The economic impacts of drought

Regional Drought Resilience Planning 2022

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EXECUTIVE SUMMARY

Australian farmers work in an environment where they respond to market signals largely driven by demand from export markets. They maintain profitability by implementing innovations to maintain and improve productivity. Despite experiencing several droughts, variable seasonal conditions, diminishing government investment in research, development, and extension they have managed to achieve continual productivity improvements for the last twenty years.

The challenge is to remain vigilant and to continue the relentless need to improve productivity and produce more with less, a challenge when terms of trade are positive because complacency becomes the enemy.

Understanding why and how the Local Government Area (LGA) pilot regions are vulnerable to drought enables the right preparation for future drought conditions. The Adaptive Capacity Framework outlined in this review provides a blueprint to achieve this.

Although similar, each LGA has unique characteristics. LGA leaders need to recognise the factors which make them vulnerable to drought. By identifying these factors, they can plan to adapt and build resilience. The data on business turnover presented in this report should help to identify vulnerabilities, build understanding, and facilitate discussion.

This review has examined the literature seeking insights into the economic impacts of drought and how we can build resilience into our communities. Significant investment already exists in assisting farmers when drought occurs, the drought in 2019 was an example where assistance was given. The policy frameworks that wrap around the rural community to assist them with programs like the Rural Financial Counselling and Farm Household Income, provide social support to rural communities in times when they need them. These services need to be easy-to-access and easy-to-use.

The policy framework providing support to smooth income using tax averaging, Farm Management Deposits and tax incentives assist farmers to remain competitive in a free market environment.

Recommendations

Recommendations for building more resilient communities and farm businesses with the capacity to manage drought:

1. Create a clear drought management and mitigation policy by identifying and assessing vulnerability to drought for each LGA,
    - Create protocols for early warning system
    - Including a communications strategy, (targeted at industry) and
    - Identify mitigation measures.
2. Understand the water requirements for each LGA and develop a plan to help farm businesses, small businesses and communities meet future requirements looking at different scenarios.
3. Investment in communication networks for fast data management and retrieval
    - A plan for each LGA
    - If it does not already exist, an audit for requirements
4. Formalise a system for monitoring farm performance with several 'typical' farms including horticulture and viticulture businesses to assist with forecasting and understanding the impacts of seasonal conditions and drought creating evidenced based informed policy direction at a state level.

Focus on Farm Business Decision making

1. Financial literacy for farm businesses using an ongoing and consistent approach
2. Planning for drought mitigation strategies
    i. Investment in water infrastructure is prioritised
    ii. The cost-benefit of investing in water infrastructure
    iii. Developing skills in stock management
        1. Grass utilisation,
        2. implementation of new technologies and innovations
        3. Confinement feeding,
        4. Lick feeders understanding grain and feed required for stock

3. Data systems to aid with informed decisions are developed.
4. Financial security & management of debt is encouraged with upskilling, reinforcing, and improving farm management decisions.
5. Development of resources and continual improvement for skills in livestock management

In summary, as the complexity of farming systems increases so too does the need to make more informed decisions. Arguably the complexity of decision making on farm has increased beyond human capacity and the utilisation of data becomes ever more important.[1] With the right investments supported by data driven decision making, the ability to understand cost of production, the margins and where to invest and innovate in a business becomes possible. This will drive the next wave of productivity improvement required to remain resilient.

[1] Lefroy, W., Jan Kennes, D., and Taylor, S. (2020). Digital Pathway to Power. Rabobank

CONTENTS

1 INTRODUCTION

This work is a component of the project "Regional Drought Resilience Program" for the Northern Agriculture Region (NAR), Southern Wheatbelt and Great Southern Inland. It contributes to the Regional Drought Resilience Plans for the three sub regions across Western Australia and needs to be aligned with national initiatives currently being undertaken under the Future Drought Fund.

The Future Drought Fund program aims to support regional organisations, local government, communities and industry to partner together to develop regional drought resilience plans (DRPs). The plans will identify and guide actions to build the region's resilience to future droughts, with a focus on agriculture and allied industries. Plans will be developed through a triple bottom line, collaborative and evidence-based approach. This is the economic analysis for stage 2 of the drought vulnerability assessment, Figure 1. The project brief is outlined in Appendix 1.

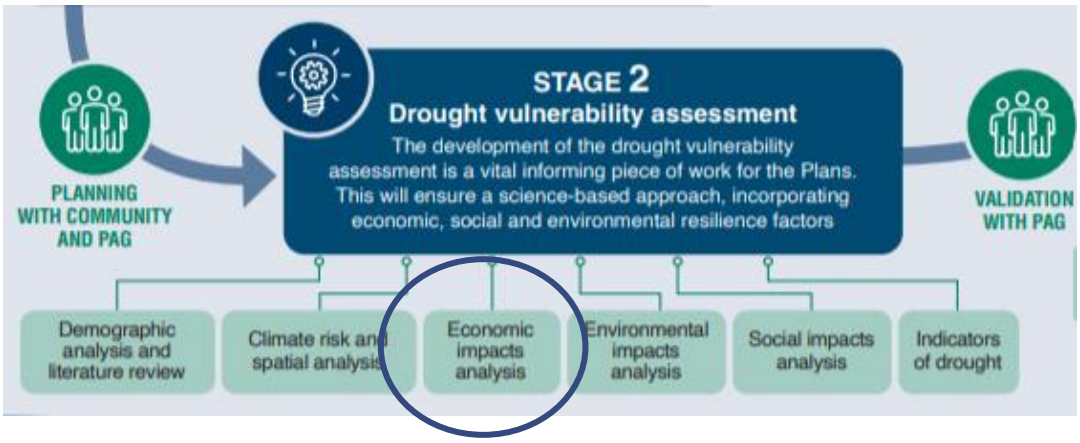

Figure 1. Drought vulnerability assessment framework

The aim of this work is to review the extent and severity of economic impacts of drought in the region, historically and assess the likely impacts of drought in the future.

The RDRP in WA will focus on three pilot regions during the 2020-21 foundation year, being:

- A Northern Agricultural consortium comprising of the Midwest Development Commission (MWDC), the Northern Agricultural Catchments Council, the City of Greater Geraldton, and the Shires of Northampton and Chapman Valley.
- The Southern Wheatbelt consortia comprising of the Wheatbelt Development Commission (WDC) and five LGAs – Dumbleyung; Kulin; Kondinin; Lake Grace, Wagin.
- The Great Southern Inland consortia comprising of the Great Southern Development Commission (GSDC) and LGAs Jerramungup; Kent; Gnowangerup; Katanning; Kojonup; Cranbrook; Woodanilling; Broomehill-Tambellup.

Combined, these three regions cover over 670,000 square kilometres and sit within WA's Grain belt - the largest agricultural producing area in WA and a key contributor to the economy. These regions generate much of WA's agricultural value and, in addition to large-scale broadacre cropping, also support a diverse

range of other primary production activities including aquaculture, livestock and livestock products (wool, eggs, milk), horticulture and viticulture, amongst others.

Drought is the most devastating type of natural hazard worldwide. According to the Emergency Database (EM-DAT), droughts have killed 11.7 million people since the beginning of the 20th century; more than earthquakes, floods, storms and volcanic eruptions combined.[1] These numbers include only 647 registered occurrences of drought-disasters, but every year there are many more areas of the world where low rainfall and high temperatures lead to low incomes and general hardship for people living off the land.[2]

Moderate or severe food insecurity effects one quarter of the world population, and it has been increasing over the past six years. Over half the population in Africa, almost one-third in Latin America and the Caribbean and more than one-fifth in Asia are food insecure.[3]

Climate change, resource scarcity, globalisation, changes in economic power, increasing Global population and increasing challenges in achieving food security, and innovation are overarching challenges changing the way we work and live.[4]

2 BACKGROUND

No one community sits in isolation from the external influences and environment in which they exist. A community's resilience to drought will be influenced by the external environment and global trends often without the ability to control them, often the only option is to be prepared and respond.

Australia plays role in supporting the World with quality food. It is a relatively small global agricultural producer, ranked 23rd in the world and representing just 1% of global production value in 2014-16.[5] (FAO, 2019). As an exporter it is more significant, ranked 12th in the world, accounting for 3% of total agriculture trade in 2014-2016 (WTS, 2010)[6].

Australia's total food and fishery exports increased steadily from 2009 and by 2019-20 the value of exports reached $51.86 billion, Figure 2.[7] This decreased to $49.6 billion in 2020/21 caused by graziers restocking after the 2018-19 drought which also meant cropping was the most valuable commodity export sector, overtaking the cattle industry for the first time since 2016/17.

[2] Fisker, P. (2014). Green Lights: Quantifying the economic impacts of drought, IFRO Working Paper, No. 2014/11, University of Copenhagen, Department of Food and Resource Economics (IFRO), Copenhagen.
[3] FAO. (2020). The state of food security and nutrition in the World (SOFI)
[4] Keston Technologies. (2021). Great Southern Strategic Economic Development Plan.
[5] Food and Agriculture Organisation of the United Nations (FAO) (2019), FAOSTAT, FAO, Rome, available at: http://www.fao.org/faostat/en/.
[6] Greenville, J. (2019). Australia's place in global agriculture and food value chains, Australian Bureau of Agricultural and Resource Economics and Sciences, Canberra.
[7] DFAT. (2020). Trade and Investment at a glance 2020. Retrieved 13-04-2022 https://www.dfat.gov.au/publications/trade-and-investment/trade-and-investment-glance-2021#rural-sector

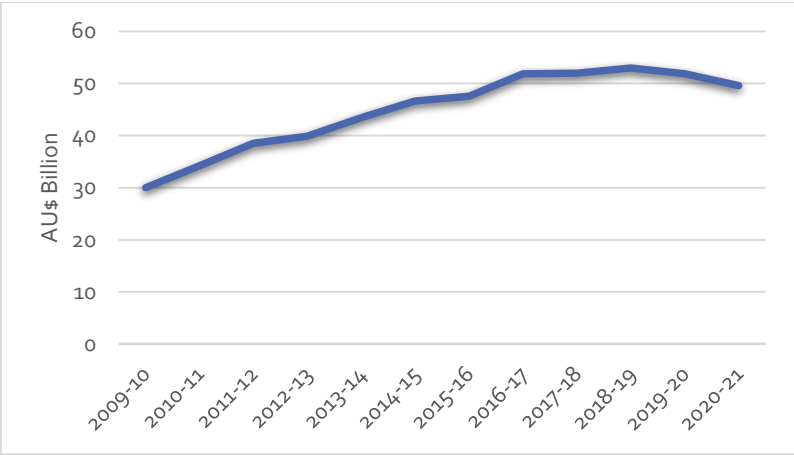

Figure 2. Total agriculture food and fishery exports

The Australian Government's plan for the agriculture sector is to grow to $100 billion by 2030.

In value terms, around two-thirds of Australian agriculture production is exported [8] which in 2017-18 represented 19% of total merchandise exports (ABS, 2019).[6] In Western Australia agriculture production has a particularly strong export focus, where 80% to 90% of grain is exported, facilitated by the close proximity to large markets creating cost of freight advantages, Figure 3.

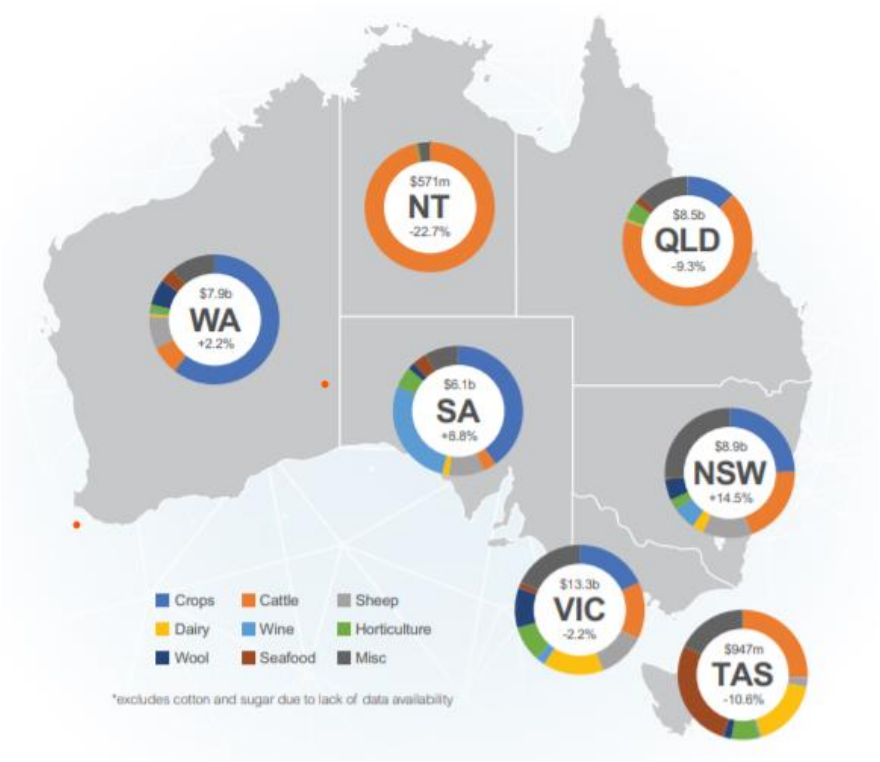

Figure 3.Value of agriculture exports by State. [9]

[8] ABARES (2018) Agricultural commodities: December quarter 2018, Australian Bureau of Agricultural and Resource Economics and Sciences, Canberra, December. CC BY 4.0. https://doi.org/10.25814/5c07aed43fec2

[9] Rural Bank, Australian Agriculture trade 2020-21. Retrieved 13-04-2022 https://www.ruralbank.com.au/knowledge-and-insights/publications/agricultural-trade/

Export markets have transformed in recent decades. Food and fibre are no longer grown and transformed into a final product in one location or country, intricate and complex Global Value Chains (GVC) have emerged. Products are often produced in different stages in different countries.

Using wheat as example, around 8% of the value of wheat exports in 2014 came from inputs sourced from overseas. Inputs like fertilisers, fuels and chemicals used on Australian farms to produce wheat that is exported. It is milled into flour overseas in places like Indonesia and then with other inputs is used to make noodles, which are then also exported.[6]

Australian agricultural exports have enjoyed lower tariffs in many export markets because of Australia's free trade agreements (FTAs).[10] These agreements bring a range of benefits, including better tariff and quota access for Australian exporters. But from the late 2010s, international competitors also started to gain similarly low tariffs through their own FTAs.[11]

This is significant given the reliance of Australia's agricultural sector on exports.

For most agricultural products, prices faced by Australian producers are set on international markets. This means that Australian farmers always need to produce an internationally competitive product to remain profitable. Productivity growth plays a crucial role in keeping Australian farmers and exporters competitive by reducing costs and/or improving returns. Hatfield-Dodds et al. (2021) explains the permanent race for advantage is the relentless need to improve productivity by producing more from less. Innovation needs to drive more efficient use of materials, energy, water, land and labour to maintain profitable and competitive food and fibre enterprises.[12]

Figure 4 shows the continual improvement in climate adjusted Total Factor Productivity (TFP) compared to the TFP for the past 30 years. Australian farmers historically have achieved strong productivity growth by increasing the volume of output from a given set of inputs, and over the long-term agricultural productivity growth is stronger than most other sectors of the Australian economy. It is comparable to farmers in other high-income earning countries.[13]

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[10] Australia's first FTA was in 1983 with New Zealand.

[11] Fell, J 2022, Analysis of Australia's future agricultural trade advantage, ABARES Insights, Canberra. DOI: https://doi.org/10.25814/2e44-ah64. CC BY 4.0.

[12] Hatfield-Dodds, S, Hajkowicz, S, & Eady S. (2021). Stocktake of megatrends shaping Australian agriculture: 2021 update, Australian Bureau of Agricultural and Resources Economics and Sciences, Canberra.

[13] ABARES. (2022). Snapshot of Australian Agriculture 2022, ABARES Insights, Canberra. Retrieved 19-04-2022, https://www.awe.gov.au/abares/products/insights/snapshot-of-australian-agriculture-2022

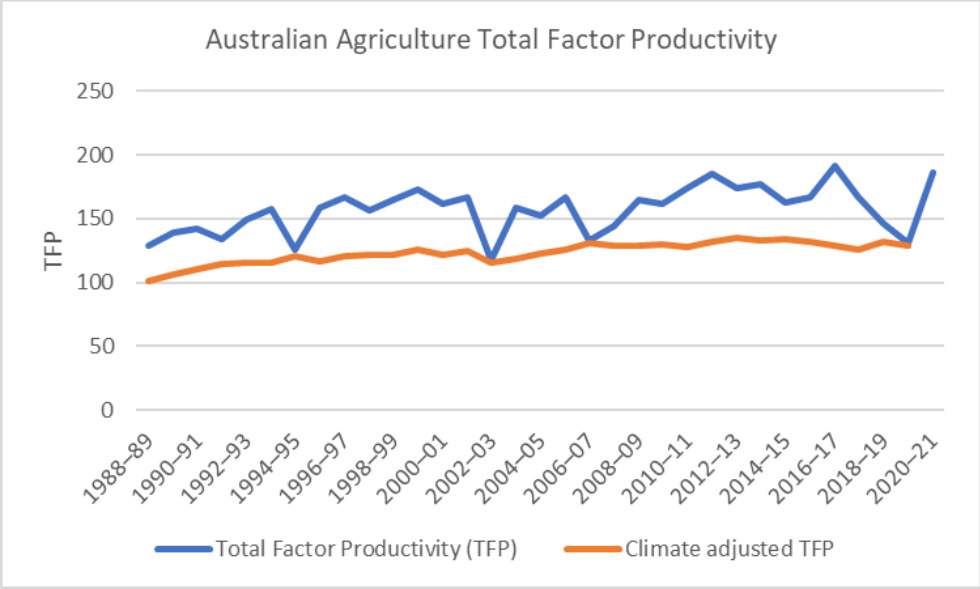

Figure 4. Australian agriculture total factor productivity (TFP).

These productivity gains are driven largely by structural change, changing farm management practices and adaptation to climate change. They have managed to outweigh deteriorating seasonal conditions and less intense public investment in research and development resulting in the improvements in productivity, particularly in recent years.[14],[15]

An example of this is the improvements in crop yields and water use efficiency for wheat (kg wheat/mm rainfall) demonstrated in Figure 5 by Planfarm benchmark data shows the improvement in productivity driven largely by new varieties, application of new and existing technologies, farming system improvements (with the introduction of canola) and agronomic practices.

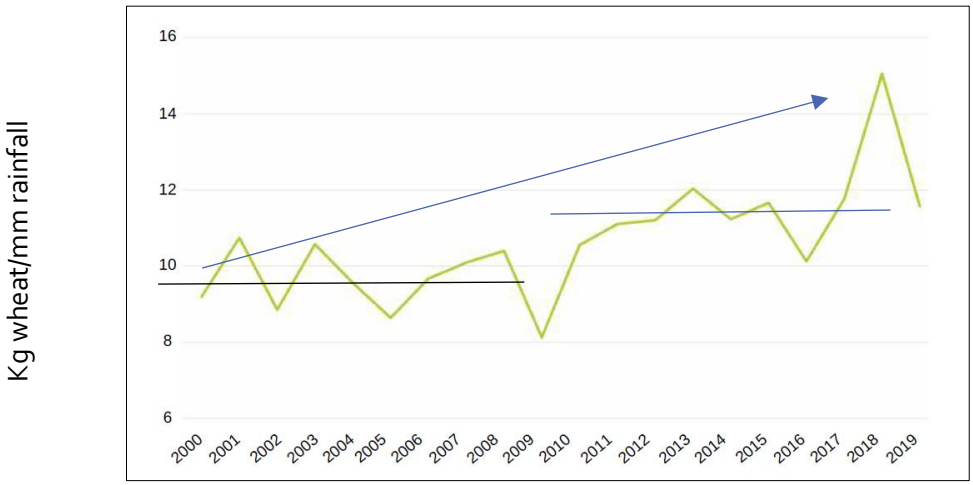

Figure 5. Water-use efficiency (kg wheat/mm rainfall)

[14] Zhao, S, Chancellor, W, Jackson, T & Boult, C. (2021). Productivity as a measure of performance: ABARES perspective, Farm Policy Journal, Autumn 2021, Australian Farm Institute, Sydney.

[15] Sheng, Y, Mullen, J & Zhao, S. (2016). Has Growth in Productivity in Australian Broadacre Agriculture Slowed? A Historical View, Annals of Agricultural & Crop Sciences, 1 (3).

In past decades, productivity growth has served as a means of offsetting longer term declines in real prices received for farm commodities on global markets and declines in farmers' terms of trade more generally (changes in prices received for outputs relative to prices paid for inputs).[13]

The trend changed from 2012-13 onwards when the growth in prices received were better than prices paid, therefore improving terms of trade for famers during this period, Figure 6 and Figure 7.[16]

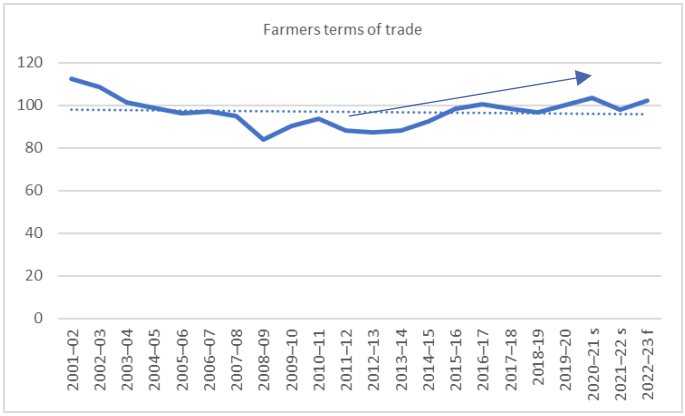

Figure 6. Farmers terms of trade from 2001 to 2022

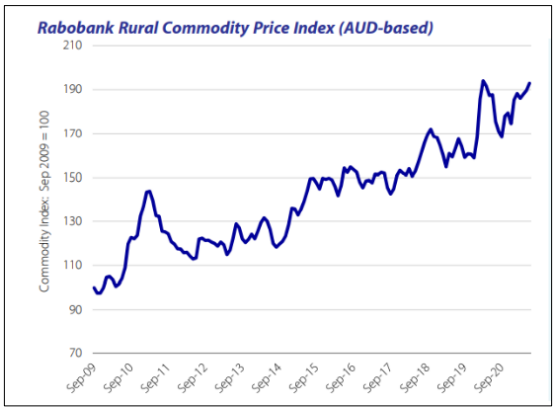

Figure 7. Rabobank commodity price index (AUD)

During the same period (2000 to 2022) rural debt significantly increased, with banks funding the largest proportion of funds to the industry. Government funding has increased recently and is now more than pastoral and other finance companies, Figure 8. The rapid increase in debt levels for the rural community follows the same trends as household debt which has also significantly increased in the same period.[17]

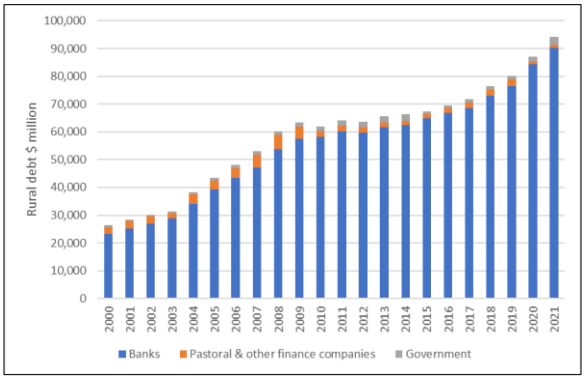

Figure 8. Level of rural debt, 2000 to 2021.

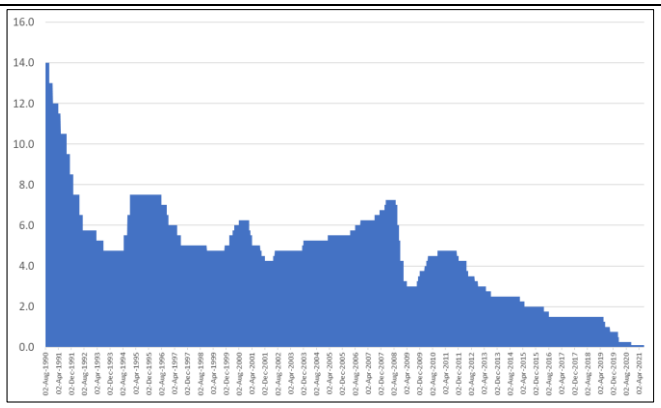

Figure 9. Interest rates 1990- 2021[18]

Several factors have contributed to this; deregulation of the financial markets in the 1980's and 1990's removing an inefficient impediment to borrowing and improved access to debt to credit worthy households[17] The extended period of low interest rates since 2008 (Figure 9) have also facilitated the capacity for increased borrowings supported by increasing land values shown in Figure 10.

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[16] Zammit, K & Howden, M. (2020). *Farmers' terms of trade: update to farm costs and prices paid*, ABARES research report, Canberra Retrieved 19-04-2022, https://www.awe.gov.au/abares/research-topics/agricultural-forecasting/farmers-terms-of-trade

[17] Kearns, J., Major. M., and Norman, D. (2020). How risky is Australian Household Debt? Reserve Bank of Australia

[18] Reserve Bank Australia, https://www.rba.gov.au/statistics/tables/xls/d09hist.xls

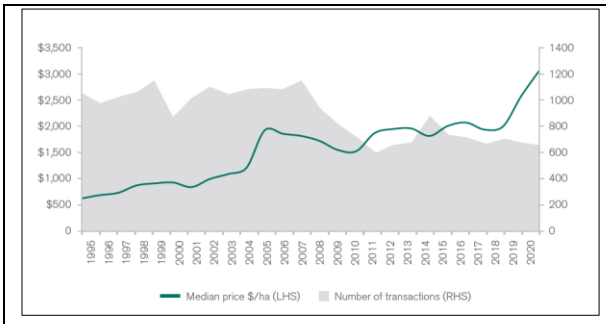

Figure 10. Trend in land values (1995 to 2020) and number of transactions in WA[19]

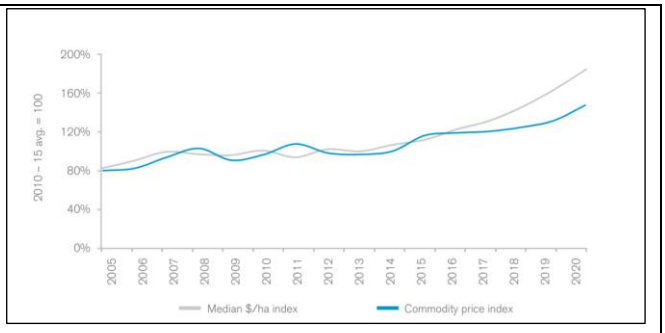

Figure 11. Commodity price index and median land values

Land values in WA gradually increased from 1990 to 2004, there was a surge in values with a rapid increase until 2008. From 2011 onward land prices started increasing again and in the last three years rapidly, due to a combination of low interest rates, strong commodity prices and confidence in the industry. Notably, as transactions decrease (Figure 10) prices have increased. A supply and demand response and a shift away from a close correlation between land values and commodity prices, Figure 11.

The commodity price index for Western Australia, is weighted based on the gross value of agricultural production (GVP) for each commodity is compared to the median price for land ($ per hectare).[19]

Historically, there is a strong correlation between commodity price and farmland values in Western Australia. However, a divergence in the relationship between commodity price and farmland values became apparent in 2019, widening significantly in 2020, driven by declining interest rates and historically low transaction volume.[9] When coupled with two excellent seasons it has provided farmers with capital to invest. Unlike other parts of the economy COVID-19 has (with some exceptions) not dented agricultural returns or confidence.

For those already in the market, increased land value provides strong balance sheets, equity, and further opportunities to invest. When you add in record low interest rates, you have a powerful mix, underpinned by the FOMO effect (fear of missing out).[9]

2.1 Rural and regional economies

The three main pillars of the rural and regional economy in WA are agriculture, forestry and fishing, mining, and tourism. Construction and manufacturing also contribute as major sectors for regional centres.

In 2019-20 the agriculture, forestry and fishing industry in Australia contributed 2.0% to total GDP, a total value of $37.68 billion. Mining was $206.8 billion, manufacturing $113.5 billion and services $1,336.3 billion.

Agriculture, forestry and fishing employ 2.6% of the workforce, more than the mining sector (1.9%) and many who work in the agriculture, forestry and fishing industry reside in the rural and regional areas contributing to the rural and regional economies.[20]

[19] Rural Bank. (2022). Australian Farmland Values 2021
[20] DFAT, (2020) Trade and Investment at a Glance 2020.

Western Australia's gross state product (GSP) was $361.8 billion in 2020-21, 17.5% of Australia's gross domestic product (GDP).

Rural and regional communities contributed $161.8 billion to the economy (2018-19)[7]. Wheat, barley, oilseeds, wool, meat, live animals and animal feeds are part of the top merchandise exports with iron-ore, gold and other precious metals, Figure 12.

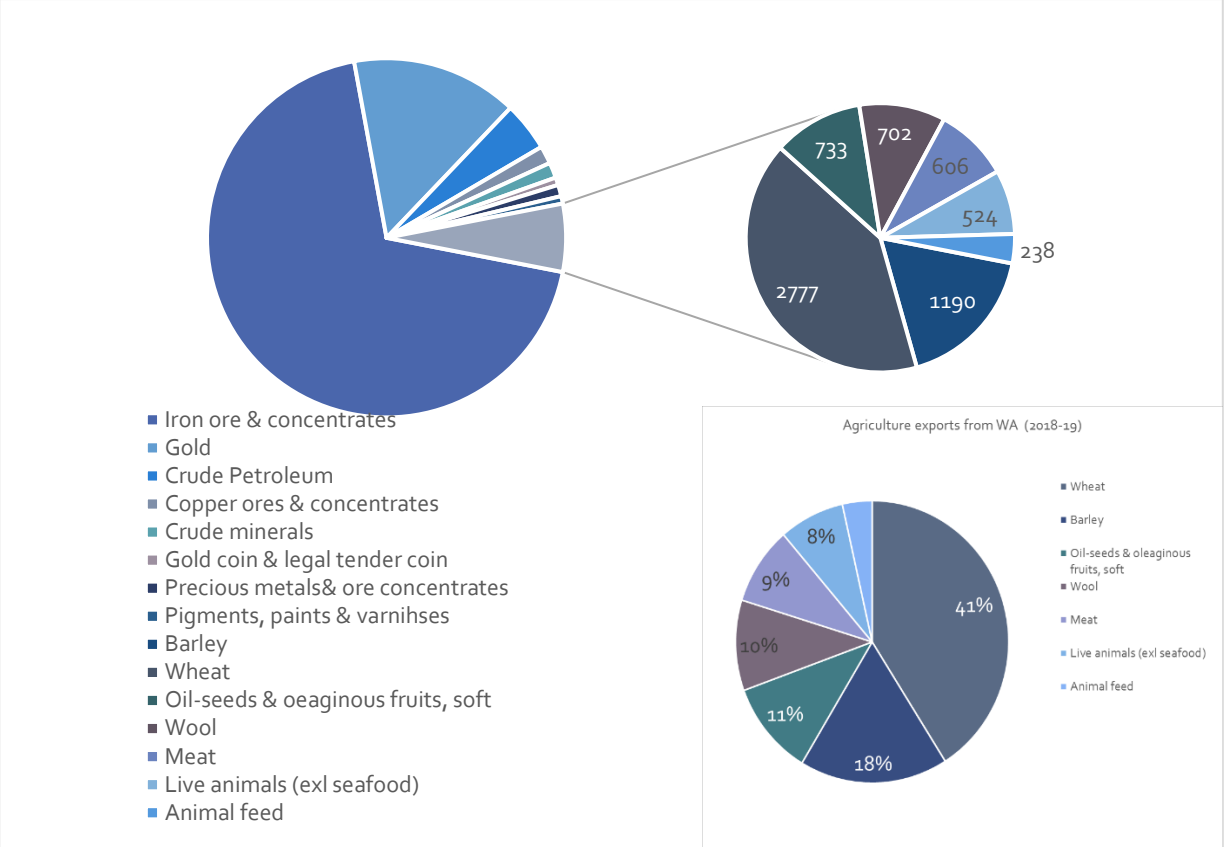

Figure 12. WA exports, 2018-19 A$ Million[21]

Wheat is the dominant broadacre crop grown and much of the agriculture area is known as the wheatbelt. The grains industry is a major contributor to the agri-food sector, producing 14 million tonnes of grain per year on average. [22] However, this varies from year to year and in 2021 more than 20 million tonnes were received by the Co-operative bulk handler (CBH).

