
   a. The focus should be on the provision of more granular weather data plus utilisation of IoT sensors and satellite information.
7. **Continued investment in R,D&E** should be considered an essential part of the Government's investment in risk mitigation, to develop new technologies such as more drought tolerant fodder species and grain types as well as improved weather and climate forecasting.
8. A cost/benefit analysis should be performed on the redirection of Government funding currently targeted to risk consequences (ex post) into **stimulation of private market risk mitigation products and improving farm business / supply chain risk management.**
9. If incentivisation of private market risk mitigation products is required, due consideration must be given to both **supply and demand** stimulus, rather than demand alone.

1. Introduction

Risk is a fundamental feature of Australian farming and agribusiness, yet the availability and uptake of a diverse range of risk mitigation products in Australian agriculture is immature compared to some other nations.

This project aims to develop a better understanding of the risk exposure of Australian agriculture subsectors using available data, and to analyse a range of different options available for agricultural risk management. These options or tools include the adoption of different business models (for example forward selling or contract supply arrangements), the use of either domestic or internationally traded soft commodity derivatives, a suite of commercial risk products (such as named insurance; multi-peril crop insurance (MPCI) and weather derivatives) and farm business management strategies (enterprise diversification; high equity; alternative sources of income) as well as mutual funds and government programs. The advantages and disadvantages of each were analysed and discussed in a series of industry interviews.

The research culminated in the development of an assessment framework to compare different risk management strategies and the identification of potential initiatives which could facilitate improved risk management options for Australian agricultural businesses.

The research covers the following subsectors of agriculture:

- Beef cattle
- Sheepmeat
- Wool
- Grains (wheat)
- Pork
- Cotton
- Sugar
- Dairy
- Poultry (meat and eggs)
- Horticulture (fruits and vegetables)

The main outcomes of the research are:

1. A **clear understanding** of the nature of risks faced by farm businesses operating in the agriculture sector in Australia
2. **Examples of risk management options** for participants in the main commodity subsectors of Australian agriculture
3. An **evaluation** of the adequacy of current risk management options available to Australian farmers and agribusinesses
4. **Identification of policies and industry initiatives** that will assist in the development of better risk management strategies for the operators of Australian farm businesses.

1.1 Scope and methodology

The research presented here aims to gauge a better understanding of risk across different commodity subsectors and to analyse and evaluate the risk management options available on a commodity-by-commodity basis.

The initial stage of research involved a literature review, considering a broad range of information sources at both an international and local level. The review provides relevant context on the availability, adequacy and effectiveness of risk management options in different international jurisdictions. Section 2, *Approaches to agricultural risk management* provides commentary on the review and major findings across selected countries including Australia. The Literature Review is attached in full as *Appendix 2*.

Arising from the literature review as well as industry interviews, a selection of risk management options was identified for further analysis. These options are detailed in Section 3, *Examples of risk management options.*

The second stage of research evaluated the level of risk to which Australian agricultural subsectors are exposed. Market and production risk were calculated and an assessment of institutional risk relevant to each subsector was made so that scores for these three categories of risk could be allocated to each subsector. Each risk management option analysed was also scored for its ability to mitigate the three different risk categories (Section 4, *Risk evaluation*).

The final stage of the research involved construction of an evaluation framework using the risk scores allocated in Section 4 to investigate the appropriateness of risk management options for each of the subsectors analysed (Section 5, *Sector analysis*).

1.2 Background

From the earliest days of European settlement, participants in the modern Australian agriculture sector have had to learn how to manage the inherent risk associated with farming in this country. The near-starvation of the first European settlers during the period from January 1788 to June 1790 provided a very early lesson about the necessity of factoring risk into agricultural management systems in Australia.

Generally, the risk faced by agricultural businesses can be separated into three broad components:

- **Production risk**: associated with the production system on-farm, including climate, disease, inappropriate management etc.
- **Market and Price risk**: derived from fluctuations in the market value of farm produce, due to supply and demand, exchange rate fluctuations and other related factors, and
- **Institutional risk**: associated with changes external to either production or market factors, such as government policy changes, trade restrictions etc. (Harwood, Heifner, Coble, Perry, & Somwaru, 1999)

Historically, national and state governments in Australia assisted farmers to manage production risk by maintaining a variety of different farm assistance measures to supplement farmers' incomes during periods of 'exceptional circumstances' (EC). These measures included access to cheap finance and the waiving of a range of different state government charges, as well as the provision of family welfare measures and farm business support in the form of grants and interest rate subsidies. The EC measures were triggered with increasing frequency over the period from 1980 to 2010. A series of reviews commencing in 2010 resulted in an Intergovernmental Agreement on National Drought Program Reform in 2013 (implemented from July 2014). This replaced existing drought and EC measures with an easier-to-access farm family welfare support measure, but essentially removed farm business support measures such as

interest rate subsidies. The Australian Government has also subsequently made available some low-interest loans for eligible farm businesses.

One of the major criticisms of previous Australian Government drought policy is that the availability of these measures (and earlier statutory marketing arrangements) 'crowded out' the development of commercial agricultural risk-management options. It was anticipated that one of the outcomes of the 2013 Intergovernmental Agreement would be the freeing up of the market for development of a wider range of risk-management options.

However, five years later a mature commercial market for agricultural risk products has yet to emerge in Australia, and the revised National Drought Agreement (COAG, 2018) signed between the Federal, state and territory governments in December 2018 seems materially similar to the 2013 agreement.

2. Approaches to agricultural risk management

This section provides commentary on the literature review presented in this report as *Appendix 2*. It addresses different attitudes towards risk at an institutional or governmental level internationally, as well as the range of government supported risk management programs and market instruments for risk management. To provide a diverse perspective the countries or regions investigated were:

- Europe
- Canada
- United States
- Brazil
- New Zealand
- Kenya

A summary of recent Australian reviews into agricultural risk management concludes the section.

Key points

- Globally, farmers and agricultural supply chains have access to a large range of risk management tools from simple, informal production measures to more sophisticated financial and index-based products to manage risk as well as government support.
- Policy addressing agricultural risk in most jurisdictions is structured around three key layers of risk which require different policy responses:
    1. normal risk (frequent risk that should be absorbed and managed by farmers via informal tools),
    2. marketable intermediate risk (transferred/pooled through market tools), and
    3. catastrophic risk (requires government assistance).
- Mature and efficient commercial markets for risk management products are generally made possible through government support mechanisms. There are very few examples globally of viable agricultural income insurance markets that have established without government support.
- Many of Australia's major agricultural competitors have access to generous and heavily subsidised agriculture insurance schemes to alleviate risk.

2.1 International attitudes to agricultural risk

The attitudes to risk in the regions considered in this review reveal a spectrum of expectations regarding farmers and government sharing the cost of agricultural risk with the common theme that the government should be involved in some way, if only in the event of catastrophic risk events.

At one end of the spectrum sits New Zealand (NZ), where most literature suggests that producers perceive risk as a normal part of business that provides not only threats but also opportunities. As such, the support provided by the NZ Government for market-based agricultural risk tools is next to none since deregulation of the NZ economy (starting in 1984) removed all price support payments for farmers and adjusted the exchange rate. This resulted in reductions in land values simultaneous with increase in farm input costs and debt, and predominately resulted in wider exposure to market risks. In response to these challenges, NZ farmers developed great resilience

and the industry's ability to respond to market demand, increased competition and responsiveness improved, of which risk management was a key component.

In the European Union (EU) it is broadly understood that farmers should be encouraged to deal with normal business risk themselves through on-farm risk management strategies. However, government support exists to help stabilise farm incomes but with the attitude that government policy should facilitate, rather than crowd out, the use of various market instruments that are available to manage risk.

In Canada there is an expectation from farmers that part of the cost of agricultural risk should be borne by the government (particularly in the event of catastrophic risk). Risk management in Canadian agriculture is therefore comprehensively supported by government policy. An OECD review in 2011 concluded that the suite of risk management programs offered was successful in stabilising incomes of farmers faced with volatile production and market conditions. However, the review also noted that the comprehensive nature of these policies crowded out the ability of the market to develop and provide risk management solutions and reduced the incentives for farmers to take ownership of their individual, on-farm risk management strategies. The Canadian agricultural industry has been growing and farming is increasingly profitable. Although many factors contribute to this growth, improved risk management is likely to have played a significant role.

Risk management in agriculture in the United States (US) similarly relies heavily on government provided and subsidised crop insurance and other revenue protection programs, authorised under the Agricultural Act of 2014. This Act included a significant shift in policy with the elimination of fixed direct payments to farmers which had been part of agricultural policy since 1996. Direct payments were replaced by enhanced crop insurance and new programs to protect farmers against risks leading to downturns in price and revenue.

Agriculture is one of the more temperamental elements of Brazil's economy, being a physically large and complex system with significant regional, economic and sectorial heterogeneity which is intensely manifest in the agriculture sector where "globalised companies and poor peasants, cutting-edge biotechnology and mattocks, soil conservation and burn-and-slash practices co-exist side by side" (Vieira Jr, Buainain, Madi, & Leda, 2008). Modernisation of the agricultural sector has resulted in increased risk and producer vulnerability due to the complexity and

interconnectedness of Brazil's production system. The approach to managing agricultural risk in Brazil has shifted in recent times from mitigation and intuition to comprehensive and technical management.

Kenyan farmers rely heavily on government assistance for risk management. Due to resource constraints, mechanisms to reduce the impact of hazards or offset risk in Kenyan agriculture are more closely associated with coping with applied risk as opposed to proactively managing and avoiding it.

2.2 Government supported risk management programs

European agriculture is centred on the Common Agricultural Policy (CAP) introduced in 1962. The objective to manage agricultural risk is recognised by the CAP with a fundamental focus on stabilising farm income. The policy is founded on two key pillars:

- **Pillar I – Market and Price Support Policy** deals with annual direct payments to farmers to help stabilise farmer income. Direct payments are the main instrument in the CAP to address financial risk by providing a stable form of income regardless of market conditions. In 2016, direct payments totalled €41 billion or 73% of the total CAP expenditure, benefitting 6.7 million farmers across the EU.
- **Pillar II - Rural Policy** addresses rural development and includes a set of optional measures with economic, environmental or social objectives. Risk management tools under Pillar II for the 2014-20 period are:
    - Insurance which is promoted by financing up to 65% of premium costs.
    - Mutual Funds which can counter risks of adverse selection and moral hazard and can compensate against consequential losses, which is difficult for insurance to compensate against (given the high premium cost).
    - Income Stabilisation Tool (IST) which works much like a mutual fund; however instead of compensating for production losses, compensates for severe income losses exceeding 30% of the average annual income**.**

The heterogeneity of risks across EU agriculture results in a decentralised approach, allowing for delivery of instruments that are best suited to a region or sector. The toolkit provided for

agriculture under Pillar II allows regions to choose from a range of tools best suited to individual conditions, while retaining the context of a broader strategic approach to risk management through the Rural Development Policy.

Federal and provincial governments of Canada develop and provide a suite of business risk management (BRM) programs. These include a whole farm margin protection program (AgriStability), insurance against natural hazards (AgriInsurance) of which 60% of the premium is subsidised by the government, a savings account where deposits receive a matching contribution from government (AgriInvest) and a framework to assist with natural disaster relief (AgriRecovery). These programs have varying levels of adoption and success but have generally been well received by the agricultural sector. Outside of the BRM programs, the Canadian government administers supply management of the dairy, poultry and egg industries. Supply management involves production control (quotas allocated among farmers), a pricing mechanism and import control to maintain stable and "fair" prices for farmers and reduce effects of production and market risks.

Farmers in the US have access to a wide range of insurance products and commodity programs administered by the United States Department of Agriculture's (USDA) Risk Management Agency (RMA). Federal crop insurance is made up of a range of coverage options including insurance against yield losses and revenue losses (mitigating yield and price downturns) with options to insure for individual performance or country performance. Additional coverage can be obtained to cover for catastrophic yield losses of greater than 50%. Federal crop insurance policies are widely adopted, with 90% of American cropland insured in 2015 (McFadden & Hoppe, 2017) with government subsidised premiums recognised as a key factor of wide adoption. The overall cost of crop insurance to the government is projected to be $89.8 billion from 2014 to 2024. Insurance options are also provided for livestock producers with livestock risk protection, a form of price insurance, and livestock gross margin, which insures against declines in gross margins due to commodity and/or feed costs. A recent addition to insurance offerings is Whole Farm Revenue Protection (WFRP) - first made available to all farmers in the US for the 2016 crop year after a pilot period - which provides coverage for revenue of all commodities produced on a farm under one insurance policy. The RMA also provides

commodity programs such as price loss coverage (PLC) which essentially sets a floor price for wheat, feed grains, rice, oilseeds, peanuts and pulses and provides a payment when the market price falls below the insured price. Dairy farmers in the US can insure a margin between milk price and feed costs through the margin protection program (MPP). The margin is calculated monthly based on the national all-milk price and a calculated average feed cost. Payments are made when the actual monthly margin falls below the coverage level threshold. Participation is high with 71% of US milk production insured in 2017. The Congressional Budget Office (CBO) projects a total net expenditure of $1.84 billion for this program over the next 10 years. The 2018 Farm Bill proposes to charge lower premiums on the first five million pounds of milk production on a dairy and to increase the catastrophic coverage level on that production.

In Brazil there are at least 21 distinct government policies or programs that either directly or indirectly address farm risk via financial or production insecurity. They include, but are not limited to:

- PPGPM (Policy of Minimum Guaranteed Prices) - 1966
- Proagro (Agricultural Activity Guarantee Program) – 1973 – an exemption from financial obligations of rural credit in the case of disaster
- National Food Supply Company (CONAB) - 1990
- PAA (Food Acquisition Program) – 2003
- Proagro-Mais – 2004 – agricultural insurance
- PSR (Support of Rural Insurance Premium) – 2005
- National Program for Strengthening Family Agriculture (PRONAF) – 2006
- Price Guarantee Program for Family Farming – 2010
- Fund for Rural Catastrophe – 2010

Most of these policies focus on mitigation rather than transfer or response; however, a report produced by the World Bank, the Brazilian Agriculture Research Company (Embrapa) and the Ministry of Agriculture, Livestock and Food Supply (MAPA) suggested that significant gaps in the risk transfer and response strategy are in need of policy attention.

State support of production, with the aim of increasing farmers' productivity and ensuring food security, continues to be strong. The current policy for agricultural price support in Brazil is still

mostly based on direct government intervention. Government policies or programs to directly or indirectly address farm risk are well-established. Insurance is provided by the federal government through the annual Agricultural Plan (PAP). However, a large share of resources for price risk mitigation is still used for government buyout policies, either through direct or indirect acquisitions.

Agriculture in Kenya has a long history of government investment in risk mitigation, transfer, and coping mechanisms. Current risk management strategies deployed by the Government of Kenya (GoK) include:

- National Agriculture Insurance Program (2016)
- Drought Risk Management Authority (2011)
- Disaster Risk Reduction Program
- National Climate Change Action Plan
- National Hunger Safety Net Program

Kenya's *Vision 2030* recognises the need to strengthen existing risk management systems, and the GoK has launched a range of new initiatives to confront the most severe threats facing the country. The National Agricultural Insurance Program (NAIP), launched in March 2016, is a significant program which marks a major shift away from disaster relief. The NAIP classifies and assesses impacts on regions as 'units'. The units are paid according to a yield penalty threshold, as opposed to everyone receiving a payout. One program line will focus on livestock insurance (the Kenya Livestock Insurance Program) while another will focus on maize and wheat insurance (the Kenya Agricultural Insurance and Risk Management Program).

New Zealand's Income Equalisation Scheme allows farmers to deposit part of their income into an account and have it excluded from taxable income until it is withdrawn. In addition to the tax benefit, deposits earn interest at 3% per annum. Aside from this scheme, the only other direct government policy for agricultural risk management is funding for erosion control and providing welfare benefits for hardship following natural disasters such as flooding or drought.

2.3 Market instruments for risk management

Insurance

Private sector insurance mechanisms are less prevalent than government supported schemes, but some examples exist in the reviewed countries.

In the US, where Federal Crop Insurance dominates the market, crop-hail insurance is popular with $36.2 billion worth of US crop protected from losses due to direct damage from hail in 2016. Some policies allow for endorsements of other perils such as wind and fire, but hail is the primary single peril covered.

Single peril crop insurance covering hail is also the most extended type of insurance in the EU. Although they are private-based schemes, they are heavily supported by government. An average 32% of the insurance premium paid is subsidised but it is as high as 60% in Spain which has the most developed insurance system.

Cattle and pig producers in some western provinces of Canada can participate in the Western Livestock Price Insurance program (WLPIP) which provides protection against a fall in commodity prices. Participants pay a premium to receive coverage for up to 95% of the price forecasted for the time of sale. If a decline in price occurs, producers are paid the difference between the insured price and the market price at the time of sale. The WLPIP maintains a small level of government support but is not part of the government provided AgriInsurance.

Current insurance schemes in NZ only exist for wheat and kiwifruit but have previously covered more commodity sectors with funding by self-imposed farmer levies. Low availability of insurance options for certain risks in NZ is believed to be reflective of a history of low farmer uptake.

Private sector insurance mechanisms in Kenya remain relatively underdeveloped due to problems of moral hazard and adverse selection. Analysing the risk insurance environment in Kenya requires a number of considerations, primarily because there are no distinct definitions of a farmer. As a consequence of the limited nature of private risk management products, producers usually turn to self-insurance strategies such as production diversification, off-farm employment and social mechanisms.

Commodity marketing

Livestock and crop producers in Canada and the US have access to well established futures markets allowing them to adopt a wider range of marketing strategies for managing market risks.

Commodity marketing strategies typically include a mix of cash market and futures markets to achieve target prices and minimise exposure to declines in prices. The buying and selling of futures and options contracts is primarily used as a risk management strategy rather than the delivery of physical commodities, evidenced by less than 1% of all futures contracts resulting in actual physical delivery of the contract. Instead, futures contracts are used to hedge by taking opposite positions in cash and futures markets. Options give a buyer or seller of a commodity the right, but not an obligation, to buy or sell an underlying commodity (or commodity futures contract) at a specified price within a specified time period. Options provide producers with protection against falling prices (similar to taking a short futures position) but unlike a futures contract, options also allow the producer to take advantage of any increase in price. The cost of being able to protect downside risk but still able to capture upside potential is the premium cost of the option. Participation in futures markets remains inconsistent, largely due to the level of time, expertise and resources required to execute a successful strategy using these tools. Minimum contract sizes also exclude many small producers from entering futures markets. Canadian farmers typically use US futures markets, adding currency risk to their decision making.

Futures markets are utilised much less in the EU in part due to the CAP guaranteed price system historically limiting price fluctuations. Following reforms, gradual exposure to price fluctuations led to the first futures market in Europe being established in 1992 which remained popular

throughout the early 2000s. However, due to the lack of market participants these markets have largely disappeared with only 3-10% of European farmers currently estimated to take out futures compared to 30% of US farmers. However, recent changes in policy have created conditions conducive to the potential development of a strong futures market. Forwards contracts are also not widespread in the EU but do exist; for grains and oilseeds, particularly in France, pigs in Denmark, and broadly in the dairy and poultry sectors of Hungary and Slovenia with a strong uptake of benchmark contracts.

New Zealand dairy farmers are able to hedge milk prices with a futures contract scheme. The dairy futures market was created in 2016 and expanded upon the global dairy futures and options market launched by the NZ Stock Exchange (NZX) in 2010. Rather than locking in a price for a percentage of milk production as per a fixed milk price scheme, NZX's futures and options contracts operate whereby trading parties buy and sell futures contracts to hedge their exposure to movements in the milk price. For example, if the farmgate milk price declines, the drop in the price a farmer receives from a processor for milk supplied will be offset by a gain on the futures contract. Futures markets allow producers, manufacturers and farmers manage price risk and help level the playing field for NZ dairy producers who have a high export exposure (95% of production is exported) and compete in the global market with risk-supported counterparts in the US and Europe.

The main market tools to manage risk in Brazilian agriculture are futures markets, insurance markets and farm product bonds. The Brazil Farm Product Bond - Cedula de Produto Rural (CPR) - facilitates cash forward contracts for agricultural and livestock production, enabling producers to collect resources or inputs beforehand by offering their production capacity as collateral to financers. Commodity-reference bonds represent an obligation to deliver agricultural products on an agreed future date (CPR in kind) or equivalent value cash (financial / indexed CPR). Created in 1994 to enable advance sales and capital flow (similar to futures), these can only be issued by farmers, cooperatives and farmers' associations. An important factor of CPRs is reduction of risk to the buyer. CPRs are used primarily by middle to large producers.

2.4 Australian reviews of agricultural risk management

There is considerable evidence that Australian farm businesses use a range of different strategies to manage risk in a highly volatile operating environment, undertaken with little to no government support (NRAC, 2012). However, Australian agricultural risk management systems are generally much less developed than other countries. Is there scope for more diversity in the market for risk management products, providing more choice for farm businesses?

Studies comparing volatility in yields and returns for farmers in Australia with those experienced by farmers globally have highlighted that Australian farmers collectively face higher levels of risk than virtually any other farmers in the world (Figure 1) (Keogh, 2012; Kimura, Antón, & LeThi, 2010).

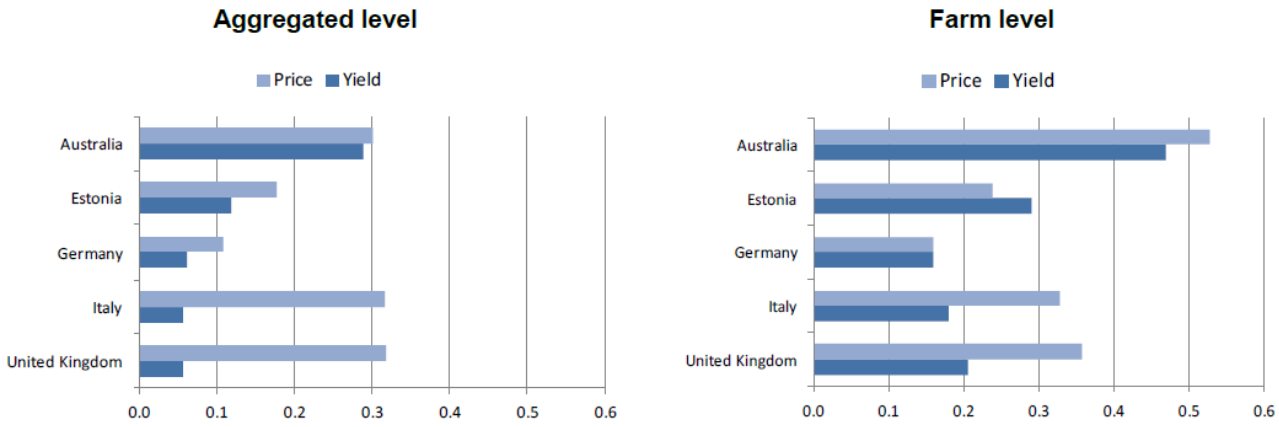


Figure 1: Comparison of price and yield variability in wheat, at the farm and aggregated national level (source: Kimura et al., 2010)

Within Australia, agriculture's volatility has recently been assessed by the Australian Bureau of Agriculture and Resource Economics and Sciences (ABARES) and identified as being nearly double that of any other industry (Figure 2).

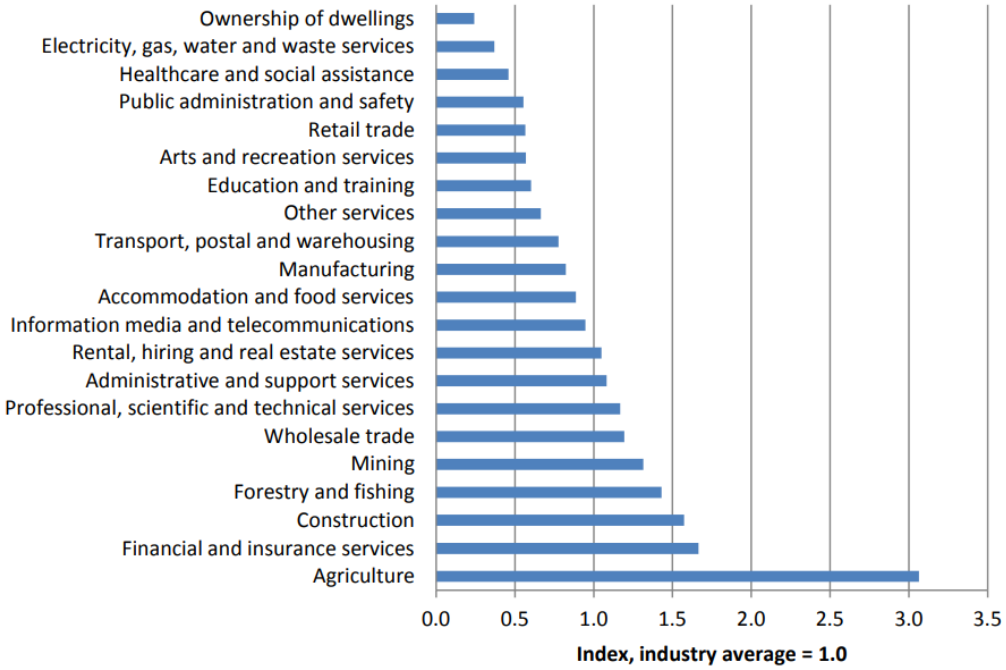


Figure 2: Industry output volatility 1975-2011 (source: Hatt, Heyhoe, & Whittle, 2012)

Literature examining agricultural risk in Australia has tended to centre on insurance options and other market tools, rather than looking at the development of overarching risk management frameworks which incorporate a range of different strategies required for various sectors of agriculture. Research has also tended to focus on the challenges of risk management at the farm level, however as value chains within Australian agriculture have become more interconnected, risk exposure has increased and is becoming a significant issue for all businesses in the agriculture supply chain (ASC) – financiers, input suppliers, processors, retailers and farm businesses alike.

However, several recent reviews have investigated a range of risk management options available to agriculture and evaluated whether Government support is warranted. Analysis and findings from the National Rural Advisory Council (NRAC), ABARES, the Independent Pricing and Regulatory Tribunal (IPART), Grain Growers Limited and Dairy Australia have been considered in this report and are summarised below.

Review of multi-peril crop insurance incentive measures, IPART 2016

This 2016 review of MPCI incentive measures against the drought program evaluation framework considered a range of options for improving the uptake of MPCI including:

- **Upfront premium subsidy** – temporary subsidy likely to be more effective to help develop the commercial market for MPCI (IPART model suggested 50% subsidy for first two years, falling to 25% for next 3 years, capped at $15,000 per farm).
- **Stamp duty waiver** – reduction in costs from waiving stamp duty would be too small to materially change uptake rate of MPCI.
- **Farm business skills professional development program** (NSW Government) – considerable overlap with Commonwealth Managing Farm Risk Program, not likely to directly contribute to increased uptake of MPCI, assists farmers in assessing options for managing drought.
- **Additional weather stations** – improved weather information might improve insurers actuarial model, likely to lead to largest net benefit per dollar spent.
- **Sharing information with insurers** – specifically, sharing NSW Rural Assistance authority data, financial information not accompanied by production data therefore unlikely to materially contribute to improving insurers model.

Feasibility of agricultural insurance products in Australia for weather-related production risks, NRAC 2012

The NRAC observed that while several types of insurance products are currently available for agricultural risk management in Australia, they are not sufficiently comprehensive to address farmers' concerns (NRAC, 2012). The abandonment of EC grants in 2013 provided an urgent need to investigate options to establish liquid and viable markets for insurance (and other risk management tools).

Experience to date indicated that multiple peril crop insurance schemes, including MPCI and mutual schemes, were not commercially viable in Australia in 2012, and were unlikely to become viable in the absence of a high and continuing level of government subsidies to cover

premiums costs, administration and operating costs, and reinsurance costs. These findings were consistent with previous reviews conducted in 2000, 2003 and 2009.

Options for insuring Australian agriculture, ABARES 2012

This report produced by ABARES (Hatt, Heyhoe, & Whittle, 2012) investigated the potential role of insurance and related products in risk management by surveying the literature on agricultural insurance.

The inability of private markets to provide all the tools necessary for farmers to manage risk has been used to justify government intervention in agricultural insurance markets internationally. Australia is one of the few countries to maintain a strong farming sector in which many of these tools are absent and without Government support.

This report found that the failure of traditional insurance products to achieve commercial viability stems from the inability of private markets to solve the problems of asymmetric information and systemic risk. International experience shows that unless these underlying problems are addressed, subsidisation of agricultural insurance schemes may become an ongoing cost burden to government and will not lead to commercially viable insurance markets.

While the report found that there is no evidence to suggest an economic case for Government subsidisation of agricultural insurance premiums and, to a lesser extent, support reinsurance, the authors suggested Government intervention may be justified on other grounds; for example, to address market failures by providing additional data or assisting in the development of new index-based insurance tools.

Managing risk using multi-peril crop insurance, Grain Growers 2017

This report on managing risk using MPCI is to date the most comprehensive overview of MPCI policies available to Australian farmers (Grain Growers, 2017).

Based on a Grain Growers member survey held in early 2017, this report found that a contributing factor in low MPCI uptake among grain producers included a lack of information

about, and understanding of, available policies and providers, and the high cost of applications and premiums. It also highlighted the large variation in premiums paid based on location, cropping history and risk profile.

An extensive review of the MPCI product range confirmed that a number of MPCI types have been offered on the market, including some products which prevent losses by covering the costs associated with producing a crop, and others that provide proportional income surety by offering to top up farm income to a proportion of historical returns.

Risk management tools for Australian dairy, Dairy Australia 2016

Dairy Australia commissioned a comparative analysis of risk management tools and techniques available to the Australian dairy industry (conducted by Shainwright Consulting and Research Group) which investigated a range of potential options based on international learnings, focused primarily on price risk.

The discussion paper (Dairy Australia, 2016) concluded that while questions remain over the ability or willingness of milk processors to transfer risk to milk producers, two broad options could be developed by milk processors to help Australian milk producers to mitigate risk with their milk price:

Option 1: A Margin Protection Scheme:

- Allows farmers to insure against a deteriorating gross margin
- Most suited to farms that buy in feed
- Based on indexed insurance, not individual farm outcomes, thus reduces moral hazard and adverse selection
- Gives farmers a chance to insure a margin – not just output price
- Can be packaged with broader rural/farm insurance
- Farmers need to fully understand the operating mechanisms

Option 2: Forward Contracting Mechanisms:

- Various schemes widely used in US, Europe, NZ

- Offered by processors offsetting milk prices; and/or
- Can be offered by processors linked into futures markets
- Allows farmers to limit exposure to market volatility
- Suitable for all milk producers

2.5 Summary

A conceptual framework for agricultural risk management developed by the World Bank sets out a case for an integrated and holistic approach to agricultural risk management (Figure 3).

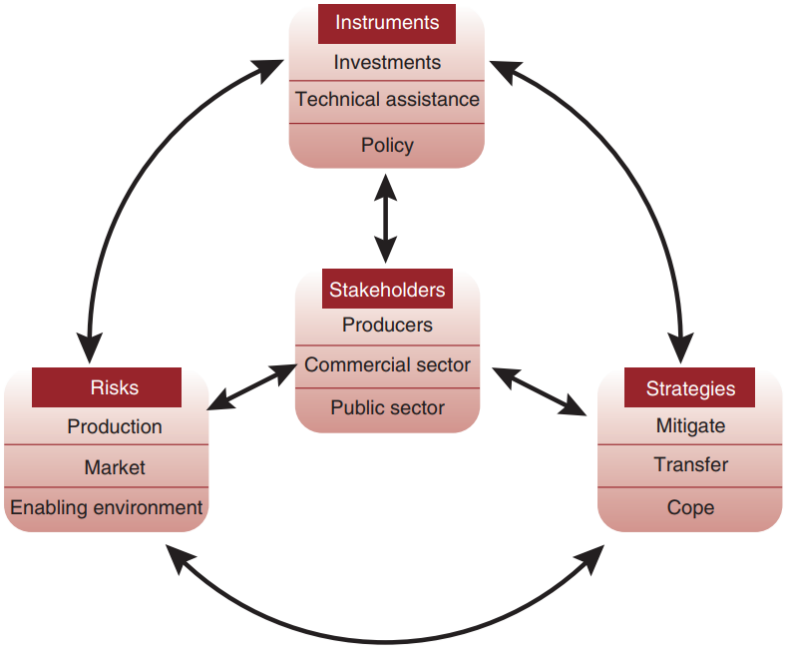


Figure 3: Conceptual Framework for Agricultural Risk Management - (Source: Choudhary et al., 2016)

This framework describes an environment where multiple risks are managed through a variety of instruments and strategies by multiple stakeholders. In an ideal environment these factors are balanced such that agricultural risk management helps to improve food security, increase economic growth and ensure sustainability.

While literature on agricultural risk to date has rarely ventured beyond the farm gate, risk management is increasingly being recognised as a supply chain issue, and for all businesses across the ASC risk management itself is a growing business opportunity.

Effective risk management requires a combination of measures, some designed to remove underlying constraints, some to address risk directly and others to deal with the after-effects. Risk management in farming takes into account a myriad of factors, including demand, yields, quality, quantity, regulation and compliance, weather, cost of production, marketing parameters and exchange rates. In addition, climate change is exacerbating the difficulties in managing on-farm risk by shifting the frequency and intensity of weather-related risks and increasing uncertainty (Choudhary et al., 2016).

While products such as MPCI, government subsidies, futures and swaps are often the focus of industry discussion as the instruments of risk mitigation and management, improved decision-making is still the most important tool for proactively managing agricultural risk. Developed and enhanced over time, proactive farm management is regarded as one of the earliest and most common forms of risk management and tends to underpin practices in the vast majority of production systems today.

In regions where market tools such as insurance are well subscribed by farmers, governments have tended to strongly support producer uptake via various incentives. For example, agricultural risk management in Canada and the US is comprehensively supported by government policy. The cost of Canada's AgriInsurance premium is shared between the producer (40%) and provincial and federal governments (60%). In the US Agricultural Risk Coverage provides payments to individual producers when the actual county revenue for covered commodities fall below 86% of the benchmark revenue. Sharing the cost of risks between producers and government improves the affordability of insurance and other programs.

Where government support has enabled a high level of participation in risk management programs, more producers are likely to have stable incomes which is clearly beneficial for the success of agricultural industries and rural communities. However, an OECD 2011 review into the Canadian system (Antón, Kimura, & Martini, 2011) also noted that the comprehensive nature of these government supported policies crowded out the ability of the market to develop and provide risk management solutions and reduced the incentives for farmers to take ownership of

their individual, on-farm risk management strategies; a criticism also levelled at the Australian Government in relation to drought management and mitigation policies.

The international literature and Australian reviews in *Appendix 2* illustrate that the ideal conceptual framework for agricultural risk management (Figure 3) remains elusive. While all the players described in the framework exist in most jurisdictions, government policies or industry structures inevitably lead to environments where the relationships between the players are asymmetrical or out of balance. For example, overwhelming public sector support can lead to limited ability for the commercial provision of risk mitigation tools

In Australia, past policy has aimed at coping with risk (through government disaster relief programs) rather than mitigating or transferring risk, although this policy has changed significantly in recent times. If this change of policy is to be successful, then a range of options addressing multiple risks for multiple stakeholders needs to be available. The next section describes a selection of risk management options and goes on to assess the effectiveness of those options in addressing agricultural risk.

3. Examples of risk management options

It has been established that Australian agriculture has a range of tools at hand to help successfully manage risk and farm business managers have been proactively seeking out appropriate risk management solutions to drive resilience, performance and growth of the sector.

Table 1 identifies and characterises a selection of risk management options for Australian agriculture. Options that have been chosen for analysis in this report are those that are either already readily available and commonly used by farm businesses or are available but used to a lesser extent. Risk management options that exist in global markets but are unlikely to become available in Australia - for example, subsidisation of production or other programs that require a high level of direct government intervention - have not been included in this analysis.

