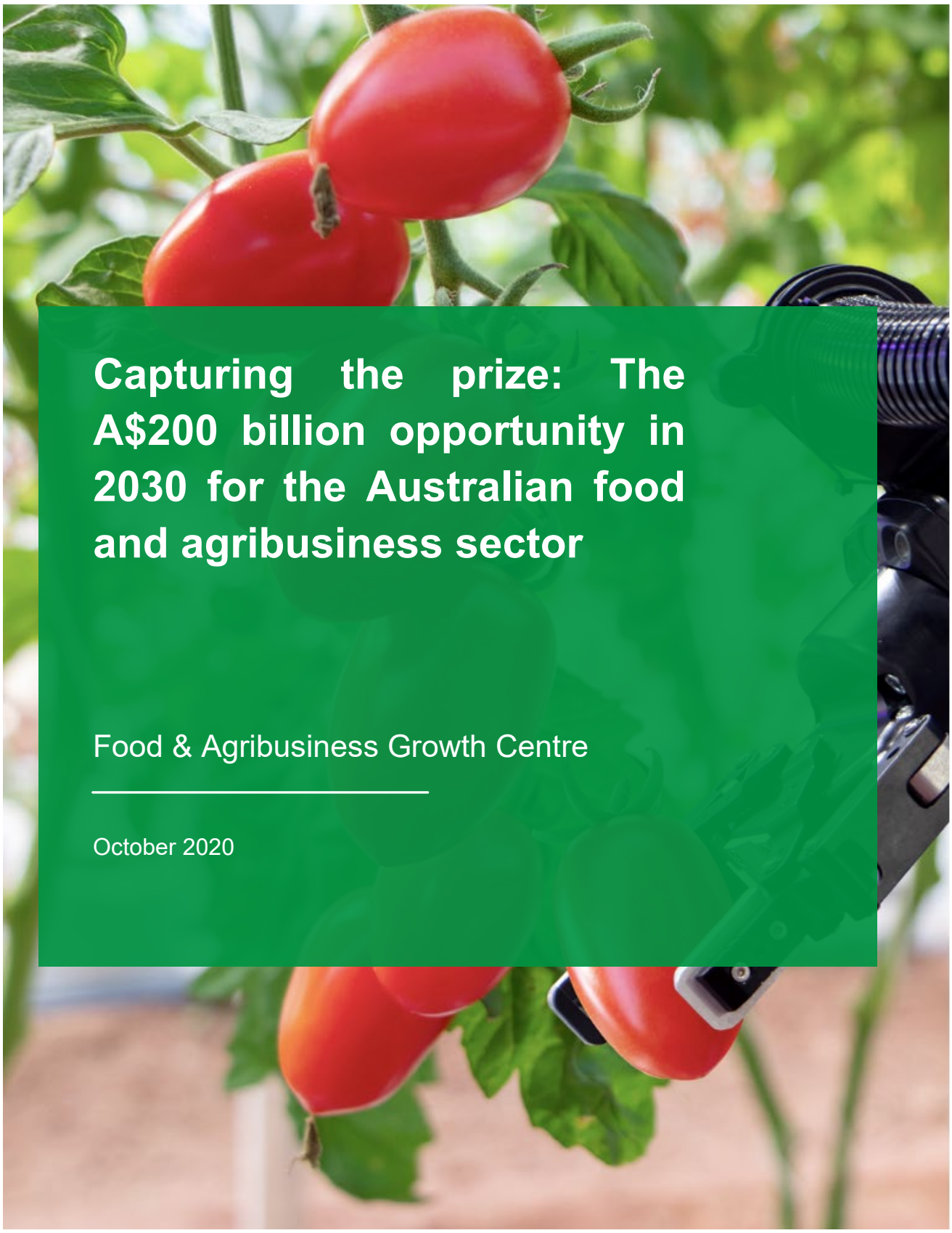

Capturing the prize: The A$200 billion opportunity in 2030 for the Australian food and agribusiness sector

Food & Agribusiness Growth Centre

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FIAL
The Food and Agribusiness Growth Centre

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Foreword

Food Innovation Australia Limited (FIAL) is an industry-led, not-for-profit organisation focused on growing the share of Australian food in the global marketplace. FIAL serves as a catalyst, helping businesses with an appetite to grow and succeed on the world stage.[1]

Each year FIAL releases a Food and Agribusiness Sector Competitiveness Plan (SCP).[2] In the SCP, the food and agribusiness sector refers to opportunities in the agriculture, fishing and food-related manufacturing value chain, including agricultural machinery, seeds and packaged food products. The SCP summarises how Australia could take advantage of global shifts. It outlines a ten-year vision and strategy for the industry on what needs to be done to achieve this vision. In addition, the Plan highlights research and development priority areas that the food and agribusiness sector require from the Australian research sector. There are four research and development priority areas in which innovation is required to ensure the growth and sustainability of the industry:

(1) **Food security & sustainability**. Protecting Australia's economy, environment and people from climate change, pest and disease through improved integrity and traceability systems that target food safety and biosecurity risks.
(2) **Enhanced production & value addition**. Using better genetics, novel technologies and processing techniques to optimise operational efficiencies, minimise waste, and produce highly differentiated and value-added foods.
(3) **A global marketplace**. Increasing connectedness with the emerging middle class in Asia, and with global value chains, provide new market insights into the needs of future consumers, identifying new opportunities, markets and supply chains.
(4) **The future consumer**. Feeding the growing and ageing population with functional and nutritional foods, personalised to their taste, health and lifestyle preferences.

During the past four years, AlphaBeta has been working with FIAL to identify pathways for Australian food and agribusinesses to innovate and respond confidently to changing markets.

This latest work identifies the relevant business opportunities for Australian food and agribusiness through to 2030 and the associated jobs and skill requirements. Specifically, this research addressed three questions:

- **What are the business opportunities of relevance for Australian food and agribusiness?** Based on a thorough analysis of local and international research, emerging trends, and interviews with industry experts, this research identifies 19 global opportunities with the potential to boost the Australian food and agribusiness sector's competitiveness and growth in FIAL's four research and development priority areas. Many of these opportunities are underpinned by rapidly emerging technologies, such as the Internet of Things (IoT), and advanced genomics, which transform how food is produced, how it is distributed and tracked in the supply chain, and how it finally reaches our plates. Other opportunities include changing consumer tastes and preferences, to alternative proteins. The research sizes the opportunities in terms of their value addition (i.e. the amount by which the value of a good is increased at each stage of its production, exclusive of initial costs) so it can be assessed relative to Australia's overall Gross Domestic Product (GDP).

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[1] FIAL (2019), *Business Plan 2019-20*. Available at: https://fial.com.au/fial-reports/Attachment?Action=Download&Attachment_id=227

[2] FIAL (2019), *Sector Competitiveness Plan 2019*. Available at: https://fial.com.au/scp

- **Which future jobs could emerge out of these opportunities?** The Australian food and agribusiness sector currently employs approximately 538,000 people today.[3] This research also examines how not only the total number of jobs but also the type of jobs could evolve if these opportunities are captured.
- **Which skills will tomorrow's food and agribusiness workers need?** This research also understands how the skill base in the food and agribusiness sector will need to evolve in order to support this shifting job landscape. A detailed literature review of academic and market research, input from FIAL leadership and industry experts, and analysis of data from the Australian Bureau of Statistics and O*NET was undertaken to inform the findings published here.

One of the key objectives of this report is to challenge the current thinking by offering fresh insights for policymakers and business leaders. Further, it aims to promote and encourage a whole-of-sector response to determine the next steps in Australia's food and agribusiness sector preparedness to make the most of the exciting shifts in science, technology and consumer markets worldwide.

[3] This 2019 estimate is based on Australian Bureau of Statistics (ABS) data and does not include downstream related services involving food (e.g., retail).

Contents

At a glance

Key takeaways

1 Shifting trends. **10 trends** will significantly shape the food and agribusiness sector over the next decade, including the **164 million people** projected to join the consuming class annually between 2019 and 2030, as well as rising food security concerns following the COVID-19 pandemic.

2 19 opportunities. These opportunities could create large new markets or cost savings in the Australian food and agribusiness sector by 2030. Many of these opportunities are underpinned by rapidly emerging technologies, such as the Internet of Things, and advanced genomics, which transform how food is produced, how it is distributed and tracked in the supply chain, and how it finally reaches our plates.

3 Big value ahead. These opportunities could unlock more than **A$200 billion** value added in 2030, which would almost **triple** the current size of Australia's food and agribusiness sector.

4 More jobs growth. Realising these opportunities could result in the creation of **842,000** potential jobs in 2030. Job creation could grow more than 2.5x faster than historically in food and agribusiness.

5 Skills shift required. Workers will need different skills to do future jobs in food and agribusiness. Demand for people with **technical, managerial and numeracy skills** will grow strongest. **Administrative workers** are expected to require the largest change in skills to do their jobs in 2030.

Executive summary

The changing food and agribusiness sector

10 trends, ranging from growth in the consuming class, through to increasing concerns with food security following COVID-19 will radically change the food and agribusiness sector over the next decade.

The food and agribusiness sector refers to opportunities in the agriculture, fishing and food-related manufacturing value chain, including agricultural machinery, seeds and packaged food products.[4] A range of socioeconomic, geopolitical, technological, and consumer trends are converging to rapidly change the food and agribusiness landscape. These include urbanisation helping to create a growing pool of new consumer markets, particularly in middleweight cities (defined as cities with populations of between one to five million) in Asia, through to increasing supply chain connectivity (linked in part to the Belt and Road Initiative) and shifting consumer tastes linked to health and environmental concerns.

The value opportunity

From superfood to urban farming – Australia's food and agribusiness sector is facing exciting new opportunities to reach consumers and lead a global race for innovation. The 19 most promising growth ideas could be worth over A$200 billion by 2030.

Growing tomorrow's food requires a mindset shift. Many traditional ways of producing crops and breeding livestock are challenged by environmental and societal changes, in Australia and globally. Soils are degrading, consumer tastes are evolving, and rising wealth is fuelling Asia's demand for meat. At the same time, these challenges present a substantial opportunity for the Australian food and agribusiness sector.

FIAL research has identified 19 areas worth exploring for Australian businesses willing to take the lead in unlocking new markets (Exhibit E1). They range from new opportunities to satisfy a growing appetite for healthy foods, to developing biodegradable packaging and technology to reduce food waste as well as increasing crop yields using robotics and internet-controlled sensors on farms.

- **The opportunity is growing:** Together, these opportunities could be worth over A$200 billion by 2030 (in terms of value added). To put this in perspective, this is almost triple the current value of Australia's food and agribusiness sector (which was A$67.2 billion in 2017-18 and A$61.3 billion in 2018-19).[5]
- **Feeding future consumers:** The largest value opportunity for firms in the Australian food and agribusiness will revolve around servicing a new generation of consumers (*the future consumer*). Opportunities in the *health and wellness* category cater to a rising number of health-conscious people favouring unprocessed, organic and "free from" foods in Australia and globally could amount to roughly A$45 billion in 2030. Growing demand for *traditional proteins (meat, egg and dairy)* could present an additional opportunity worth A$31 billion.

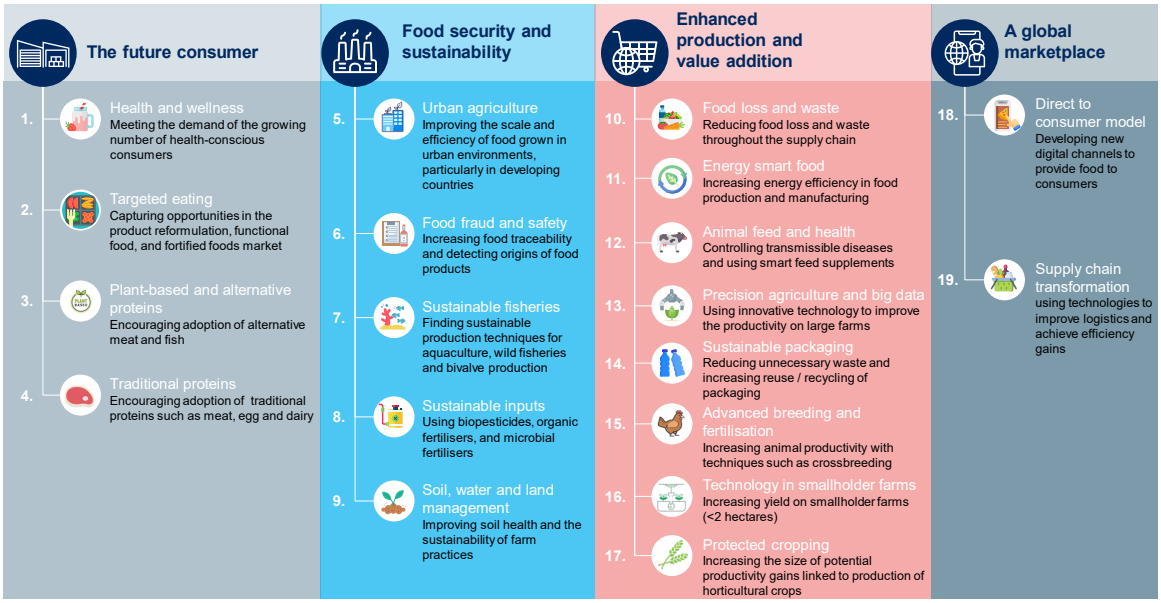
[4] Includes sub-sectors in Agriculture such as mushroom and vegetable growing, dairy cattle farming and aquaculture as well as sub-sectors in Manufacturing such as seafood processing, beverage manufacturing and machinery and equipment manufacturing.

[5] There are different ways to understand the values used to size the food and agribusiness sector in Australia. It is important to note that the current sizing of the food and agribusiness sector in Australia does not include divisions such as retail trade, wholesale trade as well as accommodation and food services.

- **Measuring the gain:** It is worth noting that these value estimates describe the Australian food and agribusiness sector's expected market size or potential efficiency gains related to the prioritised opportunities. This approach adjusts the estimates in the economic opportunity sizing to only consider the value-added share of the food and agribusiness sector. Value-added is the difference between the price of product or service and the cost of producing it. This allows the opportunities to be compared to Australia's Gross Domestic Product (i.e. considering only the incremental values of the activities). Therefore, the estimates in this analysis differ from the National Farmers Federation's vision for the industry to contribute more than A$100 billion by 2030 in farmgate sales, which considers only a selected component of the value chain, and is sized in terms of revenue rather than value-added.[6] The expenditure multiplier associated with the opportunities could be significantly larger than the estimated value-added. If the direct, indirect and consumption induced impacts of these opportunities are considered, then the total economic impact could be A$548 billion by 2030. For instance, an increase in sales of fresh food creates a direct impact on the food retailers, then indirect impact through suppliers, and an induced impact through the expenditure of workers in those sectors.

EXHIBIT E1

19 major opportunities in food & agriculture to 2030



[6] Australian Farmers (2016), *2030 Roadmap*. Available at: https://farmers.org.au/roadmap/

The employment opportunity

More growth will lead to stronger job creation – Australia's food and agribusiness sector could become a magnet for new employment. This is especially important given the job losses due to the COVID-19 pandemic. By 2030, the number of jobs associated with these opportunities could support 842,000 direct jobs.

Employment in the Australian food and agribusiness sector has historically grown by an average of 1.6 per cent each year.[7] The rapidly intensifying economic effects of the COVID-19 pandemic are proving to be far worse than previous crises. The impacts of the pandemic on jobs in Australia are already and will continue to be significant. From March to June 2020, almost 20,000 jobs in the agriculture industry were lost.[8]

In the future, the pace of job creation could accelerate significantly to 4 per cent annually if the sector is fully committed to harnessing the prioritised market opportunities.

- **Where current jobs are:** In 2019, the food and agribusiness sector employed around 538,000 people.[9] A significantly larger number of people are employed throughout the value chain – more than 900,000 alone in food and beverage services.[10] The jobs associated with the 19 identified opportunities are roughly 542,000.[11] It is difficult to assess exactly how many of these jobs are incremental to current employment in Australia's food and agribusiness sector, but based on Australia's limited capture of many of these 19 opportunities today it is clear that there are significant incremental jobs that could be captured.
- **Where future jobs could be:** The total number of jobs associated with these opportunities is expected to increase to 842,000 in 2030 (from 542,000 today). The largest source of new jobs created could be in *health and wellness*, adding up to 37,000 new jobs, followed by *supply chain transformation* and *targeted eating.* This would result in job creation in Australia's food and agribusiness sector growing more than 2.5x faster than historical rates (i.e. 4 per cent annual growth versus the historical 1.6 per cent annual employment growth).
- **Measuring the gain:** The industry's ability to achieve this strong pace of job creation will depend on the size of the realised opportunity (more growth will create more jobs); the current labour intensity of production (higher capital use could reduce the need for human labour); and improvements in labour productivity (which could mean fewer workers are needed to produce the same output).
- **The trade-off:** Some opportunities may deliver large gains in value, but few new jobs. This could occur in industries that are capital-intensive and / or that adopt automation. For example, *animal feed and health* could be a A$11 billion opportunity in Australia in 2030, or 5.4 per cent of the total value-added potential. Yet most activities in this opportunity are relatively capital intensive, which is why they would likely create only 3.0 per cent of the total jobs that emerge. Similarly, business opportunities in the technology-heavy field of *precision agriculture* may

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[7] Calculated by proxying growth of employees in agriculture and food services over 2014-2019 using data from the Australian Bureau of Statistics.

[8] McKinsey & Company (2020), "The next normal for Australian industries and workforces". Available at: https://www.mckinsey.com/industries/public-and-social-sector/our-insights/the-next-normal-for-australian-industries-and-workforces

[9] Based on estimates supplied by the Australian Bureau of Agricultural and Resource Economics to FIAL. The actual jobs in agriculture, fishing and manufacturing in 2019 has been estimated to be about 538,000. This estimate does not include downstream related services involving food (e.g., retail).

[10] Australia's Food and Agribusiness Industry data card.

[11] The 2019 potential job estimation is not the current job estimate for Australia but rather the potential opportunity from full exploitation of all the identified opportunities. The 2019 actual and potential estimates differ in two ways – a) the 2019 potential estimate includes the full exploitation of the opportunities rather than the actual value captured, and b) the 2019 actual estimate includes all food and agribusiness opportunities, beyond the prioritised ones in the 2019 potential estimate.

actually lead to the automation and loss of some jobs. Understanding how many jobs could be lost due to automation or displacement of markets (e.g. green fertilisers replacing chemical fertilisers) linked to these 19 opportunities is difficult to assess, but it reinforces the importance of industry and government working closely together to supporter workers to make this transition to jobs associated with the emerging opportunities.

The occupation scenario

Fewer managers and administrative workers, slightly more machine operators – Seizing the opportunities would leave the occupational mix in the food and agribusiness workforce largely intact.

A stronger push towards innovating business models, products and services can be expected to cause some workforce reshuffling. Some workers will be introduced to new technologies, others will be given new roles. This research report examines how pursuing the prioritised opportunities would impact five types of occupations in Australia's food and agribusiness sector: (1) managerial jobs; (2) professionals; (3) manual labour; (4) sales workers; and (5) administrative workers.

- **The occupation mix will barely change:** Overall, each occupation's share of the industry's total workforce composition is expected to remain fairly stable between 2019 and 2030, even if all opportunities are fully realised. A decline in the share of managers and administrative workers would likely be offset by an increase in professional staff and some manual labourers, such as machine operators and technically skilled labourers.
- **Opportunities will vary:** Demand for certain occupations could still vary significantly in specific fields. For example, for Australia to realise the full opportunity presented in the field of *advanced breeding and fertilisation*, it would need a workforce comprising 72 per cent professional staff and 3 per cent manual labour by 2030. In contrast, Australia's opportunity to support a *supply chain transformation* would require only 16 per cent professional staff and 59 per cent manual labour.

The skills challenge

Is the Australian food and agribusiness workforce ready for transformation? The occupational mix may not change much, but the nature of future jobs will require a radical shift in skills.

New technologies are spreading rapidly across the economy and are causing every worker, whether employed on an outback farm or in a city food retailer, to adjust to new tasks and routines. This research analyses how Australia's workforce would need to change to help the food and agribusiness sector realise the prioritised opportunities.

The research covered seven categories of skills: (1) critical thinking and complex problem solving; (2) written and verbal communication; (3) numeracy; (4) managerial skills; (5) social skills; (6) evaluation, judgement and decision making; and (7) technical and ICT skills such as computer literacy.

- **Which skills will be in demand:** Australia's food and agribusiness workforce will need substantially stronger technical skills (+33 per cent) by 2030 to facilitate the industry's growth and competitiveness. With the Fourth Industrial Revolution (4IR) changing the agriculture and food manufacturing sectors, employees are expected to need to develop critical technical skills to manage and maintain new technologies such as robotics, big data, and the Internet of Things

(IoT). Managerial skills (+14 per cent) will become increasingly important in a world where non-routine tasks represent a greater share of worker activities and there is a need to find effective ways of integrating human ingenuity and digital technologies. Numeracy skills (+11 per cent) will also become more important due to the large amount of quantitative data produced by technologies such as IoT. For example, farm sensors continuously generate information, resulting in significant data points for engineers to analyse.

- **Which workers will be most affected:** Administrative workers, such as procurement clerks and data entry specialists, are the occupations whose skill profile is expected to change most between now and 2030. This is driven by digital technologies such as IoT and big data automating tasks that were previously done manually and instead requiring administrative workers to place a greater emphasis on evaluation and technical skills. For instance, much of the current activities of procurement clerks are manual in nature (e.g., preparing and reviewing purchasing reports and price lists). However, with increased automation and the use of big data, key analyses such as price trend comparisons could be managed by software programmes and there will be a greater need for technical skills for these clerks to understand and interpret the data.

- **Skill requirements will vary:** Not every opportunity will require an equally strong shift in skills. For example, people working in *sustainable fisheries* would need better social and managerial skills in the future to help businesses in the field harness new market opportunities. As tasks get automated and technical skills become common, there could be the deployment of more employees from manual labour to sales-related tasks such as sales planning and business development. These tasks require soft skills such as negotiation and persuasion. On the other hand, critical thinking will become more important for opportunities such as tackling *food loss and waste* due to the need for innovative and comprehensive solutions to reduce wastage along the value chain. For instance, there is the demand to create more targeted behavioural campaigns and innovations for households.

The decision-maker challenge

There is a risk that Australia misses a sizeable opportunity to create more value and thousands of new jobs in its food and agribusiness sector. Policymakers and businesses need to chart a path into the future now.

This research forecasts substantial gains from new, global market opportunities for the Australian food and agribusiness sector. Value-added with the opportunities could reach over A$200 billion by 2030 (which is over 10 per cent of Australia's current GDP) and there could potentially be 842,000 jobs. However, the sector is already facing an acute shortage of labour and an ageing workforce.

- **The current labour shortage:** It is estimated that A$2 million are lost each year due to the existing workforce shortage in the food and agribusiness sector.[12] Unfavourable demographics could exacerbate the problem. The average Australian farmer is between 53 and 59 years old, much higher than the median age of 40 for the rest of the workforce.

[12] Australian Farmers blog (2019), "Survey uncovers multi-million-dollar cost of farm labour crisis". Available at: https://farmers.org.au/news/survey-uncovers-multi-million-dollar-cost-of-farm-labour-crisis/

- **The need for new talent and skills:** The sector will need to ensure existing workers have the right skills to master a changing global environment. It will also need to hire more workers that can drive its future transformation. The urgency to learn new skills is greatest for administrative workers. Addressing the rising need for technical, managerial and numeracy skills will become crucially important.
- **Takeaways for policymakers and business leaders:** The appropriate policy and business response to these challenges is outside the scope of this research, but several aspects will be particularly important to address: (1) Driving greater policy, programme and investment coordination and alignment across government and industry to grow Australia's food and agribusiness sector; (2) Rebranding the sector to attract new talent; (3) Building closer links with educational institutions to ensure future workers have the appropriate skill sets; (4) Rethinking educational models for existing workers; and (5) Developing flexible employment models for older workers.

1. *Where is the value? Sizing Australia's major opportunities in food and agribusiness*

The future for food and agribusiness looks promising. *The sector is already a strong contributor to the Australian economy, producing goods and services worth almost A$70 billion each year.*[13] *Further growth lies ahead, despite global challenges. There are 19 major global opportunities waiting to be tapped, according to research by FIAL. This chapter reviews the emerging trends that are set to shape the food and agribusiness sector over the next decade, and then identifies and sizes the opportunities it could create.*

10 trends will transform the food and agribusiness sector over the next decade

The food and agribusiness sector refers to opportunities in the agriculture, fishing and food-related manufacturing value chain, including agricultural machinery, seeds and packaged food products.[14] A range of socioeconomic, geopolitical, technological, and consumer trends are currently converging in ways that will transform the food and agribusiness sector over the coming decade. Based on a thorough review of local and international literature and expert interviews, 10 trends have been identified that could have important implications for Australia's food and agribusiness sector. While different research reports may have different terminology and descriptions of these trends, there is a significant degree of consistency across reports in the key trends of relevance for food and agribusiness.[15] It is also important to stress that we have focused on structural trends that are likely to be relevant over the 10 year period of focus, as opposed to more short-term "fads" which may emerge and disappear.

[13] Food and agribusiness added A$67.2 billion of industry gross value to the economy in 2017-18, equivalent to 3.6 per cent of Australia's total GDP. This was based on the shares of sub-divisions for SIC division A (Agriculture, forestry and fishing) and division C (Manufacturing). See FIAL (2019), Sector Competitiveness Plan. Available at: https://fial.com.au/Attachment?Action=Download&Attachment_id=37

[14] Includes 15 sub-sectors in Agriculture such as mushroom and vegetable growing, dairy cattle farming and aquaculture as well as 15 sub-sectors in Manufacturing such as seafood processing, beverage manufacturing and machinery and equipment manufacturing.