In 2018-19 the broadacre grains industry generated $6.7 billion for the WA economy, 41% of the national value for broadacre crops (ABS, 2020). Wheat contributes 44% of the total value of crops (including horticulture) and 50% to the broadacre crops in WA, 80-90% of all annual grain production is exported to over 50 countries. [22]

The sheep industry is the second largest agriculture industry in value for WA after the wheat industry. Although sheep meat (lamb and mutton) value ($547 million) is less than beef at $828 million, the combined wool and sheep meat industries are valued at $1.5 billion, Figure 12.

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[21] DFAT, (2020). Australia's Trade by State and Territory 2018-19. https://www.dfat.gov.au/sites/default/files/australia-state-territory-2018-19.pdf

[22] DPIRD. (2018). Western Australian grains industry. https://www.agric.wa.gov.au/grains-research-development/western-australian-grains-industry

2.2 Farming systems in Western Australia

Southwest WA has a Mediterranean-type climate characterised by long, hot dry summers and cool, wet winters. Seventy-five per cent of annual rainfall occurs during the winter months, between April and October. Significant rainfall can occur in the summer months from high intensity thunderstorms or rain-bearing depressions associated with tropical cyclones.

Land use and farming systems in WA respond to the varying climatic and geographic conditions. This means most of the agricultural land mass (excluding the rangelands) is used for extensive cropping and livestock grazing activities, defined as broadacre agriculture. This region is rain-fed.[23] The Australian Bureau of Agriculture and Resource Economics and Sciences (ABARES) divide the broadacre region into three main climatic zones: High-rainfall, Wheat-sheep, and Pastoral zones, Figure 13.

The main agricultural area of WA comprises the high-rainfall and wheat-sheep zones.

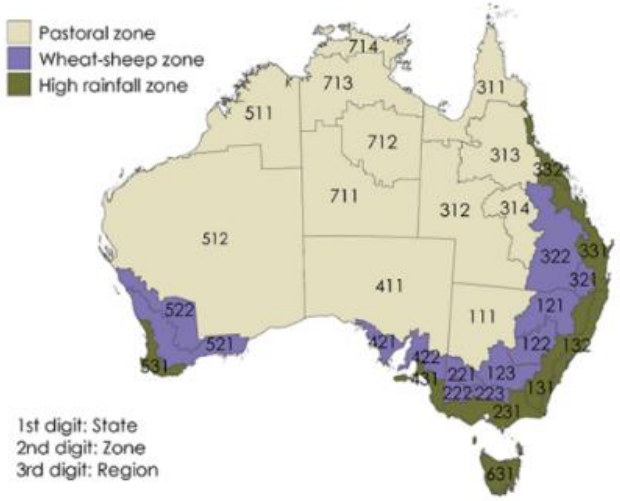


Figure 13. ABARES regions for Australia

Several of the LGA's are in more than one rainfall area, for example, Northampton shire includes high, medium, and low rainfall areas where the annual rainfall is highest immediately inland from the coast and it reaches 500 mm per year but declines rapidly with increasing distance inland to less than 300 mm east of Mullewa on the fringes of the agriculture areas.[24]

Mixed farming enterprises are typical. In the last 30 years the area of cropping on most farms increased and the area of crops grown in WA has increased. The average crop percentage in the medium rainfall is 75% and trending higher in the low rainfall areas (ABS, 2015-16).[25] Sheep numbers declined since the peak in the late 80's mostly due to the low profitability of the sheep enterprise after the collapse of the wool

[23] Salim, R.A. and Islam, N. (2010). Exploring the impact of R&D and climate change on agricultural productivity growth: the case of Western Australia, *Australian Journal of Agriculture Economics* 54, 561-582.

[24] Natural Resources Assessment Group, Agriculture Western Australia, and Landcare Western Australia. (1997) Soil information sheets for the northern agricultural areas. Department of Primary Industries and Regional Development, Western Australia, Perth. Report 13/97.

[25] MLA. (2018). Profitable integration of cropping and livestock management guideline. Rural Directions PTY LTD, Farmanco Management Consultants.

price in the early 1990's concomitant with significant productivity improvements in cropping from implementing new technology.[25] In the last ten years, the area of crop grown averaged 8.2 million hectares with low variance, the highest amount was 8.6 million in 2016 and lowest in 2015-16 was 7.8 million hectares, Figure 14.

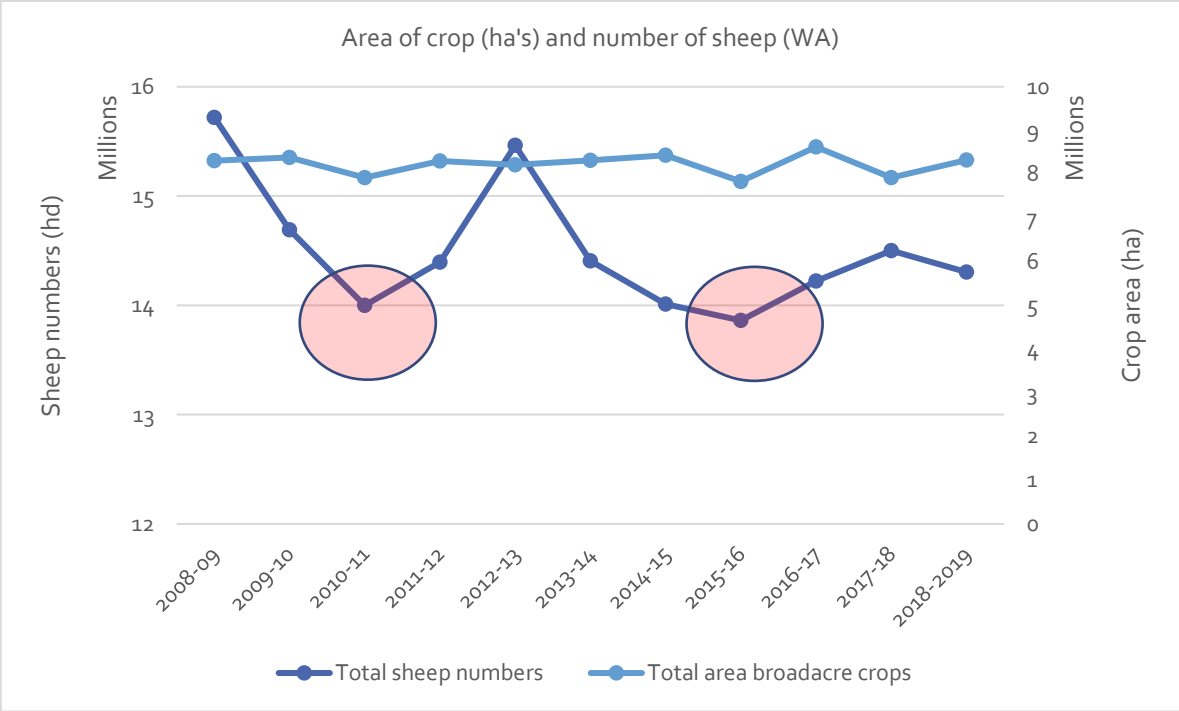


Figure 14. Crop area (hectare) and livestock numbers (head) 2008- 2020

The variation in sheep numbers is more significant, often a function of seasonal conditions and market value. The two years highlighted in Figure 14 with red circles are where numbers decreased significantly due to the impact of drought and where large numbers of sheep were sold interstate.

The balance of land use in broadacre farming between livestock and cropping is unlikely to alter radically for the foreseeable future, however prices and seasonal conditions are factors that have a high degree of variability and are factors which farmers must constantly respond.

2.3 Climate trends

Analysis of climate data for the southwest WA exposes six key messages relevant to the sustainable and profitable management of our agricultural land:

- Mean temperatures are rising.
- Annual rainfall is declining.
- Autumn and winter rainfall is declining.
- Spring and summer rainfall is increasing.
- Predictions indicate that these trends will continue.
- In the short term, year-to-year climate variability may be more important than the longer-term trends.

In the last twenty years, four significantly dry years stand out, these are 2002, 2006, 2010 and 2019 (Figure 15). They are widely recognised as drought years in Western Australia, where dry conditions were experienced by most regions across the State Dry conditions were also experienced by more localised

regional locations in other years, for example the NAR experienced dry conditions in 2007 after 2006 which had a severe accumulative effect the same as 2018 and 2019 in the Great Southern Region where dry conditions prevailed for two years. This accumulative effect meant these dry years were even more severe for these regions.

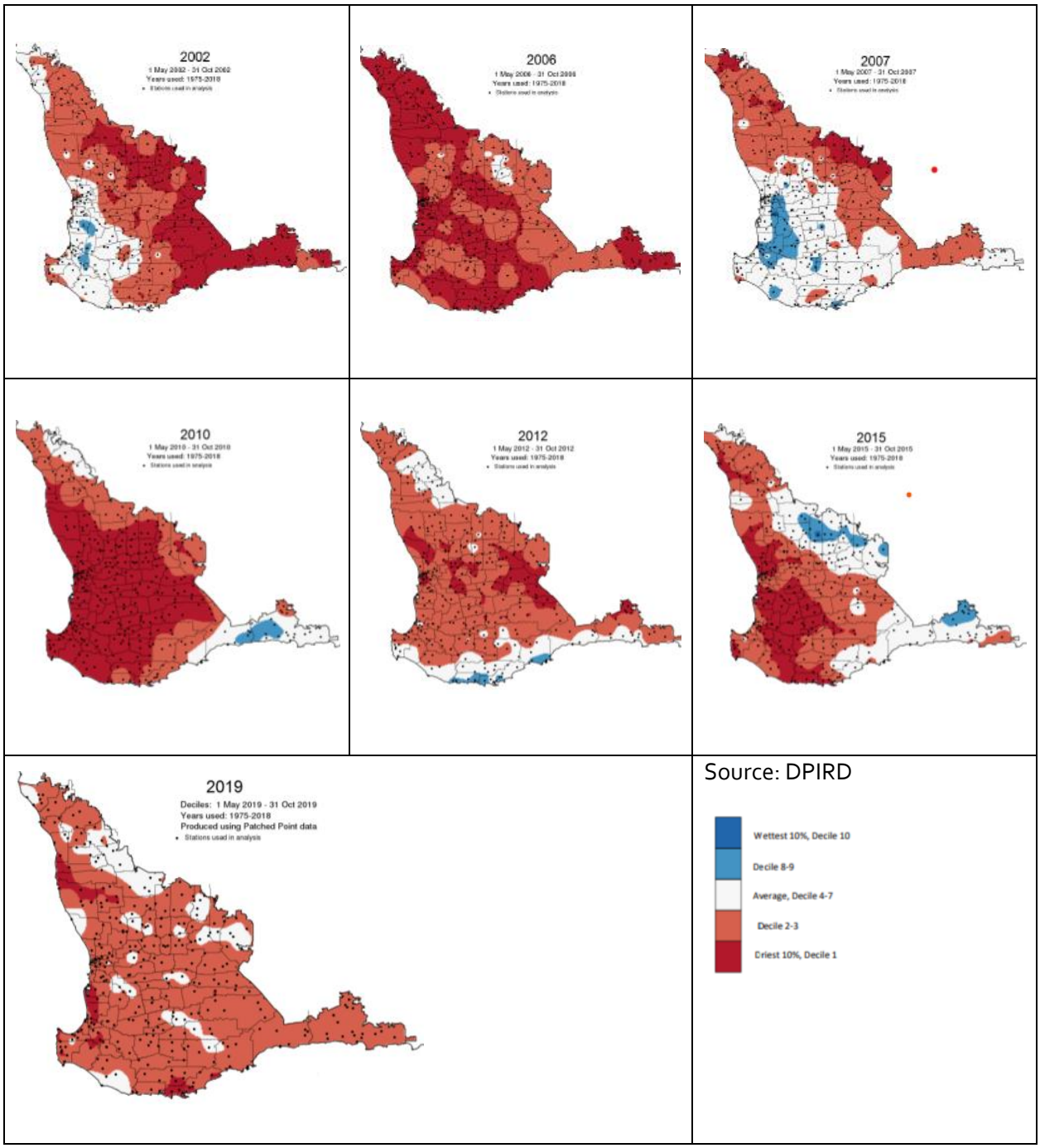
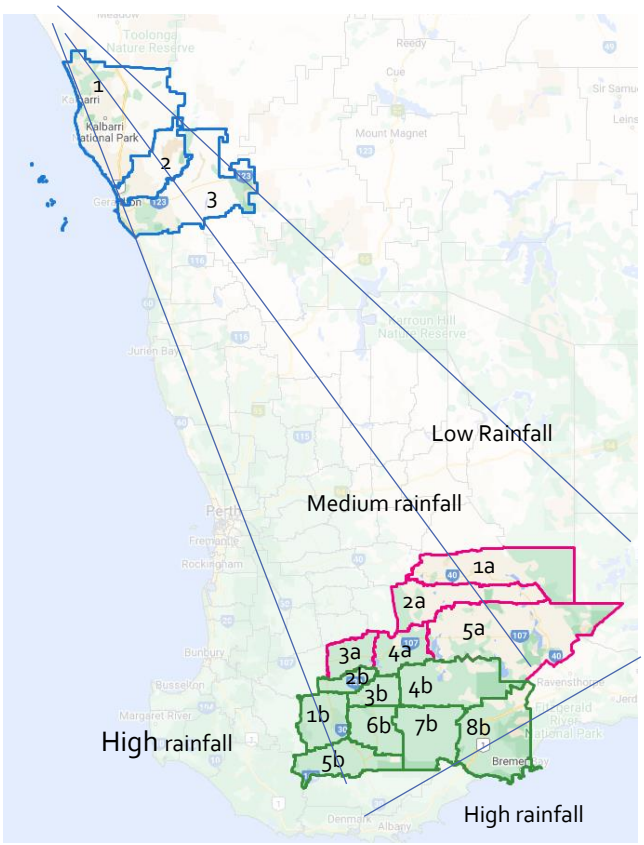


Figure 15. Selected rainfall decile maps between 2002 and 2020

2.4 Characteristics of the Local Government Areas in the pilot regions

The local government areas in the pilot region for the regional drought resilience planning are in different rainfall regions, Figure 16.



Northern Agricultural Region (NAR)

1. Northampton
2. Chapman Valley
3. City of Greater Geraldton

The Southern Wheatbelt

1a. Kondinin
2a Kulin
3a Wagin
4a Dumbleyung
5a Lake Grace

Great Sothern inland

1b. Kojonup
2b. Woodanilling
3b. Katanning
4b. Kent
5b. Cranbrook
6b. Broomehill Tambellup
7b. Gnowangerup
8b. Jerramungup

Figure 16. Map showing location of pilot region shires, NAR, CAR and Great Southern

The agriculture land division for southwest WA (Figure 16) produces more than 95% of the State's Gross Value of Agriculture Product (GVAP) and the rest is produced in the pastoral zone.[23]

The gross value of agriculture production for the Local Government Areas (LGA) in the pilot regions in Figure 17 shows the percentage value of Gross Value of Agriculture Production (GVAP) for each of the shires in the pilot regions in 2015-16, listed in ascending order of a value. Lake Grace and Northampton are the two largest contributors at 3%, the others are at 2 or 1%.

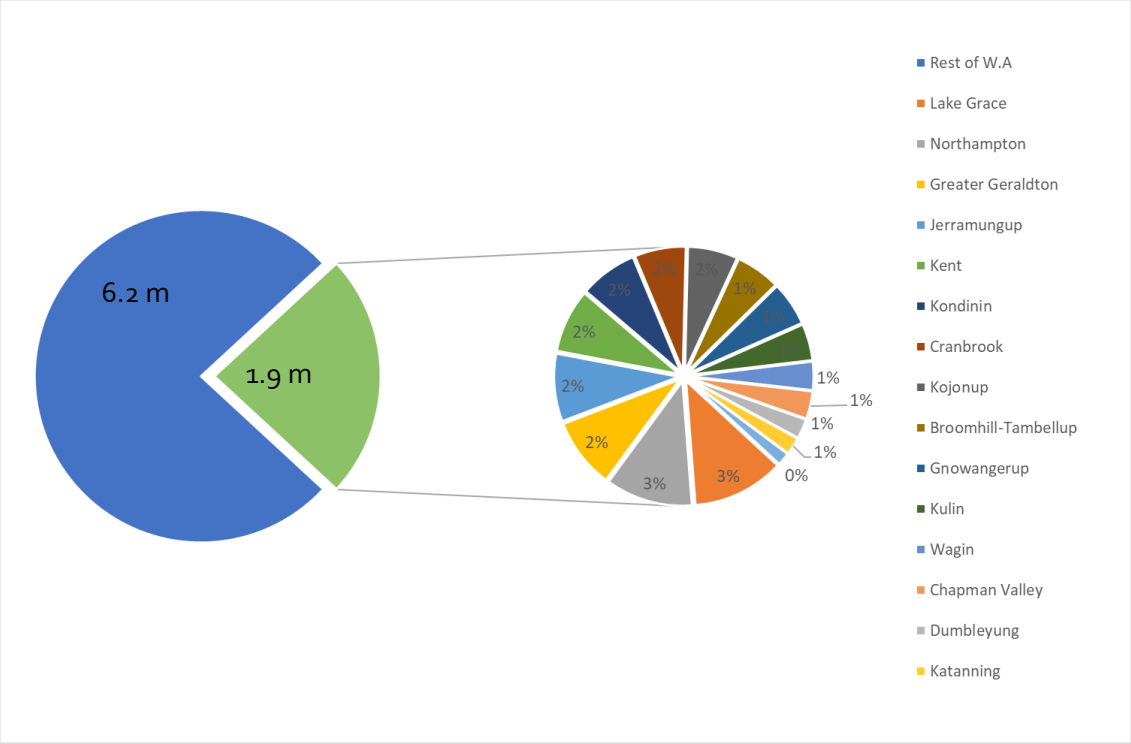


Figure 17. GVAP for W.A and LGA's in pilot regions, 2015-16.

2.5 Business type and turnover

Finding relevant and up-to-date data which represents the LGA regions selected for the pilot study is challenging. Many possible data sources like the ABARES farm survey data or ABS agriculture statistics are amalgamated into larger geographical areas and were not suited to this study.

By using ABS business counts data, the types of businesses which exist in LGA's including their size based on turnover can be identified.[26] This information provides an insight into the LGA, the dominant sector, the level of diversity and size of businesses, which also provides an insight into their potential vulnerability to drought.

The data presented is for financial year ending June 2021, which captures 2020-21 production. It is extracted from the Australian Bureau of Statistics Business Register (ABSBR), which is populated using administrative data from ABN registrations recorded in the Australian Business Register (ABR), and business data from the Australian Tax Office (ATO).

There are two significant observations that can be made from this data that informs us about the region's vulnerability to drought.

1. The high number of Agriculture, forestry and fishing businesses show a high level of reliance on Agriculture in the regions and the selected LGA's.
2. Understanding the number of businesses by turnover helps us to understand the size of the businesses in the selected pilot LGA and therefore the type of resources that might be required based on their profile.

[26]https://www.abs.gov.au/statistics/economy/business-indicators/counts-australian-businesses-including-entries-and-exits/latest-release#data-download

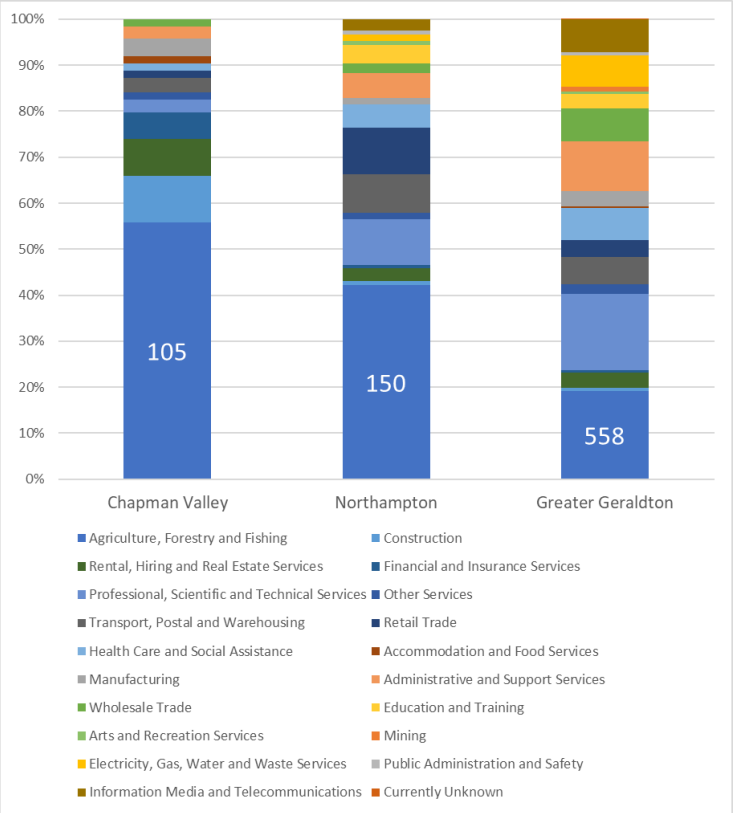
For example, generally farm businesses require a turnover (gross farm income) above $600,000 to be viable and preferably nearer $1 million to support one family[27]. This depends on several factors; the level of debt, the level of personal expenses required for education fees and or the need to support intergenerational family members and the growth stage of the business. Off-farm income may provide additional income, but all these factors influence the required turnover and viability of a business.

Planfarm's assessment on farm business vulnerability to drought provides a guide, where a matrix of ratios is used to rank farms performance. Farm businesses with less than $500,000 gross farm income (GFI) were given a value of 1, between $1.5 million and 1.75 million it was 5 and >$3 million a score of 10. As gross farm income increased, they were considered to have less vulnerability to drought.

Operating surplus pays for personal expenses, interest on debt, tax, loan repayments, machinery repayments and capital expansion and purchase of off-farm assets.

2.5.1 Northern Agricultural Region

In the Northern Agriculture Region (NAR), the Greater Geraldton LGA has a higher level of diversity compared to Chapman Valley and Northampton. As expected for a major regional centre. There are 558 agriculture, forestry and fishing businesses in the Greater Geraldton region with 240 that have a turnover less than $200,000, Figure 18 and Figure 19. A proportion of these can be small hobby-type businesses also accessing off-farm income.



There are 240 agriculture, forestry and fishing businesses with a turnover less than $200,000.

There are three businesses in Greater Geraldton with turnover greater than $10 million

The 12 agriculture, forestry and fishing businesses with turnover greater than $5 million are situated in Greater Geraldton (6), Chapman Valley (3) and Northampton (3).

Figure 18. Number and type of businesses in the selected LGA's for the NAR

[27] Planfarm. (2022). Drought Vulnerability Report.

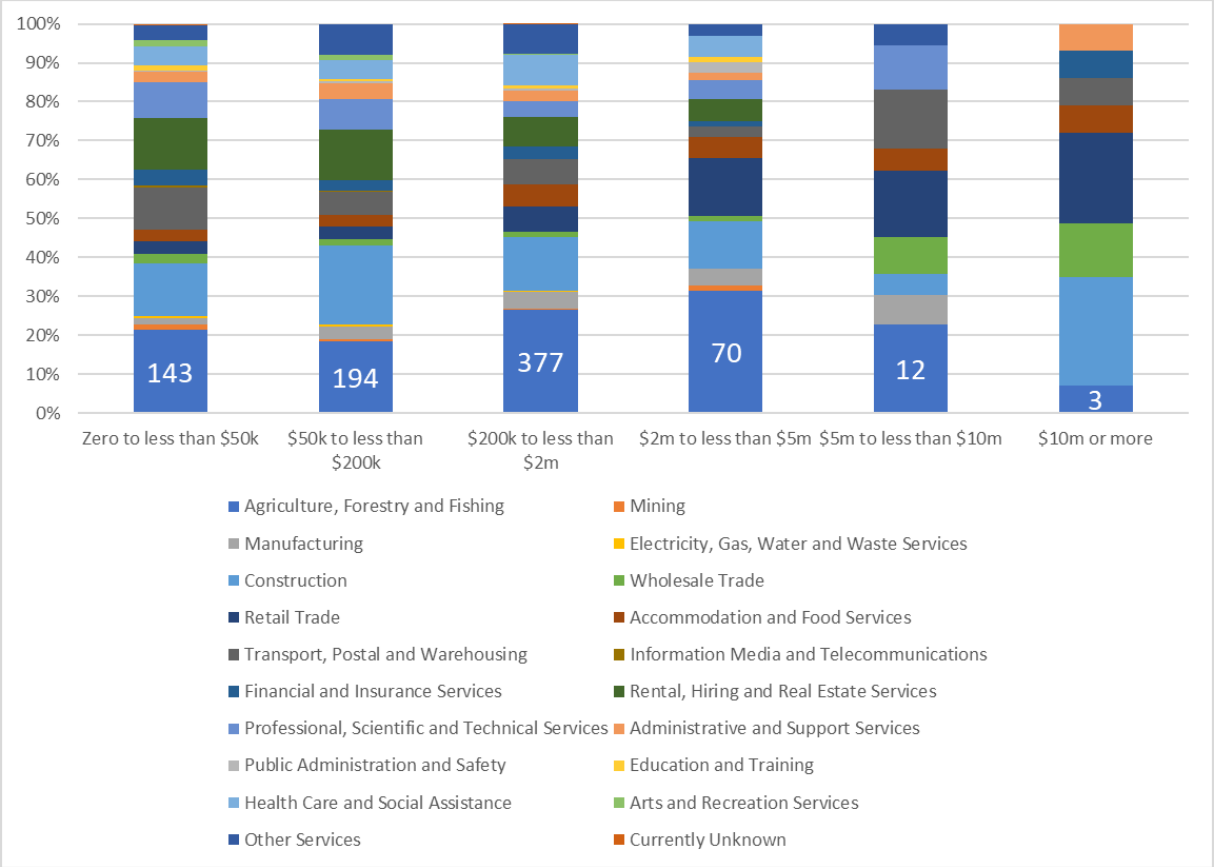


Figure 19. Number and type of business by turnover in the selected LGA's for the NAR[28]

Gross value of agriculture production (GVAP) data assists to understand the level of contribution made by each enterprise or sector; Table 2 outlines the GVAP for the three pilot LGA's in the northern agriculture region. The data is organised in ascending order of value, showing how wheat, canola and lupins dominate the broadacre farming system in this region. Vegetables for human consumption are also produced.

Table 1. Gross Value of Agriculture production for Northern Agriculture Region pilot shires, 2015-16

	Greater Geraldton	Northampton	Chapman valley
Total GVAP ($)	**177,400,000**	**219,442,000**	**61,820,000**
Wheat	99,401,071	124,306,132	39,081,794
Canola	20,504,867	25,951,672	8,140,719
Lupins	17,921,731	22,764,852	7,194,299
Vegetables for human consumption	12,563,464	14,176,750	4,878,227
Capsicum	5,239		8,289
Melons	40,932	52,805	16,391
Pumpkins	34,292	44,239	13,732

[28] Appendix 1 shows the details for each LGA

Sweet corn	160,947	207,634	64,452
All other	11,495,479	13,872,072	4,775,363
Livestock products - wool, milk & eggs	10,893,362	12,228,629	
Livestock slaughtered - Sheep and lambs	9,821,007	12,222,554	
Barley	2,967,105	3,765,774	1,245,002
Hay	1,793,447	2,135,808	680,051
Other Pulses	587,215	757,551	235,154
Oats	444,116	485,110	164,384
Nurseries, cut flowers or cultivated turf	209,991	270,904	84,092
Other broadacre crops	164,017	211,594	65,682
Fruit and nuts - Grapes	49,305	63,608	19,745
Chickpeas	31,842	41,078	12,751
All other cereals	24,407	31,487	9,774
Other Oilseeds	17,047	21,992	6,827
Triticale	4,946	6,381	1,981

2.5.2 Central Agriculture region

In the Central Agriculture Region (CAR) there are 160 agriculture, forestry and fishing businesses with turnovers less than $200,000, Figure 20. The CAR have the largest percentage (18.4%) of agriculture, forestry and fishing businesses with a turnover in the range between $2million and $5 million.

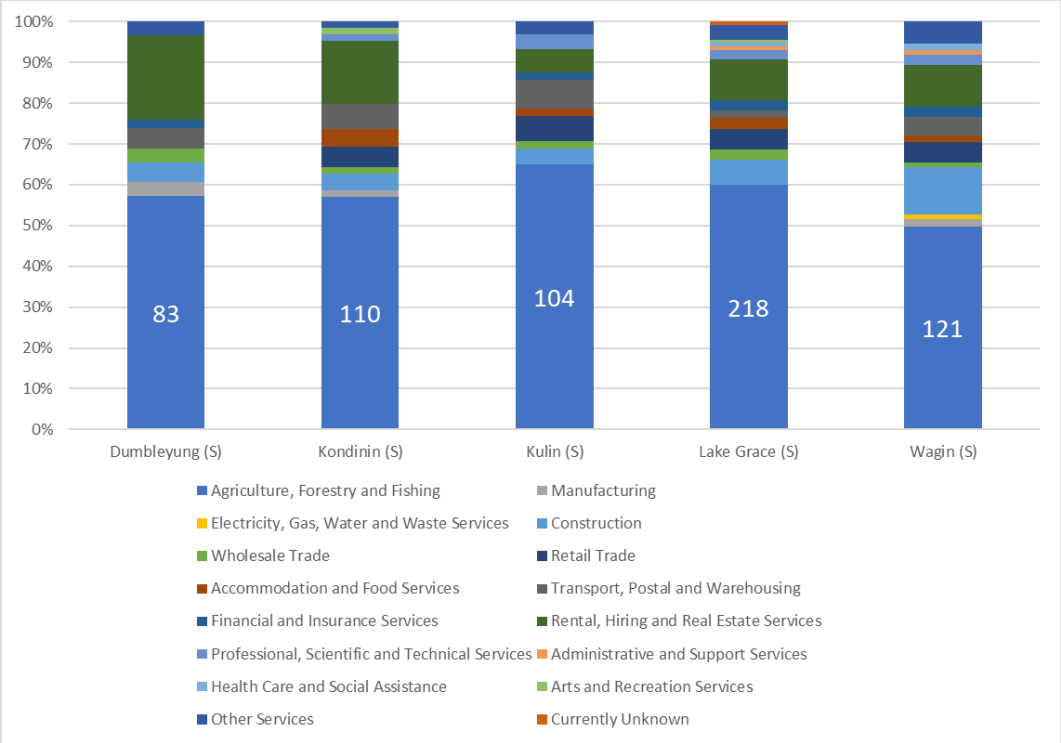


Figure 20. The number and type of businesses in the selected pilot LGS for the CAR

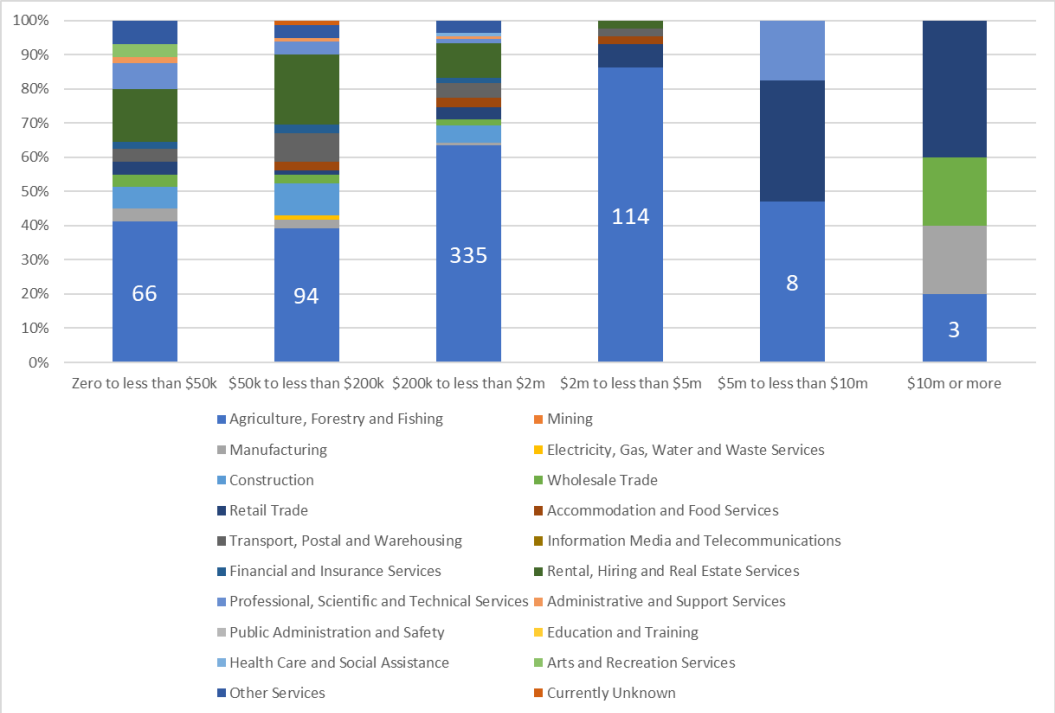


Figure 21. The number and type of businesses by turnover for selected LGA's in CAR

Table 2. GVAP for central agriculture regions LGA's

	Lake Grace	Kondinin	Kulin	Dumbleyung
Total GVAP ($)	**231,859,800**	**145,397,500**	**92,113,800**	**49,557,300**
Wheat	88,802,437	55,806,736	35,279,624	18,980,474
Barley	50,700,491	31,729,997	20,142,400	10,836,632
Livestock products – wool & eggs	27,229,281	17,059,105	10,817,707	5,819,938
Livestock slaughtered	25,170,182	15,764,970	9,999,664	5,379,830
Canola	18,777,548	11,764,217	7,459,985	4,013,480
Oats	9,757,067	6,102,349	3,876,309	2,085,458
Lupins	4,827,280	3,022,081	1,917,792	1,031,774
Hay - Total	4,464,020	2,798,454	1,773,475	954,132
Other pulses	1,609,023	1,005,871	639,236	343,910
All other	233,854	145,958	92,906	49,984
Triticale	118,181	74,745	46,951	25,260
Nurseries	108,074	67,454	42,936	23,100
Faba beans	38,216	23,852	15,183	8,168
All other cereals	19,137	17,705	7,603	4,090
Vegetables for human consumption	2,508	11,944	997	536
Fruit and nuts - Grapes	2,503	1,562	994	535
Chickpeas		454		

Table 3. GVAP for Wagin

	Wagin
Total GVAP ($)	**71,804,500**
Livestock slaughtered	19,660,876
Livestock products, wool & eggs	15,391,580
Oats	9,351,573
Barley	7,243,121
Wheat	7,190,153

In Table 2 the GVAP for the central agriculture region is ranked by the highest value

Wheat and barley rank first.

