

Agriculture in WA – Update Note

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Overview

This research note provides an update on current trends in the Agriculture, forestry and fishing sector in Western Australia.

The economic and employment contribution that the sector makes to the Western Australian economy are discussed, along with the latest trends in farm values and input costs. The significance of Agriculture as an export-orientated sector, key commodity trading partners and current issues are also presented.

A summary of opportunities for diversification within and across the sector as well as key environmental challenges and opportunities are included, based upon the Centre's latest major publications.

Economic and Employment Contribution

- The value of Agricultural production to the WA economy was just under \$11bn in 2019.
- Broadacre crops contributed 62% of the economic value, followed by pastoral farming (28%) and horticulture (10%).
- Agriculture directly employs 36,700 persons in WA, 70% of which are employed on a full-time basis.
- Sheep, beef, cattle and grain farming employs 13,000 people, almost a third of total employment.

Agriculture represents the largest count of businesses in the Gascoyne, Goldfields-Esperance, Great Southern, Mid-West and Wheatbelt regions.

Farm value and input costs

- In 2019, average farm values in WA were \$1,259,821, up from \$461,500 reported in 2009.
- Average farm cash costs have increased from \$691,000 in 2009 to \$777,000 in 2019 – a 12.5% rise.
- In 2019, the main sources of farm costs were fertiliser (18%), crop and pasture chemicals (13%), and repairs and maintenance (10%).

Trading Partners

- China is a critical trading partner for the sector, with Japan, South Korea, Philippines and Indonesia making up the top five export destinations.
- China's large population, growing middle class, and changing palate offers many great opportunities for WA.
- Increasing Australia-China trade tensions highlight the need for agricultural businesses to greater diversify their markets.
- Wheat is by far the highest value commodity for WA agricultural exports, followed by canola, barley, wool and lamb.

Diversification Opportunities

- Aquaculture, specialised beef farming, and horticulture present as possibilities across for agricultural diversification and expansion across WA's regions.
- Diversification strategies that transfer existing capabilities to other agricultural products present the greatest economic and employment opportunities.
- A local vision for regional development that accounts for regional specific characteristics and ambitions is needed to support a smart specialisation diversification policy.

Environmental Challenges

- Twenty years ago, agriculture was the biggest contributor to greenhouse emissions in WA, representing 21% of all emissions. Currently emissions from agriculture represent only 3%.
- Forest clearing has declined dramatically since the 1990s, however, the loss of sparse woody vegetation is accelerating.
- The use of fertilisers has increased fourfold between 1990 and 2018 in WA.
- WA farmers use 83% less distributed water and 50% less self-extracted water than the national average.
- Reducing tillage, introducing cover crops, growing multiple crops, crop rotation and increasing forest and are all practices that can improve the health and productivity of the farm and broader environment.

Contribution of Agriculture, Forestry and Fishing

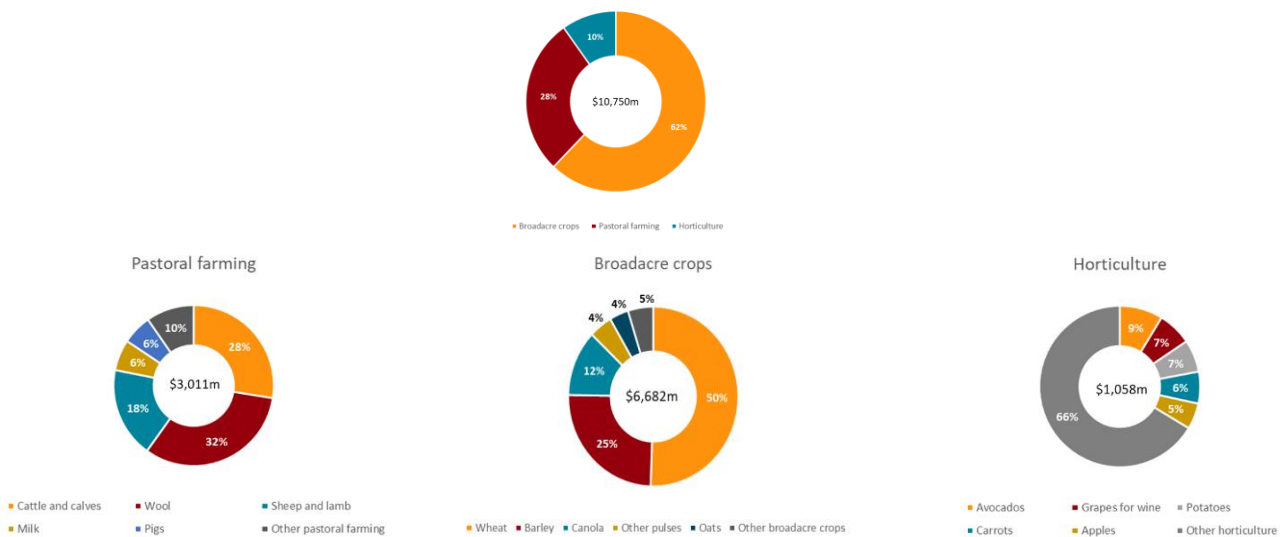
The Agriculture, Forestry and Fishing industry plays a critical role in the Western Australian economy. This section discusses the contribution of the industry from both a value and employment perspective.

Value contribution

Agricultural production in WA is valued at \$10,750m to 2019 (Figure 1), with broadacre crops contributing 62% of that value, followed by pastoral farming (28%) and horticulture (10%).

Of the \$6,682m contribution from broadacre farming, the majority comes from wheat (50%), with barley making up 25% of production value, followed by canola (12%), with other pulses and oats both at 4%. Pastoral farming contributes \$3,011m in production value, the largest contributor of which is wool (32%), followed by cattle and calves (28%) and sheep and lamb (18%). Horticulture contributes \$1,058m, with a great deal of variety of produce contributing to the total. The single largest contributor is avocados at 9%. Other horticulture contributes 66% and includes tree nut growing, other fruits, and flowers, amongst others.