Although the current project has largely focused on farm business, the identification of risk management options includes those available to Australian farmers and the wider industry, including agribusiness and other supply chain participants.

The list of risk management examples presented is thorough; however, it is not exhaustive. It is intended to provide insight and inform the development of an evaluation framework capable of assessment of each risk management option. The examples are also useful for identifying any gaps in the availability of risk management options and potential industry or government policies or initiatives that may assist in the development of better risk management strategies in Australian agriculture.

While a number of the options presented are generic to the entire agriculture sector (such as farm business diversification, maintaining high levels of equity and securing alternative sources of income), there are others noted that are specific to a particular commodity or supply chain business arrangement.

Government-provided programs remain important in helping at an individual enterprise level, for example, the Managing Farm Risk Program and Farming Together Program. These programs have not been assessed as part of the evaluation (Section 4) but have been noted as important educational offerings, designed to support the overall risk management position of an individual enterprise. A short summary of each follows.

Government programs

Managing Farm Risk Program (MFRP)

The MFRP provides rebates for advice and assessments required for applications for insurance policies that address the management of drought and other production risks (Department of Agriculture and Water Resources, 2017). To be eligible, participants need to have applied for a new insurance policy covering peril or climatic events that have not been insured against in the past five years. One rebate is permitted per eligible farm business with a grant value ranging up to $2,500. The total amount available is $903,000 (“GrantConnect: Current Grant Opportunity View - GO625,” 2017).

Farming Together Program

Farming Together helps farmers to work together through co-operative business models, taking greater ownership along the supply chain and increasing returns at the farm gate. It is a $14.9 million Federal Government initiative open to primary producers under criteria set by the Australian Tax office. The program is split into three phases:

- Knowledge platforms - providing access to relevant information to assist decision making
- Expert support – access to expert advice about co-operative structures and other forms of collaboration
- Farmer group projects – provides funding for collaborative business approaches, project funding is a competitive process (Department of Agriculture and Water Resources, n.d.-a)

Examples of available options

Table 1. Examples of risk management options for Australian agriculture

Risk management option	Description of option	Limitations	Availability/use examples
Named peril insurance (hail, fire, frost)	• Insurance policy that provides coverage for a limited number of adverse weather events that are explicitly listed in the policy • Indemnifies producer for a physical crop loss	• Does not cover for all perils (often key perils cannot be covered) • Limitations apply to maximum sum insured	• Horticulture – fruiting trees and crops insurance for fire, hail, frost, windstorm • Uptake rates vary for broadacre crops (cereals, grains) • For industrial crops (cotton, sugar) high uptake rates, low market penetration for orchard crops and horticultural ground crops
Multi-Peril Crop Insurance (MPCI)	Simultaneously covers damage/loss for a range of perils, which may include: • Drought • Water stress • Flood • Hailstones • Wind • Frost • Lightning • Excessive rain • Heat stress • Snow • Hurricane • Chemical overspray	• Limited product offering • High cost of premiums – ongoing cost • Upfront cost – application fee • Time cost – collection of detailed farm data/records • Systemic risk – requires comprehensive reinsurance program on behalf of insurer (priced into premiums) • Data limitations/difficulty gathering data, impacting design and pricing of policy • Confusion around product offering	• Cropping – Current MPCI policies are restricted to winter crops (wheat, barley, oats, canola) and uptake is low • Excludes coverage for livestock, summer grains and horticulture

	• Cyclone • Tornado • Accidental fire • Bushfire • Wildlife • Wandering livestock • Weed infestation • Insect or pest manifestation • Plant disease Yield and/or revenue loss for full cost of production Range from coverage for broadacre products to more comprehensive coverage for many aspects of farm business Insures farmers for 50-75% of expected yield	• Lack of awareness on how it can fit into long term risk management plan • Cost will vary depending on perils covered, yield/revenue variability • Not all risks are insurable. Risk is only generally insurable if an insurer is able to cover expected losses and risk management and operational costs reliably at a price both profitable to insurer and affordable to the market.	
Weather derivatives	• Ex ante agreement to indemnify producer against a predetermined and/or modelled index • Measurement of index determined by independent third party • Doesn't require a physical crop loss provides protection from uncertainty of normal weather or climate • Can be tailored to producer risk profile and budget	• Requires clearly defined, easily measured/quantifiable unit of measure for which exposure can be assessed • Must have adequate historical dataset from verified source (to base index off) • Basis risk (trigger is met at your location but not at selected measurement point or trigger is met at measurement point but not at your location)	• Immature market with many products only recently available. • Take-up and awareness low across all sectors. • CelsiusPro Australia claims do not need to be assessed, once the event occurs there is an automatic payout based on data received from BOM (ABARES 2012 report – options for insuring Australian agriculture)

	• Can be low cost depending on event insured • Reduces admin cost as no need for loss assessment	• Agents need Financial Services Licensing • Basis risk is likely to be higher the further the weather station is from the farm (ABARES 2012 report – options for insuring Australian agriculture)	
Farm level management strategies • **Enterprise / production diversification** • **High equity levels** • **Alternative sources of income**	• Well developed and tested business models that have been developed to cope with uncertainty • Creates resilience either through spreading risk among different enterprises, building equity to absorb financial shocks or providing alternative less risky revenue	• Alternate source of income may inhibit insurance eligibility if earning over a certain amount • Diversification requires a more complex set of business management skills • Difficult for new entrants to achieve equity levels required • Achieving level of profitability required to enable alternative investments	• Availability only limited by business/financial aptitude and capability.

Mutual Funds	• Cooperative approach to pooling and distributing risk	• Can be difficult to coordinate, governance needs to be professional and accountable • Poor past performance of mutual funds may lead to negative perceptions	• Farmers Mutual Limited (discretionary mutual fund) – only mutual fund currently in operation in Australia, managed by farmers • Currently is limited to grains, cotton, extensive livestock and mixed farming industries
Government programs	• Additional supporting programs/tools that help to assist farm businesses manage risk • Can help to smooth income • Works to improve understanding of risk management and products that are available to farm businesses	• Cost to public purse of establishing and maintaining programs • Questions around effectiveness • Low uptake • Strict eligibility criteria • Application and process can be lengthy and complicated	• Industry specific examples such as Dairy Support Package (for businesses affected by the Murray Goulburn and Fonterra decisions to reduce farm gate milk prices) • Farm Investment Loans • Drought Loans • Farm Innovation Fund

Farm management deposits (FMDs)	• Scheme assists producers with fluctuations in cash flows. It is designed to increase effective management of financial risks by building up cash reserves • Provides ability to deposit funds and defer applicable tax to the year the funds are withdrawn	• Companies and trusts not eligible to hold FMDs • Strict eligibility for holding FMDs • Must hold the FMD for at least 12 months to retain taxation benefits • http://www.agriculture.gov.au/ag-farm-food/drought/assistance/fmd/information-for-primary-producers#how-can-an-fmd-benefit-me	• Available to individual primary producers operating as a sole trader or partner in a partnership • Number of active FMD accounts as at October 2018 = 51,434 - value of deposits = $5.5 billion (ABARES 2018)
Futures	• Standardised forward contract that is exchange traded (Kang & Mahajan, 2006) provides a tool for price risk management	• Opportunity costs • Basis risk • Requires high financial literacy to use effectively • Some futures markets lightly traded adding risk	• Not available for all agricultural commodities e.g. no futures market for chicken meat • Need to work though accredited broker or financial services provider
Forwards	• Agreement between the seller and buyer to deliver a specified quantity of a commodity to the buyer at some time in the future for a specified price.	• Legally bound to deliver a specified quantity on a given date (Kang & Mahajan, 2006) • Exposes seller to significant extra risk if production is less than expected	• Commonly used across cropping sectors – grains, cotton, sugar

4. Risk evaluation

4.1 Subsector exposure to Production and Market risk

A key outcome of the research was to define the extent and nature of risks faced by farm businesses at a sectoral level within Australian agriculture. Within the Australian agricultural sector, there are a range of different commodity subsectors, each of which experience differing levels of volatility in commodity production volumes and prices.

Volatility has been previously used to understand exposure to risk in "Including risk in enterprise decisions in Australia's riskiest businesses" (Keogh, 2012). The research reported here used the same approach to initially calculate volatility indexes for the subsectors investigated. Production and market data for the commodity subsectors was obtained for the period 2000-2016. The primary data sources were official statistics issued by the Australian Bureau of Statistics (ABS) and the Australian Bureau of Agriculture and Resource Economics and Sciences (ABARES). Where there was a lack of publicly available data for some sectors, official statistics were supplemented with industry-sourced statistics. This data was utilised to calculate trend estimates.

Relative production and price volatility were estimated by calculating the standard deviation of the percentage difference between actual and trend value of each data point over time. Given the variable and non-linear nature of the bulk of commodity production and price data, a third order polynomial trend line was determined to provide a satisfactory trend estimate. This formed the basis for calculating all the volatility estimates presented in the analysis. The relative volatility of each subsector was then indexed around the average for the entire sector (average for sector set at 100) as shown in Table 2 and Table 3 (represented visually in Figure 4).

Where available, monthly price series data was accessed. However, to allow for consistent comparison across subsectors, averaged annual commodity price data was assessed for subsectors to develop the index.

Table 2. Index of relative volatility in Australian farm production (based on historical time series data 2001-2016)

Sector	Whole period (2001-2016)	2001-2009	2010-2016
Beef cattle	97	104	85
Sheepmeat	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
All commodity average	100	100	100

*commences from 2004 rather than 2000 due to inconsistent data

Table 3. Index of relative volatility of Australian agricultural market prices (based on historical time series data 2000-16)

Sector	Whole period (2000-16)	2000-09	2010-16
Beef cattle	79	58	112
Sheepmeat	93	98	96
Wool	88	94	89
Grains (wheat)	127	163	65
Cotton	138	73	210
Sugar	87	109	59
Dairy	77	94	58
Pork	56	71	26
Poultry – eggs*	154	141	187
All commodity average	100	100	100

* commences from 2004 rather than 2000 due to inconsistent data

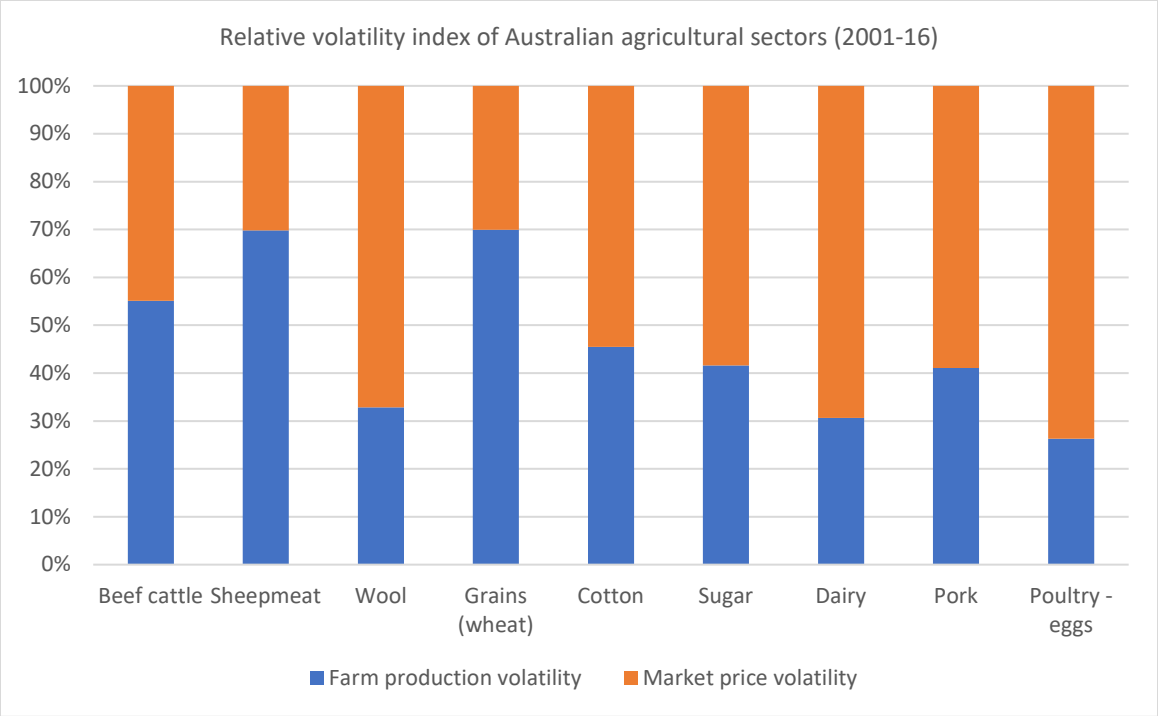


Figure 4: Comparative relative volatility index of Australian agricultural sectors (2001-16)

Development of the index was hindered by the lack of availability of consistent public production and price data series for some of the agriculture subsectors. Volatility indexes were not calculated for the Poultry–meat and Horticulture subsectors because of the lack of data. Also, Poultry–eggs data commences from 2004 rather than 2000 due to inconsistent data. A detailed list of the data series and sources used is available in Appendix 1.

The analysis presented here is at a subsectoral level using national production figures and average prices received over the whole country. Even at this high level however, it is evident from the calculated indexes that the sectors investigated experience very different levels of volatility in both production and markets. A number of general conclusions can be made from the results.

Production volatility varies enormously depending on the sector's exposure to climatic risk. For example, wheat has consistently experienced a much higher level of production volatility relative to any other subsector, however even within the wheat sector there are still distinct periods of production volatility relating to climate. Production volatility for the period from 2000–09 (corresponding with the Millennium Drought) was significantly higher than that for 2000–16.

Cotton production also has experienced large volatility in production as the crop is either rain-grown or irrigated using low security water entitlements thus subject to the same climatic pressures as wheat, however sugar production is less volatile as the bulk of the crop is either irrigated with relatively secure irrigation entitlements or grown in relatively safe rainfall environments.

In the intensive animal agriculture sectors such as dairy, pork and poultry, production tends to be less volatile as systems are not directly exposed to climatic risk. Changes in output also occur in a more predictable way in response to market trends or industry structural issues.

Market volatility is particularly evident in the subsectors which have an export focus such as wheat and cotton. Poultry–eggs, however, is also extremely volatile and this is likely driven by rapidly changing supermarket pricing trends for product categories such as free range and organic eggs.

In order to provide a comparison of production and market risk to institutional risk and to fit into the evaluation framework for risk management options, the production and market volatility indexes were converted to risk scores as per the scale in Table 4, resulting in the Production and Market risk scores displayed in Table 5.

Table 4. Risk score calculation from volatility index

Index value (higher index value = greater risk):	Risk Score	Level of risk
0-19	1	Very low
20-39	2	Low
40- 59	3	Small
60 - 79	4	Minor
80-99	5	Moderate
100- 119	6	Sizeable
120 - 139	7	High
140 - 159	8	Very high
160 - 179	9	Major
180 +	10	Extreme

Table 5. Production and Market risk scores for Australian agricultural subsectors

Sector	Index – production volatility	Production risk score	Index – market (price) volatility	Market risk score
Beef cattle	97	**5**	79	**4**
Sheepmeat	215	**10**	93	**5**
Wool	43	**3**	88	**5**
Grains (Wheat)	296	**10**	127	**7**
Cotton	115	**6**	138	**8**
Sugar	62	**3**	87	**5**
Dairy	34	**2**	77	**4**
Pork	39	**2**	56	**3**
Poultry - eggs	55	**3**	154	**8**

4.2 Subsector exposure to Institutional risk

In order to calculate an Institutional risk score for each sector a qualitative assessment was completed analysing regulatory, supply chain, contractual and other risks that together describe the Institutional risk to which each subsector is exposed. Assessments were made for each of the following:

- Competition
  - Extent of competition in the market place (1 = Plentiful competition; 5 = No competition/monopolistic)
- Contracts
  - Flexibility in contractual arrangements throughout the supply chain (1 = Competitive/diverse contractual arrangements; 5 = Onerous/restrictive contracts)
- Government
  - Likelihood of Government policy change impacting viability e.g. native vegetation or threatened species legislation, animal welfare legislation and changes to live export requirements or other social licence-induced change (1 = very small likelihood of change; 5 = High likelihood of change)
- Trade
  - Trade restrictions or trade uncertainty (1 = very small likelihood of trade disruption; 5 = high likelihood of trade disruption impacting viability)
- Supply chain
  - Increasing consolidation in the supply chain, ageing or unreliable supply chain infrastructure (1 = stable and efficient supply chains with multiple participants; 5 = unstable/ageing or consolidated supply chains)

The total score (out of a top score possible of 25) was then divided by 2.5 to give an overall Institutional risk score out of 10 to enable comparison (1 = low institutional risk; 10 = high institutional risk) as shown in Table 6.

Table 6. Calculation of Institutional risk scores

Institutional risk	Beef	Sheepmeat	Wool	Grains (Wheat)	Cotton	Sugar	Dairy	Pork	Poultry-eggs	Poultry-meat	Horticulture
Competition	2	2	2	1	1	4	3	4	3	4	4
Contractual arrangement	2	2	2	2	2	4	4	3	3	5	4
Gov. policy change	4	4	3	2	4	4	2	4	4	4	2
Trade restrictions	3	4	1	3	1	2	2	3	1	1	1
Supply chain	3	3	2	4	2	4	4	3	4	4	3
TOTAL	14	15	10	12	10	18	15	17	15	17	14
Risk Score:	**6**	**6**	**4**	**5**	**4**	**7**	**6**	**7**	**6**	**7**	**6**

Figure 5 depicts the comparative risk scores for the subsectors across production, market and institutional risk.

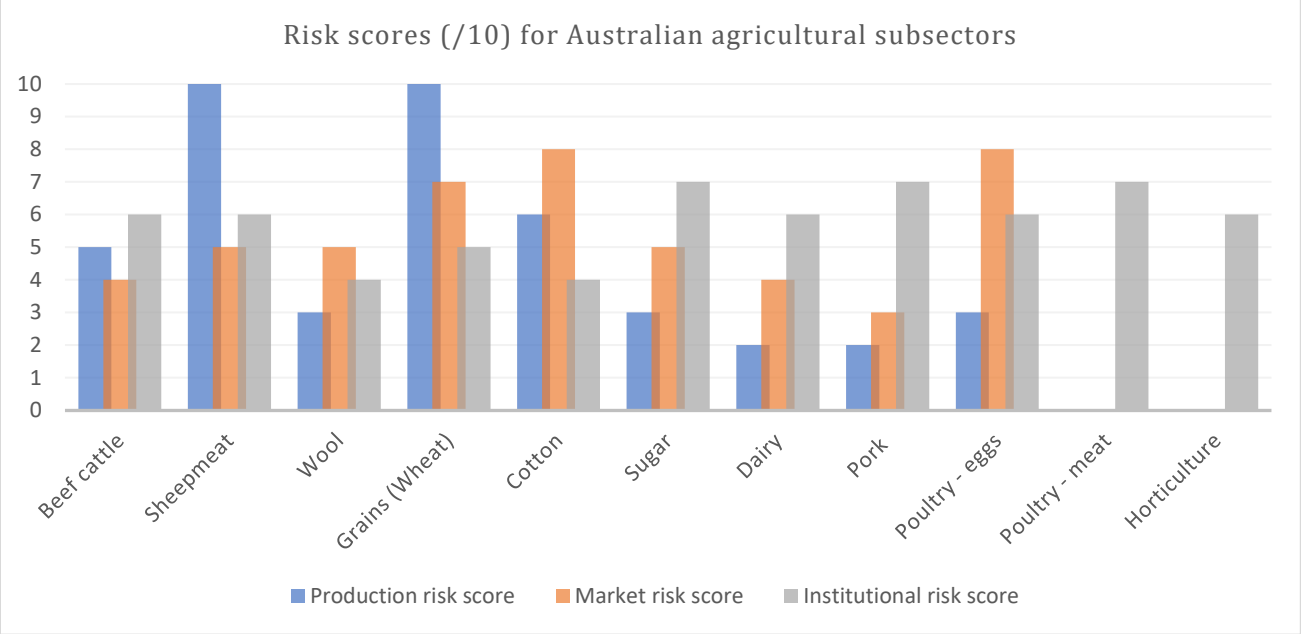


Figure 5: Comparative risk scores for Australian agricultural subsectors

4.3 Effectiveness of available options in mitigating risk

To evaluate how effective various available risk management options are in mitigating the three broad components of risk described above, effectiveness scores were allocated to risk management options on a scale of 1-10 as described in Table 7.

Table 7. Risk management effectiveness scores

Score	Effectiveness
1	Not effective – does not mitigate risk
2-4	Somewhat effective – mitigates a small proportion of risk
5-6	Effective – mitigates risk generally
7-9	Quite effective – mitigates a significant amount of risk
10	Completely effective – fully mitigates risk

The scoring procedure was used to evaluate the risk management options described in Section 3 *(Examples of risk management options)* as shown in Table 8 and Figure 6.

Table 8. Scores for effectiveness of risk management options in mitigating risk

Option	Production risk	Market risk	Institutional risk
Futures	2	9	2
Forwards	1	7	2
Named Peril Insurance	6	1	2
Multi-Peril Crop Insurance	9	2	2
Weather derivatives	8	1	2
Enterprise diversification	6	8	6
High equity	5	5	5
Alternative income sources	7	7	7
Mutual funds	6	1	2
Government programs (FMDs)	6	6	6

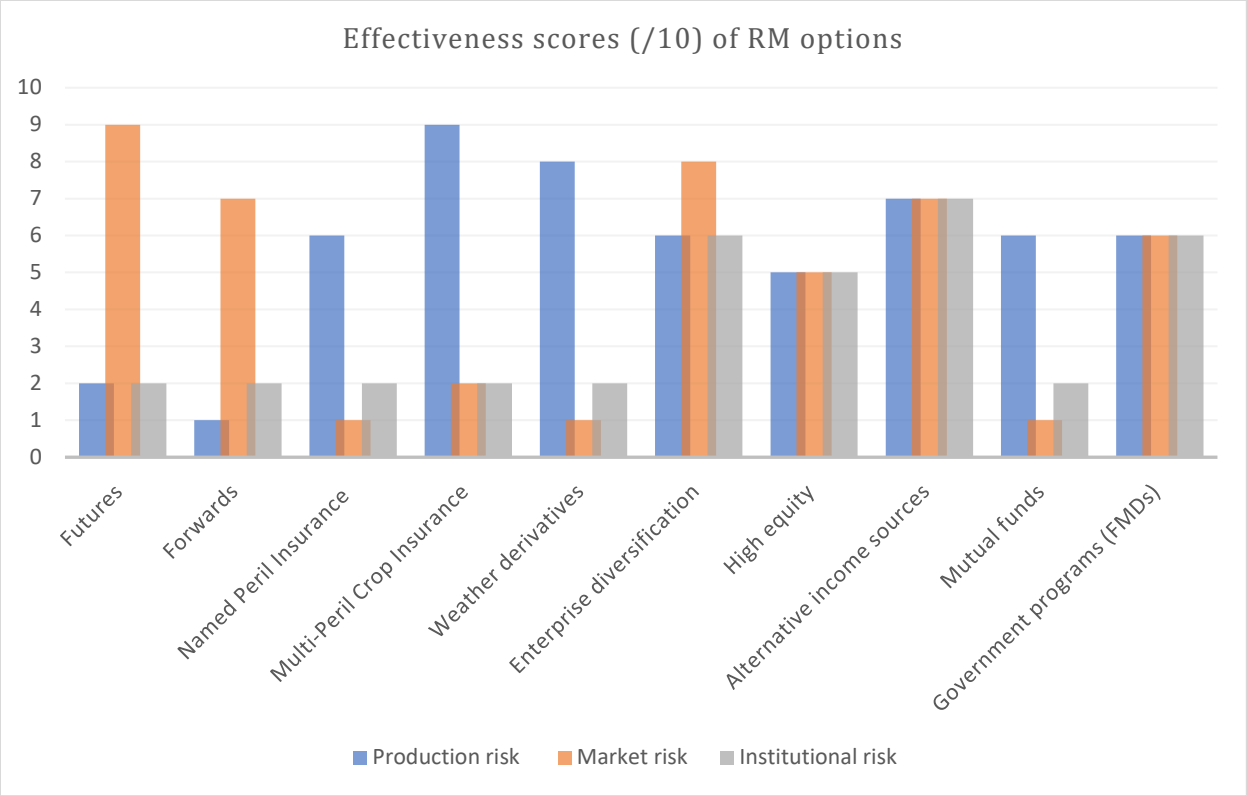


Figure 6: Comparative effectiveness scores of RM options in mitigating risk

The risk management options were scored as broad categories in terms of the way they are designed and targeted to help address production, market and institutional risk. The authors acknowledge that there may be specific products within these categories of risk management options that offer more detailed or nuanced risk mitigation. While recognising the general nature of the assessment, there are however some observations that can be made about the effectiveness of the risk management options reported on.

Most of the options investigated focus specifically on either production or market risk and are effective or quite effective in addressing that risk. An option that is market risk-focused will do very little to mitigate production risk, and vice versa. In the case of forward contracts, a market risk-focused product may even enhance production risk as a result of the need to deliver against a contract. There were no risk management options scored that mitigated institutional risk exclusively.

The high equity, alternative income, enterprise diversification and FMD options mitigate all risks simultaneously to some extent. These options are of a business or financial management nature,

rather than commercial products such as insurance. Having a strong, financially resilient and diverse business provides the most even mitigation across the three risk categories assessed; however specific insurance products or other offerings will provide a greater level of protection for single risk categories.

4.4 Cost efficiency of risk options

The previous section evaluated risk management options on their effectiveness in mitigating risk purely from a risk coverage point of view. The cost effectiveness of implementing that option (addressed in this section) is much more difficult to assess, as it is far more variable depending on the specific circumstances in which the option is used. Broad generalisations can be made about how risk management options work in practice and which risks they address, however the cost/benefit of utilising that option will vary enormously depending on risk exposure, scale and other farm business-dependent factors.

Risk appetite is also a completely subjective factor that has potentially the biggest impact on perceived cost effectiveness of risk management options. Consider two risk management options which have the same financial result for a farm business over time. The first option involves taking out an insurance policy against a defined risk. The cost of the policy means that maximum potential gross margin is reduced when there is no claim, however potential losses incurred from the defined risk are capped. Income is smoothed as a result of the policy being in place. The second option is a do-nothing approach. Losses incurred when the defined risk occurs will be higher, but the maximum potential gross margin will also be higher when the defined risk does not occur because there is no insurance premium cost.

Both approaches can result in the same financial result for a business over time. Option one achieves this with a relatively smooth income while option two achieves this with an average income made up of higher highs and lower lows. The option chosen has less to do with cost efficiency and more to do with risk appetite and personality. Some farm business managers believe that volatility creates opportunity and have sophisticated programs in place to capitalise on movement, while others have strategies that rely on stability and security. Either of these approaches can be made to work under the correct structure with business acumen.

Interviews with a range of insurance providers conducted as part of this project indicated a belief that psychological or 'rule of thumb' cost efficiency targets were a bigger impediment to uptake than calculated cost/benefit arguments. For example, a premium exceeding 5% of gross revenue would be considered a big psychological barrier to uptake for any insurance product targeted at the cropping industry, even if the forecast cost/benefit was positive.

So, while ultimately the cost efficiency of risk management options depends on the cost of the option relative to the benefit received, there are many other factors that make this a more complex and business-specific calculation.

However, some generalisations can be made about the cost efficiency of risk management options, which are summarised below.

- **Futures –** A futures trade in its most basic form is a commitment to sell or buy a quantity of a commodity at a defined price at a defined time in the future. In this context the cost efficiency of this option for risk mitigation is more related to opportunity cost than actual cost. If the price being locked in through the futures trade is desirable, then the cost efficiency of this option is high.
    - Caution needs to be taken from a cost efficiency point of view in terms of proportion of physical production which has price risk mitigated by futures trades. If the quantity of futures trades exceeds the quantity of physical production, then the cost of the trade becomes real rather than an opportunity cost offset against the cash sale of the physical good.

- **Forward Contracts –** As with futures contracts, a forward contract locks in a price for a commodity at a defined point in the future. Unlike futures contracts, a forward contract commits the contract holder to deliver a physical commodity. For this reason, there is added real risk to the cost efficiency of the option, over and above the opportunity cost of price movements, if delivery of the physical commodity cannot be made.

- **Insurance (Named and Multi-Peril)** – Only cost efficient if claims made over time are greater than cost of premiums; otherwise cost incurred for no gain.

  - One of the historical issues with confidence of the cost efficiency of insurance premiums has been the basis risk imposed through the area approach to premium calculations. A lack of historical farm level data has meant that insurance risk is often calculated at a shire level as this is the smallest aggregate unit for official production statistics. New data sources (such as satellite imagery) and analysis techniques are allowing risk calculations specific to farm or even field areas and giving confidence that premiums reflect true insurance risk.
  - With more granular approaches to premium calculation the cost efficiency of insurance products should be able to be determined with a greater level of certainty leaving risk appetite as the unpredictable factor in terms of determining likely uptake.

- **Mutual funds** – These funds provide insurance products, so a similar cost efficiency argument can be made. However, this option is likely to be slightly more cost efficient than commercially proved insurance due to the mutual structure allowing for business cost reductions which can be passed through as lower premiums. The principle of mutual operation also means that risk is shared amongst a larger group of participants.

- **Derivatives or Indexes** – Similar to insurance, however cost is more directly proportional to chance of pay-out. As with insurance, the recent provision of more granular data is allowing calculation of index premiums that minimise basis risk. Weather derivatives also require a high level of confidence in the connection between revenue risk and the weather event being indexed or there is a risk to the cost efficiency of the option.
  - Weather derivatives provide risk mitigation for weather events which are anticipated to result in revenue loss. There is a risk that revenue loss can still occur from unanticipated (and uninsured) weather events or that the link between revenue loss and the insured weather event is disrupted in some way. For example, insurance for a frost event at -1^{o}C is purchased due to the knowledge that this temperature will result in yield loss, however due to a particular set of environmental and seasonal conditions a +1^{o}C event resulted in the same damage.

Conversely a -1ºC event could cause no damage in which case there would be no revenue loss and the pay-out from the weather derivative would be received.

- **Farm Business Management (high equity, alternative income sources and farm enterprise diversification) –** It is almost impossible to generalise about the cost efficiency of this group of risk management options. While it is tempting to conclude that the cost efficiency is high because there are no defined costs associated with premiums or products, there are still real business viability and cash and opportunity cost implications from each of these approaches. For example, building high equity allows a business to be in a position to easily recover from a production or price shock. However, to achieve that equity position, profit needs to be diverted into the balance sheet rather than other potential investments such as technology which may lead to improved production techniques which could also alleviate risk. More than any other option, the cost efficiency of farm business management approaches is dependent on risk appetite and personal preferences.

- **Farm Management Deposits (FMDs)** – Very cost efficient, however the option is only able to be used under certain conditions (i.e. need to be profitable and have strong balance sheet). FMDs are not available as a risk mitigation tool to all farm businesses.

5. Sector analysis

Within Australian agriculture, the range of commodity subsectors experience very different levels of volatility in both production and commodity prices.

This section explores characteristics of industry and factors driving changes in the risk environment. This section also leads into discussion around the comparative analysis of different risk management options available on a sectoral basis. The results and conclusions stated here are intended to provide guidance and direction rather than offer definitive recommendations for specific risk management options.

Although every farm business is different, the sector analysis was performed with an awareness that generalisations had to be made based on the (sometimes limited) information available and supported by industry consultation.

In addition, risks affect various parts of and participants in the supply chain differently. As with many aspects of this research, without good visibility and transparent data across the agricultural value chain it is impossible to fully assess the likely consequences of risk or target mitigation efforts.

The analysis presented here aims to direct risk management efforts where they are most needed and are of most benefit, with the aim to help build risk resilience across agricultural subsectors and into supply chains.

To explore this, supply chain maps were developed to build a high-level picture of players and potential sources of risk across the value chain which present some highlighted risk pressure

points as examples. Subsector risk scores were overlaid with scores for the effectiveness of risk management / mitigation options in bar charts to provide a visual evaluation of the suitability of particular options for specific subsectors. For example, Figure 7 demonstrates that the subsector scores 5 overall for production risk (shaded area), and that apart from forwards and futures, the scores for the available options assessed meet or exceed the line and thus address production risk for that subsector. A colour scale was incorporated to distinguish between the strength of each option relative to the risk of sector exposure (red = unsuitable, green = suitable).

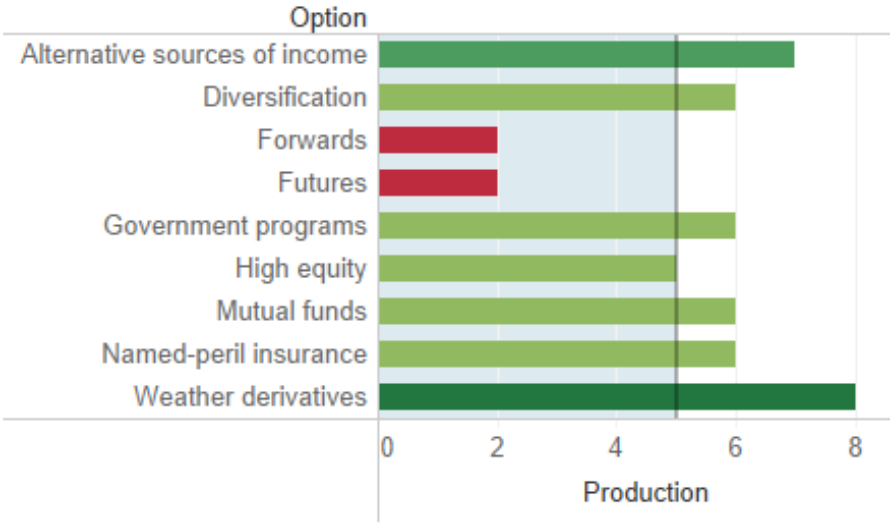


Figure 7. Example of scoring for risk management option effectiveness

For each of the subsectors the following section presents a supply chain map and accompanying table of risks/options, then commentary on these risks, summarised with a bar chart depicting the subsector's risk profile and suitability of available risk management options.

5.1 Beef cattle

Supply chain risk

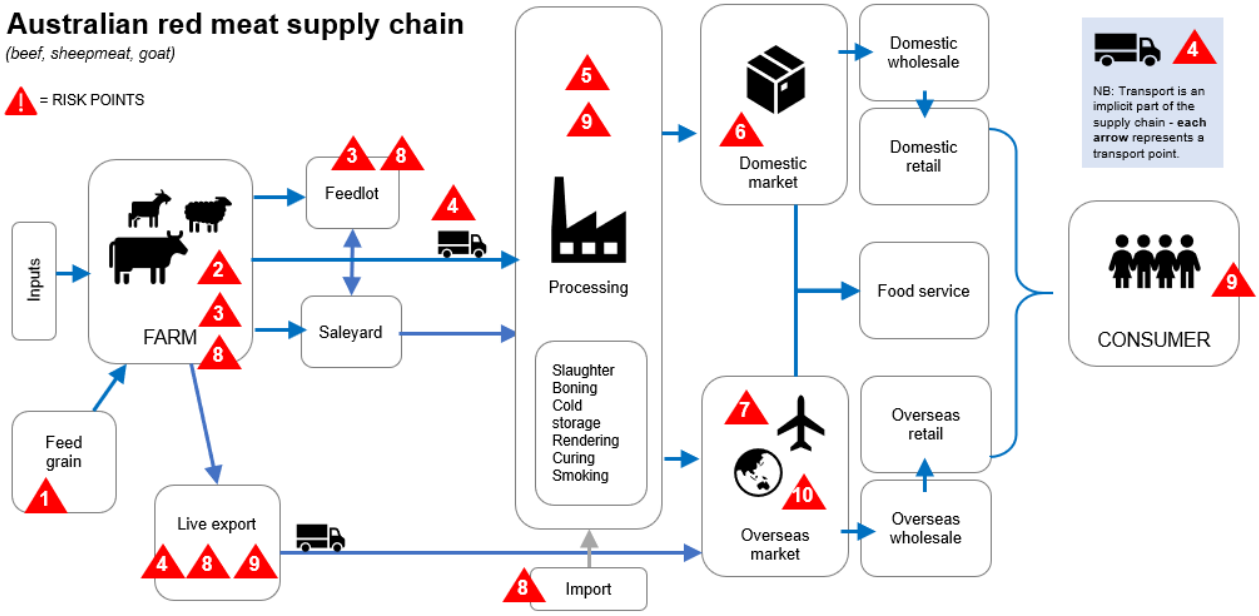


Figure 8. Examples of sector-specific risks and available options for risk management (RM) or mitigation in the Australian red meat supply chain.