In Table 3 livestock slaughtered, and livestock products are ranked higher in value than wheat which is ranked 6th showing how important livestock is for Wagin.

Canola	6,780,499
Hay - Total	4,630,184
Fruit and nuts	901,918
Lupins	518,097
All other	41,928
Triticale	30,575
Lentils	29,032
Nurseries	20,653
Vegetables	11,913
All other cereals	2,224
Other pulses	128

2.5.3 Great Southern region

There are 1,124 agriculture, forestry and fishing businesses in the Great Southern LGA pilot region, Figure 22. No mining businesses or public administration and safety businesses exist. Rental, hiring and real estate businesses are more frequent than other businesses besides agriculture and most of them have a turnover less than$2 million and 61% less than $200,000. It seems likely that many of these are individual investors with rental properties not necessarily within the regional location.

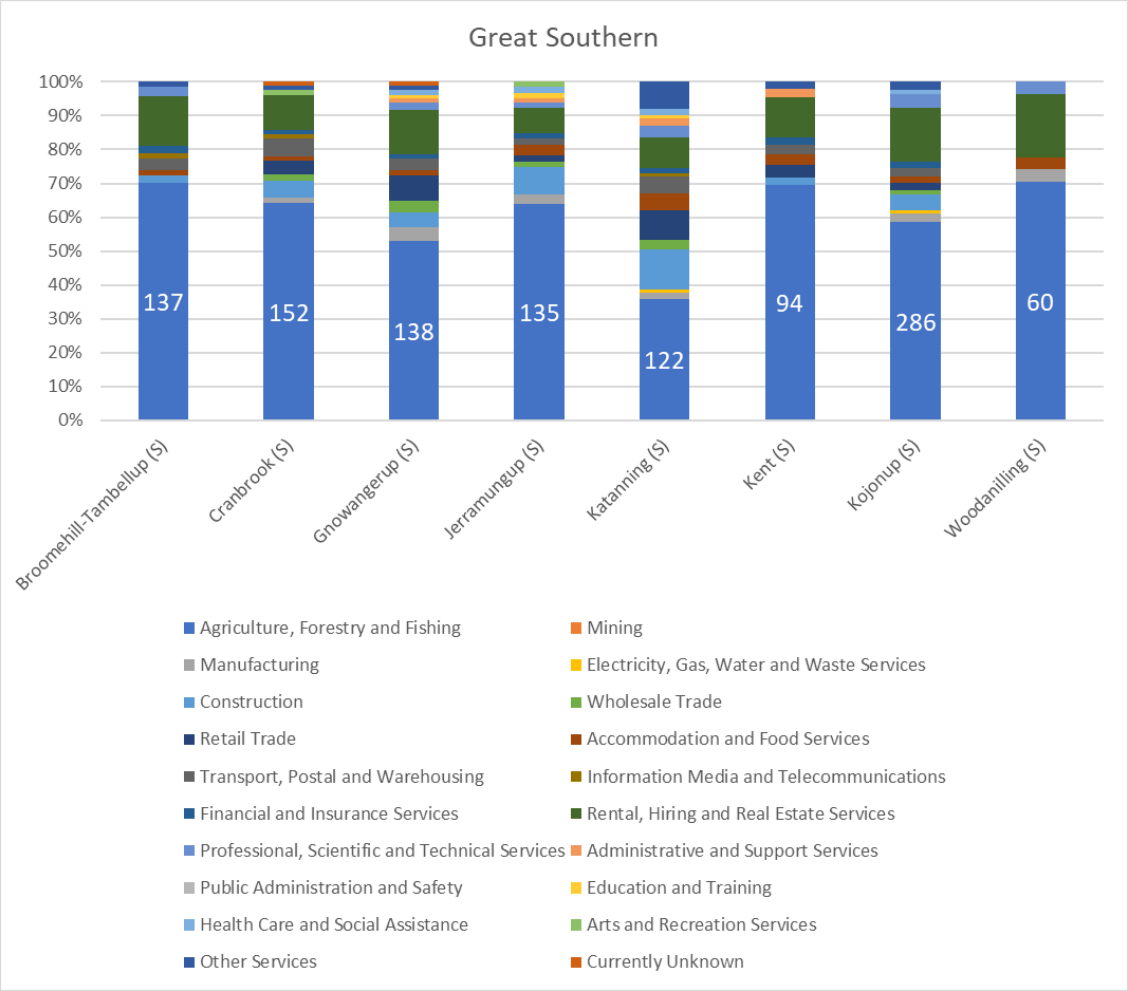


Figure 22. Total number of businesses by type for the selected pilot LGA's for the Great Southern

Katanning has a higher level of diversity in comparison to the other LGA's with a higher number of businesses besides agriculture, Figure 22. This is understandable given Katanning is a regional centre that services the surrounding areas.

There are some large and significant businesses located in its town including an abattoir, WA Meat Marketing Cooperative (WAMMCO), several machinery dealers like Macintosh & Son with the largest parts warehouse in Australia. There are 6 agriculture, forestry and fishing businesses with a turnover greater than $10 million. Oher business sectors with turnovers greater than $10 million include Manufacturing (6), Construction (3), Wholesale trade (3) Retail trade (6).

Kojonup has the greatest number of businesses (108) in the agriculture, forestry and fishing businesses with a turnover less than $200,000. They are likely to be agriculture businesses and most likely farms or contract servicing businesses. The other LGA's with agriculture businesses with a turnover less than $200,000 are Cranbrook 56, Gnowangerup 54, Broomehill-Tambellup 36, Jerramungup 41, Katanning 51, Woodanilling 45, and Kent 24. Figure 23 summarises the data for the Great Southern and the details for each LGA is in Appendix 1.

Three agriculture businesses with turnover more than $10 million are situated in Gnowangerup and three are in Kojonup. The 23 agriculture businesses with a turnover greater than $5million are situated in Gnowangerup (5), Kent (5), Jerramungup (3), Kojonup (4), Woodanilling (3), and Cranbrook (3).

There are 190 businesses in total with a turnover of between $200,000 and $2million.

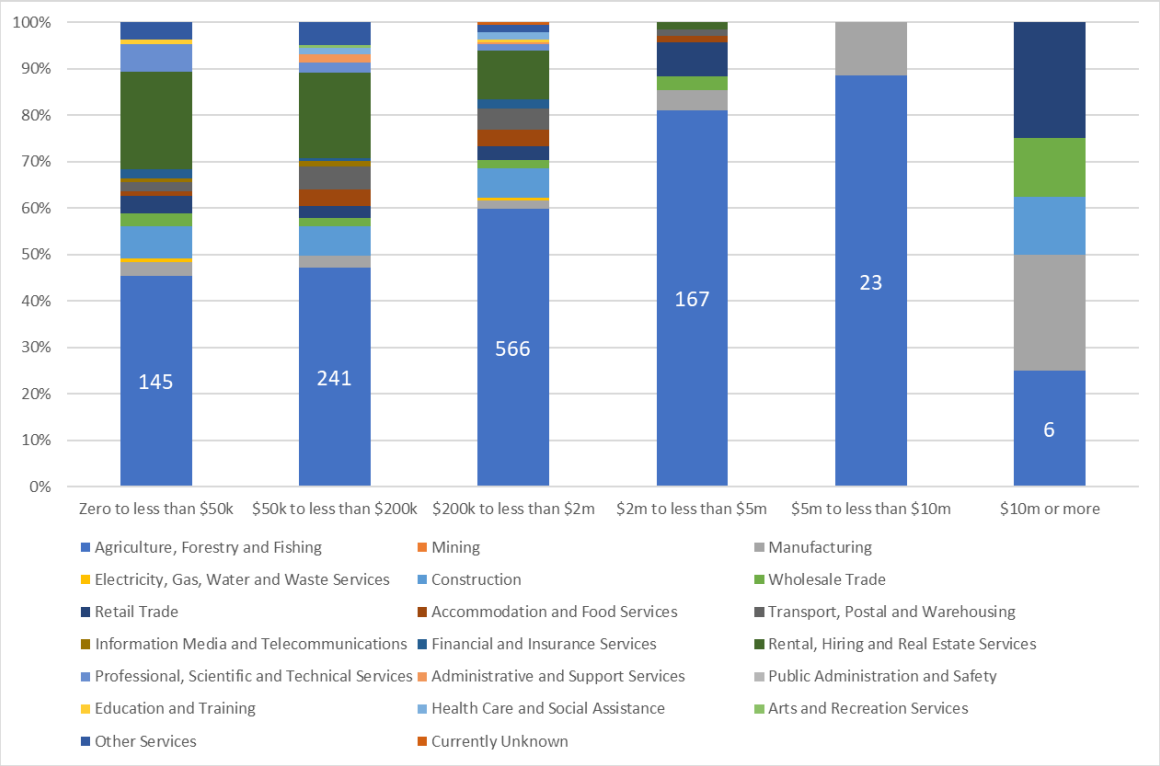


Figure 23. Total number of businesses by turnover in the selected pilot LGA's for Great Southern

Table 4 presents the Gross Value of Agriculture Production for Jerramungup, Kent and Gnowangerup. Wheat is the highest value product with Barley and Canola also dominating the farming system. Generally, for these LGA's they have mixed farming systems with livestock products, mostly wool and animal sales. Sheep and lamb sales are the dominant product but there are some cattle and calves in these regions too.

Table 4. GVAP for Jerramungup, Kent and Gnowangerup

	Jerramungup	Kent	Gnowangerup
Total GVAP ($)	**171,053,626**	**160,709,792**	**111,267,952**
Wheat	60,605,294	56,300,725	39,038,087
Barley	35,994,526	33,680,445	23,353,520
Canola	26,150,515	23,693,450	16,428,687
Livestock slaughtered - Total	18,624,153	18,425,903	12,776,247
Livestock products – wool & eggs	18,615,515	17,923,705	12,428,031
Oats	3,841,684	3,828,710	2,654,771
Lupins	3,228,682	3,267,535	2,265,660
Hay - Total	2,482,399	2,399,770	1,663,965
Other pulses	797,377	611,671	424,124

All other broad acre crops	240,433	239,973	562
Chickpeas	227,192	223,665	155,086
Other Oil seeds	72,332		
Faba beans	56,682	35,060	24,310
Triticale	54,980	36,313	25,179
Sorgham	43,338	42,867	29,723
Nurseries	17,720		
Lentils	804		

Table 5 shows the GVAP for the shires where livestock slaughtering's and products are the dominant product. They also have strong cropping component when the total GVAP for crops is calculated and compared to the total livestock slaughtering's and products.

Table 5. GVAP for Kojonup, Cranbrook, Woodanilling, Katanning and Broomehill-Tambellup

	Cranbrook	Kojonup	Broomehill-Tambellup	Katanning	Woodanilling
Total GVAP ($)	**129,715,000**	**126,147,500**	**112,331,200**	**44,032,700**	**32,723,300**
Livestock slaughtered	39,320,867	38,239,455	34,051,316	8,447,738	6,278,013
Livestock products wool & eggs	28,180,219	27,405,200	24,403,672	10,220,729	7,595,627
Total livestock GVAP	67,501,086	65,644,655	58,454,987	18,668,467	13,873,640

	Cranbrook	Kojonup	Broomehill-Tambellup	Katanning	Woodanilling
Wheat	17,911,388	17,418,785	15,511,009	9,134,064	6,788,062
Canola	16,636,086	16,178,556	14,406,615	6,740,031	5,008,915
Barley	14,015,754	13,630,289	12,137,445	5,016,744	3,728,239
Oats	6,955,399	6,764,110	6,023,278	2,590,035	1,924,808
Fruit and nuts - Total	2,785,791	2,709,175	2,412,294		
Hay - Total	2,485,864	2,417,497	2,152,723	1,334,623	991,837
Lupins	767,678	746,565	664,798	527,696	392,162
Other pulses	299,741	291,498	259,572	21,054	15,647
All other	234,781	228,324	203,317		

Faba beans	56,400	54,848	48,841		
Triticale	37,610	36,575	32,569		
Other oilseeds	25,791	25,081	22,334		
Lentils	1,590	1,546	1,377		
All other cereals		19	17		
Total GVAP crops	62,213,871	60,502,870	53,876,190	25,364,249	18,849,670

3 THE ECONOMIC IMPACTS OF DROUGHT

Since systematic weather recording began in the late-19th century, Australia has experienced three prolonged, widespread droughts — the Federation Drought (1895–1903), the drought that coincided with WWII, and the Millennium Drought (2001–09). In between these episodes, there have been shorter, more localised, but often more severe droughts — in the mid-1960s, 1982–83, and the early 1990s.[29] And, more recently, in 2019 which was one of the lowest rainfall years on record for nearly all of Australia.

The largest impacts of drought are economic, with large effects on household income, including experience of financial hardship and deterioration in household financial positions.[30]

Unlike other natural hazards such as floods, cyclones, tornadoes, and earthquakes, which occur over finite periods of time and result in visually obvious damage, drought develops slowly and quietly, lacking highly visible and structural impacts. Emerging drought conditions often go unnoticed until precipitation shortages become sever and impacts begin to occur. The slow pace and long duration of drought typically makes it difficult to quantity the overall economic impacts.[31]

For example, the most recent 2019 drought in New South Wales (NSW), started in the northern parts of the state in 2017 and spread over much of the state in 2018 continuing into 2019.[32] Initially, in 2017, the rainfall anomalies were not extreme, but maximum temperatures across Northern NSW were far above normal and reduced winter rainfall meant severe shortfalls in effective rainfall. By the end of 2019 the state was gripped in one of the worst droughts it had experienced, as were other parts of Australia like southern Queensland, Figure 24.

[29]Eslake, S. (2018). The economic impact of farm drought in rural Australia

[30] Edwards, B., Gray, M., Hunter, B. (2008). Social and economic impacts of drought on farm families and rural communities. Australian Institute of Family Studies. Retrieved 13-04-2022 www.pc.gov.au

[31] Ding, Ya, Hayes, M. J., and Widhalm, M. (2010). "Measuring Economic Impacts of Drought: A Review and Discussion". Papers in Natural Resources. 196. https://digitalcommons.unl.edu/natrespapers/196

[32] Wittwer. G (2020). "Estimating the Regional Economic Impacts of the 2017 to 2019 Drought on NSW and the Rest of Australia," Centre of Policy Studies/IMPACT Centre Working Papers g-297, Victoria University, Centre of Policy Studies/IMPACT Centre.

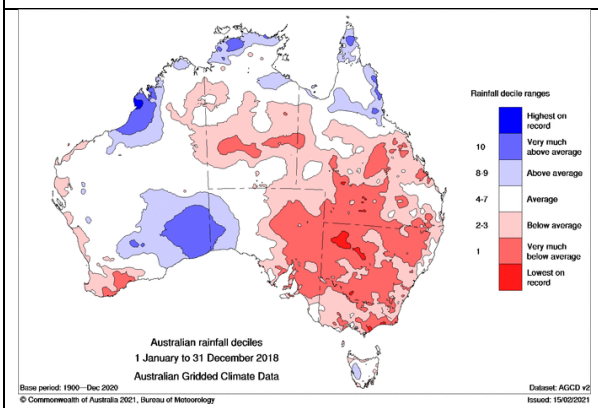
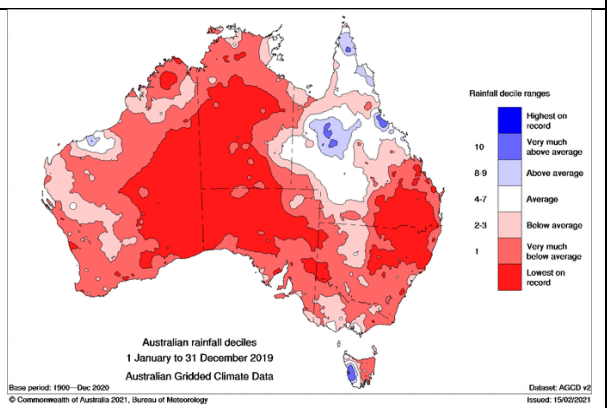
Australian rainfall deciles 2018	Australian rainfall deciles 2019
	

Figure 24. Australian rainfall deciles 2018 and 2019

From the national perspective, there were substantial impacts on national productivity. It was sufficient to force real GDP to more than 1.0% below base in 2018-19 and 2019-20. The marginal contribution of drought to national real wages growth was as much as minus 1%.[32]

Modelling results indicate that NSW real GDP decreased relative to forecast by 0.7% or $2.6 billion in 2017-18, and more than 1.3% or $5.5 billion in 2018-19 and 2019-20. These impacts reflect a severe contraction of farm output, given that agriculture accounts for around 1.6% and downstream processing for around 3.5% of NSW's income. NSW job losses due to drought were around 0.55% or 17,500 FTE jobs in 2017-18 and more than 1.0% or 34,000 jobs in 2018-19. The state-wide jobs outcome in 2019-20 was slightly better due to real wages falling further relative to base.[32]

Managing for climate variability is not new for agriculture production. Droughts, floods, frosts, severe wind events and rain at harvest can all have the potential to cause significant losses on both a localised and broad scale. At times the continuation of severe climatic events like drought have contributed to the failure of farm businesses.[34]

Edwards et al (2008) reported that drought had the most negative impact on farmers compared to others living in the rural and regional areas.[30] In their study on the social and economic impacts of drought on rural and regional families they also found evidence that drought has a negative impact on farm workers and on people who were employed in rural areas but not in agriculture, "one would expect that drought is associated with the reduced employment opportunities historically associated with depressed regional economies". But the impact of drought on overall employment rates was found to be small when farmers were included, because they are not likely to lose their jobs, unless they are forced to sell their properties.

When farmers were excluded from the same analysis there was a statistically significant impact of drought on the employment rate, which was 4 or 5 percentage points lower in drought-affected areas than in above-average rainfall areas.

Businesses involved in Australian agriculture experience more than twice the level of volatility on average compared to businesses in other sectors of the Australian economy, and Australian farm business managers operate in a more volatile business environment compared to virtually all other national

agriculture sectors world-wide.[33] It is widely accepted they face a wide range of risks, and they are particularly exposed to variability in seasonal conditions and commodity prices.[34]

The most obvious economic impact of drought is on the volume of agriculture production, particularly crops, which typically fall sharply during a drought.[4] Figure 25 illustrates how WA wheat production fluctuates between years from 2002 to 2021 showing significant impacts on wheat production in the drought years of 2002, 2006, 2010 and 2019 (see Figure 15).

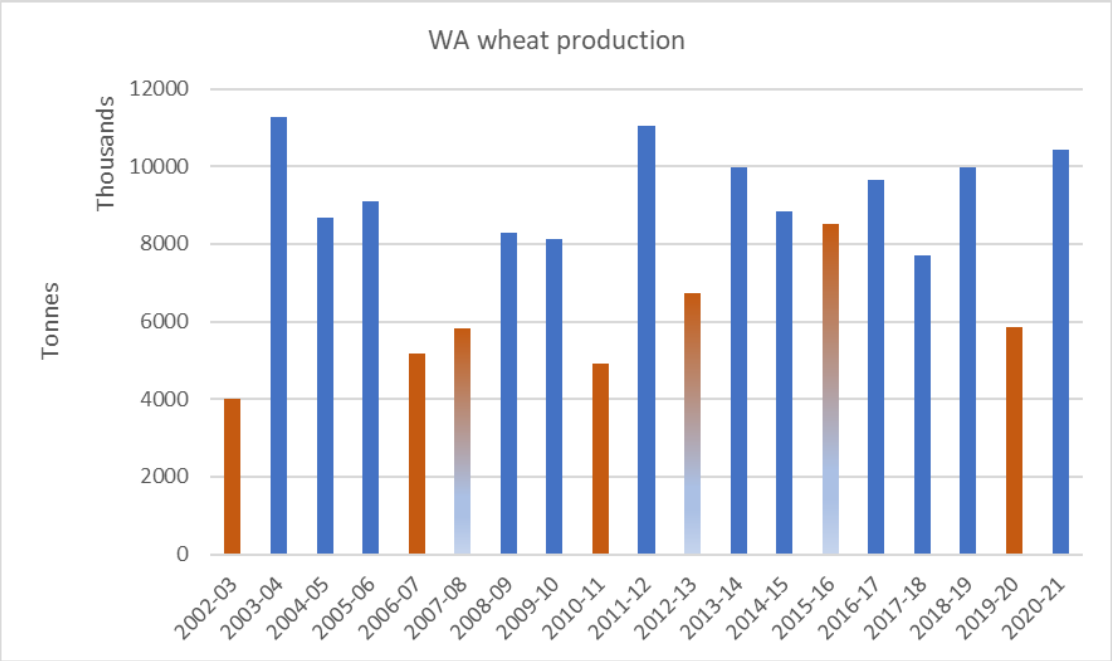
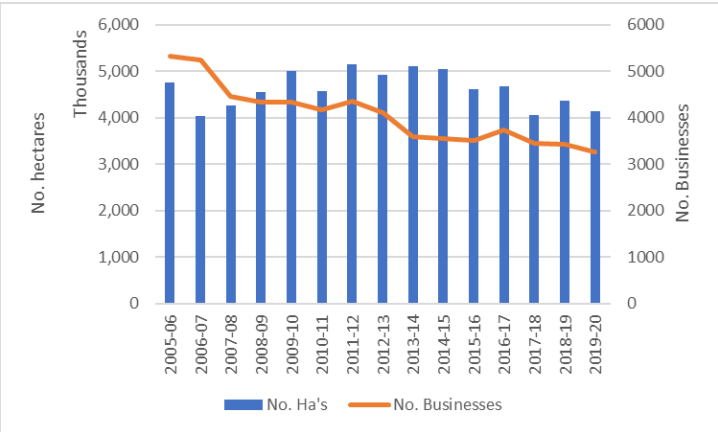


Figure 25. WA wheat production (tonnes) from 2002 to 2020



Wheat production fluctuates despite a relatively constant number of hectares of wheat being planted year to year

At the same time the number of businesses growing wheat has declined by 60% from 5328 to 3626.

This decline in number of businesses has facilitated improved productivity achieved by increasing scale

Figure 26. Area of Wheat (ha) and number of businesses (Source: ABS)

[33] Keogh, M. (2012). Including risk in enterprise decisions in Australia's riskiest businesses. Paper prepared for the 56th Annual Conference of the Australian Agricultural and Resource Economics Society, Fremantle, W.A.

[34] Hughes, N., Galeano, D., Hattfield-Dodds, S. (2019). The effects of drought and climate variability on Australian farms, Australian Bureau of Agricultural and Resource Economics and Sciences, Canberra. Retrieved 13-04-2022

3.1.1 Impacts of drought on the livestock sector

The impact of drought on livestock products (meat and wool) is a little more complicated. Once drought conditions have become sufficiently established, livestock producers will seek to reduce their herds or flocks, resulting in a temporary increase in the recorded volume of meat production. When the drought breaks, recorded meat production typically falls as graziers focus on rebuilding their herds.[29],[35]

The livestock movements in Figure 27 show the dramatic impact of the 2019 drought in Australia where livestock numbers were at their lowest. The increase in the forecasts predicted by MLA shown in Figure 27 are a combination of herd and flock rebuild and supply chain issues with slaughtering and abattoirs trying to cope with staff shortages due to COVID-19.

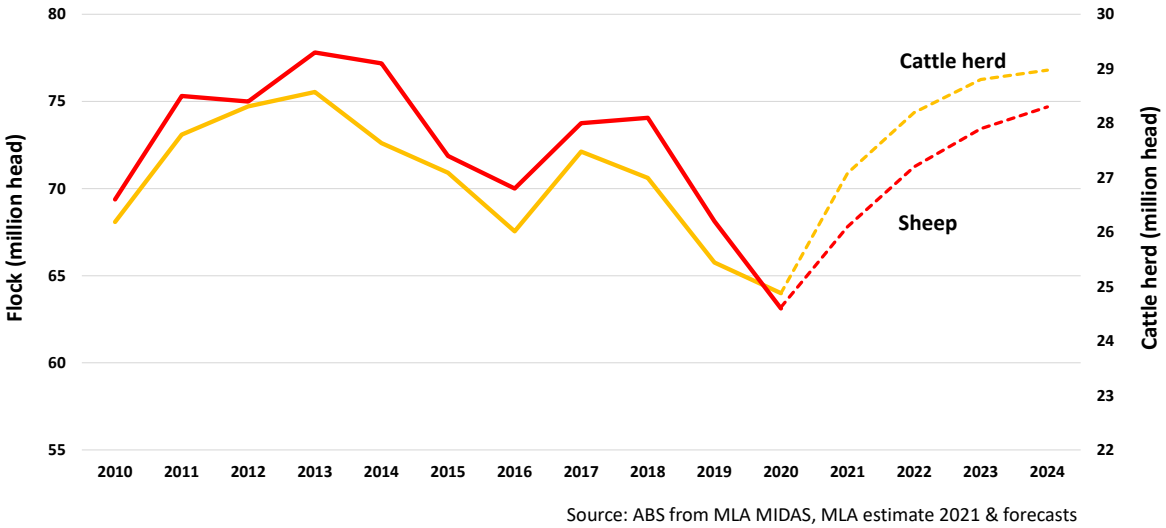


Figure 27. Livestock movements 2010 to 2024

WA followed a similar trend to the national flock figures in Figure 27. The impact of the 2011 and 2019 drought meant flock size decreased significantly which was outlined earlier in Figure 14. The number of sheep decreased from 15.7 million in 2008-09 to 14 million in 2010-11, numbers increased again but decreased to less than 14 million in 2015-16. The decrease in numbers is not all about drought but it is a significant factor. Due to high demand and good prices in the Eastern States more sheep than usual were transported across the Nullarbor for flock rebuilding and slaughter as shown in Figure 28. In total 1.36 million sheep were transported interstate 2019-2020.

Seasonal variability and risk of drought resulting in scarcity of water and feed for optimum sheep production were identified as critical limiting factors impacting farmers decisions to increase sheep numbers in 2010 and 2020.[36]

[35] Anderton, L and Weeks, P (2020). How are global and Australian sheep meat producers performing. Global *agri benchmark* network results 2019. MLA Market Information. https://www.mla.com.au/agribenchmark

[36] Anderton, L & Kilminster, K. (2021). Investigating flexible farming systems for the eastern wheatbelt, WA. Final project report Part I. https://www.laoneconsulting.com/projects-blog/investigating-flexible-farming-systems-for-the-eastern-wheatbelt-wa-part

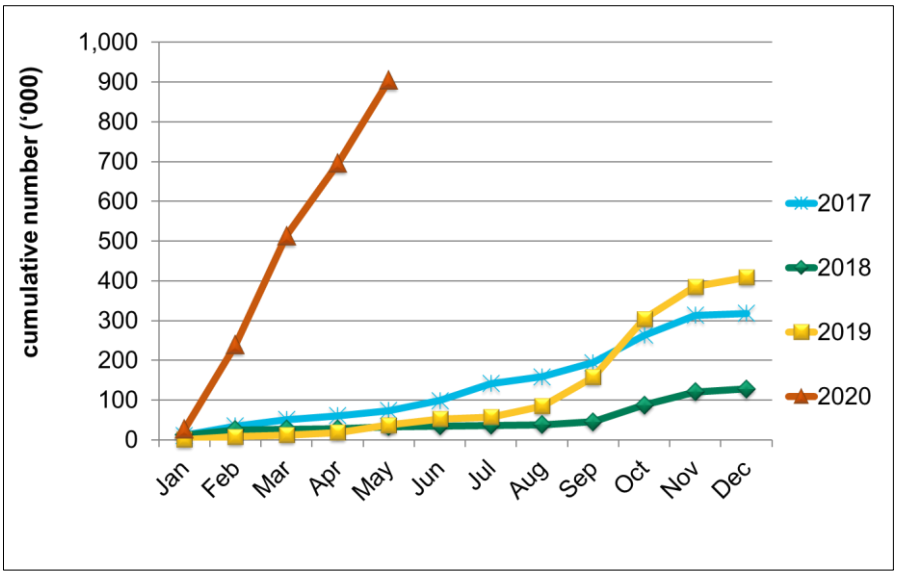


Figure 28. Cumulative number of sheep leaving WA through Ceduna (Source: PIRSA DATA, DPIRD analysis)

The economic impact of drought reaches beyond the farm gate and the impact on the supply chain can be significant, particularly for small processors with limited capital reserves and less ability to diversify.

Processors are vital for sheep meat value chain sustainability. Processing margins are tight which is evident by small processors like Hillside, Shark Lake and Beaufort River Meats stuggling to consistently remain open (ABC, 2012). Hermann et al., (2017) sum up the processing game as "cents and pennies game" number of throughput is the key economic driver and economies of scale are vital for efficiency so the variability in seasonal supply of lamb for small processors with intermitent supply can create difficulties, especially maintaining or accessing a workforce. Most processors in WA have a winter break, when supply is low for maintenance shut down.[36]

WA is reliant on three main processors, Fletcher's at Narrikup, Western Australian Meat Marketing Co-Operative (WAMMCO) in Katanning and V & V Walsh in Bunbury. If any one of these processors were to close the reduction in buyers competing in the marketplace will create a downward pressure on prices. Already, WA saleyard prices lag Eastern State saleyard prices, mostly because there is less competition between buyers, sometimes the difference can be as high as 200 cents per kg. During these periods trade flows from WA to South Australia increase, usually when the price gap is more than 50 cents per kg or greater, and when the price difference is greater than the cost of freight.[37]

If the processing sector in WA were to contract, farm gate sheep enterprise profitability will be negatively impacted, potentially decreasing sheep numbers further so creating more pressure on processors. Droughts are intermittent and most processors have the flexibility to manage the decrease in supply. The have several strategies to manage short-term shortages of supply, these are, winter shutdowns, reducing number of shifts in a week and improving technology to reduce labour shortages. On the flip side they can increase operations quite quickly subject to availability of labour.