Figure 1: Value of WA agriculture by broad sector, 2019

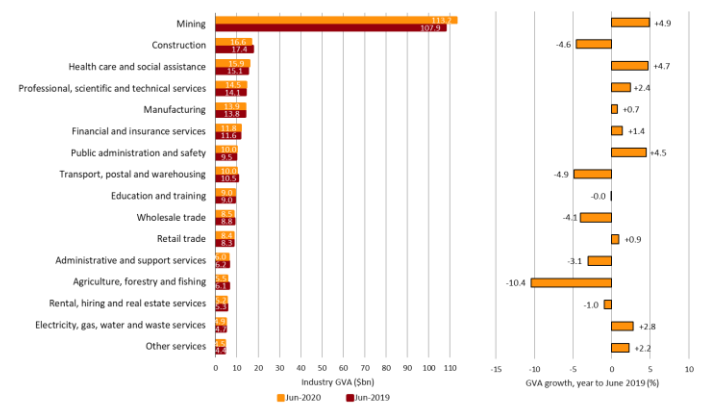


Source: Bankwest Curtin Economics Centre | ABS cat 7503.0

In gross value added (GVA) terms, the agriculture, forestry and fishing industry contributes 1.9% to the WA economy, declining from a value of \$6.1Bn in 2018-19 to \$5.5Bn in 2019-20 (Figure 2). However, this 10.4% decline was on the back of a bumper year of almost 10% growth in 2018-19. In dollar terms, the sector remains at one of the highest on record.

Much of WA's growth continues to come from the mining sector. For the financial year ending June 2020, mining comprised 47% of the state's industry value (GVA), growing by 4.9% to now stand at a value of \$113.2Bn.

Figure 2: Industry share of Gross Value Added, WA, 2020



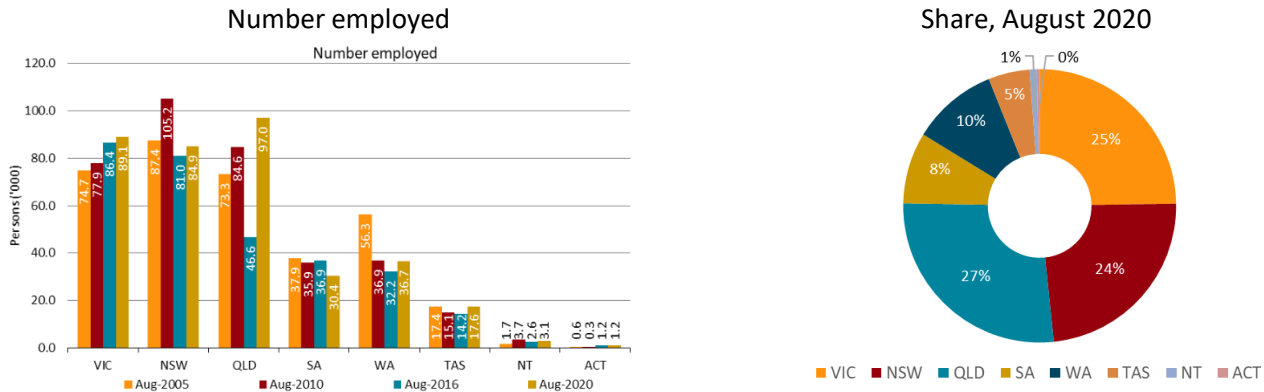
Source: Bankwest Curtin Economics Centre | ABS cat 5220.0

Employment contribution

By state, Queensland employs the largest number of workers in the agriculture industry, sitting at 97,000 persons (26.9% share) as of August 2020. This is double the number of employees reported in August

2016. This is followed by Victoria, at 89,100 employees. WA’s employment level of 36,700 people contributes 10.2% to the overall level of employment in the agriculture sector nationally, and is in line with the state’s population share.

Figure 3: Employment trends in agriculture by state and territory, 2005 to 2020 and share of national employment by state, August 2020



Source: Bankwest Curtin Economics Centre | ABS cat 6291.0

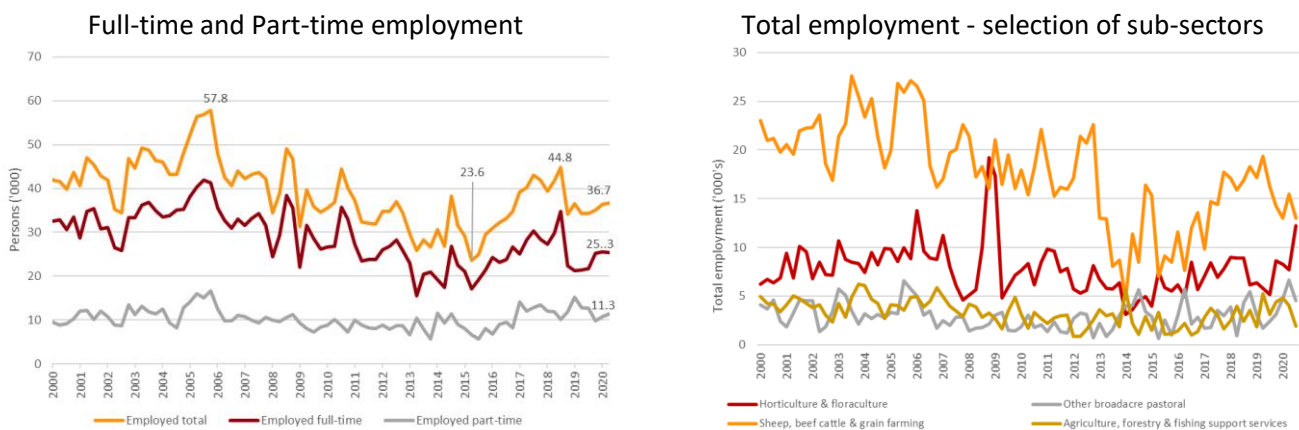
Between 1990 and 2005, total agricultural employment in WA’s agricultural sector hovered between 40,000 and 50,000, with a peak of 57,800 persons in February 2006 (Figure 4). From that point total employment went on a downward trajectory, with an all-time low of 23,600 persons employed in the sector in August 2015. Since then, a return to employment growth was observed with a recent peak of 44,800 in November 2018. And a return to employment growth was observed with a recent peak of 44,800 in November 2018. And a return to employment growth was observed with a recent peak of 44,800 in November 2018.