Red meat		
RISK		**RM OPTION**
PRODUCTION	1. Feed price	Forwards; Futures
	2. Climate / weather impact (feed production, animal health)	Farm business management; Enterprise diversification; Weather derivatives
	3. Disease outbreak (animal health)	Named insurance; Farm business management
	4. Transport failure (animal health, supply contract)	Named insurance
	5. Operational incident (e.g. fire, malfunction)	Named insurance (if available)
MARKET / PRICE	6. Market price change	Futures; Forwards; Enterprise diversification
	7. Global commodity price fluctuation	
INSTITUTIONAL	8. Biosecurity breach (animal health)	Government programs; Farm business management
	9. Social licence (animal welfare)	
	10. Trade access	Government programs

The red meat supply chain is complex and fragmented in nature with strong competition. The industry is made up of a diverse range of participants and comprises many channels to the

market. A number of firms operate in multiple parts of the supply chain with varying degrees of vertical integration. Efficiency of transport is a particular concern. More than 90% of red meat is processed domestically with a broad geographical spread of processing facilities.

Risk profile

The Australian beef industry is subject to moderate production risk, minor market risk and sizeable institutional risk – see Figure 10. The index of relative volatility of market prices shows that there was more pronounced volatility in prices in the 2010-16 period than the previous nine years. This period included a downturn in prices due to drought induced turn-off followed by a rapid increase in prices during a period of tight supply. The risk profile is based on average conditions. There may be variation in the risk profiles between northern and southern production regions.

Production risk

Weather and climate impacts are the major source of production risk experienced by Australian cattle producers. This is firstly experienced through impacts on feed production and water availability in grazing systems. Seasonal conditions also impact the availability and price of supplementary feed which is becoming of greater significance to the industry as the grain fed production segment expands. Finally, weather impacts production by disrupting the ability to deliver stock to saleyard, feedlots and/or processors in a safe and timely manner.

Market risk

Australian cattle producers are exposed to a moderate level of market risk. Local commodity prices move in response to local supply and international market conditions. Australia is the third largest exporter of beef in the world, exporting approximately 50% of beef production each year. This level of exposure to export markets means exporters experience risk from international competition and prices, particularly from lower cost producers such as the US and Brazil. This contributes to the overall market risk experienced by producers back down the supply chain.

Institutional risk

Institutional risk covers a number of different aspects of the industry including regulation, social licence and biosecurity.

The sector is already heavily regulated at both national and international levels. Regulatory burden has become a heightened concern for the industry due to their potential high impact, high likelihood, interdependencies and difficulties in direct mitigation. Regulation exists in many forms, including:

- Biosecurity
- Environmental
- Chemicals
- Animal welfare standards
- Livestock certification/identification
- Food regulation
- Trade
- Employment

Social licence to operate is another form of institutional risk. Social licence can be threatened on both environmental, animal welfare and social grounds. Cattle industries around the world are widely perceived to be substantial contributors to greenhouse gas emissions, bringing into question the impact of production practices and the role of the industry as a whole to mitigate emissions. Animal welfare is another area of social concern which makes the industry vulnerable to disruption; for example, community pushback against feedlot densities and practices, processing and the live trade could force dramatic change in those practices. In addition, the proximity of feedlots, processing/logistic centres to residential areas or waterways can result in a change to social licence to operate.

Risk management options and suitability

Figure 9. Risk profile and suitability of RM options for Australian beef cattle

Farm management is the primary strategy cattle producers use to mitigate production risk. This includes grazing management, maintaining feed stocks and adjusting stock inventories to adjust to conditions. Some production risks such as animal health, operational incidents and transport incidents can also be covered by named insurance.

Market risk can be managed by utilising different marketing methods and strategies. Producers have access to three major selling channels with prices varying depending on the channel. Physical auctions at saleyards offer a competitive market but also create volatile prices depending on supply and number of buyers. Online auctions provide a similar option but remove some of the costs associated with transporting and selling at physical options. Producers can also opt to sell direct to processors with over the hooks (OTH) prices often made known in advance.

Decision-making on where to sell stock is heavily reliant on accurate, up to date, robust and reliable price data. Historic saleyard prices are publicly available, giving information on previous market movements. However, deciding between saleyard and direct sales is made difficult as saleyard prices do not always match the weight categories used for OTH price reports, so comparisons are unclear and not easily comparable. Likewise, online auction data is available but difficult to compare. Data is also difficult to query, reducing the effectiveness of decision making.

The Australian cattle industry lacks robust forward pricing mechanisms which means buyers and sellers are reliant on historical prices to assess future prices and returns. This limits effective decision-making by not providing a guide to future market trends, and also hinders the ability of stakeholders to mitigate price risk by hedging prices.

Institutional risk is largely mitigated at an industry and government level for biosecurity, social licence and trade risks. Industry are addressing social licence to operate risk by working with local communities to ensure processors/feedlots/logistic centres do not create perceptions of inhumane or environmentally damaging practices. Industry level work such as the national livestock identification scheme and import requirements also reduce the level of biosecurity risk, which in turn has improved the perception of Australian beef and cattle internationally.

5.2 Sheepmeat

Supply chain risk

See graphic and commentary above for red meat.

Risk profile

Evaluation of risk in Australia's sheepmeat industry shows extreme production risk, moderate market risk and sizeable institutional risk – see Figure 11.

A large amount of risk is carried by sheepmeat producers, particularly given very high level of production risk. The level of risk here is a concern further up the supply chain with processors interested in maintaining throughput amidst a seasonal pattern for sheep and lamb supply. There is also an element of market risk being shared between producers and processors.

Production risk

With dryland grazing being the major production system for sheepmeat, production is exposed to risks from seasonal conditions. Conditions are a major factor in pasture growth and feed availability which in turn determines size of breeding flock and rates of conception, lambing and

lamb growth which all contribute to eventual slaughter and meat production. Feed prices are a factor in the ability/cost effectiveness of carrying capacity and production rate.

Market risk

Australian sheep producers experience moderate market risk, characterised by year-on-year fluctuations in price and volatility during each year as prices follow the seasonal supply pattern. The seasonality of prices creates challenges as prices are low when most producers are ready to sell, but also opportunities as higher prices provide an incentive to sell outside of peak supply periods. While market risk is linked to domestic supply, it is also influenced by global markets. Sheep meat has a high exposure to export markets with lamb and mutton exports equivalent to 52% and 86% of their respective production.

The Western Australian sheep industry is separated from eastern states markets, adding a further element to market risk due to a lesser ability for the WA industry to even out sheep and lamb slaughter throughout the year. In eastern states, varying climatic conditions are advantageous as processors can run efficiently all year by acquiring animals from a broader base. Inflexibility in supply sources means that WA processors factor in additional risk in buying decisions (MLA).

Institutional risk

The Australian sheep industry has a significant level of institutional risk. Risk levels in competition and contractual arrangements are low with relatively free and open market conditions. The industry also has minimal biosecurity risks but is considered to have increasing consolidation in the supply chain, adding to institutional risk.

The major concern regarding institutional risk comes from potential policy change for live sheep exports, both from a likelihood and impact of policy change perspective. Live sheep export an important market for Australia's sheep meat industry, valued at approximately $250 million and accounting for 7.6% of the value of sheep industry exports. The impact of policy change would be low on the east coast, but significant in WA where 85% of Australia's live sheep exports come from. Live sheep exports account for 31% of WA sheep and lamb offtake, which is a significant portion of supply exposed to a change in trade access.

Risk management options and suitability

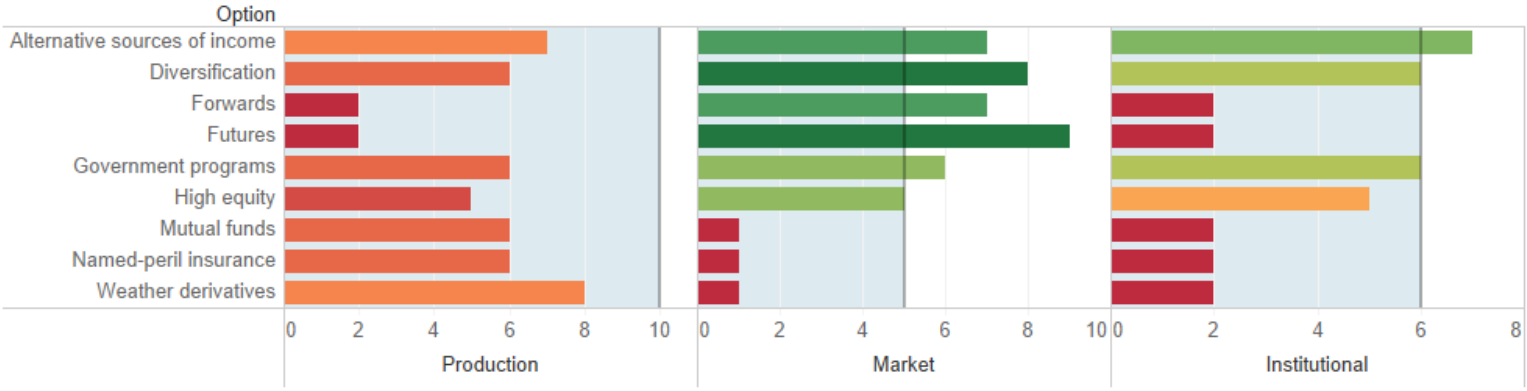


Figure 10. Risk profile and suitability of RM options for Australian sheepmeat

Mitigation of production risk is largely achieved through farm management. Farm management includes practices to optimise pasture growth and utilisation as well as managing flocks to maximise production, particularly at key times of joining, lambing and weaning. Drought-lotting has become a widely adopted tool to manage pastures while maintaining production during extended dry periods. This does require producers to have a source of supplementary feed which adds risk if required to be purchased.

Market risk can be managed using different selling structures that exist in the sheep industry. Producers can buy and sell stock through physical and online auctions or direct to abattoirs, with prices varying between selling methods. However, prices are likely to track similarly across these options. The only option currently available for producers to lock in a selling price in advance is through forward contracts with processors. Forward contracts are relatively new to the Australian sheep industry. They are offered by processors on an inconsistent basis and generally offered over a short term of 3-6 weeks. This offers protection over short-term declines in price but is of limited value for longer term decision-making. The lack of forward contracting continues to be a concern to the industry.

5.3 Wool

Supply chain risk

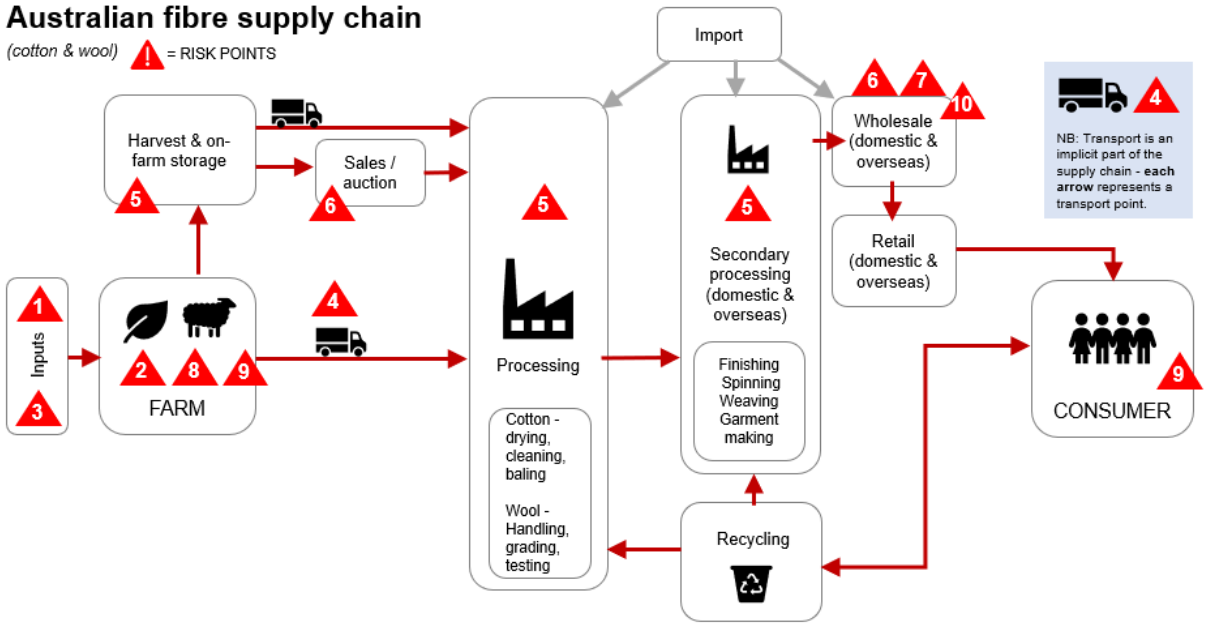


Figure 11. Examples of sector-specific risks and available options for risk management (RM) or mitigation in the Australian fibre supply chain (cotton and wool).

Fibre (cotton & wool)		
RISK		**RM OPTION**
PRODUCTION	1. Feed price (wool)	Forwards; Futures
	2. Climate / weather impact (cotton)	Farm business management; Weather derivatives
	3. Water price and availability (cotton)	Farm business management; Enterprise diversification
	4. Transport failure (animal health, supply contract)	Named insurance
	5. Operational incident (e.g. fire, malfunction)	Named insurance (if available)
MARKET/ PRICE	6. Market price change	Futures; Forwards; Enterprise diversification
	7. Global commodity price fluctuation	
INSTITUTIONAL	8. Biosecurity breach (crop and animal health)	Government programs; Farm business management
	9. Social licence (animal welfare, water and chemical use, GMO)	
	10. Trade access	Government programs

The wool supply chain is one of the more complicated and elongated chains within Australian agriculture in terms of transformation time and geographic location. There are a range of disparate market participants. Auctions dominate with brokers facilitating sale for growers. Wool buyers act on behalf of the processors. The dominance of the auction system, where wool is channelled through a small number of brokers and exporters, means diversity is lost, however there is a strong level of diversity amongst weavers, spinners and knitters.

Risk profile

Evaluation of risk indicates that the wool industry operates within a relatively moderate risk environment compared to other sectors of agriculture, with moderate market risk, low production risk and minor institutional risk – see Figure 13.

Production risk

Similar to sheep meat production, wool production risk is linked to rainfall driving pasture growth. In addition to the production risks linked to sheep fertility and growth, wool producers also need to manage wool growth and quality which are also affected by grazing conditions. Feed prices can also be a factor in the ability/cost effectiveness of carrying capacity and production.

Market risk

Market risk for Australian wool is driven strongly by international demand and domestic supply. Australian wool production is heavily reliant on Chinese processing mills with over 85% of wool being exported, of which approximately 75% is exported to China. Fortunately, the recent prevailing market dynamic has been that of demand outweighing supply, which has contributed to stability and growth in prices. The likelihood of market downturn eventuating is low, but impact may be high.

Market risk also includes counterparty risk whereby Australian exports are exposed to risk of default by the offshore buyers. Contractual default is a major risk assumed by Australian wool exporter due to adverse market movement (price fall) and involves arbitration to resolve.

Institutional risk

Australian wool involves relatively free and open market competition with low levels of contractual arrangements. However, institutional risks exist from the strong reliance on export markets and risks differ according to producer and trader perspective. One such risk is the concentration of buyers, i.e. the 10 largest buyers account for 70% of wool sold.

Risk management options and suitability

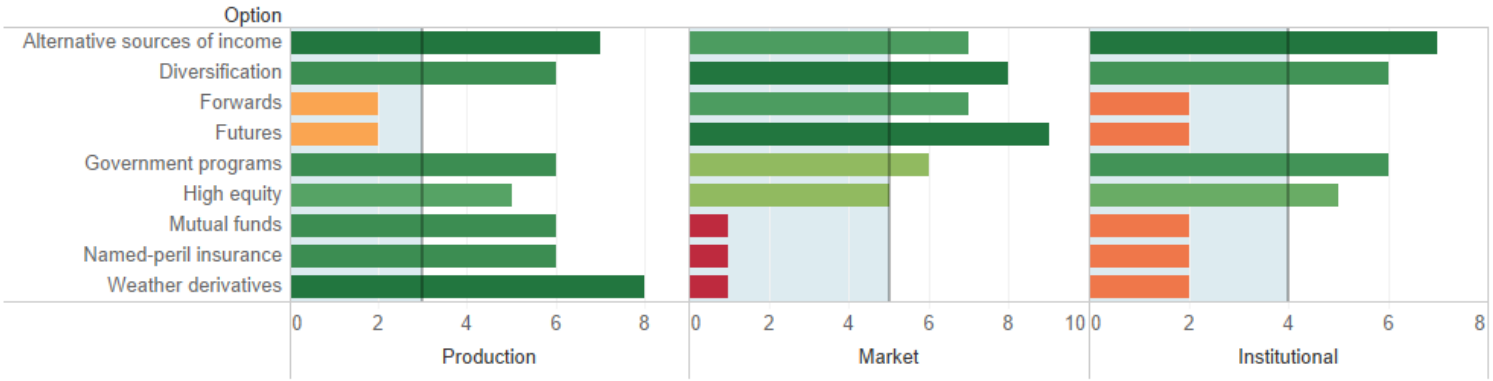


Figure 12. Risk profile and suitability of RM options for Australian wool

Production risks for wool producers can be managed through farm management practices, including diversification and access to alternative sources of income. A specific risk management tool to address production risks is flock and grazing management. Management of feed is crucial to achieve targeted wool growth and quality characteristics.

Producers have access to a couple of selling options to manage market risk. The primary method of selling wool is through the spot market at open cry auctions. These are the most liquid market for Australian wool, particularly for export buyers and covers full spectrum of greasy wool produced in Australia with approximately 80-90% of all wool offered in this market. Producers can also sell through forwards or deferred markets. This is a domestic channel through which approximately 5% of overall supply is bought/sold. Forwards are accessed via broker and widely recognised by exporters. Derivative (paper) trading is also available on the Sydney futures exchange (SFE) and are a widely recognised pricing point but acceptance is limited.

Large volumes of wool are stored in broker or warehouse storages around the country, particularly in the major wool auction centres. Insurance for these storage facilities would be crucial to mitigate the impacts of damage.

Institutional can be addressed both on farm and through industry and Government-led programs. Alternative sources of income, diversification and maintaining high equity all rate highly to manage institutional risk. Comprehensive on-farm risk management strategies in conjunction with industry or Government-led initiatives provides an effective response to institutional risk.

5.4 Grains

Supply chain risk

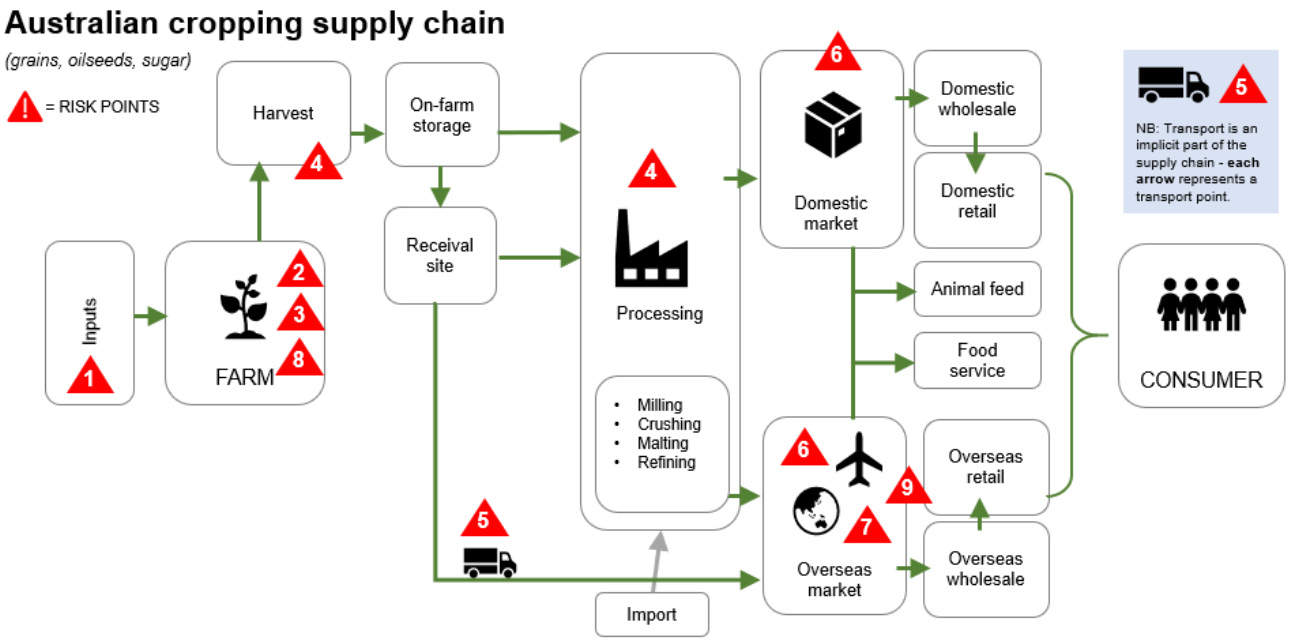


Figure 13. Examples of sector-specific risks and available options for risk management (RM) or mitigation in the Australian cropping supply chain.

Cropping		
RISK		**RM OPTION**
PRODUCTION	1. Input price	Forwards; Futures
	2. Climate / weather impact	Farm business management; Enterprise diversification; Weather derivatives; Yield-index insurance; MPCI
	3. Disease / pest outbreak (crop health)	Named insurance; Farm business management; Enterprise diversification; Yield-index insurance; MPCI
	4. Operational incident (e.g. fire, malfunction)	Named insurance (if available)
	5. Transport failure	Named insurance
MARKET/ PRICE	6. Market price change	Futures; Forwards; Enterprise diversification
	7. Global commodity price fluctuation	
INSTITUTIONAL	8. Biosecurity breach (crop health)	Government programs; Farm business management
	9. Trade access	Government programs

An extensive set of processes make up the grain supply chain including storage, handling, freight and shipping and arrange of ancillary activities such as financing and quality testing. The grain supply chain must operate efficiently to deliver high quality grain during the limited December – May marketing window. A select few bulk handlers dominate storage and transport across WA, SA and eastern Australia. Despite strong bulk grain handling storage capacity, there is a growing trend towards on-farm storage, particularly in eastern Australia.

Risk profile

The results of the index demonstrate that the grains sector has consistently experienced a much higher level of volatility than any other subsector of agriculture. Over the period analysed, the grains sector has experienced a significant level of farm production and market/price volatility. Grain growers in Australia operate in a unique business environment, fully exposed to the instability in international grain markets, and more exposed to the extremes of the Australian climate than perhaps any other businesses – see Figure 15.

Developments internationally and within Australia over the past decade are likely to mean that the strategies grain growers have previously used to manage some of the risks they face are no

longer adequate, and may need changing in order for their business to remain sustainable (Keogh, 2013).

Significant changes in the industry over past decade include, but are not limited to:
Globally:

- Government policy – particularly in US and EU
- Dominance/consolidation in global grain trading - 6 large multinational corporations account for more than 75% of all grain and oilseeds globally (Keogh, 2013).
- Growth in speculative interest in soft commodity derivative markets (futures, options) has resulted in changes in these markets; speculator participants surpass participants holding physical stocks resulting in market behaviour that is not consistent with supply and demand forces

In the domestic market:

- Technological change
- Below average seasonal rainfall
- Changes in the level of Government support

At an individual farm business level, risk largely depends on whether producing grain or oilseed, whether production is supplied for human consumption or stock feed and whether principal markets are domestic or international.

Production risk

Grain producers are faced with significant and unpredictable weather volatility. Higher levels of volatility across the non-irrigated portion of industry, due to adverse seasonal conditions, particularly low and untimely rainfall, likely contribute to elevated levels of volatility (Keogh, 2013).

Production risk also varies by location of cropping business, subject to variable weather and seasonal conditions. For example, the cropping sector in Queensland is exposed to an elevated level of production volatility as a result of weather risks. Of particular concern to growers is the damaging effects of cyclones and hailstorms on grain quality. The Australian Export Grains

Innovation Centre (AEGIC) note the shift in rainfall zones (White, Kingwell, & Carter, 2018). Rainfall zones have shifted between 100km-400km both southward and westward. This has seen crop yields grow at a faster rate in the medium and high rainfall zones compared with low rainfall areas.

In addition to locational differences, production risk will largely depend on the crop type – e.g. whether farmer is growing wheat, barley, oats or other grain/oilseed types. Some crop types may be more prone weather related or seasonal variability.

Risks related to crop inputs include chemical residue, environmental contamination, and the inappropriate use of chemicals. The national residue survey (NRS) is considered important for managing risk of chemical residues and environmental contamination, monitoring to help identify potential problems or inappropriate use of chemicals and indicate where follow-up action is required. It conducts a collection of samples from export terminals, containing packing facilities and on delivery to domestic users. Since 1993, the program has been funded by the statutory 0.015% farm gate value levy on producers of participating grains. The NRS 2016-17 for grains recorded overall compliance rates of 99.2% against Australian standards and noted that Australian primary producers and grain handlers continue to demonstrate a high degree of good agricultural practice (Department of Agriculture and Water Resources, n.d.-b).

The grains industry has produced a Code of Practice since 2013 (Grain Trade Australia, 2018) in an effort to reduce risk across all aspects of grain production. The latest code of practice covers:

- On-farm activities
- Grain sampling and testing
- Storage facilities
- Chemical use
- Grain quality management
- Transport
- Marketing
- Training – development/training for staff to maintain high professional standards

Australian grain production is exposed to risk from weeds, pests and disease, with serious consequences if they enter and become established in Australia. Biosecurity aspects for grain farming operations are an important production consideration. At present, there are more than 600 exotic pests identified that pose a threat to the Australian grains industry.

Plant Health Australia (PHA) and Grain Producers Australia (GPA) publish the *Biosecurity Manual for Grain Producers* to assist in on-farm management of weeds, pests, disease. Updated frequently, it is a relevant and useful resource for the grains industry, particularly in a changing regulatory environment, with the last version (4.1) released January 2017 (Plant Health Australia & Grain Producers Australia, 2015). The manual details and recommends simple preventative measures alongside immediate reporting of anything unusual or of concern.

Market risk

Australian grain producers are exposed to significant levels of market risk given the export-oriented nature of the grains industry. Over time however, the industry has gained status as a supplier of high-quality wheat and grains, providing opportunity to access higher quality markets and securing, on average, a better price relative to the general market as a result.

Western Australian and South Australian grain markets are largely geared to exports and eastern states have greater domestic use and consumption of grain. According to AEGIC, around 85-95% of grain produced in WA and SA is exported. Over the period 2006-2016, WA exported 88% of their total production and exports from SA totalled 72% over the same period (White et al., 2018). In eastern Australia, approximately 50% of the grain grown is consumed locally. Variations in export volumes from eastern Australia are substantially greater than exports from WA and SA given domestic demand. Consequently, this increases the risk from investments in supply chain infrastructure in eastern states.

Another contributing factor to the degree of market risk within the grains sector is crop type. Prices for Australian wheat are driven largely by prices in the international market. Prices for barley rely more on a mix of domestic and international prices.

Institutional risk

The Australian grains industry has a relatively low level of institutional risk given significant diversity in grain marketing and secure access to and trade with international markets.

From a supply chain perspective, risk is dependent on individual supply chain characteristics and structure. For wheat, various supply chain structures exist (traditional from farm to receival site, direct from farm to port and on farm storage). Large variations in total costs, with a range of factors contributing to this variation, make comparisons between individual supply chains difficult and not always meaningful. In some cases, supply chain costs can be the single largest cost item for a grain producer (White et al., 2018).

The grains industry in Australia naturally holds a competitive advantage over other grain exporters by virtue of proximity to major wheat export locations. High costs to move grain from farm gate to port for export could jeopardise this competitive advantage and has been an ongoing risk concern for the grains industry.

The cost of transport is difficult to estimate, however there are clear disparities in total supply chain costs between states. For sites in NSW with distances of around 600km from port, total supply chain costs are more than $100/t. In contrast, sites in South Australia and Western Australia are on average between 100-200km from port with costs ranging from $50-$80/t dependent on location (White et al., 2018).

Risk management options and suitability

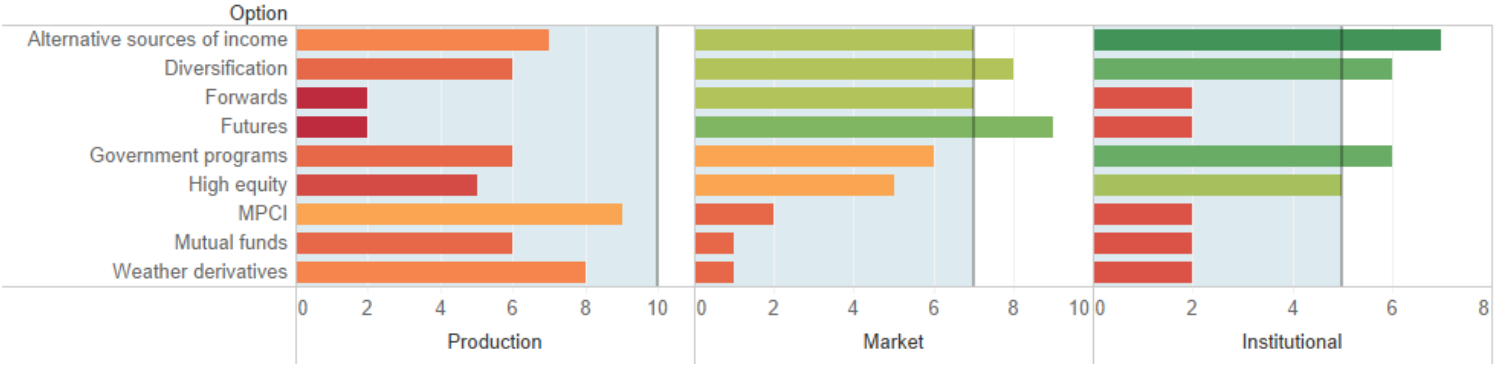


Figure 14. Risk profile and suitability of RM options for Australian grains

In addressing production and market risk, farm grain storage has become a more common farm management option in recent times. It has been estimated that over the past five years, the amount of grain stored in high-quality steel silos in NSW, Queensland and Victoria has doubled (White et al., 2018). Both short-term and permanent farm storage continues to grow across all major grain growing regions. Growth in on-farm storage in eastern states has been driven by the likelihood of persistent drought conditions. It also provides the opportunity for farmers to capitalise on high grain prices during prolonged drought periods.

For producers in WA, growth in on-farm storage has been slow. There is less incentive to invest in on farm storage given cooperative structures of grain companies. More recently, producers in WA have been able to receive a rebate for using CBH storage and handling network. A major advantage of delivering to warehouse system is that the risk associated with grain hygiene and classification is shifted from grower to grain storage service.

Production and market risk are also addressed through insurance. An assessment of the most suitable insurance options should be made on an individual enterprise basis.

The grains futures market is one risk management option that has not been used particularly well. Knowledge and technical competence barriers have limited the use of financial instruments across the grains industry. There is opportunity to take advantage of the market if producers can monitor and gain a familiarity with basis movements. This is difficult given the time required to

be up to date on futures, currency and daily basis movements (Murray & Agribusiness, 2005). Professional market advice may be necessary to support price risk management activity.

5.5 Pork

Supply chain risk

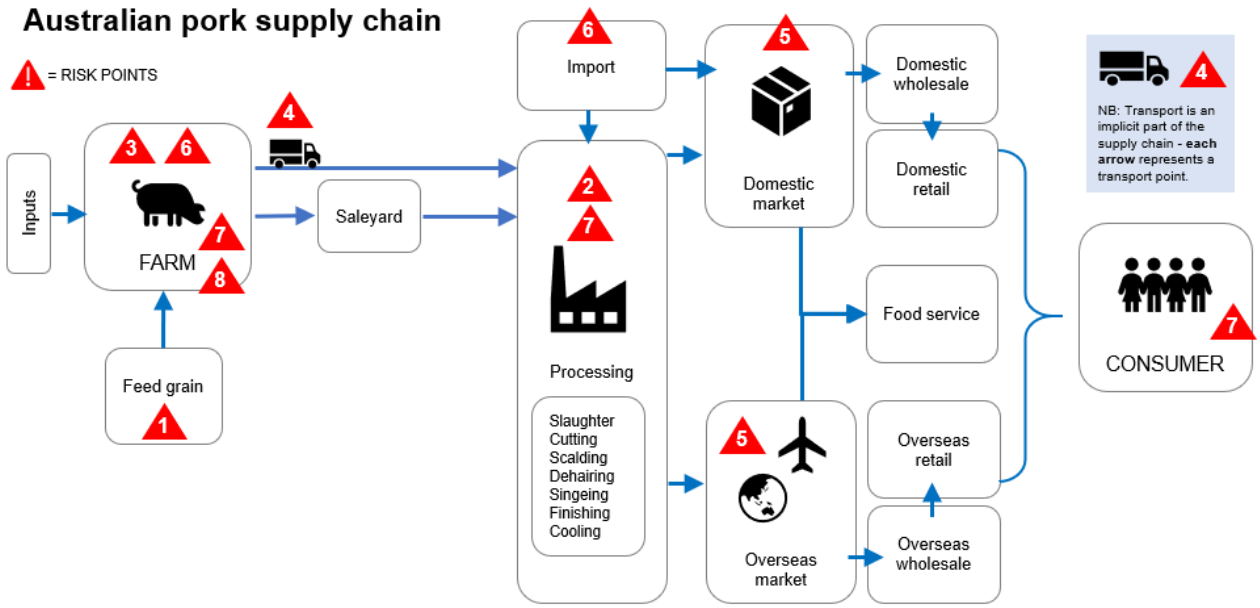


Figure 15. Examples of sector-specific risks and available options for risk management (RM) or mitigation in the Australian pork supply chain.

Pork		
RISK		**RM OPTION**
PRODUCTION	1. Feed price	Forwards; Futures
	2. Operational incident (e.g. fire, malfunction)	Named insurance (if available)
	3. Disease outbreak (animal health)	Named insurance; Farm business management
	4. Transport failure (animal health, supply contract)	Named insurance
MARKET/ PRICE	5. Market price change	Futures; Forwards; Enterprise diversification
INSTITUTIONAL	6. Biosecurity breach (animal health)	Government programs; Farm business management
	7. Social licence (animal welfare)	
	8. Urban encroachment	

The pork industry supply chain is characterised by a mix of vertically integrated operations and small scale, family enterprises. Some larger farms are completely vertically integrated. The removal of import restrictions has precipitated significant industry change. There is a growing focus on supply chain integration to promote cost efficiencies and to compete successfully against high volumes of imported pork products.

Risk profile

Results from the risk index indicate that during the period 2000-16 the pork industry on average experienced relatively low levels of farm production volatility and moderate to high price volatility when balanced against other subsectors of agriculture – see Figure 17.

Production risk

Production risk is an acute and a live risk for the pork industry. The disease risks inherent in importing pig meat pose a very real threat, given that more than 70% of processed pork consumed in Australia is imported.