[15] Reports covered include Top 50 global trends by Frost & Sullivan (this report covers the top 50 global trends, beyond food and agribusiness, including agriculture 4.0, protein engineering and sustainable packaging); Surviving and Thriving in the 21st Century: A discussion and call to action on global catastrophic risks by The Commission for the Human Future (this report explores ten global risks, such as rising food insecurity and falling nutritional quality, and recommends solutions); Pursuing the global opportunity in food and agribusiness by McKinsey & Company (this report highlights major trends including urbanisation and demographic changes in mature markets), and Nine Trends Transforming the Agribusiness Industry by L.E.K. (this report indicates nine key trends that are driving transformation within the industry such as increased focus on sustainability and evolving protein demand).

I. THE GREAT URBAN MIGRATION

Over the next two decades, nearly all of the world's net population growth is expected to occur in urban areas, with about 1.4 million people added each week.[16] Urbanisation is helping to create a growing pool of the consuming class, with households that have income available for discretionary purposes.[17] Between 2000 and 2019, 111 million people were added to the global consuming class each year. This annual growth is expected to accelerate to 164 million annually between 2019 and 2030.[18] The rate of urbanisation is also increasing reaching 79 million per year globally (versus 75 million people added to cities annually from 2000-19).[19] Some of the fastest growth in the consuming class is happening in middleweight cities (with 1-5 million population). For example, research by AlphaBeta and Nielsen has shown that in South East Asia, some of the fastest-growing and largest new consumer markets are in middleweight cities such as Nakhon Ratchasima, Chonburi, and Rayong (all in Thailand).[20] This growth in the consuming class will create large new markets for Australian produce but also require developing new supply chains to service the growth of these emerging middleweight cities.

II. INCREASING PHYSICAL CONNECTIVITY

Despite trade tensions, there is increasing connectivity through infrastructure which is reshaping supply chains. The estimated demand for connecting infrastructure projects between 2015 and 2030 amounts to US$1.8 trillion per year. This is around 30 per cent of the overall infrastructure demand, although 40 per cent of this investment has yet to be committed.[21] The Belt and Road Initiative (BRI) being led by China has already committed up to US$8 trillion in investment through to 2050, in projects including roads, railroads, shipping lanes, airports, and gas pipelines.[22] This new infrastructure could open new trade routes and improve the efficiency of delivering produce to growing markets in Asia.

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[16] United Nations Department of Economic and Social Affairs, Population Division (2018), *World Urbanisation Prospects: The 2018 Revision.*

[17] Consuming class defined as people in the middle class, which is defined by Kharas (2017) from Brookings as households with per capita incomes between US$10 and US$100 per person per day (pppd) in 2005 PPP terms. This implies an annual income for a four-person middle-class household of US$14,600 to US$146,000.

[18] Homi Kharas (2017), *The unprecedented expansion of the global middle class: An update*. Available at: https://www.brookings.edu/wp-content/uploads/2017/02/global_20170228_global-middle-class.pdf

[19] AlphaBeta estimates based on data from the United Nations Population Division. Available at: https://population.un.org/wup/

[20] AlphaBeta and Nielsen (2017), *Rethinking ASEAN: Dispelling 8 myths about consumer markets*. Available at: https://www.alphabeta.com/wp-content/uploads/2017/07/ASEAN-Consumer-Demand-Report_Jul2017.pdf

[21] World Economic Forum (2020), *Nature Risk Rising: Why the Crisis Engulfing Nature Matters for Business and the Economy. Available at:* http://www3.weforum.org/docs/WEF_New_Nature_Economy_Report_2020.pdf

[22] WWF and HSBC (2017), *Greening the Belt and Road Initiative: WWF's Recommendations for the finance sector.* Available at: https://www.sustainablefinance.hsbc.com/mobilising-finance/greening-the-belt-and-road-initiative

III. DIETARY SHIFTS DUE TO HEALTH AND ENVIRONMENTAL ISSUES

Animal products provide only 18 per cent of calories while accounting for over 80 per cent of farmland, 58 per cent of food-related greenhouse gas emissions (GHGs), and most deforestation.[23] According to one study, consumers shifting to nation-specific recommended diets could reduce GHGs by 25 per cent, eutrophication by 21 per cent and land use by almost 18 per cent in high-income countries.[24] Shifting just 20 per cent of global calorie consumption from meat to fish would save 60 to 80 million hectares of cropland, equivalent to two to three times the landmass of the United Kingdom.[25] Furthermore, there have been recent studies on the health issues related to animal products. For instance, a study of over 80,000 people in the United States and Canada has reported that animal proteins were found to be strongly associated with cardiovascular diseases, compared to plant proteins such as nuts.[26] Increased focus on detrimental health impacts and environmental issues linked to most animal-based diets have accelerated the shift towards plant-based foods. Studies reveal that 27 per cent of Europeans intend to eat less meat over the next five years;[27] a third of Americans intend to reduce meat consumption, and 14 per cent of Australians are making a concerted effort to avoid red meat.[28]

IV. ENVIRONMENTAL CONSTRAINTS IMPACTING PRODUCTION

The World Economic Forum has highlighted that US$44 trillion of economic value generation – over half the world's total GDP – is potentially at risk because of the dependence of business on nature and its services.[29] Biodiversity loss and ecosystem collapse ranked as one of the top five threats humanity will face in the next 10 years, according to the World Economic Forum's 2020 Global Risks Report.[30] These risks are particularly acute for the global food system. At an estimated US$12 trillion, the hidden costs of the food, ocean and land use system now exceed its contribution to global GDP.[31] According to the EAT-Lancet Commission, without a radical transformation in food production processes, a halving of food loss and waste, and significant dietary shifts, by 2050 we will not be able to feed the world's

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[23] Poore, J., and Nemecek, T., (2018), "Reducing food's environmental impacts through producers and consumers", Science 360 (6392), 987-992. Available at : https://josephpoore.com/Science%20360%206392%20987%20-%20Accepted%20Manuscript.pdf

[24] Paul Behrens et al. (2017), "Environmental impacts of dietary recommendations". Proceedings of the National Academy of Sciences Dec 2017, 114 (51) 13412-13417. Available at: https://www.pnas.org/content/114/51/13412

[25] Size varies depending on the efficiency of feed conversion; production is assumed to come from aquaculture.

[26] Marion Tharrey, François Mariotti, Andrew Mashchak, Pierre Barbillon, Maud Delattre, Gary E Fraser (2018), "Patterns of plant and animal protein intake are strongly associated with cardiovascular mortality: the Adventist Health Study-2 cohort", International Journal of Epidemiology, Volume 47, Issue 5, Pages 1603–1612. Available at: https://doi.org/10.1093/ije/dyy030 and Heli E K Virtanen, Sari Voutilainen, Timo T Koskinen, Jaakko Mursu, Petra Kokko, Maija P T Ylilauri, Tomi-Pekka Tuomainen, Jukka T Salonen, Jyrki K Virtanen (2019), "Dietary proteins and protein sources and risk of death: the Kuopio Ischaemic Heart Disease Risk Factor Study", The American Journal of Clinical Nutrition, Volume 109, Issue 5, Pages 1462–1471. Available at: https://doi.org/10.1093/ajcn/nqz025

[27] ING Economics Department (2017), The protein shift Will Europeans change their diet? Available at: https://www.ing.nl/media/ING_EBZ_-the-protein-shift-will-Europeans-change-their-diet_tcm162-136110.pdf

[28] FIAL (2019), Protein market: Size of the protein analysis for Australia. Available at: https://fial.com.au/Attachment?Action=Download&Attachment_id=200

[29] World Economic Forum (2020), *Nature Risk Rising: Why the Crisis Engulfing Nature Matters for Business and the Economy. Available at:* http://www3.weforum.org/docs/WEF_New_Nature_Economy_Report_2020.pdf

[30] World Economic Forum (2020), *2020 Global Risks Report. Available at:* https://www.weforum.org/reports/the-global-risks-report-2020

[31] The Food and Land Use Coalition (2019*), Growing Better: Ten critical transitions to transform food and land use*. Available at: https://www.foodandlandusecoalition.org/wp-content/uploads/2019/09/FOLU-GrowingBetter-GlobalReport.pdf; and Martin van Nieuwkoop (2019), "Do the costs of the global food system outweigh its benefits?" World Bank Blogs. Available at: https://blogs.worldbank.org/voices/do-costs-global-food-system-outweigh-its-monetary-value;

growing population while operating within safe planetary boundaries.[32] A few examples illustrate the scale of the challenge we face. Globally, pollinator populations have declined, putting at risk the production of global crops with an annual market value of between US$235 billion and US$577 billion – because these crops depend on animal pollination.[33] To cope with the decreased catch in their traditional fishing grounds, commercial fishing fleets are targeting new species and expanding to new areas, raising the total area fished from 60 per cent to 90 per cent of the world's oceans.[34] As a result of industrial fishing, 93 per cent of fish stocks today are fished at or beyond maximum sustainable levels.[35] Despite these challenges, there is a range of opportunities in the food system that could help address biodiversity loss and create significant new markets or cost savings for the food and agribusiness sector. Recent research by AlphaBeta and the World Economic Forum has found that six business transitions in the food, land and ocean use system could create almost US$3.6 trillion of additional revenue or cost savings by 2030 while creating 191 million new jobs.[36] These opportunities range from tackling food waste in the supply chain through to deploying technology in large-scale farms that could lead to 40 per cent improvements in yields. Australia is at the forefront of these challenges as well as the opportunities. For example, Australia is experiencing long-term trends of increasing water scarcity impacting agriculture. Water trading in the Murray–Darling Basin is worth A$2 billion annually.[37]

V. TECHNOLOGICAL ADVANCES

A range of technology applications could transform the food and agribusiness sector. Since 2013, food and beverage start-ups have raised US$9.5 billion across 2,100 deals globally, and the number of investors in this space has doubled.[38] Past research by the World Economic Forum with McKinsey & Company identified 12 particular technologies with high potential to transform the sustainability of the food sector.[39] The technologies include the use of precision agriculture for water and input use optimisation (taking account of soil quality) and microbiome technologies to enhance crop resilience. New technologies are also supporting the growth of alternative proteins, such as cell-based meats. Investments in cultured meat start-ups increased by more than 120 per cent between 2018 and 2019.[40] The learning curve has been fast. The first cultured hamburger patty, created in 2013 by Mosa Meat co-founder Mark Post, cost more than US$278,000 to produce. In 2019, this had fallen to US$100.[41]

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[32] Walter Willett et. al. (2019), *Food in the Anthropocene: the EAT-Lancet Commission on healthy diets from sustainable food systems.* The Lancet Commissions, Vol. 393, Issue 10170, P447-492. Available at: https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(18)31788-4/fulltext

[33] IPBES (2017), *The Assessment Report on Pollinators, Pollination and Food Production*. Available at: https://ipbes.net/assessment-reports/pollinators

[34] David Tickler et al., "Far from home: Distance patterns of global fishing fleets," Science Advances, 2018, Volume 4, Number 8, Available at: advances.sciencemag.org.

[35] IPBES, "Summary for policymakers of the global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services".

[36] World Economic Forum (2020), New Nature Economy Report II: The Future of Nature and Business. Available at: https://www.weforum.org/reports/new-nature-economy-report-ii-the-future-of-nature-and-business

[37] Murray-Darling Basin Authority. Information available at: https://www.mdba.gov.au/managing-water/water-markets-and-trade

[38] Food Business News (2018), "Venture capital investing in food accelerating". Available at: https://www.foodbusinessnews.net/articles/12060-venture-capital-investing-in-food-accelerating

[39] World Economic Forum and McKinsey & Company (2018), *Innovation with a Purpose: The role of technology innovation in accelerating food systems transformation*. Available at: http://www3.weforum.org/docs/WEF_Innovation_with_a_Purpose_VF-reduced.pdf

[40] Food Business News (2020), "Cell-based meats approaching scalability". Available at: https://www.foodbusinessnews.net/articles/15286-cell-based-meats-approaching-scalability

[41] Food Business News (2020), "Cell-based meats approaching scalability". Available at: https://www.foodbusinessnews.net/articles/15286-cell-based-meats-approaching-scalability

VI. AN AGEING POPULATION

The share of people aged over 65 out of the global population is expected to increase from 9 per cent in 2019 to more than 12 per cent in 2030.[42] This will have implications for not only the volume of food but the type. The share of Australia's population above 60 years of age has increased from 16.4 per cent in 2000 to 21.8 per cent in 2020.[43] A survey in Australia found that people in the age group of 51 and above on average consumed 145 grammes of meat, poultry and fish per day, which is 20 per cent lower than the average of 177 grammes consumed per day by people in the age group of 19 to 50 years, implying that the aged population presents business opportunities unique to this population segment.[44] These business opportunities include producing fortified foods and food products with smaller portion sizes.[45] Food products devoid of common allergens like gluten, crustaceans, egg, fish, milk, peanuts, and soybeans could also be an attractive business opportunity. In 2011-12, about 15 per cent of men and 25 per cent of women between 51 and years of age in Australia reported avoiding food due to allergies or intolerance.[46]

VII. GOVERNMENT RESHAPING THE WAY WE PRODUCE, TRANSPORT AND CONSUME FOOD RELATED TO HEALTH AND ENVIRONMENTAL CONCERNS

A range of government regulations related to addressing health and environmental concerns could significantly influence the food and agribusiness sector. For example, China has issued new dietary guidelines which aim to reduce the amount of meat consumption by around 50 per cent.[47] The regulatory status of alternative proteins remains unclear in many jurisdictions around the world, and greater focus will be placed on understanding the health and safety implications of these proteins. Plastic packaging is also increasingly being regulated by governments around the world. Research by AlphaBeta has identified 112 markets around the world that are currently implementing regulations related to taxation or extended producer responsibility (EPR) of plastics.[48]

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[42] FIAL (2019), Protein market: Size of the protein analysis for Australia. Available at: https://fial.com.au/Attachment?Action=Download&Attachment_id=200

[43] United Nations (2019), *World Population Prospects 2019*. Available at: https://population.un.org/wpp/

[44] Sui Z, Raubenheimer D. and Rangan A (2017), Consumption patterns of meat, poultry, and fish after disaggregation of mixed dishes: secondary analysis of the Australian National Nutrition and Physical Activity Survey 2011–12. Available at: https://bmcnutr.biomedcentral.com/articles/10.1186/s40795-017-0171-1

[45] AFN (2016), "Factors identified in food for the elderly, expert." Available at: https://www.ausfoodnews.com.au/2016/04/13/factors-identified-in-food-for-the-elderly-expert.html

[46] Australian Bureau of Statistics (2014), *Australian Health Survey: Nutrition First Results - Foods and Nutrients, 2011-12.* Available at: https://www.abs.gov.au/ausstats/abs@.nsf/Lookup/by%20Subject/4364.0.55.007~2011-12~Main%20Features~Food%20avoidance%20due%20to%20allergy,%20intolerance%20or%20ethical%20religious%20reasons~600

[47] The Guardian (2016), "China's plan to cut meat consumption by 50% cheered by climate campaigners". Available at; https://www.theguardian.com/world/2016/jun/20/chinas-meat-consumption-climate-change

[48] Extended Producer Responsibility (EPR) is a policy approach under which producers are given a significant responsibility – financial and / or physical – for the treatment or disposal of post-consumer products.

VIII. RISING CONCERNS ON FOOD SECURITY

The COVID-19 pandemic has highlighted concerns on food supply chain vulnerability, and thoughts on "near-shoring" to promote future resilience. For example, issues such as food security may see countries place restrictions on exports of agricultural products, as witnessed during the COVID-19 crisis.[49] Vietnam, the world's third-largest rice supplier, temporarily banned exports of rice. Cambodia and India also stopped rice exports due to reasons related to food security and logistical challenges.[50] Given the trade restrictions, Australian retailers found it challenging to meet consumer demand. Australian stores experienced shortages of staples such as flour, rice, mincemeat and sugar during the COVID-19 pandemic.[51] The Woolworths supermarket had to open exclusively for elderly and disabled shoppers for an hour to allow them to purchase staples, which were repeatedly sold out during normal operating hours.[52]

IX. THE NEW AGE OF GEO-STRATEGIC CONCERNS

The COVID-19 crisis could reinforce the recent shift towards the "nation-state" and place pressures on multilateral approaches. Further compounding this challenge are trends such as the shift towards a multipolar global power structure (constituted by the US, China, Japan, India and Russia), unresolved and overlapping territorial and maritime claims, and various transnational issues (e.g., haze from forest fires, climate change, terrorism, people smuggling, dam building, plastic waste, etc). These developments create both opportunities and risks for the food and agribusiness sector. The risks include greater regulatory interventions preventing market access, such as the rise of non-tariff barriers. On the positive side, new bilateral trade deals (e.g., a possible Australia-UK trade deal) could provide new market opportunities.

X. THE RISE OF FOOD PROVENANCE

Supply chains in the agriculture and seafood industry are complex, opaque, and lacking in international harmonisation.[53] The lack of clarity makes it easier for producers to operate illegally or unethically and this frustrates consumers, investors and regulators, who are increasingly demanding more information about the composition and the environmental and social impact of the products they consume. But trends in sustainable sourcing and increased reporting are encouraging. For example, sales of Marine Stewardship Council (MSC) certified seafood reached one million tonnes for the first time in 2018, increasing to 15 per cent of overall production from 10 per cent in 2014.[54] There is also an increasing focus on combating food fraud. Food fraud – where fake, cheap and often dangerously low-quality products are sold under the label of well-known brands – is costing the Australian economy A$2-3 billion

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[49] Food Navigator (2020), "'Serious consequences': ASEAN COVID-19 lockdowns heighten food supply fears". Available at: https://www.foodnavigator-asia.com/Article/2020/04/01/Serious-consequences-ASEAN-COVID-19-lockdowns-heighten-food-supply-fears

[50] Reuters (2020), "Trade restrictions on food exports due to the coronavirus pandemic." Available at: https://www.reuters.com/article/us-health-coronavirus-trade-food-factbox/trade-restrictions-on-food-exports-due-to-the-coronavirus-pandemic-idUSKBN21L332

[51] The Straits Times (2020), "Coronavirus: Empty shelves in food-rich Australia raise questions about supply chains." Available at: https://www.straitstimes.com/asia/australianz/coronavirus-empty-shelves-in-food-rich-australia-raise-questions-about-supply

[52] The Straits Times (2020), "Coronavirus: Aussie supermarket chain Woolworths holds 'elderly hour' as panic buying continues." Available at: https://www.straitstimes.com/asia/australianz/coronavirus-elderly-hour-in-aussie-stores-as-panic-buying-continues

[53] The Food and Land Use Coalition (2019*), Growing Better: Ten critical transitions to transform food and land use*. Available at: https://www.foodandlandusecoalition.org/wp-content/uploads/2019/09/FOLU-GrowingBetter-GlobalReport.pdf; and FishWise, (2018), *Advancing traceability in the seafood industry: Assessing challenges and opportunities.* Available at: fishwise.org

[54] Marine Stewardship Council [MSC] (2019), *Working together for thriving oceans – The MSC Annual Report 2018-19*. Available at: https://www.msc.org/docs/default-source/default-document-library/about-the-msc/msc-annual-report-2018-2019.pdf?sfvrsn=e37c6f59_5

each year.[55] Greater consumer pressure combined with new technologies such as blockchain and Internet of Things are now combining to bring greater transparency into supply chains and enhance food provenance (i.e. knowing where food was grown, caught or raised; knowing how food was produced; and knowing how food was transported).

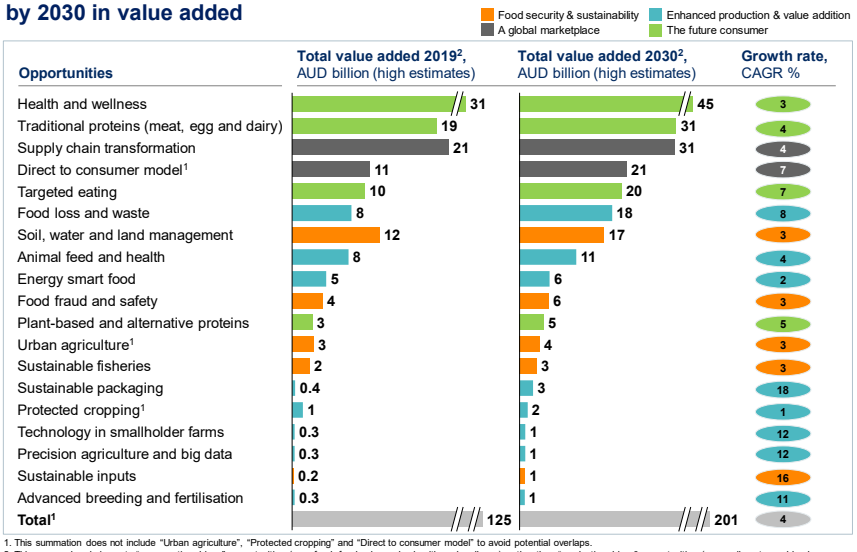
Based on these emerging trends, 19 opportunities have been identified for Australia's food and agribusiness sector, potentially worth over A$200 billion in value added terms by 2030

New technologies and shifting consumer tastes are reshaping food production and farming practices worldwide. **How can Australia's food and agribusiness sector benefit from these global trends?** Past research by FIAL identified 16 opportunities worth exploring globally.[56] This report is going a step further by helping to update that past work to consider new opportunities that may have recently emerged, particularly linked to the trends discussed earlier. It deepens previous calculations and shows which opportunities have the biggest value added potential today and in 2030.

The results should offer a strong incentive for businesses to consider new markets and consumer groups. Together, the opportunities already amount to an estimated value of A$125 billion and they could gain another 60 per cent in the coming years to reach A$201 billion in 2030 (Exhibit 1).[57] Box 1 summarises the different food and agribusiness estimates for Australia. Appendix A describes the methodology for identifying the opportunities, Appendix B describes the overall methodology for sizing the opportunities, and Appendix C provides the specific assumptions used for each opportunity.

EXHIBIT 1

Australia's food and agribusiness opportunity could be worth over A$200 billion by 2030 in value added



1. This summation does not include "Urban agriculture", "Protected cropping" and "Direct to consumer model" to avoid potential overlaps.
2. This approach only impacts "consumption-driven" opportunities (e.g., fresh food sales under health and wellness), rather than "production-driven" opportunities (e.g., soil, water and land management). It also accounts for the entire value chain (from production to retail). Note: the 2019 value is not the current value added for Australia but rather the potential value added from full exploitation of all the identified opportunities.

SOURCE: Literature search; AlphaBeta analysis

[55] PWC, How PwC's Food Trust Platform uses micro tag technology to protect Australian brands from food fraud. Available at: https://www.pwc.com.au/about-us/solving-important-problems/how-pwcs-food-trust-platform-protects-australian-brands-from-food-fraud.html

56 FIAL (2017), Size of the Prize: An Overview of 16 Opportunities for Australian Food & Agribusinesses. Available at: https://fial.com.au/size-of-the-prize-report

[57] While 19 opportunities have been sized, to ensure minimal overlaps, when the total size of opportunities is calculated, three opportunities ("Urban agriculture", "Protected cropping" and "Direct to consumer model") have been removed.

Box 1. Comparison to other estimates of the food and agribusiness sector potential

There have been several related areas of research aimed at understanding the future growth opportunities in Australia's food and agribusiness sector. However, it is important to understand the methodologies used in this past research which often differ significantly and can make direct comparisons difficult. Much of the research varies in terms of (a) what stage of the value chain they focus on (e.g., farm gate level or the entire value chain); (b) the measure of output (e.g. revenue-based estimates or value added); (c) the scope of opportunities included; (d) the quantification units (e.g., 2018 or 2020 dollars), and (e) the time period of analysis (e.g., 2025 or 2030). Below is an overview of some of the recent research and how they compare to the estimates presented in this report.

- **The National Farmers' Federation (NFF).** In 2016, the NFF announced an ambitious vision for the industry to achieve A$100 billion in farm gate output by 2030.[58] Farm gate output represents the prices received by farmers for their produce at the location of the farm (excluding any further value addition throughout the rest of the value chain). As such, it only captures a portion of the total available value in the food and agribusiness sector. The NFF does not provide a detailed breakdown of this opportunity so direct comparison to our estimates is difficult.
- **AgriFutures Australia.** This research was used to assess the current trajectory of the industry in achieving the A$100 billion target of the NFF and found an estimated shortfall of A$15.7 billion based on the current growth trajectory of the sector (i.e. achieving A$84 billion farm gate output by 2030).[59] Like the NFF research, the AgriFutures Australia report also only focuses on the farm gate level, whereas this research focuses on the entire value chain. However, opportunities that were sized at the farm gate level in this report were similar to those in the AgriFutures Australia research. For example, if just focusing on the three opportunities in this report which are closest in scope to their analysis (*health and wellness*, *traditional proteins (meat, egg, dairy)* and *sustainable fisheries*), we estimate there could be value-added of A$79 billion in 2030, which is slightly lower than their estimate of A$84 billion.
- **The Commonwealth Scientific and Industrial Research Organisation (CSIRO).** CSIRO has estimated that there could be A$25 billion (in 2018-dollar terms) by 2030.[60] There are several differences between the CSIRO research and this report. First, the CSIRO research is not based on the value added associated with the opportunities, but rather the total market value or savings. In addition, the CSIRO analysis only considers eight opportunities: domestic and export opportunities of Free-From & Natural; Fortified & Functional; Vitamins & Supplements; Personalised Nutrition; Alternative Proteins; Convenience Meals; Luxury & Novel Products and Agri-tourism.[61]

Opportunities around *health and wellness*, *traditional proteins (meat, egg and dairy)*, and *supply chain transformation* appear particularly promising. They account for 53 per cent of the total value that Australian businesses could capture in the coming years.