While much of the variation in total employment comes from full-time employment, there has been a steady increase in part-time employment in the

sector. Across the last five years, part-time employment has averaged 30% of total employment, up 3 percentage points from the five-year average to August 2015.

Much of the variation in total employment too is driven by employment in sheep, beef, cattle and grain farming. In recent history, a peak of 27,600 persons was reached in this category in 2003, and sat at 13,000 people as of 2020. Horticulture and floriculture is the second largest employment category, sitting at 12,200 in 2020. Other broadacre pastoral employed 4,500 persons in 2020.

Figure 4: Full-time and Part-time employment trends in WA, and total employment by sub-sector, 2000 to 2020



Source: Bankwest Curtin Economics Centre | ABS cat 6291.0

Business Counts, Farm Values and Farm Costs

This section provides an overview of the number of businesses in the agricultural sector in WA, and provides an insight into the changing nature of farm values and input costs in recent years.

Business counts by region and industry

There are some 233,000 businesses in WA, 24% of which are based in WA’s regions. Some 7% (16,400) of

businesses in WA are agricultural businesses, the 6th largest number by industry (Table 1). This share is much higher across many of the regions, with agriculture presenting the largest number of businesses in the Gascoyne, Goldfields-Esperance, Great Southern, Mid-West and Wheatbelt regions. Agriculture presents the second largest count of businesses in the South West and the third largest in the Kimberley.

Table 1: Share of businesses in WA by region, 2019

All Businesses	Gascoyne	Goldfields	Great southern	Kimberley	Md West	Peel	Perth	Pilbara	South West	Wheatbelt	Total WA
Agriculture, Forestry and Fishing	28%	19%	35%	9%	27%	8%	2%	4%	19%	46%	7%
Mining	1%	4%	0%	0%	1%	1%	1%	2%	0%	1%	1%
Manufacturing	3%	4%	4%	3%	3%	4%	4%	3%	4%	3%	4%
Electricity, Gas, Water and Waste Services	1%	0%	0%	0%	1%	0%	0%	1%	0%	0%	0%
Construction	15%	15%	13%	20%	14%	25%	18%	20%	20%	11%	18%
Wholesale Trade	1%	2%	2%	2%	2%	2%	3%	1%	2%	2%	3%
Retail Trade	7%	6%	5%	9%	6%	6%	5%	6%	6%	5%	5%
Accommodation and Food Services	7%	4%	4%	6%	4%	4%	4%	5%	5%	2%	4%
Transport, Postal and Warehousing	9%	7%	4%	6%	6%	8%	9%	8%	4%	6%	8%
Information Media and Telecommunications	0%	0%	1%	1%	0%	0%	1%	0%	0%	0%	1%
Financial and Insurance Services	4%	7%	5%	6%	8%	8%	10%	6%	8%	4%	9%
Rental, Hiring and Real Estate Services	8%	11%	10%	11%	9%	9%	11%	12%	10%	7%	11%
Professional, Scientific and Technical Services	4%	6%	6%	7%	5%	8%	14%	7%	7%	4%	12%
Administrative and Support Services	3%	3%	2%	6%	2%	3%	4%	7%	3%	2%	4%
Public Administration and Safety	0%	0%	0%	0%	0%	0%	0%	1%	0%	0%	0%
Education and Training	0%	1%	1%	1%	1%	1%	1%	1%	1%	0%	1%
Health Care and Social Assistance	2%	4%	3%	3%	4%	5%	6%	5%	4%	2%	6%
Arts and Recreation Services	1%	1%	1%	1%	0%	1%	1%	1%	1%	0%	1%
Other Services	5%	7%	4%	6%	5%	5%	4%	9%	5%	4%	4%
Currently Unknown	1%	1%	1%	1%	1%	1%	1%	2%	1%	1%	1%
All industries	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Note: The largest three industries by region are denoted by the gold, silver and bronze shading.

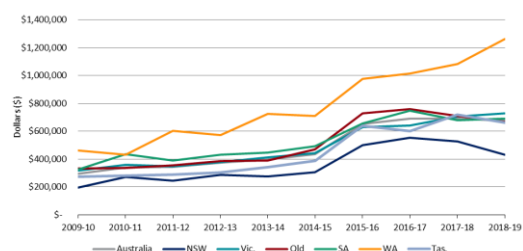
Source: Bankwest Curtin Economics Centre | ABS cat 8165

Farm values and costs

In general, average farm values across all states have gradually increased over time (Figure 5).

WA’s average farm value has increased at a much higher rate, with a growing gap evident to other states. In 2009, average farm values in WA were \$461,516, increasing to \$1,259,821 by 2019. This could be attributed to a variety of factors, including farm consolidation, and increased farm size. Notably, NSW’s average farm value has declined over recent years. This may be explained by events such as droughts, flooding and bushfires.

Figure 5: Average farm value by state, 2009 to 2019

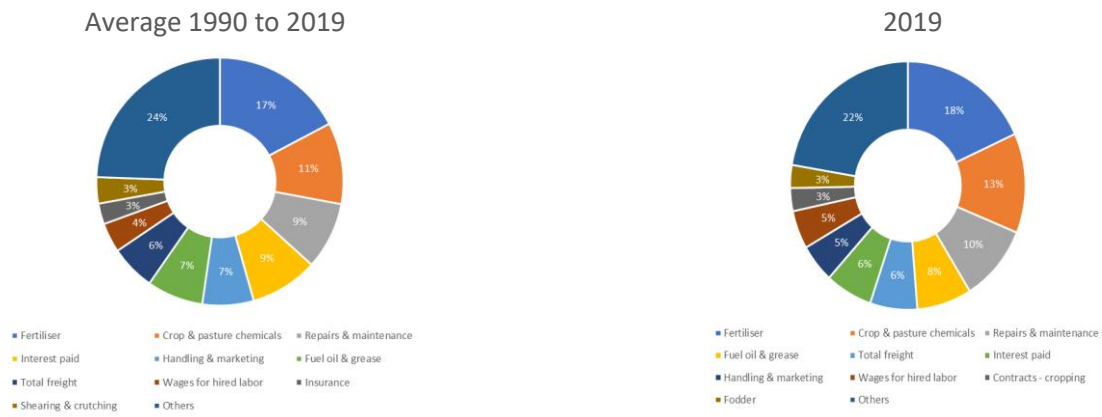


Source: Bankwest Curtin Economics Centre | ABS cat 7503.0 & 7121.0

In 2019, the main sources of farm costs were fertiliser (18%), crop and pasture chemicals (13%), and repairs and maintenance (10%), with fuel (8%), freight (6%) and interest paid (6%) closing out the top six (Figure 6). Other costs¹ made up a significant portion (24%) of average farm costs in WA.