Biosecurity is currently an issue for the industry; the threat of exotic disease entering the system looms large given the high volume of imports. A relaxing of biosecurity protocols would devastate the industry.

The biosecurity risk is compounded by that fact that at the farm level some producers do not fully understand the seriousness of biosecurity concerns. Generally, the pork industry have strong controls but high risk that non-compliance with traceability and biosecurity may inadvertently allow exotic and endemic disease incursions to occur (Australian Pork Limited, 2017). There is a serious need for greater education and better understanding of the material risks associated with disease at the producer level.

At a national level, there is mounting pressure from major exporting countries to allow fresh pig meat into Australia negotiated through trade deals. Biosecurity protocols require an import risk

analysis for pig meat (DAFF, 2013). As at 2013, there were 11 countries approved to export uncooked, cooked and cured pig meat to Australia, with risk analysis generic across all countries. The heavy reliance on assurances provided by competent authorities of exporting countries may need to be revised, given the growth in volume of pig meat imports in Australia.

Market risk

Significant price pressures across the supply chain are of risk to the pork industry. Surplus production compounded by recent imports of frozen pork products has had a dramatic effect on returns. A direct link exists between pork imports and farm gate pig meat prices, with a strong correlation between increasing import volumes and decreasing domestic pig prices.

Pig prices are also seasonally dependent. Prices of pig meat tend to fall in the middle of the year as supply improves and then, as demand rises and supply tightens in the run-up to December, prices trend upwards.

In commercial pig production, feed costs contribute around 60-75% of production costs for a pork producer. Market conditions for grain have been exacerbated by drought, with grain supply for feed increasing to unsustainable prices. Prices for grain have risen rapidly particularly in the eastern states of Australia. The feed grain price is affected by several components including the world grain price (futures), exchange rates and the Australian domestic basis. Feed grain pricing is complex and there is a growing need to understand components of feed grain price given the effect high grains prices can have on production levels and the viability of pig farming businesses.

Unfavourable market conditions are having the biggest impact on small producers. Smaller producers are much more vulnerable to price fluctuations in the pork market as they often trade through saleyards or at the discretion of prices offered by processors. Price pressure placed on smaller producers is also compounded by fact that they have a reduced ability to secure contracts and bulk discounts from feed suppliers.

Smaller producers are also more likely to have their supply 'turned away' by abattoirs during periods of oversupply due to the lack of a supply contract - even where the supply relationship has been longstanding and in some cases, without a contract (Australian Pork Limited, 2018).

Institutional risk

There are a number of key institutional risks facing the pork industry that are likely to have a significant impact across the supply chain. The major concerns are social licence to operate and the impact of urban encroachment, particularly at the farm level.

Stringent and growing animal welfare regulations are a point of concern for the pork industry. Attenuation or loss of government and societal support through major animal welfare incidents has implications for all participants across the supply chain.

Continued urban encroachment on productive farm land is placing additional pressure on growers to demonstrate environmental stewardship. The pork industry have in place a number of The response to environmental concerns is made difficult given the high level of uncertainty in the legislative arrangements that underpin environmental management (Australian Pork Limited, 2017).

Risk management options and suitability

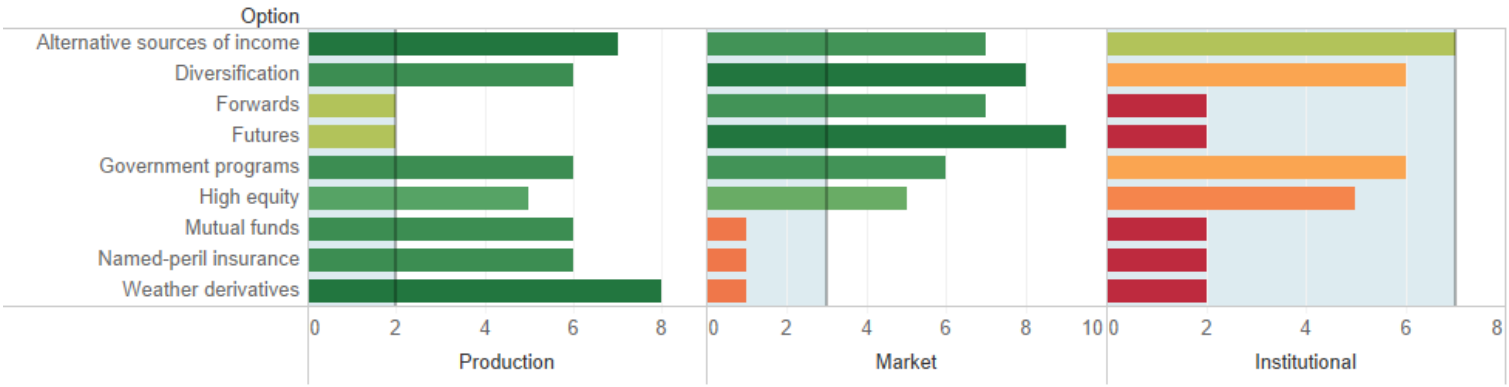


Figure 16. Risk profile and suitability of RM options for Australian pork

The strongest way to address production risks from disease is through a combination of on farm and industry led options. A valuable industry led program is PigPass. As a national tracking system of all live pigs in Australia, it provides real time information on the movement of

animals. PigPass remains extremely important in the event of a disease outbreak, enabling industry to control the spread of disease. The importance of the system to the viability of the industry is demonstrated through mandatory reporting requirements of the traceability of pigs to the PigPass database. The linkage of PigPass with abattoir system ties animal information to the carcase for strong traceability of animals across the entire value chain.

There are insurance options available across the pork value chain. One key concern is that insurance options for pork processors is extremely limited. Insurance is easier to access at the farm level, but it is near impossible for processors to get appropriate insurance coverage. There is a massive amount of risk associated with limited access to adequate insurance coverage, including significant loss of infrastructure and interruptions in supply in say the event of a fire. Given this situation, processors are having to self-insure and underwrite their losses.

The industry has managed social licence issues by developing key programs to demonstrate responsible farming practices. The Australian Pork Industry Quality Assurance Program (APIQ) is a practical on-farm program based on risk management. It provides the standards through which Australian pig producers can demonstrate they are trusted and responsible farmers with a strong commitment to animal welfare, the environment and their customers by following safe and sustainable practices. It is a voluntary program that many farmers are involved in given APIQ accreditation is required by major processors in Australia.

There has been a strong response by industry for collective bargaining. This kind of action covers multiple production, market and institutional risks, especially for smaller producers. APL note that the current process required to access Australian Competition and Consumer Commission (ACCC) exemption for collective bargaining is time-consuming, costly and legally challenging (Australian Pork Limited, 2018). Collective bargaining via producer cooperatives and other kinds of networks could be a way for smaller producers to work to increase their bargaining power against larger processors and feed suppliers. This would potentially assist smaller pork producers to reduce their cost of production and bring their bargaining power closer to that of the larger producers, processors and feed suppliers. Cooperation has a range of

additional benefits for producers, enabling the sharing of market and production information as well as costs related to accessing inputs and other resources within a group.

5.6 Cotton

Supply chain risk

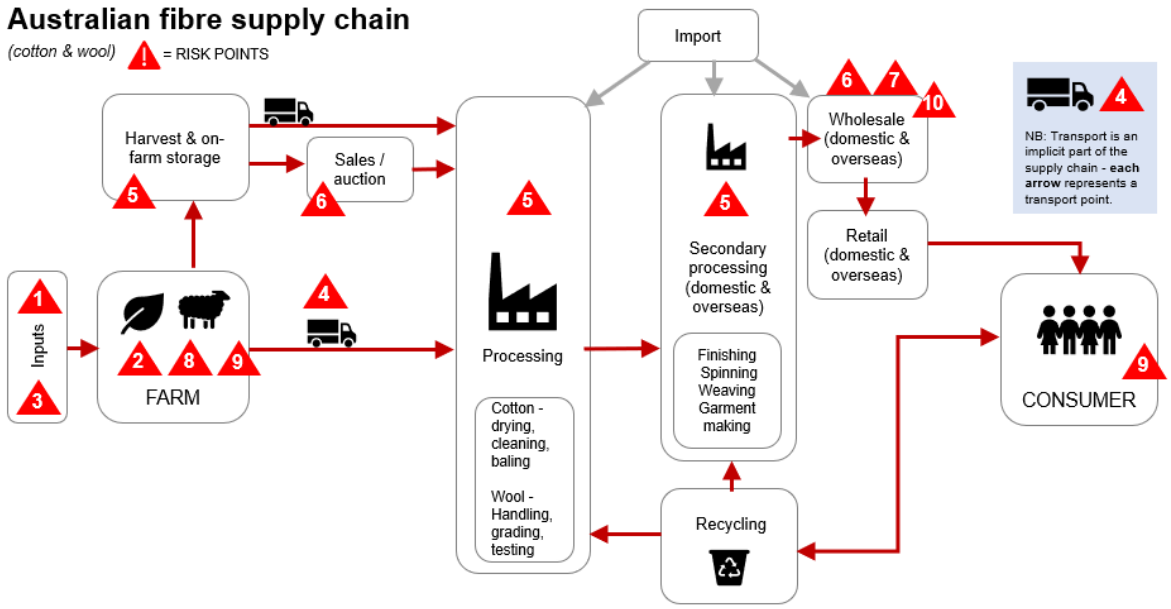


Figure 17. Examples of sector-specific risks and available options for risk management (RM) or mitigation in the Australian fibre supply chain (cotton and wool).

Fibre (cotton & wool)		
RISK		**RM OPTION**
PRODUCTION	1. Feed price (wool)	Forwards; Futures
	2. Climate / weather impact (cotton)	Farm business management; Weather derivatives
	3. Water price and availability (cotton)	Farm business management; Enterprise diversification
	4. Transport failure (animal health, supply contract)	Named insurance
	5. Operational incident (e.g. fire, malfunction)	Named insurance (if available)
MARKET/ PRICE	6. Market price change	Futures; Forwards; Enterprise diversification
	7. Global commodity price fluctuation	
INSTITUTIONAL	8. Biosecurity breach (crop health)	Government programs; Farm business management
	9. Social licence (animal welfare, water use, GMO)	
	10. Trade access	Government programs

The cotton supply chain is long and complex with a diverse set of end products processed from cotton lint and seed. Three key stages include farm to gin, gin to warehouse/processor/export, warehouse/processor to domestic and export manufacturers and spinners. Gins typically do not have adequate storage capacity on site so there is a heavy reliance on efficient freight. Transport is predominantly by road, due to deficiencies and restrictions on rail to port infrastructure. Australia is the fourth largest cotton exporter.

Risk profile

The Australian cotton industry is exposed to moderate-high level of production volatility and significant market volatility – see Figure 19. Results of the index suggest that production and price volatility is relatively high when compared with other sectors of agriculture. It is also clear that there has been a dramatic increase in both production and price volatility in the most recent period under analysis, 2010-2016 compared to the earlier period, 2000-2009.

Production risk

Cotton producers are very regularly threatened by weather extremes. The majority of Australian cotton being grown under irrigation providing a degree of flexibility for irrigated cotton producers during dry periods. Clear differences exist between the production risk that dryland and irrigated cotton producers are subject to. Dryland cotton producers often incur a broader range of production risk, with greater yield variability associated with dryland cotton.

Hail presents a significant weather risk to cotton crops, particularly in warmer, summer months. Hailstorms are unpredictable, and farmers sometimes fail to factor hail into their farm risk management plan. The impact of hail on cotton crops is elevated, given the cost of growing cotton is higher relative to other summer crops.

Cotton crops can also be devastated by pests and disease.

Market risk

Being one of the world's largest exporters of raw cotton, with more than 90% of production exported, the price of Australian cotton is driven primarily by international factors. In addition, producers and exporters operate in a heavily subsidised international market.

There are three main factors that influence the cash price of cotton: New York futures, basis and currency (CottonInfo, 2017). Components of the cotton cash price move independently, with approximately 80% of the price volatility attributed to futures and currency movements. A strong understanding of movements in the cotton cash price is required to make optimal marketing and selling decisions. Where farmers have cotton ready for sale, they can sell it via the daily or 'spot' price. With only a very small portion of cotton traded on the spot market, there is growing pressure to understand and adopt effective financial market instruments. Education on financial markets will continue to be important in building confidence in producers to adopt complex price management tools.

Similar to the experience of other agricultural sectors, the uptake and effectiveness of price risk management in the Australian cotton industry may be constrained by the extent of producer confidence and understanding of price risk management principles and processes.

Institutional risk

The cotton supply chain is long and complex, specifically in terms of transport. Cotton transport arrangements are influenced by the location of ginning and storage facilities, and nearby transport links.

The freight task involved is lengthy and differs between states, particularly Queensland and NSW. Transport of Australia's cotton harvest is currently handled by a mix of road and rail transport modes. The cotton supply chains in Queensland and NSW are predominantly road-based. A small proportion of the cotton crop destined for export relies on rail for transportation.

Cross border issues present a significant challenge and supply risk for the Australian cotton industry; for example, regulatory and permit arrangements for the use of machinery on road

networks. Another major concern is the differences in road train networks between states, particularly between NSW and Victoria. NSW has a more extensive road train network than Victoria. Supply interruptions and disruptions to freight movements between farm and port may exist where there are cross border issues and restrictions on infrastructure.

Risk management options and suitability

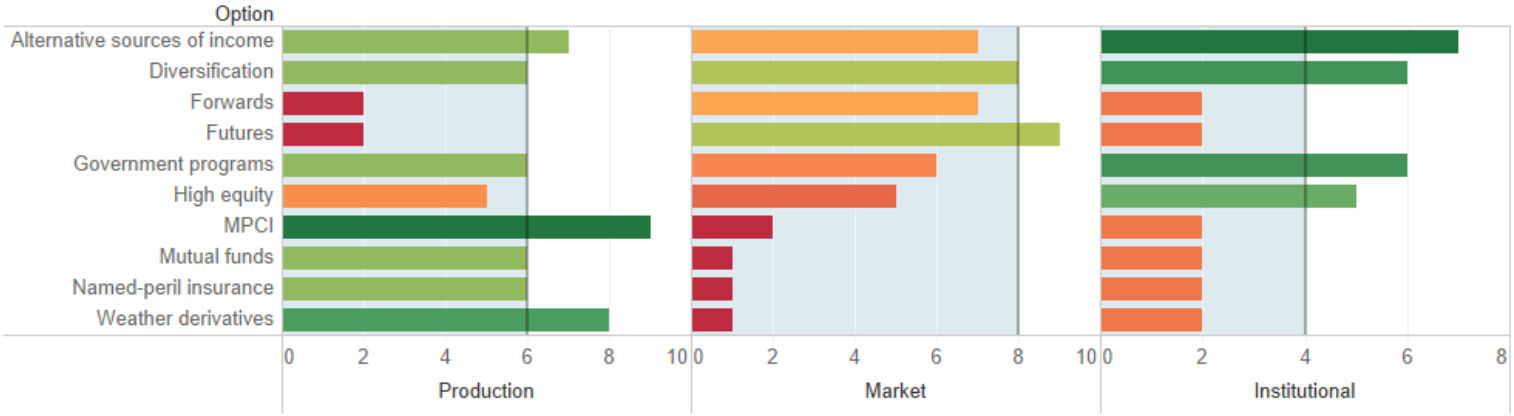


Figure 18. Risk profile and suitability of RM options for Australian cotton

Good production practices are important to protect the industry from pests, disease and weeds both endemic and exotic. Responsibility for pest and disease management falls largely back on the producer where it is critical at a farm level to understand and identify any threat of pest and disease. The implementation of basic disease management strategies, even where disease is not an immediate problem, can significantly reduce outbreak (CottonInfo, n.d.).

The industry is well served by MyBMP, an industry-led best management practice system for cotton growers to improve on-farm production, providing information and guidelines to implement best practice across all farm activities. MyBMP covers (CRDC, n.d.):

- Biosecurity – avoidance, management and control and pest and disease
- Fibre quality – growing the best quality cotton
- Integrated Pest Management (IPM) – for pest and disease
- Pesticide management – covers all aspects of storage and use
- Petrochemical storage and handling – all aspect of storage and on farm use
- Soil health – how to best look after soil conditions

- Water management – water quality, efficiency of storage and distribution as well as dryland and irrigated farming practices

Cotton producers have opportunity to directly improve price performance by adopting marketing strategies or through different cotton selling systems. A number of pricing alternatives are available to farmers, including:

- Cash sale
- Forward contract
- Seasonal pool
- Call pool

Weather derivatives are a relatively new risk management product for the cotton industry that can help mitigate weather volatility. Currently, there are no tailored weather derivative options for the cotton industry. Prototype insurance products are being developed for the cotton industry, specifically around drought and wet harvest cover (Mushtaq et al., n.d.).

Using the cash market involves a certain amount of price risk, i.e. the spot price may fall when the grower is ready to sell. To help insure against this risk, the grower is able to negotiate a forward contract with a buyer. Forward contracts are a common and effective price risk management tool. Most cotton is sold using forward contracts in which most cotton growers sell physical cotton forward for up to five years. These contracts set out the price, quantity and quality of cotton the grower must deliver on a specified future date. Therefore, the grower can know how much of the crop can be sold even before it has been planted and be certain on what price they will receive for their crop.

5.7 Sugar

Supply chain risk

See graphic above for cropping (grains).

The sugar supply chain is characterised by horizontal separation between the stages. There has been considerable consolidation in the milling sector over the past 20 years and capacity is

largely owned by foreign companies. More than 80% of all sugar produced in Australia is exported as bulk raw sugar . This is transported by rail or road to bulk storage terminals before being sold to Australian or overseas refineries or directly to Australian refineries for processing. Four refineries operate in Australia, two in Queensland and one in both NSW and Victoria. Most Australian refined sugar products are destined for the domestic market.

Risk profile

The Australian sugar industry is subject to moderate-high level of market volatility and has been exposed to a low level of production variability; however, institutional risks have become significant – see Figure 20.

Production risk

Australia's sugar cane production is largely concentrated along Australia's eastern coastline, in Queensland and NSW. While the volume of raw sugar produced by each state, Queensland 95% compared to NSW 5% (Australian Sugar Milling Council, n.d.), is vastly different and there are very clear differences in the risk that producers face, there are issues of common concern to bot states and growing regions.

The effects of climate change have already seen a dramatic shift in rainfall patterns in some growing regions in Northern Queensland. Given that sugarcane is grown in regions prone to natural disasters, weather and climate has a significant impact on the sugarcane industry. Of considerable concern to the industry is the increased storm and cyclone intensity that is likely to contribute to more frequent damage to crops and industry infrastructure. Not only is weather a primary farm risk, it is a secondary risk with subsequent impact arising up or down stream of the value chain.

Weather and climate risk may also result in a growing abundance of pest and disease or introduction of new pests and diseases to a sugar cane growing region. These are serious biosecurity threats affecting farmers throughout Queensland and NSW. Pests and disease can severely affect farming operations, making harvesting difficult and reducing cane quality due to contamination. Protection of the Australian sugarcane industry from the entry, establishment and

spread of exotic plant pests and diseases is a high priority for growers, industry groups and Government.

Market risk

Australia is currently one of the world's largest exporters of raw sugar, with Queensland exporting about 80- 85% of its total raw sugar production (Australian Sugar Milling Council, n.d.). Depending on the season, sugar can be Australia's second largest export crop after wheat and an industry that is highly vulnerable to the global sugar price. Exchange rate factors are also a huge determinant of sugar prices paid to farmers and are incorporated into the final price of sugar that producers receive.

Institutional risk

Prices paid to sugarcane farmers are not only determined by the volume of sugar that is extracted from cane but are also largely affected by cane quality. Therefore, transport and access to mill is crucial for growers and millers. Cane movements off farm to mill need to be efficient to ensure that cane quality is maintained, and the grower can receive a strong price for their product.

The cost of cane transport via rail networks has escalated. This has resulted in decreasing use of rail to transport sugar from mill to bulk sugar terminals.

Risk management options and suitability

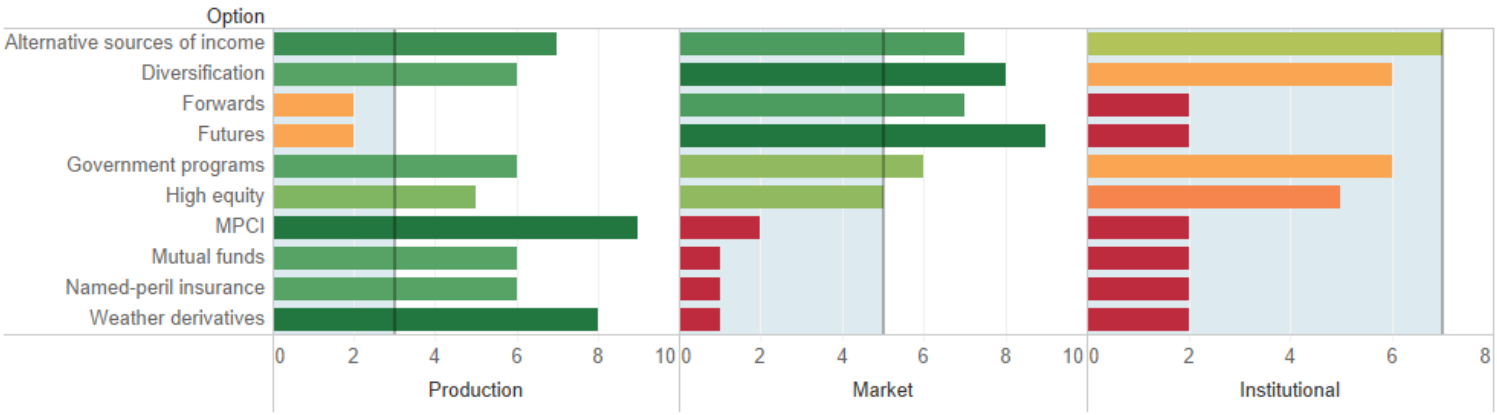


Figure 19. Risk profile and suitability of RM options for Australian sugar

Managing the risks of climate variability is largely achieved through on farm strategies and through Government programs. Smartcane BMP is an industry-led, Government-supported, best management practice system for cane growing in Queensland. The system benchmarks grower practices against industry agreed standards, encouraging continuous improvement on farm. It is comprised of several modules:

- soil health and nutrient management
- weed, pest and disease management
- irrigation and drainage management
- crop production and harvesting management
- natural systems management
- farm business management
- workplace health and safety

In the case of biosecurity, the industry has developed biosecurity manuals, plans and resources for core weed, pest and disease management.

Weather derivatives are a relatively new risk management product for the sugar industry that can help mitigate weather volatility. Weather derivative products are best used in additional to strong on farm management to buffer against specific weather events that an individual farm is vulnerable to. These products are not currently available but are being tried and tested based on individual farm information.

Market risk is managed through a number of alternative forward arrangements and pricing mechanisms. Forward contract arrangements are used commonly in the sugar industry. Australian cane producers have good access to the futures market. Hedging price risk is an important strategy used by many cane farmers. These tools allow growers to capture value from their crop despite lower volumes and gives them the advantage of hedging price risk over the longer term.

5.8 Dairy

Supply chain risk

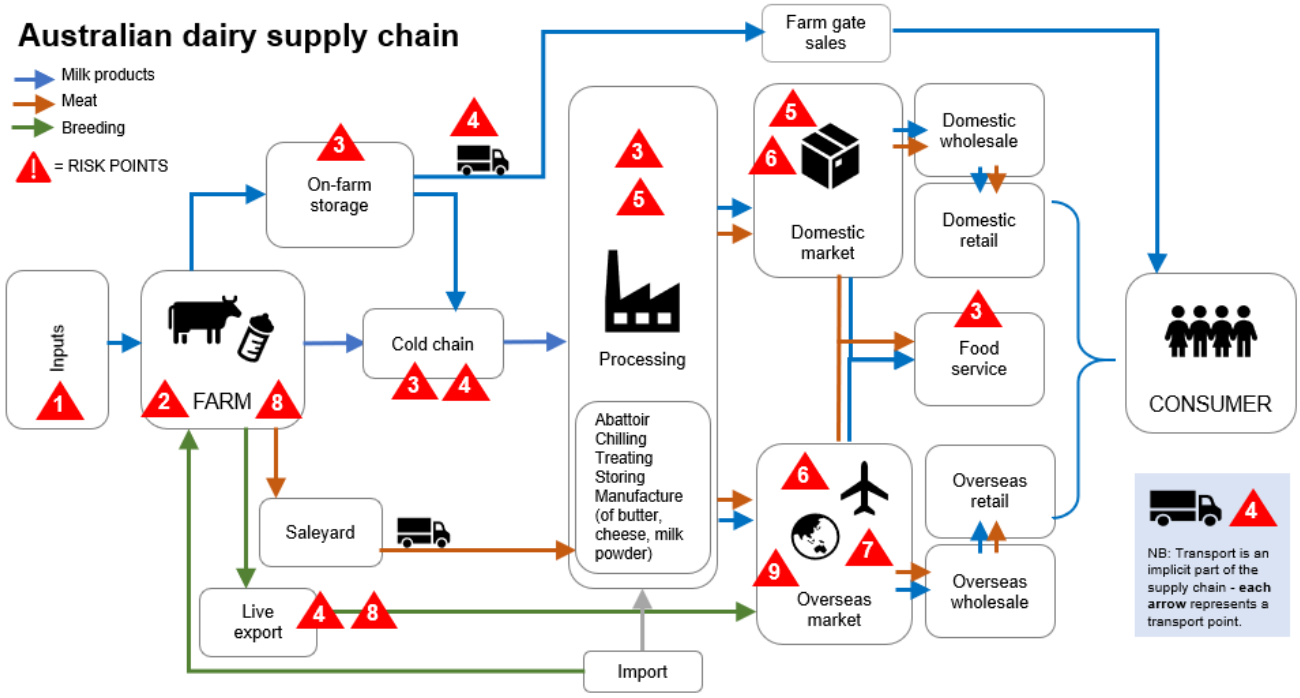


Figure 20. Examples of sector-specific risks and available options for risk management (RM) or mitigation in the Australian dairy supply chain.

Dairy		
RISK		**RM OPTION**
PRODUCTION	1. Feed price	Forwards; Futures
	2. Climate / weather impact (feed production, animal health)	Farm business management; Enterprise diversification; Weather derivatives
	3. Operational incident (e.g. fire, malfunction)	Named insurance (if available)
	4. Transport failure	Named insurance
MARKET/ PRICE	5. Market concentration	Futures; Forwards; Enterprise diversification
	6. Market price change	
	7. Global commodity price fluctuation	
INSTITUTIONAL	8. Social licence (animal welfare)	Government programs; Farm business management
	9. Trade access	Government programs

The dairy value chain is highly interdependent. To make profits, farmers need processors to buy their milk, process it and sell it. For processors to make profits, they need access to sustainable

milk supplies. Farmers and processors need strong domestic and international markets, industry capability, innovation and community acceptance of their processes.

Risk profile

The dairy industry is exposed to relatively low levels of production and price volatility (compared to other agricultural subsectors) at the farm level; however, institutional risk for the dairy industry is elevated due to the nature of contractual arrangements and the growing uncertainty around animal welfare and social licence – see Figure 22.

Production risk

The evaluation indicates low levels of production volatility at the sectoral level. However, within the sector there are distinct differences in production variability due to regional climatic conditions. Many dairy farms are in regions with high rainfall and generally favourable climatic conditions, with pasture growth largely dependent on natural rainfall. A small proportion of inland dairy farms rely on irrigation. For those regions dependent on natural rainfall there is a heighted risk of having inadequate feed volumes.

The industry being predominantly pasture based, and 60-65% of feed requirements come from grazing in years of normal seasonal conditions. Drier conditions have increased the use of supplementary feeding across all dairy farming systems and regions. As a result of increased expenditure on supplementary feeding arrangements, farm cost structures have increased in response to the need to adapt to drier conditions. Purchased feed is the single largest cost for many dairying businesses. This has challenged the industries status as a low-cost producer.

Market risk

International market conditions have dramatically increased price volatility over past decade. The Australian dairy industry operates in a highly competitive international dairy market, made challenging by the strong level of Government support and interventionist policy offered across major dairy export countries. Australian milk producers generally receive a lower price than their international counterparts, reflecting the lower levels of Government support for Australian farmers. With approximately 75% of Australia's milk production exposed to world prices for

dairy commodities, market risk is a major concern for the dairy sector (Senate Economics References Committee, Commonwealth of Australia, 2017).

Dairy manufacturers are particularly exposed to market volatility. Australian dairy processing companies operate in an open an internationally competitive market. Primary risk concerns for manufacturers include global dairy commodity prices and adverse market movements. Ultimately, farm gate milk prices are heavily dependent on the performance of the manufacturer.

Institutional risk

Contracting practices in the dairy industry are an ongoing risk concern. Supply contract arrangements have long dominated the dairy industry in Australia. Supply contracts provide a level of security around quantity, price and quality of milk for both the producer and the manufacturer. The nature of supply contracts varies significantly with payment structures from processors to individual farmers based on a range of incentives for milk quality, productivity, off-peak production, contract length or volume levels. Risk exists in the transparency, flexibility and power imbalance between the farmer and the processor, with contracts heavily in favour of the processor. Standard milk supply contracts give the ability to the processor to vary the price paid for milk and allow the processor to adjust price over the season (Senate Economics References Committee, Commonwealth of Australia, 2017).

Social licence is a new element of risk that leaves both producers and processors exposed to high levels of uncertainty. Public trust in the dairy industry is in decline, dropping from 70% in 2011 to 63% in 2017 (Department of Agriculture and Water Resources, n.d.-b). This has shifted industry focus to maintaining a social licence to operate in areas of animal health and welfare and environmental sustainability.

Risk management options and suitability

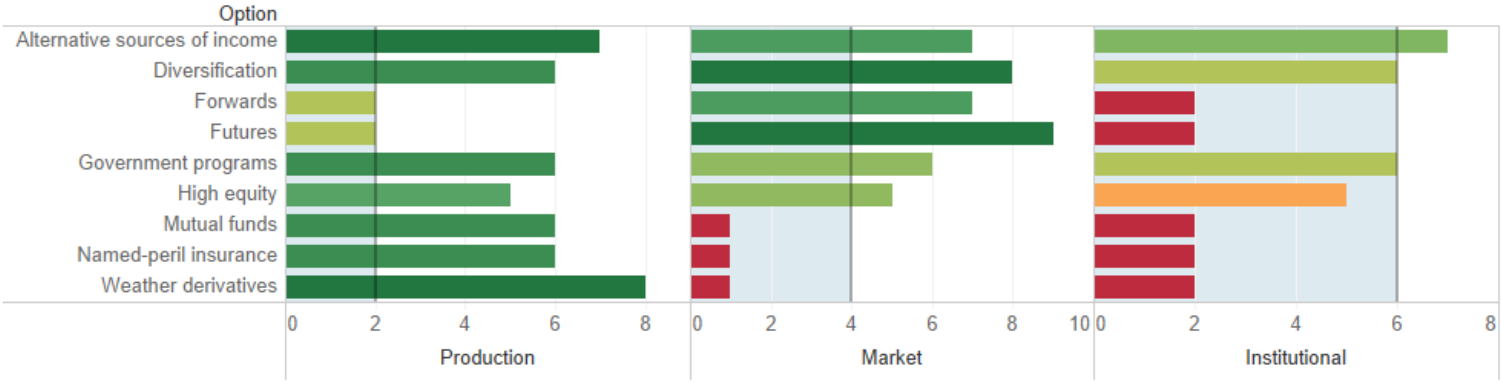


Figure 21. Risk profile and suitability of RM options for Australian dairy

The risk management tools available to the dairy industry are immature compared to the international market.

Alternative sources of income provide strong risk management coverage across all of the risk categories assessed. Diversification also ranks strongly across each of the risk categories.

Production risks for dairy producers can be managed through a combination of on farm management strategies. In addition to alternative sources of income, diversification strategies for producers may include adding value by processing milk into a range of dairy based products. This diversification strategy may be better suited to smaller producers who, while taking on greater risk, are able to receive a higher price to what they might have received from supplying a large processor.

A range of financial tools are available to manage market risk in the dairy sector. Participation in the futures market is limited to more advanced farmers. Financial literary may be needed given the technical nature of financial market instruments. Given the pricing system, there is not a huge appetite for these products amongst producers.

Futures are seen to work best at the processor level as they are generally more directly affected by fluctuations in the global dairy markets and manufacturing companies are already involved in

exchange rate hedging activity. Although financial tools are common amongst manufacturers there is still a strong need to increase awareness and understanding of financial risk management tools. Focus needs to be given to the development of tools around price discovery and transparency. This will ensure price signals are visible and properly communicated across the industry and to allow for trends and market opportunities to be clear and well understood.

To overcome the risk associated with volatility of grain prices, dairy producers require knowledge of the grain market. Australian dairy farmers compete in a world market for grain and an understanding of how the global grain market works informs farmers grain buying decisions.

Institutional risk is best managed at an industry or Government level through industry or Government led programs. The dairy industry is a prominent user of collective bargaining. It is a strategy used to help strengthen the power of milk producers in negotiating milk prices and terms of supply contract with processors.

Social licence concerns have been addressed at an industry level. The Dairy Industry have developed voluntary guidelines under *Australian Animal Welfare Standards and Guidelines for Cattle: A Guide for Dairy Farmers* (Dairy Australia, Australian Dairy Farmers, & Australian Dairy Industry Council, 2014). The standards and guidelines clearly set out consistent regulation based on current scientific knowledge, recommended industry practices and community expectations. They cover a full range of on-farm management practices for cattle including feed, water, risk management, facilities and equipment, handling, breeding and dairy management.

5.9 Poultry – chicken meat and eggs

Supply chain risk

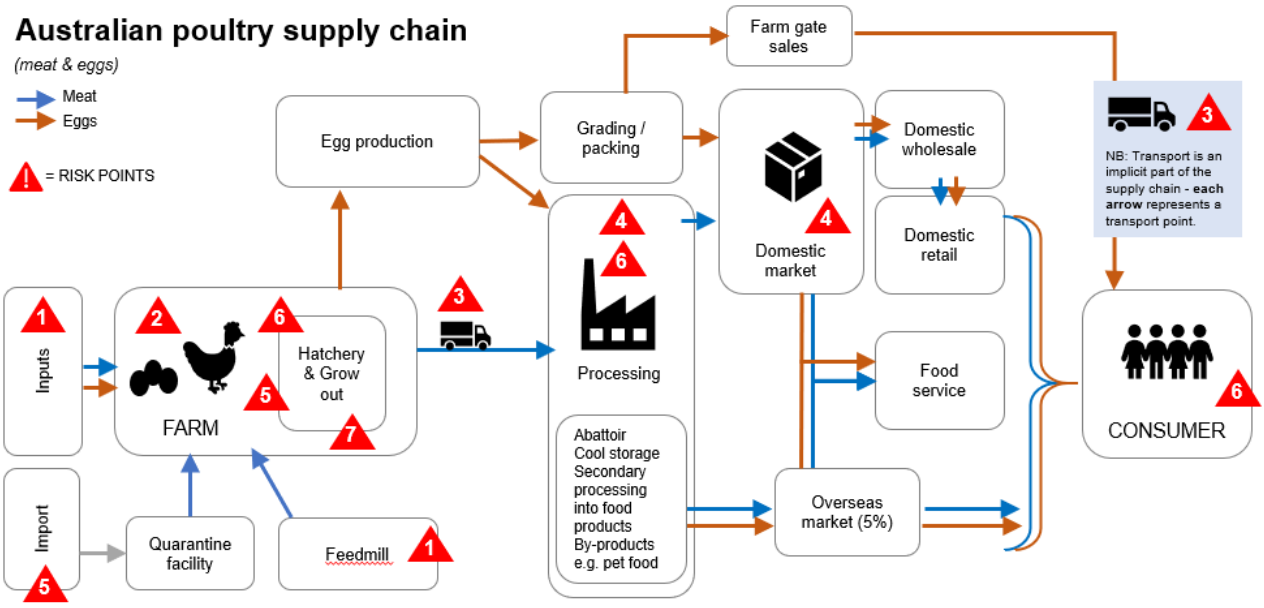


Figure 22. Examples of sector-specific risks and available options for risk management (RM) or mitigation in the Australian poultry supply chain.