[37] Hermann, R., Dalgleish, M., and Agar, O., (2017). Sheep meat market structures and systems investigation. MLA https://www.mla.com.au/globalassets/mla-corporate/research-and-development/documents/industry-issues/2017-12-18-sheepmeat-market-structures-and-systems-investigation.pdf

3.1.2 Impact on farm profitability.

The financial impact of drought on the farm sector is evident in the Planfarm benchmark data in Figure 29. This time series for the operating surplus (Gross farm income minus total operating expenses (variable + fixed costs) also known as earnings before interest and tax (EBIT) shows how the impact of drought affects the farm business. The operating surplus is required to pay for interest, tax and personal expenses as well as any business expansion, machinery replacement or capital improvements. When it is impacted by drought it becomes difficult for farm businesses to meet all their financial commitments and they often must rely on using equity or find an off-farm income.

There are several observations that can be made about this data:

- The drought years of 2002,2006,2010 and 2019 are evident with low operating surplus for all regions (2002 being an exception for the high rainfall region)
- The operating surplus in the low rainfall regions are more often below $50 per hectare, in 2002, 2004, 2006, 2009, 2010 and 2019
- There is a notable increase in variation between years in the last two decades compared to the first ten years.
- Operating surplus between the low rainfall region and the medium-high rainfall region diverges from 2010 onwards.
- An increasing trend in operating surplus for all regions.
- The significant decrease in operating surplus in 2019 for all regions.

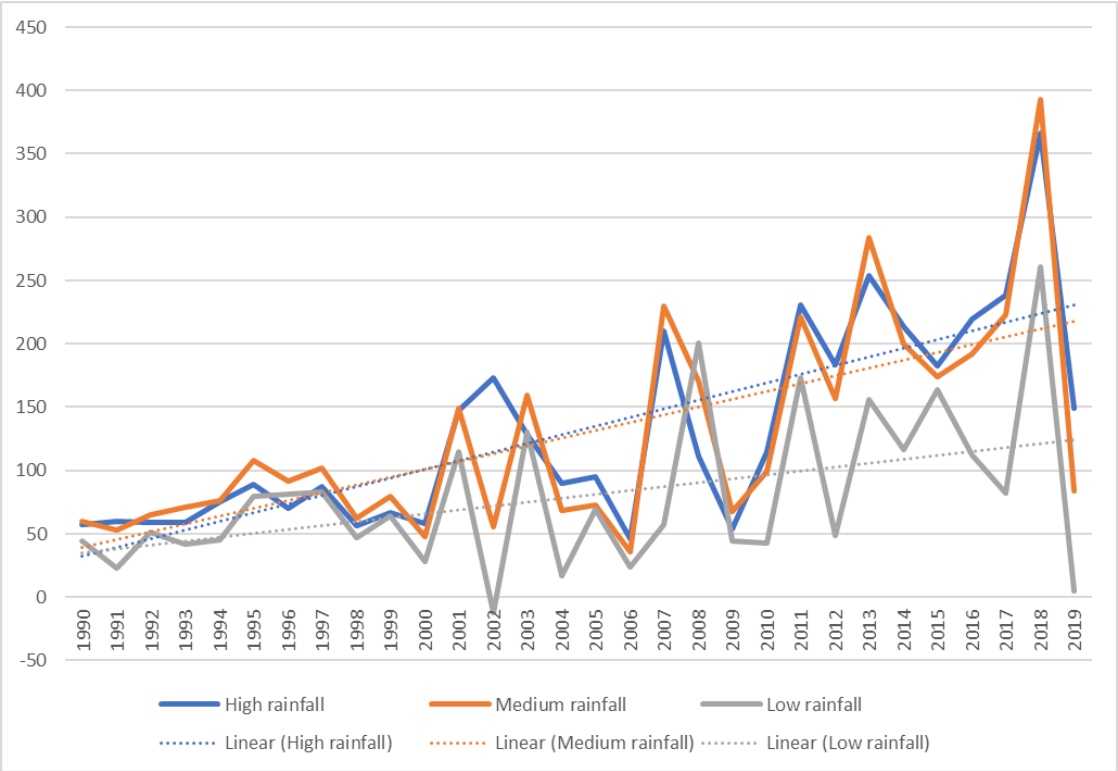


Figure 29. Operating surplus for WA farms 1990 to 2019[38]

[38] Bankwest-Planfarm benchmarks and Planfarm benchmark publications since 1990, the average of each region e.g., High rainfall operating surplus is the average of High rainfall region 1, 2, 3, 4 and 5.

The likely reasons for the increase in variation in the operating surplus between years is the combination of increasing variation between seasonal conditions and increased area of cropping. It is this year-to-year change in seasonal conditions and variability within seasons that farming communities must manage whilst keeping a view on the medium and long-term risks to achieve longevity in business.

Typically, during drought years the operating surplus is not sufficient to support all business expenses resulting in increased debts to pay for inputs the following year.

The significant drop in operating surplus in 2019 (Figure 29) resulted in the worst financial outcome for farms in this data set. The reason for this significant loss was drought, but also the complexity in decision making compounded the outcome. The 2018 year was extremely profitable, and in 2019 confidence was high, producers had surplus cash and invested in more fertiliser, lime, and potassium. Early seeding often before rains to achieve optimum yields means 80% of inputs are at the start of the season. Further nitrogen and potassium, due to confidence in the seasonal conditions were applied, however the lower-than-average rain in August and September reduced yields significantly. The combination of low yields and high costs reduced margins and operating surplus, Figure 28. (R. Grima, personal communication, June 13, 2022)

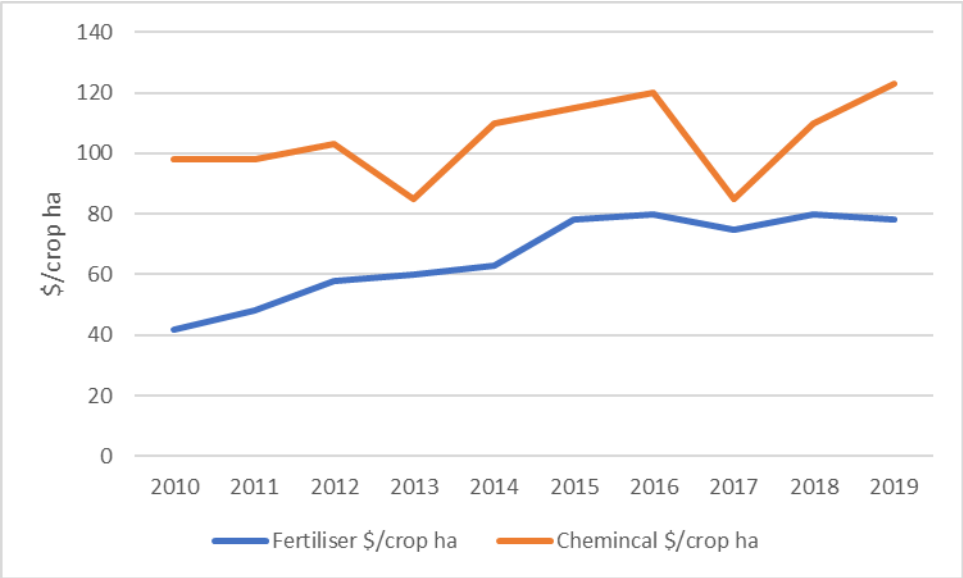


Figure 30. Fertiliser and Chemical costs $/crop ha

ABARES research using *farmpredict* (see Appendix 3 for an explanation) controls for non-climate factors and uses farm business profit to show that changes in climate conditions over the last 20 years have had an adverse effect on the productivity of Australian cropping farms.[34] Changes in climate over the period 2000 to 2019 (relative to the period 1950 to 1999) have had a negative effect on the profitability of broadacre farms in Australia including both cropping and livestock sectors, shown in Figure 32 and Figure 31.

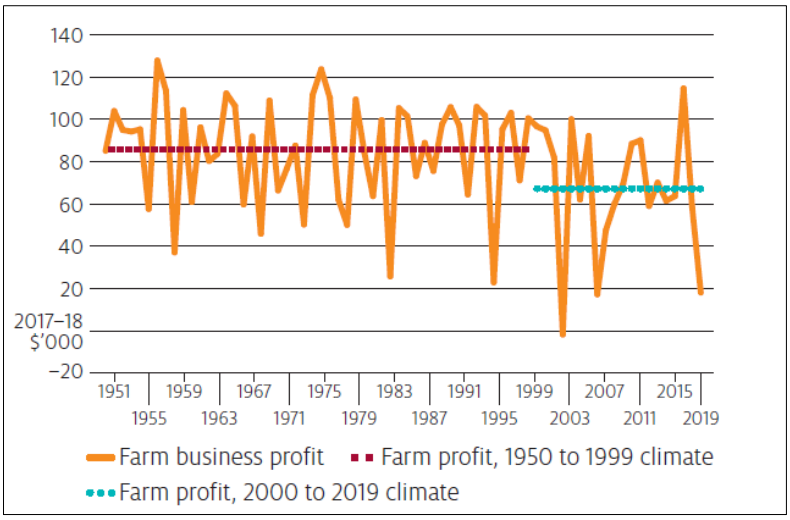


Figure 31. Effects of climate variability on average farm business profit 1949-50 to 2018-19 assuming current farms and commodity prices.

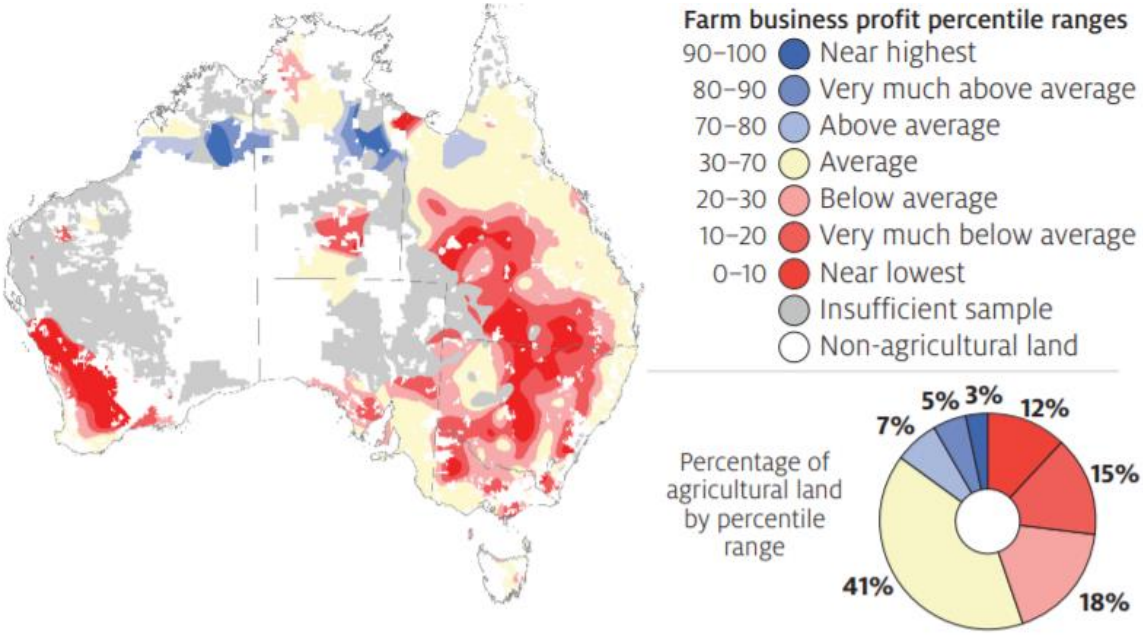


Figure 32. Effect of 2000 to 2019 climate conditions on average farm business profit[39]

These results show changes in climate since 2000 have reduced average annual broadacre farm profits by 22%, or around $18,600 per farm.

[39] Simulated broadacre farm business profit with current farms and commodity prices (2015–16 to 2017–18). Percentiles for the 20-year period 1999-2000 to 2018–19 relative to the reference period 1949–50 to 2018–19. Farm business profit is calculated at market prices for all inputs and outputs, including unpaid family labour, as well as changes in the value of stocks (including inventory and livestock). Pie chart percentages do not add due to rounding error.

In Western Australia average annual broadacre farm profit from 1950-1999 was $226,000, from 2000 to 2019 this decreased by 25.8% to (-$58,000) to $167600. This was the largest decrease out of all States. The cropping sector was impacted the most, with a reduction in average profits of 35% or $70,900 for a typical cropping farm, which seems counter intuitive when looking at data from WA, however the increase in farm size and associated efficiencies mask the climatic impact ABARES identify.

This ABARES analysis also shows how the Northern Agriculture Region LGA pilot regions are in the near lowest farm business profit percentile range. The Central Agriculture Region is also in the near lowest range and the Great Southern farm business profit is mostly average although some of the area appears to be in the near lowest range.

During workshops held with communities in the Northern Agriculture Region to discuss the impacts of drought, many of the issues identified are supported by the literature and analysis.[40]

3.1.3 Impact of drought from a community's perspective:

- The financial impact resulted in people giving up farming and selling their properties, around 50% of the community was lost as people relocated seeking financial survival and security.
- Increasing debt loads.
- A significant reduction in livestock numbers, as they were either sold, agisted or destroyed.
- Work off-farm work became normal to financially support families and farm debt.
- A significant negative effect on mental health as stress levels increased to extremes, with 'suicidal' tendencies and suicide incidents.
- Social impacts included marriage breakdowns
- Small businesses supported by farm businesses struggled or disappeared reducing services, skilled workers, and long-term employment opportunities.
- Communities' fragility increased.
- Bores ran out of water.
- Long-term residual anxiety about the certainty of rainfall, when and if it will rain enough and at the right time.
- The younger generation were negatively impacted and did not return to rural and regional communities to farming businesses
- Dust everywhere and significant soil erosion.

3.1.4 Impact of drought on viticulture industry

Grape vines are reasonably tolerant to dry conditions and drought, however even though grapevines can survive a dry spell with minimal watering, they will start to shed their leaves when their ability to circulate water and nutrients is reduced by 50 per cent. This is due to lower water pressure in their stems and roots. Under stress, the vines push hard to draw water and can form air bubbles in tissues that circulate water from the roots. These air bubbles stop the sap from flowing into the vines so they start losing leaves and can eventually kill the vine. There is also a direct correlation between the amount of water a vine receives and the fruit it will yield. Eighty per cent less water means eighty per cent less fruit, so impacting on productivity and cost of producing wine.[41]

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[40] Bourne, A. (2021). Notes from Regional Drought Resilience Planning Program Presentation to Council Shire of Chapman Valley.
[41] https://www.stmaurwines.com.au/drought-and-wines-what-it-means-for-quantity-quality/

The largest areas of grape vines are grown in Broomehill-Tambellup, Cranbrook, and Kojonup, as outlined in Table 6. The largest area (Cranbrook and Kojonup) is west of the Albany Highway in a high rainfall environment and the volume of water applied is less than the amount applied in the for small areas of grapes in the NAR.

Table 6. Area of grapes grown, area watered, and volume applied. [42]

LGA	Grapevines - Total area grown (ha)	Area watered (ha)	Volume applied (ML)	Volume applied (ML/ha)
Broomehill-Tambellup	316	307	144	0.47
Kojonup	307	299	140	0.47
Cranbrook	255	24	166	0.67
Greater Geraldton	44	44	214	4.86
Northampton	30	30	147	4.90
Chapman Valley	16	16	76	4.75

A dry year means a dry subsoil and a reduced canopy which is the engine room for ripening. This results in reduced yields and increased sugar levels in the fruit which accelerate quickly making picking time difficult because it needs to be determined on sugar levels instead of taste. The high sugar levels impact on fermentation and wine quality.

A lower-than-average rainfall year is 450 mm of rainfall. Evaporation rates on dams increase from 22-30% in a normal year to 40-45% and irrigation needs to manage, a dry year requires careful management but is not as severe as frost in spring at bud bursting time or hail in the summer. (Personal communication, 19-08-22, Chris Zur, Ferngrove)

3.1.5 Impact of drought on the horticulture industry

Literature on the impact of climate change on horticulture products identifies the risks around higher temperatures reducing shelf-life for products and increasing the need for improved cooler storage and handling facilities. But finding literature on the impact of drought appears limited, however, assuming drought occurrences increase in frequency this means increased management and costs for the horticulture industry as they will have to apply new technologies and innovations to adapt.

The city of Geraldton website states that 'Geraldton produces high end foods through its growing horticultural industries. Quality soils, access to water and application of advanced shade-house technology means a long season of the freshest and cleanest variety of foods, including tomatoes, bitter melon, buffalo spinach, Chinese cabbage, coriander, egg plants, and garlic. Horticulture production value in the region is currently $25 million/annum, with 80 percent derived from vegetables and 20 percent from fruit.'[43].

[42] Water Use on Australian Farms, 2020-21 financial year | Australian Bureau of Statistics (abs.gov.au)
[43] https://www.cgg.wa.gov.au/business/growing-greater-geraldton/sectoral-performance.aspx

Most horticulture production is irrigated and applying technologies like shade-house technology and efficient water management systems with the use of technology and innovations is critical to achieve productivity improvements and efficiencies.

Small areas of high value horticulture crops are grown in the NAR with a proportion being irrigated according to recent ABS data shown in Table 7. However, the data for the Total vegetable area is the latest available from 2015-16 and may have changed.

Table 7. Area of Vegetables grown in the NAR

	Number of businesses irrigating	Vegetables area watered (ha)	Total Vegetable area (ha)
Northampton	3	32	360
Chapman Valley	3	7	125
Greater Geraldton	9	32	319

3.1.6 Impact of drought on food supply chain

Food reaches consumers by many different routes, typically involving some or all of processors, manufacturers, warehouse operators, retailers and the companies or individuals who transport food between them. These networks comprise of Australia's food supply chains. There are different types of chains for different products, such as dry goods, fresh fruit and vegetables, meat, frozen food, dairy and bread.[44]

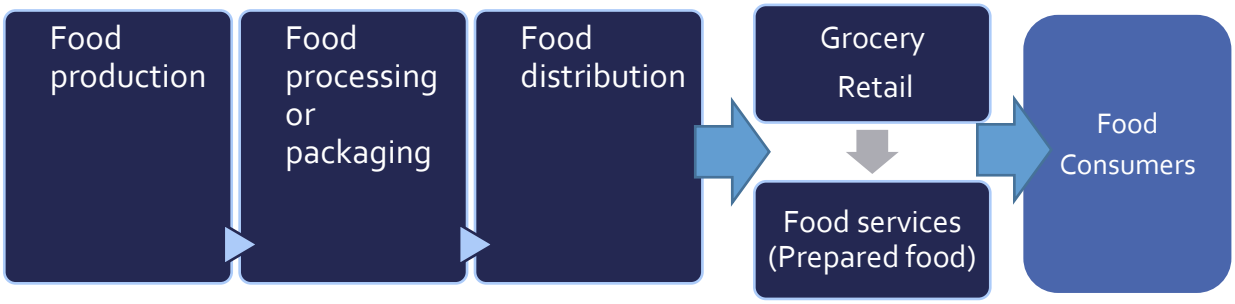

Figure 33. Overview of Food Supply Chain[45]

Sometimes these Supply Chains are referred to as a "value chain" where each link adds value to a product, for further discussion on this concept refer to Bartos (2022)[45]

For several weeks in January and February 2020 food supply shortages were experienced by Australians probably for the first time since the end of World War II. COVID-19 pandemic has exposed vulnerabilities in Australia's food supply chain exacerbated by climatic events like the floods in South Australia causing

[44] Bartos, S., M., Balmford, A., Karolis, J., Swansson, Alistair, D. (2012). Resilience in the Australian Food Supply Chain Report prepared by Sapere Research Group for the Australian Government Department of Agriculture, Forestry and Fisheries.
[45] Bartos, S. (2022). Fork in the Road. Impacts of climate change on our food supply. A report on current and growing risks and vulnerabilities in Australia's food supply chain arising from climate change.

disruptions in the rail freight into WA. Supplies normally readily available were disrupted. Empty supermarket shelves required purchasing restrictions for the second time in two years.

The level of dependency within a supply chain is high and disruptions caused by climatic events can create issues along supply chains. Sometime critical dependencies are not well understood and "a broader view of climate change beyond disasters and food production, has yet to be fully integrated into food security policy – and supply chain governance and practice – in Australia"[44]

3.2 Measuring the economic impacts of drought

Understanding the economic impacts of drought is critical to informing policy to provide appropriate support in drought affected regions.[46] Yet, the economic impacts of drought are complicated, not only is the start date difficult to determine, but also the duration and drought creates winners. For example, drought-induced higher prices attract goods from other regions to flow into the local market. For farmers in Western Australia the price of grain was supported in 2018 (Wheat price was at historic levels for the time at $360/tonne) by reduced supply in the eastern states caused by drought conditions.[47]

In drought years Australian grain and hay prices tend to increase above world market prices increasing the profits of some farms (grain producers) and decreasing the profit of others (livestock farmers). These farmers could be considered drought affected even if their local rainfall levels would indicate otherwise.

Another important issue is that drought causes long-term impacts. The negative impacts might linger for multiple years with the depletion of farm capital, usually through two mechanisms, first reduced farm income depresses investment during drought years. Second, a depletion in livestock numbers and quality of pastures. Consequently, drought depletes the income earning capacity of farms in recovery relative to no drought. [32] Analysis by Anderton, L. (2016) identified farmers that made a loss in years of drought were less able to invest in new or existing innovations to improve productivity.

Secondary impacts of drought occur on inter-sectoral businesses relying on the agriculture sector because the interactions and transactions between industries and sectors, that is the outputs from one industry/sector become inputs into other industries/sectors are affected. The direct economic impacts on an individual industry spread through the upstream or downstream linkages to other industries, causing secondary impacts. An example of this is when grain production is impacted, and supplies are limited to downstream food processors like flour mills who must bid a higher price to obtain wheat. The alternative is to reduce their production. Ultimately the additional costs get passed on to the end consumer.[31]

Another example is livestock, as they are sold to cope with drought, the abattoirs benefit from additional supplies of livestock, but the medium to long-term impacts mean less livestock in the farming system from reduced numbers and reduced livestock slaughtering's.

The upstream impacts of suppliers of inputs to the farming system, like fertiliser or animal health products. These upstream and downstream effects are known as indirect effects.[31]

The non-agricultural sectors through its effects on water supplies including streamflow's, reservoirs, wetlands and groundwater. Tourism, recreation, public utilities, horticulture and landscaping services are

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[46] Gladish, D.W., and Z., Hochman. (2022). Investigating the application of drought indices to Western Australia, CSIRO. Australia

[47] Prendergast, J., Bennett, M. and Jose, L. (2018). Record harvest potential for Western Australian farmers as prices spike on east coast drought. https://www.abc.net.au/news/rural/2018-08-23/record-grain-harvest-potential-for-wa-farmers/10152200

all examples of industries with significant reliance on the consumption of water. Figure 32 represents the economic impacts of drought on the agriculture and non-agriculture sector.[31]

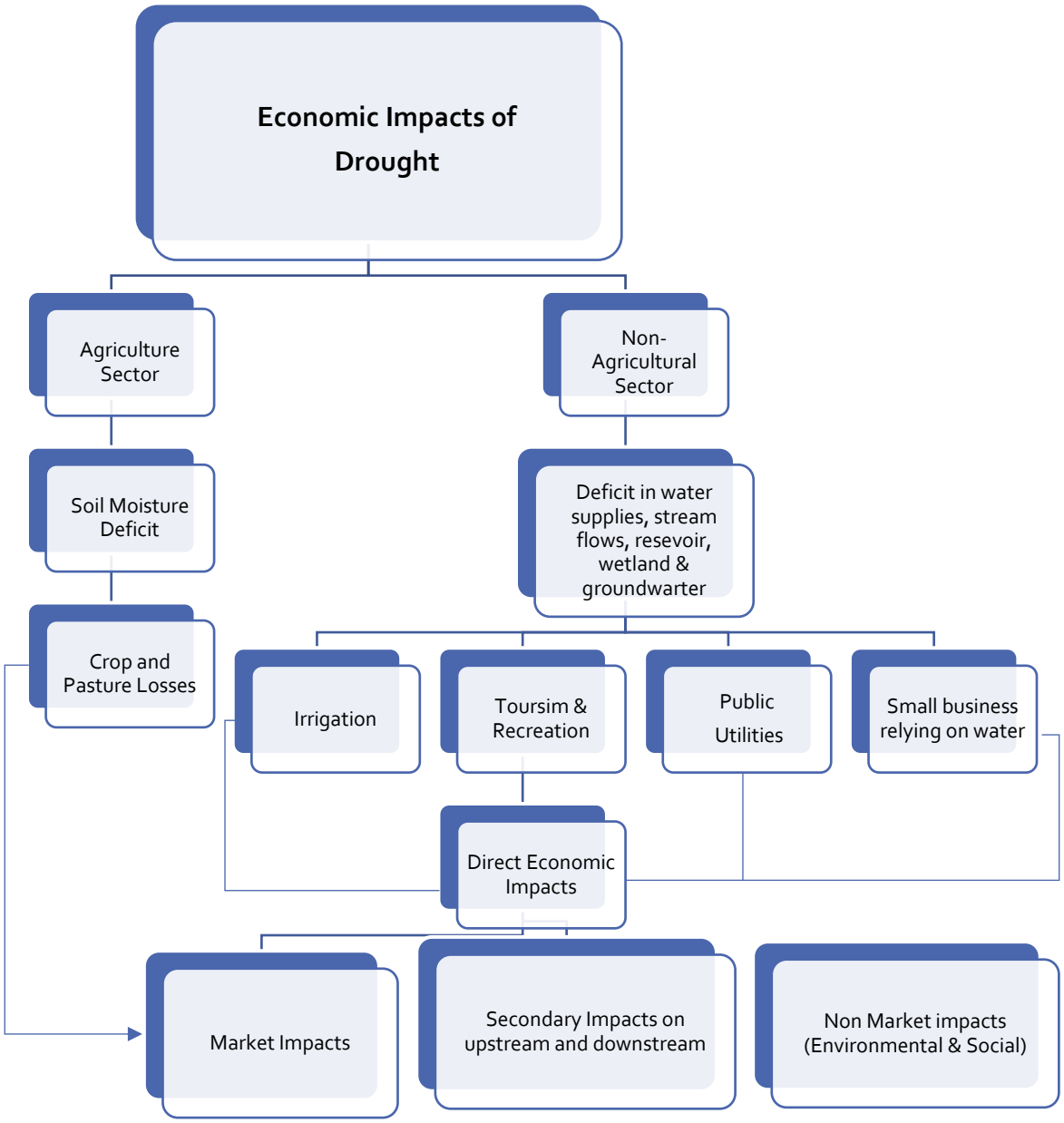

Figure 34. An overview of the economic impacts of drought on Agricultural and Non-Agricultural Sectors[31]

The level of complexity in understanding the direct and indirect impacts of drought on the economy is high and for a comprehensive analysis requires a computable general equilibrium (CGE) model. A CGE model is an economy-wide model that solves for both quantities and prices together. The dynamic VU-TERM

model combines the theory of dynamic national models with bottom-up, regional representation and can be used to model the impacts of drought.[48]

3.2.1 Measuring drought at the farm level – identifying some issues

At the farm level measuring drought has traditionally used indicators that measure rainfall. In Australia the work of Gibbs and Maher (1967) established rainfall percentiles as the de-facto standard measure of meteorological drought. Although their popularity has waned in recent years, governments tend to use this measure to trigger the implementation of drought measures and support.

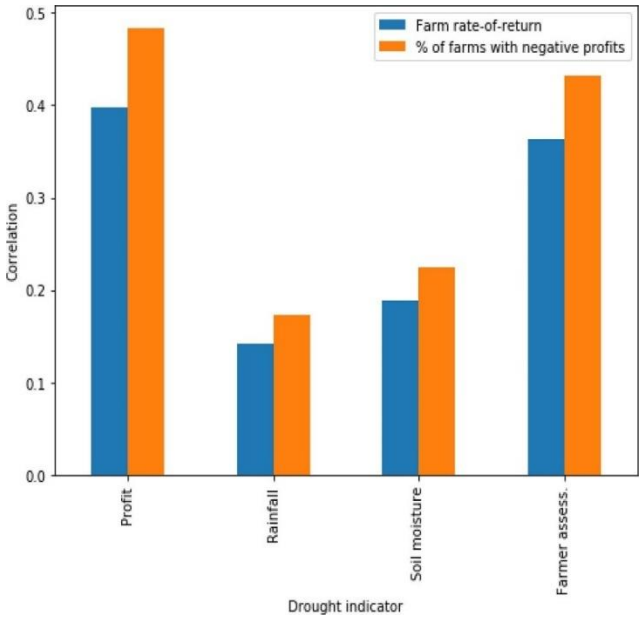

Figure 35. Correlation between drought indicators and farm financial outcomes (all farms)

Hughes, et al., 2022 shows how rainfall indicators are weakly corelated with farm outcomes (with soil moisture offering only a marginal improvement) whereas the profit-based indicator shows a higher correlation.[34]

The financial ramifications of drought can be different in different years and different businesses can be differently affected.[49] ABARES broadacre farm survey data in Figure 36, uses total family income, defined as the family share of farm cash income less family share of depreciation, plus all off-farm income of the owner/manager and spouse. This is national data used to help guide policy decisions for the sector. These results aggregate observations across regions, environments, farm size and product mix which masks the actual volatility of income of individual farms. Therefore, identifying the real impact of drought conditions is difficult with aggregated data.

[48] Wittwer, G. (2020). Estimating the regional economic impacts of the 2017 to 2019 drought on NSW and the rest of Australia. CoPS working paper No. G-297.

[49] Kingwell, R. and Xayavong, V. (2016). How drought affects the financial characteristics of Australian farm businesses, Australian Journal of Agricultural and Resource Economics, 61, pp. 344-366

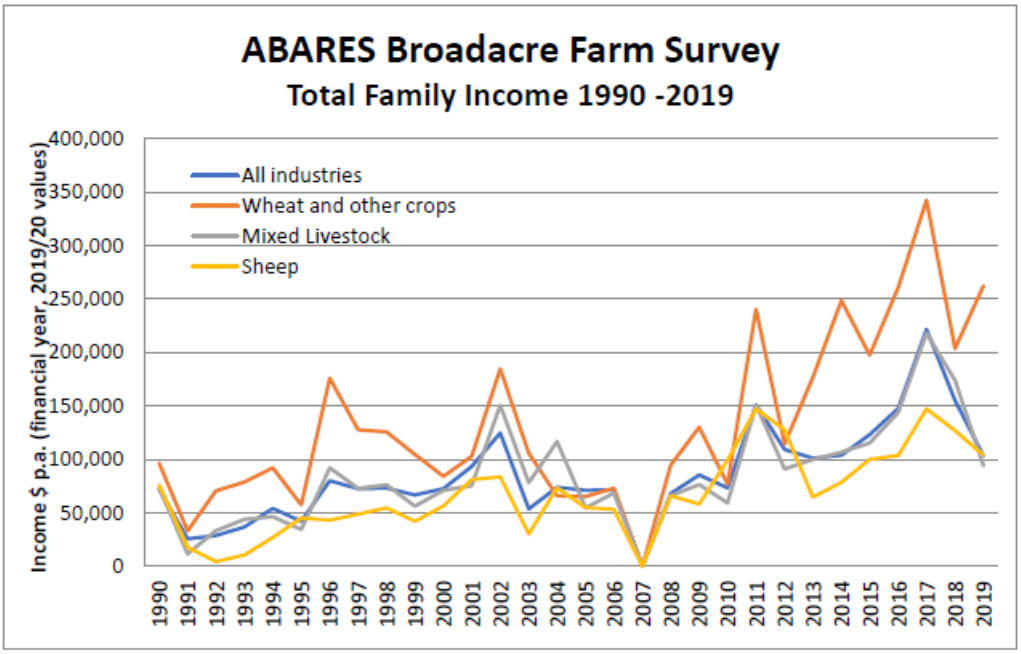

Figure 36. ABARES farm survey data 1990 to 2019[50]

At minimum, individual State or regional results from the farm survey would remove some of this aggregation effect and should, for example, show the level of impact of the drought in drought years.[50]**Error! Bookmark not defined.** A comparison between the median farm income of all commercial farms and a hypothetical, typical commercial farm in the US demonstrates the effect of aggregation across the range of environments, classes of output and sizes of business and how it masks the extent of the year-to-year income variation experienced by an individual within the population, Figure 37.[50]

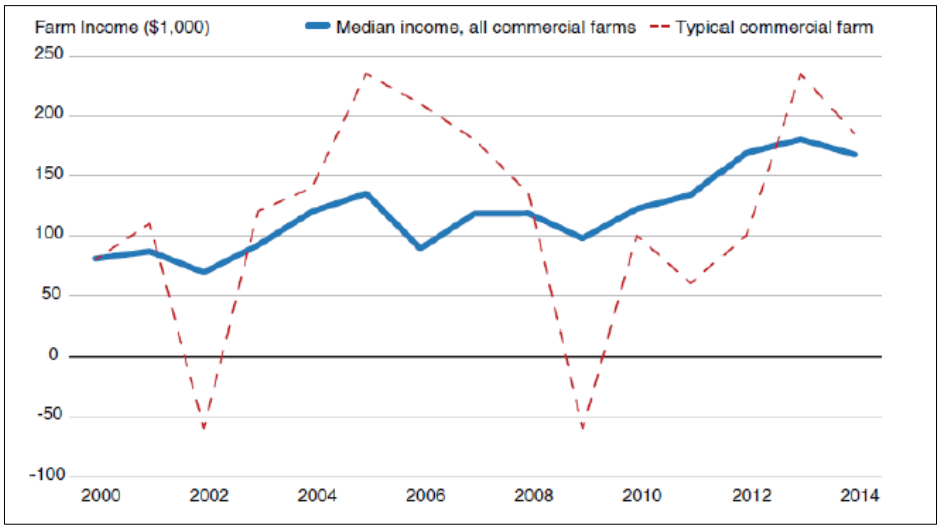

Figure 37. US farm income 2000 to 2014[50]

Any one indicator by itself is inadequate to understand farm performance and how the impacts of drought or other shocks effect a business. Kingwell and Xayaphong (2016) use four key indicators to show the impact of drought on 240 farms in Western Australia. The indicators were debt-to-income ratio, return-on-

[50] Australian Farm Institute (2020) Government farm financial risk management measures. Research Report

capital, business equity and operating surplus. The advantage of this study was the longitudinal data set enabling the analysis of 240 farms over 10 years (2002 to 2011). They found that despite the incidents of drought during the period almost all the farm businesses were wealthier by the end of the decade of observations, and despite drought creating financial pain, farms were able to manage their businesses such that their wealth (i.e., farm business net equity) improved. Much like the findings by Planfarm in their study on the effects of drought.[27]

This was achieved by farms increasing their farm size and altering their farming systems towards greater cropping and creating additional profit. However, debt increased to fund expansion, more machinery and years where finance needed to be extended to cover the aftereffects of drought from the previous year. At the same time land appreciation, allowed for increased borrowing capacity.