¹ Other costs include items such as accounting and advisory services, shire & council fees, livestock contracts, electricity, fodder, land rent, leasing charges, livestock material, water charges, seed, stores & rations, telephone, vet fees, payments to sharefarmers, and other services.

Figure 6: Average farm costs by major component, WA



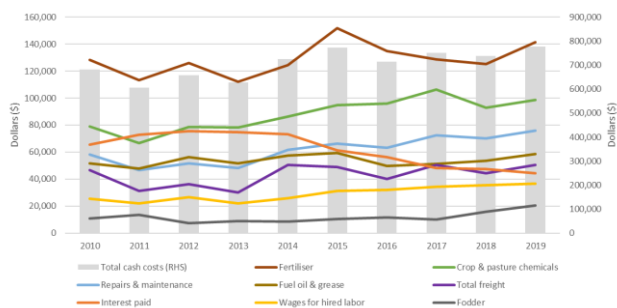
Source: Bankwest Curtin Economics Centre | Agsurf

Over the last decade fertiliser costs have been a major component of WA's farm costs (Figure 7). The cost of fodder has shown a significant increase over the last two years, as have repairs and maintenance.

After showing a steady increase over the time series reported, the average cost of crop and pasture chemicals began to decline in 2017, but have increased again to 2019.

Average interest costs have fallen since 2012, reflecting the lower interest rates on offer. Over a similar period, wages for hired labour increased, although they have plateaued in more recent years.

Figure 7: Average farm costs by major component, WA, 2010 to 2019



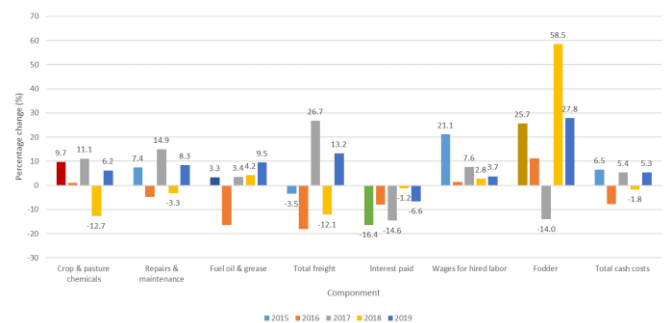
Source: Bankwest Curtin Economics Centre | Agsurf

Over the period 2015 to 2019 in WA, average farm costs by major component have shown wide fluctuations (Figure 8). For example, in 2017, average fodder costs declined by 14%, but in the following year increased by 58.5%. In 2019, the biggest change in average costs was also recorded by fodder (27.8%).

Average freight costs have also varied wildly, as farms often use multiple freight transport companies to get their products to market. Interest paid is the only category to show constant declines over the time period specified.

Wages for hired labour displayed an increase of 21.1% in 2015, perhaps reflective of a labour shortage for agricultural workers. This is also the only category to show increases in average costs from 2015 to 2019.

Figure 8: Change in average farm costs by major component, WA, 2015 to 2019



Source: Bankwest Curtin Economics Centre | Agsurf

Key Trading Partners

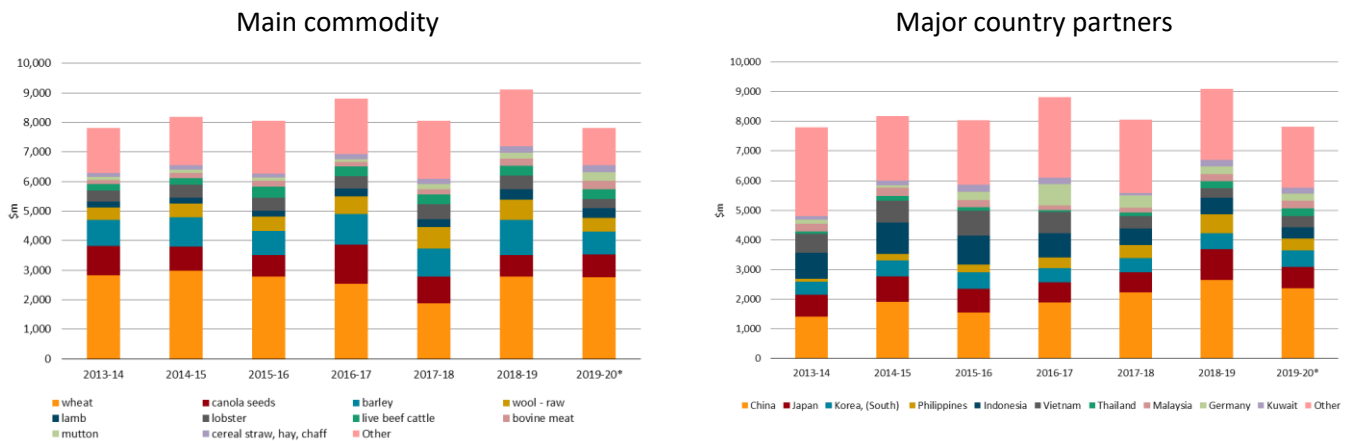
With increasing Australia-China trade tensions, it is important to look at WA’s key trading partners in the agricultural sector, with a particular eye on the commodities most exposed to the Chinese market.