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[58] Australian Farmers, 2030 Roadmap. Available at: https://farmers.org.au/roadmap/

[59] ACIL Allen Consulting and AgriFutures Australia (2019), *Agriculture– A $100b sector by 2030?* Available at: https://www.agrifutures.com.au/product/agriculture-a-100b-sector-by-2030/

[60] Commonwealth Scientific and Industrial Research Organisation [CSIRO] (2019), *Growth opportunities for Australian food and agribusiness*. Available at: https://www.csiro.au/en/Do-business/Futures/Reports/Ag-and-Food/Opportunities-for-Food-and-Agribusiness

[61] CSIRO also estimated that the industry could be worth A$250 billion in 2030 (in terms of value-added), but this was based on a continuation of historical growth rates (2.4 per cent per annum) and an estimate of the current size of the industry (A$138 billion) than is considerably higher than the FIAL estimate of A$67 billion in 2017-18. This appears due to the inclusion of sectors beyond the FIAL estimate. The 2018 A$138 billion value added estimate is made up of 1) agriculture A$27 billion from SIC division "Agriculture, forestry and fishing"; 2) food and beverage manufacturing A$46 billion from SIC division "Food, beverage and tobacco manufacturing", and 3) food and beverage retail, wholesale and services A$65 billion from 2016-17 available information on sub-divisions.

Health and wellness

Value added potential: **A$45 billion in 2030**

Average growth**: 3 per cent per year**

This is the largest economic opportunity for the Australian food and agribusiness sector, driven by a growing health consciousness among consumers, particularly in high-income countries. Demand for "premium" or "sustainable" food is on the rise and includes higher-priced fresh foods, organic foods, as well as "free from" (such as gluten-free) foods that are meant for consumers with intolerances but are often generally perceived as healthier or of better quality. An ageing population will likely add to the demand for fresh and healthy food.[62] In Australia, market research firm Ipsos reveals eating fresh food and vegetables is a priority for 40 per cent of consumers.[63] A survey by industry advocacy group Australian Organic found that 65 per cent of Australian households have purchased at least one organic product in the past year.[64] That's double as many as in the United States.[65] Australia also has the largest area of certified organic farmland in the world.[66]

Traditional proteins (meat, egg, and dairy)

Value added potential: **A$31 billion in 2030**

Average growth: **4 per cent per year**

Global protein consumption has risen 40 per cent since 2000, with more than half of the increase being driven by Asia. Going forward, growth in the consumer class could see global total protein demand increasing at an annual rate of 2.7 per cent from now till 2025 – faster than historical growth.[67] Despite the increasing concern over environmental impacts related to traditional proteins and a shift in consumer preferences toward alternative proteins, the demand for traditional proteins is likely to remain strong in Australia.[68] A key reason for this is the continued population increase domestically, which could rise from 25 million today to reach 30 million between 2029 and 2033.[69] The mix of traditional proteins could shift significantly however. For example, due to health and environmental concerns, Australians are likely to reduce their consumption of red meat in favour of white meat.[70] The OECD estimates that the

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[62] Inside FMCG (2018), "Aussies becoming more health conscious". Available at: https://insidefmcg.com.au/2018/01/18/aussies-becoming-more-health-conscious/

[63] IPSOS (2015), Australia's most comprehensive study integrating consumer attitudinal trends with consumption behaviour change. Available at: https://www.ipsos.com/sites/default/files/2017-07/Food_CHATs_report_6_May_2016.pdf

[64] Australian Organic (2019), Australian organic market report. Available at: https://www.smartcompany.com.au/industries/retail/six-in-ten-aussies-buy-organic-inside-the-2-4-billion-industry/

[65] Organic Authority (2019), "30% of U.S. Homes Use Organic Food, New Report Shows"/ Available at: https://www.organicauthority.com/buzz-news/organic-food-reaches-30-per cent-of-households-new-report-shows

[66] ABC News (2015), "Australia ranks number one with the most organically farmed land in the world". Available at: https://www.abc.net.au/news/rural/2015-10-28/australias-organic-farming-future/6891384

[67] FIAL (2019), Protein market: Size of the protein analysis for Australia. Available at: https://fial.com.au/Attachment?Action=Download&Attachment_id=200

[68] AgriFutures Australia (2020), *The Changing Landscape of Protein Production: Opportunities and challenges for Australian agriculture.* Available at: https://www.agrifutures.com.au/wp-content/uploads/2020/02/20-001.pdf

[69] Australian Bureau of Statistics (2018), "Australia's population to reach 30 million in 11 to 15 years." Available at: https://www.abs.gov.au/ausstats/abs@.nsf/latestProducts/3222.0Media%20Release12017%20(base)%20-%202066

[70] AgriFutures Australia (2020), *The Changing Landscape of Protein Production: Opportunities and challenges for Australian agriculture.* Available at: https://www.agrifutures.com.au/wp-content/uploads/2020/02/20-001.pdf

beef and veal consumption in Australia will fall from 19.96 kilograms per capita in 2018 to 18.15 kilograms per capita in 2029, while the poultry meat consumption will increase from 42.4 kilograms per capita in 2018 to 45.2 kilograms per capita in 2029.[71] In addition, Australia's traditional protein industry is well placed to cater to the expected increase in protein demand in Asia, particularly in key emerging markets such as Indonesia and China.[72] Globally, meat and egg demand is expected to increase at around 3 per cent annually between now and 2025.[73]

Supply chain transformation

Value added potential: **A$31 billion in 2030**

Average growth: **4 per cent per year**

Technologies such as the Internet of Things (IoT) and a trend to shared modes of transport (shared mobility) are offering new opportunities to improve how food can be moved and tracked across global supply chains. Australian businesses that embrace these new technologies are expected to benefit from significantly higher productivity and lower costs. The transformation of supply chains in Australia's food and agribusiness sector is already underway. In Victoria, farmers are receiving government funding to install IoT and other technology on farms.[74] Supply chain businesses are also increasingly using digital platforms, blockchain and IoT technology to transport fresh produce fast across borders and monitor its movement in real-time.[75] Telecommunications firm Telstra and logistics consultancy Peloris have been using IoT and Cloud technology to cut delivery times for fresh milk to China from three weeks to less than 36 hours. Their upgraded supply chain now includes a real-time temperature and location tracker for every bottle of milk sold, as well as instant data sharing with China's quarantine authority.[76]

Direct to consumer model

Value added potential: **A$21 billion in 2030**

Average growth: **7 per cent per year**

Buying groceries online is a growing trend and there is a myriad of opportunities for businesses to generate value by establishing new direct to consumer and e-commerce sales channels. This market segment is growing extremely fast, with an increase in online food and liquor sales by 41 per cent in

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[71] OECD. "Meat consumption." Available at: https://data.oecd.org/agroutput/meat-consumption.htm

[72] Tim Whitnall and Nathan Pitts (2019), *Global trends in meat consumption*. Available at: https://www.agriculture.gov.au/sites/default/files/sitecollectiondocuments/abares/agriculture-commodities/AgCommodities201903_MeatConsumptionOutlook_v1.0.0.pdf

[73] FIAL (2019), Protein market: Size of the protein analysis for Australia. Available at: https://fial.com.au/Attachment?Action=Download&Attachment_id=200

[74] The Victorian government invested A$12 million in 2016-17 for IoT trials in agriculture and will provide a further A$15 million to Victorian farmers to fund installation of IoT and other digital technologies on farms. See IoT Hub (2018), "Victorian govt to pump another $15m into agtech". Available at: https://www.iothub.com.au/news/victorian-govt-to-pump-another-15m-into-agtech-487746

[75] KPMG (2018), *Talking 2030 Growing agriculture into a $100 billion industry*. Available at: https://assets.kpmg/content/dam/kpmg/au/pdf/2018/talking-2030-growing-australian-agriculture.pdf

[76] ZDNet (2017), "How an IoT sensor is helping Australian milk reach China faster", Available at: https://www.zdnet.com/article/how-an-iot-sensor-is-helping-australian-milk-reach-china-faster/

2018 alone.[77] People under 35 with no children are the most important consumer group driving the new shopping trend: their online spending almost doubled in the 12 months to October 2018, according to Nielsen research.[78] Families with children in primary-school age are another important source of demand; they increased their online shopping expenditure by around 45 per cent over the same time. The trend of direct farm sales is also gaining traction. For example, Australia Post has established a digital platform called Farmhouse Direct, which connects food growers directly with consumers and is now used by 400 farmers nationwide.[79] Farmers who sell directly to the public can benefit from higher sales margins, although they also face relatively high transaction costs, and figuring out delivery logistics can be challenging.[80] Situations, that restrict travelling and traditional retail options, such as pandemics and natural disasters can alter consumer behaviours and generate greater direct to consumer sales. The current COVID-19 pandemic is one such example. In 2019, a study by Inside Retail Australia found out that only 10 per cent of shoppers buy groceries online, but this has increased significantly with the COVID-19 pandemic.[81] Based on available estimations, during the first two months of 2020, online purchases of pasta and eggs in Australia increased by 76 and 72 per cent respectively.[82]

Targeted eating

Value added potential: **A$20 billion in 2030**

Average growth: **7 per cent per year**

This includes opportunities related to product reformulation to reduce fat and sugar content, functional foods, and food fortification to support nutrient intake and address health concerns. The shift to a healthier diet, paired with a higher disposable income among consumers worldwide, will open new market opportunities for Australian businesses to sell food with reformulated nutritional content. Such products include food low in fat and sugar, or so-called functional foods with high nutritional value. For example, the Australian Beverage Council has pledged to reduce sugar in the country's non-alcoholic drinks industry by 20 per cent by 2025.[83] Australia has also committed to the World Health Organisation's target of reducing the average population's salt intake by 30 per cent by 2025.[84] Product reformulation could help food manufacturers reach consumers who have obesity or diabetes concerns. Demand for functional foods high in Vitamin D is expected to increase, driven by a growing number of

[77] Webalive (2019), "The State of Australia's Ecommerce in 2019". Available at: https://www.webalive.com.au/ecommerce-statistics-australia/

[78] Australian Food News (2018), "Online grocery sales growth surging as Amazon enters the fray". Available at: https://www.ausfoodnews.com.au/2018/11/28/online-grocery-sales-growth-surging-as-amazon-enters-the-fray.html

[79] Good Food (2019), "From farm gate to plate: How farmers are harnessing technology to bring food to your door". Available at: https://www.goodfood.com.au/recipes/news/farmers-are-doing-it-for-themselves-20190405-h1d7ko

[80] Open Food Network, "Farm Direct to Wholesale". Available at: https://about.openfoodnetwork.org.au/project/farm-direct-to-wholesale/

[81] Nielsen (2020), "COVID-19: Entering a New Norm in Consumer Behaviour". Available at: https://www.nielsen.com/sg/en/insights/article/2020/covid19-new-norm-consumer-behaviour/ and Inside Retail Australia (2020), "A 'tipping point' for e-commerce in Australia". Available at: https://insideretail.com.au/news/a-tipping-point-for-e-commerce-in-australia-202002

[82] Statista (2020), "Increase in online purchases as a result of coronavirus outbreak in Australia in 2020, by product". Available at: https://www.statista.com/statistics/1104128/australia-increase-in-online-grocery-purchases-covid-19-outbreak/

[83] Australian Beverages (2018), Sugar reduction pledge. Available at: https://www.australianbeverages.org/initiatives-advocacy-information/sugar-reduction-pledge/

[84] Vic Health (2019), "Australia's first salt reformulation guide for food manufacturers has been launched by the Heart Foundation and VicHealth to help reduce the high salt intake in Australian diets". Available at: https://www.vichealth.vic.gov.au/media-and-resources/media-releases/australias-first-salt-reduction-guide-for-food-manufacturers

elderly people with a greater risk of Vitamin D deficiency. A dietary trend towards increased protein consumption also offers opportunities to produce and market new protein-rich types of food.

Food loss and waste

Value added potential: **A$18 billion in 2030**

Average growth: **8 per cent per year**

Finding new ways to reduce food waste offers major market opportunities for Australian businesses. Food waste is an issue across the entire value chain, from the farms to the dinner table, costing the Australian economy A$20 billion each year, according to the Australian Government.[85] More than five million tonnes of food end up going to landfill in Australia every year, enough to fill 9,000 Olympic swimming pools.[86] And only a fraction of food waste is put to good use, with a recovery rate of around 12 per cent in the fiscal year 2017 (11 per cent is recycled and 1 per cent converted to energy).[87] In 2017, Australia pledged to halve its food waste by 2030 and to fund initiatives that help reduce food waste with A$1.3 million.[88] FIAL has been partnering with stakeholders across the food value chain to develop a roadmap and identify initiatives such as sector action plans to achieve that target.[89] Several food and agribusinesses have also launched their waste reduction targets and programmes. For example, Coles has begun to give away unsold edible food to people in need and convert some of its food waste into animal feed, clean energy and compost. The retailer is closely working with suppliers. Similarly, Woolworths is partnering with food rescue organisations to cut down on food waste.

Soil, water and land management

Value added potential: **A$17 billion in 2030**

Average growth: **3 per cent per year**

Farmers and grazers in Australia will need to find ways to reduce their impact on the land in order to keep their businesses viable on the driest inhabited continent on earth. There are many opportunities for Australian businesses to develop new methods and products that can improve soil health and make existing farming practices more sustainable. These include agroforestry, no-till / low-till agricultural methods, holistic grazing, and water saving techniques linked to drip irrigation and sprinklers. The Australian Government is incentivising the shift towards sustainable soil and land management. It has committed a total of A$2 billion over the decade to 2023 as part of its National Landcare Programme to

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[85] Department of the Environment and Energy (2017), *National Food Waste Strategy*. Available at: http://www.environment.gov.au/protection/waste-resource-recovery/publications/national-food-waste-strategy

[86] FoodWise, *Fast Facts on Food Waste*. Available at: https://www.foodwise.com.au/foodwaste/food-waste-fast-facts/

[87] Department of the Environment and Energy (2017), *National Waste Report, 2018*. Available at: https://www.environment.gov.au/system/files/resources/7381c1de-31d0-429b-912c-91a6dbc83af7/files/national-waste-report-2018.pdf

[88] FIAL (2019), *A Roadmap for reducing Australia's food waste by half by 2030*. Available at: https://www.environment.gov.au/system/files/resources/fca42414-c4df-4821-b195-4948ad673f69/files/roadmap-reducing-food-waste.pdf and Department of the Environment and Energy (2017), *National Food Waste Strategy*. Available at: http://www.environment.gov.au/protection/waste-resource-recovery/publications/national-food-waste-strategy

[89] FIAL (2019), *A Roadmap for reducing Australia's food waste by half by 2030*. Available at: https://www.environment.gov.au/system/files/resources/fca42414-c4df-4821-b195-4948ad673f69/files/roadmap-reducing-food-waste.pdf

encourage more sustainable use of resources in agriculture and create healthier ecosystems.[90] The Australian Agroforestry Foundation, a not-for-profit, also educates farmers on how to move towards healthier management of forests.[91]

Animal feed and health

Value added potential: **A$11 billion in 2025**

Average growth: **4 per cent per year**

Australians have some of the world's highest per-capita consumption of meat (particularly beef and lamb), and this demand for quality produce offers many new market opportunities. There is an ongoing need for innovative technology and products to keep Australian farm animals healthy. Opportunities range from developing animal feed additives and health products to smart health monitoring and diagnostic systems. The growing demand for meat and dairy is expected to fuel demand for feed additives. The yearly per-capita consumption of chicken meat in Australia alone increased ten-fold from 4.6 kilogrammes per person in 1965 to 47 kilogrammes in 2016. It is expected to increase by another two kilogrammes by mid-2020.[92] The productivity of ruminant animals can often be boosted with supplements, some of which encourage microbes in the rumen to grow quickly and to provide better nutrition. Experts suggest that there is an opportunity for a 15-20 per cent feed efficiency improvement through feed additives and improved practice.[93] The increase in zoonotic diseases is also leading to higher spending on disease prevention and treatment in animals. According to the Centre for Disease Control and Prevention (CDC), scientists estimate that 6 out of every 10 known infectious diseases in people are spread from animals and 1 in 6 Americans get sick from eating contaminated food each year.[94] These numbers are likely to be higher in countries with less regulated food hygiene standards, presenting an opportunity for Australia given its adoption of best practice animal welfare and biosecurity standards.

[90] National Landcare Programme (2018), National Landcare Programme Phase Two. Available at: (http://www.nrm.gov.au/national-landcare-program

[91] Australian Agroforestry Foundation, "Taking MTG to the World". Available at: http://agroforestry.org.au/Main.asp?_=International%20MTG

[92] The Conversation (2017), "Three charts on: Australia's declining taste for beef and growing appetite for chicken". Available at: https://theconversation.com/three-charts-on-australias-declining-taste-for-beef-and-growing-appetite-for-chicken-78100

[93] McKinsey Global Institute (2011), *Resource Revolution: Meeting the world's energy, materials, food, and water needs*. Available at: https://www.mckinsey.com/business-functions/sustainability/our-insights/resource-revolution

[94] Centers for Disease Control and Prevention, *Zoonotic Diseases*. Available at: https://www.cdc.gov/onehealth/basics/zoonotic-diseases.html

Energy smart food

Value added potential: **A$6 billion in 2030**

Average growth: **2 per cent per year**

Agriculture is the fourth most energy-intensive industry in Australia and is the only industry where energy productivity has declined by more than 21 per cent since 2008.[95] The need to make the food and agribusiness sector more energy-efficient offers another opportunity to generate more value. The combined energy bill for businesses in the Australian agriculture sector is estimated to amount to A$5.8 billion each year. To remain cost-competitive, businesses are looking at alternative energy sources and ways to reduce their overall energy consumption. For example, a cotton and chickpea producer in Queensland has set up a solar power system to support its bore pumps, reducing its annual electricity costs by A$8,000. Meanwhile, a specialty nursery in Victoria switched to a more energy-efficient tree-growing technology and lowered its energy bill by almost 80 per cent.[96] More businesses are expected to follow.

Food fraud and safety

Value added potential: **A$6 billion in 2030**

Average growth: **3 per cent per year**

Food fraud – where fake, cheap and often dangerously low-quality products are sold under the label of well-known brands – is costing the Australian economy A$2-3 billion each year.[97] Businesses who can reduce such fraud and find ways to improve food safety tests are facing a big opportunity. Every fifth product Australian consumers buy during an average shopping trip could be mislabelled or adulterated, estimates John Watling, a professor of forensic chemistry at the University of Western Australia.[98] Olive oil, fish and organic products are some of the most common "fake foods". In a comprehensive study, researchers at Macquarie University found that more than half of all honey samples from China and up to 27 per cent of Australian-labelled honey sold in local supermarkets and markets were mixed with other substances.[99] Capilano, Australia's largest honey producer, was among those accused of fraud.[100] Clearer certification, insurance and serialisation methods can help combat food fraud, and Australian authorities have begun to create a stronger framework for businesses in food and agribusiness. For example, the Australian Government recently approved five new certifying bodies for

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[95] Department of the Environment and Energy (2017), Australia Energy Update. Available at: https://www.energy.gov.au/sites/default/files/energy-update-report-2017.pdf

[96] Clean Energy Finance Corporation (2017), *Transforming Australian Agriculture With Clean Energy*. Available at: https://www.cefc.com.au/media/402212/cefc_transform_aust_agriculture_w_clean_energy.pdf

[97] PWC, How PwC's Food Trust Platform uses micro tag technology to protect Australian brands from food fraud. Available at: https://www.pwc.com.au/about-us/solving-important-problems/how-pwcs-food-trust-platform-protects-australian-brands-from-food-fraud.html

[98] Australian Institute of Food Safety (2019), "Consumers Fooled by Fake Food". Available at: https://www.foodsafety.com.au/blog/consumers-fooled-by-fake-food

[99] ABC News (2018), "Almost 20 per cent of Australian honey samples found to not be pure". Available at: https://www.abc.net.au/news/2018-10-03/almost-20-per-cent-australian-honey-found-not-pure/10327988

[100] ABC News (2018), "Capilano, Australia's biggest honey producer, and supermarkets accused of selling 'fake' honey". Available at: https://www.abc.net.au/news/2018-09-03/capilano-and-supermarkets-accused-of-selling-fake-honey/10187628

the organic food industry.[101] Food Standards Australia New Zealand (FSANZ) is also planning to review food safety standards, which have not been modified since 2000.[102]

Plant-based and alternative proteins

Value added potential: **A$5 billion in 2030**

Average growth: **5 per cent per year**

Environmental concerns related to traditional proteins are likely to lead to a change in consumer preferences toward plant-based and alternative proteins. Alternative proteins could capture 10 per cent of the global meat market by 2030, up from less than 1 per cent in 2017, to create a market value of US$85 billion.[103] Some products seek to mimic traditional proteins like beef, chicken and pork, using mainly plant protein – including extracts from soy and pea – as the base ingredient. Others use microbes, fungi or insects, and some have even started using stem cells from animals, reproduced in laboratories.[104] Change in dietary preferences is the main factor behind the expected rise in demand for plant-based and alternative proteins. A 2019 survey reported that in addition to approximately 10 per cent of vegans / vegetarians, 12 per cent of Australians identify themselves as "meat-reducers" and 20 per cent as "flexitarians".[105] The plant-based protein industry could also unlock other opportunities. For example, it could capture the additional demand in plant protein for livestock feed as global meat consumption increases.[106]

Urban agriculture

Value added potential: **A$4 billion in 2030**

Average growth: **3 per cent per year**

Australians love home-grown food, and businesses that can cater to this trend even in the country's most populated urban areas will find a valuable market. A study by the Australia Institute estimated in 2014 that every second Australian household was growing some food themselves – from fruit to eggs – and 13 per cent intended to start.[107] Health, taste and cost-savings are key motivators. There are opportunities for Australian businesses to increase the efficiency and scale of city farming. For example, an urban farm project in Melbourne, powered by coffee compost and food waste, is successfully growing

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[101] The Sydney Morning Herald (2018), "What do you do for money honey- the problem with food fraud". Available at: https://www.smh.com.au/national/what-do-you-do-for-money-honey-the-problem-with-food-fraud-20181015-p509sh.html

[102] Food Safety News (2019), "Australia plans to review food safety standards". Available at: https://www.foodsafetynews.com/2019/05/australia-plans-to-review-food-safety-standards/

[103] Barclays, 2019, "I Can't Believe It's Not Meat", https://eu16.salesforce.com/sfc/p/#1t000000wCuV/a/1t000000Xg33/q3Bm_z_oiIm8K7s4mnGLApU.WpmqvU6rEsBaiqGRob4

[104] Bashio, Z. et al., 2019, "Alternative Proteins: The Race for Market Share Is On", McKinsey & Company, https://www.mckinsey.com/industries/agriculture/our-insights/alternative-proteins-the-race-for-market-share-is-on; and Lagally, C. et al., 2017, Plant-Based Meat Mind Maps: An Exploration of Options, Ideas and Industry, The Good Food Institute, https://www.gfi.org/files/PBMap.pdf

[105] Food Frontier & Life Health Foods (2019), *Hungry for Plant-Based: Australian Consumer Insights.* Available at: https://www.foodfrontier.org/wp-content/uploads/2019/10/Hungry-For-Plant-Based-Australian-Consumer-Insights-Oct-2019.pdf

[106] AgriFutures Australia (2020), *The Changing Landscape of Protein Production: Opportunities and challenges for Australian agriculture.* Available at: https://www.agrifutures.com.au/wp-content/uploads/2020/02/20-001.pdf

[107] The Australia Institute (2014), The potential value and impacts of residential and community food gardening. Available at: https://www.tai.org.au/sites/default/files/PB%2059%20Grow%20Your%20Own.pdf

large amounts of vegetables and herbs.[108] Meanwhile, an evolving community of urban farmers is taking advantage of unused spaces within Brisbane's suburban estates and on the metropolitan fringe to grow food for city people.[109]

Sustainable fisheries

Value added potential: **A$3 billion in 2030**

Average growth: **3 per cent per year**

There is significant scope to produce more sustainably farmed fish in Australia to meet consumer demand domestically and globally. Currently, 70 per cent of all seafood and half of all prawns consumed in the country are imported.[110] An increase in sustainable aquaculture could unlock new opportunities for Australian producers to sell seafood domestically and abroad. Asian countries such as Japan and Korea are particularly attractive export markets.[111] Australian technology company Calix is among the early adopters of a promising trend. It has developed a new production technology to improve aquaculture yield. Meanwhile, CSIRO scientists have created a new type of aquaculture food made from agriculture plant waste. Prawns fed with this high-tech food grow up to 40 per cent faster than regular prawns and need no wild fish in their diet.[112]

Sustainable packaging

Value added potential: **A$3 billion in 2030**

Average growth: **18 per cent per year**

Developing sustainable packaging involves reducing unnecessary packaging (through initiatives such as innovation, packaging redesigns and lightweighting) as well as promoting the reuse and recycling of packaging waste.[113] A large proportion of food and agribusiness packaging in Australia ends up in landfills – offering a major opportunity for businesses to extract more value out of the supply chain. According to the Australian Packaging Covenant Organisation (APCO), only just over half (56 per cent) of all packaging waste gets recycled in Australia and only a third of the country's plastic packaging waste.[114] The recycling industry is evolving fast and opportunities will continue to emerge, also driven by policy decisions and consumer demand. The Australian Government wants to increase the recycling

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[108] City Farmer News (2019), "This car park turned urban farm has grown 300kg of produce for people in need". Available at: https://cityfarmer.info/australia-this-car-park-turned-urban-farm-has-grown-300kg-of-produce-for-people-in-need/#more-322228

[109] ABS News (2019), "Queensland farmers' vision to transform the south-east into Australia's largest urban farm network". Available at: https://www.abc.net.au/news/2019-09-29/growing-a-vision-of-australias-largest-urban-farm-network/11553622

[110] CSIRO Blog (2019), "Black Tiger Prawn Case Study". Available at: https://www.csiro.au/en/Research/AF/Areas/Aquaculture/Premium-breeds/Black-tiger-prawn

[111] Sustainability Matters (2017), "Sustainable aquaculture in Australia". Available at: https://www.sustainabilitymatters.net.au/content/wastewater/news/sustainable-aquaculture-in-australia-996520984

[112] CSIRO Blog (2019), "A more sustainable and productive aquaculture industry". Available at: https://www.csiro.au/en/About/Our-impact/Our-impact-in-action/Agriculture-and-Fisheries/Aquaculture

[113] Lightweighting refers to the replacement of packaging material with a lighter weight alternative or the reduction of excess plastic packaging materials.