Poultry (meat & eggs)		
RISK		**RM OPTION**
PRODUCTION	1. Feed price	Forwards; Futures
	2. Disease outbreak (animal health)	Named insurance; Farm business management
	3. Transport failure (animal health, supply contract)	Named insurance
MARKET/ PRICE	4. Market concentration	Futures; Forwards; Enterprise diversification
INSTITUTIONAL	5. Biosecurity breach (animal health)	Government programs; Farm business management
	6. Social licence (animal welfare)	
	7. Urban encroachment	

The Australian chicken meat industry is highly concentrated and vertically integrated. The supply chain is extensive and comprised of multiple links between the feed mill, breeding farm, hatchery, grow-out farm and processing plant.

The egg industry in Australia is dominated by large-scale producers who sell direct to large retail sellers. Most farms will grade and pack eggs on site. Most Australian eggs are sold domestically, but some are exported as shell eggs or egg products.

Risk profile

As data on the poultry industry was very difficult to obtain, risk assessments were based on generalised observations from production data and industry interviews. Overall the poultry sector is exposed to most risk at the production level, notably in biosecurity, input price, animal welfare and lack of information for decision-making – see Figure 24. Poultry–eggs market risk was assessed as extremely volatile, likely influenced by rapidly changing retail pricing trends (Figure 25).

Production risk

Biosecurity (particularly the threat of avian influenza) and food safety (e.g. salmonella) are primary risk concerns for the poultry industry. While protocols are in place to prevent and monitor outbreaks, a small number of non-compliant operators (outliers) could easily jeopardise the entire sector's biosecurity and commercial viability.

The poultry sector is also dependent on feed price and vulnerable to the risk of feed market fluctuations, which often negatively impacts on the cost of production.

Animal welfare concerns on-farm also present a risk to social licence to operate in both chicken meat and eggs. Changes to stocking densities and husbandry / production practices brought about by community and political pressure can affect productivity and profitability.

Market risk

A combination of factors including opacity of market information available within the Australian poultry sector, combined with market concentration and lack of competition, dramatically impede producers' decision-making and limit producer choice, thus enhancing risk. Over-investment in industry infrastructure also impacts egg/bird prices and imperils profitability.

Institutional risk

As noted previously, in Australia the chicken meat industry is highly concentrated and vertically integrated, and the egg industry is dominated by large-scale producers who sell direct to large retail sellers. Market concentration and lack of competition are major sources of institutional risk for the poultry industry.

Urban encroachment and consumer concern about animal welfare pose a threat to social licence to operate. Lack of reliable and timely industry data introduces risk into decision-making across the sector, particularly at the production level.

Risk management options and suitability

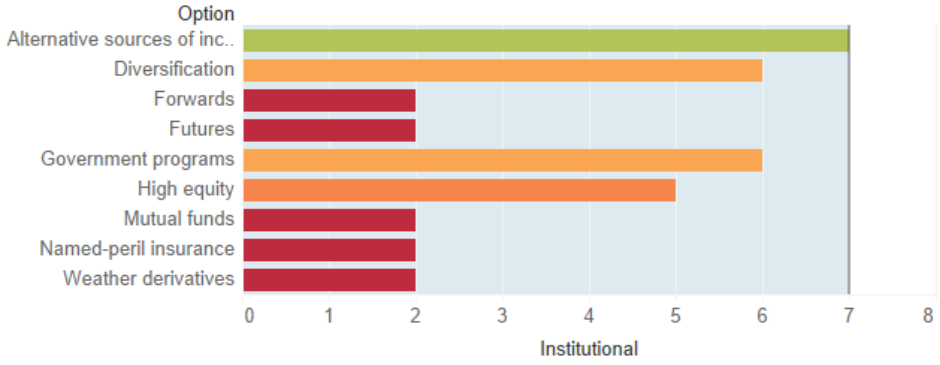


Figure 23. Risk profile and suitability of RM options for Australian chicken meat

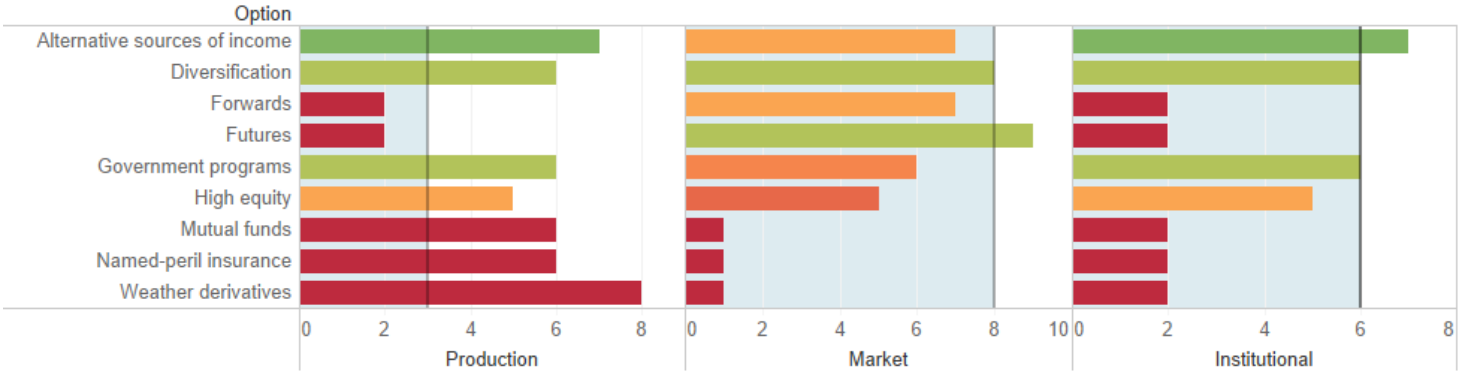


Figure 24. Risk profile and suitability of RM options for Australian eggs

For chicken meat, insufficient data was available to adequately assess production and market risk, therefore only institutional risk assessment is presented (Figure 20).

The implementation of a sustainability framework will help address environmental and animal welfare risks which threaten social licence in both chicken meat and eggs. Government regulation to address competition issues could address some market and institutional risk. Forward purchase of inputs (feed), and industry regulation to enhance biosecurity protocols across all industry operators regardless of size, could address some production risk.

5.10 Horticulture

Supply chain risk

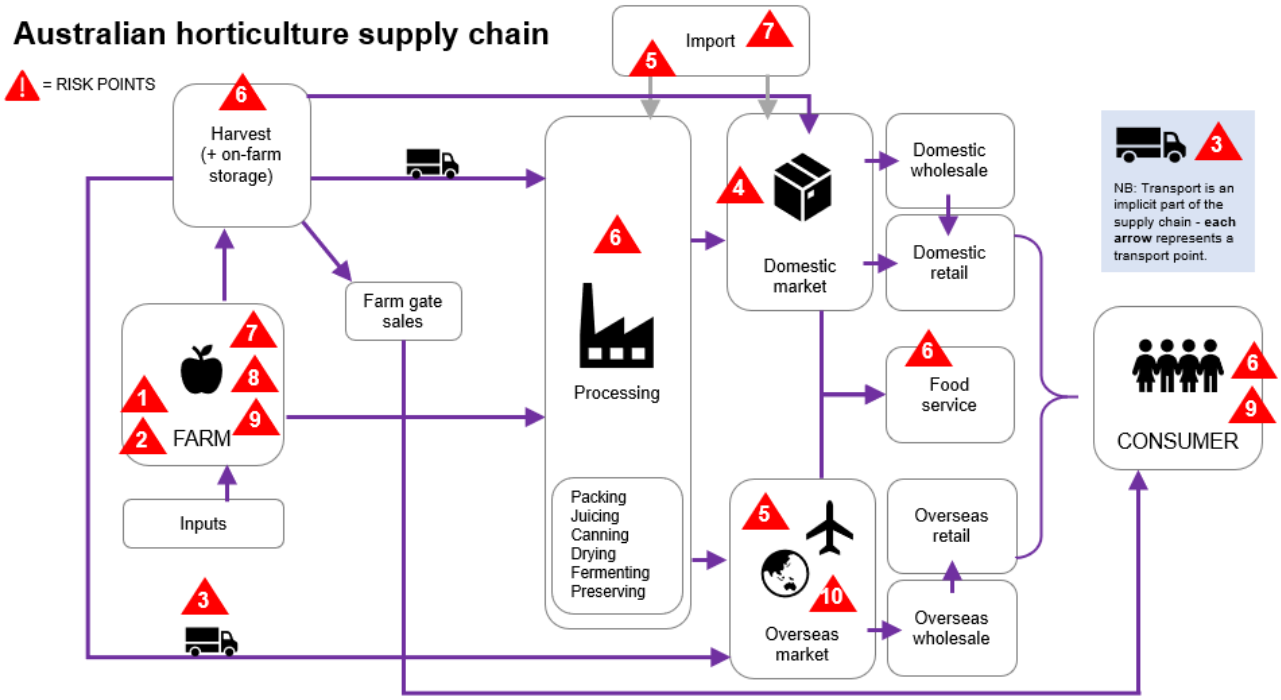


Figure 25. Examples of sector-specific risks and available options for risk management (RM) or mitigation in the Australian horticulture supply chain.

Horticulture		
RISK		**RM OPTION**
PRODUCTION	1. Climate / weather impact	Farm business management; Enterprise diversification; Weather derivatives
	2. Disease / pest outbreak (crop health)	Named insurance; Farm business management
	3. Transport failure (animal health, supply contract)	Named insurance
MARKET/ PRICE	4. Market price change	Futures; Forwards; Enterprise diversification
	5. Global commodity price fluctuation	
	6. Food safety	Government programs; Farm business management; Named insurance
INSTITUTIONAL	7. Biosecurity breach (crop health)	Government programs; Farm business management
	8. Urban encroachment	
	9. Social licence (worker treatment)	
	10. Trade access	Government programs

Australia's horticulture industry comprises fruit, vegetables, nuts, flowers, turf and nursery products, and thus a number of discrete supply chains are in operation. The farm component comprises mainly of small-scale family farms. Wholesale markets remain a major function where most sector prices are influenced. Individual horticultural commodities have different channels to market depending on end use (fresh or manufacturing). Recently, major grocery retailers have established direct relationships with growers, overriding wholesale markets.

Risk profile

In the absence of suitable data, horticulture was assessed by way of industry consultation and a literature study. Key risk factors were highlighted with evaluation of risk management tools based on this – see Figure 27.

Production risk

Biosecurity is a major threat to the sector, particularly at the import stage. At producer level, there is a need for better understanding of how the biosecurity system works, and at a broader level there is a need to embrace shared responsibility between government agencies, industry groups and producers. Food safety was another risk noted by industry representatives.

As with many other Australian subsectors, changing climate conditions are noted as presenting a particular production risk in the near future. Adaptation to a changing climate also comes at a cost, for example increased refrigeration expenses, which exacerbate production risk.

Market risk

Market price change, global commodity price fluctuation and food safety were noted as market risks for the sector, however a lack of or opacity of available data (due in part to sector fragmentation and supply chain complexity) made assessment of this risk very difficult.

Institutional risk

Social licence factors present a risk to horticulture primarily via community concerns on worker treatment and human rights. The sector has a high dependence on seasonal labour and a patchy record on fair treatment of itinerant employees. The 'Fair Farms' training and certification initiative recently launched by Growcom aims to foster fair employment practices in the Australian horticulture industry and to lift standards more broadly across the sector by helping growers understand legal obligations and promote a 'beyond-compliance culture'.

Urban encroachment is also a risk to horticulture. Significant areas of productive land are likely to be lost to real estate development in coming years, and industry groups have emphasised the need for better acknowledgement and recognition of agricultural priorities in rural planning.

Risk management options and suitability

For horticulture, insufficient data was available to adequately assess production and market risk, therefore only institutional risk assessment is presented (Figure 23).

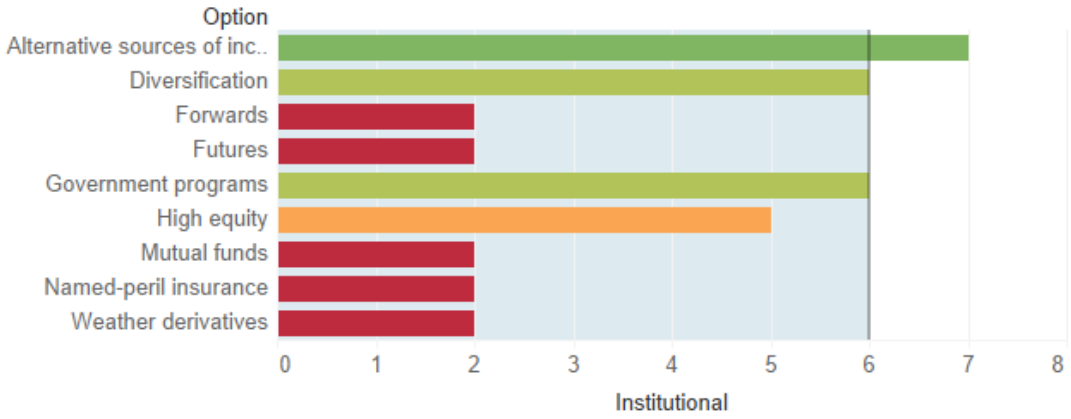
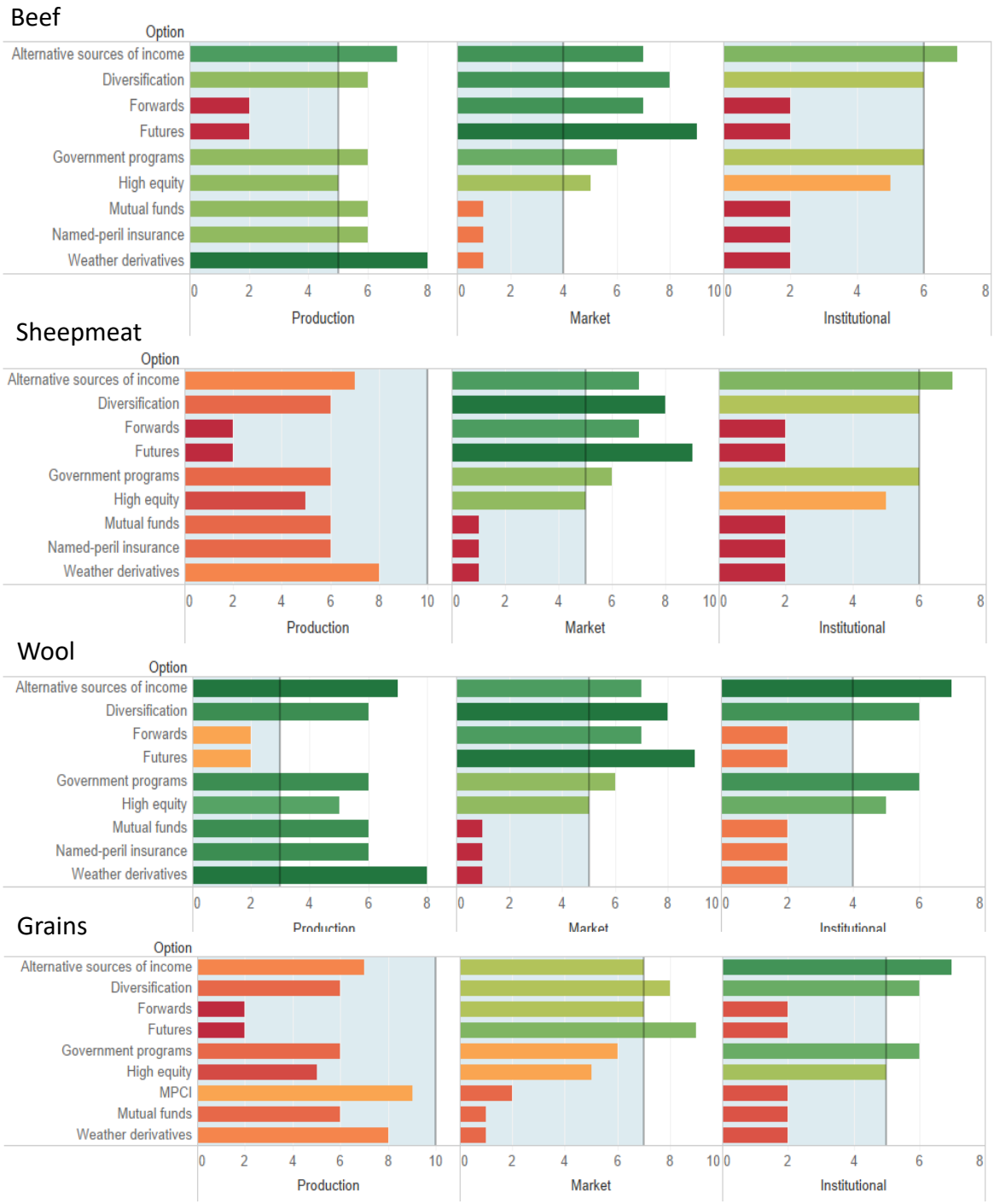


Figure 26. Risk profile and suitability of RM options for Australian horticulture

6. Conclusions and recommendations

This report has investigated the nature of risks to which Australian agriculture is exposed and the effectiveness of a selection of options in alleviating those risks. The sectoral analysis detailed in Section 6 (summarised in Figure 24) contains broad areas for findings described in this section.



90 ***Figure 27. Summary of effectiveness of risk management options for mitigating risk***

 Figure 28b. Summary of effectiveness of risk management options for mitigating risk

6.1 Institutional risk has become a significant factor for Australian agriculture.

Institutional risk describes a suite of factors external to either production or market factors, such as policy changes or trade restrictions, which have the ability to impact on farm business viability. Some institutional risks (such as extent of competition and restrictive contractual arrangements) have been present in Australian agriculture for some time, while others (such as social licence-influenced disruptive regulatory change) are rapidly emerging as new risks.

Institutional risk tends to be insidious and is often only expressed when a crisis in the supply chain leads to awareness of the risk inherent in concentration of power.

There are no specific commercial product offerings designed to address and alleviate institutional risk. However, farm business management approaches such as developing alternative sources of income and enterprise diversification provide some level of protection.

Institutional risk tends to be insidious and is often only expressed when a crisis in the supply chain leads to awareness of the risk inherent in concentration of power.

For example, closure of the Baiada chicken processing plant in January 2018 at Ipswich in Queensland had flow-on effects which included the loss of 500 jobs at the Churchill Abattoir. With only a couple of other processors in the south-east Queensland region, Queensland Chicken Growers' Association estimated the closure would leave 26 meat chicken growers without contracts and strip approximately $150 million in lost production and devaluation of farms (Mitchell-Whittington, 2017). Baiada said market conditions required consolidation of national processing operations.

Because of the insidious nature of institutional risk, it is important that the monitoring and awareness of new and developing risks is a continual function of industry bodies and advocacy groups. Coordinated policy responses and industry strategy may mitigate some institutional risks before they translate to disruption for farm businesses. In some cases regulatory intervention may be required by bodies such as ACCC to ensure that institutional risk is manageable and does not adversely impact on the profitability and competitiveness of Australian agriculture.

Recommendation:

New and developing institutional risks are a multi-faceted and significant threat to many agricultural sectors. Industry bodies and advocacy groups have a responsibility to monitor these risks and proactively develop co-ordinated and effective responses.

6.2 Farm business management is the most effective way of mitigating a wide range of risks.

Farm business management approaches such as retaining high equity, creating alternative income sources and enterprise diversification mitigate multiple types of risk simultaneously. All of these risk management options underpin financially resilient businesses that are able to withstand and recover from production, market or institutional shocks. However, there are some drawbacks to employing each approach.

- **High equity** – significant barrier to entry and reduced investment in innovation
- **Alternative income sources** – requires significant revenue generation to be able to divert profits from farm business to develop other investments
- **Enterprise diversification** – requires high levels of management skill to manage multiple enterprises effectively.

Financial literacy on farm business risk management approaches is inconsistent across the industry. Some subsectors are very advanced in promoting risk aversion, management and mitigation, and while Government education programs exist the uptake is often low. A consistent and coordinated approach to agricultural risk management education would benefit the industry.

Recommendation:

Government and industry should collaborate on a consistent and coordinated education approach to raise the sector's level of financial literacy and awareness of types of risk and provide information and resources to develop diverse approaches to ameliorating those risks.

FMDs are a government program aimed at enhancing farm business viability and are very effective at mitigating against a range of risks. The FMD scheme increases effective management of financial risks by providing a tax effective mechanism to build up cash reserves to cope with cash flow fluctuations.

Recommendation:

Given their applicability and cost effectiveness as a general risk management tool, barriers or restrictions on the use of FMDs should be investigated and removed.

6.3 Options which address single risk factors are effective; however, some are still in market failure.

The risk factor with the greatest volatility (biggest variation) is production risk. Combined with the human attraction to drama, this is a likely reason why production shocks like drought, flood and fire get so much attention.

Production and market volatility can lead to large swings in farm business revenue potentially impacting on financial viability; however, multiple options are available to address these risk factors.

Market risk is generally well served with options e.g. futures and forward contracts, although these products are more available in cropping subsectors than animal subsectors.

Production risk is also covered by multiple products, although those which address a wider range of production risks, e.g. MPCI, and weather derivatives, are in market failure or are not widely used. As noted above, issues with lack of knowledge and education hinder uptake of available products, particularly regarding weather derivatives and to some extent MPCI. How the products

work and the ability to adequately assess cost/benefit can be quite opaque, thus uptake is restricted because premiums remain high and the cost/benefit (value) is not apparent.

Recommendation:

Behavioural economics filters (e.g. perceptions of cost related to risk appetite) should be applied in the development of risk managements products such as insurance and derivatives to expediate uptake.

Interviews with insurance providers indicated that a recent boost in availability of reinsurance capital has resulted in the development of new and innovative products for the agricultural market place. This factor was particularly evident in the weather derivatives market where the development of products suitable for farm businesses has been accelerating recently. The availability of greater amounts of farm scale data have also stimulated development of products in these categories.

Weather derivatives and multi-peril insurance products remain relatively misunderstood in the market place. An issue with the ability to adequately compare and assess these products is the different licensing requirements required to sell them. Weather derivatives are classed as financial instruments therefore weather derivative providers require a financial services licence (FSL). Many agricultural insurance providers and brokers do not have FSLs which means that the products are unlikely to be provided by the same organisation allowing for comparative assessment and understanding.

Recommendation:

Weather derivative products competing in the agricultural insurance market place should be licensed in the same manner as other insurance products.

6.4 Improved data availability would have a positive effect on provision of risk management options.

Lack of relevant, accurate and comprehensive data was a consistent theme that arose throughout the compilation of this report, impacting the ability to adequately assess all sectors. Data limitations also impede the ability of the market to develop and provide cost-competitive risk management products. Lack of data and underwriting skills have been noted as a key constraint on the development of a mature farm insurance sector; that is, the Australian insurance industry lacks detailed climatic information to accurately assess the exposure of and estimated duration for an insured event, and also lacks specialist underwriters (Deloitte, 2017).

Improved access to and interoperability of data would benefit the whole agricultural value chain to better manage risk.

Technology is providing access to new data (for example, the Internet of Things, satellite imagery, blockchains) which will help the development of new risk products; however, a critical mass of data collected over time is needed before these sources can be useful for this purpose, which may take several years.

Improved access to and interoperability of data would benefit the whole agricultural value chain to better manage risk. Some subsectors are more advanced than others in pursuit of better data and statistical collection, thus cooperative efforts are needed to ensure the industry improves collectively. The agriculture sector should also learn from other industries/sectors which have improved data collection, particularly where this relates to risk management and mitigation.

Government has a role to play in enabling the supply of appropriate data to make risk information more readily accessible, not only to provide foundations for the maturing of the commercial risk product market but also to improve farm business risk management decisions.

The National Flood Risk Information Project (NFRIP) is a good example. Following the devastating floods across eastern Australia in 2011, the Australian Government's Natural Disaster Insurance Review highlighted the lack of consistency in collection and availability of flood risk information. In response, the NFRIP was established to improve the quality, availability and accessibility of flood information across Australia.

Recommendation:

Government and official statistics agencies (ie. ABS, ABARES) should collaborate with industry to support and enable the supply of appropriate industry data to make risk information more readily accessible.

- The focus for this should be on the provision of more granular weather data, as well as utilisation of IoT, satellites, blockchain etc.

6.5 The role of Government in provision of risk management options is fraught.

Questions consistently arose throughout the research around the role for Government in stimulating the risk management product market where there is now market failure or immaturity.

Australian governments are already spending billions of dollars on ad-hoc risk mitigation through drought payments and other emergency measures. If Government is to consistently address risk in the broadest sense across the greatest number of subsectors, a better approach would be to investigate and support measures which enable and extend best-practice farm business management as widely as possible. Investing in R,D & E to improve productivity and profitability in a changing climate, negotiating and maintaining beneficial trade arrangements and creating efficient infrastructure for supply chains, results in a profitable, resilient farm sector – thus enhancing the ability of the businesses that make up that sector to use profit/equity to mitigate risk (e.g. via FMD-type arrangements).

Recommendation

Continued investment in R,D&E to develop new technologies (such as more drought tolerant fodder species and grain types) and improved weather and climate forecasting should be considered an essential part of the Government's investment in risk mitigation.

However, even with best practice risk mitigating-business practice widely adopted, there are likely to be occasional severe climatic events which will place even the most resilient businesses under pressure. A more mature and affordable market for income insurance products would provide another tool for farm business to consider in anticipation of these scenarios.

International precedent indicates that it is unlikely that commercial insurance markets aimed at typical scale farm businesses will mature quickly without some level of government support. However, the recent takeover offer for GrainCorp by Long-Term Asset Partners (LTAP) provides an interesting example of the market starting to investigate ways where risk can be addressed at scale.

To enable the bid, LTAP sought out a reinsurer willing to guarantee Australia's east coast grain harvest for the next 25 years. LTAP has reportedly negotiated an arrangement with Allianz under which the giant insurer would insure the larger part of the risk, underwriting a substantial proportion of revenue. The 'swap' contract would smooth out earnings, removing significant risk and volatility and allowing the bid to be based almost entirely on debt capital (Boyd, 2018).

The fact that large parts of the supply chain now appear to have the capacity to minimise risk through a form of commercial revenue insurance adds weight to the argument that farm businesses are disadvantaged in globally competitive markets and now in domestic supply chains by not having access to a mature market for equivalent products.

Realistically there is likely to be very little political support or indeed support from the agricultural community for public money to be used to support risk minimisation if the form of that support leads to costly, difficult to remove schemes which provide perverse outcomes such as supporting the viability of inefficient and unsustainable businesses. It is arguable however that the current public spend on risk mitigation, through the form of emergency drought payments, is achieving exactly that.

As previously stated, Australian governments are already investing significantly in alleviating the consequences of production, market and institutional shocks in Australian agriculture. It is likely that by performing a thorough examination of the cost benefit of that investment, compared to a more proactive approach which prioritises the stimulation of financially resilient

and prepared farm businesses, that have access to mature insurance markets as one of their risk management levers, a more efficient spend of the public dollar will be found.

If some form of public support is required to establish mature insurance markets, it is critically important that this support be provided in a manner which is;

a) temporary,
b) does not lead to perverse outcomes such as sustaining unsustainable businesses,
c) continues to provide price signals for risk so that the relative viability and riskiness of agricultural businesses in different subsectors and regions is reflected in the market.

To increase the likelihood that these requirements are met it is important that the supply side of the equation is investigated as thoroughly as the demand side. Previous proposals for incentivisation of income insurance have focused on the demand side through measures such as tax-deductible premiums. It was evident through the course of the investigations for this project however, that supply-side factors such as increase in re-insurance capital leading to competition to develop and place innovative new products in the market are equally important to the successful development of mature markets and indeed may require less, if any, government intervention.

Recommendation:

A cost/benefit analysis should be performed on the redirection of Government funding currently targeted to risk consequences (ex post) into stimulation of private market risk mitigation products and improving farm business / supply chain risk management.

As noted above, Government undoubtedly has a role in supporting the supply of appropriate data on risk information to improve planning and management.

Recommendation:

If incentivisation of private market risk mitigation products is required, due consideration must be given to both **supply and demand** stimulus, rather than demand alone.

General findings

This research has endeavoured to understand why there appears to be a less diverse range of risk management options used in Australia compared to many other countries. Commercial insurance and derivative markets in particular are immature compared to other jurisdictions. However, as the risk management examples outlined in Section 3 demonstrate, there is not necessarily a lack of options on offer, it is more that the uptake of these options remains low resulting in immature markets or indeed market failure.

There are many and varied reasons for the lack of uptake of commercial risk management options. While cost is obviously a significant barrier, as has been highlighted earlier in this report, it is often perception of cost related to risk appetite that has a bigger impact on decision making than a reasoned and dispassionate examination of the cost/benefit of using these products. A deep and detailed understanding of how risk appetite interacts with the assessment of the value proposition of risk management products would help in the development and likely success of new products.

Perception of cost related to risk appetite has a bigger impact on decision-making than a dispassionate examination of the cost/benefit of using these products.

In the absence of general uptake of insurance products, good farm management practices and resilient financial business models remain as the most widely used and generally successful method for risk mitigation. It is worth noting that although Australian agriculture is exposed to significant risk, the Australian farm sector has experienced sustained growth suggesting that farm businesses are dealing with risk successfully and sustainably.

Australian farm businesses are dealing with risk successfully and sustainably.

In fact, there is some argument in the farming community that exposure to risk is a large driver of innovation and has led to the development of sophisticated business models that are attuned to the level of risk imposed. For this reason, there is also some argument that lessening risk would lead to less innovation in business practice and make it too easy for inefficient businesses to survive. And indeed, highly subsidised agricultural economies in other countries can be used as examples where inefficient farm businesses are sustained by publicly supported risk mitigation programs.

However, strategies for mitigating risk through farm business structures and practices generally require existing strong and profitable businesses that are able to maintain high equity levels and divert profits to build alternative income sources. They are generally not suitable strategies for adoption by new entrants to agriculture and can also be restrictive in terms of the ability to have regular innovation investment cycles.

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8. Appendix

Appendix 1: Data sources referenced for index

Commodity	Source - production	Year	Source - price	Year	Price series
Beef cattle	ABARES	2001-2016	MLA statistics database	2000-2016	Eastern Young Cattle Indicator (EYCI)
Sheepmeat	ABARES	2001-2016	MLA statistics database	2000-2016	Eastern States Trade Lamb indicator (ESTLI)
Wool	Australian Wool Testing Authority (AWTA)	2001-2016	Mercado	2000-2016	Eastern market indicator (EMI)
Wheat	Australian crop forecasters	2001-2016	GrainGrowers	2000-2016	Australian Premium White (APW) Wheat Newcastle track
Pork	Australian Pork Limited (APL)	2001-2016	Australian Pork Limited (APL)	2000-2016	
Cotton	Australian crop forecasters	2001-2016	ABARES	2000-2016	Australian base price raw cotton
Sugar	Australian Sugar Milling Corporation (ASMC)	2007-2016	ABARES	2000-2016	Return to cane growers
Dairy	Dairy Australia	2001-2016	Dairy Australia	2000-2016	Farmgate milk price (national average)
Poultry – chicken meat	Australian Chicken Meat Federation (ACMF)	2001-2016	n/a	n/a	n/a
Poultry – eggs	Australian eggs	2006-2016	Australian eggs	2004-2015	Farm gate price

Appendix 2: Detailed global literature review

Europe

Overview

Agriculture is at the cornerstone of the European Economy. In 2016, the agricultural industry, recorded an output value of €400 billion and experienced strong growth throughout 2017 with a total output value of €427 billion (European Commission, 2018). European agriculture is centred on the common agricultural policy (CAP). The policy was introduced in 1962 and is one of the European Union's (EU) oldest policies. The objective to manage agricultural risk is recognised by the CAP with a fundamental focus on stabilising farm income. The policy is founded on two key pillars:

1. Market and Price Support Policy
    - After the MacSharry Reform of 1992, has merged into a Market and Income Support Policy
    - Deals with annual direct payments to farmers to help stabilise farmer income
    - Financed through the European Agricultural Guarantee Fund (EAGF)
2. Rural Policy
    - Concerns measures of member states for rural development under Rural Development Programs (RDP's)
    - Set of optional measures with economic, environmental or social objectives with the aim of achieving a sustainable farm sector that is environmentally sound and to promote competitiveness and innovation
    - Financed through the European Agricultural Fund for Rural Development (EAFRD)

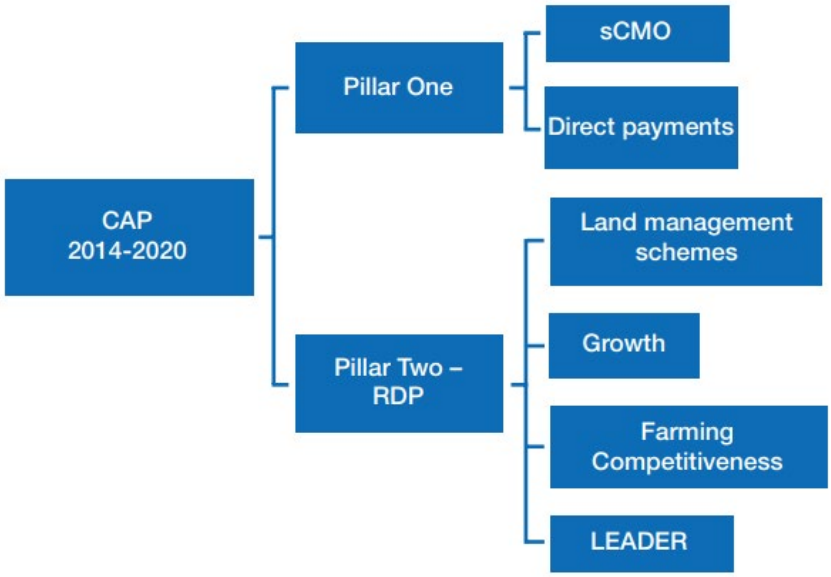


Figure 28. Shape of the Common Agricultural Policy - *Source: Government of the United Kingdom, 2014 (Government of the United Kingdom, 2014)*

Under the current 2014-2020 Multiannual financial framework (MFF), the CAP is allocated a total of €408.31 billion. The majority (€308.72 billion) is allocated to the first pillar with the remaining (€99.6 billion) allocated to the second pillar (European Parliamentary Research Service Blog, 2016).

The heterogeneity of risks across European agriculture gives rise to a more decentralised approach allowing for delivery of instruments that are best suited to a region or sector. Pillar II of the CAP provides a toolkit for agriculture to select from a range of tools that are best suited to individual conditions but in the context of a broader strategic approach to risk management through Rural Development Policy.

Since the 1990s, there has been progressive reform of the CAP. Market and price support was the popular policy direction during the 1970s and 1980s with the aim of guaranteeing stable and high prices for producers. The only exception being production quotas for milk, sugar and wine. These measures resulted in overproduction with a massive food surplus, budgetary pressure and had a distorting effect on trade rendering them economically inefficient and unsustainable. Currently, markets measures represent less than 2% of the CAP budget (Workshop 'Risk Management in EU Agriculture,' 2017). The major CAP reform of 1992 (MacSharry Reform) reduced the system of guaranteed price. Instead, the CAP moved to compensating farmers for

any price volatility via direct payments. Direct payments were initially coupled to production however over time they have gradually been decoupled.