In value terms, WA’s key commodity exports and the top destination countries are reported in Figure 9. By far wheat is the highest value commodity of WA’s agriculture exports, remaining reasonably steady since 2013. The second and third largest are canola and barley, interchanging their rank on almost a yearly basis.

In terms of destination, China is a critical trading partner, with Japan, South Korea, Philippines and Indonesia making up the top five. While reliance on China has generally increased over time, those other countries sitting outside of the top ten remain sizeable. This indicates that overall, WA’s agricultural sector has a diverse range of trading partners across the globe.

Growing demand from emerging Asian economies was emphasised in the BCEC Paddock to Plate report, with changing consumer preferences demonstrating huge potential in developing Asian markets.

Figure 9: WA's top 10 agriculture exports by main commodity, and top trading partners 2014 to 2020



Note: 2019-20 data is missing 'confidential data' and is therefore subject to change, when such data is included in the total in 2021. Top ten commodities and destinations as of 2019-2020.

Source: Bankwest Curtin Economics Centre | DAFWA and ABS

Figure 10 considers WA’s top five agricultural commodities by export market and how they have changed over recent years. Several observations can be made.

First, the importance of China is reiterated, being the largest export destination for four of the top five commodities, and sitting second for wheat.

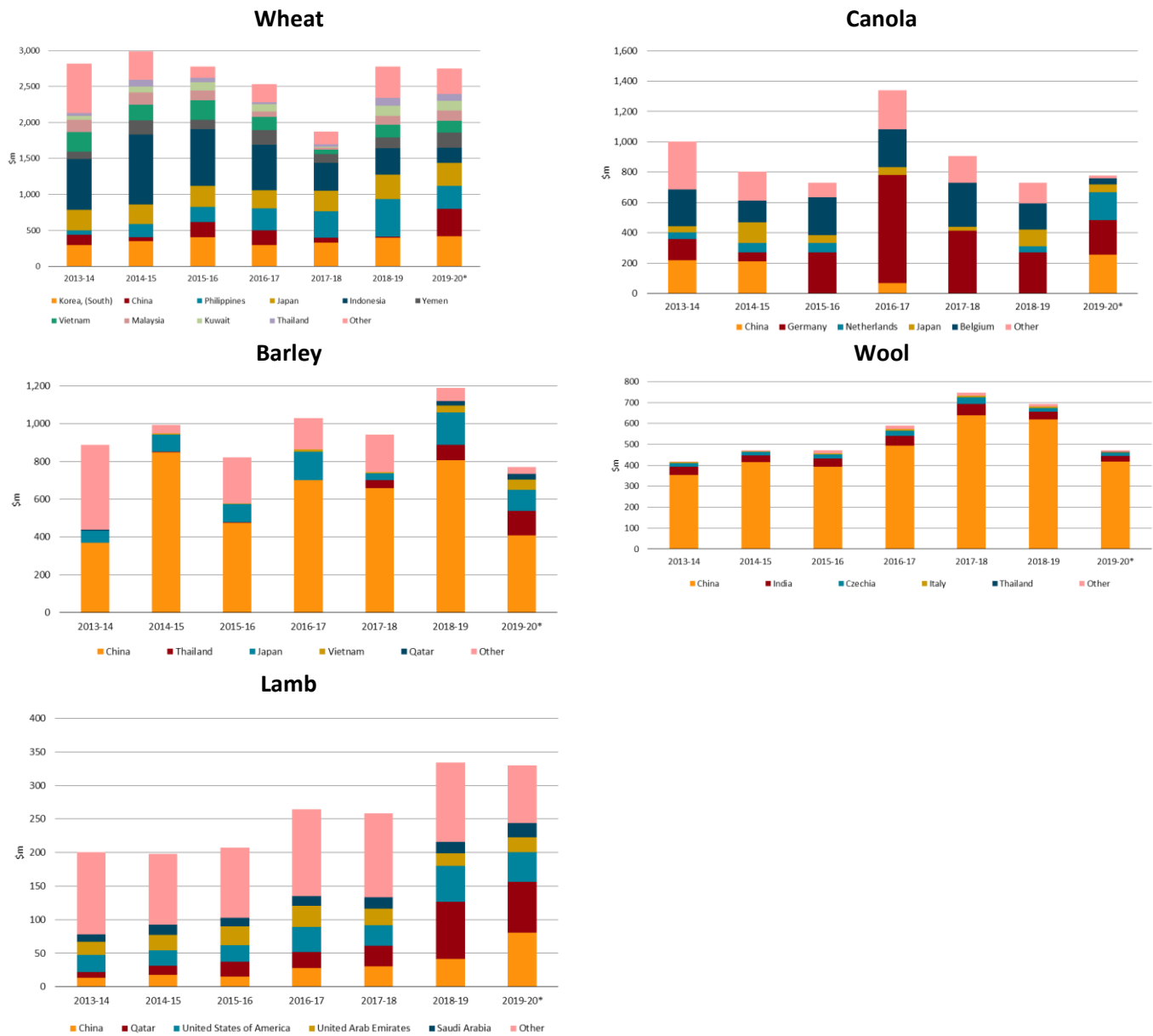
Second, China is by far the largest export destination for WA wool and barley. China is the world’s dominant producer of clothing and textile. Though China is itself a large producer of wool, the sheer volume of its domestic and export textile and apparel industry means that it imports large amounts of wool.

WA exports large amounts of feed and malting barley (a key ingredient for beer production) and its share into China has increased.

Third, WA lamb export to China has risen, with significant increases in the year to June 2020.

Finally, trade with many economies can fluctuate year on year, as is demonstrated for example by canola exports to Germany and the Netherlands. In some instances, countries often play the role of 'third party'. This has previously been observed in the case of crayfish, with Vietnam being a 'third party' destination between WA and the ultimate importer, China.

Figure 10: WA's agriculture exports with major country partners, 2014-2020



Note: 2019-20 data is missing confidential data and is therefore subject to change. Top 5 commodities by value, in current prices. Top five commodities, including destinations, as of 2019-2020.