[114] The Guardian (2019), "Only a third of Australia's plastic packaging waste gets recycled". Available at: https://www.theguardian.com/environment/2019/mar/03/only-a-third-of-australias-plastic-packaging-waste-gets-recycled

rate and has pledged A$20 million to boost the national recycling industry in 2019. Meanwhile, the Australian Council of Recycling has called for a stronger domestic recycling economy at a time when China has restricted its waste intake from Australia and elsewhere.[115] In a sign that the domestic recycling trend is gaining traction, a new plastics recycling plant has just opened in Victoria. It is the largest in the country and was partly funded by the Victorian state government.[116]

Protected cropping

Value added potential: **A$2 billion in 2030**

Average growth: **1 per cent per year**

Protected cropping, also referred to as greenhouse horticulture, is the production of horticultural crops within, under or sheltered by structures to provide modified growing conditions and / or protection from pests, diseases and adverse weather. With food security and climate change concerns, the protected cropping industry is expected to play a significant role in Australia's agriculture industry by 2030. The protected cropping industry could help farmers increase yield, improve quality, increase labour productivity, and extend supply windows.[117] According to research by Hort Innovation, protective cropping could increase the "gross yield of large marketable fruit" for strawberries from 0.75 kilogram/plant in an open field to 1.1 kilogram/plant in a retractable greenhouse/substrate.[118] A study investigating the returns of protective copping in the Greater Collie Region in Western Australia on a 10-hectare unit found that protective cropping could achieve economic returns of 16.05 per cent to 18.64 per cent.[119] These returns arise not only due to an increase in yield but also due to a decrease in resource usage. For example, hydroponic crops have been found to reduce water use significantly.[120]

Technology in smallholder farms

Value added potential: **A$1 billion in 2030**

Average growth: **12 per cent per year**

A lack of a standardised definition of a smallholder farm makes it challenging to address such farms. Some researchers have used land size as a criterion to define smallholder farms, while others have

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[115] Business Insider (2019), "Australia's recycling industry is getting a $20 million boost, but at least one environmental group says the government is all talk". Available at: https://www.businessinsider.com.au/australias-recycling-industry-is-getting-a-20-million-boost-but-at-least-one-environmental-group-says-the-government-is-all-talk-2019-8. See also: The Guardian (2019), "How will a domestic waste recycling industry work in Australia?". Available at: https://www.theguardian.com/environment/2019/aug/14/how-will-a-domestic-waste-recycling-industry-work-in-australia

[116] Sustainability Victoria (2019), "Australia's largest recycling plant for plastics opens in Victoria". Available at: https://www.sustainability.vic.gov.au/About-us/Latest-news/2019/07/01/00/31/Australias-largest-plastics-recycling-plant-opens-in-Victoria

[117] Hort Innovation (2018). *Transitioning to protected cropping*. Available at: https://www.horticulture.com.au/globalassets/hort-innovation/resource-assets/bs15002-transitioning-to-protected-cropping.pdf

[118] Hort Innovation (2018). *Transitioning to protected cropping*. Available at: https://www.horticulture.com.au/globalassets/hort-innovation/resource-assets/bs15002-transitioning-to-protected-cropping.pdf

[119] Aris (2018), *Collie Futures – Protected Cropping Prefeasibility Investigation.* Available at: https://www.agric.wa.gov.au/sites/gateway/files/Protected%20Cropping%20Prefeasibility%20Investigation.pdf

[120] Graeme Smith, *Overview of the Australian Protected Cropping Industry*. Available at: https://www.graemesmithconsulting.com/images/documents/An%20Overview%20of%20the%20Australian%20Protected%20Cropping%20Industry%20Compatibility%20Mode.pdf

used the number of farm animals as a criterion.[121] A 2004 study estimates that small farms in Australia occupy 23 million hectares and represent five per cent of Australia's total agricultural land.[122] Small landholders are usually located on the outer edges of urban development in towns and cities with their impact on the environment more concentrated in these areas.[123] Lack of scale associated with smallholder farms makes it challenging for farmers to recoup their overheads and costs of inputs and machinery.[124] However, the improvement potential is significant through greater yield and production efficiency. Academic evidence shows there is the potential to double current yields – more than on large-scale farms.[125] The range of levers for achieving this yield improvement includes extension services, new technology for greater connectivity, improved access to capital (to fund the acquisition of necessary equipment), aggregation mechanisms (to achieve economies of scale among smallholders) and better links to markets. A meta-study of smallholder extension services found a median rate of return of 58 per cent, and the available case study evidence demonstrates the large potential impact on total factor productivity (through more capital per worker, better use of fertilisers and improved farming practices).[126] However, a lack of ICT skills and investment in ICT could be a significant barrier for small farmers to capture these yield improvement opportunities. A survey by the Australian Bureau of Agricultural and Resource Economics (ABARES) found that 40 per cent of small farms reported a lack of skills as an impediment in adopting ICT, compared with less than 20 per cent of large farms.[127]

Precision agriculture and big data

Value added potential: **A$1 billion in 2030**

Average growth: **12 per cent per year**

In recent years, several new technologies have become available that can dramatically improve crop yields. They include big data analytics to help farmers make better decisions, drone technology and advanced robotics. They also comprise global-positioning-systems (GPS) and multispectral sensors that can be mounted on tractors to fertilise crops with greater precision, as well as auto-steer technology that enables agricultural machinery to drive in autopilot.[128] In Australia, the greatest uptake in precision agriculture has been around grains, wine and sugarcane. There has also been some adoption in livestock, cotton and potatoes. Anecdotal evidence suggests that up to 90 per cent of grain farmers in Australia may already be using auto-steer technology, whereas systems to monitor crop yields and so-

[121] Marta Hernández-Jover et al (2014), *Smallholder production in Australia.* Available at: https://pdfs.semanticscholar.org/f145/1e0aac9d09c372f23c4f846be17d304b8220.pdf

[122] R Nelson (2004), Socioeconomic Indicators for Natural Resource Management: capacity to change and adopt sustainable management practices in Australian agriculture.

[123] Government of Western Australia. "Small landholders in Western Australia." Available at: https://www.agric.wa.gov.au/climate-land-water/land-use/small-landholders-western-australia

[124] The Courier (2017), "Small farmers looking to a sustainable future." Available at: https://www.thecourier.com.au/story/4978021/the-people-surviving-off-small-scale-farming/

[125] McKinsey Global Institute (2011), *Resource Revolution: Meeting the world's energy, materials, food, and water needs.* Available at: https://www.mckinsey.com/business-functions/sustainability/our-insights/resource-revolution

[126] Julian M. Alston, Connie Chan-Kang, Michele C. Marra, Philip G. Pardey, TJ Wyatt (2000), *A Meta-Analysis of Rates of Return to Agricultural R&D: Ex Pede Herculem?,* International Food Policy Research Institute. Available at: https://www.ifpri.org/publication/meta-analysis-rates-return-agricultural-r-d

[127] Australian Bureau of Agricultural and Resource Economics and Sciences (2018), *Information and communication technology use in Australian agriculture.* Available at: https://www.agriculture.gov.au/sites/default/files/sitecollectiondocuments/abares/ict-use-australian-agriculture.pdf

[128] The Economist (2016), "The future of agriculture". Available at: https://www.economist.com/technology-quarterly/2016-06-09/factory-fresh

called variable rate software to make fertiliser use more efficient are less popular as yet.[129] The Society of Precision Agriculture Australia, a non-profit group founded in 2002, is promoting the benefits of precision agriculture to Australian farmers. The Australian Government's trade promotion agency Austrade is encouraging new investment in precision agriculture through its digital platform "Australia for Agriculture 4.0". The platform has attracted more than 300 start-ups offering innovative solutions for common problems in agriculture, including drought and livestock management.[130] The Australian Government is also funding new satellite technology for precision positioning of farm equipment, which will help maximise yields and improve crop production.[131]

Sustainable inputs

Value added potential: **A$1 billion in 2030**

Average growth: **16 per cent per year**

Excessive use of fertilisers that are high in nitrogen and phosphorous take a toll on the environment, leading to contaminated water and depleted soils. Conventional fertilisers can also cause chemical burns to crops and create food safety issues when applied incorrectly. There are exciting opportunities for Australian businesses to help develop, and apply, alternative ways to control weeds and pests on farmland. These opportunities include the development of biopesticides, as well as microbial and organic fertilisers. The market for sustainable fertilisers and pesticides is growing rapidly, as both producers and consumers are changing their behaviour. For one, there's a rising consumer preference for organically grown food, prompting farmers to adopt new farming practices. Secondly, the fertiliser industry is shifting towards more sustainable compounds because crops are becoming pesticide-resistant and because finding new synthetic pesticides is expensive.[132] Fertilizer Australia, the national fertiliser industry association, has begun to promote more sustainable farming practices through its Fertcare programme.

Advanced breeding and fertilisation

Value added potential: **A$1 billion in 2030**

Average growth: **11 per cent per year**

The world population is expected to reach 9.7 billion by 2050 and it will take smarter breeding and plant growing techniques to feed more people with our existing agricultural resources.[133] Biotechnology and genomics are expected to play a much greater role in the food production of the future. Australian businesses will find a growing number of opportunities in fields such as animal genetics and agricultural

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[129] CSIRO (2013), PRECISION AGRICULTURE IN AUSTRALIA: PRESENT STATUS AND RECENT DEVELOPMENTS. AVAILABLE AT: HTTPS://WWW.RESEARCHGATE.NET/PUBLICATION/262706376_PRECISION_AGRICULTURE_IN_AUSTRALIA_PRESENT_STATUS_AND_RECENT_DEVELOPMENT

[130] Verdict (2019), "Agriculture 4.0: Australia invests in future of farming". Available at: https://www.verdict.co.uk/agriculture-4-0-in-australia/

[131] Ministers for the Department of Industry, Science, Energy and Resources (2019), *Satellite technology boosts the future of farming.* Available at: https://www.minister.industry.gov.au/ministers/canavan/media-releases/satellite-technology-boosts-future-farming

[132] Grains Research and Development Corporation (2014), "Biopesticides; fresh hope for the future". Available at: https://grdc.com.au/resources-and-publications/grdc-update-papers/tab-content/grdc-update-papers/2014/02/biopesticides-fresh-hope-for-the-future

[133] UN Population Division (2019), *World Population Prospects 2019*. Available at: https://www.un.org/development/desa/en/news/population/world-population-prospects-2019.html

biotechnology (genomic products, agricultural biotechnology tools and biologicals). The Australian Government is facilitating the growth of this market. In a likely boost to the advanced breeding and fertilisation industry, the government announced in April 2019 that it would not regulate the use of gene-editing techniques in plants and animals as long as no new genetic material is introduced.[134] Much of the agricultural genomic activity in Australia has so far focused on improving the yield of wheat – an area where an Australian scientist achieved a breakthrough in 2018 with the first-ever sequencing of the complex, but highly valuable wheat genome.[135] Genomics are also widely used in Australia to help breed more productive dairy cows.[136] More recently, researchers in Australia and India have begun a collaborative, government-funded genome project with the goal of developing stress-tolerant chickpeas, which are an attractive export crop for Australian farmers.[137]

Taking into account the indirect impacts, the overall economic impact of these food and agribusiness opportunities could be worth up to A$548 billion in 2030

An expenditure-based approach, also referred to as the "output multiplier approach", considers the total economic impact, taking account of expenditure multipliers (e.g., direct, indirect and induced impacts). For instance, an increase in sales of fresh food creates a direct impact on the food retailers, then indirect impact through suppliers, and an induced impact through the expenditure of workers in those sectors. This approach is described in more detail in Appendix B. The expenditure multiplier associated with the opportunities could be significantly larger than the value added opportunity at A$548 billion in 2030 (Exhibit 2).

[134] Nature (2019), "Australian gene-editing rules adopt 'middle ground'. Available at: https://www.nature.com/articles/d41586-019-01282-8

[135] Financial Review (2018), "Australian scientist leads consortium to crack wheat genome". Available at: https://www.afr.com/policy/health-and-education/australian-scientist-leads-consortium-to-break-the-wheat-genome-20180815-h13zav

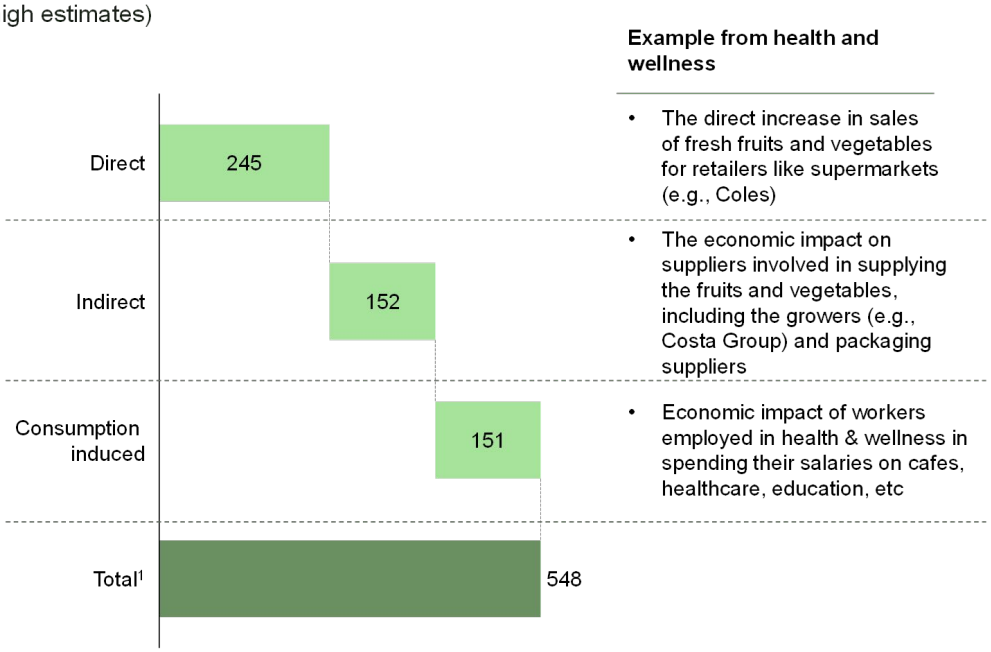
[136] Dairy Australia, "Genomics". Available at: https://www.dairyaustralia.com.au/farm/animal-management/genetics/genomics

[137] Department of Industry, Innovation and Science (2018), *Genomic approaches for stress tolerant chickpea*. Available at: https://www.industry.gov.au/data-and-publications/genomic-approaches-for-stress-tolerant-chickpea

EXHIBIT 2

The total economic impact associated with the food and agribusiness opportunities could be worth up to A$548 billion in 2030

Total economic impact in 2030[2], AUD billion in 2019 dollars (high estimates)



1. This summation does not include "Urban agriculture", "Protected cropping" and "Direct to consumer model" to avoid potential overlaps.

A review of the projects which FIAL has supported over the past four years indicated that out of the 123 projects related to the opportunities, only 30 are related to the biggest category of opportunities (*the future consumer*). [138] Furthermore, FIAL has limited coverage of opportunities such as *urban agriculture*, *precision agriculture* and *protected cropping*. Therefore, Australia's food and agribusiness sector could capture a significant value from the prioritised opportunities in the coming years with the appropriate focus and investment. This chapter has shown that emerging trends could radically alter Australia's food and agribusiness sector. 19 opportunities have been identified that could create over A$200 billion in value added by 2030, and almost A$548 billion when taking account of the indirect effects associated with the expenditure in the supply chain and by workers. **But what does this mean for jobs?** The next chapter explores the jobs and occupations linked to these 19 opportunities.

[138] The 123 projects included are categorised based on their self-stated primary priority area only. Many projects have crossed over to multiple priorities.

2. Where are the jobs? Tracking the future job opportunities for food and agribusiness in Australia

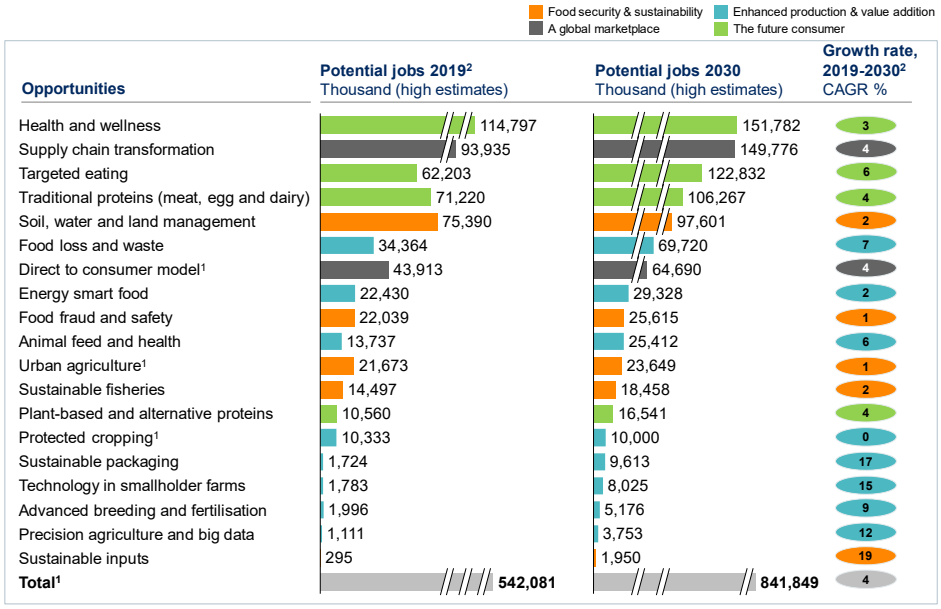
An industry that creates more value also creates more jobs. *How would employment change if businesses in the Australian food and agribusiness industry were to pursue the 19 major food and agribusiness opportunities? This chapter shows that the job gain could be significant between now and 2030. Higher skilled manual and sales jobs have the strongest growth outlook, while managerial and administrative jobs may see a decline.*

SIZING THE TOTAL JOB POTENTIAL

By 2030, the major food and agribusiness opportunities could support 842,000 jobs (Exhibit 3), compared to 542,000 potential jobs in 2019.[139] The most valuable market opportunities (*health & wellness*, *supply chain transformation* and *targeted eating*) would also create the largest employment growth. The methodology used to estimate the jobs potential is described in Appendix D.

EXHIBIT 3

Potential jobs are expected to increase to 842,000 in 2030



1. This summation does not include "Urban agriculture", "Protected cropping" and "Direct to consumer model" to avoid potential overlaps.
2. The 2019 job estimation comparison is not the current job estimate for Australia but rather the potential opportunity from full exploitation of all the identified opportunities.
SOURCE: Literature search; AlphaBeta analysis

Box 2 compares the job estimate to existing research on Australia.

[139] Adjustments have been made to isolate the agriculture and manufacturing jobs (from total potential jobs including retail) for the FIAL 2030 estimates. This summation does not include "Urban agriculture", "Protected cropping" and "Direct to consumer model". The 2019 job estimation comparison is not the current job estimate for Australia but rather the potential opportunity from full exploitation of all the identified opportunities.

Box 2. Comparisons to other estimates

While some research has examined job implications in agriculture, it is difficult to compare across estimates as the coverages and methodologies differ greatly. Below is an overview of some of the recent research and how they compare to the estimates presented in this report.

- **The Commonwealth Scientific and Industrial Research Organisation (CSIRO)**. According to this report, there were 228,000 on-farm domestic workers in 2016, up 4 per cent since 2011. 59 per cent of these workers were managers.[140] Between 2006 and 2016, the number of self-reported agricultural workers fell by over 7 per cent. The FIAL 2030 estimate is larger than the CSIRO estimate (projected to be around 254,000 on-farm domestic workers in 2030 based on historical growth rates).[141] The FIAL 2030 estimate focuses on jobs in the food and agribusiness sector (beyond just agriculture) while the CSIRO report focuses on on-farm workers.
- **Department of Employment, Skills, Small and Family Business**. In this 2019 report, new jobs in the food and beverage services are projected to reach 79,100 in 2023 while employment in agriculture, forestry and fishing is projected to fall by 0.4 per cent in 2023.[142] This report has a different time period of focus (i.e. 2030 versus 2023), a different scope (i.e. focusing on food and agribusiness jobs beyond agriculture and fishing), and a different methodology (focusing on jobs associated with the 19 potential opportunities, rather than a forecast of total jobs in the industry which takes account of jobs lost).
- **Regional Australian Institute**. The 2018 report reveals that 20 to 30 per cent of jobs are considered highly vulnerable to automation.[143] This report does not focus on the automation of jobs associated with the 19 opportunities.

These job estimates depend on three factors:

1. **Size of the opportunity.** Typically, the larger the increase in the opportunity between 2019 and 2030, the larger is the opportunity for increased jobs, unless the opportunity is more capital intensive or the labour in the industry has high productivity.
2. **Current labour intensity**. This refers to the degree to which production is labour or capital intensive. For opportunities that are capital intensive, fewer jobs are created as opposed to those with high labour intensity.
3. **Changes in productivity.** An increase in labour productivity over time means fewer employees are required per unit of output, which can lead to a decline in total labour.

It is important to stress that the job estimates are the total potential jobs associated with the 19 opportunities if they were fully captured by 2030. **The job estimates do not take account of net job creation in the food and agribusiness sector or the broader economy**. For the food and agribusiness sector, there are other opportunities beyond the 19 opportunities presented here that could

[140] CSIRO (2019), *The Future of Australia's Agricultural Workforce*. Available at: https://data61.csiro.au/en/Our-Research/Our-Work/Future-Cities/Planning-sustainable-infrastructure/Future-of-Australias-agricultural-workforce

[141] Team analysis.

[142] Department of Employment, Skills, Small and Family Business (2019), "Australia Jobs". Available at: https://australianjobs.employment.gov.au/jobs-future/industry-outlook

[143] Regional Australia Institute (2018), *Job Vulnerability in Australia*. Available at: http://www.regionalaustralia.org.au/home/wp-content/uploads/2018/08/180829_JobVulnerabilityInAustralia_Final.pdf

drive job creation. At the same time, the 19 opportunities could lead to job losses in some areas due to market displacement (i.e. some of these opportunities may lead to a substitution of market demand from other sectors, such as green fertilisers replacing chemical fertilisers) and automation displacement (i.e. some of these opportunities may lead to a substitution of labour for capital in adjacent areas, such as precision agriculture requiring significantly less labour in farming operations). There could also be greater job creation in the broader economy linked to these 19 opportunities than is analysed here. For example, as shown in Chapter 1, the 19 opportunities could have significant expenditure multipliers, which would create further jobs in the supply chain and adjacent industries (e.g. food and agribusiness professionals spending their money in the economy creating jobs in healthcare, education, etc.).

ESTIMATING THE JOBS SHIFT

Overall, the prioritised opportunities are expected to create more jobs in the Australian food and agribusiness sector. Historically, employment in the food and agribusiness sector has grown at a rate of 1.6 per cent per annum (between 2014 to 2019), but if the 19 opportunities identified in this report could be fully captured, then employment in the industry could grow more than 2.5x faster than this historical rate, reaching 4 per cent per annum.[144]

Box 3. Measuring the occupational shift

Analysts used a three-step method to calculate how the 19 major opportunities would influence the occupational mix in the Australian food and agribusiness sector. See Appendix E for details.

- **Step 1: Determining current and historical occupational changes.** The 19 food and agribusiness opportunities were matched to specific sub-industries and the occupation profile of each sub-industry was calculated based on data from the Australian Bureau of Statistics in 2011 and 2016.
- **Step 2: Determining future occupational changes.** The occupation profile of each sub-industry was calculated based on historical changes in the ABS data. It was assumed that the sub-industry share of total employment linked to each opportunity remains constant at the 2016 levels (only the share, not the absolute values).
- **Step 3: Refining estimates.** We finally refined our estimates for future occupational shifts using insights gained from interviews with relevant experts.

However, the outlook for different occupations varies. Some industries would need fewer labourers or certain types of professionals in the coming years, others would need more. Box 3 describes the methodology used to estimate these occupational shifts.

This analysis distinguishes between five broad occupation types:

- **Managers.** Management jobs are leadership positions that require the management of employees to complete projects and tasks. Managerial jobs include chief executive officers (CEOs), chief financial officers (CFOs), farm managers, industrial production managers and purchasing managers.
- **Professionals.** Professional jobs include non-managerial specialised roles as well as technical workers. Examples are accountants, auditors, HR professionals, agricultural and forestry scientists, animal scientists and environmental scientists. They also

[144] The 4 percent annual growth rate is calculated with the 2019 potential job estimate and 2030 potential job estimate.

comprise technical professionals such as ICT professionals, product safety engineers, product development engineers, manufacturing engineers, ICT support technicians, as well as non-agricultural professionals such as veterinarians.