Anderton, L (2016) discusses farm performance metrics and used a set of criteria and financial ratios to determine the strength of a businesses, Table 8.[51]

Table 8. A method to categorise and score farm performance[51]

Farm performance rating	Operating surplus	Net Profit	Change in equity	Score
Growing	Yes	Yes	Ve+	5
Strong	Yes	Yes	Ve+	4
Secure	Yes	No	neutral	3
Less secure	Yes	No	Ve-	2
Non-viable or Bad year	No	No	Ve-	1

Planfarm's analysis of drought uses a set of criteria and framework of more than one indicator to evaluate farmers vulnerability to drought.

Table 9. Identified parameters and rank for vulnerability assessment used by Planfarm.

Parameters	Description	Value for rank 1	Value for rank 5	Value for rank 10
Opening equity %	Gross assets minus liabilities divided by gross assets	<50%	70-75%	>90%
Loan Valuation Ratio	Peak debt divided by owned land	>70%	45-50%	<20%
Equity/Family Unit	Net equity per family unit drawing	<$1.8M	$3.2-$3.8	>$6M

[51] Anderton, L. (2017). Financial, Productivity and Socio-Managerial Characteristics of Broadacre Farms in Western Australia: A Decadal Assessment. A thesis presented for the Master of Science at the University of Western Australia School of Agricultural and Resource Economics. https://api.research-repository.uwa.edu.au/portalfiles/portal/20988873/THESIS_MASTER_BY_RESEARCH_ANDERTON_Lucy_2017.pdf

Return on capital	6-yr average profit before tax over total capital within the business is expressed as a percentage.	<2%	6-7%	<50%
Operating efficiency	6-yr average Operating expenses as a percentage of gross farm income	>82%	65-68%	<50%
Gross farm income per family unit	6-yr average gross profit revenue per family unit drawing from the business	<500K	$1.5-$1.75	>$3M

3.2.2 Adaptive Capacity Framework

A framework developed by Sietchiping R. (2007) for the Victorian wheatbelt in collaboration with key stakeholders created an adaptive capacity index to identify the LGA's vulnerability to climate change. The adaptive capacity index is constructed from a multi-dimensional perspective that considers policy outcomes, structural adaptation, local context and stakeholder priorities. The framework used three broad themes crucial to a strong and prosperous grains industry and regional communities: socio-cultural, economic, institutional/infrastructure. These three themes are dependent on the biophysical conditions, they are interlinked and represented in Figure 38[52]

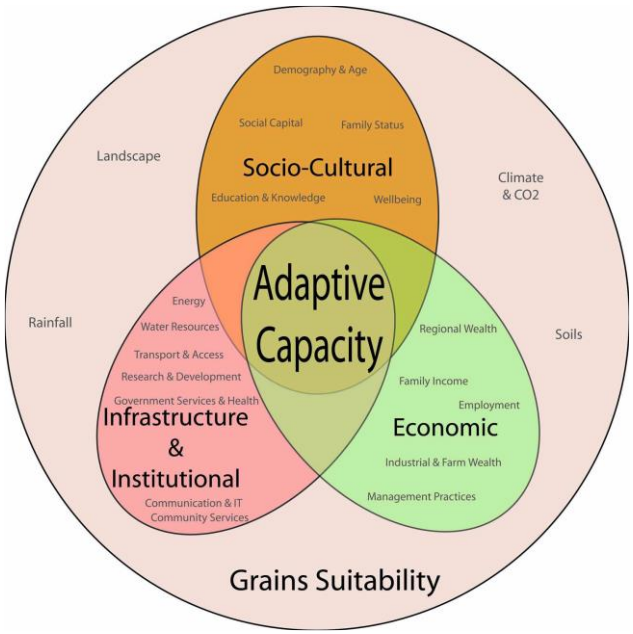

Figure 38. Components of the Adaptive Capacity Framework

Sietchiping, R. (2007) study identified investment in targeted infrastructure is a long-term adaptation strategy required to build strong communities and reduce vulnerabilities to incidents like drought that are forecast to become more frequent with climate change.

[52] Sietchiping, Remy. 2007. 'Applying an index of adaptive capacity to climate change in north-western Victoria, Australia'. *Applied GIS* 2 (3): pp. 16.1–16.28. DOI: 10.2104/ag060016.

4 INFRASTRUCTURE IN REGIONAL AREAS

Improved infrastructure access can assist rural and regional communities to meet economic challenges, build resilience and improve quality of life more successfully. One of the main issues with droughts is the impact on water supplies and the negative impact on quality of life and economic sustainability.

4.1.1 Water

Water scarcity is a persistent issue in Australia given the relatively dry and variable climate. It is a valuable commodity particularly within agriculture, which accounts for around three quarters of total use. Water is also of value to other industries, households and increasingly environmental agencies.[53]

For communities in regional areas water resources are becoming an increasingly problematic issue because the south-west of WA has experienced a fifteen per cent decline in average annual rainfall since 1975. This has reduced recharge to groundwater aquifers from Geraldton to Esperance.

Over 11 million litres of drinking water, with additional water for livestock, was carted to over fourteen different towns as of Feburary 2020, due to the local dams drying up. This saw the urgent need for more water storage and collection methods for these regions, as the current water solutions are unsustainable for the drying climate. [54]

Out of twelve water deficiency declarations announced from May 2019 to June 2020, seven were related to the LGA's in the pilot regions, these were Lake Grace, Jerramungup, Kent and Dumbleyung.[55]**Error! Bookmark not defined.** The total cost of water carting to (all) areas with water deficiency declarations was $3.7 million.[56]

The State Government also invested $915,902 through the Community Water Supply Program in 2020–21, helping nine local governments deliver 10 projects which will improve their emergency community water capacity and reduce their future use of scheme water. The shires of Merredin, Mukinbudin, Wyalkatchem (two projects), Chapman Valley, Toodyay, Jerramungup, Plantagenet, Gnowangerup and Lake Grace received grants to undertake works, including improving the stormwater reuse network, fitting new pump, pipe and tank facilities, and realigning catchment channels. This builds on works the government have previously undertaken on community water supplies, bringing the total to nearly $1.5 million for 17 projects. The Rural Water Planning works program also invested $741,890 to upgrade 32 agriculture area dams vested with the Department of Water and in priority areas to continue to build on the strategic water supply network across the dryland agricultural area.**Error! Bookmark not defined.**

Demand for water in agriculture is changing. There is a growing need for clean good quality water for spraying crops, as cropping programs grow and there is reduced demand for livestock.

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[53] https://www.agriculture.gov.au/abares/research-topics/water#water-markets-information

[54] Daley, J. (2020). Drinking water to be trucked into more than a dozen West Australian towns due to the unprecedented dry, https://www.abc.net.au/news/2020-02-06/wa-water-minister-warns-of-unprecedented-shortages/11934262

[55] DWER Annual Report 2019-20 Operational performance, https://www.awe.gov.au/abares/research-topics/water#australian-water-markets-reports

[56] DWER (2021) Annual report 2020-21

In the 2019 drought which occurred after two consecutive years (2018 and 2017) with low rainfall, it resulted in low water reserves for many farmers and communities. Consequently, livestock was sold due to water shortages and water was carted to replenish community supplies and the needs for farmers. Considering the need to conserve this precious resource, farmers carting livestock water were encouraged to cart to closed storages or tanks rather than into dams where water losses are high because of evaporation.[55]

The FAO identifies water scarcity as an outcome of undervaluing water as a finite resource. Water markets allow Australia's scarce water resources to be efficiently allocated between competing uses in response to fluctuations in supply and demand.

Infrastructure WA states that new water infrastructure may be deferred where there is scope to optimise how existing water assets are used and where demand management measures can make existing water supplies go further. Similarly, where there is sufficient headroom and operational flexibility to respond to changing circumstances, decisions about costly infrastructure may be deferred enabling more cost-effective or sustainable solutions to be found in the interim. As less ground or surface water is available due to climate change, investments in infrastructure to save water as well as alternative water source infrastructure become a greater priority for both potable and non-potable water supplies.

> Economic water scarcity is due to the lack of water infrastructure in general or poor management of water resources. It can also be the result of unregulated water use for agriculture or industry. Major inefficiencies in water use are usually due to economic undervaluing of water as a finite natural resource. (FAO)

4.1.2 Communications

The provision of high-speed broadband is critical to communities in regional and rural areas as it serves to expand economic capacity and stimulate commerce. However, accessibility to and availability of broadband networks are generally lower in rural areas than urban areas in both the developed and developing countries due to low population densities and economies of scale.[57]

In advanced economies many remote rural areas, from a digital infrastructure provision and capabilities perspective are lagging.[58],[59] America, Australasia and Europe over the last decade have prioritized effort (and spend) in densely populated areas with the more costly and technically challenging remote rural upgrades left until last, if scheduled at all.

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[57] Islam, R. Selvadurai, N., Town, G. (2008) Wireless broadband technologies for regional and rural Australia. A last-mile perspective. *Telecommunications Journal of Australia,* Vol 58, No. 2-3, 2008 Monash University Press.

[58] Riddlesden, D., Singleton, A.D. (2014) Broadband speed equity: a new digital divide? *Applied Geography*, Vol.52, 25-33

[59] Philip. L., Williams, F. (2019). Remote rural and home-based businesses and digital inequalities: Understanding needs and expectations in a digitally undeserved community. *Journal of Rural Studies*, Vol.68, 306-318, available at: https://www.sciencedirect.com/science/article/pii/S0743016717312615

There has been a reluctance on the part of internet service providers (ISPs) to invest in more remote areas where a small potential consumer base makes commercial roll out of upgraded infrastructure appear unprofitable.[59], [60]

A divide remains in the capabilities of urban-rural digital infrastructure. This means many rural communities are unable to exploit the full potential of the internet and thus continue to be at a comparative disadvantage to many of their urban counterparts.[59]

It is widely agreed that the provision of affordable access to effective broadband networks and services is critical to the development of e-commerce and success of the national economy through enhanced global competition of local firms and industries.[61] "Access to online resources or information is now normative, taken for granted by ever larger array of basic commercial and other service providers including government services".[62]

Digital engagement has become an essential element of day-to-day business practice, regardless of size, sector, or location of an enterprise. It is essential that rural citizens can both (a) access and use the internet and (b) access a fit for purpose internet connection capable of providing access to online resources which are often designed with fast connections in mind.[59]

4.1.3 Freight

In the regions, infrastructure efficiency is a key enabler of international market competitiveness. Road and rail networks act as complements or substitutes in moving product to ports for export. The freight rail network across the south of the State remains in public ownership, though it is under private operation through the 49-year lease held by Arc Infrastructure. Third-party access to the network has presented some challenges, including with the major grain handling customer CBH, and highlighted the related issue of how commercially marginal Infrastructure WA branch lines are treated.

Planning for metropolitan freight needs is guided by Perth and Peel Transport Network. While the State Government retains control over road network planning and investment, freight rail planning and major investment in the southern part of the State requires cooperation from the private leaseholder of the network, which retains overall control. The draft Revitalising Agricultural Region Freight Strategy was released in June 2019 and proposes improvements to the movement of agricultural products across all transport modes over the next ten to 15 years. Infrastructure Australia has recognised the national significance of the secondary road freight network in the Wheatbelt region. Enhancements to the complementary rail freight network require the involvement of the network's private leaseholder, Arc Infrastructure.

4.1.4 Energy

The vast and dispersed nature of settlement across the State presents challenges for electricity transmission and distribution, particularly to rural and remote users. Western Power and Horizon Power are expanding the installation of stand-alone power systems as an alternative to grid supply for customers

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[60] Park. S. (2017) Digital inequalities in rural Australia: A double jeopardy of remoteness and social exclusion. *Journal of Rural Studies*, Vol.54, 399-407, available at: https://www.sciencedirect.com/science/article/abs/pii/S0743016715300693

[61] Deloitte Access Economics. (2017). Australia's Digital Pulse. Policy priorities to fuel Australia's digital workforce boom. Australian Computer Society 2017, available at: https://www2.deloitte.com/tl/en/pages/economics/articles/australias-digital-pulse.html

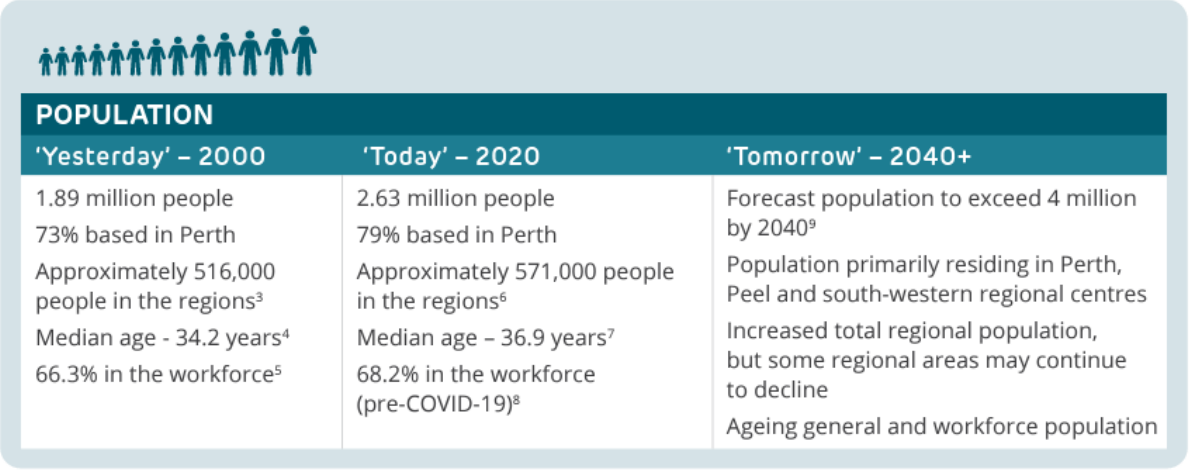
[62] Stover. S. (2014). The US Digital Divide: a call for a new philosophy. Critical Studies in Media Communication, Vol 31, Issue 2.

located in low-density parts of the network. A financial tipping point has now been reached where, in some circumstances, this is a more cost-effective option than building or maintaining connections to the network. These alternatives also provide other benefits including improved reliability and bushfire mitigation.

The cost of power and connecting to the grid in regional and remote areas is one of the major barriers for encouraging economic development and diversification of sectors in the regions.

4.1.5 In summary

The ability to adequately meet our infrastructure and service needs is expected to become more challenging over time, as demands for infrastructure increase in a context of limited public funding capacity.[63] As populations increase and demographics change infrastructure requirements need to meet the ongoing demand, Figure 39.



POPULATION		
'Yesterday' – 2000	'Today' – 2020	'Tomorrow' – 2040+
1.89 million people 73% based in Perth Approximately 516,000 people in the regions[3] Median age - 34.2 years[4] 66.3% in the workforce[5]	2.63 million people 79% based in Perth Approximately 571,000 people in the regions[6] Median age – 36.9 years[7] 68.2% in the workforce (pre-COVID-19)[8]	Forecast population to exceed 4 million by 2040[9] Population primarily residing in Perth, Peel and south-western regional centres Increased total regional population, but some regional areas may continue to decline Ageing general and workforce population

Figure 39. Forecast population for West Australia[63]

Australia's small towns, rural and remote areas face very different infrastructure opportunities and challenges to their urban counterparts. High construction costs are a major challenge, sometimes compounded by:

- Vast distances with low population density
- Limited local workforces, and
- Significant challenges of attracting workers to remote projects.
- Exposure to extreme climate and weather events, including drought, bushfire and flood, also bring considerable resilience risks.
- And rural and remote areas can be more vulnerable to the risks of natural hazards, requiring greater investment to protect or maintain these assets.[64]

Many of our small towns, rural and remote communities also rely on single assets and networks, with limited choice for users and increased likelihood of redundancy or asset failure. At the same time, communities and businesses in these areas are also more reliant on available infrastructure for their

[63] Infrastructure Western Australia. (2020). A look at the Sectors, a complementary resource to: A Stronger Tomorrow, State Infrastructure strategy Discussion Paper

[64] https://www.infrastructureaustralia.gov.au/listing/speech/challenges-and-opportunities-regional-infrastructure-investment

productivity and wellbeing. There are opportunities to share resources, skills and facilities between these communities, and between smaller communities and larger metropolitan centres, to:

- Reduce costs
- Improve access and
- Co-ordinate infrastructure delivery more effectively.

The need for well-functioning, fit for purpose and cost-effective infrastructure is fundamental for regional and rural economic development. Keeping the agriculture sector competitive in an export focused market requires governments to invest and support ongoing improvements in transport corridors, communications, and energy. Access to water is critical and encouraging and supporting self-sufficiency with a level of back up for extreme droughts and risk management appears a sensible position for WA.

5 POTENTIAL FUTURE ECONOMIC IMPACTS OF DROUGHT

The world population is expected to be almost 10 billion people by 2050 and Australia's population is expected to be 35.9 million. Not only can we expect a lot more mouths to feed, but improvements to the socio-economic status of people across many regions, including Asia and Africa, will lead to changes in diet. This will result in a large increase in food demand, which will in turn require increased food production through the expansion and intensification of agriculture.[65]

As the Australian population increases somewhere between 4 and 4.9 million people by 2030, the outlook for the Australian feed grain demand is anticipated to increase by between 2.24 million tonne (mt) and 2.48 mt which means an additional 0.6 to 0.77 mt will be required for feed grain and food demand in flour and malt production. Population and per capita income growth will also drive an increased demand for animal protein which in turn will increase domestic demand for feed grains.[66]

This anticipated increased demand is concomitant with an expectation that droughts are expected to increase in frequency.[67] In 2008, CSIRO and the Bureau of Meteorology identified that the areal extent and frequency of exceptionally hot years had increased rapidly in previous recent decades. They predicted this trend to continue. For southwest WA the mean projections indicated that by 2010-2040 exceptionally hot years were likely to affect 80% of the region and occur every 1.2 years on average. Exceptionally low rainfall years were likely to affect 18% of the region and occur once every seven years on average and by 2030 exceptionally low soil moisture years are likely to occur once every six years on average.[68]

During periods of drought when grazing animals have inadequate pastures they will require supplementary grain-feeding to maintain animal welfare and sustain their production putting further pressure on grain supplies and during these periods of low supply concomitant with high levels of demand it is likely that prices increase, ultimately being passed on to consumers, although this depends on world supply and demand.[69]

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[65] Phalan, B., R. Green and A. Balmford. (2014). 'Closing yield gaps: Perils and possibilities for biodiversity conservation', Philosophical Transactions of the Royal Society B: Biological Sciences 369(1639): 20120285. DOI:10.1098/rstb.2012.0285.

[66] Kingwell, R. (2019). Australia's Grain Outlook, 2030, AEGIC https://www.aegic.org.au/publications/reports/

[67] DAFWA. (2014). The evolution of drought policy in Western Australia. Developed by the Rural Business Development unit. Retrieved 11-04-2022 https://www.agric.wa.gov.au/drought-and-dry-seasons/evolution-drought-policy-western-australia?

[68] Hennessy K, Fawcett R, Kirono D, Mpelasoka F, Jones D, Bathois J, Stafford Smith M, Mitchell C, and Plummer N. (2008). An assessment of the impact of climate change on the nature and frequency of exceptional climatic events, Bureau of Meteorology and Commonwealth Scientific and Industrial Research Organisation.

[69] Australian Farm Institute. (2020). Government farm financial risk management measures. Research Report

At the regional level, relatively farm intensive parts of the regions like the pilot LGA's suffer proportionally greater through drought induced losses, however, drought also creates wins for other locations supplying grain or hay and receiving higher prices due to low supplies.

5.1.1 Factors that make farm businesses and regions more vulnerable to the economic impacts of drought.

- Low levels of water infrastructure
- High levels of debt
- High interest rates
- Declining terms of trade
- Low levels of productivity (more inputs for output)
- Low populations in communities
- Low levels of diversification (sector)
- Low quality internet communications – reduces the capacity for diversification in communities and accessing data is problematic.

5.1.2 Factors that make farm businesses and regions more resilient to the economic impacts of drought.

- Access to water and good water infrastructure
- Low levels of debt
- Low interest rates
- Improving terms-of-trade – commodity prices
- Efficiency in productivity (less inputs more output)
- Populated communities
- Diversification
- Fast and reliable internet communications

Innovations and farming practices that are helping farmers to adapt to climate change.[70]

1. General sound management such as weed control, appropriate varieties and stock husbandry.
    a. Practices such as new varieties are readily adopted, but other issues such as weed management needs to be integrated into a complex system.
2. Non-wetting management, such as clay spreading, mouldboard ploughing or application of wetting agents.
3. Seeking methods for improving soil biology to improve efficiency of inputs such as fertiliser
4. Application of lime to improve soil pH and deep ripping for improvement in subsoil pH
5. Precision Agriculture tools such as GPS monitoring of operations allow for better targeted application of inputs.
6. Alternative crops and pastures, chickpeas, long coleoptile wheat varieties
7. Lick feeders and increased storage facilities for grain and fodder
8. Labour-saving technology for stock.
9. Re-greening farms to benefit biodiversity in a changing climate.

[70] Rees, D (2014) Capacity of farmers to adapt to changing climate in the south coast region of Western Australia, South Coast NRM.

Table 10. Vulnerability and Resilience to drought

Factors that make regions vulnerable to drought	Factors that make regions more resilient to drought

• Low populations
• Reliance on one sector
• Low level of support service for mental health
Insufficient infrastructure to grow economies
• Communications - internet
• Power
• Water
Environmental management – no control of feral animals – creates high grazing pressure on remnant vegetation and biodiversity.
	• Strong communities
	  ○ Functioning community groups
	  ○ Sporting facilities
	  ○ Community facilities
	  ○ Diversity in the economy
	• Access to mental health resources
	• Access to high-speed internet
	• Access to backup water resources
	• Fire management infrastructure
	• Feral animal control management plans - Fox shoots

Factors that make farm businesses vulnerable to drought	Factors that make farm businesses resilient to drought

• High levels of debt and low equities
• High debt to income ratios – high debt levels and low income or high variability in income
• Complacency
• No planning for drought
• Scale – size of farm
• Poor soil health
  ○ Poor water retention
  ○ Low pH
  ○ Salinity
  ○ Non-wetting
• High pest and disease pressure
	• Low levels of debt with high levels of equity
	• Assets that can be sold quickly
	• Good decision making
	• Preparedness – a drought plan
	  ○ Water
	  ○ Stocking rates
	  ○ Fodder management
	  ○ Fire management plan
	• Financial management
	• Implementation of natural resource management practices
	• Adoption of existing and new technologies
	  ○ Understanding and monitoring pasture growth rates
	• Data driven decisions
	  ○ Understanding risk
	  ○ Calculating break-even yields

5.2 Australian drought Policy – Past and Present

Drought policies go back decades with varying degrees of success accompanied by much debate. During the 1970's and 1980's drought was treated as a natural disaster and assistance was given like other natural disaster relief payments. However, it was considered poorly targeted, distorted input prices and acted as a disincentive for farmers to prepare for drought, so in 1989 drought was removed from the natural disaster arrangement. In 1992 a Nation Drought Policy which emphasised self-reliance and sustainable management of farms to protect the resource base was established.

The policy was amended again in 1997 when interest rate subsidies and relief payments were introduced for drought declared areas underdoing 'Exceptional Circumstances' (EC). The area in drought had to be declared an EC area to receive any assistance, Figure 40.[71]

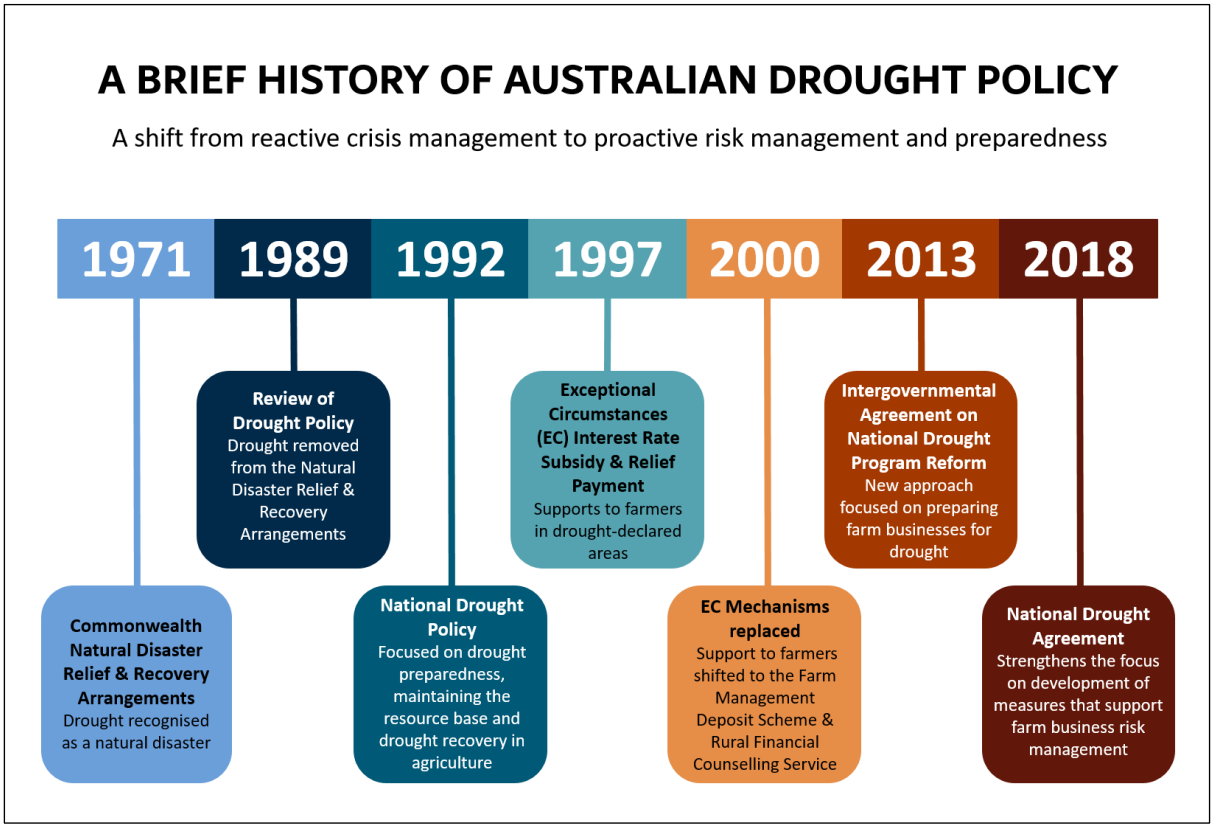

Figure 40. A brief history of Australian drought policy

Several reviews of the EC program found it to be ineffective with little or no motivation for farmers to be prepared and responsive to drought. Criticism of the EC declaration process included the 'lines on maps' where some people on one side of a road were ineligible, yet their neighbours were eligible, and yet they were all in drought conditions. Another common criticism from many farmers was how the interest rate subsidies 'supports bad managers' .....'some farmers should leave the industry due to their mismanagement'.

Interest rate subsidies and relief payments slow the rate of adjustment, they allow some farmers to survive, but ultimately, they provide a level of support to land prices. EC programs were closed in

[71] Bourne, A. (2022) Drought report

2012 with a view of implementing drought policy that motivated farmers to be prepared for drought.

The National Drought Agreement (NDA) agreed by the Council of Australian Governments (COAG) in December of 2018 sets out a joint approach to drought preparedness, responses and recovery, with a focus on accountability and transparency. The agreement recognises the need to support farming businesses and farming communities to manage and prepare for climate change and variability. It continues to build on drought policy reform including moving away from Exceptional Circumstances arrangements associated with lines on maps to qualify for drought support and provides a framework to enable consistency of drought policy and reform objectives and complementarity of drought preparedness, response and recovery programs.

Under the NDA the Commonwealth is responsible for:

- Funding and delivering household support payment based on individual and farming family needs, including.
    - Reciprocal obligations that encourage resilience; and
    - Case management to support reciprocal obligation requirements.
- Establishing and operating a Future Drought Fund, to enhance drought preparedness and resilience.
- Providing continued access to incentives that support farming businesses' risk management, including taxation concessions, the Farm Management Deposit (FMD) Scheme and concessional loans.
- Improving and maintaining national, regional and local predictive and real time drought indicator information, drawing on the Bureau of Meteorology's (BOM) observation network and forecasting.

Each State or Territory is responsible for:

- Encouraging the delivery and uptake of capability-building programs to improve farming businesses' skills and decision making that are flexible and tailored to farming businesses' needs.
- Ensuring animal welfare and land management issues are manage during drought.

There remain wide differences in policies between States in relation to drought assistance. Western Australia, South Australia, the Northern Territory and Tasmania do not provide any programs for the assistance of dealing with drought. New South Wales and Queensland provide a range of drought relief subsidies including fodder and water transport subsidies (NSW & QLD), concessional drought loans (NSW) and concessional farm improvement loans (NSW).

There is a degree of criticism with regards these assistance programs:[69]

- The assistance has unintended consequences and adverse incentives that inconsistent with the NDA
- The assistance is based on transaction subsidies and concessional lending that have been criticised by many past reviews of drought policy.
- The assistance programs are inconsistent with the NDA to which the States are signatories
- The programs do little to reward preparedness and self-reliance which are objectives of the NDA

- The dramatic difference in state assistance regimes causes significant inequity between farming businesses in different States.

Economic analysis conducted by Wittwer, G (2019) using dynamic VU-TERM CGE modelling on subsidies given to farmers in NSW during the 2019 drought appears to support these criticisms, subsidies create winners and losers.

A case study from the most recent 2019 drought:
Subsidy of road freight for fodder transport in NSW.[72]

The NSW government provided $190 million of transport subsidies to facilitate the movement of fodder. The rationale is that if livestock can be kept alive until the season breaks, livestock farmers will maintain their capital base (i.e., herd) as a source of future income.