Source: Bankwest Curtin Economics Centre | DAFWA and ABS

Diversifying the WA economy – Opportunities in Agriculture

The Western Australian economy remains heavily concentrated in mining, a sector which now contributes 47% of industry value. As a result, the WA economy is more volatile than the Australian economy as a whole, with volatility increasing steadily since 2014. This volatility represents a significant risk for businesses, investors and workers in WA.

Academic research shows that economies grow by diversifying into related industries. Diversification will help to reduce volatility in WA and the risks of exposure to fluctuations in the price of iron ore. In July 2019 the WA Government released its Diversify WA policy. Unfortunately it did not include a significant focus on regional areas. Since the COVID-19 pandemic, the WA Government is now more focused on recovery than diversification, though as the recovery continues it is likely that diversification will return to the agenda.

BCEC released a research [report](#) in August 2019 that analysed regional employment data to identify related industries as potential opportunities for diversification in the nine WA regions plus Perth.² Related industries are pairs of industries that are frequently seen together across Australia. If a region has one industry but not the related industry, it is a strong indicator of its feasibility as an option for diversification. This is because diversification into very different industries is more difficult than diversification into a similar industry that uses similar factors of production.

For most regions in WA, this analysis identified a number of opportunities to diversify within agriculture and in some regions to expand food processing or manufacturing. These diversification options build on existing industries. For example, a region that already has a significant fishing industry, and fish processing industry might also have the

opportunity to expand into various forms of aquaculture.

Diversification may require some initiative to reduce barriers to entry, but recognising the opportunities is a first step to identifying the relevant policy responses from governments. For example, some of the identified opportunities in Aquaculture have been subsequently supported by various government initiatives such as the Geraldton marine finfish nursery.

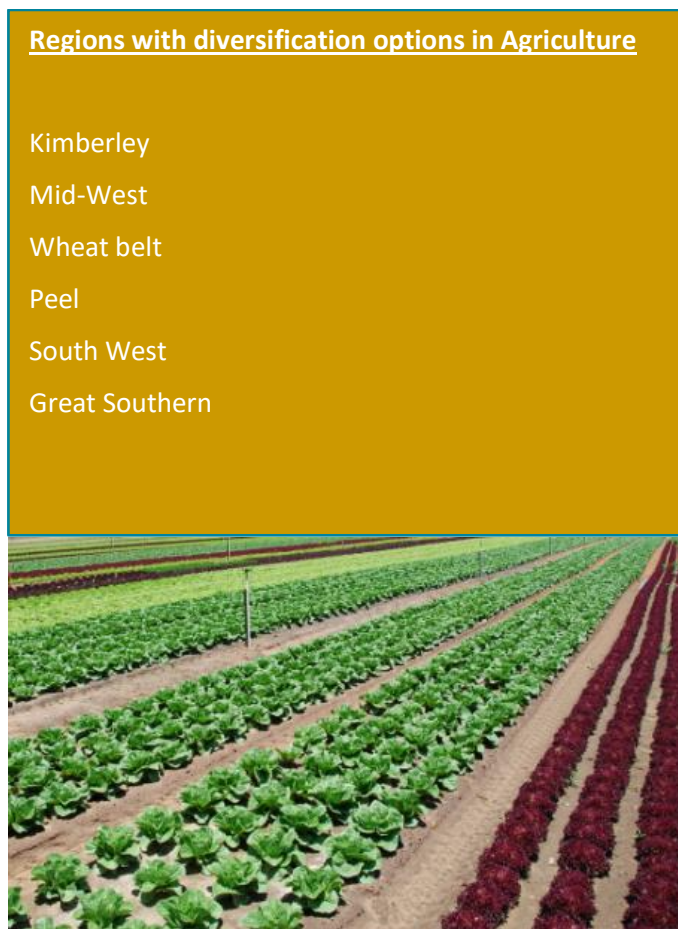
Detailed profiles for each region can be found in BCEC's report "*Future-proofing the WA economy: A roadmap to industrial diversification and regional growth*". The box below outlines some of the highlights for diversification in agriculture from these profiles. Industries that are identified as more feasible could be new opportunities for investment in regional areas.

In this report BCEC recommended a *Smart Specialisation* approach to diversification policy. This is a policy approach widely used in Europe to support regional growth. It requires a local vision for regional development that accounts for regional specific characteristics and ambitions. The recommended policy would support research and development in areas identified as regional strengths, as well as addressing specific barriers to the development of certain new industries such as infrastructure. It is not the government picking winning industries, but supporting broad areas of activity used by the industries that are already identified as local strengths or feasible opportunities.

As the WA government shifts its focus from recovery to diversification, changes in government policy that support regional diversification into the identified industries would indicate opportunities for investment.

² Bond-Smith, S. Dockery, A.M., Duncan, A., Kiely, D., and Salazar, S., "Future-proofing the WA economy: A roadmap to industrial diversification and regional growth," Bankwest

Curtin Economics Centre, Focus on Industry Series, No. 4., 2019. Available at <https://bcec.edu.au/publications/future-proofing-the-wa-economy/>

Box 1: Diversification options within agriculture and relevant agricultural regions**Diversification options**

- Offshore caged aquaculture; Offshore long-line and rack aquaculture; Onshore aquaculture; Prawn fishing; Fishing
- Seafood processing; Meat processing; Other food product manufacturing; Cheese and dairy product manufacturing; Wine and other alcoholic beverage manufacturing
- Produce wholesaling and retailing; Flower retailing
- Diversified farming; Specialised beef farming; Dairy farming; Poultry farming; Poultry farming eggs; Sheep beef farming; Specialised sheep farming; Grain sheep or grain beef farming
- Apple and pear growing; Grape growing; Mushroom growing; Other fruit and tree nut growing; Citrus fruit growing; Vegetable growing; Berry fruit growing; Stone fruit growing; Pig farming.
- Beekeeping; Shearing services; Nursery production; Veterinary services

Source: Bankwest Curtin Economics Centre | Bond-Smith, S. Dockery, A.M., Duncan, A., Kiely, D., and Salazar, S., "Future-proofing the WA economy: A roadmap to industrial diversification and regional growth," Bankwest Curtin Economics Centre, Focus on Industry Series, No. 4., 2019. Available at <https://bcec.edu.au/publications/future-proofing-the-wa-economy/>

Agriculture and the Environment

The reliance of agriculture on rainfall and soil quality makes this industry more vulnerable to climate change and environmental degradation. However, some agricultural practices can also contribute to the deterioration of soil, water and air pollution. The environmental impact of the agricultural sector has been detailed in BCEC’s [Green Shoots](#) report. Here, some key findings are highlighted.