- **Manual labour.** Manual labour can be further divided into four sub-categories:
  - *Farm labour.* This includes labourers involved directly in the field, such as crop farm workers, pest control workers and livestock farm workers.
  - *Factory labour and machine operators.* This includes labourers on the factory floor who perform routine tasks and operate machines. Examples are food batchmakers, food processors, meat slaughters, fork lifters and truck drivers.
  - *Warehouse and supply chain labour.* This includes labourers involved in the supply chain process. Examples are packers and assemblers.
  - *Support services.* This includes labour from complementary industries. Examples are cleaners.
- **Sales workers.** Sales related staff (without retail jobs such as supermarket cashiers) include ICT sales assistants, commodities traders, sales representatives and telemarketers.
- **Administrative workers.** Admin staff manage and distribute information within an office, for example by answering phones, taking memos and maintaining files. This job category includes workers such as personal assistants and secretaries, numerical clerks, procurement clerks and data entry keyers.

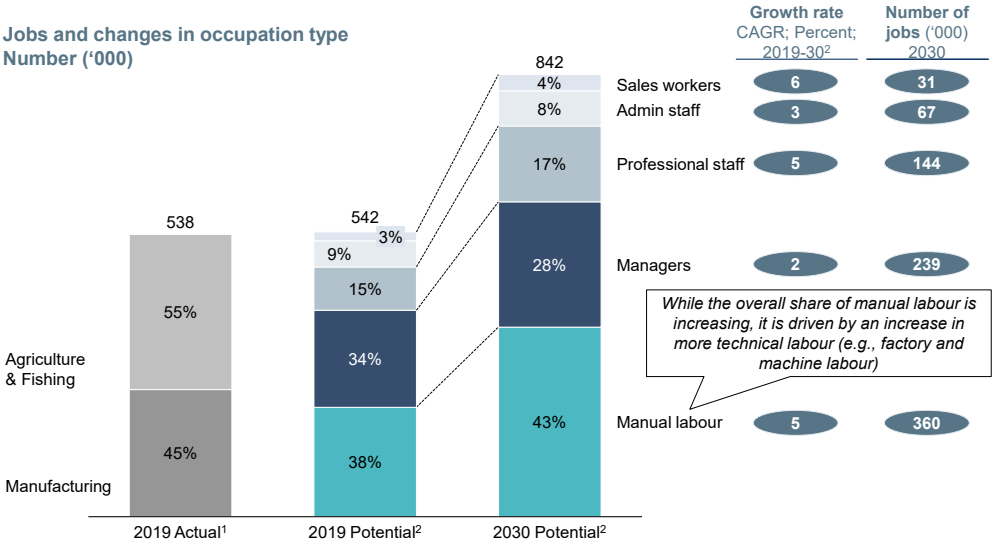
Seizing the major opportunities in food and agribusiness would have barely any effect on the total occupational composition of the sector's workforce. The share of managers could decline slightly between 2019 and 2030, but this would likely be offset by an increase in professional staff, administrative staff and certain manual labourers (Exhibit 4).[145]

The overall number of manual labour jobs is expected to increase. However, demand for farm labourers could decline, while labourers with technical and manufacturing expertise could be in higher demand (Exhibit 5).

[145] The 2019 potential job estimates initially reflect the full value chain including downstream related services involving food (e.g., retail). However, the retail component has been taken out for comparison. The FIAL 2019 potential job estimates differ from the 2019 actual job estimates in two main ways: 1) The estimates reflect the potential addressable opportunity, not its actual current value. The results of our analysis are estimates based on a variety of sources and assumptions. They measure how much value could be unlocked if Australian businesses fully seized the available opportunities. Data challenges prevent us from calculating the actual amount of value that Australian businesses may already be realising, and 2) The estimates account only for selected growth opportunities. The results do not include all the opportunities in the food and agribusiness sector, but only the most promising growth opportunities prioritised based on emerging trends, relevant research as well as discussions with key experts. Due to the lack of data, the breakdown of the 2019 actual jobs into the occupation types is not available.

EXHIBIT 4

There will be a decline in the share of managers, but an increase in the share of professional staff and some categories of manual labour

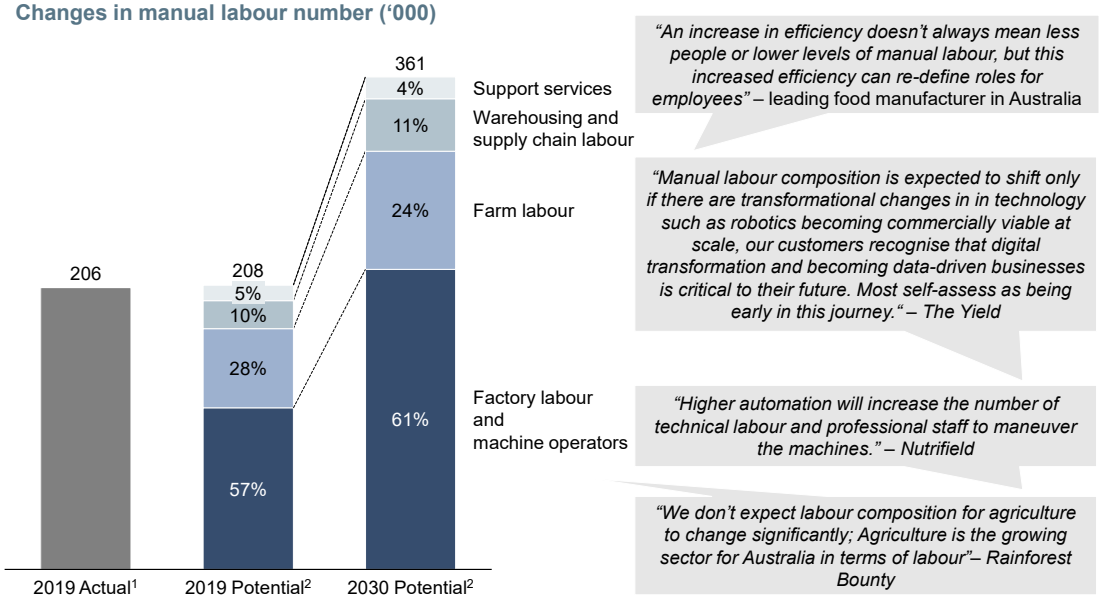


1. This estimate is from FIAL and does not include downstream related services involving food (e.g., retail). The 2019 actual and potential estimates differ in two ways – a) the 2019 potential estimate includes the full exploitation of the opportunities rather than the actual value captured, and b) the 2019 actual estimate includes all food and agribusiness opportunities, beyond the prioritised ones in the 2019 potential estimate. Due to the lack of data, the breakdown of the 2019 actual jobs into the occupation types is not available.
2. These summations do not include "Urban agriculture", "Protected cropping" and "Direct to consumer model" to avoid potential overlaps. The 2019 job estimation is not the current job estimate for Australia but rather the potential opportunity from full exploitation of all the identified opportunities

SOURCE: Literature search; ABS; AlphaBeta analysis

EXHIBIT 5

While overall manual labour is growing, this increase is primarily driven by rising technical labour, as the share of farm labour is decreasing



1. This estimate is from FIAL and does not include downstream related services involving food (e.g., retail). Therefore, it cannot be directly compared to the "2019 Potential" estimate.
2. These summations do not include "Urban agriculture", "Protected cropping" and "Direct to consumer model" to avoid potential overlaps. The 2019 job estimation is not the current job estimate for Australia but rather the potential opportunity from full exploitation of all the identified opportunities

SOURCE: Literature search; ABS database; AlphaBeta analysis

The following detailed occupational shifts can be expected:

Health and wellness

Employment opportunity: **152,000 jobs in 2030**

Opportunities around healthier eating and wellness food could support around 152,000 jobs in 2030 - an increase of close to 37,000 additional jobs from the 2019 potential figure. New jobs could emerge across the value chain. The jobs include manual labour (for example, farmers and machine operators), as well as manufacturing professionals and technical workers (for example, organic food processing workers). An expected increase in demand for technical and manufacturing labour would drive up the share of manual labour in the total food and agribusiness workforce to 43 per cent in 2030, from 38 per cent today.

The share of managers is expected to decline from 35 per cent to 30 per cent, as non-managerial staff will likely gain more responsibilities and increase their oversight. While many Australian agri-food manufacturers are currently trying to reduce manual labour through automation, the growing output would require them to hire more production workers and technical staff.

Box 4. Health and wellness case study

Automation does not necessarily lead to lower employment. For example, some organic and fresh food businesses in Australia continue to hire more staff even as they partly automate their operations. The need to employ more workers increases with growing production volumes. It is estimated that for every 20 per cent increase in tonnage, companies will hire 10 per cent more production labour (manufacturing).[146]

Australia's largest supermarket, Coles, offers one example for a business that is shifting its focus to wellness food. The company recently started offering a new health-food range. It also plans to refurbish 100 stores to provide café-style "feel-good" meals. Such initiatives are expected to create new food production jobs. On the flipside, Coles plans to cut 450 office jobs (managerial and administrative roles) by 2022/23 to reduce costs.[147]

Supply chain transformation

Employment opportunity: **150,000 jobs in 2030**

The estimated jobs linked to this opportunity could increase by 60 per cent between 2019 and 2030, reaching almost 150,000 in 2030 (approximately 56,000 additional jobs). The largest worker group needed to transform supply chains in the Australian food and agribusiness sector are manual labourers. However, as highlighted in Box 5, there is likely to be a significant overall reduction in jobs through the adoption of robots and other technologies in warehouses.

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[146] Expert interview.

[147] News.com (2019), "Coles unveils new health food range with 28 affordable products". Available at: https://www.news.com.au/finance/business/retail/coles-unveils-new-health-food-range-with-28-affordable-products/news-story/a4fffe63722d5d4f668005a600567f63

Box 5. Supply chain transformation case study

Australian supermarket chain Woolworths is leading the trend to transform supply chains with a new, highly automated warehouse that is set to significantly increase worker productivity. The A$562 million, partly solar-powered facility spreads over 57,000 square metres and comes with 14 kilometres of high-speed conveyors, 50 robots and 13 cranes. Machines automatically pick cartons off shelves, assemble pallets and load them onto trucks in the right sequence, reducing labour costs and congestion in stores. However, the new warehouse will need less manual labour – employing only 250 staff compared with 400 in the previous facility.[148] In June 2020, Woolworths announced the loss of 1,350 jobs in its warehouses as it invests in more automated services.[149] Another example is a cattle station in central Queensland that is relying extensively on new Internet-of-Things technology by technology companies Vodafone and Hitachi to improve logistics on the farm and across the value chain. Sensors and drones monitor cattle movements, water use and soil moisture.[150]

Targeted eating

Employment opportunity: **123,000 jobs in 2030**

Opportunities around reformulated, functional and nutritionally fortified foods could support around 123,000 jobs in 2030 - almost double the potential number of jobs associated with this opportunity in 2019 (i.e. 61,000 additional jobs). Managers and manual labour are the largest components of the workforce related to this opportunity in 2019 and are expected to remain so in 2030. Manual labour is expected to increase by 5 per cent, while the share of managers could decline by 6 per cent. Professional staff could increase from 12 percent in 2019 to 13 percent in 2030 with higher demand for product development engineers.

Box 6. Targeted eating case study

Food producers are increasingly eyeing opportunities in the market for functional foods, according to an interview with one of Australia's leading food manufacturers, who says the trend is driven by a new health focus among consumers. Supermarkets are updating their product mix, and aisles that used to be dominated by orange juice are now dominated by functional drinks such as Kombucha. Automation, robotics, and digitally enhanced business processes are shifting labour requirements, rather than reducing them.[151]

[148] Financial review (2018), "Woolworths banking on quantum leap from new distribution center". Available at: https://www.afr.com/companies/retail/woolworths-banking-on-quantum-leap-from-new-distribution-centre-20180903-h14umz

[149] The Guardian (2020), "Woolworths to cut 1,350 jobs and admits it owes at least $90m more to underpaid workers". Available at: https://www.theguardian.com/business/2020/jun/23/woolworths-to-cut-1350-jobs-and-admits-it-owes-at-least-90m-more-to-underpaid-workers

[150] Future IoT Case Studies, "Calliope Station in Australia improves farm operations with IoT". Available at: https://futureiot.tech/calliope-station-in-australia-improves-farm-operations-with-iot/

[151] Expert interviews.

Traditional proteins (meat, egg and dairy)

Employment opportunity: **106,000 jobs in 2030**

Opportunities around traditional proteins could support about 106,000 jobs (an increase of around 35,000 jobs from 2019) in 2030 including meat slaughters and beef cattle farmers. The fastest growing and largest occupation category is projected to be manual labour due to increased production volumes in farms and factories. Between 2019 and 2030, factory and machine labour is expected to increase by 4 per cent.

Box 7. Traditional proteins (meat, egg and dairy) case study

To help the dairy industry meet its labour demands, Australia's Ministry for Agriculture announced a Dairy Farm Induction Programme, worth A$715,000. The programme aims to help job seekers in Victoria's dairy industry upskill rapidly and aims to provide training to employers to help them quickly induct new workers into their businesses.[152] As part of this programme, an online learning training will help job seekers understand the culture of the workplace, and important day-to-day tasks such as machinery operation and handling stock. This programme is part of the A$50 million Agriculture Workforce Plan, which seeks to provide support to agriculture, food processing, and critical food supply chain businesses in rural, regional, and outer metropolitan areas in Victoria, to meet their labour and operational needs in light of the COVID-19 crisis.[153]

Soil, water and land management

Employment opportunity: **98,000 jobs in 2030**

Opportunities to create healthier soils could see employment increase by 30 per cent (about 22,000 new jobs) to 98,000 jobs between 2019 and 2030. Managers and manual labour are the largest component of the opportunity-related workforce at present and are expected to remain so in 2030. However, in the next 5-7 years, the uptake of automation in this area of the industry is expected to increase significantly. Businesses will likely use more IoT technology, such as sensors for soil management, as well as automated irrigation. Interviews with industry experts suggest this could make operations 25 to 50 per cent more productive by 2025, but it would also reduce demand for some types of manual labour.

Box 8. Soil, water and land management case study

Not every new technology will lower the need for manual workers in food and agribusiness. Drip irrigation systems, for example, require more humans to function properly, according to interviews with Rainforest Bounty, a food producer committed to regenerative agriculture and land rehabilitation. It can, therefore, be expected that manual labour will remain constant or even increase in business opportunities around soil, water and land management. Rainforest Bounty itself aims to double its number of employees by 2025.[154] Growing investor interest in regenerative agriculture could also bolster the industry and lead to higher demand and more job opportunities.

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[152] The Standard (2020), "Minister for Agriculture Jaclyn Symes on Wednesday announced $715,000 for the Dairy Farm Induction Program." Available at: https://www.standard.net.au/story/6755253/upskilling-workers-to-boost-victorias-dairy-workforce/

[153] Government of Victoria, "Agriculture Workforce Plan." Available at: https://agriculture.vic.gov.au/farm-management/emergency-management/coronavirus-covid-19/agriculture-workforce-plan

[154] Expert interview.

Food loss and waste

Employment opportunity: **70,000 jobs in 2030**

There's great potential for new jobs around waste collection, disposal and recycling services. Employment linked to this opportunity could double between 2019 and 2030, representing 35,000 additional jobs. The food waste industry is labour intensive and is expected to remain so in the future, even as labour productivity will likely improve further, and more routine processes could be automated (see Box 9).

Box 9. Food loss and waste case study

Several projects worldwide show how new opportunities in the food waste industry change employment. Self-compacting smart bins that run on solar power and inform collection teams when they need emptying are becoming a new feature in cities from Sydney to Auckland. Their use in Singapore demonstrates that waste collection can be done in 80 per cent less time and with less manual labour.[155]

Australia is ramping up efforts to find new ways to reduce food waste across the supply chain, with a new national research centre in Adelaide that employs 200 researchers tackling the food waste issue.[156] Meanwhile, food rescue charities such as OzHarvest, which employs more than 100 people, has opened the country's first rescue food supermarket, opening up more opportunities for employment.[157]

Direct to consumer model

Employment opportunity: **65,000 jobs in 2030**

Opportunities to deliver food to consumers via new digital platforms and online shopping channels as well as agro-tourism could create around 65,000 jobs by 2030. This would be about 50 per cent more than the opportunity's employment potential in 2019 (close to 21,000 additional jobs compared to 2019). Overall, demand for different types of workers linked to this opportunity is expected to remain fairly stable - with the exception of administrative workers, whose share could fall from 19 per cent to 10 per cent. The decline in administrative staff, such as cashiers and receptionists, would be driven by the shift to online sales. It would be offset, however, by a growing need for manual labour, such as warehouse workers, and staff handling machinery and logistics. Evidence from the United States defies the widespread assumption that an increase in e-commerce may lead to large job losses in retail. Statistics show that the American e-commerce sector added 355,000 jobs between 2007 to 2017,

[155] Today Online (2018), "JTC puts up more 'smart' waste bins that alert cleaners via SMS when full", Available at: https://www.todayonline.com/singapore/jtc-puts-more-smart-waste-bins-alert-cleaners-sms-when-full

[156] ABC News (2018), "New centre in Adelaide to help tackle Australia's food waste problem". Available at: https://www.abc.net.au/news/2018-10-24/new-research-centre-to-tackle-australias-food-waste-issues/10422314

[157] Foodtank, "How OzHarvest Is Helping Australia Halve Its Food Waste by 2030". Available at: https://foodtank.com/news/2019/08/how-ozharvest-is-helping-australia-halve-its-food-waste-by-2030/

significantly outweighing the displacement of 51,000 workers in the general retail sector over that period.[158] Similar trends can be expected in Australia.[159]

Box 10. Direct to consumer case study

Between 2019-20, Amazon aims to create 500 permanent jobs at its warehouses with the opening of its first Australian fulfilment centre in Dandenong South in Victoria. The company plans to recruit primarily for pickers and packers (manual labour), systems technicians and operations professionals (professionals). The company already has about 1,000 employees across its other two warehouses in Melbourne and Sydney. Amazon has doubled the number of full-time employees in its retail business function since December 2017, i.e. when the company was launched in Australia.[160]

Store retailers such as Coles are also working on increasing productivity by increased automation. For example, currently, Coles uses its fleet of 650 drivers to deliver online orders. Coles is building fulfilment centres across the country, to improve productivity five-fold and reduce delivery times and costs.[161] Additionally, Coles has also partnered with Accenture to provide digital solutions for activities such as faster automated checkout leading to lower administrative staff and deploying smarter planning approaches in distribution centres by attaching a scanning device to the wrists of warehouse workers when they are unpacking pallets.[162]

[158] Forbes (2017), "How E-Commerce Is Raising Pay And Creating Jobs Around The Country". Available at: https://www.forbes.com/sites/realspin/2017/04/03/how-e-commerce-is-raising-pay-and-creating-jobs-around-the-country/#55e5fab16dff

[159] Department of Industry, Innovation and Science (2017), *Inquiry into impacts on local businesses in Australia from global internet-based competition*. Available at: https://www.aph.gov.au/internetcompetition

[160] Sydney Morning Herald (2019), "Amazon hires permanent employees after complaints about casual work". Available at: https://www.smh.com.au/business/workplace/amazon-hires-permanent-employees-after-complaints-about-casual-work-20190227-p510ir.html

[161] Financial review (2019), "Coles partners with Ocado to shake up online grocery shopping". Available at: https://www.afr.com/companies/retail/coles-partners-with-ocado-to-shake-up-online-grocery-shopping-20190325-p5177l

[162] ZDNet (2019), "Coles ramps up digital transformation with extended Accenture deal". Available at: https://www.zdnet.com/article/coles-ramps-up-digital-transformation-with-extended-accenture-deal/

Energy smart food

Employment opportunity: **29,000 jobs in 2030**

Opportunities to produce food with less energy could support around 29,000 jobs in 2030, representing about 7,000 more jobs compared to 2019. Demand for manual labour (those working on farms, handling machinery and processing food) is estimated to increase from 39 to 43 per cent (of total jobs associated with this opportunity) between 2019 and 2030; managerial positions could decline from 40 to 34 per cent; the share of professional workers could increase slightly from 12 to 13 per cent.

Box 11. Energy smart food case study

Agriculture is the fourth most energy-intensive industry in Australia after manufacturing, transport and mining. A projected increase in energy prices will increase costs not only for farmers, but ripple through the entire supply chain. This will force more businesses to consider a smarter energy use in food production. For example, food manufacturer Simplot has begun to audit all its sites with the objective to reduce energy costs.[163]

Teys Australia, the second largest beef processing and cattle feeding company, plans to invest A$42 million to develop a Low Emissions Energy Hub at its Wagga Wagga facility in NSW, which it expects will create 4,000 direct and indirect new jobs.[164] Another project by Asia Pacific Agri-Corp is focused on developing a meat processing plant powered by its own on-site renewable energy facility worth A$308 million in Queensland. The facility is expected to process up to 2,400 head of cattle per day. As a result, the project is expected to deliver more than 600 direct jobs in construction and operations.[165]

Food fraud and safety

Employment opportunity: **26,000 jobs in 2030**

New opportunities to detect food fraud and improve food safety in Australia could create approximately 4,000 additional jobs between 2019 and 2030, an increase of 16 per cent. Professional staff and managers represent the bulk of the workforce linked to this market opportunity and their combined share will barely change in the coming years. The share of managers could increase from 15 to 19 per cent (of total jobs related to food fraud and safety), while the share of professional staff (particularly technical roles) could shrink from 64 to 61 per cent. The decline in professional jobs could be driven by the growing use of technology including blockchain, bio-sensing, and advanced packaging.[166]

Box 12. Food fraud and safety case study

Interviews with Sanikleen, a provider of professional cleaning services to food processing facilities across Australia, have reinforced estimates for a decline in the number of technical professionals in industries related to food fraud and safety. The company employs 860 people. It expects to install new equipment that would require less hands-on human work. As a result, it expects professional hygiene staff to decline by around 20 per cent to 25 per cent in the next 5-7 years.

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[163] Food and Beverage Industry News (2017), "The power of efficient food processing", Available at: https://www.foodmag.com.au/the-power-of-efficient-food-processing/

[164] Farm Online National (2019), "Teys to develop a $42m low emissions energy hub at Wagga". Available at: https://www.farmonline.com.au/story/5931223/teys-invests-in-low-emissions-energy-hub/

[165] Energy Matters (2018), "Queensland government sets new guidelines for solar farms". Available at: https://www.energymatters.com.au/renewable-news/queensland-solar-farm-guide-government/

[166] CSIRO Futures (2017), *Food and Agribusiness A Roadmap for unlocking value-adding growth opportunities for Australia*. Available at: https://www.csiro.au/en/Do-business/Futures/Reports/Food-and-Agribusiness-Roadmap

Animal feed and health

Employment opportunity: **25,000 jobs in 2030**

The number of jobs linked to creating healthier farm animals could increase by about 12,000 to around 25,000 by 2030. Businesses in this area rely heavily on managers and professional staff, which today account for an estimated 70 per cent of the opportunity-related workforce. For instance, sales managers are required to expand business lines and coordinate sales agents linked to new animal feed and health products. Increasing automation in this area is expected to see a reduced need for manual labour.

Box 13. Animal feed and health case study

Some of Australia's leading providers of animal nutrition solutions have already fully automated certain routine tasks, such as the mixing of ingredients in animal feed. One provider of animal nutrition suggested in an interview that automation could lift the productivity in the animal feed and health area by 10 to 25 per cent by 2025. The company itself is investing in more highly automated and energy-efficient production plants.[167] Meanwhile, animal nutrition producer Ridley opened a new state-of-the-art facility in Tasmania to produce aquaculture and pet feed, which will employ 20 full-time staff and was built with 550 contractors in the construction industry.[168]

Urban agriculture

Employment opportunity: **24,000 jobs in 2030**

The job creation potential of business opportunities in urban agriculture is expected to strengthen further in the coming years. The opportunity could support around 24,000 jobs in 2030 – an increase of 9 per cent (about 2,000 additional jobs) compared to 2019. These jobs would include research and development professionals, technologists, project managers, maintenance workers, marketing and retail staff, as well as manual labour to do the hands-on planting, cultivating, monitoring, and harvesting of fruit and vegetables.[169] In 2019, manual labour (31 per cent) and managers (57 per cent) form the bulk of the occupations in urban agriculture, and they are expected to remain the dominant occupation types in 2030 as well.

Box 14. Urban agriculture case study

Social enterprise Green World Revolution has developed a 400-square-metre urban farm in Perth that supplies food to more than 30 restaurants. The non-profit plans to build 100 such farms with the goal of employing 600 people. Currently, 120 unemployed Western Australians are engaging in urban farming in East Perth.[170]

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[167] Expert interview.

[168] Food processing blog (2019), "Ridley extrusion feed plant opens in Tasmania". Available at: https://www.foodprocessing.com.au/content/the-food-plant/news/ridley-extrusion-feed-plant-opens-in-tasmania-533240306

[169] TandFonline (2017), Future food-production systems: vertical farming and controlled-environment agriculture. Available at: https://www.tandfonline.com/doi/full/10.1080/15487733.2017.1394054

[170] ABC News (2015), "Green Revolution: Tiny inner city Perth farm stocks high-end restaurants, gives work to unemployed". Available at: https://www.abc.net.au/news/2015-10-30/green-world-revolution-tiny-inner-perth-farm/6900144

Sustainable fisheries

Employment opportunity: **18,000 jobs in 2030**

The estimated job creation potential of business opportunities in sustainable aquaculture could grow by almost 30 per cent in the years to 2030, leading to about 4,000 additional jobs. However, the industry's increasing focus on making operations more productive and energy-efficient (to combat relatively high costs for inputs such as electricity, water and gas) could see a substantial workforce shift in this field. With an increase in the minimum wage in Australia, automation in aquaculture is becoming more cost-competitive than hiring unskilled labour. As a result, the share of manual labourers linked to the sustainable fisheries opportunity could shrink from 40 to 27 per cent between 2019 and 2030. On the other hand, the share of professional staff could increase from 16 to 24 per cent over the same period.