From economic analysis without using a model, it is expected that any subsidies on either fodder transport or fodder will push up the producer price of fodder. This will disadvantage buyers of fodder who are not beneficiaries of the subsidy. Fodder supplies have also been reduced due to drought, so that in effect a subsidy used to purchase a drought diminished quantity of fodder will push fodder prices up even more than drought alone. The subsidy will also push up the price of road transport. The hope of government in implementing a subsidy is that the upward pressure on producer prices for fodder and road transport will be more than offset by reductions in user prices. This is only so for direct beneficiaries.

Beneficiaries are those farmers for whom the subsidy more than offsets the hike in producer prices. Losers are users of hay, cereal & fodder who are not beneficiaries of the subsidy. State-wide livestock output losses are smaller with the subsidy. But these apparent gains come at the expense of producers who are not direct beneficiaries, including those in NSW in drought-affected areas who are not recipients of the subsidy.

This illustrates the complexity of providing subsidies and the complexity of drought. On further exploration a better alternative for the $190 million spend was to give the money to households in drought affected regions. This resulted in a slight improvement in both national and state welfare compared to drought with no transfer to households.

Other forms of support provided in the 2019 drought was the **Emergency Water Infrastructure Rebate**. This rebate was made available to horticulture farmers and primary producers in each State and Territory. The rebate was made available to help drought impacted farmers with the cost of buying, installing or updating on-farm water infrastructure by rebating 25% of eligible costs. Introduced as a short-term response to drought in 2018-19. This policy response is possibly without true consideration for all the implications, it was unplanned, ad-hoc and disadvantaged farmers who had invested in these assets prior to the drought. It therefore reduces incentive for farmers to invest in drought preparedness prior to the next drought and sends a confused message about government preparedness to support farmers.[72]

Australian farmers are some of the least subsidised in the World (Figure 41). A low taxation base in comparison to other countries is one of the main reasons for this. Also, Australia's climate and its geography are unique. Australia is a small, open, trading economy, remote from many of its markets,

[72] Wittwer, G. (2019). The regional economic impacts of the 2017 to 2018 drought on NSW. Centre of Policy Studies Victoria University. Paper accompanying presentation at the Global Economic Analysis Conference in Warsaw, Poland.

which sells two-thirds of its agricultural produce to other countries. Heavily subsidising Australian agriculture would mean the Australian taxpayer subsidising overseas customers as part of the benefit is transferred to the recipients.[69]

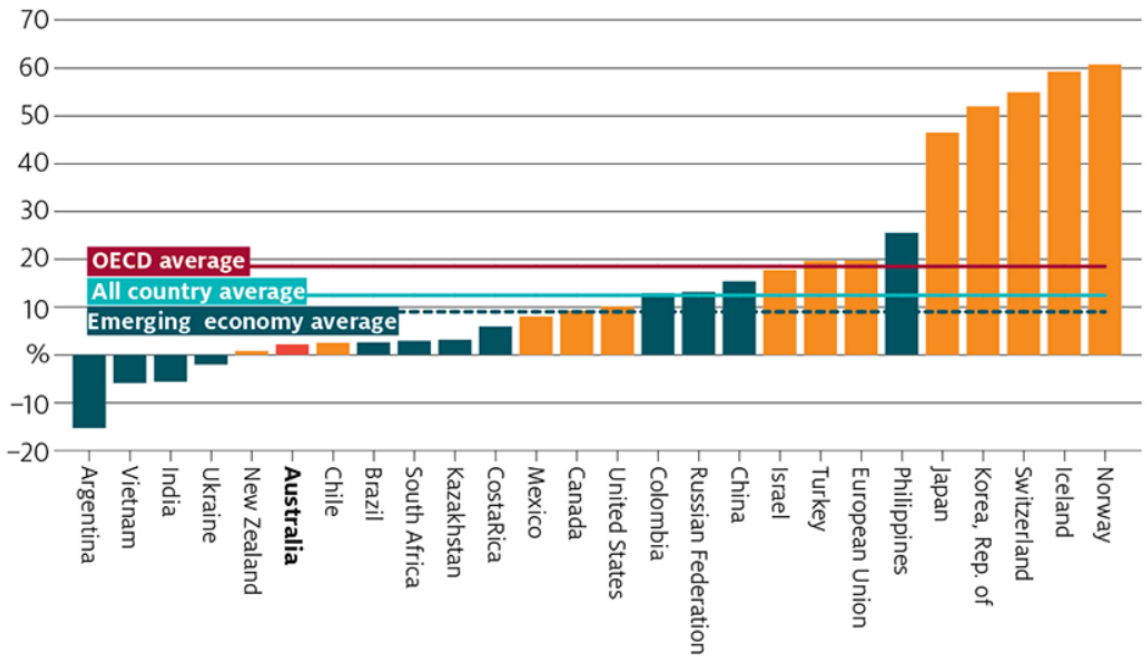

Figure 41. Level of subsidisation in World agriculture[73]

Governments rely on investment in research and development and creating open and effective markets to grow exports. However, in recognition of the variability and risk associated with farm incomes due to climate, several services are provided to farmers, and more recently, small business in regional areas in times of hardship.

Provision of timely and accessible social security measures are an important counterpoint to a policy environment in which minimal assistance is provided by government to mitigate farm business risks.[48]**Error! Bookmark not defined.**

Besides the tax incentives outlined in Appendix 4, the key programs for drought and crisis management are.

5.2.1 Rural Financial Counsellors

This service is for farmers and rural small businesses to access assistance at no cost in times of hardship. Financial counsellors assist clients to identify their options and access services required.

The RFCS is a critical element in providing a social support network for farmers who fall into financial difficulty. It operates at the difficult nexus between the farm business and the often-urgent needs of the farm family. The service addresses the prospects for the farm business while also providing support for the family, very often dealing with issues around anxiety and depression. This exposes a fine line between facilitating adjustment for the farmer client while not impeding the

[73] Greenville, J. (2020). Analysis of government support for Australian agriculture producers. ABARES Research Report, Canberra, May, CC BY 4.0 https://doi.org/10.25814/5ec71d9ccf774

adjustment process for struggling businesses. Being able to access mental health services in a timely manner required in remote areas can be difficult.

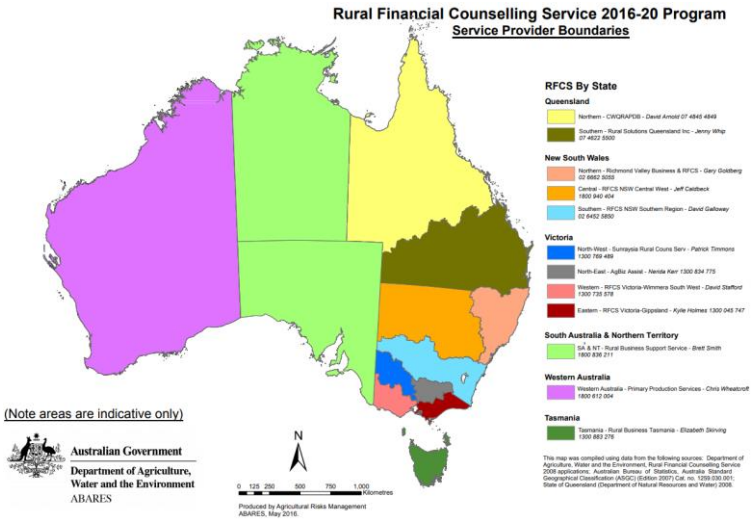

Figure 42. Map of boundaries for Rural Financial Counselling service

5.2.2 Farm Management Deposits

The scheme allows primary producers to make tax-effective deposits in higher-income years, which can then be withdrawn in lower-income years. It does this by providing a deduction for deposits into an FMD account in the year the deposit is made and taxing the income in the year it is withdrawn. This reduces the impact of progressive marginal tax rates, particularly for primary producers with highly variable incomes.

As of 30th May 2021, the total funds held in farm management deposit (FMD) accounts is $5.27 billion. In the order of 25,000 primary producers make deposits or withdrawals in their FMD accounts each year. The costs of the FMD Scheme (in revenue forgone) vary each year and depend on the extent to which primary producers invest in FMD accounts or withdraw from them. Treasury estimates the revenue forgone from the scheme of $500 million in 2017–18, reducing to approximately $110 million in 2020–21.[74].

The latest and fourth review of the FMD scheme established that the scheme is supported by most stakeholders as a valuable tool to support primary producers manage risk, including building resilience and managing through drought.

There is an opportunity to assist small producers, with less cash-flow, with other risk management tools because there is limited take-up of FMD's in this cohort. FMD's are used by profitable primary producers with adequate liquidity to participate.

[74] DAW. (2021). Farm Management Deposits Scheme: 2021 evaluation, Department of Agriculture, Water and the Environment, Canberra. CC BY 4.0.

5.2.3 Regional Investment Corporation – helping with finance

The RIC was established to provide a nationally consistent source of finance for:

- Australian farm businesses and regional communities.
- Growth of regional economies across Australia.
- Construction of major water infrastructure by state and territory governments.
- Infrastructure investments that provide long-term regional economic growth and development by providing secure and affordable water through investments in economically viable water infrastructure.

Drought loan

To assist farm businesses through drought, with loans of up to $2 million with a 10-year term and a 2.11 variable interest rate, the first two years are interest free with no repayments required.

If the Drought Loan is being used to refinance, at least 50% of total debt must stay with a commercial lender.

Farm Investment Loan

Assists farm businesses to invest in in projects and infrastructure with loans of up to 0 $2 million, a 10-year term and a 2.11 variable interest rate that will strengthen their business. The first five years repayments are interest only.

Agristart loan

Assists first time farmers with loans to support farm succession arrangements – from April 2022 this loan includes share farming and leasing.

AgBiz drought loan

Assists small business (not primary production) through drought, with loans of up to $500,000 with a 10-year term and a 2.11 variable interest rate, the first two years are interest free with no repayments required interest rate, the first three years repayments are interest only.

In Australia there is a general acceptance that businesses of all types need to manage their risks, big and small, as well as the financial consequences of those risks. The freedom and the incentive to find the right balance between risk and reward, the 'sweet spot' between driving business growth and being able to satisfy suppliers, lenders and owners has contributed to Australia's overall economic prosperity - and in agriculture, to its efficiency and trading success.[69] In the next section we examine the farmers response to drought and how they make decisions to balance risk and reward.

5.2.4 Farm Household Income support

FHA was developed by the Federal Government in 2014 to provide income support and assistance to primary producers facing financial hardship. The FHA is available to farmers irrespective of cause, it is available to farmers impacted for drought but also when they are experiencing financial hardship for other reasons besides drought.[75]

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[75] Lawrence, M, Somerset, G & Slonim, R 2019, Rebuilding the FHA: a better way forward for supporting farmers in financial hardship, an independent review of the Farm Household Allowance, Canberra, February. CC BY 4.0.

The FHA is available to farmers who are an Australian citizen or permanent resident over the age of 16 who have a legal interest or right in land which is used for the purpose of a farming enterprise.

A large amount of the farmer's labour and capital must be contributed to the farming business which is in Australia and has a significant commercial character or purpose.

The allowance includes:[76]

- fortnightly income payments.
- ancillary allowances for expenses such as telephone and pharmaceutical.
- access to financial business assessments.
- grants for upgrading skills.

As of 30 September 2020, data from ABARES indicates that more than 19,000 farmers appear to be eligible for the allowance but have not applied. Since the scheme began in 2014, more than 16,000 farmers have received the FHA with most recipients residing in NSW, Queensland, and Victoria.[69]

5.3 How do farmers respond to drought?

Resilient farming systems which have the capacity to adapt to changing environments are key to the future success of farm businesses facing uncertain conditions. Farmers mitigate risk with their management practices, through active management, farmers limit the effects of climate and price risk. For example, in the cropping sector farmers make use of weather and commodity price forecasts, reduce crop area planted and inputs applied (like fertiliser) when drought conditions or poor output prices are more likely.[77]

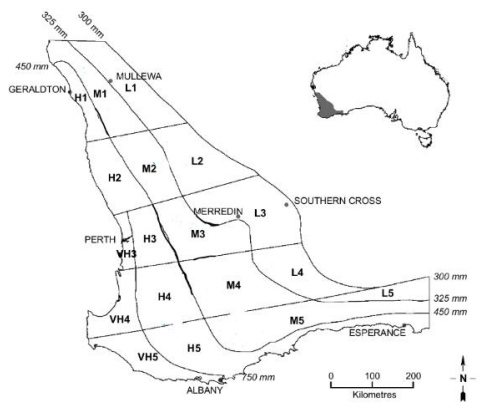
In the livestock industry farmers monitor pasture growth rates, store adequate quantities of grain and hay, and generally run lower stocking rates.

The importance of organisational skills and timely management decisions cannot be underestimated for managing risk and farm performance. Figure 43 shows the operating surplus/deficit per hectare for a group of 270 broadacre farms between the years of 2002 and 2011. The results are organised into different rainfall regions, which are shown in the map This data shows the:

- Variation in the operating surplus/deficit per hectare between years, as expected.
- Operating surplus/deficit per hectare in the drought years of 2002, 2006 and 2010 is lower in most regions than other years, for example, M1 and M2.
- Large variation between farms in the same region, supporting the concept that management decisions alter financial outcomes for farms.
- Farms are unique and profit outcomes are specific to each farm and set of circumstances, i.e., debt levels, size, machinery, innovations, human resources, etc

[76] Department of Agriculture. (2020). *Farm Household Allowance*. https://www.agriculture.gov.au/agfarm-food/drought/assistance/farm-household-allowance

[77] Hughes, N., Galeano, D and Hatfield-Dodds, S. 2019 The effects of drought and climate variability on Australian farms. ABARES Insights.

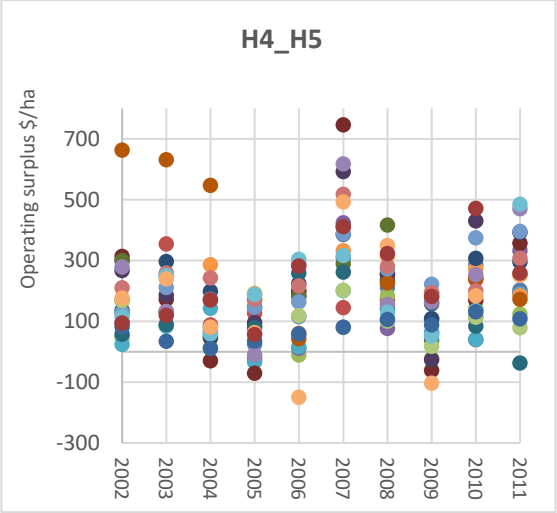


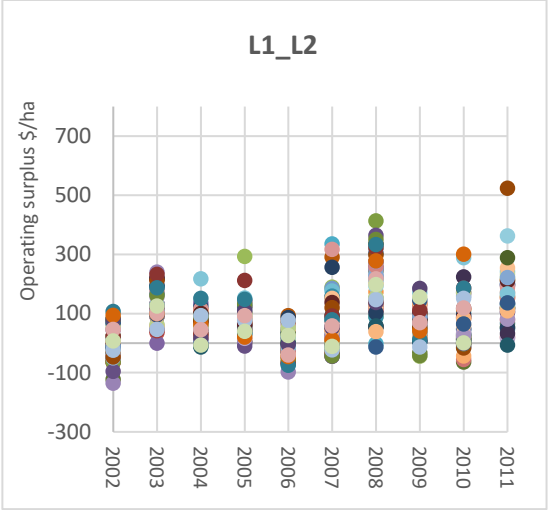
VH – Very high rainfall,

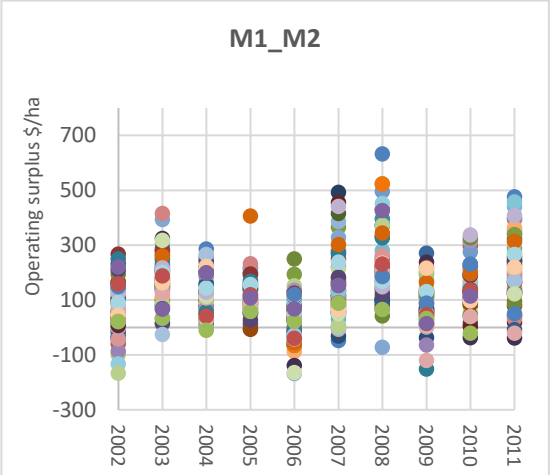
H- High rainfall

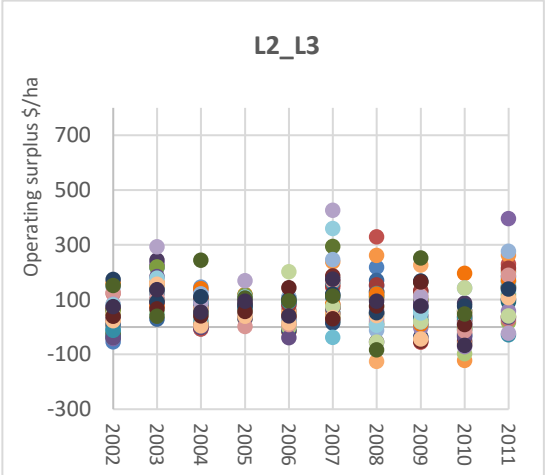
L – Low rainfall

M – Medium rainfall









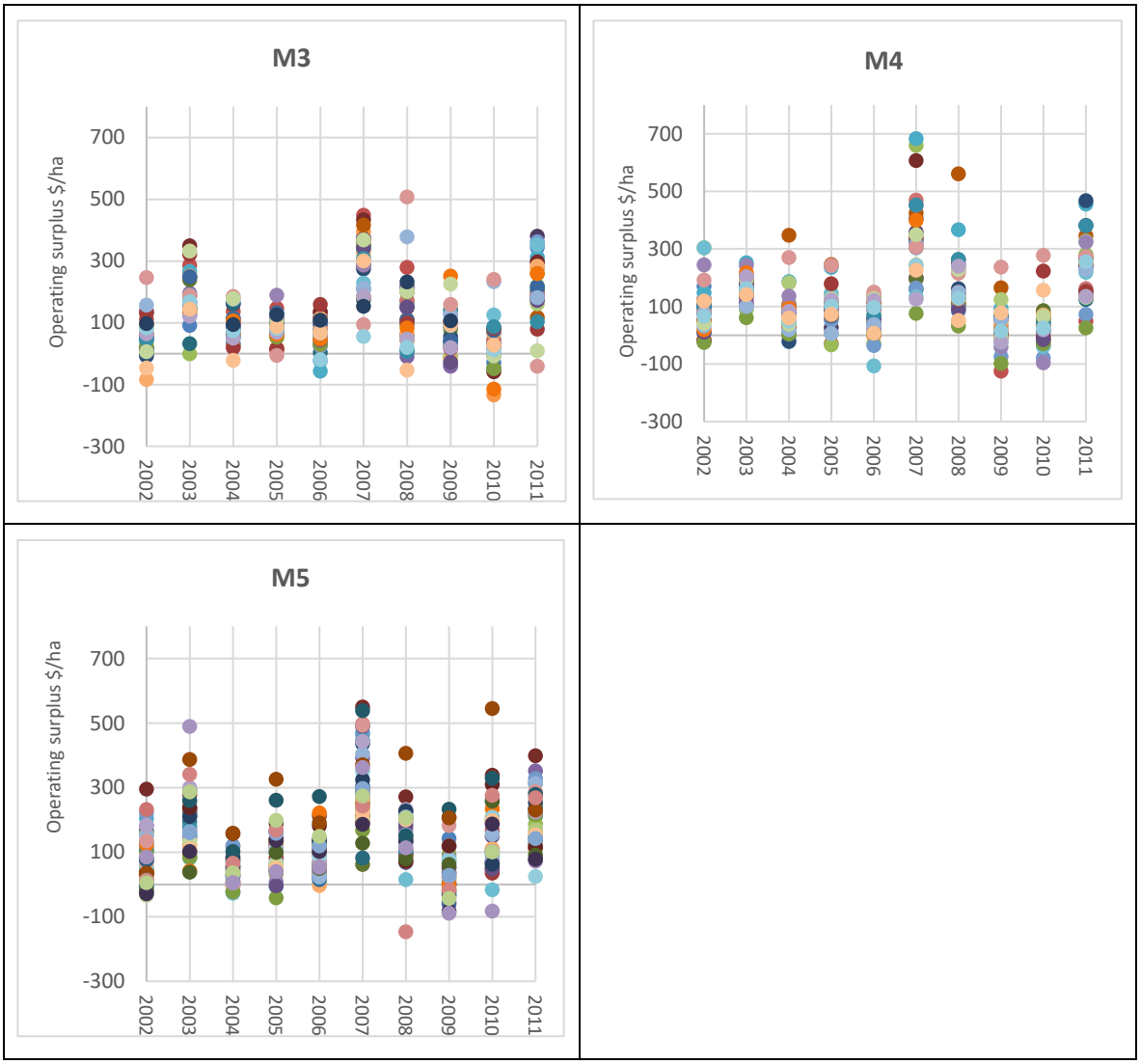


Figure 43. Operating surplus ($/ha) for 270 farms in WA by rainfall region 2002 to 2011[51]

Drought can be highly localised such that even in years of widespread drought as many as half of all farms may not be considered drought affected. Further, the indicators show that drought effects are highly farm specific such that outcomes can vary greatly even for farms in the same region facing similar weather conditions.[78]

Decision-making is identified as a key factor which influences farmer's capacity to adapt and build resilience, and the financial performance of the farm business is inextricably linked to business resilience and its ability to cope with variability. Therefore, understanding the risks and financial implications of decisions is necessary for building resilience.[Error! Bookmark not defined.]

Resilient farming systems which have the capacity to adapt to changing environments are key to the future success of farm businesses facing uncertain conditions. Resilience is defined in terms of the ability of a system to absorb shocks, to avoid crossing a threshold into an alternate and possibly

[78] N. Hughes, W.Y. Soh, C. Boult, K. Lawson. (2022). Defining drought from the perspective of Australian farmers, Climate Risk Management, Volume 35,

irreversible new state, and to regenerate after disturbance.[79] The Department of Agriculture Fisheries and Forestry define the building of resilience as 'increasing the human capacity for anticipation and learning to minimise environmental, financial and social costs through enhanced adaptive capacity'. [80]

Resilience is recognised as a key component for the adaptive capacity of an individual, group, community, or sector. It is a complex process which needs to be understood in the context of wider and social economic systems. Greenhill et al. (2009) identified eight themes that influenced the process of resilience, (1) Pre-existing viability of the business, (2) Income security, (3) Managing risk and decision-making, (4) More than a farmer, (5) Opportunities to disengage, (6) Health and well-being (7) Farm women (8) Age and generational change.

Studies such as Hogan et al. (2011) and Greenhill et al. (2009) identified financial viability as one of the key issues for farmers. The main objective of policy and investment decisions should be to improve farm business performance and profitability of the farm sector which assists their adaptive capacity and builds their resilience to climate change.

5.3.1 Farmer decision making

Decision making processes for the farm business can be improved. The literature shows that, although farmers make many of their decisions based on 'gut feel' or rules of thumb, that their decision making (and that of their advisors) can be improved by encouraging them to access more information, reflect more on their experiences and get a better understanding of the relationship between the many variables of their business.

There are several areas for farmers to focus on to improve their decision-making processes:

- Farmers to know themselves and their businesses better. Smart farmers have a better understanding of the big picture of their business and how it interacts with the world and use experience, observation and a comprehensive 'world view' to identify the important variables of a decision quickly.[81]
- It is also important for farmers to know themselves and understand the prejudices and biases that influence their decision making. [82]
- Helping farmers to identify and assess the risks and uncertainty of their situation.
- Encouraging farmers to develop a clear vision for the future with the other members of their household/business.
- Consider who is responsible for the final decisions in the different area so your farm business.[83]

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[79] Resilience Alliance. (2009). Assessing and managing resilience in social-ecological systems: a practitioner's workbook, version 1.0. http://wiki.resalliance.org/index.php/Main_Page.

[80] DAFF. (2006). National Agriculture and Climate Change Action Plan 2006-2009. Department of Agriculture, Fisheries and Forestry, Canberra.

[81] Gibb, I. (2015). How do some farm managers always seem to make the right decision? Australian Agribusiness Perspectives, Paper 105.

[82] Vegetable Industry Development Program. (2016). "Business Decision Making" - ausvegvic.com.au. (n.d.). http://ausvegvic.com.au/pdf/ VIDP_business_decision_making.pdf WALRC, (2020) WALRC priorities for the MLA 2020-21 R & D call

[83] GRDC. (2013). Making effective business decisions. Farm business management fact sheet. GRDC, Barton ACT.

- Extending and promoting existing resources that will enable farmers to make complex decisions. These might be decision tools, rules of thumb or information sources and how they can be used.
- Encouraging farmers to make decisions that include non-economic factors of farm i.e., household, people, resources. Farmers need to acknowledge non-profit maximising influences on their decision making.[82]
- Developing intuition and rules of thumb. Several strategies exist that can assist in developing intuitive decision-making capacity.
- Helping farmers develop the skills to ask the right questions, gather and analyse enough relevant information, from others and those affected by a decision, to be confident in that decision.[82] "Fundamental to good farm management analyses and decision making is identifying the real nature of the problems correctly, bringing to bear on them the technical, human, economic and financial conceptual and analytical skills".[84] Figuring out when to stop gathering information is also important. "Our goal is crudely right, not precisely wrong," (USDA, 1993)
- Encouraging farmers to have processes in place to review and improve decisions.

Farm business management is about converting resources, skills and competencies into a financial outcome to meet business and family lifestyle goals. Decisions are made on physical inputs and outputs, which are determined by climatic, technical, and economic environment, it is about responding to a complex set of variables and risks. Like most walks of life, risk and uncertainty are inescapable.

The complexity associated with understanding these risks and the many variables and their interactions is time consuming, therefore, many farmers outsource their most basic financial analyses to a third-party which is costly. The advantage to this strategy is having a third party with expertise to discuss options. The disadvantage is the third party usually has control of the economic model and numbers; the farmer must rely on the firm to "crunch-the-numbers" and perhaps why farmers rely on gutfeel and intuition for many of their decisions.

5.4 Data & Decision support tools

Arguably, some on farm decisions have moved beyond human capacity and using technology to provide the intellectual power required to optimize decisions is inevitable.[Error! Bookmark not defined.] As momentum gathers in the world of digitalisation there is an opportunity to create tools to assist farmers with understanding risks and the financial implications of their decisions. Data based decisions backed by scientific principles will increase the objectivity of farm-decision making. As farms continue to grow and ownership structure more complex, automated data-based decision-making will simplify decision processes.[1] However, these tools need to be user friendly and talk the same language as farmers. It means that the end user must feel the technology is relevant and credible, using terminology they can relate to with a low-level pain threshold to achieve some quick wins.

One of the limitations of this review was being able to access suitable data to understand how farm businesses and small businesses perform and react to drought conditions. Accessing individual farm

[84] Moran, J. (2009). *Business Management for Tropical Dairy Farmers*, Chapter 2, Pages 11-14 Land-Link Press.

data is problematic, the cost of data collection appears prohibitive and there are limited data sources available, despite the number of products ABS and ABARES produce.

- Australian Bureau of Statistics- production and gross value data is available but is limited in approach to access and not available in time series.
- ABARES farm survey data is limited by financial year instead of production year and is therefore difficult to interpret performance.

The sources of information available like the ABS statistics provides some useful statistics on production quantities, hectares grown and numbers of sheep but there is very limited financial data available which is collected by ABARES. There is significant reliance on data from farm consultants which also has limitations because it does not necessarily provide a representative sample of farmers, so there is an element of risk relying solely on this type of data for policy decisions.

With advances in digital data collection and big data sets there is an opportunity for harvesting of data to inform government policy and the industry sector. Figure 44 provides a visual concept for data collection and analysis.

Figure 44. The digital data possibilities

5.4.1 Review of existing tools

A range of computer-based tools, developed by scientists or software companies to assist farmers, collectively known as decision support tools, offer a range of services to farmers. Some of these farm management software programs and tools were developed 30 years ago and others more recently. Many of these decision support tools are developed by researchers or commercial operators and often without the collaboration of the end-user.

A review of tools available in 2016-17 was conducted by Anderton and Kilminster (2017).[36] The purpose of the review was to evaluate their suitability as a whole-farm analysis tool, simulating a mixed farming wheat-sheep system typical to broadacre farms in WA. Hutchings, T (2013) outline four specifications for a successful dynamic, whole farm model

1. The capacity to use all relevant information available to the farm manager.[85],[86]
2. This would encompass the multi-disciplinary nature of the farm business process.

[85] Makeham, J.P. and Malcolm, L.R. (1993). *The Farming Game Now*, Cambridge University Press, pp 399.
[86] Malcolm, L.R. (2004). Farm Management Analysis: a core discipline, simple sums, sophisticated thinking. AFBM Journal, 1(1), 45-56.

3. The ability to replicate the decision-making process at both strategic and tactical levels for a range of sites and regions
4. A range of reports which make the process fully transparent to the user. This includes the ability to calculate movement in all common financial benchmarks including a statement of net worth.[86]
5. An output which incorporates a validation and verification process which lends credibility to all aspects of the output.[87]

An updated summary of tools most likely to be used in WA agribusiness or for research purposes are presented in Appendix 4.[88] The criterion used for evaluation of the tools is, similar to Hutchings, T (2013) and are:

- Does the tool evaluate or analyse the whole farm?
- Is it easy-to-use?
- Is it Transparent, i.e., the ability to see how the figures are calculated
- Does it require minimal inputs by the user?
- Is it possible to do different scenarios for scenario planning?

6 DISCUSSION

Rural communities like the pilot region LGA's examined in this study have a low level of diversity in sectors across these regions, except for a few regional centres like Katanning and Greater Geraldton and they are very dependent on the agriculture sector for their economic well-being.

The long-term trend in regional areas populations declining is a separate issue from the effects of drought; however, there is an interaction between the two issues. Economic and social decline in regional Australia is not simply a result of declining contributions of certain sectors—either because of drought or falling prices for produce. Rather, it also includes a demographic decline that feeds back into a lack of regional infrastructure and local amenity (Barr, 2004). In the long run, if drought conditions become more prevalent, we can expect populations to move away from less productive areas unless there is the capacity to adapt.

Never more so has the need for fast and quality internet been so important. It provides an opportunity for people to live and work in the regions and for businesses to access the latest data collection systems. Since the COVID-19 pandemic and the willingness to use video conferencing on personal computers people have moved from urban areas to seek a different lifestyle and populations in some rural areas are increasing.

The reliance on agriculture in regional areas means that drought impacts negatively on the economic and social well-being of these communities. The difficulty around defining and measuring drought creates difficulties for all actors to respond in a timely and appropriate way and the true economic impacts of drought on a region can only be measured in hindsight, at the end of the drought, because the duration is so unpredictable.

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[87] Cahane, C. (2008). Modelling Fundamentals. *Centennial Review*, 24(1), 43:64.

[88] Hutchings, T.R. (2013). Financial risk on dryland farms in south-eastern Australia. A thesis submitted for the degree of Doctor of Philosophy Faculty of Business CSU.

Forecasting can estimate the impact and the dynamic VU-TERM CGE model appears to be one of the few models available to understand the impacts of drought on the whole economy (Australia & regional). Early detection and understanding when a drought start's is still proving difficult despite the improved weather forecasting and data collection. Despite the availability of 'BIG DATA', systems and infrastructures we appear a long way from having the ability to inform farmers that a drought has started.

There is an opportunity to establish a network of 'typical' farms in WA to monitor farm performance and volatility of climate impacts which would be a cost effective and more informative strategy to understand the impacts of seasonal conditions. Already some 'typical' farms exist and are reported on by GRDC and Meat and Livestock Australia (MLA).[89] Canada, Spain and France use this approach.

We know from research that farmers work in complex environments with multiple variables to consider, they use "Rules-of-thumb", experience and knowledge to make decisions. They require skills in logistics and organising multiple factors because timing is critical and the top 25% have good organisational skills, Figure 45.

These are the farmers that are prepared for drought when it does arrive.