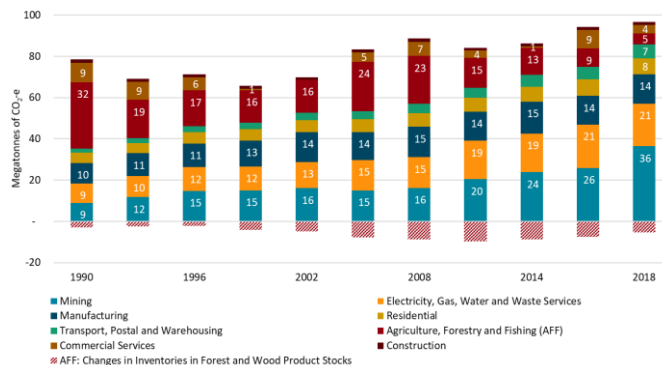
Carbon emissions

Carbon emissions increase the temperature on earth causing changing weather patterns, altering water supply and crop growing periods, as well as rising sea levels.

Carbon emissions decreased by 13% in Australia since the 1990s’ due to lower emissions intensity and decreased emissions of the Agriculture, Forestry and Fishing industry. Nevertheless, Australia’s carbon emissions per capita are the highest among OECD countries and the sixth highest in the world.

WA contributes to 17% of Australian’s emissions. In the past five years, WA greenhouse emissions increased by 12%, the only state with rising emissions. Twenty years ago, Agriculture was the biggest contributor to greenhouse emissions in WA, constituting 21% of emissions in 1990. Since then, agriculture’s contribution has decreased dramatically to 3% of overall emissions. This represents a decline of 83% in WA, compared to 63% nationally.

Figure 11: Direct emissions by economic sector, Western Australia, 1990-2018



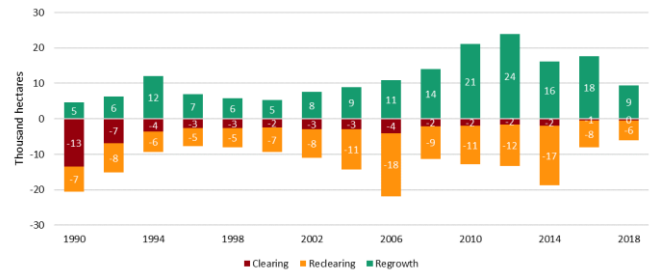
Source: Bankwest Curtin Economics Centre | Authors' calculations based on DISER 2020, National Inventory by Economic Sector 2018, Data Table 1.

Land use

Land-use and forestry are a fundamental aspect to consider in the reduction of greenhouse emissions, and in water, land and ecosystem conservation. Agriculture is the single largest contributor to land clearing in WA. Half of the species listed on the *Environment Protection and Biodiversity Conservation (EPBC) Act* were threatened by habitat fragmentation and degradation due to agricultural and aquaculture practices.

Forest clearing has declined dramatically since the 1990s’, from almost 60,000 hectares to none nowadays. Nevertheless, as forest clearance declined, forest re-clearing has risen. Overall, in 2018, more forest has regrown (+9 ha) than has been lost (-6ha).

Figure 12: Annual area of forest cleared, recleared and regrown, WA, 1990-2018



Source: Bankwest Curtin Economics Centre | Australian Greenhouse Emissions Information System (AGEIS), Department of Industry, Science and Energy and Resources.

However, when we look at the sparse woody vegetation, an important characteristic of WA ecosystems, we observe an increasing loss, especially since the turn of the 21st century. In 2018, 1,500 kilohectares of sparse woody vegetation was lost.

Forests are essential for capturing carbon emissions. Ninety-nine percent of carbon is stocked in Australian forests and only 1% in plantations. Even if forests regrow, it would take 150 years for a forest to absorb 90% of the carbon it did before clearance. Forest clearing also influences our climate. It has been estimated that 50% of the rainfall decline in the South West of WA is as a result of forest clearing alone³.

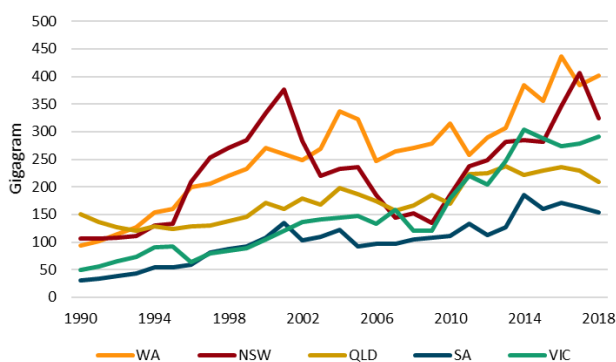
³ Andrich, M. A., & Imberger, J. (2013). International Journal of Sustainable Development & World Ecology, 20(6).

Chemical use

Fertilisers and pesticides have allowed for enormous growth in productivity in the last 70 years. As the use of synthetic products rises, the physical and chemical properties of the land have changed significantly.

The use of fertilisers have increased fourfold between 1990 and 2018 in WA. Fertilisers bring nutrients to the soil, but rainfall and compact soils cause significant runoff of these products into watercourses. This not only creates pollution in our water systems but too much nutrient can also leads to algal blooms, which in turn consume important quantities of oxygen from the water. This is one of the main causes of kill fish episodes, and is exacerbated by declining rainfall.

Figure 13: Use of fertilisers over time and by type of crop, by select states, 1990-2018



Source: Bankwest Curtin Economics Centre | Australian Greenhouse Emissions Information System (AGEIS), Department of Industry, Science and Energy and Resources, Australian Government.