Box 15. Sustainable fisheries case study

While emerging economies continue to rely heavily on human labour for procedural operations in aquaculture (such as feeding fish), automation is becoming commonplace in countries like Australia. Technology company AQ1 Systems developed the world's first sensor-based systems to feed shrimp on demand. Studies show that shrimp fed with this automated feeding system gain more weight, faster, compared to human feeding.[171]

A representative of Mainstream Aquaculture shared the view that manual and unskilled labour in aquaculture could decline significantly. He suggested that feeding fish manually was economical until 2015, but increasing labour costs, technological advances and falling equipment costs have made automated feeding the only commercially sensible strategy. Tasks such as the monitoring of water quality, the harvesting, and the packing of fish are also increasingly automated.[172]

[171] Auburn University, An Evaluation of Feed Management, the Use of Automatic Feeders, and Feed Leaching in the Culture of Pacific White Shrimp. Available at: https://etd.auburn.edu/bitstream/handle/10415/5987/Carter%20Ullman-%20Thesis-%20Final%2011_17.pdf?sequence=2

[172] Expert interview.

Plant-based and alternative proteins

Employment opportunity: **17,000 jobs in 2030**

The number of jobs linked to creating plant-based and alternative proteins could increase by approximately 6,000 to around 17,000 by 2030. Businesses in this area rely heavily on managers and manual labour, which account for over 80 per cent of the opportunity-related workforce currently and in 2030. The share of professional staff is expected to remain stable at 9 percent in 2019 and 2030. This could be due to the capital-intensive nature of the opportunity and the relatively high productivity of the employees (e.g., scientists, product safety engineers).

Box 16. Plant-based and alternative proteins case study

In 2019, the Australian company, Australian Plant Proteins (APP) built a A$35 million pulse processing plant in Horsham, Victoria to extract in-demand protein isolates.[173] The company worked with the Commonwealth Scientific and Industrial Research Organisation (CSIRO) to optimise the protein extracted from faba beans.[174] The plant's annual capacity is expected to reach 5,000 tonnes of protein isolate which would require processing 20,000 tonnes of faba beans annually.[175] The company aims to build several such plants across Australia and increase its total capacity to 25,000 tonnes of protein isolate per annum. The processing plant is expected to create dozens of jobs and farming opportunities (e.g., machine operators) for the agricultural industry in Victoria's Wimmera region.[176]

[173] Farm Online (2019), "Plant based protein business set to launch in May." Available at: https://www.farmonline.com.au/story/6458553/protein-processor-set-to-make-a-big-shake/#:~:text=The%20new%20Australian%20Plant%20Protein,the%20developer%20of%20protein%20plant.

[174] CSIRO (2019), "Australian Plant Proteins: Optimised faba bean protein extraction." Available at: https://www.csiro.au/en/Do-business/Solutions-for-SMEs/Our-track-record-working-with-SMEs/Kick-Start/APP

[175] Grain Central (2019), "Horsham facility to boost domestic faba-bean demand." Available at: https://www.graincentral.com/news/agribusiness/horsham-facility-to-boost-domestic-faba-bean-demand/

[176] CSIRO (2019), "Australian Plant Proteins: Optimised faba bean protein extraction." Available at: https://www.csiro.au/en/Do-business/Solutions-for-SMEs/Our-track-record-working-with-SMEs/Kick-Start/APP

Protected cropping

Employment opportunity: **10,000 jobs in 2030**

Opportunities to improve the potential productivity gains from switching from field cropping to protected cropping could create 10,000 jobs in 2030 (a slight decrease of about 300 jobs compared to 2019). Manual labour is likely to decrease from 41 per cent to 30 per cent, while managers are likely to increase from 41 per cent to 55 per cent. As more technologies are used, there could be a shift away from manual labour.

Box 17. Protective cropping case study

The protected cropping industry in Australia constantly faces a shortage of skilled workers, junior growers, middle-level greenhouse managers, and senior growers that could be a barrier for the industry's future expansion.[177] The Western Sydney University, New South Wales Department of Primary Industries' Tocal College, and Tertiary & Further Education (TAFE) New South Wales aim to fill this gap by supporting selected workers from a diploma to an undergraduate degree with greenhouse specific units of study. Units of studies include solution chemistry for hydroponics, plant physiology, post-harvest / food tech, on-farm research skills, greenhouse environmental control systems, and greenhouse engineering.[178] The training programme has multiple entry and exit points, providing significant up-skilling opportunities to people with varying experiences in the protective cropping industry.

Sustainable packaging

Employment opportunity: **10,000 jobs in 2030**

Activities to help create a more sustainable packaging approach could see a substantial increase in employment between 2019 and 2030, growing from an estimated 2,000 to around 10,000 jobs (with about 8,000 additional jobs). This opportunity is currently dominated by manual labour (over 60 per cent). Demand for managers and professional staff could increase slightly from 22 per cent to 26 per cent in the coming years, as the food and agribusiness sector needs more innovative thinkers to help reduce packaging waste. Innovation will be critical to achieve the waste reduction goals stated in Australia's 2025 National Packaging Target, for example, the target to develop packaging that is 100 per cent recyclable or compostable. It is estimated that domestic recycling of the 4.5 million tonnes of waste that are currently being sent overseas could create up to 5,000 jobs in Australia.[179]

Box 18. Sustainable packaging case study

Waste management company Veolia is partnering with 11 councils in Sydney's southern suburbs to reduce the amount of landfill, using a new approach to treat household waste. As part of the contract, Veolia will build a new recycling plant that would create 40 additional jobs.[180]

[177] Protective Cropping Australia (2018), "Training For the Protected Cropping Industry." Available at: https://protectedcropping.net.au/training-for-the-protected-cropping-industry/

[178] Protective Cropping Australia (2018), "Training For the Protected Cropping Industry." Available at: https://protectedcropping.net.au/training-for-the-protected-cropping-industry/

[179] The Guardian (2019), "Recycling industry calls for dollars and action after decision to end exports". Available at: https://www.theguardian.com/environment/2019/aug/13/recycling-industry-calls-for-dollars-and-action-after-decision-to-end-exports

[180] Veolia, Millions tonnes of waste re-treated. Available at: https://www.veolia.com.sg/millions-tonnes-waste-re-treated

Technology in smallholder farms

Employment opportunity: **8,000 jobs in 2030**

The number of potential jobs related to this opportunity could increase significantly from 2,000 to around 8,000 in the years to 2030 (about an additional 6,000 jobs). Professional staff currently represent 67 per cent of the total workforce in this opportunity area, and its share could remain fairly stable (65 per cent) in 2030.

Box 19. Technology in smallholder farms case study

Several initiatives in Australia are supporting small-landholder farms and businesses improve their sustainability and long-term profitability. For example, the Department of Agriculture, Water, and The Environment of the Australian Government has developed a A$34 million Australian Stewardship Package to highlight Australia's commitment to sustainable agriculture development. Under the programme's Agriculture Biodiversity Stewardship Pilot, small and medium farm businesses would be incentivised to adopt practices that improve biodiversity on farms. Similarly, an Australian startup, Hillridge Technology, aims to enable global insurance companies to provide weather protection for small to medium-sized Australian farm businesses, which could minimise the risks associated with extreme weather conditions.[181]

Advanced breeding and fertilisation

Employment opportunity: **5,000 jobs in 2030**

Opportunities to improve the breeding and fertilisation techniques in agriculture could result in strong employment growth and create around 3,000 additional jobs between now and 2030. Professional staff will likely continue to account for the majority of the workforce due to the growing need for research and development of seed and livestock breeding. Currently, the level of automation in companies related to this opportunity is not as high as in other areas. However, automation is expected to increase also in advanced breeding and fertilisation, leading to significant productivity gains (based on industry interviews).

Box 20. Advanced breeding and fertilisation case study

Food and animal growers are shifting to advanced business methods, and this trend will increase the demand for technical staff. Based on an interview with a leading Australian company in advanced seed breeding, the largest demand for automation technology revolves around machinery with powerful visual identifiers (to identify promising plant breeds), as well as equipment for semi-automated pollination.[182] An Israeli company, Edete Precision Agriculture, is prototyping new pollination technology in almond orchards in Israel and Australia. The company is developing mechanical tools to harvest flowers from trees and extract pollen from blossoms, as well as robotics to apply the dry pollen to blooming fruit trees.[183]

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[181] The Sydney Morning Herald (2020), "The future is fertile: how Australian innovation could save farming." Available at: https://www.smh.com.au/national/the-future-is-fertile-how-australian-innovation-could-save-farming-20200207-p53yph.html

[182] Expert interview.

[183] Goodfruit (2019), "New technology explores pollination automation". Available at: https://www.goodfruit.com/new-technology-explores-pollination-automation/

Precision agriculture

Employment opportunity: **4,000 jobs in 2030**

The number of potential jobs related to the precision agriculture opportunity could triple to about 4,000 in the years to 2030 (with an additional 3,000 jobs). It is estimated that professionals account for around two-thirds of the opportunity-related workforce, while managers could make up 17 per cent of jobs in precision agriculture. Their importance will likely increase further, reaching a share of 71 per cent for professionals and 22 per cent for managers in 2030. Multiple grant programmes and funds in Australia are encouraging the adoption of precision agriculture techniques with the objective of promoting new jobs. For example, the A$200 million Regional Jobs Fund in Victoria supports job creation and retaining existing jobs, with a specific focus on advanced technologies that can boost productivity.[184]

Box 21. Precision agriculture case study

Based on our interview with the Yield, an Australian Agricultural technology company, even though precision agriculture is increasing the level of automation in jobs, this leads to higher productivity which allows for higher production and not necessarily fewer employees. For example, with a Yield Prediction tool, the allocation of labour is improved by better matching supply and demand, allowing the same employees to do more tasks, rather than necessarily reducing the number of employees.

Sustainable inputs

Employment opportunity: **2,000 jobs in 2030**

Jobs linked to opportunities around bio-fertilisers and other sustainable inputs are expected to increase significantly from 300 to about 2,000 between now and 2030. Professional staff currently represent 42 per cent of the total workforce in this opportunity area, and their share could increase to 48 per cent by 2030. At the same time, businesses producing greener fertilisers and other sustainable inputs are actively looking at ways to become more productive through automation. This could lower the demand for certain types of manual labour.

Box 22. Sustainable inputs case study

Nutrifield, a manufacturer of fertilisers and plant nutrients for the horticultural industry, expects automation will make workers for some manual tasks in the business obsolete. For example, workers used to check the temperature of liquids in the production process. Today, heat sensors are performing this task, which saves time and allows the company to complete up to four times as many production cycles per day. Interestingly, demand for professional staff has remained constant or even increased, as more workers are needed to manage the fast-growing production.[185]

[184] KPMG (2016), *Powering Growth – Realising the potential of agtech for Australia*. Available at: https://home.kpmg/content/dam/kpmg/au/pdf/2016/powering-growth-realising-potential-agtech-australia.pdf

[185] Expert interview.

3. Which talents? Understanding the opportunity-related skills need

When job opportunities change, workers have to respond. *They may need to learn new skills and adapt to new tasks. This chapter shows that harnessing the 19 opportunities outlined by FIAL would leave the current mix of occupations in the food and agribusiness workforce largely similar in 2030 as compared to today. However, demand for workers with technical, managerial and numeracy skills would increase significantly. Administrative staff will likely have the greatest need for reskilling between 2019 and 2030.*

The analysis in this chapter is based on a simple distinction of seven skills categories, in line with the standard definitions used in the O*NET database:[186]

- **Critical thinking and complex problem solving** is the ability to derive pertinent insights and conclusions from large amounts of information. It also relates to a worker's ability to pick up new skills as demanded by the job, to identify complex problems, and to develop solutions. This category includes active learning, active listening, complex problem solving, critical thinking and learning strategies.
- **Written and verbal communication** is the ability to read and understand written information and ideas, and to communicate information and ideas in writing so that others can understand. This category includes reading comprehension, speaking and writing.
- **Numeracy** is the ability to add, subtract, multiply or divide quickly and correctly. This category includes mathematics and science skills.
- **Managerial skills** relate to the ability to motivate, develop and direct people as they work, and identify the best people for the job. Skills in this category are often used to manage finances, personnel and material. They are also used for monitoring and time management.
- **Social skills** imply the ability to work successfully with people to achieve goals. This category includes coordination, instruction, negotiation, persuasion, service orientation and social perceptiveness.
- **Evaluation, judgement and decision making** is the ability to identify measures or indicators of a system's performance and the actions needed to improve or correct this performance, relative to the goals of the system. It also relates to the ability to consider the relative costs and benefits of potential actions and to choose the most appropriate one. Typical tasks related to skills in this category include systems analysis and systems evaluation.
- **Technical and ICT skills** relate to the ability to design, set up, operate, and correct malfunctions of machines or technological systems. Typical tasks for skills in this category include equipment maintenance, equipment selection, installation, operations and control, operations monitoring, operations analysis, programming, quality control analysis, repairing, technology design and troubleshooting.

[186] O*NET Database. Available at: https://www.onetonline.org/help/onet/database

Which skills would Australia's workforce need to acquire now in order to meet the projected future jobs demand from the 19 major opportunities in food and agribusiness? Box 23 describes the methodology that was used to understand the expected shift in skills.

Box 23. Estimating the required skills shift

Four steps were used to determine how the 19 opportunities might change the future demand for skills in food and agribusiness. Appendix F contains further details on this approach.

- **Step 1: Converting O*NET database codes to ABS codes.** The O*NET database contains serial data on skills by occupation type. We standardised O*NET occupation types to make them comparable with data from the Australian Bureau of Statistics (ABS).
- **Step 2: Understanding skill requirements by occupation.** We identified the relevant jobs for all 19 opportunities (based on the analysis described in Chapter 2). We then linked these jobs back to the O*NET database to understand which skills are required for jobs and occupations in the food and agribusiness sector, and to understand their change over time.
- **Step 3: Estimating the skills required today and in 2030.** To make predictions about the future, we first examined which skills workers needed in 2019 in the mix of jobs related to the 19 food and agribusiness opportunities. We then estimated the future skill requirements in 2030 that can be expected if job profiles shift as described in Chapter 2. We estimated the skills shift both within a job and across occupations (based on our analysis of O*NET data from 2012-2019).
- **Step 4: Refining results.** We adjusted our results for the expected change in skill requirements using insights from interviews with industry experts.

Harnessing new opportunities in the Australian food and agribusiness sector would require workers to significantly improve their technical, managerial and numeracy skills by 2030. This could be a challenge. Previous research in Australia has shown that there is a major gap in terms of digital skills and capability across the entire agricultural value chain.[187] Exhibit 6 shows that several other skills would also become more important for the food and agribusiness workforce in the coming years, including critical thinking and problem solving skills (rising from the second-most important skill in 2019 to the most important in 2030).

Technical skills are expected to increase the most in importance from now to 2030. With the Fourth Industrial Revolution (4IR) changing the agriculture and food manufacturing sectors, employees are expected to develop critical technical skills to manage and maintain new technologies such as robotics and big data.

These findings are in line with a recent report by the Australian Industry and Skills Committee, which states that the top generic skills needed in agriculture are learning agility and self-management, as well as managerial skills, financial skills, and skills related to technology, science and numeracy.[188]

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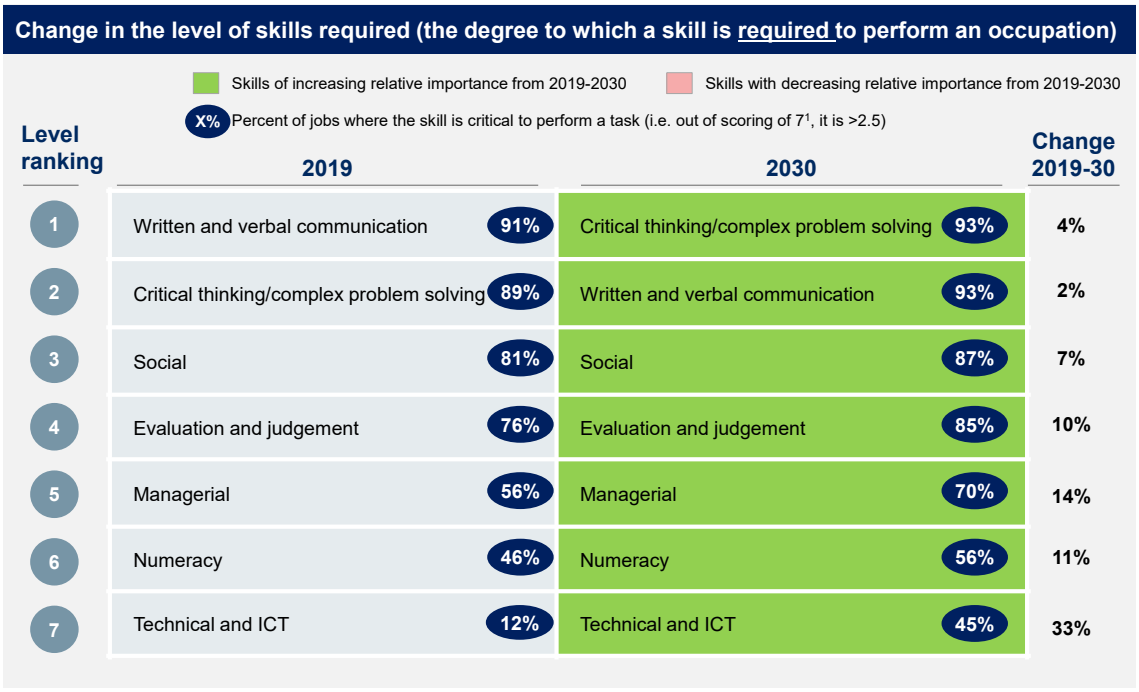
[187] Farm Policy Journal (2018), *Enabling Digital Agriculture in Australia*. Available at: https://www.precisionag.com/in-field-technologies/connectivity/enabling-digital-agriculture-in-australia/

[188] Australian Industry and Skills Committee (2019), *IRC and Skills Forecast*. Available at: https://nationalindustryinsights.aisc.net.au/industries/agriculture

EXHIBIT 6

Technical skills, managerial and numeracy are the skills categories which are expected to increase the most in importance from 2019-2030



1. O*Net provides a scoring from 1-7, based on degree to which a skill is required for a certain occupation.

SOURCE: O*NET; AlphaBeta analysis

Administrative workers (such as procurement staff and data entry clerks) could feel most under pressure to learn new skills in the years to 2030 (Exhibit 7). Interestingly, jobs might not change much, but the skills needed to do these jobs will. Their overall job prospects could remain relatively stable (as shown in Chapter 2). However, what these workers could be doing in 2030 might look very different from today. This is driven by digital technologies such as IoT and big data automating tasks that were previously done manually and instead requiring administrative workers to place a greater emphasis on evaluation and technical skills. For instance, procurement clerks currently conduct a large share of their tasks manually (e.g., preparing and reviewing purchasing reports and price lists). However, with increased automation and the use of big data, key analyses such as pricing benchmarks and trends could be managed by software programmes, and there would be more need for evaluation and technical skills to interpret the data.

Other occupation categories also require a changing mix of skills. According to the Australian Information Industry Association, manual labourers such as mechanics and technicians would need better technical skills, so they can handle some of the automation systems that are expected to take over some of the tasks previously done by humans. These workers would also need to increase their managerial skills to oversee drones, monitor IoT systems, and supervise the digitally connected crop production of the future.[189] Some farmers in Australia are already integrating technical skills with farming skills, for example by using computer models to check the soil health and the growth of their crops. Farmers and farm workers are expected to need ever-more sophisticated technical skills, as they

[189] Australia Information Industry Association (2018), *Jobs for Tomorrow*. Available at: https://www.aiia.com.au/

will have a growing amount of technology at hand - from genetic data to predictive climate models – to help them decide when to sow or fertilise crops.[190]

Technical skills can be learned in training courses. However, industry experts in interviews also noted that social skills and managerial skills will become more important, as manual labourers will likely move into more customer-facing roles in the future. For example, increased automation in retail stores means warehouse workers will also be expected to play a role at the front of the store to help with customer queries.

Box 24. Shift in skills case studies

Training institutions are already observing a shift in the way the Australian workforce is responding to changing skill needs. For example, officials at the Australian Institute of Packaging said in an interview that training courses for workers in the packaging industry are focusing more strongly than in the past on recycling, sustainable materials and technical skills. The type of workers attending these courses has also changed over the past couple of years, according to the Institute: from professionals such as packaging technologists and industrial designers to a greater number of attendees with non-packaging backgrounds (such as quality control professionals, sustainability and environmental professionals, or production staff).[191]

Aware of changing skill needs, specialist food and drink manufacturer Flavour Creations has set up several training programmes for its workforce. The company seeks to ensure that its staff have strong leadership, social and technical skills. It also encourages innovative thinking. An 'Emerging Leaders Programme' engages staff across all departments, from warehouse and HR to administration and communication, and equips participants with specific managerial and leadership skills to increase their participation and influence within the organisation.[192]

[190] The Conversation (2014), "Agriculture in Australia: growing more than our farming future". Available at: https://theconversation.com/agriculture-in-australia-growing-more-than-our-farming-future-22843

[191] Expert interviews.

[192] Expert interviews.

EXHIBIT 7

Administrative workers are expected to see the greatest reskilling needs over the next 11 years

Percentage of jobs in which skill change is higher than the average skill change for all food and agribusiness jobs from 2019-30

Occupations with greatest shift in skill requirements by skill category

Skills	Managers	Professionals	Sales workers	Administrative workers	Manual labour
Written and verbal communication	29%	31%	29%	47%	40%
Critical thinking	32%	34%	29%	16%	49%
Social	24%	33%	50%	42%	44%
Evaluation and judgement	15%	21%	36%	42%	37%
Numeracy	17%	13%	14%	42%	35%
Managerial	5%	17%	21%	47%	42%
Technical and ICT	27%	18%	50%	58%	30%
Overall	21%	24%	33%	42%	40%

SOURCE: O*NET database; Australian Bureau of Statistics (ABS); AlphaBeta analysis

Skills required in the food and agribusiness sector in 2030 vary by opportunity. Promising business areas that demand innovative thinking, such as *health and wellness* and *food loss and waste*, will require more workers who can think critically and solve problems. For instance, there is the demand to create more targeted behavioural campaigns and innovations for households. Meanwhile, opportunities that rely heavily on digital and automation technology, such as *precision agriculture*, will require a higher number of technically skilled workers. Various expert interviews confirm this finding (Exhibit 8).

EXHIBIT 8

Based on our discussion with industry experts, the key skills will vary by opportunity

Sustainable Fisheries	*"**Managerial skills and social / cultural capabilities** are becoming more important as technical skills are in many respects becoming commoditised"*	MainStream AQUACULTURE
Health and Wellness	*"Young hires are usually academically smart but lack innovation and out of the box thinking. Their problem-solving capability and decision-making capability is low. Thus, developing the **critical thinking and complex problem solving**, and **evaluation and decision-making** skills is very important"*	***An Australian company producing organic gluten- and dairy-free sauces products***
Precision Agriculture	*"While **technical skills** are becoming increasingly important in this line of work, the employees also need to have strong **social skills**, along with **critical thinking and evaluation** in order to interact with clients and collaborate"*	THE YIELD TECHNOLOGY SOLUTIONS
Food Loss and Waste	*"**Written and verbal skills are becoming less important**, instead **critical thinking and complex problem solving** is key to adapting to a changing world. Especially with food waste, where we need innovative thinking on reducing waste"*	***An Australian company specialising in gluten free and organic foods***

SOURCE: Industry sources

4. Key takeaways for business leaders and policymakers

The Australian food and agribusiness sector is faced with tremendous opportunities to create value and jobs. To fully capture these opportunities, businesses will need to remain agile and willing to change – towards more sustainable practices and products, as well as more high-tech equipment on farms, in food factories and the supply chain. What is also needed is a large transformation of the workforce, both in terms of volume and skills.

Value-added with the opportunities could reach over A$200 billion by 2030 (which is over 10 per cent of Australia's current GDP). In addition, there could potentially be 842,000 jobs associated with these opportunities in Australian food and agribusinesses by 2030. However, agriculture in Australia is already facing an acute labour shortage, with estimates that the lack of workers causes the industry to lose A$2 million each year.[193] Unfavourable demographics are exacerbating the issue. The average Australian farmer is between 53 and 59 years old, much higher than the median age of 40 for the rest of the workforce, meaning a large share of the farming workforce will retire soon.[194]

Workers in the food and agribusiness sector, particularly administrative staff, will also need to learn a substantial amount of new skills to be ready for new technologies and tasks. The new market opportunities are huge, and equipping the workforce with stronger technical, managerial and numeracy skills is crucially important to make the most of the untapped value ahead.