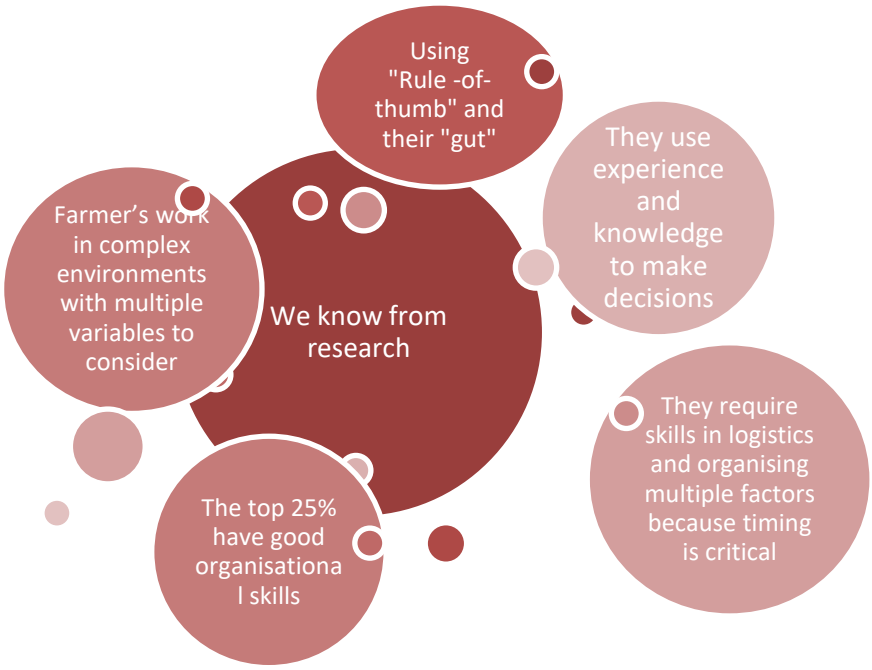

Figure 45. Farmer decision making

Farmer drought perception has changed over time with current farmers less likely to assess as being 'in-drought" compared to farmers in the past in the same circumstances, and generally, regions where average winter rainfall has declined significantly over the last two decades (such as south-eastern and south-western Australia) show strong changes in drought perception. But we know that farmers who have higher debt levels, higher off-farm incomes and older less-educated farmers are more likely to identify as being in a drought.[77]

There is a need to collect specific detailed wealth and asset data for farmers to better understand the implications of shocks like drought and there is a substantial role for government to play in ensuring that services in drought-affected regions are not run down in particular, the stresses arising from drought warrant publicly funded rural counselling services and health services.

[89] https://www.mla.com.au/prices-markets/Trends-analysis/agribenchmark/

Preparation for drought from a whole community perspective at the Local Government Level using an adaptive capacity index similar to the one developed by Sietchiping, R. (2007) would strengthen the community's capacity to adapt to droughts when they do occur.

7 CONCLUSIONS

Although WA is subject to a drying and warming trend in climate with increasing variability, it is the most reliable grain production area in Australia, at least to date.[90] The optimism and ingenuity of Australia's farmers cannot be underestimated. Farmers are achieving returns from seasons that would have been loss-makers a decade ago. Australian farmers manage inputs and costs more effectively than ever before, achieving returns on good and marginal land. [19] But the importance of building resilience to manage the future risks is essential for continuation of business success and the importance of Australian farmers being competitive in an export market, must not be underestimated. The priority for governments is to create and encourage open markets and trading conditions which allow farm businesses to sell products.

Fell, 2022 argues that to there is a need to continue to reduce non-tariff measures, open biosecurity export pathways, strengthen the multilateral trading system, address trade-and production-distorting agricultural subsidies, respond to changing societal concerns (including promoting and improving sustainability and emissions credentials) and advance productivity growth.[91]

The beef sector in 2019 was a clear example where strong demand from export markets supported prices during a period of severe drought. Farmers were able to respond to drought conditions with strategies that limited the financial impact, they could sell into a strong market to reduce numbers, but they could also afford to feed animals. Usually in drought conditions prices fall and the incentives to do either are lowered which creates further issues.[35]

The financial impacts of a drought on a farm can be considerably different from the biophysical impacts. Reporting, monitoring, and a better understanding of the main metrics of farm performance allows for a more complete view of the financial impacts of drought on farm businesses. This includes for the farm manager and for policy development. The important role of farm management in responding to drought indicates that support for and encouragement of skills in farm management is a better use of public funds than provision of farm input subsidies during drought.

Witwer, G. (2020) analysis concludes that temporary transfers to households in drought-affected regions are more beneficial than providing subsidies to farmers for drought support.[48]

In this review we have identified several decision support tools suitable for farmers to use to improve their decision making and preparedness for drought. There is an opportunity to assist smaller producers to use the risk management tools identified suitable.

Early detection, monitoring and dissemination of information to farming communities about the potential of drought conditions will allow for timely decisions. Using the right measures to understand drought in a timely manner will assist with the management of farm businesses and

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[90] Kingwell, R. (2020). Australia's Grain Industry in 2030 – a look into the Future. AEGIC

[91] Fell, J. 2022, Analysis of Australia future agricultural trade advantage, ABARES Insights, Canberra. Retrieved 13-04-2022https://www.awe.gov.au/abares/products/insights/australias-future-agricultural-trading-advantage

assist policy decisions. With early information appropriate services can be provided and accessed by rural and regional communities.

Figure 45 summarises priorities for drought planning identified by the FAO.

Figure 46. FAO Drought Planning

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APPENDIX 1

Project Brief

This work was commissioned by the Department of Primary Industries and Regional Development (DPIRD).

LA.ONE economics & consulting Pty Ltd (LA.ONE) was requested to review available economic data for agricultural and allied industries in the regions and identify regional vulnerability, needs and priorities for promoting economic resilience to future drought.

The request:

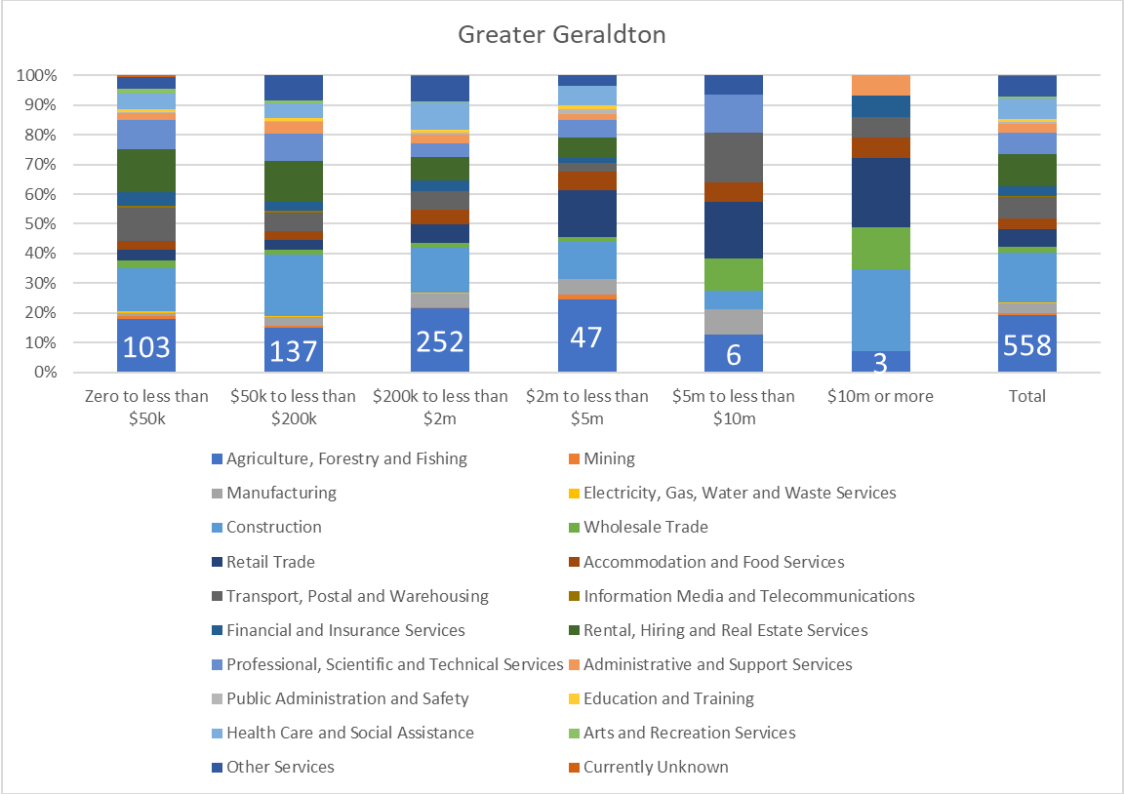
1. Review the extent and severity of economic impacts of drought in the region historically, and
2. Assess the likely economic impacts of drought in the future

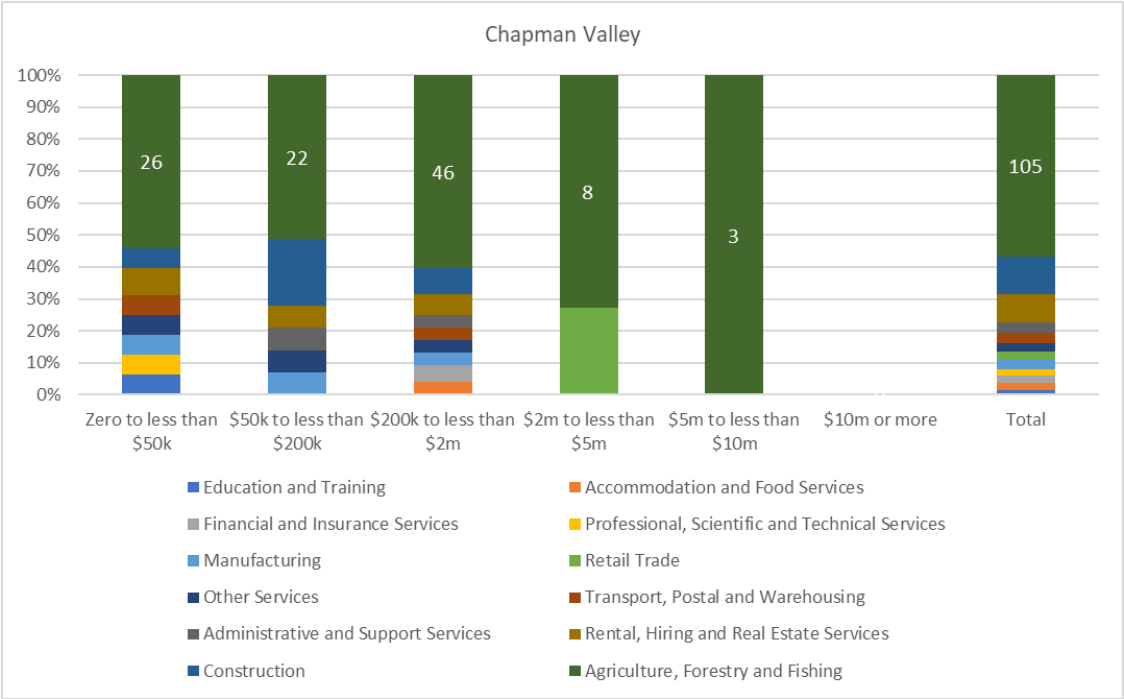
The requested method is to:

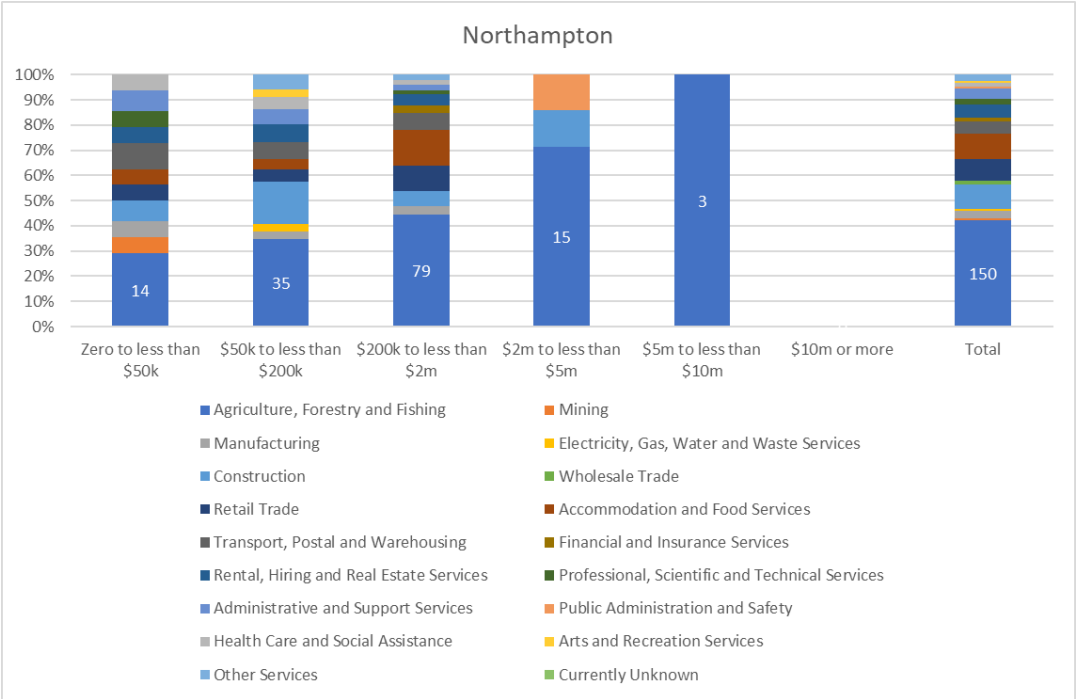
1. Conduct a review of the historical and potential future economic impacts of drought on farming businesses, communities, agribusiness and supply chain sectors in the project regions.
2. Identify the economic factors that make a region more vulnerable and / or resilient to the economic impacts of drought.
3. Identify how these factors could be measured to assess vulnerability and evaluate the success of drought resilience interventions.
4. Identify the key responses, initiatives and programs that may mitigate the adverse economic impacts of drought, including an overview of what has been done in the past to make farming communities, agribusiness and supply chain sectors more resilient, and an assessment of the effectiveness of these interventions.
5. Identify a roadmap with high-level options and pathways including any new / transformational interventions that build economic resilience to drought in the focus regions.

APPENDIX 2

Northern Agriculture Region







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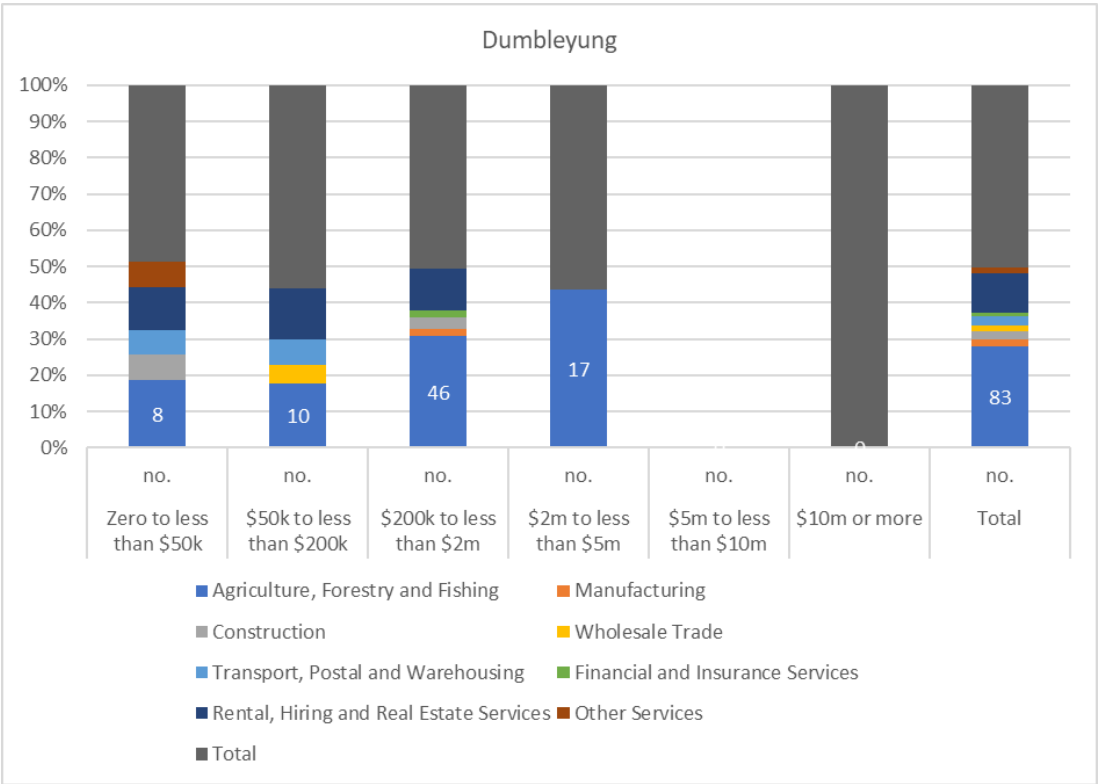

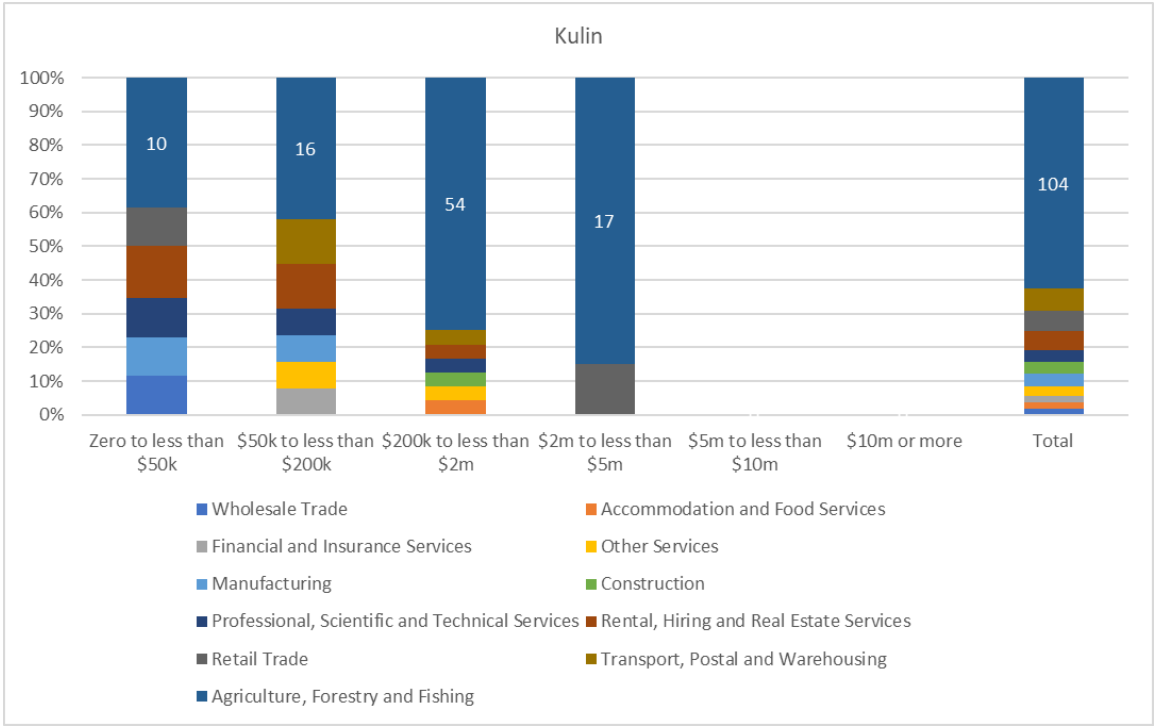
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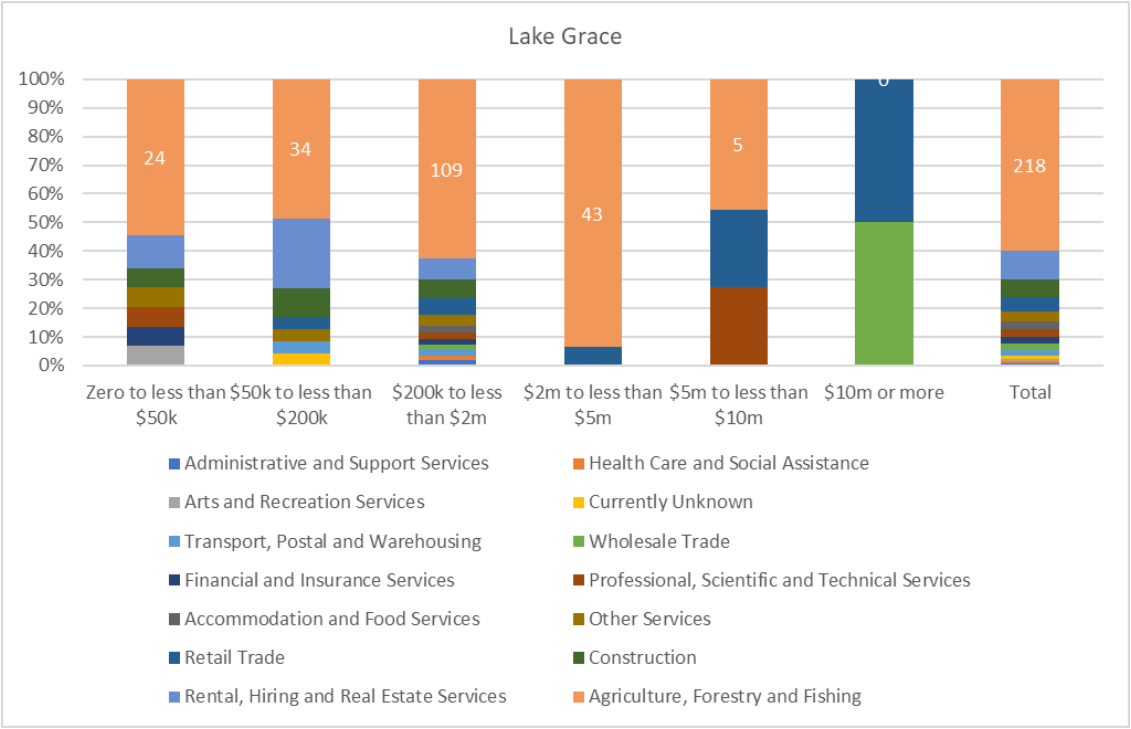
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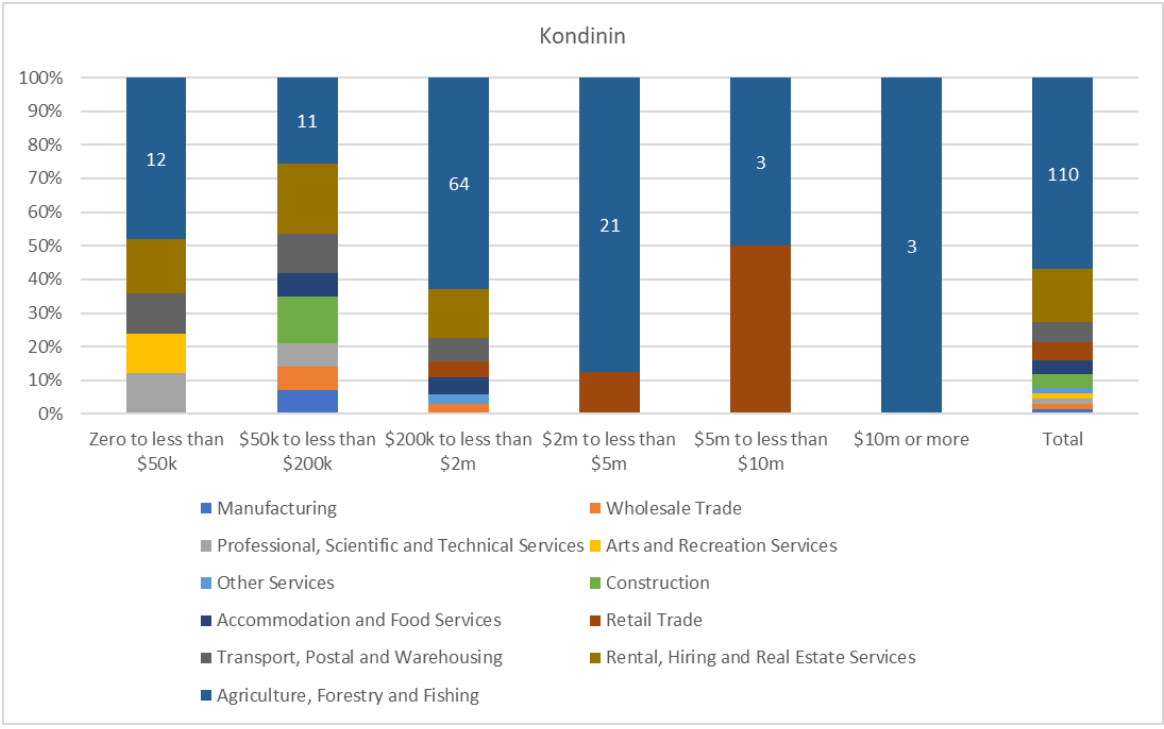
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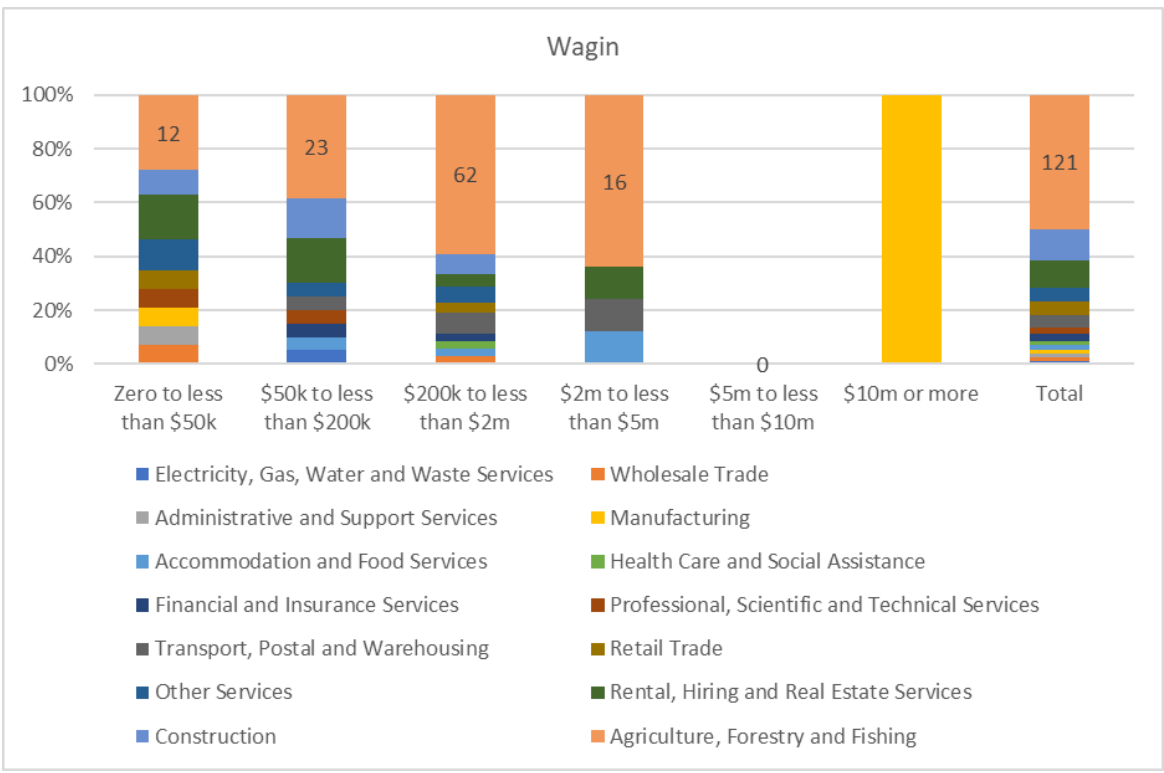
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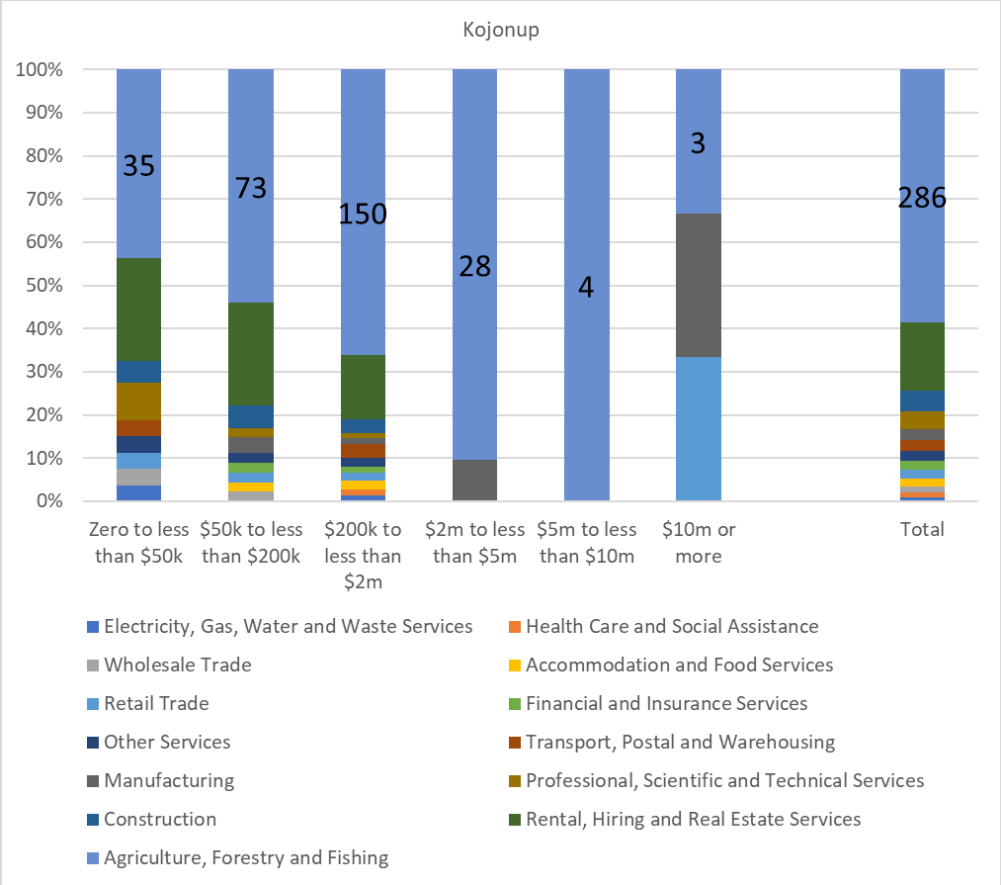