Although no data on the amount of pesticide or herbicide use by state is available, there is some evidence that there is an increasing trend in Australia⁴. The overuse of pesticides can lead to pest resistance such as that observed in the 1990s' with the boll worm in the cotton industry. Weed resistance

has also become a common issue for Australian farmers, in fact, Australia has the second worst weed resistance on earth⁵. Furthermore, insecticides kill not only the pest but also beneficial insects. Insecticides that attack the neurological system can also have detrimental impacts on human health.

Water scarcity

Water scarcity has always been a concern in WA but even more so in the past 50 years. Water is essential for our survival but also for industrial processes and agriculture.

Since the 1970s' there has been a 17% decline in average rainfall in the South West of Australia. The decline in streamflow runoff to dams is much greater, with an average 80% decline in runoff into Perth dams across the same period.

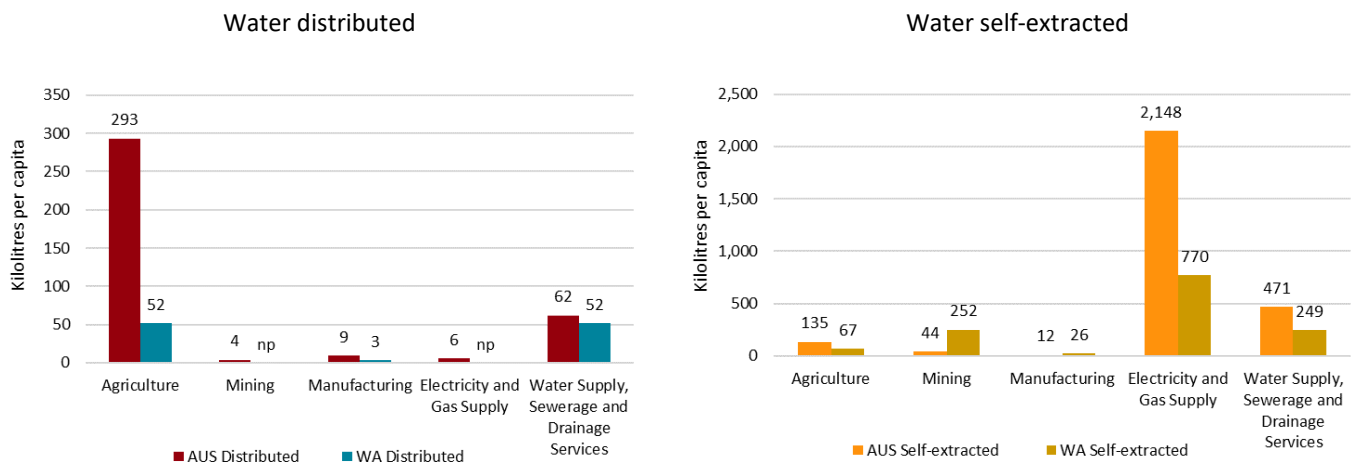
WA has a very different mix of water sources to other Australian states. In 2019, 42% of WA's water came from groundwater and 25% from desalinated plants. Only 30% came from surface water, and this percentage goes to zero in years with drought intensive periods such as 2016-17. This compares starkly to all other Australian states, at least 90% of water is sourced from surface water.

After electricity and gas supply, agriculture is the industry that uses the most water in WA. However, WA farmers use 83% less distributed water and 50% less self-extracted water than the national average.

This is due to the characteristics of WA farms, which are mainly rain-fed. WA holds 21% of the agricultural land of Australia and 10% of agri-business but they only use 5% of water. In terms of land, less than 0.03% of agricultural land in WA is irrigated compared to 0.5% in Australia.

⁴ Radcliffe, J. (2002). Pesticide use in Australia: A review undertaken by the Australian Academy of Technological Sciences and Engineering. Australian Academy of Technological Sciences and Engineering (ATSE).

⁵ Heap, I. (2014). Global perspective of herbicide-resistant weeds. *Pest management science*, 70(9), 1306-1315.

Figure 14: Distributed and self-extracted water use per capita by selected industries, Australia and WA, 2017-18

Source: Bankwest Curtin Economics Centre | Authors' calculations based on ABS Cat 4655

As for the future, among all areas that grow wheat internationally, WA belongs in the top 10% of hot spots – those most at risk of an increased probability of severe water scarcity events during wheat season⁶. The WA South West as well as areas east of Albany are likely to suffer from relatively less severe water scarcity events. Farm prices in areas with reliable rainfall have soared recently, increasing by 60% around Esperance in 2019 alone.

What techniques can be used to improve the environment?

No tillage: Already widely adopted in WA. No-tillage decreases dust storms, helps to keep moisture in the soil and retains carbon. It also leaves insects and bacteria undisturbed.

Cover crops: Increasing use in WA. Cover crops hold the soil in place and provide shade, increasing water retention and soil moisture. Some cover crops can provide natural nutrients and fix nitrogen to the soil, which will in turn decrease the need for fertilisers.

Multiple crops: Planting multiple crops allows for better diversification and reduces risks. It can also improve the farmer's time management by smoothing crop harvesting peaks.

Crop rotation: Different crops need different nutrients. Planting the same crop in the same spot every year will deplete the soil nutrient specifically needed for that particular crop, hence increasing the need for fertilisers and deteriorating the soil.

Use of companionship planting: Planting trees or crops together can be beneficial for each other. Trap crops lure and 'trap' pests, leaving the main crop intact. Some companionship planting also deters fungus and nematodes that can compromise crop health. Some crops perform better when planted next to one another as they can fix nutrients necessary for the other.

Use of animals: Animals can enhance soil health if rotated wisely, through acting as natural fertilisers. They also present an opportunity for farm diversification.

Create small patches of forest: Bringing forest back can enhance biodiversity and provide shade for animals. It can also increase local rainfall if sufficient areas in the region are covered by forest.

⁶ Trnka, M., Feng, S., Semenov, M. A., Olesen, J. E., Kersebaum, K. C., Rötter, R. P., & Hlavinka, P. (2019). Mitigation efforts will not fully alleviate the increase in

water scarcity occurrence probability in wheat-producing areas. Science Advances, 5(9), eaau2406.