The appropriate policy and business responses to these challenges are outside the scope of this research, but decision-makers could help to ready the sector for success with the following five actions:

Driving greater policy, programme and investment coordination and alignment across government and industry to grow Australia's food and agribusiness sector. Currently, the food and agribusiness sector operates in a highly fragmented manner. This includes dealing with multiple federal governments and at least a dozen state departments on a policy front; multiple support agencies (e.g., Research and Development Corporations or RDCs) and scores of industry organisations with different priorities. This current arrangement leads to costly duplication and gaps in focus, investment and resourcing. As the food and agribusiness sector spans the whole value chain, a coordinated system is crucial. For instance, government and industry stakeholders could work together on one streamlined plan for capturing the opportunities outlined in this report. There are currently several reports published, covering different areas, guiding the development of the food and agribusiness sector in Australia. Examples include the NFF "2030 Roadmap: Australian Agriculture's Plan for a $100 Billion Industry" and CSIRO's "Food and Agribusiness: A roadmap for unlocking value-adding growth opportunities for Australia".[195] Furthermore, the estimates related to the food and agribusiness sector (see Box 1) are often calculated using different methodologies and scopes, limiting

[193] Australian Farmers blog (2019), "Survey uncovers multi-million-dollar cost of farm labour crisis". Available at: https://farmers.org.au/news/survey-uncovers-multi-million-dollar-cost-of-farm-labour-crisis/

[194] Deloitte (2015), *Farming on the verge of a workforce crisis*. Available at: https://www2.deloitte.com/au/en/pages/consumer-business/articles/farming-verge-workforce-crisis.html

[195] National Farmers Federation (2016), 2030 Roadmap: Australian Agriculture's Plan for a $100 Billion Industry. Available at: https://nff.org.au/wp-content/uploads/2020/02/NFF_Roadmap_2030_FINAL.pdf and Commonwealth Scientific and Industrial Research Organisation (2017), Food and Agribusiness: A roadmap for unlocking value-adding growth opportunities for Australia. Available at: https://www.csiro.au/en/Do-business/Futures/Reports/Ag-and-Food/Food-and-Agribusiness-Roadmap

useful comparisons across reports. These issues could lead to confusion among stakeholders and hinder the full exploitation of the opportunities. Stakeholders could work towards creating one strategic plan for Australia's food and agribusiness sector. This would require multi-stakeholder alignment on the key opportunities, the valuation approaches to size them and actions necessary to capture them. In addition, with the consolidation of resources into one plan, more effort could be channelled to generate useful granular information on certain opportunities. For instance, in the *health and wellness* opportunity, researchers could deep dive into components such as organic foods to better understand the emerging value pools in this area.

Rebranding the sector to attract new talent. The food and agribusiness sector is sometimes perceived as a sector that offers relatively unsophisticated and uninteresting work. Over the years, there have been increasing initiatives to generate exposure to the food and agribusiness sector. For instance, the "Educating kids about agriculture" initiative by the Department of Agriculture, Water and the Environment aims to increase understanding of the role of agriculture through farming experiences for children.[196] The "Fair Farms Initiative" is an industry-led programme to improve the reputation of the sector and promote fair and ethical employment conditions.[197] The RDCs have also introduced several programmes including the Young Dairy Network Australia (YDNA) and the Fisheries RDC National Seafood Industry Leadership Programme (NSILP) which organise networking activities and workshops to attract talents.[198] However, there is a need to scale these initiatives to attract sufficient talent from now to 2030. Furthermore, as the analysis in this report demonstrates, technology is reshaping the entire sector – from farming with drones and satellites to genetic plant breeding and high-tech recycling. The future will offer exciting employment opportunities, and the sector's branding should reflect this change and create an alluring value proposition to attract young talent (for example, more could be done to market the industry's innovative power and striving for sustainability). Given that 68 per cent of the workforce is currently male, the talent hunt could focus more strongly on females.[199] A better gender balance would be particularly desirable in technical and professional roles, where women represent less than 5 per cent of the workforce in the agricultural sector. Surveys gathering insights into the career aspirations of students signal that a few rebranding messages would resonate well with younger talents: the vital contribution agriculture makes to society, the strong employment prospects, and the diversity of jobs and conditions.[200]

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[196] Australian Government Community Grants Hub (2020), "Educating Kids About Agriculture: Kids to Farms grant program". Available at: https://www.communitygrants.gov.au/grants/educatingkidsaboutagriculturekidstofarms#:~:text=Farms%20grant%20program.-,The%20Educating%20Kids%20About%20Agriculture%3A%20Kids%20to%20Farms%20grant%20program,Agriculture%3A%20Our%20Heritage%20Our%20Future. Other government initiatives include the National Agricultural Workforce Strategy. Australian Government Department of Agriculture, Water and the Environment (2020), "National Agricultural Workforce Strategy". Available at: https://haveyoursay.awe.gov.au/national-agricultural-workforce-strategy

[197] Australian Government Department of Agriculture, Water and the Environment (2020), "National Agricultural Workforce Strategy literature review". Available at: https://haveyoursay.awe.gov.au/national-agricultural-workforce-strategy and Fair Farms (2020), "About Us". Available at: https://www.fairfarms.com.au/

[198] Australian Government Department of Agriculture, Water and the Environment (2020), "National Agricultural Workforce Strategy – Discussion Paper". Available at: https://haveyoursay.awe.gov.au/national-agricultural-workforce-strategy

[199] Australian Bureau of Agricultural and Resource Economics Sciences (2018), "Snapshot of Australia's Agricultural Workforce". Available at: https://www.agriculture.gov.au/abares/publications/insights/snapshot-of-australias-agricultural-workforce#young-people-in-the-agriculture-industry

[200] University of Queensland (2011), *Career motivations and attitudes towards agriculture of first-year science students at The University of Queensland*. Available at: http://www.aph.gov.au/DocumentStore.ashx?id=4fd9533f-93c8-42a9-ac5b-38d7174791f8

Building closer links with educational institutions to ensure future workers have the appropriate skill sets. A promising move would be to engage students as early as in secondary school, and to build close links with education institutions to ensure their curricula prepare the future workforce for changing skill needs (and technical, managerial and numeracy skills in particular). The Mitchell Institute in 2018 found that Australia's education system would need to go beyond literacy, numeracy and core subject knowledge to adequately prepare young people for a successful future.[201] More opportunities for students to do industry apprenticeships would make curricula more relevant.

Rethinking educational models for existing workers. Apart from the formal education system, the food and agribusiness workforce would benefit substantially from more short-term, on-the-job training opportunities as well as new forms of educational models such as micro-credentials. Rethinking educational models could entice more people to enter and stay in the food and agribusiness sector. For instance, mid-career workers have a particularly large need to learn new skills to cope with rapid technological change. These individuals considering entering the sector could upskill themselves through obtaining micro-credentials via online personalised courses, bootcamps and apprenticeships (compared to going through the formal education system to get a degree). This could potentially reduce the time needed for interested individuals to make the switch into this sector. In Australia, the RDCs and private sector have been driving initiatives such as technology transfer and extension programmes to increase knowledge and enhance the skills of those working in the food and agribusiness sector.[202] For instance, the Fisheries RDC and the Tuna Boat Owners of Australia managed to increase the value and volume of Australia's supply of Southern Bluefin Tuna by training the workforce to catch, transfer and farm wild tuna in open sea cages.[203] To achieve greater impact, businesses and governments would both need to invest in training opportunities to further incentivise the skills transformation Australia needs. Employers are often deterred by the cost of retraining programmes. However, it would make good business sense to weigh up the long-term benefits against such training programme costs.[204] Singapore leads by example: it provides government subsidies that cover up to 95 per cent of course fees and absentee payroll costs and offers higher subsidies for courses earning professional qualifications.[205]

Developing flexible employment models for older workers. The large share of over-50-year-old food and agribusiness workers, and the depth of their experience increases the need for new models to retain and reskill this segment of the workforce. Businesses should consider redesigning certain work tasks to match the strengths, needs and capabilities of older workers. Investments in this area can have attractive returns. For example, research shows that every dollar invested in workplace enhancement for older-age workers can deliver a 3- to 5-fold return

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[201] The Educator (2018), "Students not prepared for future – report". Available at: https://www.theeducatoronline.com/k12/news/students-not-prepared-for-future--report/252961

[202] University of Melbourne (2018), *Stimulating private sector extension in Australian agriculture to increase returns from R&D*. Available at: https://rirg.fvas.unimelb.edu.au/__data/assets/pdf_file/0005/2800256/Privatising-Ag-Ext-Rpt-C-Advisory-Ext-system-V4.pdf and Rural RDC (2020), "About Us". Available at: http://www.ruralrdc.com.au/about/

[203] Rural RDC (2018), "Southern Bluefin Tuna jobs, value boost". Available at: http://www.ruralrdc.com.au/case-studies/southern-bluefin-tuna-jobs-value-boost-2/

[204] AlphaBeta (2019), *Preparing for AI: The Implications of Artificial Intelligence for Jobs and Skills in Asian Economies*. Available at: https://www.alphabeta.com/wp-content/uploads/2019/08/ms-ai-report.pdf

[205] Skillsfuture SG (2019). "Funding support for employers". Available at: https://www.ssg.gov.sg/programmes-and-initiatives/funding/funding-for-employer-based-training.html

in just a few years.[206] Such improvements are most effective when they reduce time pressures and physically demanding work for older workers, as well as providing better pay, more autonomy, and a higher focus on on-the-job training.[207]

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The opportunities highlighted in this report could transform Australia's food and agribusiness sector. But making it happen will require a major multi-stakeholder effort.

[206] European Agency for Safety and Health at Work (2012), "Promoting active ageing in the workplace". Available at: https://osha.europa.eu/en/publications/articles/promoting-active-ageing-in-the-workplace

[207] Andreas Cebulla (2019), "There's a yawning gap in the plan to keep older Australians working". Available at: https://www.abc.net.au/news/2019-11-20/retraining-wont-keep-older-workers-from-choosing-to-retire/11720482

Appendix A: Methodology for identifying the 2030 opportunities in food and agribusiness

19 food and agribusiness opportunities were prioritised from a long-list of potential opportunities gathered from emerging trends, relevant research as well as discussions with key experts. The research has drawn upon different sources including:
Trend analysis reports

1. **Top 50 global trends** – This report covers the top 50 global trends, beyond food and agribusiness, including agriculture 4.0, protein engineering and sustainable packaging.[208]
   Surviving and Thriving in the 21st Century: A discussion and call to action on global catastrophic risks – This report explores ten global risks, such as rising food insecurity and falling nutritional quality, and recommends solutions.[209]
   Pursuing the global opportunity in food and agribusiness – This report highlights major trends including urbanisation and demographic changes in mature markets.[210]
   Nine Trends Transforming the Agribusiness Industry – This report indicates nine key trends that are driving transformation within the industry such as increased focus on sustainability and evolving protein demand.[211]

Relevant global food and agribusiness sector reports

Valuing the SDG Prize – This report identifies 60 business opportunities in four systems, including food and agriculture.[212] Opportunities include sustainable aquaculture and urban agriculture.
Creating a Sustainable Food Future – This report focuses on technical opportunities and policies for cost-effective scenarios to meet food, land use and greenhouse gas emissions goals in 2050.[213] Relevant opportunities include product reformulation and plant-based meats.
Growing Better: Ten critical transitions to transform food and land use – This report is centred around ten critical transitions that would enable food and land use systems to provide food security and healthy diets for a global population by 2050.[214] These transitions include healthy diets and diversifying protein supply.

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[208] Frost & Sullivan (2020), *Top 50 Global Trends*.

[209] The Commission for the Human Future (2020), *Surviving and Thriving in the 21st Century: A discussion and call to action on global catastrophic risks*. Available at: https://humanfuture.net/sites/default/files/CHF_Roundtable_Report_March_2020.pdf

[210] McKinsey & Company (2015), *Pursuing the global opportunity in food and agribusiness*. Available at: https://www.mckinsey.com/~/media/McKinsey/Industries/Chemicals/Our%20Insights/Pursuing%20the%20global%20opportunity%20in%20food%20and%20agribusiness/Pursuing%20the%20global%20opportunity%20in%20food%20and%20agribusiness.pdf

[211] L.E.K. (2017), *Nine Trends Transforming the Agribusiness Industry*. Available at: https://www.lek.com/sites/default/files/insights/pdf-attachments/1962_Agribusniess_Trends_LEK_Executive_Insights.pdf

[212] BSDC (2017), *Valuing the SDG prize in food*. Available at: https://s3.amazonaws.com/aws-bsdc/Valuing-SDG-Food-Ag-Prize-Paper.pdf

[213] World Resources Institute (2019), *Creating a Sustainable Food Future: A Menu of Solutions to Feed Nearly 10 Billion People by 2050*. Available at: https://research.wri.org/sites/default/files/2019-07/WRR_Food_Full_Report_0.pdf

[214] The Food and Land Use Coalition (2019*), Growing Better: Ten critical transitions to transform food and land use*. Available at: https://www.foodandlandusecoalition.org/wp-content/uploads/2019/09/FOLU-GrowingBetter-GlobalReport.pdf

Healthy diets from sustainable food systems: Food Planet Health – This report seeks to develop global scientific targets for the food system to achieve planetary health diets by 2050.[215]

Farmer 4.0: How the coming skills revolution can transform agriculture – This report highlights sector trends and explores how agriculture could be enhanced with the right mix of skills, capital and technology.[216]

New Nature Economy Report II – This report identifies biodiversity threats and sizes business opportunities such as organic food and beverages as well as sustainable inputs.[217]

Relevant Australia-specific reports

2030 Roadmap: Australian Agriculture's Plan for a $100 Billion Industry – This report introduces the target of exceeding A$100 billion in farm gate output by 2030 for Australia.[218]

Food and Agribusiness: A roadmap for unlocking value-adding growth opportunities for Australia – This report analyses the opportunities for growth and enablers needed for Australia's food and agribusiness sector.[219] Examples include personalised nutrition and waste conversion.

Growth opportunities for Australian food and agribusiness: Economic analysis and market sizing – This report builds on findings from the roadmap by providing an outlook on the market size of the growth opportunities.[220]

Agriculture – A $100b sector by 2030? – This report re-examines the A$100 billion target established, introduces a baseline projection of A$84 billion and investigates opportunities and barriers that impact agriculture's ability to exceed this projection.[221]

Connecting Australia: Future of Farming – This report analyses how accelerated adoption of emerging technologies, enabled by the National Broadband Network (nbn), could add close to A$16 billion to the agriculture sector's gross value of production by 2030.[222]

Relevant COVID-19 related reports

Maintaining food resilience in a time of uncertainty – This report seeks to understand the importance of food value chains and how to ensure their resilience during the COVID-19 crisis.[223]

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[215] EAT-Lancet Commission (2019), *Healthy diets from sustainable food systems: Food Planet Health*. Available at: https://eatforum.org/content/uploads/2019/01/EAT-Lancet_Commission_Summary_Report.pdf

[216] Royal Bank of Canada (2019), *Farmer 4.0: How the coming skills revolution can transform agriculture*. Available at: http://www.rbc.com/economics/economic-reports/pdf/other-reports/Farmer4_aug2019.pdf

[217] World Economic Forum (2020), *New Nature Economy Report II: The Future of Nature and Business*. Available at: http://www3.weforum.org/docs/WEF_The_Future_Of_Nature_And_Business_2020.pdf

[218] National Farmers Federation (2016), *2030 Roadmap: Australian Agriculture's Plan for a $100 Billion Industry*. Available at: https://nff.org.au/wp-content/uploads/2020/02/NFF_Roadmap_2030_FINAL.pdf

[219] Commonwealth Scientific and Industrial Research Organisation (2017), *Food and Agribusiness: A roadmap for unlocking value-adding growth opportunities for Australia*. Available at: https://www.csiro.au/en/Do-business/Futures/Reports/Ag-and-Food/Food-and-Agribusiness-Roadmap

[220] Commonwealth Scientific and Industrial Research Organisation (2019), *Growth opportunities for Australian food and agribusiness*. Available at: https://www.csiro.au/en/Do-business/Futures/Reports/Ag-and-Food/Opportunities-for-Food-and-Agribusiness

[221] ACIL Allen Consulting and AgriFutures Australia (2019), *Agriculture– A $100b sector by 2030?* Available at: https://www.agrifutures.com.au/product/agriculture-a-100b-sector-by-2030/

[222] National Broadband Network (2020), Connecting Australia: Future of Farming. Available at: https://www.nbnco.com.au/content/dam/nbnco2/2020/documents/media-centre/nbn-connecting-australia-agriculture.pdf

[223] Food Industry Asia (2020), *Maintaining food resilience in a time of uncertainty*. Available at: https://foodindustry.asia/documentdownload.axd?documentresourceid=32471

COVID-19 and impact on agriculture and food security – This report highlights the impact of COVID-19 and measures taken by different countries to support agricultural businesses and short-term social protection measures.[224]

The priority opportunities were selected based on three filtering criteria:

1) **Relevance**: Relevance to Food Innovation Australia Ltd (FIAL) and its members. This was based on these opportunities being relevant for the four priority R&D areas identified in the FIAL Sector Competitiveness Plan. Specifically, the opportunities must relate to the production, distribution or consumption of food (for humans or animals).
2) **Significance**: Potential size of opportunity by 2030 for the Australian food and agribusiness sector.
3) **Comparability**: The opportunities should be mutually exclusive (do not overlap with each other) and able to be sized in economic terms.

[224] International Labour Organisation (2020), *COVID-19 and impact on agriculture and food security*. Available at: https://www.ilo.org/sector/Resources/publications/WCMS_742023/lang--en/index.htm

Appendix B: Methodology for sizing the opportunities

The opportunities have been sized using three methodologies.

- **Economic opportunity** – The value, benefit or income from providing a good or service that could be unlocked or tapped if businesses seized available opportunities. It can include the total cost savings and market revenues associated with the opportunities. This sizing will be greater than the value added opportunity as it accounts for all the inputs to generate the good or service from all stages of production. It is generally not comparable to the Gross Domestic Product (GDP) or Gross Value Added (GVA) of the sectors but can be compared with the sales and service income. This is the same approach used in FIAL 2017 "Size of the prize" analysis. A low-end and high-end range has been included for most opportunities.
- **Value added opportunity** – The difference between the price of product or service and the cost of producing it, focusing on the value added component rather than just total value, benefit or income. This approach adjusts the estimates in the economic opportunity to only consider the value added share which is the amount by which the value of a good or service is increased at each stage of its production, exclusive of initial costs. This allows the opportunities to be compared to Australia's GDP (i.e. considering only the incremental values of the activities) and sectors' GVA. This will be a smaller number than the economic opportunity estimate but will only impact "consumption-driven" opportunities (e.g., fresh food sales under health and wellness), rather than "production-driven" opportunities (e.g., soil, water and land management).
- **Expenditure based approach**[225] – this approach considers the total economic impact, taking account of expenditure multipliers (e.g., direct, indirect and induced impacts). This number will be higher than the economic opportunity and value-added components.

ECONOMIC OPPORTUNITY

The business opportunity figures presented in this report are estimates of the annual savings or the revenue upside generated by the major opportunities related to food and agribusiness in 2030, expressed in 2019 Australian dollars and rounded to the nearest A$1 billion. The estimates do not include pricing of externalities, such as natural ecosystem services or adjustment for resource subsidies. As such, these are potentially conservative estimates of the total value of the opportunities.
We used a top-down approach to estimate the size of the 19 prioritised food and agribusiness opportunities for Australia in 2030. We first estimated the global size of the opportunity before calculating Australia's value share (*top-down estimates*). Wherever possible, we also estimated Australia-specific results with the help of external country-specific research (*bottom-up estimates*). In most cases, the higher estimates were reported.
For opportunities that have an export component (mainly the "consumption-driven" opportunities), we also sized the export value in addition to the domestic value. For some opportunities (focusing on production), export opportunities were not analysed as it was difficult to distinguish value from domestic

[225] This is also referred to as the "Output multiplier approach". The output multiplier for an industry is defined as the total value of production by all industries of the economy required to satisfy one extra dollar's worth of final demand for that industry's output. For instance, an increase in sales of fresh food creates direct impact on food retailers, then indirect impact through suppliers, and an induced impact through expenditure of workers in those sectors. The analysis uses the latest statistics (2017-2018) from Australian Bureau of Statistics (ABS).

consumption and export. To reflect the impact of the COVID-19 pandemic, "consumption-driven" estimates have been revised to incorporate the impact of the crisis on GDP growth in 2020 and 2021 as forecast by the International Monetary Fund.[226]

It is important to note the following aspects for the opportunities:

- ***Our estimates reflect the potential addressable opportunity, not its actual current value***. The results of our analysis are estimates based on a variety of sources and assumptions. They measure how much value could be unlocked if Australian businesses fully seized the available opportunities. Data challenges prevent us from calculating the actual amount of value that Australian businesses may already be realising.
- ***Some opportunities may overlap***. We have worked to our best effort to ensure all opportunities are mutually exclusive. However, as some opportunities focus on end markets, others on production or supply chain elements, a full separation of value sources has proved impossible and some overlap remains. To ensure minimal overlaps, when the total size of opportunities is calculated, three opportunities ("Urban agriculture", "Protected cropping" and "Direct to consumer model") have been removed.

VALUE-ADDED SIZING APPROACH

Value-added is the difference between the price of product or service and the cost of producing it. The price is determined by what customers are willing to pay based on their perceived value. Value is added or created in different ways. This approach adjusts the estimates in the economic opportunity sizing to only consider the value-added share of the specific industry. This allows the opportunities to be compared to Australia's Gross Domestic Product (i.e. considering only the incremental values of the activities). This will be a smaller number than the economic opportunity estimate, but will only impact "consumption-driven" opportunities (e.g., fresh food sales under health and wellness), rather than "production-driven" opportunities (e.g., soil, water and land management).

Approach

- **Step 1:** Obtain the relevant input output tables and industry statistics (e.g., Gross Value Added, total output) from the Australian Bureau of Statistics (ABS). The latest is based on the 2017-2018 data.[227]
- **Step 2:** Identify "production-driven" opportunities. There are 11 opportunities and we will assume that their entire economic estimates can be treated as their value added. The 11 opportunities are "Food safety", "Sustainable inputs", "Soil, water and land management", "Energy smart food", "Animal feed and health", "Precision agriculture and big data", "Sustainable packaging", "Advanced breeding and fertilisation", "Technology in smallholder farms", "Protected cropping" and "Supply chain transformation".

[226] Prior to the COVID-19 pandemic, the International Monetary Fund (IMF) forecasted global growth of 3.3 per cent in 2020 and 3 per cent in 2021. It has now forecasted the global economy to shrink by 3 per cent in 2020 and grow by 5.8 per cent in 2021. The average global growth rates over the next two years are now 41 per cent of the predicted growth rates that were forecasted previously. This adjustment is made to the growth rates of "consumption-driven" opportunities (e.g., functional foods) for the next two years, and then it is assumed the pre-COVID estimates of growth return. For further details, see International Monetary Fund (2020), The Great Lockdown: Worst Economic Downturn Since the Great Depression.

[227] Australian Bureau of Statistics (2020), 227 5209.0.55.001 - *Australian National Accounts: Input-Output Tables, 2017-18*.

- **Step 3:** For the remaining 8 “consumption-driven” opportunities, we assume that “Retail” will be the starting point, accounting for consumer demand. The Gross Value Added to total output ratio for “Retail” is taken. The 8 opportunities are “Health and wellness”, “Targeted eating”, “Plant-based and alternative proteins”, “Traditional proteins (meat, egg and dairy), “Urban agriculture”, “Sustainable fisheries”, “Food loss and waste” and “Direct to consumer model”.
- **Step 4:** As Food and Agribusiness cuts across many other industries such as “Wholesale”, “Manufacturing” and “Road transport” along the entire value chain, we will obtain the relative shares of the food- and agribusiness-related components of these other industries These shares will be added to the figure obtained in Step 3.
- **Step 5:** The estimated Gross Value Added to total output (adjusted for the cross-cutting nature of Food and Agribusiness) ratios are applied to the economic opportunity sizings.

EXPENDITURE BASED APPROACH

Expenditure based approach, also referred to as the “Output multiplier approach”, considers the total economic impact, taking account of expenditure multipliers (e.g., direct, indirect and induced impacts). The output multiplier for an industry is defined as the total value of production by all industries of the economy required to satisfy one extra dollar's worth of final demand for that industry's output. For instance, an increase in sales of fresh food creates a direct impact on food and agribusiness, then indirect impact through suppliers, and an induced impact through the expenditure of workers in those sectors. Exhibit B1 summarises how the multiplier works.

The analysis uses the latest input output statistics (2017-2018) from the Australian Bureau of Statistics (ABS).[228] For opportunities that are sized as cost savings (e.g., food safety) in Appendix C, the multipliers are not applied as the process will involve assumptions on the transfer of output from one industry to another as well as pricings for externalities (which can be subjective).

[228] Australian Bureau of Statistics (2020), 228 5209.0.55.001 - *Australian National Accounts: Input-Output Tables, 2017-18*.