Further reforms were negotiated in 2003 and 2013. Outcomes of the 2003 reforms were the establishment of a single payment scheme (SPS), a direct payment decoupled from production, as well as the introduction of a cross compliance concept whereby payments were conditional on maintaining food safety and environmental standards. In 2013, there was a move towards a more holistic and integrated approach to policy support for the period from 2014-2020. The reforms mainly concerned changes to SPS payments and are aimed at better targeting of support and a fairer distribution of payments.

It is broadly understood in European agriculture that farmers should be expected and are encouraged to deal with normal business risk themselves through on farm risk management strategies. Government policy should facilitate, rather than crowd out the use of various market instruments that are available to manage risk.

Farm management

Diversification

Favourable production in one crop may help cope with loss in another and is in some cases extended to off farm activities. It was found in a recent study that although it does not require public support, crop diversification contributes to a significant decrease in income variability in Europe (Castañeda-Vera & Garrido, 2017).

Vertical Integration

Ownership of two or more level of activities, either backwards or forwards e.g. common in livestock with ownership of feed manufacturing and fresh vegetable sector with ownership and packing and processing.

Investment in physical assets

Improved efficiency of irrigation infrastructure, water use technologies and storage capability.

Private based solutions

Private based agricultural insurance schemes in the EU are difficult to establish and are heavily supported by government. The uptake of many tools remains low, in particular marketable tools such as futures, insurance and mutual funds. Difficulties arise due to asymmetric information

(adverse selection and moral hazard), foreseeing and calculating costs of potential risks and the systemic nature of risks. Given this, insurance companies may have to set very high premiums as well as cover themselves through either futures markets or reinsurance.

Single peril crop insurance and multi-peril crop insurance

Both insurance types are available in the EU. The most extended type is single peril crop insurance covering hail damage. Multi-peril crop insurance covers a larger range of weather events and is available but to a lesser extent. Overall, the uptake of crop insurance remains limited due to high premiums and the associated high cost of deductibles. Photo sanitary and livestock insurance is also available. Phytosanitary insurance covers against exotic pests for potatoes and livestock insurance, can cover against death and emergency slaughter due to illness, accident, theft, fire or storm. To render insurance premiums affordable to farmers, public sector support is available through CAP or national subsidies. Insurance is largely subsidised in part by the national Government. Through EU Rural Development regulation, member states can allocate a percentage of the budget to insurance subsidies, with a support level of up to 65% (European Commission, 2017a).

Single peril insurance schemes are available in every EU member state and for most countries this is the main insurance product available. Multi-peril crop insurance is more limited with only a few member states offering this product. Across member states, there are significant differences in the implementation of subsidy schemes. Differences range from the number of farms covered and the amount of loss that must occur before compensation is granted. Spain has one of the most developed insurance systems (both single and multi-peril insurance), where national and regional governments subsidise up to 60% of the premiums farmers pay (European Parliament, 2016a).

The agricultural insurance industry in the EU is dominated by a few market players. There is opportunity to promote competitiveness to lower insurance costs and provide better access to the market. This is in comparison to the US, with agricultural insurance provided by 17 private companies who work in agreement with the United States Department of Agriculture (USDA). The US also has a higher Government support for agricultural insurance, with support for 72% of the total premiums compared to 32% in the EU (European Commission, 2006).

Risk can also be managed through involvement in a mutual fund. The establishment of mutual funds in the EU rely on public support in the form of start-up capital or annual contributions. In

a mutual fund, participants contribute a fixed amount to a common financial reserve. This fixed amount is independent of the individuals level of risk. Mutual funds are normally established at a sector level as farmers are more likely to experience common risks and are likely to know each other, addressing issues of moral hazard and adverse selection. A disadvantage of mutual funds is systemic risks where correlation of loss may occur amongst many farmers, placing pressure on available funds & servicing capacity. One way to alleviate this financial pressure is through reinsurance.

Reinsurance has a large influence in the agricultural sector. Reinsurance can cover potential losses in excess of the funds accumulated capital. Because of their size, reinsurers are able to perform geographical diversification even to the extent where they can group EU risk with risk in US or Asia ("State of play of risk management tools implemented by member states during 2014-2020," 2016).

Mutual funds are not prevalent in the EU due to the difficulties in attracting a critical mass. A lack of trust in the robustness of mutual funds and the wide availability of public support has limited the support for mutual funds. However, recent changes to mutual fund legislation which allow for farmers and member states to set up specific mutual funds is likely to drive wider participation.

Example: Glanbia Fixed Milk Price Scheme

The Irish dairy cooperative, Glanbia, introduced a voluntary fixed milk price scheme in 2016. It offers milk suppliers the option to protect a share of their milk supply from the extremes of market price volatility.

The scheme allows milk suppliers to lock in a base milk base price. The price is based on a given quality and quantity of milk over either one year or three years.

The base milk price is made up of the milk cost plus a farmer's margin that moves accordingly with the Consumer Price Index. The scheme applies a market adjuster that increase the base price per litre with 0.5c/L when the milk price gets one cent above a maximum threshold. The base price will decrease when the milk price gets below a minimum threshold.

A minimum milk price provides farmers with certainty for the duration of the scheme, however the farmer accepts a milk price that may not be as attractive as the market price.

20% of Glanbia's milk supply is now under Fixed Milk Price Schemes with 60% of suppliers participating.

Market solutions

Forwards, futures and options are private, market-based risk management alternatives for farmers to reduce their price risk associated with the trade of agricultural commodities.

Forwards

Forwards are non-standardised agreements where parties agree on the transfer of a commodity to take place at a predetermined price at a scheduled future point. Entering into forward agreements can help to manage cash flow, reduce uncertainty and stimulate investment. The opportunity to engage in the futures market and the extent of uptake may be limited in some sectors. For a vertically integrated sector it may be unnecessary because of the integration of producers and processors. In sectors with several participants, farmers can negotiate contracts with downstream participants however generally lack bargaining power.

In the EU, there is not a widespread use for crops and livestock. Forwards have been developed much more for grains and oilseeds, particularly in France. In Denmark forwards are common for the pig sector and in Hungary and Slovenia there is a broad use in the dairy and poultry sector with a strong uptake of benchmark contracts (European Commission, 2017a).

Futures

Futures are standardised forwards contracts traded on futures markets. The quality, quantity and delivery method of the commodity is predetermined. Futures are traded on the futures market and are a type of derivative as its value is derived from the physical commodity. Prices of futures contracts are determined via an auction process (demand and supply). Up until reforms, EU agricultural markets were highly protected through the guaranteed price system under the CAP. This public intervention limited impacts of price fluctuations and therefore eliminated the need for farmers to take out futures contracts. Gradual reductions in price support exposed EU agriculture to greater price fluctuations and subsequently, the first futures market in Europe was established in 1992 (European Commission, 2017a).

Futures contracts can be traded for a variety of different agricultural products across several futures exchanges in Europe. The trade activity of commodities on the futures exchange in the EU is variable. The most traded commodities are rapeseed and wheat with 19% and 10% of crop production traded on futures markets in 2016 (European Commission, 2017a). The major European exchanges include: (Madre & Devuyst, 2016)

- Intercontinental Exchange Futures Europe (ICE Futures Europe, London) – wheat, barley, canola, coffee, cocoa, cotton, sugar, soybeans
- Marche a Terme International de France (MATIF, Paris) – wheat, corn, barley, rapeseed, potatoes, sunflower seeds
- Budapest Commodity Exchange (BCE, Hungary) – wheat, corn, barley, rapeseed, sunflower seeds
- Poznan Commodity Exchange (PCE, Poland) – live hogs and wheat
- Amsterdam Agricultural Futures Market (ATA) – live hogs and potatoes
- Futuros de Citrios y Mercaderias de Valencia (FC&M, Spain) – navel and Valencia oranges
- Waterenminborse Hannover AG (WTB, Germany) – hogs, piglets, table and processing potatoes, wheat and rapeseed

Commodity futures in the EU are used much less and not as heavily traded as in the US. An estimated 3-10% of European farmers take out futures compared to 30% of US farmers (Madre & Devuyst, 2016). This is the case given the high level of public support available in the EU under Pillar I of the CAP and the consolidation of farming in the US, with larger, corporate style farms more inclined and have greater capacity to use financial innovation.

Livestock futures exchanges were popular throughout the early 2000s, however due to the lack of market participants, with only producers positioning themselves and little interest from buyers

(abattoirs, processors, manufacturers), these markets have disappeared. The extent to which commodity futures are used also depends heavily on the characteristics of products. Some products in the EU are less favourable to be traded on futures. In general, homogenous products like cereals are suitable to be traded on futures whereas products like cheese are less likely to be exchanged via futures contracts.

The outlook for futures markets in the EU is strong although European producers today make limited use of the futures market, changes in policy have created conditions conducive to the development of a strong futures market. A greater demand for price risk management tools has been stimulated by the move to market determined prices. Increased price volatility is likely to enhance the use of futures markets and will depend on future changes to EU agricultural policy and future rounds of trade negotiations (Normile & Leetmaa, 2004). The market is also likely to grow aided by greater facilitation by Government where there is a role to encourage farmers to enter the futures market by offering information, training and advice on derivative products, particularly for smaller producers (Tangermann, 2011).

Government-provided measures

Direct payments

Direct payments provide a stable form of income for farmers regardless of market conditions. The main instrument in CAP to stabilise farm income is direct payments. In 2016, direct payments totalled €41 billion or 73% of the total CAP expenditure, benefitting 6.7 million farmers across the EU (European Commission, 2017b). Direct payments work to address the long term economic viability of producers and is important given the relatively low level of income in the agricultural sector, with the average agriculture income in the EU27 is less than half of the average salary in the total economy (European Commission, 2011).

The CAP has undergone significant reform, with several changes successfully implemented. The level of direct payments has grown since the MacSharry Reform of 1992. These reforms centred on direct payments that were coupled with production until 2003 reforms gradually implemented decoupled payments. Further adjustment was made to direct payments in 2013 with better targeting of payments to ensure improved distribution. Structural adjustments have meant that direct payments are granted on the condition that beneficiaries adhere to certain strict environment, human and animal health and welfare rules. For example, if a farmer does not fulfil the greening criteria, direct payments may be reduced The greening criteria stipulates adoption of

activities including crop diversification, set ecological focus areas and maintenance of permanent grassland (Weiss, 2017).

The level of direct payments varies across sectors and member states. After 2003 reforms, decoupled payments could be distributed by the EU15 in a variety of ways. There are three models proposed:

- Regional Model – divided equally between farmers at the regional level, so all farmers receive the same payment per hectare
- Historic Model – provide each farmer with an individual payment based on a farms historic receipts, this involves different payment levels for farmers
- Hybrid Model – mix of the regional and historic model

In all models, payment is fixed from year to year.

There has been an alternative 'flat rate' proposed. This would entail giving the same amount of direct payment per hectare to each farmer across the 27-member states. It has been viewed by some as a fairer mechanism as every hectare of land is believed to have the same benefit to society therefore receive the and equal amount. Therefore, the differences in support are entirely determined by farm size.

Direct payments are crucial for farmers in Europe. The impact of direct payments has been assessed to some extent. It was found that farm incomes would have fallen by 27% on the 2004-2007 period in the absence of direct payments (Agrosynergie, 2011). It also notes that these payments represented around 50% of the income for livestock farms, 40% for crop farms and mixed farms, and 30% for dairy farms (European Parliament, 2016b).

Given this assessment, a recent report has highlighted limited reliable data for farm household income at the EU level as a major barrier to properly assessing the impact of direct payments and the effect of their removal. Farm household income data would help better identify the number of families who are currently in poverty and most in need and enable the development of robust models to estimate the impact of removing direct payments (Hill, 2013).

In addition, policies are also available and regulated at a state/national level. Member states are granted permission to support three risk management tools through state rural development programs. The risk management tools included in the CAP are currently under Pillar II on Rural Development. Conditions for receiving support under Pillar II are demanding as they require

strict compliance with WTO rules. Member states have the option to include these as part of their programs and are co funded by both the EU and member state itself. Because these risk management tools are categorised under CAP Pillar II, the adoption is determined by member states where there is large variation in uptake.

The three risk management tool available for the 2014-2020 period (European Parliament, 2016b):

Insurance premiums

- Farmers can take out insurance and be compensated by the insurance company in the event of serious damage or loss where the rural development program promotes the use of these forms of insurance by financing up to 65% of the premium costs.

Mutual Funds

- Mutual funds have the benefit of minimising risks of adverse selection and moral hazard
- Can compensate against consequential losses, something which is difficult for insurance to compensate against (given the high premium cost)
- Three member states (France, Italy, Romania) support the creation of mutual funds (European Parliament, 2016b)

Income Stabilisation Tool (IST)

The IST works as a mutual fund protecting against low incomes (Castañeda-Vera & Garrido, 2017). Before growing each season, a farmer will pay a premium to the mutual fund of the IST. After harvest selling, if income is lower than 70% (income loss higher than 30% of their annual average income in the past 3 or 5 years) of the average income received by the farmer in the preceding five-year period (excluding the highest and lowest entry) then the farmer is correspondingly indemnified. It is much like a mutual fund however instead of compensating for production losses, through the IST farmers are compensated for income losses.

The implementation of the IST has been slow with only two member states (Italy and Hungary) and one region (Castilla y Leon, Spain) using the IST (European Parliament, 2016b). The reason for low uptake of the IST is that to be useful it requires specific data on farm incomes and mutual funds. The IST may however prove to be a very effective risk management tool with further development and testing.

In general, insurance schemes are the most developed out of the three. At least one risk management tool was included in the rural development programs of Italy, France, Romania, Portugal, Hungary, Croatia, the Netherlands, Lithuania, Latvia and Malta (European Parliament, 2016b).

Code of conduct

Recently, there has been increasing attention placed on the functioning of the food supply chain. Concerns have been raised in relation to participants abusing their market power and creating unfair trading practices, causing another layer of price volatility. It is the larger and more powerful actors (food processors/retailers) that can impose contracts to their advantage when negotiating with smaller farmers (in turn, farmers more likely to receive a lower price).

The European Commission have addressed this issue through the creation of a voluntary code of conduct, the 'Supply Chain Initiative' (SCI) for the food and retail sector to promote fair business practices. To date, this has only led to very modest improvements.

Harmonisation of rules and regulations

Europe understands that prevention is better than cure. Therefore, aiming to have the highest levels of animal, public health and food safety. Investment in protection has proven cost effective for the EU over the longer term. The main tools used to address this type of risk include monitoring and surveillance, biosecurity measures (disinfection, segregation, cleaning) and containment and eradication.

There has been a more general harmonisation of rules and regulations. The EU are looking at the overhaul of food law so that each member states' food, animal health/welfare and plant health rules are all based on EU-level legislation. This ensure the same level of protection for all consumers and a level playing field for business to operate.

Literature

Role of Direct payments in stabilising farm income

This sections details some of the evidence and findings from Severini, Tantari and Tommaso who assess how and by how much direct payments reduce the variability of farm income over time for a sample of Italian farmers (Severini, Tantari, & Di Tommaso, 2016).

Stabilising farm income is seen as an important problem for EU farmers. With the variability of farm incomes far exceeding the variability of income for non-farm households and with limited

empirical evidence on whether direct payments play an income stabilising role, three aspects of EU direct payments were investigated.

- Assess whether direct payments are less variable than other income components. Direct payments have been observed to vary over time. This is due to production choices as well as farmers fulfilling conditional requirement or policy changes.
- Consider whether direct payments play a crucial role against fluctuations of the remaining part of income
- Assess the targeting efficiency of direct payments. In Italy, there is not a homogenous distribution of the payments among farmers in the same region.

The research analyses a large sample of individual Italian farms belonging to the EU Farm Accounting Data Network (FADN) farms during all years 2003-2012. It considers a sample of 24,012 farms for 10 years, with data deflated by means of a GDP deflator to allow for comparison over time.

The role of direct payments on income stabilisation was analysed by comparing the coefficient of variation calculated on farm income with and without direct payment. Correlation analysis was also conducted to assess whether direct payments are targeted to stabilise the income of farms facing larger income variability levels.

Results and Discussion

Overall, on average direct payments (DP) account for around 42.6% of farm income (FI) (DP/FI). Around 10% of farms did not receive direct payments in the 10-year period, most belonging to group of specialist horticultural farms. For specialist field crop and mixed livestock, direct payments account for a strong share of income. The relative importance of DP is higher in small farms than in medium and large farms.

Variance decomposition highlighted the income components that contribute most to income variability. The greatest sources of income variability were revenues (65%) and external factors e.g. farm costs (30%). The high variability of farm revenue is due to the variability of both price and production levels. During the considered period, both product prices and input prices experienced high levels. Direct payments account only for the remaining 5% of variability. Direct payments stabilise farm income because it is an income component that is less variable than the other components remaining part of the income e.g. Market Income (MI). On average, the variability of farm income is around 30% lower than the variability of MI on average.

The countercyclical role of direct payments was also investigated. The paper explores whether direct payments play a countercyclical role against fluctuation of market income over time. The variability of direct payments was found to be not negligible therefore if negatively correlated with evolution of market income, it will increase the effectiveness of the income stabilisation role of direct payments. The correlation between the 10 year series of direct payments and market income in each farm is negative and very low across the entire sample. Therefore, the results suggest that direct payments play a limited countercyclical role against fluctuations of market income over time.

To understand whether direct payments are specifically targeted to stabilise income of the farms facing the highest income variability the correlation between the variability of market income and the relative level of direct payments was assessed. This is particularly important from a policy perspective as good targeting should result in enhancement of the efficiency of the policy as well as strengthen the overarching objective of stabilising farm income. It was found that the correlation is very low on average across the different types of farming and for different farm sizes. This supports the fact the direct payments are not well targeted.

Following on from findings from (Hill, 2013) and (Kimura et al., 2010), the paper highlights the importance of availability of historical farm level data to analyse the risk exposure of individual farms. It is well understood that aggregated data can be misleading and severely underestimate farm level production risk. For example, at higher levels of aggregation poor income across some farms is offset by good income in others.

Overall, the results suggest that the income of many farms strongly relies on the benefits coming from direct payments. It remains important to understand the stabilising role of direct payments given recent changes to the CAP. The results support the idea that direct payments could be increased to balance the decrease in market income. Currently, the scope for changing the direct payments policy is limited. Allowing DP level to change over time to compensate for changes in market income is not compatible with the current CAP financial rules. Another limiting factor includes the lack of detailed data regarding income condition of farms which does not allow for the calibration of DP level according to the income level of the individual farm.

Canada

Introduction to Canadian agriculture

Agriculture is a significant industry in Canada with total farm cash receipts of $56.5 billion in 2016, made up of $32.6 billion from cropping and $23.9 billion from livestock (Agriculture and Agri-food Canada, 2017b). This level of production comes from 193,492 farm operations spread across a diverse range of industries, but a large proportion of grain and oilseed operations (33%) and beef cattle (19%) (Statistics Canada, 2018).

Canada is divided into 13 provinces, with two main agricultural zones in southern parts of the country. The Western prairies are a large, arid zone primarily producing field crops, beef and pork. This zone benefits from access to the US market with over the border often more practical than trade with eastern provinces of Canada. While this access creates opportunities, high dependence on an export market does create some extra risks.

Eastern provinces generally have higher rainfall which can support more intensive production such as fruit, vegetables and corn. Dairy and poultry industries are also more concentrated in this zone. Eastern provinces are also less export dependent due to a higher concentration of population in eastern cities and policies for dairy, poultry and eggs limiting trade (Antón et al., 2011).

Canadian agriculture has a high dependence on trade, particularly with the United States. Approximately 40% of agricultural production is exported (Antón et al., 2011).

Overview of agricultural risk management in Canada

Canadian farmers are exposed to a variety of production, market, financial and institutional risks. Exposure to different types of risk can vary between the two major agricultural zones.

Production of both crop, forages and pasture in the western prairies is affected by moisture and length of growing season. South and western parts experience more frequent droughts, while east and northern parts find excess moisture to be more of a factor during seeding and harvest.

Eastern Canada is more likely to experience production risks associated with cold weather (snow and frost either side of winter), lack of heat and excessive rainfall, but also experiences drought (Antón et al., 2011). Canadian farmers can also be exposed to plant and animal disease and pests, affecting crop or grazing yields and animal health (Agriculture and Agri-food Canada, 2017d).

Market risks for most agricultural commodities in Canada relate to commodity prices and exchange rates. Not only is there variability in domestic prices due to local supply and demand,

but as a net exporter of agricultural commodities, Canadian markets are often determined by global supply and demand factors. High dependence of export markets also increases the sector's exposure to exchange rate risk. This is most commonly experienced by western livestock and crop producers who frequently trade commodities across the US border. Trade policies (regulations and restrictions) are also a factor in price risk with experiences such as BSE in cattle resulting in the restriction of trade, forcing the domestic market to absorb all domestic production (Antón et al., 2011). These are difficult for farmers to manage and predict. Market risks also include the volatility of input costs such as fertiliser, fuel, feed and labour.

Canadian agricultural industries are supported by a variety of risk management programs and products. While many of these options are provided by the private sector, there is a significant amount made available by provincial and federal governments. This provision by government began with the *Crop Insurance Act (1959)* which was passed by the federal government to support provincial governments provide affordable crop insurance to farmers (Agriculture and Agri-food Canada, 2017d). Government involvement in agricultural risk management has continued to evolve since then with current programs built upon the *Farm Income Protection Act (1991)* which emphasises support for income stabilisation on the basis that many risks translate into farm income risk (Antón et al., 2011) (Government of Canada, 2013).

There is an expectation from Canadian farmers that part of the cost of agricultural risk should be borne by the government. This expectation is particularly firm in the event of catastrophic risk (Antón et al., 2011).

Government-provided risk management solutions

Federal and provincial governments share in the development and provision of risk management options to farmers through the suite of business risk management (BRM) programs which "help manage significant risks that threaten the viability of their farm and are beyond their capacity to manage" (Agriculture and Agri-food Canada, 2017c). Canadian farmers have access to a suite of five BRM programs which cover a range of risks such as production losses, price and exchange rate volatility, margin and income declines and catastrophic disaster:

- AgriStability provides support by partially covering a significant decline in the margin of an entire farm operation, as opposed to commodity specific losses.
- AgriInvest is a savings account to help producers manage cash flow and income declines. It is comparable to farm management deposits available to Australian farmers.

- AgriInsurance provides cost-shared insurance against natural hazards, protecting farmers from the financial impacts of production losses.
- AgriRecovery framework to assist producers with relief following natural disasters.

These programs have varying levels of adoption and success but have generally been well received by the agricultural sector.

AgriStability

Canadian agricultural policy has included an income stabilisation program since 1998, using an average of either price, revenue or margin (Antón et al., 2011). The current core income stabilisation program under BRM is called AgriStability which aims to support producers when they experience a large decline in the net production margin of the whole farm.

Participants of AgriStability become eligible for a payment when their margin declines below 70% of their reference margin, the average of last 5 years' margins. The payment received is equal to 70% of the difference between the actual margin and 70% of the reference margin, up to $3 million (Agriculture and Agri-food Canada, 2017d). The actual margin is calculated after payments from other BRM programs are included as revenue (Antón et al., 2011).

AgriStability example:
Reference margin = $80,000
Payment trigger level (70% of reference margin) = $56,000

Actual margin is lower due to unavoidable loss such as natural disaster, low commodity prices or rising input costs.

Actual margin = $13,000
Decline (payment trigger level – actual margin) = $43,000
AgriStability benefit (70% of decline) = $30,100

A survey by AAFC found that 64% of surveyed producers who had received an AgriStability payment described the program as "effective in helping them recover their income losses" (Agriculture and Agri-food Canada, 2017d). Over the last 10 years, AgriStability payments have totalled $6 billion, filtering down to $36,197 per producer each year on average.

Despite this result, participation rates in AgriStability have been declining, and at a faster rate than the decline in number of farm operations, with only 33% of producers participating in 2014 (Agriculture and Agri-food Canada, 2017d). Although only a third of producers participate in AgriStability, larger operations with higher revenue make up a larger proportion of participants and mean that 55% of Canadian agricultural revenue was covered by AgriStability in 2014 (Agriculture and Agri-food Canada, 2017d).

A common complaint with AgriStability is the complexity of calculating the net margin of an entire farm, requiring increased reporting by producers and programme agencies to calculate and verify payments and poor timeliness in receiving payments, with producers waiting up to two years to receive a payment (Antón et al., 2011). Poor timeliness means that the ideal program benefit of covering losses at the time of loss isn't always realised.

AgriStability participants are charged an annual administrative fee of $55 and an annual program fee of $4.50 per $1,000 for 70% of their reference margin (Agriculture and Agri-food Canada, 2015). The government budgets for an annual expenditure of $277.6 million each year on AgriStability (Agriculture and Agri-food Canada, 2017d).

AgriInsurance

Canadian farmers have had access to government provided production insurance since 1959 when the federal government passed the Crop Insurance Act which assisted provincial governments to make affordable crop insurance programs(Agriculture and Agri-food Canada, 2018a). These programs have evolved into what is now known as AgriInsurance, a program developed and delivered by provinces and supported by the federal government.

The objective of AgriInsurance is to "stabilise a producer's income by minimising the economic effects of production losses caused by natural hazards". The crops that can be covered under AgriInsurance programs varies between provinces, but generally include field crops, horticulture production and forage production. The hazards covered by AgriInsurance include drought, excessive moisture, fire by lightening, flood, frost, hail, insect infestations, plant disease, snow, wind (Alberta Agriculture and Forestry, 2016) (AFSC, 2016), with some variation between provinces. Insurance covers production losses as well as downgraded product quality.

To make insurance more affordable to producers, the cost of the premium is shared between the producer (40%), provincial and federal governments (60%). The premium does not include administration costs, and these costs are shared between the federal and provincial governments in addition to their contribution to premiums(Agriculture and Agri-food Canada, 2018a).

AgriInsurance programs differ between provinces, but the general premise is that producers can insure a level of production (a percentage of long term average yield) at a forecasted price for the upcoming crop season and the provincial government acting as the insurer will pay the difference between the coverage amount and actual production if it falls below the insured amount because of an insured hazard.

AgriInsurance example (Alberta province):
Average canola yield = 40bu/ac
Coverage level = 80%
Price option = $10/bu
Coverage amount = (40bu x 80%) x $10/bu = $320/ac

Premium rate = 10%
Premium cost = $320/ac x 16% = $32/ac
Producer premium cost = $32/ac x 40% = $12.80/ac

Actual production = 20bu/ac

Claim payable = (32bu – 20bu) x $10/bu = $120/ac

AgriInsurance is perceived as being successful at reducing the financial impact of production losses for producers. Between 2004/05 and 2014/15, claims have resulted in a total of $1.6 billion in indemnities paid (AAFC, 2017), and premiums collected of $3 billion (OECD, 2011). Participation has been high with $14.9 billion of agricultural production insured in 2014/15, equal to approximately 75% of production eligible for insurance (Agriculture and Agri-food Canada, 2017d). To reach this level of coverage, the premiums paid by government was $924 million in 2014/15, plus $119 million in administration costs.

The history of crop insurance as a government program has made it challenging for private insurance products to enter the market. In addition to subsidised premiums making potential private options uncompetitive, government agencies now have a dataset of farmers, risks and

claims spanning 60 years and covering the majority of potentially insurable land. Aside from some privately provided hail and fire insurance, there are no private alternatives to AgriInsurance programs (Antón et al., 2011).

Western Livestock Price Insurance program

The Western Livestock Price Insurance program (WLPIP) is a product that allows cattle and pig producers to protect against a fall in commodity prices. WLPIP has been available since 2009 in Alberta and expanded to other western provinces of British Columbia, Saskatchewan and Manitoba in 2012 (WLPIP, n.d.). Although technically not part of AgriInsurance, it maintains a small level of government support.

WLPIP is offered for calves, feeder cattle, fed cattle and hogs. Producers select which type of livestock they will be selling and what quantity (in carcass weight). They can then choose when they will sell, ranging from 12-36 weeks out and select what price they want coverage for. Producers can get coverage for up to 95% of the forecasted value. Because the forecasted values for feeder and fed cattle account for CME futures, Canadian dollar forecasts and the cash to futures basis, WLPIP covers producers from price, currency and basis risks in the one product. Usually producers have to account for those three types of risk when using other strategies of price risk management.

By taking out this insurance, producers set a floor price for their livestock. If the cash market falls below their coverage price at the time of settlement, they can make a claim and get paid the difference between the cash market (based on Alberta auction market data) and the coverage price. If the cash price is higher than the coverage price, producers can sell for the cash price and wear the cost of the insurance premium they paid. The insurance guarantees producers a minimum price whilst still allowing them to capture upside potential of the cash market, for the price of the premium ("Alberta Agriculture and Forestry," n.d.).

Western livestock price insurance example:
Feeder cattle to sell in October
Select coverage level @ $140/cwt
Premium = $1.03/cwt

Scenario 1:
October market price = $120/cwt
Indemnity payment = coverage price – market price = $20/cwt

Scenario 2:
October market price = $160/cwt
No claim made, cattle sold for $160/cwt
Producer wears cost of insurance premium

Government assistance of this program was provided by funding the program development and administration, with the provision to cover deficit funding. There is no cost-sharing of the premium provided by the government. It is recommended that WLPIP is purchased to compliment AgriStability with AgriStability payments determined on producer margins after receiving a WLPIP settlement (WLPIP, n.d.).

The Canadian cattle industry is approximately half the size of the Australian industry in herd and production terms (USDA beef data). This indicate that the Australian industry has more than sufficient scale to adopt a livestock price insurance program.

AgriInvest

AgriInvest is a Business Risk Management policy with the objective of assisting farmers to cover small income shortfalls, ideally between 85-100% of their average margin. It is a government supported savings account that allows producers to set money aside to draw upon to recover from small income declines or to make investments to reduce on-farm risks" (Agriculture and Agri-food Canada, 2017a).

Producers can make annual deposits into their AgriInvest account and have a percentage of their deposit matched by the government. Annual deposits are limited to 100% of a farm operation's allowable net sales (ANS) up to $1.5 million. ANS is the revenue from agricultural commodities less the purchase costs of agricultural commodities. The government contribution to AgriInvest accounts is 1% of an annual deposit to a maximum of $15,000. The total balance of AgriInvest

accounts must not exceed 400% of the average ANS of the current year and the two preceding years (Agriculture and Agri-food Canada, 2017a).

Participation in AgriInvest is high with 127,384 participants in 2014, equivalent to 75% of eligible producers (Agriculture and Agri-food Canada, 2017d). Participants made average annual contributions of $2,490 in 2013 and 2014 and were using the savings accounts for cash flow, farm expenses, offset decline in income, make on-farm expenses and reduce debts.

Canadian farmers have had access to government supported savings accounts under various policies since 1990. AgriInvest is the third version of these accounts which have all had the common element of producer deposits based on sales revenue and a matching contribution from government (Antón et al., 2011). The government budget for AgriInvest for 2013/14 to 2017/18 is $781 million with $243 million and $182 million of actual expenditure in 2013/14 and 2014/15, respectively (Agriculture and Agri-food Canada, 2017d).

The AgriInvest program is similar to Australia's farm management deposits (FMD) which can be used manage fluctuations in cash flow and tax position of producers. A significant difference between the two policies is the lack of government contribution for FMDs. The balance of FMDs is significantly larger than AgriInvest accounts with $6.1 billion held in FMDs in June 2017 (Department of Agriculture and Water Resources, 2018) compared to $2 billion in AgriInvest accounts (Agriculture and Agri-food Canada, 2017d). This difference in scale comes from Australian farmers being able to hold up to $800,000 in FMD accounts.

AgriRecovery

AgriRecovery provides a framework for federal-provincial-territorial governments to assist producers recover from natural disasters. Income and production losses from natural disasters are partially managed by other BRM programs such as AgriStability and AgriInsurance. Therefore, the focus of AgriRecovery is on assisting with the extraordinary or catastrophic costs associated with disaster recovery, beyond those covered in other programs. AgriRecovery initiatives are introduced at the discretion of the different levels of government assessing the impacts of a natural disaster event (Agriculture and Agri-food Canada, 2018b).

The government intervention following flooding in Alberta, Saskatchewan and Manitoba in 2010 is an example of the *ad hoc* program that governments can create under AgriRecovery. Flooding caused farmers to miss planting and losses were expected to exceed other forms of coverage. Federal and provincial governments co-funded a payment of CAD 30/acre to producers for a total of CAD 450 million (Antón et al., 2011).

Supply management

Canada's dairy, poultry and egg industries operate under supply management systems and have done so since the 1970s. Supply management systems were adopted to "address unstable prices, uncertain supplies and fluctuating producer and processor revenues" (Canadian Dairy Commission, 2016). Each industry has a national agency to administer supply management, but all use the same three pillars of production control, pricing mechanism and import control to maintain stable and "fair" prices for farmers.

Production control involves a production quota system to prevent surpluses and shortages which would otherwise drive price fluctuations for both producers and consumers. National production levels are set and allocated among farmers by provincial boards, according to the quotas they own.

The pricing mechanism gives farmers a guaranteed minimum price to give them a "fair" return based on cost of production and market conditions. The production level can be set to ensure demand meets supply at the determined price point.

Import control is the final pillar of supply management as imported products form part of the overall supply equation. Imports are controlled by setting tariff-rate quotas on supply managed products to protect domestic production from international competition. Tariff-rate quotas give trading partners a minimum level of access to imports before imposing high tariffs on imports above those levels. For example, the import quota for chicken is 190.1 million kilograms, equivalent to 15.5% of domestic consumption (Agriculture and Agri-food Canada, 2018c)For example, the import quota for chicken is 190.1 million kilograms, equivalent to 15.5% of domestic consumption (Agriculture and Agri-food Canada, 2018c) ;(Indexmundi, 2018). Imports above this volume are subject to a tariff rate of 238% (Canada Border Services Agency, 2018).

The supply management system has been effective at reducing price risk with stable prices received by farmers since its inception (Antón et al., 2011). Dairy Farmers of Canada are highly supportive of the system which allows Canadian dairy farmers to "earn comparatively stable returns, without the need for direct government subsidies" which has been the case in other countries (Dairy Farmers of Canada, 2017). It is argued that while this policy doesn't require the government to financially support dairy farmers, the system leads to higher retail prices compared to other countries and the imported products that have restricted access to the market. This effectively places an "indirect tax" onto consumers in order to support domestic production (Tamilia & Charlebois, 2007); (Dairy Farmers of Canada, 2017) . (Dairy Farmers of Canada, 2017) (Dairy Farmers of Canada, 2017). It is argued that while this policy doesn't require the government to financially support dairy farmers, the system leads to higher retail prices compared to other countries and the imported products that have restricted access to the market. This effectively places an "indirect tax" onto consumers in order to support domestic production (Tamilia & Charlebois, 2007).

There are many criticisms of this system, including from the World Trade Organisation (WTO), and critics point to the deregulation of similar systems in the New Zealand and Australian dairy industries as examples of successful reforms with wider benefits from an open marketplace (Tamilia & Charlebois, 2007).

Commodity marketing

Canadian livestock and crop producers have access to different marketing strategies for managing commodity price and currency risks. These strategies include a mix of cash market and futures markets with futures markets either used directly or as an information source for decision making. Within these markets there are many strategies that are recommended to achieve target prices and minimise exposure to declines in prices.

Futures Contracts

Using the futures market is a way crop and livestock producers can manage price risk of commodities they plan to sell (or buy in the case of feeder cattle). Canadian producers mainly trade on the futures markets through the Chicago Mercantile Exchange (CME) group or the Intercontinental Exchange (ICE). The CME group trades in the US and includes the Chicago Mercantile Exchange for cattle, hogs and currency exchanges, Chicago Board of Trade (CBOT)

for most crops and the Kansas City Board of Trade (KBOT) for hard red winter wheat. The ICE provides futures contracts in Canada for milling wheat, durum, canola and western feed barley. Canadian producers can also trade ICE futures in the US for other commodities such as soybeans and corn (Alberta Agriculture and Forestry, 2017a) in US futures markets means that Canadian traders also need to be aware of and manage exchange rate fluctuations, adding another layer of risk (Antón et al., 2011).