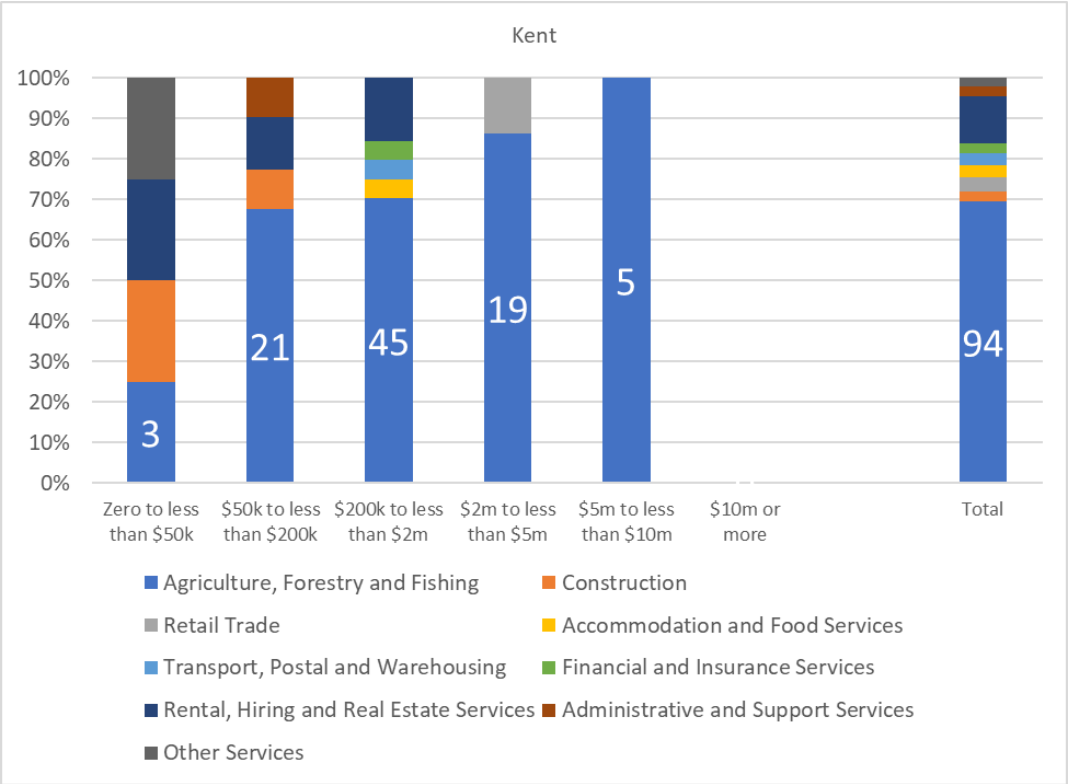

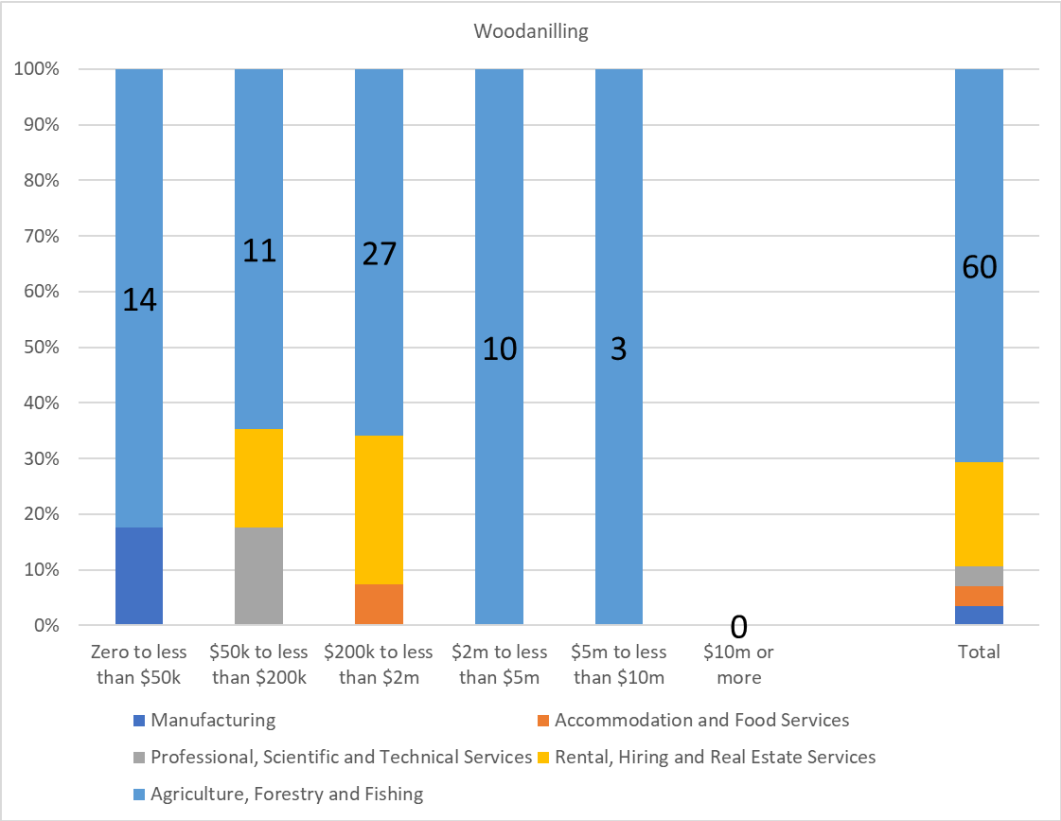
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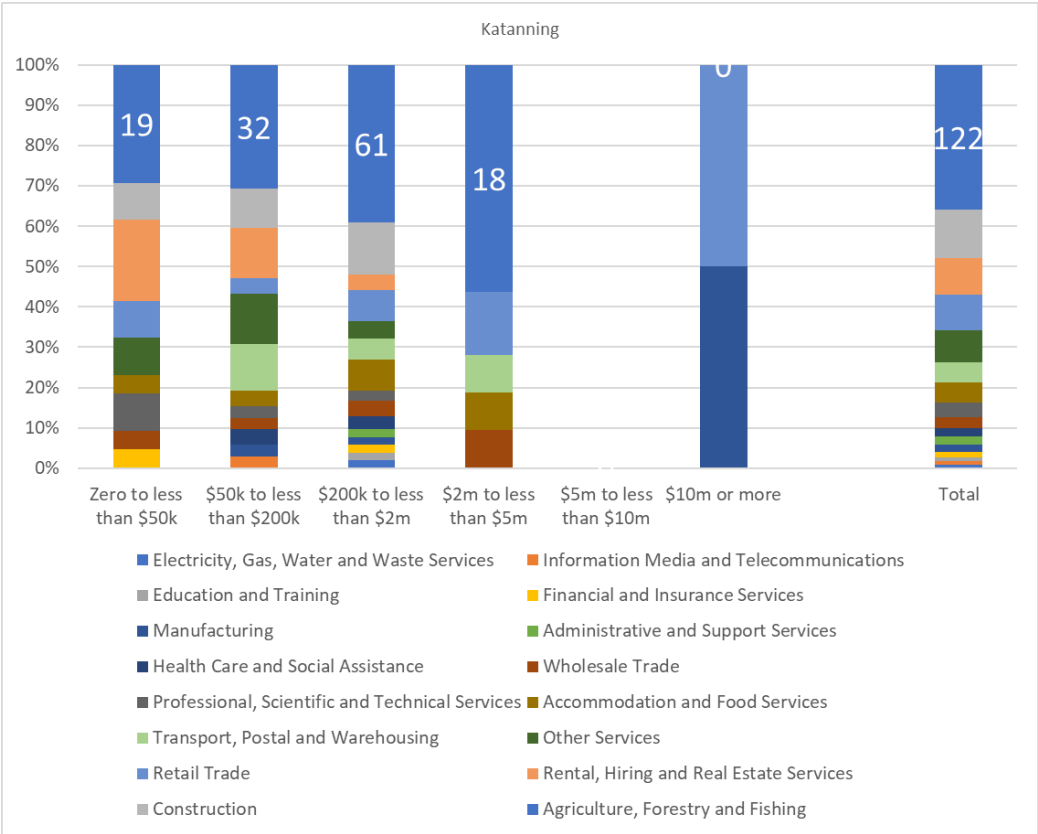
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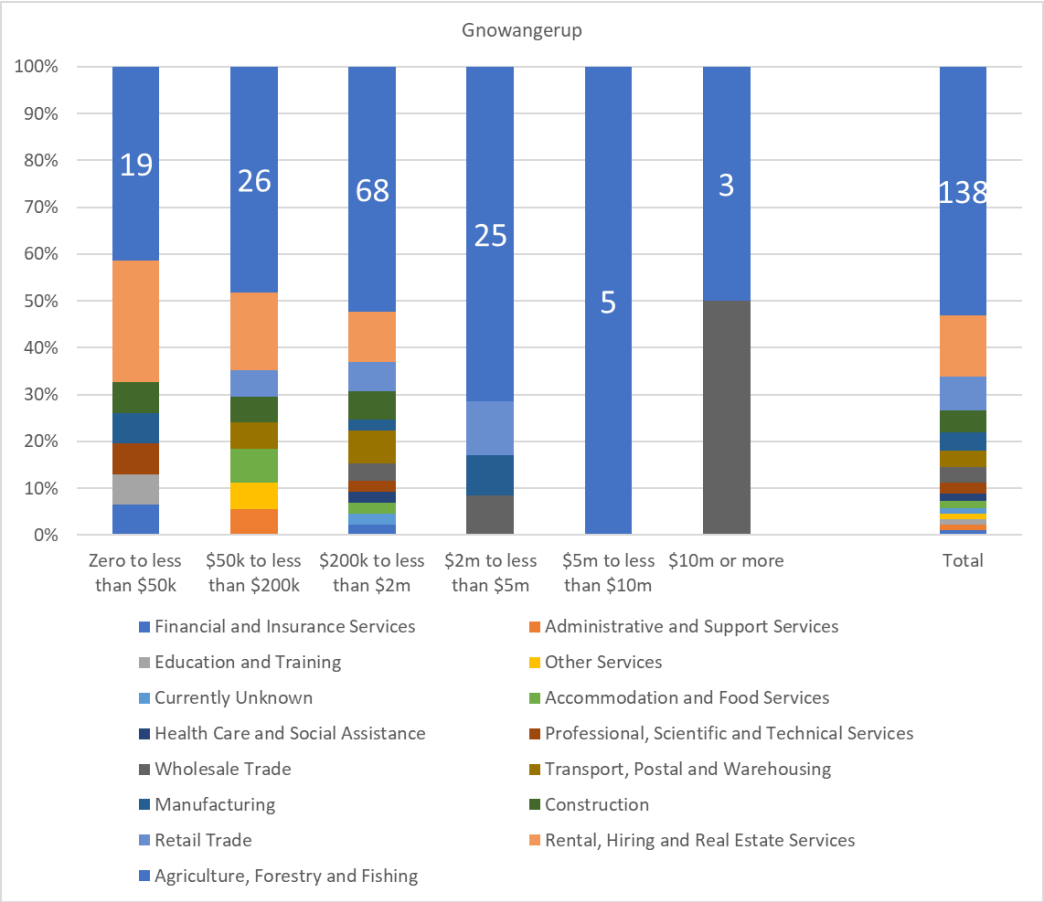
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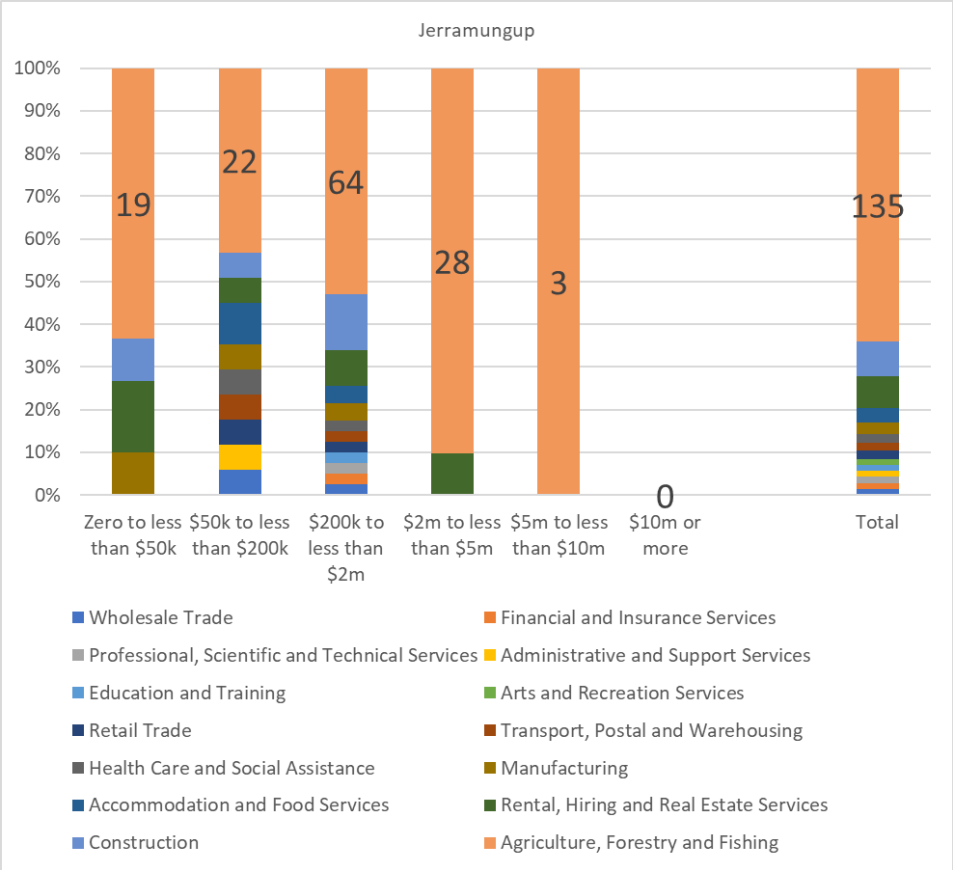
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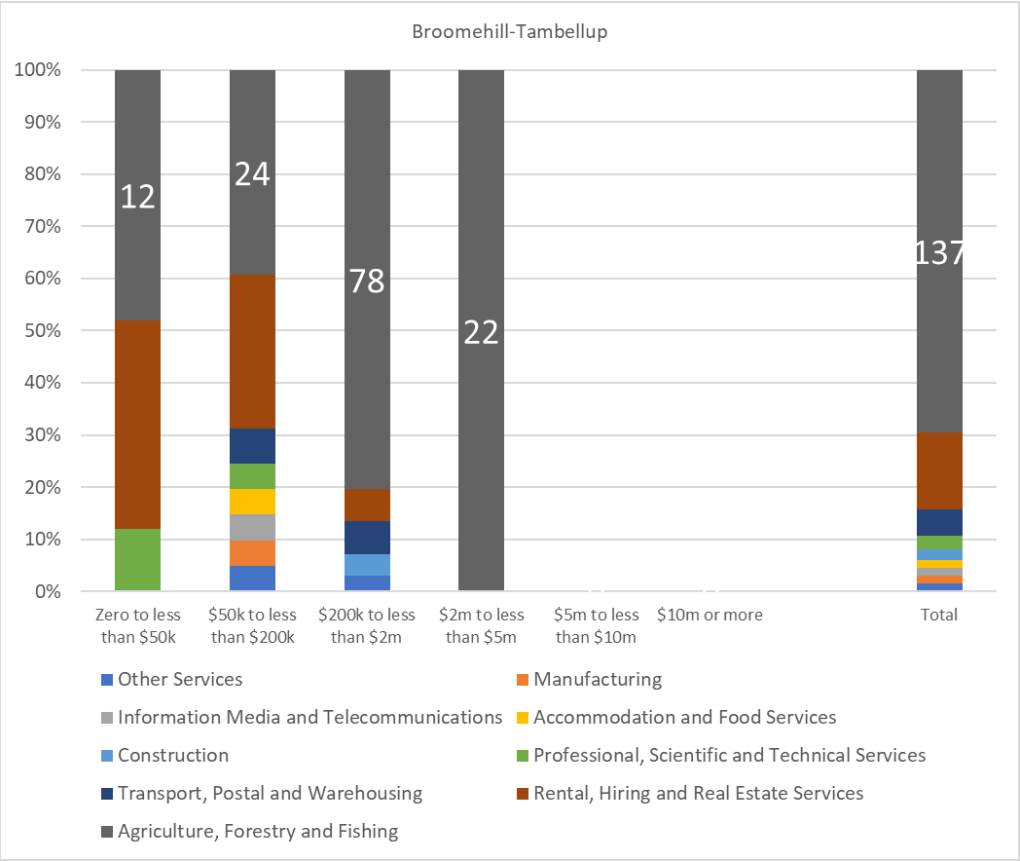
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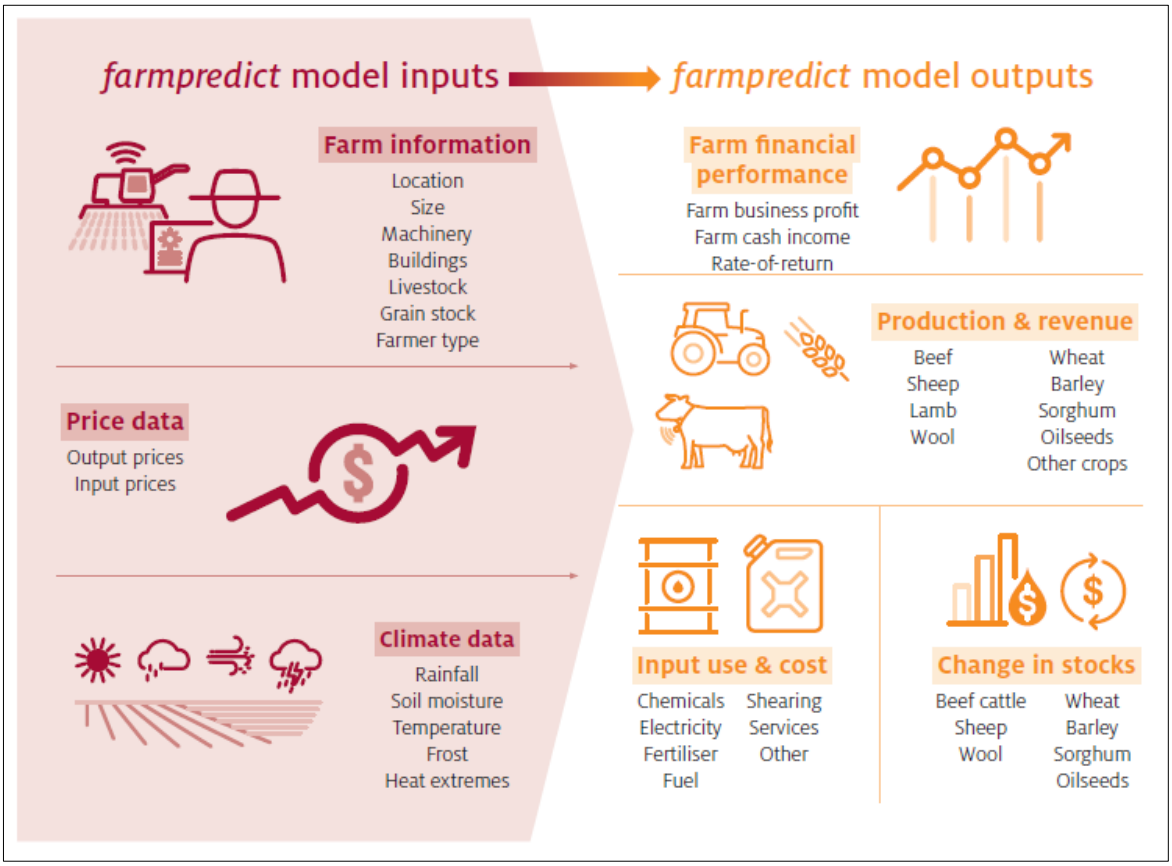
APPENDIX 3

ABARES Farmpredict is a statistical model developed using historical farm data from ABARES Australian Agricultural and Grazing Industry Survey (AAGIS) along with climate data from the Bureau of Meteorology (BoM). The farmpredict model draws on over 40,000 farm observations to predict, or simulate, over 50 physical and financial farm variables. This includes simulation of the production of farm outputs (e.g., wheat, beef cattle, wool etc.), the use of farm inputs (e.g., fuel, fertiliser, labour etc.) and changes in farm stocks (e.g., livestock and grain), given information on farm fixed inputs (e.g., land and capital), input and output prices and prevailing climate conditions. Farmpredict provides coverage of all major broadacre farming regions and industries, including extensive cropping and livestock (beef and sheep) and mixed farming types.[92]



[92] Hughes, N., Soh, W., Boult, C., Lawson, K., Donoghoe, M., Valle, H., Chancellor, W. 2019, 'farmpredict: A micro-simulation model of Australian farms', *ABARES working paper,* https://www.agriculture.gov.au/abares/research-topics/working-papers/farmpredict.

APPENDIX 4

Table 11. Decision support tools available for farmers to use for drought

Model/product	Purpose	Suitable for farmers?	Drought preparedness tools?	Drought management tools?
myFARMSMART	Online software for farmers to support their decision making	Yes, designed with farmers in mind Easy-to-use with some level of skill	Yes – designed as drought preparedness tool for farmers to examine and understand risk Uses climate scenario Calculates yields based on deciles	Management for future drought – Yes Management for current drought – Yes
PLAN2PROFIT	To help farmers explore the impact of important 'what-if' management strategies on their business, helping them to manage risks to their business and improve profitability.	Whole farm Scenario planning Requires a high level of skill to use	Suitable for looking at the impact of drought	Management for future drought – Yes Management for current drought – Yes
DR-SAT Developed by Deloittes for DAWE	To aid farmers with drought planning, mitigation	Yes, designed for farmers	Yes, suitable for looking at impact of drought – looking at triple bottom line In development stage Provides lots of resources – one stop shop for assistance	Management for future drought – Yes Management for current drought – Yes

AGRIMASTER	Software for compliance in farm business management – BAS budget V's actual	Yes High level of use by farmers to meet compliance standards	No. It is a finance tool. There is no section to specifically deal with possible drought implications. The user would have to already know possible drought impacts and run it through the program? Nothing specific about cost of water	Management for future drought – No. Farmers would have to already know possible drought impacts and therefore management protocols. Management for current drought – No. (Users could only use it for prediction if they are aware of the likely impacts drought has on their business and have sourced outside information whether a drought is likely to occur. Then they could alter their budget to compensate for this. Agrimaster is unable to provide future predictions as a drought management tools
PHEONIX	To monitor actuals V's budget.	Yes High level of use by farmers to meet compliance standards	No. It is a finance tool. There is no section to specifically deal with possible drought implications. The user would have to already know possible drought impacts use that knowledge to alter their budget. Nothing specific about cost of water	Management for future drought – No. Farmers would have to already know possible drought impacts and therefore management protocols. Management for current drought – No. (Users could only use it for prediction if they are aware of the likely impacts drought has on their business and have sourced outside information whether a drought is likely to occur. Then they could alter their budget to compensate for this. However,

				PHEONIX itself is unable to provide future predictions or drought management tools)
AGRIWEBB	Easy in paddock farm record keeping	Yes Enterprise level Not whole farm	No. Allows users to track their livestock (weight, movements) via EID tags, however, does not have future prediction tools for drought. (Only live data of livestock)	Management for future drought – No. only shows the live data, cannot help mitigate the impacts of drought on the livestock. **Management for current drought –** Allows users to monitor, track and store their livestock's progress via scanning the EID tag identifier. During a drought the user might be able to see the implications of the drought on their livestock and alter their management strategy.
AGWORLD	Manages costs and inputs by paddock for cropping enterprises including chemical types and rates. Outputs include records, notes, and activities per paddock for a season.	Yes Enterprise level Not whole farm	Yes. Has scenario planning features, if you are aware of the potential impacts of drought you can scenario plan your risk on the app.	Management for future drought – Has scenario planning features, if you are aware of the potential impacts of drought you can scenario plan your risk on the app. However, there's no tool that has drought implication predictions. Management for current drought – Yes. Allows users to track their farms performance, they will have to adjust their management strategy

AUSFARM, CSIRO	AusFarm is designed for large complex research projects. Training in writing management rules is required.	Not designed for growers to use	Not suitable for Drought preparing farmers (as they do not have access)	Not for Farmers.
APSIM	APSIM is structured around plant, soil and management modules. These modules include a diverse range of crops, pastures and trees, soil processes including water balance, N and P transformations, soil pH, erosion and a full range of management controls.	Not easy-to-use and not designed for growers to use	Suitable for researchers, however not suitable for Drought preparing farmers.	Not for Farmers.
Grazplan models, CSIRO	GrazFeed calculates the energy and protein requirements from pasture and supplement of one class of grazing ruminants for *one day*. GrassGro simulates pasture and animal production for a whole sheep or cattle enterprise through time (days, months, or years). GrassGro enables different management options to be tested over	Not whole-of-farm Does not meet the easy-to-use criteria and is not designed for growers to use. Elements will be useful as reference.	Not suitable for Drought preparing farmers.	Not for Farmers.

	several seasons and provides a gross margin analysis.			
Grazfeed	Main aim is to help the grazier 1. Make the best use of pasture 2. Minimize the use of expensive supplements 3. Select the most efficient supplement when feeding is necessary Can be used for cattle or sheep enterprises and for any pasture except the shrub vegetation of semi-arid rangelands.	Is not easy-to-use and is not designed for growers to use.	Does not actively prepare users for a drought, unless they know the effects drought will have on their particular pasture, if so, they can enter the potential FOO values and see how much supplementary feed they might need for their livestock. Nothing specific about cost of water	**Management for future drought –** Overall no. Only shows the current feed requirement to the livestock based on current pastures. (Users could only use it for prediction if you are aware of the likely impacts drought has on your pasture and have sourced other information whether a drought is likely to occur). **Management for current drought –** Yes. Users can see the supplementary feed required for the current FOO totals and livestock population.
MetAccess	Provides easy access to decades of weather data from the Bureau of Meteorology for analysis, including probabilities for weather forecasting.	Not relevant	Yes. Has weather prediction analysis, showing long term likely weather scenarios. Nothing specific about cost of water	Management for future drought – It shows users the likely weather events, however, cannot directly help them with drought management. (Shows the situation, not how to deal with it) Management for current drought – Yes/no. It shows users the likely weather events, however, cannot directly help them

				with drought management. (Shows the situation, not how to deal with it). Although it will give farmers an insight on how long the drought may last, which will give farmers an idea on how much supplementary feed etc. required (if they know how to do the calculations).
MIDAS	A research tool to identify opportunities for improving the farm system by applying new technologies.	Is not suitable for farmers A research tool	Linear Programming steady state farm MUDAS is a version that considers climate variability	Management for future drought – Suitable to examine the impact of policy settings Management for current drought – No
Yield Prophet	Monitoring of water use efficiency of a paddock to identify reasons for the yield gap between actual and potential yield. Encourages crop monitoring sites which can match crop performance against predictions by the model.	Yes, suitable for farmers		Management for future drought – Helps to understand the limitations in a drought Management for current drought – Yes

APPENDIX 5

Summary of taxation benefits for primary producers, on June 21[93]

Temporary loss carry-back – corporate entities with up to $5 billion turnover can offset tax losses against previous years' profits on which tax has been paid to generate a refund. Losses incurred in the 2019–20, 2020–21 and 2021–22 financial years can be carried back against profits made in the 2018–19, 2019–20 and 2020–21 financial years. Eligible corporate entities may elect to receive a tax refund when they lodge their 2020–21 and 2021–22 tax returns. The loss carry-back measure now includes losses made in the 2022-23 income year.

Accelerated depreciation arrangements for business entities:[94]

Temporary full expensing – eligible businesses with aggregated annual turnover or total income of up to $5 billion can deduct the full cost of eligible depreciable assets acquired from 7:30pm (AEDT) on 6 October 2020 and first used or installed for use by 30 June 2022 (to be extended until 30 June 2023, subject to the passage of legislation). Eligible assets include new depreciating assets and the cost of improvements to existing eligible assets. Small and medium-sized businesses with an aggregated annual turnover of less than $50 million can also fully deduct the cost of second-hand assets.

Backing Business Investment incentive – For assets purchased from 12 March 2020 and first used or installed by 30 June 2021, businesses with an aggregated annual turnover of less than $500 million can deduct 50 per cent of the cost of new eligible assets, of any value, in the year of first use or installation, with ordinary depreciation rules applying to the balance of an asset's cost.

Instant asset write-off – From 12 March 2020, businesses with an aggregated annual turnover between $10 million and $500 million can fully deduct eligible new and second-hand assets costing less than $150,000. Eligible assets need to be purchased by 31st December 2020 and first used or installed by 30 June 2021.

Simplified depreciation rules – small businesses with an aggregated annual turnover of less than $10 million can choose to use these rules to access the instant asset write-off and pooling arrangements (or temporary full expensing while it applies).

Tax averaging for primary producers – enables primary producers with fluctuating incomes to even out their tax payable over a maximum of 5 years, ensuring they do not pay more tax over several years than taxpayers on comparable but steady incomes.

Profit from the forced disposal or death of livestock – allows the deferral, over a period of 5 years of profit from the forced disposal or death of livestock. An alternative is to reduce the cost of replacement livestock by the amount of the profit in the disposal year or any of the next 5 years.

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[93] Department of Agriculture, water and the Environment. (2021). Farm Management Deposits Scheme: 2021 evaluation

[94] Where a business entity is eligible for multiple concessions for a particular asset, only one can apply.

Double wool clip proceeds – allows the deferral of the profit on the sale of the second wool clip in an income year to the next income year.

Insurance recoveries for trees or livestock – allows a primary producer who has an assessable insurance recovery for loss of livestock of trees that were assets of a primary production business to elect spreading income in equal instalments over 5 years.

Zone tax offsets – applies to all people living in specified remote or isolated areas. Provides people who have lived or worked in a remote or isolated area of Australia with a tax offset in the form of a fixed amount and a percentage of a base amount.

Research and development (R&D) tax incentive – encourages companies to engage in R&D benefiting Australia, by providing a tax offset for eligible R&D activities by either a refundable tax offset for eligible entities whose aggregated annual turnover is less than $20 million, or a non-refundable tax offset for other eligible entities.

Accelerated depreciation for primary producers:

Electricity and phone connections – capital expenditure incurred in connecting a telephone line to a primary production property and capital expenditure incurred in connecting or upgrading mains electricity to a property on which a business is conducted can be deducted in equal instalments over 10 years

Fodder storage assets – from 19 August 2018, primary producers can immediately deduct capital expenditure on fodder storage assets

Water facilities – primary producers (and certain irrigation water providers) can immediately deduct capital expenditure on water facilities, such as dams, tanks and pumps.

Fencing – primary producers can immediately deduct capital expenditure on fencing assets.

Horticulture plants – capital expenditure incurred in establishing horticultural plants can be written off using an accelerated depreciation regime. The cost of establishing plants with an effective life of less than three years can be written off in the first commercial year; plants with an effective life of three or more years can be depreciated over a shorter period than their effective life using the maximum write-off periods set out in the legislation.

Landcare operations – primary producers and business users of rural land can claim an immediate deduction for capital expenditure on land care operations.

Shelterbelts – allows deductions for establishing a shelterbelt (a line of trees or shrubs planted to protect an area from fierce weather). Immediate deductions for new fencing and reticulation; and deductions for the costs of site preparation, chemicals, and trees if the shelterbelt is established mainly to prevent or fight land degradation.

Carbon Sink Forests – allows a deduction for capital expenditure incurred for establishing trees that meet the requirements for constituting a carbon sink forest.

Forestry Managed Investment Scheme (MIS) – allows deductions for contributions to forestry MIS that started on or after 1 July 2007, encouraging expansion of commercial plantation forestry in Australia by the establishment and tending of new plantations for felling.

Fuel tax credits – provide businesses with a credit for the fuel tax (excise or customs duty) that's included in the price of fuel used in machinery, plant, equipment, heavy vehicles and light vehicles travelling off public roads or on private roads.

Luxury car tax refund – From 1 January 2020 primary producers can claim a refund of LCT they have paid on one eligible vehicle per financial year, up to a maximum of $10,000, for vehicles delivered to them on or after 1 July 2019. (Previously up to $3,000 if delivered before 30 June 2019).

Reduction in fringe benefits tax – allows for a reduction in the taxable value of certain fringe benefits, resulting in a reduced amount of fringe benefits tax, where the employer provides items such as fuel, food, electricity, housing, help with rent, help with mortgage repayments and relocation expenses, in certain circumstances.

Simplified trading stock rules – eligible small businesses do not have to conduct a formal stocktake or account for the changes in trading stock's value if the changes are less than $5,000.

Immediate deductions for prepaid expenses – eligible small businesses can claim an immediate deduction for prepaid expenses where the payment covers a period of 12 months or less that ends in the next income year.

Small business capital gains tax (CGT) concessions – small businesses with an aggregated annual turnover of less than $2 million or net asset value of no more than $6 million can access the following concessions:

15-year exception – if a primary producer is 55 or older and retiring or permanently incapacitated and has owned an active business asset for at least 15 years, they will not pay CGT when they dispose of the asset by sale, gift or transfer. Amounts from this exemption may be able to be contributed to their super fund without affecting their non-concessional contributions limits.

50% active asset reduction – this concession reduces the capital gain on an active asset by 50% (in addition to the 50% CGT discount if asset owned for 12 months or more).

Retirement exemption – capital gains from the sale of active assets are exempt up to a lifetime limit of $500,000. If the small business owner is aged under 55, the exempt amount must be paid into a complying super fund or a retirement savings account.

Rollover– upon sale of an active asset, a small business owner can defer all or part of a capital gain for two years, or longer when acquiring a replacement asset or incurring expenditure on making capital improvements to an existing asset.

Tax relief for people affected by short-term financial difficulties – aids farmers and other taxpayers whose income is affected by short-term financial difficulties occasioned by natural disaster and droughts. Taxpayers finding it difficult to pay their tax debts can apply for more time to pay or arrange

to make payments by instalment without interest being charged. There may also be remission of general interest charges.