The futures market trades futures contracts, not physical commodities. The futures contracts are an agreement to buy or sell a specified volume of a commodity in a specified month in the future. Most elements of the contracts are standardised, with the price and time of potential delivery agreed upon between buyer and seller (Alberta Agriculture and Forestry, 2017a).

Participants in futures contracts use them to "hedge", meaning they take opposite positions in cash and futures markets. For example, a producer planning on selling livestock at some point in the future and concerned about falling prices in their local market would use a "short futures hedge". To do this, they would enter into a futures contract to sell livestock. When the time comes to sell the actual livestock, the producer would buy back the initial futures position and sell the livestock in the local market. If the local market price has fallen, the lower revenue received when selling the livestock will be offset by an equivalent gain in the futures market. As a result of this commonly used approach, less than 1% of futures contracts result in the delivery of physical commodities (CME Group, 2017).

Marketing strategies in futures markets are adopted by less than 25% of Canadian producers (Antón et al., 2011) (Agriculture and Agri-food Canada, 2017d). The low participation in futures market is largely due to the level of time, expertise and resources required to execute a successful strategy using these tools. Minimum contract sizes also exclude many small producers from entering futures markets. Large scale operations with sufficient production scale and available human resources are therefore more likely to participate in futures markets. Despite low participation in futures markets producers may rely on futures prices to inform marketing decisions.

Options Contracts

Options contracts are another tool available on the futures markets. Options differ from futures contracts in that they trade the rights, but not the obligation to buy or sell an underlying commodity at a future time and are bought with a premium (CME Group, 2017). The benefit offered by options contracts is that a producer can be protected by a fall in prices by taking up the underlying contract, but without being locked into the contract they also retain the ability to capture any upside in prices. Options effectively give producers the ability to set a floor (or minimum target) price for their product.

Delivery contracts (forward contracts)

Delivery contracts are agreements entered into between livestock or crop buyers and sellers before the delivery of the physical commodity. Delivery contracts usually specify the amount of a commodity to be delivered by a certain date, for an agreed price on the day of delivery. Delivery contracts benefit the producer because all factors (price, quantity, date) are known, risk of price declines is eliminated, the contract comes at no direct cost and they are relatively simple to enter into. With those benefits come the limitations of low flexibility if situations change, have no ability to capture potential increases in price and can apply discounts if the delivered commodity does not match the specified quality or quantity (Alberta Agriculture and Forestry, 2017b).

Canadian Wheat Board

Since the 1940s, producers of wheat, barley and oats in western provinces had to sell their grain through the Canadian Wheat Board (CWB) (Schweizer, 2013). The CWB was responsible for the handling, shipment and marketing of grain with the aim of reducing price risk for producers. The most common way this was achieved was through price pooling, which 85% of producers elected to utilise (Antón et al., 2011). Price pooling gave farmers an initial partial payment upon delivery of grain before eventually receiving the average price that the entire pool of the commodity was sold for during the marketing year. Producers were also able to elect to sell all or part of their crop to the CWB for a fixed, non-pooled price. After declining political support, the CWB's single-desk powers were removed under the *Marketing Freedom for Grain Farmers Act (2011)*, coming into effect in August 2012, establishing a competitive market for buying and selling Canadian grains.

Management decisions

Off-farm income

Many Canadian farm households use off-farm income as a way to increase household income. Higher household income, including from a source not exposed to agricultural risks is an effective way to mitigate the effects of farming risks (Agriculture and Agri-food Canada, 2017d). Off-farm income is more common on small farms with less than CAD 100,000 in annual revenue where extra income is required to offset farm losses (Antón et al., 2011).

Diversification and specialisation

Producing different commodities within a farm operation is considered an appropriate management strategy to produce more stable margins as falls in revenue from one commodity can be offset by gains in another. Diversified farms are still exposed to the risks of disasters that affect all commodities produced. Diversification is becoming harder to achieve due to the increasing capital costs required to realise the benefits of economies of scale in the production of multiple commodities (Agriculture and Agri-food Canada, 2017d).

Specialisation can provide an operation with greater economies of scale and efficiency, but also has greater risk exposure with no other commodity to offset downturns in the specialised commodity.

The current suite of Business Risk Management programs, particularly AgriStability, favour specialisation. A diversified farm is more likely to have stable incomes and therefore less likely to make an AgriStability claim, and a claim is unlikely to be substantial. However, a specialised farm is more likely to have larger fluctuations in margin and require larger payments in bad years than a farm which has diversified (Antón et al., 2011).

Farm capital and debt

Canadian farmers also aim to maintain low debt to equity ratios. This can work as a risk management strategy as it creates borrowing capacity that can be utilised when situations arise that result in low returns. Access to debt is helpful to cover cash-flow deficits between triggering an AgriStability payment and eventually receiving the payment (Antón et al., 2011).

Conclusions

Risk management in Canadian agriculture is comprehensively supported by government policy. An OECD review (Antón et al., 2011) concluded that the suite of risk management programs offered was successful at stabilising incomes of farmers faced with volatile production and market conditions. However, the review also noted that the comprehensive nature of these policies "crowded out" the ability of the market to develop and provide risk management solutions and reduced the incentives for farmers to take ownership of their individual, on-farm risk management strategies.

The Canadian agricultural industry has been growing with market receipts increasing from $31.5 billion in 2004 to $57.6 billion in 2015. Farming is also increasingly profitable with the average net operating income per farmer increasing between 2004 and 2015 from $28,784 to $78,795 (Agriculture and Agri-food Canada, 2017d). Although many factors contribute to the growth in income and profitability, improved risk management is likely to have played a significant role.

United States

Overview of agricultural risk management in the US

Risk management in US agriculture is heavily reliant on government provided and subsidised multi-peril crop insurance and other revenue protection programs. These government supported programs are authorised under the Agricultural Act of 2014. This Act include a significant shift in policy with the elimination of fixed direct payments to farmers which had been part of agricultural policy since 1996 and worth approximately $4.5 billion per year (Zulauf & Orden, 2014). Direct payments were replaced by enhanced crop insurance and new programs to protect farmers against risks leading to downturns in price and revenue.

There are a variety of other tools and strategies that US farmers use outside of government provided risk management strategies, such as futures markets and approaches to farm management.

Government-provided insurance programs

Federal Crop Insurance

The United States Department of Agriculture's (USDA) Risk Management Agency (RMA) provides multiple peril crop insurance policies for difference types of coverage. Federal crop insurance programs are delivered through a public-private partnership whereby 15 private companies authorised by the RMA deliver policies that are regulated and overseen by the RMA (McFadden & Hoppe, 2017) (USDA Risk Management Agency, 2018a). Types of crop insurance policies available include:

- Actual Production History (APH) insures against "yield losses due to natural causes such as drought, excessive moisture, hail, wind, frost, insects and disease". Producers can insure for 50-75% of average yield at between 55-100% of the predicted crop price set by RMA. Producers make a claim when harvested yield is less than insured yield and is paid an indemnity equal to the difference in yield multiplied by the selected price.
- Actual Revenue History (ARH) is similar to APH but insures average revenue rather than average yield. By insuring average revenue, producers can mitigate yield losses, low prices, low quality or a combination of these.
- Area Risk Protection (ARP) provides coverage based on performance of an area (usually county), rather than an individual farm. Payments are made when the area yield or

revenue index falls below the insured level and producers are paid an indemnity based on county performance rather than individual.

- Catastrophic Risk Protection Endorsement (CAT coverage) provides additional coverage to producers for certain policies when yield losses are 50% or greater. When these catastrophic losses occur, producers receive a payment valued at 55% of the RMA's commodity price multiplied by the lost yield below 50% of insured yield. The Federal government pays the premium for CAT coverage with producers only required to pay a $300 fee.

Federal crop insurance policies are widely adopted, with 90% of American cropland insured in 2015 for a value of $103 billion (McFadden & Hoppe, 2017). A key factor in the wide adoption of federal crop insurance is the premium subsidy paid by the government. Goodwin and Smith (2013) estimate that in excess of 60% of the premium is paid by the government, ensuring that crop insurance is affordable to the majority of producers. In 2015, 1.2 million insurance policies were sold, collecting $9.8 billion in premiums, of which $6.1 billion was subsidised. These values can fluctuate based on the value of insured crops, a factor or area insured and commodity prices. The cost to government of subsidised premiums was as high as $7.9 billion in 2011. Indemnities paid were valued at $6.3 billion, and also fluctuate based on value of crops insured and the extent losses, up to $18.2 billion in 2012 (McFadden & Hoppe, 2017). In addition, private insurance companies also receive subsidies to assist the costs of operating and administering insurance programs, valued in excess of $2 billion in 2008 (Goodwin & Smith, 2013). The overall cost of crop insurance to the government is project to be $89.8 billion over the next 10 years (Zulauf & Orden, 2014).

Whole Farm Revenue Protection

Another form of insurance available to producers is Whole Farm Revenue Protection (WFRP) which provides coverage for revenue of all commodities produced on a farm under one insurance policy. This product was first made available to all farmers in the US for the 2016 crop year after a pilot period.

An extensive range of agricultural commodities can be included in a WFRP policy with revenue of up to $8.5 million protected from natural causes of unavoidable loss, including market loss.

Insured revenue is calculated based on a coverage percentage between 50-85% of either whole-farm historic average revenue (usually determined by five years of tax files) or expected revenue, whichever is lower. The policy rewards the more risk-averse nature of diversified operations but allowing coverage levels of 80% and 85% when revenue is made up of three or more commodities. Other eligibility requirements for WFRP are a maximum of $1 million revenue from each of animals or animal products and greenhouse and nursery.
Participants in WFRP policies also receive subsidised premiums, with government contributing 80% of the premium cost in most cases (USDA Risk Management Agency, 2017).

Indemnity payments of WFRP policies are calculated as the difference between the insured revenue amount and the actual revenue when tax files are submitted. The AGR policy had the added component of producers electing for the indemnity to pay either 75% or 90% of the difference between insured revenue and actual revenue. As with other insurance products, WFRP is developed by the USDA's Risk Management Agency under the current Farm Bill and is available from private insurance agents (USDA Risk Management Agency, 2017).

Uptake of WFRP polices has been increasing with 2,844 policies sold in 2017, covering liabilities of $2.86 billion. Indemnities were paid on 17% of policies for a total of $63 million or an average of $129,305 per indemnified policy (USDA Risk Management Agency, 2018b).

Stacked Income Protection Plan (STAX)

Upland cotton producers have access to revenue insurance policies under the Stacked Income Protection Plan (STAX). STAX is a form of area-based insurance, using actual and expected revenue for an area (usually county) to determine losses. Indemnities are paid when county revenue falls between 70-90% of expected revenue. STAX policies can be purchased with individual insurance under the federal crop insurance program, in this case the indemnity will cover a loss between individual coverage level and 90% of expected county revenue (Zulauf & Orden, 2014). Producers are only required to pay 20% of the policy's premium, with the remainder subsidised by the federal government (Glauber, 2018) (USDA Economic Research Service, 2018).
STAX was introduced in the Agricultural Act of 2014 and is specific to upland cotton in place of Price Loss Coverage and Agriculture Risk Coverage programs. The program was introduced to

comply with obligations under a World Trade Organisation ruling against the previous government support for the US cotton industry which was argued to have distorted US production, trade and depressed world prices. Previous policies in place since 1995 included countercyclical payments which covered the difference between a target price and actual season price, based on historical production, as well as subsidised yield and revenue insurance. Between 1995 and 2014, federal subsidies to cotton producers averaged $2.1 billion per year, equivalent to almost 50% of the value of production (Glauber, 2018).

Participation of STAX has been low with only 24% of eligible area covered in 2017. Even with low participation, the Congressional Budget Office estimates that net cotton insurance indemnities will average $500 million per year (Glauber, 2018). As low participation suggest, cotton producers are not satisfied with the STAX program and are lobbying for countercyclical payments to return to the 2018 Farm Bill to provide them with improved risk management given the high costs of production and volatile prices.

Government-provided commodity programs

Price Loss Coverage

Producers of wheat, feed grains, rice, oilseeds, peanuts and pulses also have access to the price loss coverage (PLC) which essentially sets a floor price for their commodity. PLC offers producers a payment when the market price (national annual average) falls below the reference price. The payment is the difference between the market and reference prices, multiplied by up to 85% of the planted acres and the reference yield (USDA Economic Research Service, 2018). Producers are not required to pay a premium to participate in PLC (Zulauf & Orden, 2014).

Agricultural Risk Coverage

Another program introduced in the Agricultural Act of 2014, Agricultural Risk Coverage (ARC) provides payments to individuals when the actual county revenue for covered commodities fall below 86% of the benchmark revenue. This program is also offered on an individual basis (USDA Economic Research Service, 2018).

Livestock insurance

Livestock policies only insure producers against declines in market prices of pigs, cattle, lambs and milk. Prices are determined using futures and options prices from the Chicago Mercantile Exchange Group. One type of livestock insurance is Livestock Risk Protection, which will pay an indemnity if the market price is less than the price selected by the producer when taking out the policy. The other type of livestock insurance is Livestock Gross Margin which will pay an indemnity of the difference between the expected and actual gross margins, taking the commodity and feed costs into account. Producers can select the number of head (or milk volume) to insure and the length of coverage period (USDA Risk Management Agency, 2018a).

Margin Protection Program (Dairy)

The Agricultural Act of 2014 replaced dairy price and income support programs with the margin protection program (MPP) which insures a margin between milk price and feed costs for dairy farmers. The margin is calculated based on the national milk price (average price of milk marketed in the US, reported by the NASS) and a calculated average feed cost (weighted averages of corn, soybean meal and alfalfa hay). This margin is calculated monthly and payments are made when the actual monthly margin falls below the coverage level threshold. Coverage level thresholds begin at the "catastrophic" coverage level of $4 per hundred pounds, which producers can apply for with no premium. This will cover 90% of a farm's historic production. Producers can elect coverage for a higher margin, up to $8, and select coverage between 25-90% of historic production, this coverage incurs a premium.

Payments are calculated on the difference between the actual production margin and the coverage threshold, multiplied the percentage of covered production divided by 12 (Congressional Budget Office, 2018) (USDA Farm Service Agency, 2018).

Margin protection program example:
Production history = 3 million pounds (30,000 cwt)
Monthly production = 2,500 cwt
Coverage level = 50%
Coverage threshold = $7

Actual month production margin = $5

Payment = ($7-$5) x (50% x 2,500cwt) = $2,500

Participation is high with 20,314 operations participating in 2017 with 153 billion pounds of milk production covered, equivalent to 71% of total US milk production (USDA Farm Service Agency, 2017). Interestingly, 93% of producers opted for the $4 coverage which requires no premium, up from 44% and 87% in 2015 and 2016, respectively (USDA Farm Service Agency, 2017).

The Congressional Budget Office (CBO) projects the program to pay $312 million in 2018 and collect $97 million in premiums and fees, based on an average production margin of $8.20. Over the next ten years, the CBO projects a total net expenditure of $1.84 billion for this program (Congressional Budget Office, 2018).

The 2018 Farm Bill proposes to charge lower premiums on the first five million pounds of milk production on a dairy and to increase the catastrophic coverage level on that production (House Agriculture Committee, 2018).

Market information and statistics

An important factor for a farmer when considering risk management is understanding market trends. The US government helps to support farmers make informed business decisions by providing agricultural research, extension, global and domestic market information and statistics. The provision of this extensive range of information to producers for no cost through USDA agencies improves the industry by allowing participants to be well informed (McFadden & Hoppe, 2017).

Market solutions

Futures and options

The buying and selling of livestock and crop futures and options contracts is primarily used as a risk management strategy rather than the delivery of physical commodities. This is evident by less than 1% of futures contracts resulting in actual physical delivery of the contract (CME Group, 2017). Instead, futures contracts are used to hedge by taking opposite positions in cash and futures markets.

For example, a producer planning on selling a commodity at some point in the future and concerned about falling prices in their local market would use a “short futures hedge”. To do

this, they would enter into a futures contract to sell. When the time comes to sell the actual commodity, the producer would buy back the initial futures position and sell the commodity in the local market. If the local market price has fallen, the lower revenue received when selling the commodity will be offset by an equivalent gain in the futures market. This assumes that the futures and cash markets are correlated and move up and down together and that the basis (difference between the futures and cash markets) has remained constant.

Short hedge example (falling price):			
Date	Cash market	Futures market	Basis
March	Expected October price of $70, based on expected September basis of -5	Contract to sell in October for $75	-5
September	Sell physical commodity at $65	Buy (offset) October futures at $70	-5
Result	Lower revenue of $5	Gain of $5	No change
Net selling position = cash revenue of $65 plus futures gain of $5 = $70			

In the example above, the cash market fell between March and September by $5, resulting in lower revenue. But the trading of futures contracts resulted in a gain that offset the cash market loss and protected the producer's expected selling price of $70. The opposite situation can occur where a gain in the cash market is offset by a loss in the futures market. The expected selling price is still achieved in this case, but the ability to capture upside in the cash market is lost.

Another strategy available to producers are options contracts. Options give a buyer or seller of a commodity the right, but not an obligation, to buy or sell an underlying commodity (or commodity futures contract) at a specified price within a specified time period. Options provide producers with protection against falling prices, similar to taking a short futures position, but unlike a futures contract, options also allow the producer to take advantage of any increase in price. The cost of being able to protect downside risk but still able to capture upside potential is the premium cost of the option.

Participation in futures markets is considered low, largely due to the level of time, expertise and resources required to execute a successful strategy using these tools. Minimum contract sizes also exclude many small producers from entering futures markets. Large scale operations with sufficient production scale and available human resources are therefore more likely to participate in futures markets. Despite low participation in futures markets producers may rely on futures prices to inform marketing decisions.

Crop-hail insurance

Crop-hail insurance is a form of crop insurance provided by private insurers and is not part of the Federal Crop Insurance Program and therefore not subsidised. This form of insurance provides coverage for losses due to direct damage from hail. Some policies allow for endorsements of other perils such as wind and fire. It is recommended that producers purchase crop-hail insurance in addition to multiple-peril crop insurance (MPCI) under the Federal Crop Insurance Program. The benefits of crop-hail insurance are extra protection against hail damage on an acre-by-acre basis, meaning claims can be made on part of a property rather than the entire operation under the federal program. Unlike MPCI policies which must be purchased before planting, crop-hail policies can be purchased anytime during the growing season. This allows producers to identify high valued crops that may require further protection. Adoption of crop-hail insurance is relatively high with $36.2 billion worth of US crop protected in 2016. This incurred premiums of $983 million and paid out claims of $880 million (Paggi, Schnapp, & Crane, 2017).

Farm management

Off farm income

Farm households in the US are very likely to seek off farm income as a means to stabilise income (Gillespie & Mishra, 2011). Brown and Weber (2013) calculate that 91% of farm households have at least one member earning off farm income. Off farm income as a percentage of farm household income is very high, with the USDA's estimates of farm operator household finances (USDA Risk Management Agency, 2018b) revealing that 79% of the average US farm household income came from off farm sources in 2016. The primary reasons why farm households seek off farm income is to increase income of the household and stabilise income.

Specialisation and diversification

The long-term trend in US farm enterprises is towards specialisation in the production of a few commodities. Hoppe (2014) explains that 75-90% of farms produced chickens, milk or hogs in 1900 and 80% produced corn, largely to feed livestock. In 2010 however, less than 10% of farms produced chickens, milk or hogs and only one-sixth of farms produced corn. Producers have generally opted to specialise in one species of livestock and rely on purchased feed. The basis of specialisation is that enterprises can capture economies of scale and improve efficiency. Specialisation also increases market risks and production risks with greater exposure to fewer commodities.

Diversification is a good approach to mitigate exposure to market and production risks by spreading the risk across a number of commodities. This comes at the expense of lower efficiency. In 2011, the average number of commodities produced on a US farm was 1.6, with 42% of farms producing two or more commodities (Hoppe, 2014).

Conclusions

Agricultural risk management in the US is well supported by government programs and complemented by market instruments and farm management strategies. Keys to the success of risk management in the US is the culture of sharing the cost of risks between producers and government which improves the affordability of insurance and other programs. By having high participation in risk management programs, more producers are likely to have stable incomes which is identified as being beneficial for the success of agricultural industries and rural communities.

Brazil

Overview

Agriculture is a key pillar of Brazil's economy, ranked the world's seventh largest economy in 2012. Primary production makes up 6% of gross domestic product (GDP) and Brazil is a major player in global agricultural trade, accounting for 7.3% of global agricultural exports. It is the world's third-largest exporter of agricultural products, behind only the EU and the United States (FAO, 2014).

Agricultural and pastoral production in Brazil covers approximately 230 million hectares, or 27% of the country's land mass – a vast territory featuring dramatically diverse climates, biomes and production systems.

Agriculture and agribusiness in Brazil are served by two separate government ministries, namely: MAPA, the Ministry of Agriculture, Livestock and Food Supply, and the Ministry of Agrarian Development (MDA), created in 1999 to establish land reform, promote sustainable development and support family farming.

In the decade from 2007-17, the volume of agricultural exports from Brazil grew more than 200%. Agricultural exports reached US$100 billion in 2013, representing almost 42% of total exports. Brazil is the largest exporter of coffee, sugar, orange juice and meat; the second largest in maize and soy, and is one of the leaders in pork meat and cotton exports (Arias, Vieira, & Mendes, 2017). Soybean products remain the largest export, followed by sugarcane products (sugar and ethanol), meat (especially poultry and beef), coffee and cereals (FAO, 2014).

The agricultural sector absorbed about 13% of Brazil's employment in 2012, or almost three times its share in GDP (OECD, 2015). Agribusiness across the supply chain represents 23% of GDP, and family farms (representing 84% of all Brazilian farms) contributed 38% of agricultural GVP in 2006 (FAO, 2014).

Brazilian agriculture has seen strong growth for more than two decades, despite poor harvests in some years. By volume, total agricultural output has more than doubled compared to 1990, and livestock production has almost trebled.

Deep economic reforms in the 1990s spurred agricultural growth, led by broad trade, exchange rate and domestic market liberalisation. While the first half of the 1990s were said to be

"extremely turbulent and destabilising" for the sector, a greater degree of macroeconomic stabilisation was reached by the turn of the millennium. Agricultural policies were liberalised, production and supply control systems were dismantled and price interventions scaled down and re-instrumented (OECD, 2015).

Some volatility in the enabling environment of Brazilian agriculture still remains - to a lesser degree than during the 1990s, but a much greater degree than in Australia or the United States, for example.

Risk strategies in Brazil

Agriculture is one of the more temperamental elements of Brazil's economy, being a physically massive and complex system with significant regional, economic and sectorial heterogeneity, which is "intensely manifested in agriculture, a sector where globalized companies and poor peasants, cutting-edge biotechnology and mattocks, soil conservation and burn-and-slash practices co-exist side by side" (Vieira (Jr), Buainain, Madi, & Leda, 2008).

Modernisation of the agricultural sector has resulted in increased risk and producer vulnerability due to the complexity and interconnectedness of Brazil's production system.

> "There was a time when the risks for extensive producers were less because investment and expenses, in general, were less. Thus, the eventual losses caused by climate variations, market fluctuations and institutional changes were also less. However, risk factors have multiplied over recent decades: overspecialized producers are more subject to single-market conditions than those who have a more diversified production, because it is unlikely that all the markets will collapse at the same time. Modernisation, the intensification of production and the inclusion of multiple financial circuits are processes that generally increase producer vulnerability, besides demanding the use of complex risk management instruments in order to avoid or reduce the damaging effects of risks." (Buainain & Loyola, 2015)

With its relatively turbulent geographic climate and sociopolitical landscape, Brazilian agriculture is subject to significant risk in:

- **Production** – weather, fires, plant and animal health, natural resource management, eg. prolonged droughts, frosts, excess rain, winds, floods, bushfires, resource mismanagement, change in water allocation rights BSE, *helicoverpa armigera*, etc
    - NB: on average, 1% of Brazilian GVP is lost due to extreme events
- **Market risk** – Fluctuations in the price of inputs and outputs, financial credit and global trade, eg. substantial price change in inputs/outputs, interest rates, credit terms, closing of export markets, access to imported inputs
- **Enabling environment** – infrastructure, logistics, regulatory, policy or institutional framework, eg. strikes, road/rail/port closures, changes in incentive for storage, changes in laws/regulations for environment, labour, inputs, land management

Buainain et al. also note that the increasingly intensive use of agricultural technology entails an "unspoken" risk to the sector, which depends on the "continuity of the innovation process, whether to respond to problems created by technology, from plague resistance to reducing production, or to ensure new productivity earnings and profitability" (Buainain & Loyola, 2015).

The approach to managing agricultural risk in Brazil has shifted in recent times from mitigation and intuition to comprehensive and technical management. Farmers and governments have evolved since the mid-1990s from traditional intuitive and reactive risk mitigation models toward comprehensive risk management after accumulating significant losses. Different risk management strategies and the distribution of responsibilities between producers/communities, market and government are demonstrated in Figure 29.

Strategies	Institutional level		
	Producers/Community	Market	Government
Prevention	Choice of technology	Training in risk management techniques	Macroeconomic policies; disaster prevention; disease prevention in animals
Mitigation	Product diversification; sharing knowledge	Derivative contracts; rural insurance; vertical integration; commercialization done throughout the year (not focused on the harvest); diversifying financial investments; work outside the farm	Progressive income tax system; counter-cyclical programs; biosecurity measures
Confrontation	Loans from relatives, friends and the community	Sale of assets; loans; income beyond agriculture	Welfare; farmers aid program

Source: adapted from the Organization for Economic Co-operation and Development (2009)

Figure 29. Agricultural Risk Management Strategy - Source: Comprehensive Agricultural Risk Management (Buainain & Loyola, 2015)

The two main market tools to manage risk in Brazilian agriculture are futures markets (price risk) and insurance markets (production risk). Government policies or programs to directly or indirectly address farm risk are also well-established.

Financial instruments to cope with production or price risk in Brazil are generally limited due to informality and lack of scale. Capital markets, which offer the natural tools for price hedging, are less developed in Brazil than in other countries.

Insurance is essentially provided by the federal government through the annual Agricultural Plan (PAP). Resources for the 2012-13 PAP totalled BRL 133.2 billion, BRL 5.4 billion of which was allocated to price risk management. However, a large share of resources for price risk mitigation is still used for government buyout policies, either through direct or indirect acquisitions (Assunção, Hemsley, & Gandour, 2015).

Agricultural insurance

Agricultural insurance is strongly supported by the Brazilian government. The four main insurance programs are:

- the rural insurance premium program (Programa de Subvenção ao Prêmio do Seguro Rural, **PSR**) - covers up to 70% of the insurance policy value contracted by producers
- the general agriculture insurance program (Programa de Garantia da Atividade Agropecuária, **Proagro**)
    - these two programs target commercial farmers and are administered by MAPA
- Proagro-Mais or family agriculture insurance (Seguro da Agricultura Familiar, **SEAF**), and
- The crop guarantee program (Programa Garantía-Safra, **GS**) for family-owned small-scale agriculture.

These four programs support farmers either by paying part of the insurance premium costs or by compensating farmers for production losses due to natural disasters. Agricultural insurance, which has been increasing rapidly, accounted for 17% of the support to farmers during 2012-14 (OECD, 2015).

In March - April 2009, the Swiss Reinsurance Company (Swiss Re) commissioned a field survey of Brazilian farms, (30 cooperatives, 220 large farms, and 20 corporate farms) to evaluate farmers' risk perception and investigate on-farm risk management strategies (Tüller, Cullen, Trüb, & Schelske, 2009). The farmers surveyed by Swiss Re identified natural perils, high input costs and volatility in commodity (cooperatives and large farms) or currency (corporate farms) prices as their greatest risk concerns (Figure 28).

To address agricultural risk, the respondents either bought insurance, diversified their crops or did nothing at all. Insurance uptake varied by operating model, farm size, and region: whilst the majority of the farmers in cooperatives had insurance, only 21% of the large farms and 15% of the corporate farms were insured.

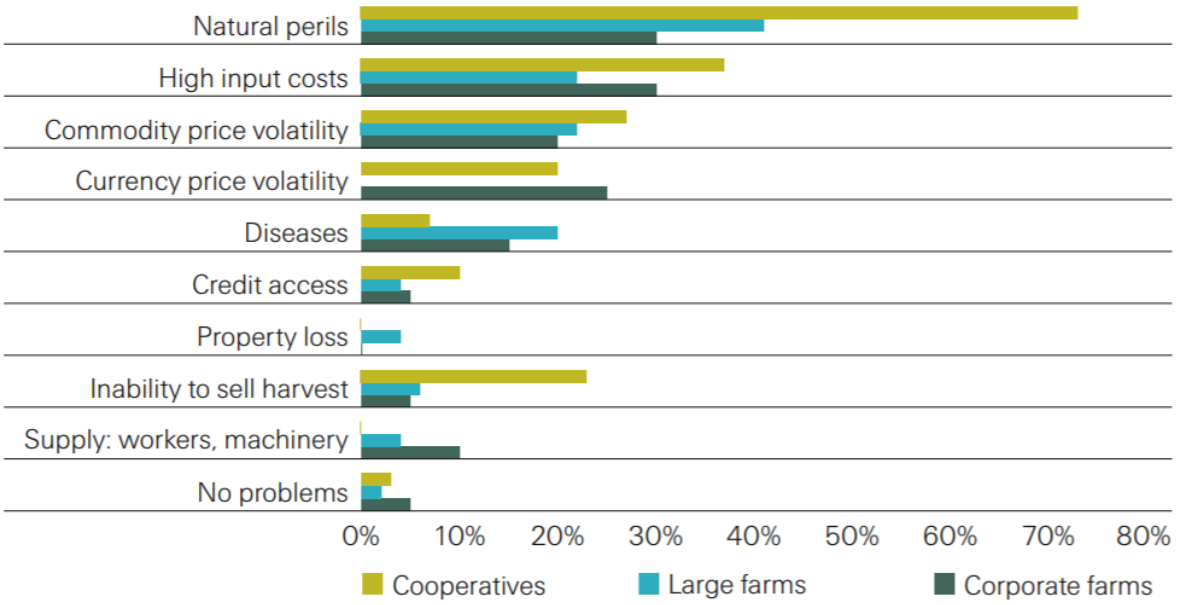


Figure 30. Largest agricultural risks in Brazil - Source: Betting the farm, SwissRe (Tüller et al., 2009)

Government-supported agricultural risk management

In recent decades the Brazilian government has developed many programs under its risk management strategy with the goal of reducing the volatility of cash flow in the agricultural sector, consisting primarily of policies and programs that finance ex-ante instruments such as the Support to Insurance Premium (PSR) and Agricultural Activity Guarantee Program (Proagro). The responsibility for the operation of these and other programs is currently fragmented among institutions, including several government ministries and the Central Bank (BACEN) (Bracale, 2016).

At least 21[1] distinct government policies or programs in the agropolitical landscape directly or indirectly address farm risk via financial or production insecurity (see Figure 4), including but not limited to:

- PPGPM (Policy of Minimum Guaranteed Prices) - 1966

[1] While the sheer number of support programs is high compared to Australia, this situation is not unique to the agriculture sector - notably, Brazil allocated approximately 25% of GDP to social expenditure in 2012 - the highest rate of social expenditure in the region (Latin America and the Caribbean).

- Proagro (Agricultural Activity Guarantee Program) – 1973 – an exemption from financial obligations of rural credit in the case of disaster
- National Food Supply Company (CONAB) - 1990
- PAA (Food Acquisition Program) – 2003
- Proagro-Mais – 2004 – agricultural insurance
- PSR (Support of Rural Insurance Premium) – 2005
- National Program for Strengthening Family Agriculture (PRONAF) – 2006
- Program for the Modernisation of Agriculture and the Conservation of Natural Resources (MODERAGRO) - 2009
- Price Guarantee Program for Family Farming – 2010
- Fund for Rural Catastrophe – 2010

Most of these policies focus on mitigation rather than transfer or response – which is considered a more cost-effective strategy, but a report produced by the World Bank, the Brazilian Agriculture Research Company (Embrapa) and the Ministry of Agriculture of Brazil (MAPA) suggested significant gaps in the risk transfer and response strategy are in need of policy attention (Arias et al., 2017).

This report noted the importance of integration in managing agriculture risks, due to the clear interrelationships among the main risks facing the agriculture sector of Brazil.

ANNEX I. MAIN STRATEGIES AND POLICIES RELATED TO FOOD SECURITY AND NUTRITION (SINCE 2000)

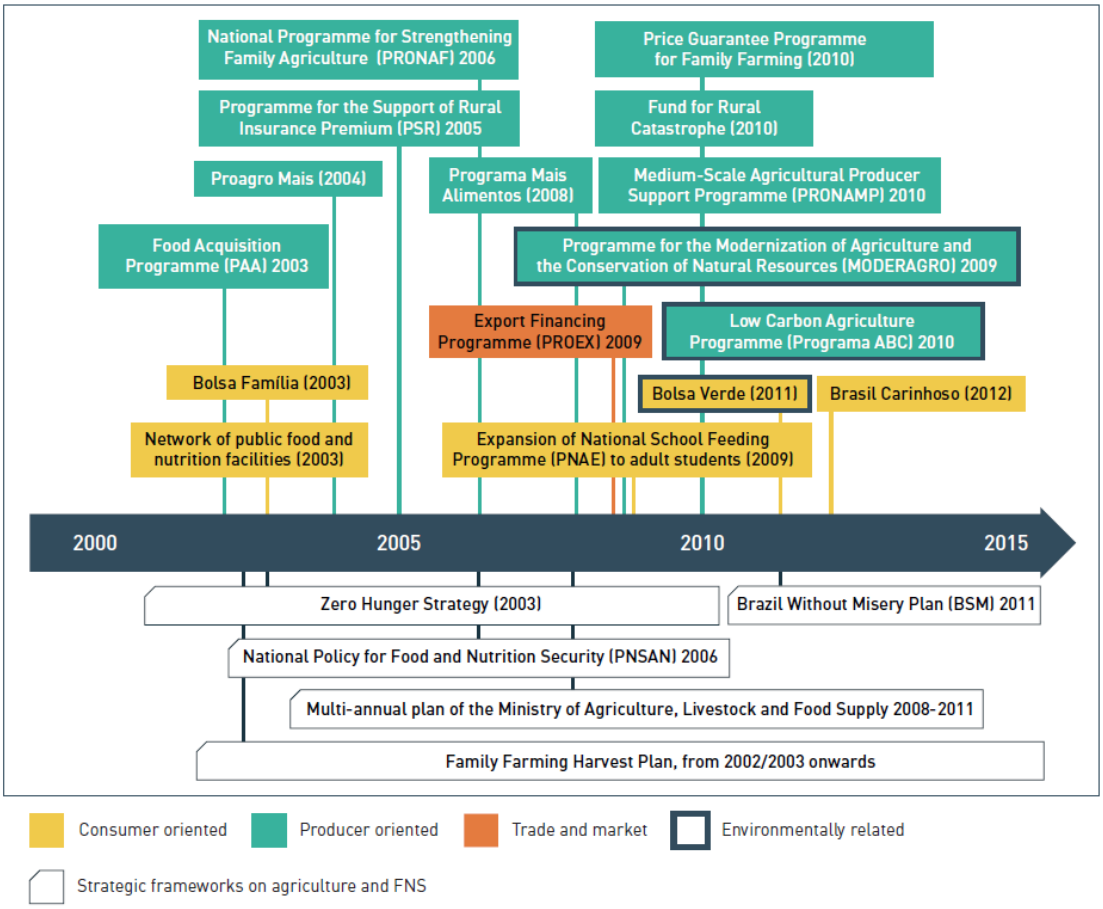


Figure 31. Food Security Strategies and Policies in Brazil since 2000. Source: (FAO, 2014)

State support to production, with the aim of increasing farmers' productivity and ensuring food security, continues to be strong. The government's priorities from 2007 to 2013 fell into three major categories: rural credit, marketing and risk management:

- The Policy of Guaranteed Minimum Prices (PGPM), in place since 1966, had the objective of protecting producers when market prices fall to low levels.
- The National Food Supply Company (CONAB), established in 1990, bought products directly from small and medium farmers, most often through the Food Acquisition Programme 7 (PAA). The products were purchased at a minimum fixed price to replenish public food stocks.

- Disbursements reached their peak after the global financial crisis in 2009, yet continued to be a significant expenditure, costing an average of more than US$ 650 million a year.
- The Agricultural Activity Guarantee Programme (Proagro), in place since 1973, exempts those settlements hampered by natural disasters, pests and diseases from financial obligations of rural credit. The premium fee, subsidised by the government, is very low. (FAO, 2014)

In 2015, Assunção et al. noted the current policy for agricultural price support in Brazil was still mostly based on direct government intervention: when prices fall below a threshold, the government either buys the output directly, or matches the producer to some out-of-the market consumer who values it less than the market itself. The authors found this policy offered "very limited insurance to farmers, who are still exposed to volatility above the threshold" and they suggested policy should move in the same direction as the United States and the European Union - i.e. government should pay only the necessary amount to avoid poverty or excessive volatility. (Assunção et al., 2015)

CPR Bonds

The Brazil Farm Product Bond - Cedula de Produto Rural (CPR) - facilitates cash forward contracts for agricultural and livestock production, enabling producers to collect resources or inputs beforehand by offering their production capacity as collateral to financers.

Commodity-reference bonds represent an obligation to deliver agricultural products on an agreed future date (CPR in kind) or equivalent value cash (financial / indexed CPR). Created in 1994 to enable advance sales / capital flow (similar to futures), these can only be issued by farmers, cooperatives and farmers' associations. An important factor of CPRs is reduction of risk to the buyer. CPRs are used primarily by middle to large producers.

There are three types of CPR:

- Physical (resources advanced under mandatory obligation of delivering commodity at future date)
- Financial (resources advanced under expectation of delivering commodity at future date, bond can be exchanged for cash – ie. investors buy the CPRs, farmers sell goods for required amount to repay CPR)

- Indexed (as per financial but price indexed to relevant futures market) – best of both worlds:
  - Guarantees to seller indexation of debt to value of product
  - Attracts investors as transaction is financial, not physical
  - Increases futures market transactions

Conclusions:

Modernisation of the agricultural sector has resulted in increased risk and producer vulnerability due to the complexity and interconnectedness of Brazil's heterogenous production system.

CPR bonds offer intriguing potential to both manage and mitigate agricultural risk.

Brazilian agriculture is well-served by an array of risk management instruments and strategies, including state support, agricultural insurance and extension of information. However, the operation of risk programs lacks coordination and consistency. Agricultural trade policies are not presently well-integrated into agricultural risk management policy. Better integration of risk-related information, planning, tools and management could reduce exposure to agricultural risks in weather, agrologistics and infrastructure.

New Zealand

Overview

Agriculture is a major industry in New Zealand (NZ), contributing approximately 5% ($13 billion) to the country's Gross Domestic Product (GDP) (Stats NZ, 2018). The country's agriculture industries are crucial to the economic and social fabric of rural communities, districts and regions; and to wider NZ. A relatively small and remote economy, international trade is particularly important to NZ, and as such relies strongly on overseas markets for both supplies and outlets for its domestic economy.

New Zealand's dominant agricultural activity is pastoral farming based on year-round outside grazing. Better quality land, both in terms of contour and soil, is used for intensive pastoral enterprises that include dairying, finishing lamb, beef and deer, and the cultivation of forage crops. Steeper and poorer quality land is used for sheep, beef and deer breeding with limited scope for intensification, or for the cultivation of forage crops. Some flat land can be irrigated, but pasture irrigation is economically justified only for the most profitable activities (e.g. dairying).

In the 1950s and 1960s, farm subsidies were virtually non-existent in NZ, however in attempts to make up the foreign exchange shortfall from increased oil costs, the collapse in commodity prices and the loss of significant income from agricultural exports to Britain, in the 1970s and early 1980s, the NZ government introduced agricultural support to farmers to encourage them to boost production. This resulted in the development of a number of support mechanisms such as minimum prices for agricultural goods, input subsidies, low-interest loans, tax incentives and debt write-offs. As a result, farmers became less responsive to market signals, including demand for products, less innovative, and resources were not used efficiently.

The rapid realisation that policy subsidising agriculture was not effective, with high costs and declining productivity and competitiveness in international markets meant that it soon became economically unsustainable to continue to subsidise agriculture. Since the start of deregulation of the NZ economy in 1984, the economic environment facing NZ producers has changed remarkably. The reforms removed all price support payments for farmers and the exchange rate was adjusted. For farmers, this resulted in reductions in farm income, profitability and land values simultaneous with increase in farm input costs and debt, and predominately resulted in wider exposure to market risks. Despite the challenges that arose, NZ farmers showed great

resilience and these changes led to better positioning of the industry's ability to respond to market demand, increased competition, and responsiveness, of which risk management was a key component.

Risk and risk management in NZ

NZ farmers are exposed to a multitude of risks, primarily including price risk, associated with their orientation as one of the world's most export-oriented economic sectors and the lack of government policies to buffer or stabilise domestic prices which are largely determined by world market prices, fluctuations in international commodity prices and variability in value of NZ dollar. Production risk are most closely associated with climatic and other natural risks such as flood, drought, hail, severe frost, storms and heavy snowfalls, earthquake, and volcanic eruption. These situations are issues for both in terms of production losses and damage to infrastructure. Risks stemming from biosecurity risks and product contamination are also important considerations for NZ producers.

Government-provided risk management solutions

In the absence of any major risk assistance programs, government interventions only seek to ensure macroeconomic stability, address market failure by risk management policy in NZ focused on the prevention of pest and disease incursions and risk assessment/ communication and dealing with catastrophic risk. Described by the World Trade Organisation as "Green Box" subsidies, these have a minimal effect on trade.

New Zealand's only direct government funding to farmers is for erosion control, as well as provision of welfare benefits for income hardship due to natural adverse events, such as flooding or drought.

Most literature on risk management in NZ supports the view that many NZ producers perceive risk as a normal part of business that provides not only threats but opportunities. It is important to understand that in terms of the perspectives on the risk management system by the agricultural sector, operating in a situation of high dependency on government would mean operating in a highly risky environment, and at the end of the day, feel they are better to have the right price.

Policy analysis on risk management in NZ agriculture is typically structured around three layers of risk that require a differentiated policy response:

1. Normal (frequent) risks that should be retained by the farmer.
2. Marketable intermediate risks that can be transferred through market tools.

3. Catastrophic risk that requires government assistance.

Shadbolt (2009) analysed farmers' perceptions of different types of risk and ranked them by importance. All farmer groups (livestock farmers, sheep and beef farmers, deer farmers, and dairy farmers) ranked product prices as their primary risk. Market risk were most dominant across sheep and beef farmers and dairy farmers. However, except for deer farmers, production risks such as weather (rainfall) was also ranked among the top 5 concerns for all farmer groups. Pests and diseases were regarded as an important risk in earlier studies compared by Shadbolt (2009), however were of much less importance in newer studies. In this study, social risks were not identified by farmer groups, however legal risks, such as chanced in producer board policies and changes in laws and policies were of particular concern for dairy farmers and was equal to perceived human risks (i.e. accidents and health problems), and financial risk from interest rates. Discussing trends observed by Gray et. Al. (2009), Shadbolt notes the significance of changes in the level of significance of perceived risk over time from 2005 to 2009. These changes are likely attributed to increased awareness of health and safety laws as well as the predominately sole-operator nature of farm businesses at the time. The decline in production-based risks was associated with improvements in management strategies.

Interestingly, the majority of literature regarding risk management has been limited to discussion on the negative aspects of risk and failed to consider its multidimensional nature. Long-term and short-term dimensions of risk include opportunities and threats.

A report by the Organisation for Economic Co-operation and Development (OECD) found that the uncertainties that were easiest to manage are perceived to provide the greatest opportunities. And the relationship between the threat and the short/long-term (i.e. product prices and negative uncertainty in the short-run and providing opportunity in the long-run). This meant that producers may not always perceive risks solely as a threat, but also an opportunity.

The overall policy and regulatory framework in NZ deserves to be highlighted in relation to farm household risk management. The country's broad policy design is oriented at maintaining a competitive economic environment and creating as few impediments as possible to economic adjustment. The reforms of the 1980s led to the introduction of important acts with respect to fiscal, monetary, and labour areas as well as the introduction of new institutions. This created a macro-economic framework enabling adaptation. Successive governments have continued the broad market orientation of economic policy. In a market-oriented and relatively stable macro-

economic framework, farmers have substantial flexibility to adapt their production through access to competitive financial, credit and service markets and to develop appropriate marketing strategies. For example, a specific tax provision allows farmers to smooth income over time. Tax relief and income assistance is available in the event of extreme weather and natural disasters. Of those measures, which include income equalisation, provisional tax estimates, outstanding tax, late filing and late payment, exemptions, tax credits, and additional tax measures, the *Income Equalisation Scheme* is most specific to farmers and farm production. The Income Equalisation Scheme is available to those who receive their gross income (greater than 50%) from farming, forestry or fishing under which they can deposit a part of their total income received in a given year into a special (income equalisation) account. This is excluded from taxable income until its withdrawn from the deposit (Melyukhina, 2011). The income equalisation scheme allows taxpayers to deposit income from farming, fishing or forestry with Inland Revenue. The money is paid into a special account and earns interest at 3% per annum on amounts left on deposit for more than 12 months. The interest paid becomes part of the deposit for tax purposes. The deposit is held for a maximum period of five years.

Private-based risk management solutions

NZ farmers consider risk as a normal part of production and distinguish between risks that generate threats and those that generate opportunities. As a sector dominated by exports, the volatility of domestic prices derives from two principle sources, fluctuations in international commodity prices, and variability in the value of the NZ$. The pressure for competitiveness implies intensified use of natural resources and practices that are associated with high production, financial and market risks. However, sustainability implies constraints on how resources can be exploited and an increasing internalisation of resource use costs into farming costs. A key challenge for risk management is to develop strategies that reconcile these competing pressures. Many producers are believed to seek external information and consultation and outsource the management of risks. However, there's an apparent gap between farmers rising appreciation of risk management strategies and the actual use of such strategies. This could be associated with a decline in producers employing strategic management of risk, despite increased awareness of the importance of risk management under particular circumstances.

No level of government in NZ has any formal responsibility for advising farmers on agricultural risks, although government agencies do perform other tasks that generate information relevant to

farmers in assessing risks, especially with respect to adverse events. Information concerning market and financial risks is largely provided by private companies and farmer organisations in NZ (Melyukhina, 2011).

At the farm or business level, producers opt for several common risk management strategies that best suit their circumstances and production systems. These strategies align with financial management, such as that involving off-farm income, equity and insurance; feed management, irrigation, drainage and flood control, and in a similar fashion to Australian production, involvement with levy organisations. Generally, diversification as a risk mitigation strategy is not a feature of agricultural risk management in NZ.

These risks are managed according to the two primary risk classes of *marketable risk* and *normal risk.* Marketable risks are considered more frequent with a smaller magnitude of damage. Risks in this category can be managed by specific arrangements set up by producers that enable them to either transfer these risks to other parties or pool them (e.g. insurance market, futures, forward contracting, risk pooling with cooperatives). Normal risks are considered frequent and typically result in relatively small losses. Producers manage these risks by modifying on-farm practices or other mechanisms associate with tax, credit, and/or social security. Unlike in Australian production systems, enterprise diversification is not as viable (due to markets, systems etc). For some farms, production specialisation has played an important role in improving efficiency following the withdrawal of agricultural subsidies in the mid-1980s. In some sectors (e.g. dairy) the primary focus is to control output risks and farm financial management, with less emphasis on controlling market risks. Farmers in these sectors seem to implicitly outsource the management of market risks to downstream agents by virtue of the industry's vertical arrangements. In other less coordinated sectors (e.g. meat and pipifruit), managing market risks through techniques available to individual farmers seems to be as important as managing production and financial risks, although no studies exist quantifying that.

In the past, common insurance schemes for specific commodity sectors funded by self-imposed farmers' levies existed. But today, moral hazard risks are too high (too many people paying for the few who didn't undertake risk management). The only two in current existence are (sectoral) for wheat and kiwifruit. Low availability of insurance options for certain risks in NZ is believed to be reflective of a history of low uptake by farmers of such insurance. They have generally had

low incentive to take on insurance (possibly, the risks and losses are not that great in comparison to opportunities that risks posed or they are well managed).

Risk management in NZ Dairy – Milk Price Derivatives (Special focus)

Dairying is the country's most significant agricultural activity in many regions (Stats NZ, 2018). The dairy sector contributes $7.8 billion (3.5%) to New Zealand's total GDP (Ballingall & Pambudi, 2017). New Zealand is the eighth-largest milk producing country in the world and accounts for around 3% of global milk production with around 95% of all dairy production exported. Around 84% of NZ milk supply is controlled by Fonterra, a farmer-owned cooperative. Because of the significance of dairy production in NZ, both in terms of production and export value, and the relatively few tools that exist to manage milk price risk, NZ dairy farmers are at a disadvantage compared to their international competitors.

In 2010, the NZ Stock Exchange (NZX) launched a global dairy futures and options market, with contracts developed to better enable farmers, producers, and manufacturers to manage their risk around price fluctuations. Since then, the market has continued to expand its offering, launching whole milk powder futures and options, skim milk powder futures, anhydrous milk fat futures and butter futures. Most significantly perhaps, was the launch of an NZ$ liquid milk contract in 2016, as a tool aimed at dairy farmers to manage milk price risk.

Milk price options and futures contracts - Dairy on the NZX

From 27 May 2016, NZ dairy farmers have been able to hedge milk prices with a futures contracts scheme. Similar schemes have been commonplace in Europe and the united states for several decades. Futures options were made available following the consultation between the NZX, dairy industry participants and NZX Derivatives Market stakeholders, with formal approval of the contracts by the Financial Markets Authority and the Reserve Bank. With almost all of their product sold overseas, NZ dairy farmers are highly exposed to the global dairy market. The new futures and options contracts aims to help level the playing field with their overseas counterparts in the US or Europe, who have access to a wide range of risk management tools.

Once the futures and options contracts are available for trading on NZX's dairy derivatives market, all users of these contracts will be required to trade through an NZX derivatives participant (a broker). Derivatives contracts carry risk and operate differently to fixed-price schemes offered by milk processors.

A futures contract is an agreement, generally made through an exchange, to buy or sell a commodity or asset at a date in the future, and at a price agreed today. When futures contracts mature, they can be settled by buyers and sellers either exchanging the commodity or asset, or by settling in cash whereby the contracting parties pay or receive a loss or gain (calculated by reference to the settlement price). In the case of NZ milk price futures, the buyers and sellers will settle by exchanging cash, calculated by reference to Fonterra's announced farmgate milk price. Options contracts provide the buyer with the right, but not the obligation, to buy or sell a particular asset or commodity at a predetermined price, on an agreed date in the future. For example, a dairy farmer may use an options contract to protect against the milk price falling but retain the benefit of potentially higher milk prices.

Fixed price vs. futures and options

Fixed milk price schemes generally allow parties to lock in a price for a percentage of their milk production. NZX's futures and options contracts operate very differently. Trading parties buy and sell futures contracts to hedge their exposure to movements in the milk price. For example, if the farmgate milk price declines, the drop in the price a farmer receives from a processor for milk supplied will be offset by a gain on the futures contract. Parties that trade futures contracts are also subject to obligations relating to holding a margin account, as well as "basis risk" (where the futures contract price differs from the underlying physical market price).

Conclusions

The support provided by the NZ Government for market-based agricultural risk tools is next to none, and most literature on risk management suggests that NZ producers perceive risk as a normal part of business that provides not only threats but also opportunities.

Deregulation of the NZ economy (starting in 1984) removed all price support payments for farmers and adjusted the exchange rate, resulting in reductions in farm income, profitability and land values simultaneous with increase in farm input costs and debt, and predominately resulted in wider exposure to market risks. In response to these challenges, NZ farmers developed great resilience and the industry's ability to respond to market demand, increased competition and responsiveness improved, of which risk management was a key component.

Kenya

Agriculture and farming is the mainstay of Kenya's economy, contributing 26% of the Gross Domestic Product (GDP) and another 27% of GDP indirectly through linkages with other sectors (Food and Agriculture Organisation of the United Nations, 2018). Large and complex, Kenya's agriculture sector constitutes a multitude of public, parastatal, non-governmental and private sectors, employing more than 40% of the total population and more than 70% of Kenya's rural people.

Most of Kenya's land mass is arid or semi-arid, with approximately 20% suitable for farming (medium-high potential), although currently, only around 8% of Kenya's land is under agriculture. Farming is typically carried out by small producers who cultivate no more than five acres. Smallholder farms are predominately subsistence grown with cash crops. Cereals such as maize, wheat and millet are the most common crops grown by majority of farmers with more than half of all farming output for subsistence. However, large sized farms tend to grow high value crops such as vegetables and fruits (Association of Kenya Insurers & Consumer Options, 2016).

According to Kenya National Bureau of Statistics (2018), small-scale production, mostly on farms averaging 0.2-3 ha, accounts for 75% of the total agricultural output. Small-scale farmers produce over 70% of maize, 65% of coffee, 50% of tea, 80% of milk, 85% of fish, and 70% of beef and related products.

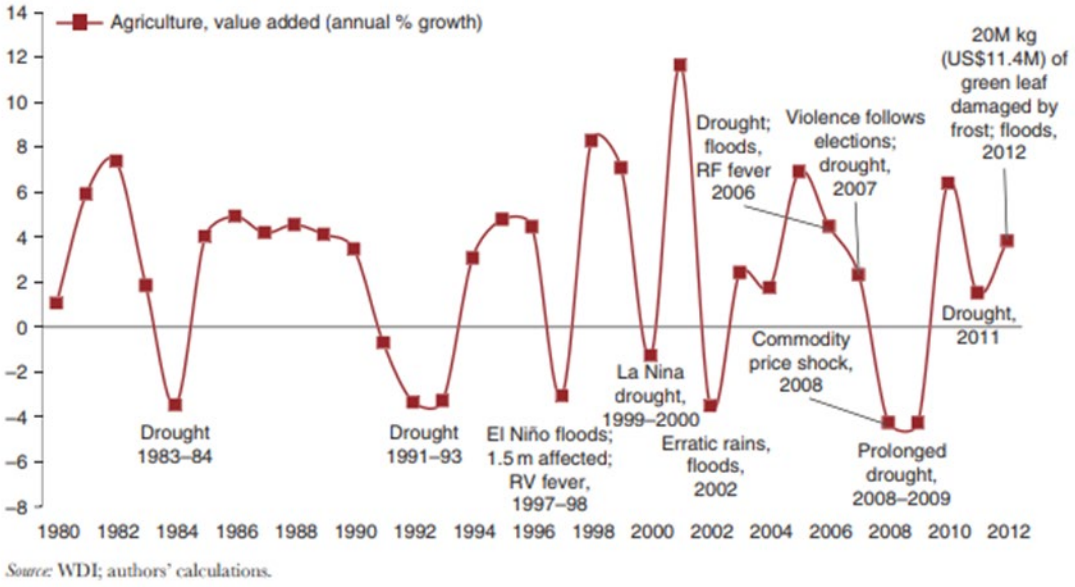
Agricultural risk in Kenya

In Kenya, risk contributes to poverty, limits food availability, constrains food access, disrupt income, and depletes productive assets. Extreme weather events, the global financial and economic crisis, high food and fuel prices and a tension and uncertainty within the political environment in recent years has repeatedly disrupted agricultural supply chains and markets. Risks stemming from these events are greatly associated with flow on effects which range from the individual, to the triggering of food shortages, deterioration in nutritional status and destitution.

Historically, the greatest, and most widely reported, impacts on Kenyan agriculture production have been attributed to drought (Figure 6). The combination of frequent severe droughts, high dependence on rainfed agriculture, and high poverty rates among smallholder farmers and pastoralists makes Kenya particularly vulnerable to the effects of droughts. In addition, there are

also a number of broader issues associated with natural, economic and socio-political environments that affect risk exposure and impacts on producers. Determining the vulnerability of producers and addressing risk through management, or mechanisms of 'coping' requires an understanding of a function of these dimensions, including exposure to societal and/or environmental stresses, associated sensitivities, and related adaptive capacities. Deep-rooted contextual issues extending from investment in funding and research at the institutional and national level, adequacy of policies, bureaucracy, competition, and industry linkages are important considerations in any attempt to inform the discussion around agriculture-related risk management.

For many counties within Kenya, risk sharing institutions such as national insurance and credit schemes that help reduce the burden of risk to producers are weak. In addition to the limited nature of private insurance products, producers tend to turn to self-insurance strategies like enterprise diversification and social mechanisms to cope with risk. However, producer strategies and the interplay of risk dynamics (in terms of both influencing ex ante decision making among farmers, traders, and other sector stakeholders and causing ex post losses to crops, livestock and incomes) is not well understood.



Source: WDI; authors' calculations.

Figure 32. Historical timeline of major agricultural production shocks in Kenya, 1980-2012 – Source: WDI

The major risks faced by Kenyan producers are outlined below:

I. Production risk associated with:

- Drought

- Flood
- Frost
- Windstorms
- Hailstorms (heavy rain)
- Pests and diseases

When crop yields decline or fail, farmers adopt a variety of strategies to maintain their livelihoods. Household conditions including income and farm size may limit the ability to experiment with adaptation strategies such as growing market orientated crops and diversifying income through off-farm employment given the household's inability to tolerate a failed endeavour.

Grains production is significant to maintaining livelihoods in Kenya. However, because interest and/or ability to store grains is low, there is little consideration given to moisture content and quality. Rather, value chain participants each attempt to sell the grain before it deteriorates, leaving the responsibility for drying and quality to the next buyer in the chain. Shifting of responsibility of quality to the next buyer means that much of the gain entering commercial channels is unfit for storage, and subsequently, quality degrades and resulting in significant losses. The majority of pests and disease threats are manageable, but farmers and livestock herders don't always practice prevailing control measure or avail themselves of available technologies, due to lack of information, access to needed inputs, or financial resources.

II. **Price/market risk (financial)** associated with:

- Price variability for crops and inputs
- Exchange rate volatility
- Counterparty risks
- Interest rate volatility
- Livestock theft
- Counterparty and default risk:

Price or market risk is associated with changes in prices of output or inputs. Kenyan farmers are exposed to unpredictable competitive markets for inputs and outputs including unpredictable exchange rates. High transportation and marketing costs in developing countries isolate local rural markets from national and international markets since yield fluctuations are correlated

within a small area, local prices determined by local production and demand are volatile and for an individual farmer are negatively correlated to their production.

Government procurement programs regularly exert pressure on normal market price developments and contribute to higher intra-annual price volatility for maize and other major staples. For example, prices invariably collapse at the peak of the harvest season. The Government of Kenya (GoK) intervenes by announcing a pan-territorial price for all maize bought by the NCPB for replenishment of the strategic grain reserve. The intervention invariably pushes up prices in the short term.

Depending on the commodity, farmers can receive a supplement year-end bonus determined on the average selling price at auction (excluding marketing, processing, and transport costs). Total payments are typically 70% of the auction price and is considered a good incentive to maintain good crop husbandry and carry out farm investments.

Multinational companies operating in Kenya make one payment to their outgrowers. For coffee, price risks faced by buyers of Kenya coffee is largely managed via hedging on futures. Agents and other downstream actors in the supply chain work on commission and fixed fee-based rates, so face little to no price risk. The biggest concern for farmers is the consistently low price at the farmgate.

Kenya also faces a threat to long-term viability of coffee production. International buyers and marketing agents wield excessive market power while farmers are forced to absorb an oversized share of market and production risks. This means farm gate prices are consistently low and there is little incentive for farmers to maintain good crop husbandry (ie. ageing trees, disease, declining productivity).

Conflict across borders contributes to instability and abandonment of field or delayed preparation. Insufficient infrastructure and low education levels, poor delivery of health care and other services all contribute to the volatility of Kenya's primary production sector.

Livestock marketing has been liberalised, and no livestock trade policies or regulations directly affect domestic prices.

Counterparty and default risk refers to the risk that one or more parties participating in a transaction will not live up to, or otherwise default, on their obligations. Kenyan agricultural supply chains have a limited means of managing such risks. Most minimise their exposure by operating on a limited volume, cash-and-carry basis. Repayment failure is a constant problem

and a significant disincentive to lend to farmers who represent a substantial and hard to manage default risk. Side-selling is another form of non-payment risk that is particularly common among sugarcane (and tea) producers. Small scale producers dishonour contracts with mills who regularly provide inputs in exchange for the crop they help finance to sell to impromptu roadside buyer. This is known as 'cane poaching'.

III. **Institutional** associated with:

- growing dependence on food aid.
- government intervention

Government intervention in input markets (eg. in fertiliser trade) poses a significant risk to producers. For example, the fertiliser subsidy program has created a number of challenges including uncertainty over the timing of delivery and year-on-year support; poor targeting of subsidies; late planting and high farmer dependency; and lack of a clear exit or sustainability strategy.

Unrecorded imports of commodities, particularly refined sugar, from outside the region, unpredictability of current policy with regards to import regulations and exceptions to the COMESA (Common Market for Eastern and Southern Africa) is a risk that impedes both public and private sector investment.

Seismic change in government in Kenya imparts uncertainty and significant and myriad institutional risks in the short to medium term. These include potential for increased inefficiencies, disruptions, and breakdown of critical public services such as extension, data collection, and management information systems (MIS) and higher volatility of producer, wholesale, and retail prices.

IV. **Human (HR)** associated with:

- level of income
- land entitlements
- illness
- crime

Other sectoral risks arise from both internal and external changes in the broader political and economic environment in which agriculture operates. Agriculture sector policy and regulation are a source of risk when public involvement in sector activities has unexpected, adverse

consequences. For example, anecdotal evidence suggests that counties have a growing tendency to raise taxes collected on local agricultural production and to collect taxes again on any products in transit across their territory. This may significantly increase the cost of transporting grain and other staples from surplus to deficit areas, especially if they must cross several counties to get there. In addition, the government's active role in regulating domestic food markets creates uncertainty over the scope and timing of GoK interventions in grain markets poses due to lack of storage at the farm level or a strong disincentive to store grain. Policy that enables this type of environmental risk can cause unexpected adverse price shocks, suspension of tariffs or release grain from strategic stores.

Risk management strategies

Agricultural risk management has a long history in Kenya. The GoK has an extensive record of investment in risk mitigation, transfer, and coping mechanisms. Until 2012, the sector was controlled by over 100 pieces of legislation spread over several government departments and ministries (Association of Kenya Insurers & Consumer Options, 2016). An ongoing issue however, has been the that these policies and legislation have characteristically been incoherent, conflicting and inadequate.

For many counties, risk sharing institutions such as national insurance and credit schemes that help reduce the burden of risk to producers are weak. In addition to the limited nature of private insurance products, producers tend to turn to self-insurance strategies like diversification and social mechanisms to cope with risk.

Current risk management strategies deployed by the GoK include:

- National Agriculture Insurance Program (2016)
- Drought Risk Management Authority (2011)
- Disaster Risk Reduction Program
- National Climate Change Action Plan
- National Hunger Safety Net Program

Kenya's *Vision 2030* recognises the need to strengthen existing risk management systems, and the GoK has launched a range of new initiatives to confront the most severe threats facing the country. Recommendations provided by World Bank include to the GoK in achieving this progress include many practices standard to nations with greater established agriculture systems.

These include:

- Conservation agriculture
- Integrated pest management (IPM)
- Use of certified seed
- Training to strengthen monitoring and enforcement of pests and diseases
- Soil, water and NRM
- Development of feed/fodder production and storage systems, animal health, market and weather information
- Investments in agricultural insurance mechanisms and markets with a focus on asset protection
- Investment in data and information systems to aid improved decision based
- Capacity building and technical training at county and national levels to promote standardized collection and management of agricultural data
- Food security
- Poverty reduction
- Subsistence

The overreaching statement by World Bank with regards to Kenya's *Vision 2030* was that, because the vast majority of Kenya's poor depend on smallholder agriculture for their livelihood, increasing their productivity can contribute at once to improving food availability, increasing rural incomes, lowering poverty rates, and growing the economy.

Historically, policy only improved performance of state organisations to revive specific commodity sectors, such as beef and sheep. For example, the National Cereals and Produce Board (NCPB) is the most prominent state agriculture organisation. Commodity-chain-focused organisations such as the NCPB are associated with good agriculture performance, however have not been without their problems in terms of the reliance on them by producers. When reliance on these organisations occurs, the benefits to producers are disproportionate as investment is detracted away from national public goods in support of smallholder agriculture.

The National Agriculture Insurance Program

In March 2016, the GoK launched the Kenya National Agricultural Insurance Program. The program, which is designed as a partnership between the government and the private sector, was

developed with assistance from the World Bank Group and builds on the experience of similar programs in Mexico, India, and China. One program line will focus on livestock insurance, the Kenya Livestock Insurance Program (KLIP) (first introduced in October 2015) while another will focus on maize and wheat insurance, The Kenya Agricultural Insurance and Risk Management Program (KAIRMP). The insurance program is a substitute for natural disaster relief provided by GoK.

The KLIP will operate by the GoK will purchase insurance from private insurance companies on behalf of vulnerable pastoralists. The program uses satellite data to estimate the availability of pasture on the ground and triggers payouts to pastoralists when availability falls.

The KAIRMP will operate according to an area yield approach whereby farming areas are divided into insurance units characterised by 'average' production. When production falls below the nominated threshold, all insured farmers within the unit receive an insurance payment. The program uses statistical sampling methods, GPS, mobile phones to increase accuracy of estimates and transparency between parties involved.

The NAIP is interesting given the insurance provided on the basis of natural disaster, given that the majority of households (more than half of ag production in Kenya is for subsistence farming-therefore households reliant) are most vulnerable to economic and financial risks compared with production risks, which are likely to impact on the amount and quality of food supply. However, production risks are the single most important risk for farming households.

On-farm risk management

For Kenyan producers, risk management measures fall into three categories (FAO, 2016):

1. **Risk mitigation (ex ante):** Actions designed to reduce the likelihood of risk or to reduce the severity of losses (e.g., water harvesting and irrigation infrastructure, crop diversification, extension).
2. **Risk transfer (ex ante):** Actions that will transfer the risk to a willing third party. These mechanisms typically trigger compensation in the case of a risk-generated loss (e.g., purchasing insurance, reinsurance, financial hedging tools).
3. **Risk coping (ex post):** Actions that will help affected populations overcome crises and build their resilience to future shocks. Such interventions usually take the form of compensation (cash or in-kind), social protection programs, and livelihood recovery

programs (e.g., government assistance to farmers, debt restructuring, contingent risk financing).

Risk prioritisation is inherently difficult due to resource constraints.

Diversification

Enterprise diversification is a strategy used by some producers to reduce their vulnerability. Diversification includes polycultures, agro-forestry systems, and crop rotation systems, with diversity evident in form, function and scale. Diversification not only expands the number of potential crop types for market and mitigates some climate risk.

There are particular issues for the prospect of crop diversification to reduce household vulnerability within semiarid systems. In addition to high variability in climate and rainfall, this makes diversification a challenging decision for farmers. Land suitability, income level, risk avoidance, contact with extension officers, and social norms are potential determinants of crop diversification at a narrowed scope. Typically, diversification is an option better suited to higher income producers. The trend of increasing diversity onfarm occurs with increased income which reduces the perceived risk involved, due to the offset in financial risk. Wealthier producers better absorb failed crops and can afford infrastructure, machinery and labour.

Interestingly, maintaining traditional land practices is another factor that influences production and diversification on farm. Strategies for adopting cropping practices are manifold. Benefits such as increased productivity, market returns from innovation, ability to cope with adverse climatic and market events, food security, and maintaining traditional practices all may influence crop choices (McCord, Cox, Schmitt-Harsh, & Evans, 2015).

Private sector mechanisms

Insurance

Private sector insurance mechanisms remain relatively underdeveloped due to problems of moral hazard and adverse selection. According to AKI Associates (2016), analysing the risk insurance environment in Kenya requires a number of considerations, primarily that there is no distinct definitions of a farmer, and as such, indicators of farmers' classifications can be misconstrued. Often scale, measured by farm size, is used to classify farmers. The challenge however, is that, in reality, the distribution of farm sizes depends on agroecological and demographic conditions, along with economic and technological factors. There is no unique and unambiguous definition

of a farmer; particularly, the smallholder farmer. Often scale, measured in terms of farm size is used to classify farmers. However, across countries, the distribution of farm sizes depends on a number of agro-ecological and demographic conditions and economic and technological factors. The Smallholder Data Portrait by FAO provides a guideline for the classification of farmers by taking into consideration a number of attributes (Table 1).

Table 9. Smallholder Data Portrait - Source: FAO

Indicator group	**Indicators**			
Farm size	Average (hectares)	Minimum, maximum (hectares)	Number of holdings	
Production	Value of crop production	Value of food produced	Value of crop production per hectare	
Income, pluri-activity & poverty	Household income	Shares of income from different sources	Poverty headcount	
Family labour days supplied on-farm	Hired labour days supplied over a day	Family labour days supplied off-farm over a day		
Capital & inputs	Livestock (tropical livestock units)	Percent of households using motorised equipment	Irrigation (percent of land)	Fertiliser and seeds per hectare
Innovation and technology	Percent of improved to total seeds	Percentage of households using improved seeds	Percent of households recipient of extension services.	Percent of households owning a telephone
Access to markets	Percent of agricultural production sold	Percent of expenditure for inputs on value of production	Credit & credit programmes (no. of beneficiary households)	Distance of household from road (km)

Although there is some contention around classification and definition of farmers, utilising the above indicators, farmers are classified by the FAO as:

- **Marginal Farmer**

  A farmer with a bare subsistence level of income from own land, sometimes works as agricultural labour or runs a small business on the sidelines during his/her spare time. Keeps small stock animals mostly indigenous such as chicken, goats, sheep and rabbits. Farming is mostly for subsistence.
- **Small Farmer**

  A farmer who grows and sells between Kes.60,000 (Kenyan shilling) and Kes.200,000 per year in agricultural products, farm operators are either retired or report a major occupation other than farming.
- **Medium Sized Farmer**

  Farming is the major occupation, more than 50 percent of farm output is for market, they grow and sell between Kes.200,000 and 500,000 per year in agricultural products. Keeps large stock animals both/either indigenous or exotic breeds
- **Large Sized Farmer**

  Farming is a business enterprise, more than 50 percent of farm output is for market, they hold great revenue potential with per year sales of more than Kes.500,000 and some farms even up to Kes.20,0000,000. Keeps large stock animals both/either indigenous or exotic breeds.

Conclusions

Mechanisms to reduce the impact of hazards or offset risk in Kenyan agricultures are more closely associated with coping with risk as opposed to managing it. Determining the vulnerability of producers and addressing risk through management, or mechanisms of 'coping' requires an understanding of a function of these dimensions, including exposure to societal and/or environmental stresses, associated sensitivities, and related adaptive capacities.

These issues are deep-rooted and characterise the level and nature of risk in Kenyan agriculture. There has been a recent major shift away from disaster relief to the national agricultural insurance program, which classifies and assesses impacts on regions as 'units' - the units are paid according to a yield penalty threshold as opposed to everyone receiving a payout.

Kenyan farmers rely heavily on government assistance - although this has its challenges, as public services are biased towards the most profitable producers in the most profitable regions, so extension is very limited when it comes to small-holder producers, and there is a very low level of trust in the government.

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