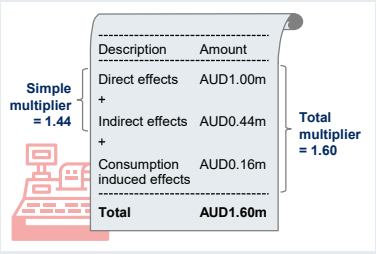
EXHIBIT B1

Overview of the output multiplier

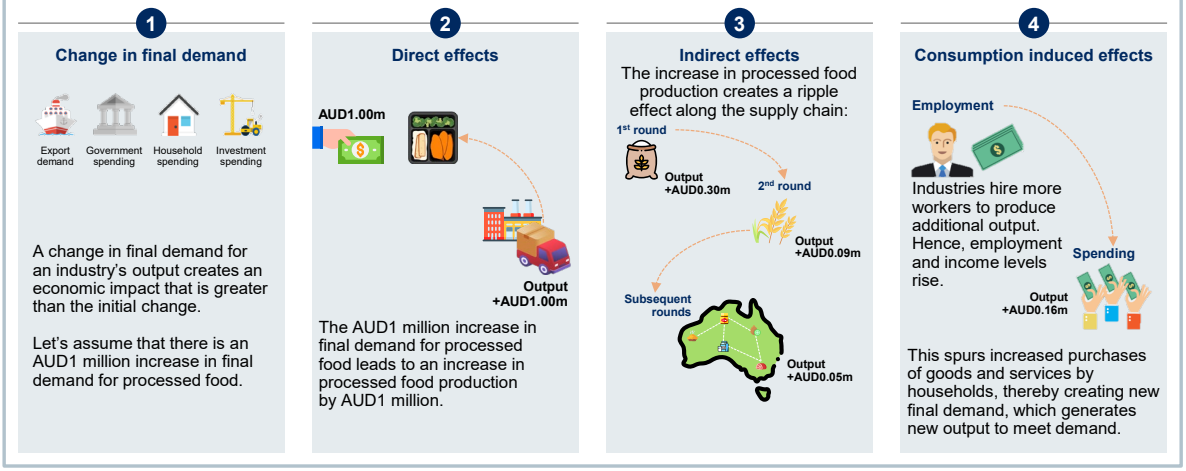
ILLUSTRATIVE NUMBERS

What is it?

- The output multiplier represents the total output produced by all industries in response to a dollar increase in final demand for an industry's output. There are two types of output multipliers: i) simple ii) total.
- The simple output multiplier consists of the direct and indirect effects, while the total output multiplier includes the consumption induced effects.
- Using the food industry as an illustration, an initial AUD1 million increase in final demand will increase output in the economy by AUD1.44 million. If consumption induced effects are included, output will increase by AUD1.60 million.



How does it work?



Approach

- **Step 1:** Obtain the relevant input output tables and industry statistics from the Australian Bureau of Statistics (ABS). The latest is based on the 2017-2018 data.
- **Step 2:** Calculate the Type I multiplier and Type II multiplier (considering compensation of employees and final consumption expenditure).
- **Step 3:** Distinguish how the opportunities are seized (e.g., sales, revenues, cost savings). For opportunities that are sized as cost savings (e.g., food safety), the multipliers are not applied as the process will involve assumptions on the transfer of output from one industry to another as well as pricings for externalities (which can be subjective).
- **Step 4:** For the remaining opportunities (e.g., revenue-oriented ones), the relevant industry Type I and Type II multipliers are applied to the opportunities. When there are several relevant industry multipliers, a simple average is taken. For instance, health and wellness will be linked to industries such as "Retail", "Wholesale" and "Fruit and vegetable product manufacturing". The average of the output multipliers for these industries is calculated and applied to the economic sizing for health and wellness.

Appendix C: Specific assumptions used for sizing each opportunity

Description	***Assumptions***	***Sources***
THE FUTURE CONSUMER		
Opportunity 1: Health and wellness		
Catering for the growing number of health-conscious consumers, for example with • high-quality fresh food (specifically vegetables and fruits) • organic food • "free from" food	**Top-down estimate:** To calculate the size of this opportunity, we analysed three market components: 1) *Fresh vegetables and fruits.* Market opportunity related to fresh vegetables and fruits in 2030. PR Newswire provides an estimate for global fresh food sales in 2019.[229] We used Euromonitor's estimate of a 2.5 per cent CAGR to forecast the market's future value.[230] To obtain the share for fresh vegetables and fruits, we used FAO global statistics for new food balances in 2017 (latest available information). 2) *Organic food.* Market opportunity related to organic food in 2030. Research by The World of Organic Agriculture provides data on the current global sales of organic foods and estimated a CAGR of 8.1 per cent, which we used to calculate the market's future value.[231] 3) *"Free from" food*. Market opportunity related to "free from" food in 2030. MarketsandMarkets estimated that the global sales of gluten-free food in 2015 was US$5 billion.[232] Euromonitor provides data on the global sales of gluten-free food and estimates the share of gluten-free sales to be 28 per cent of all food intolerance products. We used these data to determine the market component's overall size	• PR Newswire • Euromonitor • Food and Agriculture Organisation of the United Nations (FAO) • FIBL & IFOAM – Organics International • MarketsandMarkets • Euromonitor • American Journal of Experimental Agriculture

[229] PR Newswire (2015), *Global Fresh Food Market*. Available at: https://www.prnewswire.com/news-releases/global-fresh-food-market-2015-2019-300197995.html

[230] Euromonitor International (2016), *2015 Fresh Food Data: What is it Telling Us.* Available at: https://blog.euromonitor.com/2015-fresh-food-data-update/

[231] FIBL & IFOAM Organics International (2016), *The World of Organic Agriculture*. Available at: https://orgprints.org/31151/1/willer-lernoud-2016-world-of-organic.pdf

[232] MarketsandMarkets (2015), "Global gluten-free food market size from 2013 to 2020".

	(including other "free from" foods). A study in the American Journal of Experimental Agriculture estimates a CAGR of 10 per cent in the gluten-free product market, which we used as the proxy for our future value calculations.[233]	
	To size the value of the opportunity in Australia, we applied Australia's share of global organic sales in 2018 (1.3 per cent) to the global estimates of the three components. [234] Australia's shares of the other components were not readily available. As the global estimates include production for domestic consumption only (do not include exports), we also added Australia's export share, using the Department of Foreign Affairs (DFAT) and Australian Bureau of Statistics (ABS) data on the shares of fresh vegetables and fruits produced and exported.[235]	• FIBL & IFOAM – Organics International • Department of Foreign Affairs and Trade (DFAT) • Australian Bureau of Statistics (ABS)
	Bottom-up estimate: We compared our top-down results using the CSIRO report, which estimates the value of Australia's market for "free from" and natural foods to be A$4.2 billion in 2030 (including exports and before COVID-19 adjustments).[236] In addition to this calculation, we used data from a Roy Morgan research report, which valued Australia's fresh vegetables and fruits market at A$18 million in 2017.[237] The same growth rate as that of "free from" and natural food was used to forecast the 2030 values, and the domestic to export share from DFAT / ABS was used to determine the export values.	• Commonwealth Scientific and Industrial Research Organisation (CSIRO) • Roy Morgan

233 Jolly Masih and Amita Sharma (2016), *Study on Consumer Behaviour and Economic Advancements of Gluten-free Products.* Available at: https://www.researchgate.net/publication/299653853_Study_on_Consumer_Behaviour_and_Economic_Advancements_of_Gluten-free_Products

234 FIBL (2020), *Organic retail sales. Available at:* https://statistics.fibl.org/world/retail-sales-world.html?tx_statisticdata_pi1%5Bcontroller%5D=Element2Item&cHash=35a0fcd89ae099d2ff14fe1ddb38a1aa

235 Department of Foreign Affairs and Trade (2019), *State / Territory's Merchandise Exports and Imports.* Available at: https://www.dfat.gov.au/sites/default/files/australia-state-territory-2018-19.pdf; Australian Bureau of Statistics (2020), *Value of Agricultural Commodities Produced, Australia, 2018-19.* Available at: https://www.abs.gov.au/ausstats/abs@.nsf/mf/7503.0

236 Commonwealth Scientific and Industrial Research Organisation (2019), *Growth opportunities for Australian food and agribusiness*. Available at: https://www.csiro.au/en/Do-business/Futures/Reports/Ag-and-Food/Opportunities-for-Food-and-Agribusiness

237 Roy Morgan (2018), "$40b+ fresh food market dominated by fresh fruit & vegetables and fresh meat." Available at: https://www.roymorgan.com/findings/7568-40bplus-fresh-food-market-dominated-by-fruit-veg-meat-201804200630; Roy Morgan (2018), "Coles and Woolworths continue to gain share in fresh fruit and vegetable market." Available at: http://www.roymorgan.com/findings/7597-coles-and-woolworths-continue-to-gain-share-in-fresh-fruit-and-vegetable-market-201805220618

	As these are "consumption-driven" opportunities, we accounted for the impacts of the COVID-19 pandemic. **Values from the top-down and bottom-up approaches**: 1) Top-down – A$38 billion 2) Bottom-up – A$61 billion	
Opportunity 2: Targeted eating		
Opportunities related to product reformulation, such as • food with reduced fat and sugar content • functional foods • fortified food with higher nutrient value	**Top-down estimate:** We estimated the size of opportunities to create healthier types of food by analysing the following three market components: 1) *Product reformulation.* Market opportunity related to reformulated foods in 2030. We used research by Sustainable Asset Management (SAM) AG to identify the current size of the reformulated global food market and estimated its future value using the report's estimated CAGR of 3-6 per cent.[238] 2) *Functional food.* Market opportunity related to functional food in 2030. Grandview Research provides an estimate of the market value for functional foods, and we used its forecast CAGR of 7.6 per cent to estimate the market's future value.[239] 3) *Food fortification.* Market opportunity related to fortified food in 2030. Research Nester provides an estimate of this market component's size. We used its proposed CAGR of 10.5 per cent to forecast the industry's future value.[240] To determine Australia's share in the product reformulation and functional food market components, we broke the existing data down to reflect the share of people	• Sustainable Asset Management (SAM) AG • Grandview Research • Research Nester

238 Sustainable Asset Management AG (2012), *Healthy Living: Obesity – A Heavy Burden*. Available at: https://docplayer.net/27548858-Healthy-living-obesity-a-heavy-burden.html

239 Grandview Research (2016), "Functional Foods Market Analysis by Product." Available at: https://www.grandviewresearch.com/industry-analysis/functional-food-market

240 Research Nester (2010), *Fortified food market global demand analysis opportunity outlook 2021*. Available at: https://www.researchnester.com/reports/fortified-food-market-global-demand-analysis-opportunity-outlook-2021/53

	in the global consuming class (according to OECD definitions) in 2030. The reason was our assumption that opportunities around reformulated food would be more relevant in higher-income regions.[241] We used regional GDP forecasts for the Asia-Pacific in 2030 to estimate Australia's market share (1.4 per cent) and multiplied it by the global value figures to derive a national value estimate. As the global estimates include production for domestic consumption only (i.e. they do not include exports), we added Australia's export share using a CSIRO report showing the shares of exported and domestically consumed fortified and functional foods.[242] **Bottom-up estimate:** We validated our top-down results with the data from CSIRO, which forecasts the value of Australia's functional foods market to be A$8.3 billion in 2030 (including exports and before COVID-19 adjustments).[243] As these are "consumption-driven" opportunities, we accounted for the impacts of the COVID-19 pandemic. **Values from the top-down and bottom-up approaches**: 1) Top-down – A$28 billion 2) Bottom-up – A$15 billion	• Organisation for Economic Co-operation and Development (OECD) • International Monetary Fund (IMF) • Commonwealth Scientific and Industrial Research Organisation (CSIRO) • Commonwealth Scientific and Industrial Research Organisation (CSIRO)
Opportunity 3: Plant-based and alternative proteins		
Market opportunity related to alternative meat and fish (including	**Top-down estimate:** We estimated the size of opportunities by analysing the following four market components:	

241 OECD Development Centre (2010), *The Emerging Middle Class in Developing Countries*. Available at: https://www.oecd-ilibrary.org/development/the-emerging-middle-class-in-developing-countries_5kmmp8lncrns-en

242 Commonwealth Scientific and Industrial Research Organisation (2019), *Growth opportunities for Australian food and agribusiness*. Available at: https://www.csiro.au/en/Do-business/Futures/Reports/Ag-and-Food/Opportunities-for-Food-and-Agribusiness

243 Commonwealth Scientific and Industrial Research Organisation (2019), *Growth opportunities for Australian food and agribusiness*. Available at: https://www.csiro.au/en/Do-business/Futures/Reports/Ag-and-Food/Opportunities-for-Food-and-Agribusiness

plant-based, microbial, hybrid and cell-based), edible insect proteins, alternative dairy products as well as nuts and seeds	1. *Alternative meat and fish market, including blends*. Market opportunity related to alternative meat and fish. There are two estimates for this component. Allied Market Research estimated that the global meat substitutes market was worth US$4.2 billion in 2017, growing at a CAGR of 7.7 per cent through 2030.[244] This forecast assumes current levels of R&D spending and consumer interest. Barclays estimated that the alternative meats could capture up to 10 per cent of the US$1.4 trillion global meat market in 2030.[245] This forecast is contingent on a range of levers being pulled to scale R&D, rapidly reduce production costs, increase the availability of protein feedstocks, and increase consumer product differentiation across geographies. *Plant-based dairy alternatives market*. Market opportunity for alternative dairy products, including milk, yoghurts, butter, etc. There are two estimates for this component. From Grand View Research, the market size of US$14 billion in 2018 grows at the same CAGR of 4.3 per cent as the overall dairy products market through 2030 (from Statista) – creating a US$23 billion market.[246] If the market would grow at a faster pace, the market size of US$14 billion in 2018 grows at an accelerated CAGR of 17 per cent through 2030 creating a US$90 billion market.[247] *Edible insect protein market*. Market opportunity related to edible insect proteins. Research and Markets estimated that the edible insect protein	• Allied Market Research • Barclays • Grand View Research • Statista

244 Allied Market Research (2019), "Global Meat Substitute Market to Garner $7.55 Billion by 2025 at 7.7% CAGR, Says Allied Market Research." Available at: https://www.globenewswire.com/news-release/2019/04/17/1805404/0/en/Global-Meat-Substitute-Market-to-Garner-7-55-Billion-by-2025-at-7-7-CAGR-Says-Allied-Market-Research.html

245 Barclays (2019), *I can't believe it's not meat*.

246 Grand View Research (2019), *Dairy Alternatives Market 2019-2025, Grand View Research, 2019 and Milk products – Worldwide overview*. Available at: https://www.grandviewresearch.com/industry-analysis/dairy-alternatives-market

247 Grand View Research (2019), *Dairy Alternatives Market 2019-2025, Grand View Research, 2019 and Milk products – Worldwide overview*. Available at: https://www.grandviewresearch.com/industry-analysis/dairy-alternatives-market

	market was US$0.4 billion in 2019.[248] We used the forecast CAGR of 24.4 per cent from a report by the Food and Land Use Coalition (FOLU) to estimate the market's future value.[249]	• Research and Markets • Food and Land Use Coalition (FOLU)
	Nuts and seeds market. Market opportunity for nuts and seeds required to be consumed according to reference intakes. There are two estimates for this component. The global edible nuts market was estimated to be worth US$89 billion in 2018 and is expected to grow by 3.5 per cent through 2030 to reach a market value of US$129 billion.[250] The global seeds market (proxied by taking sunflower seeds and chia seeds – the two largest edible seed markets) was estimated to be worth US$15 billion in 2018 and is expected to grow by 6.2 per cent through 2030 to reach a market value of US$19 billion.[251] Therefore, the total global nuts and seeds market is expected to be US$148 billion in 2030. The EAT-Lancet Commission estimates that global reference dietary intake of nuts and seeds is 10 per cent of recommended consumption.[252] For this opportunity, it is conservatively assumed that global reference intakes in 2030 will match the best-in-class region – North America (20 per cent). As a result of this additional growth, the global nuts and seeds market will be worth approximately US$209 billion in 2030.	• Zion Market Research • Hexa Research • Grand View Research • EAT-Lancet Commission
	These opportunities exclude fresh vegetables and fruits. To size the value of the opportunity in Australia, we	• Food and Agriculture

248 Research and Markets (2019), *Edible Insects Market by Product Type (Whole Insect, Insect Powder, Insect Meal, Insect Type (Crickets, Black Soldier Fly, Mealworms), Application (Animal Feed, Protein Bar and Shakes, Bakery, Confectionery, Beverages) - Global Forecast to 2030.* Available at: https://www.researchandmarkets.com/reports/4757400/edible-insects-market-by-product-type-whole

249 The Food and Land Use Coalition,(2019), *Growing Better: Ten Critical Transitions to Transform Food and Land Use*. Available at: https://www.foodandlandusecoalition.org/wp-content/uploads/2019/09/FOLU-GrowingBetter-GlobalReport.pdf

250 Zion Market Research (2019), *Global Edible Nuts Market Will Reach Around US$ 92.1 Billion by 2026: Zion Market Research*. Available at: https://www.zionmarketresearch.com/news/edible-nuts-market

251 Hexa Research (2019), *Sunflower Seeds Market Size And Forecast, By Application (Edible Oil, Bakery Products, Snacks), By Distribution Channel (Offline, Online), By Region, And Trend Analysis, 2019 – 2025*. Available at: https://www.hexaresearch.com/research-report/sunflower-seeds-market; Hexa Research (2019), *Chia Seeds Market Size, Share & Trends Analysis Report By Form (Oil, Milled/Ground, Whole, Pre-hydrated), By Type (Black, Brown, White), By Region (North America, APAC, Europe, MEA), And Segment Forecasts, 2019 – 2025*. Available at: https://www.grandviewresearch.com/industry-analysis/chia-seeds-market

252 The Lancet Commissions (2019), *Food in the Anthropocene: the EAT-Lancet Commission on healthy diets from sustainable food systems.* Available at: https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(18)31788-4/fulltext

	applied Australia's share of global protein consumption (0.4 per cent) to the global estimates. As the global estimates include production for domestic consumption only (do not include exports), we added Australia's export share using a CSIRO report showing the shares of exported and domestically consumed alternative proteins.[253] **Bottom-up estimate:** We complemented our top-down results with the data from CSIRO, which forecasts the value of Australia's alternative proteins market to be A$6.6 billion in 2030 (including exports and before COVID-19 adjustments).[254] This value also excludes environmental savings. As these are "consumption-driven" opportunities, we accounted for the impacts of the COVID-19 pandemic. **Values from the top-down and bottom-up approaches**: 1) Top-down – A$3 billion 2) Bottom-up – A$7 billion	• Organisation of the United Nations (FAO) • Commonwealth Scientific and Industrial Research Organisation (CSIRO) • Commonwealth Scientific and Industrial Research Organisation (CSIRO)
Opportunity 4: Traditional proteins (meat, egg and dairy)		
Market opportunity related to traditional proteins such as meat, egg and dairy	**Top-down estimate:** Research and Markets estimates that the global meat market is worth US$1.1 trillion in 2023.[255] We used the reported CAGR of 4 per cent to project the 2030 value. In addition, Statista estimates that the global revenues of dairy products and eggs to be US$814 billion in 2020 with a future CAGR of 3.4 per cent.[256]	• Research and Markets • Statista • Food and Agriculture Organisation of the United Nations (FAO) • Statista

253 Commonwealth Scientific and Industrial Research Organisation (2019), *Growth opportunities for Australian food and agribusiness*. Available at: https://www.csiro.au/en/Do-business/Futures/Reports/Ag-and-Food/Opportunities-for-Food-and-Agribusiness

254 Commonwealth Scientific and Industrial Research Organisation (2019), *Growth opportunities for Australian food and agribusiness*. Available at: https://www.csiro.au/en/Do-business/Futures/Reports/Ag-and-Food/Opportunities-for-Food-and-Agribusiness

255 Research and Markets (2019), *Global Meat Sector Market Analysis & Forecast Report, 2019 - A $1.14 Trillion Industry Opportunity by 2023.* Available at: https://www.globenewswire.com/news-release/2019/05/02/1815144/0/en/Global-Meat-Sector-Market-Analysis-Forecast-Report-2019-A-1-14-Trillion-Industry-Opportunity-by-2023.html

256 Statista (2020), "Dairy Products & Eggs"

	To size the value of the opportunity in Australia, we applied Australia's share of global meat production (1.4 per cent from FAO) and global dairy product and egg revenue (1.3 per cent from Statista) to the global estimates.[257] We used trade and production statistics from the DFAT as well as ABS to determine the export ratios.[258] **Bottom-up estimate:** We used the gross value of agricultural commodities produced of three market components: Meat (beef, mutton, pork, poultry and other meats), egg and dairy from ABS data.[259] This data contains the sum of the market values for fresh, factory inputs and exports. Using the historical CAGRs from 2008-09 and 2018-19, we projected the value of production to 2030. Subsequently, we used trade statistics from DFAT to determine export opportunities.[260] As these are "consumption-driven" opportunities, we accounted for the impacts of the COVID-19 pandemic. **Values from the top-down and bottom-up approaches**: 1) Top-down – A$53 billion 2) Bottom-up – A$42 billion	• Department of Foreign Affairs and Trade (DFAT) • Australian Bureau of Statistics (ABS) • Australian Bureau of Statistics (ABS) • Department of Foreign Affairs and Trade (DFAT)
FOOD SECURITY & SUSTAINABILITY		
Opportunity 5: Urban agriculture		
Opportunities to improve the scale and efficiency of food grown in urban environments, particularly in	**Top-down estimate:** Economic gains from income creation. Studies on the number of households that engage in urban farming, as well as the average income they derive from it, informed our global estimates on the	• Agronomy for Sustainable Development • Business & Sustainable Development Commission

257 Statista (2020), "Dairy Products & Eggs"

258 Department of Foreign Affairs and Trade (2019), *State / Territory's Merchandise Exports and Imports*. Available at: https://www.dfat.gov.au/sites/default/files/australia-state-territory-2018-19.pdf; Australian Bureau of Statistics (2020), *Value of Agricultural Commodities Produced, Australia, 2018-19.* Available at: https://www.abs.gov.au/ausstats/abs@.nsf/mf/7503.0

259 Australian Bureau of Statistics (2020), *Value of Agricultural Commodities Produced, Australia, 2018-19*. Available at: https://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/7503.02018-19?OpenDocument

260 Department of Foreign Affairs and Trade (2019), *State / Territory's Merchandise Exports and Imports*. Available at: https://www.dfat.gov.au/sites/default/files/australia-state-territory-2018-19.pdf

developing countries	income potential of urban agriculture.[261] We determined the current and future value using a World Health Organisation forecast of urban population growth at 1.84 per cent per year, as well as a World Bank estimate of global per-capita income growth of 1.5 per cent per annum. To determine the size of the opportunity for Australian businesses, we first calculated Australia's share of urban agriculture (1.4 per cent) by multiplying the global urban farming population and the share of urban agriculture in developed countries. The Australian market share was then multiplied with the global value estimates. We also accounted for the export value by using the DFAT and ABS data on the shares of fresh vegetables and fruits produced and exported.[262] **Bottom-up estimate**: We used research by a National High Technology Grant from China and Google to compare our global top-down findings.[263] We multiplied the share of Australia's agricultural production suitable for urban agriculture by the expected share of agricultural produce grown in urban environments.[264] This share is expected to be 40 per cent in 2030 (from 25 per cent in 2015). As these are "consumption-driven" opportunities, we accounted for the impacts of the COVID-19 pandemic. As there would be some overlaps with "Health and wellness", when all the opportunities were summed, we accounted for the overlap and took this estimate out.	(BSDC) ● World Health Organisation ● World Bank ● United Nations (UN) Population Division ● Department of Foreign Affairs and Trade (DFAT) ● Australian Bureau of Statistics (ABS) ● Research by a National High Technology Grant from China and Google ● Future Directions International

261 Orsini et al. (2014), *Urban agriculture in developing countries*. A review. Available at: https://www.researchgate.net/publication/257305405_Urban_agriculture_in_the_developing_world_A_review; BSDC (2017), *Valuing the SDG prize in food*. Available at: https://s3.amazonaws.com/aws-bsdc/Valuing-SDG-Food-Ag-Prize-Paper.pdf

262 Department of Foreign Affairs and Trade (2019), *State / Territory's Merchandise Exports and Imports*. Available at: https://www.dfat.gov.au/sites/default/files/australia-state-territory-2018-19.pdf; Australian Bureau of Statistics (2020), *Value of Agricultural Commodities Produced, Australia, 2018-19.* Available at: https://www.abs.gov.au/ausstats/abs@.nsf/mf/7503.0

263 Clinton et al (2018), *A Global Geospatial Ecosystem Services Estimate of Urban Agriculture*. Available at: https://agupubs.onlinelibrary.wiley.com/doi/full/10.1002/2017EF000536%0D

264 Future Directions International (2015), *Localising Food Production: Urban Agriculture in Australia*. Available at: http://www.futuredirections.org.au/publication/localising-food-production-urban-agriculture-in-australia/

	Values from the top-down and bottom-up approaches: 1) Top-down – A$5 billion 2) Bottom-up – A$4 billion	
Opportunity 6: Food fraud and safety		
Opportunities related to • food fraud and provenance • food safety testing	**Top-down estimate:** We estimated the size of opportunities combating food fraud for two market components: 1) *Food fraud.* Potential savings from reducing food fraud. We determined the value of this market component based on the potential opportunity rather than solutions to this challenge. We based our calculations on studies by the Grocery Manufacturers Association (GMA) and The Food Fraud Initiative that estimated the cost of global food fraud for 2010 and 2014.[265],[266] We then applied the annual growth rate in global food demand (estimated to be 1.5 per cent) to the global cost figures to forecast the opportunity's future value.[267] 2) *Food safety testing.* Market opportunity related to food safety diagnostic products. McKinsey has estimated the market for food safety diagnostic products, while MarketsandMarkets has estimated the global food safety testing market for 2016.[268] McKinsey forecasts this component to grow at 7.5 per cent per annum.[269] To determine the size of the opportunity for Australian businesses, we multiplied these global value estimates	• Grocery Manufacturers Association (GMA) • Pricewaterhouse Coopers (PwC) • Food and Agriculture Organisation of the United Nations (FAO) • McKinsey • MarketsandMarkets • Food and Agriculture Organisation of the United Nations (FAO)

265 Grocery Manufacturers Association (2010), *Consumer Product Fraud: Deterrence and Detection*. Available at: https://dokumen.tips/documents/consumer-product-fraud-deterrence-and-product-fraud-deterrence-and-detection.html

266 PwC (2015), *Food fraud vulnerability assessment Free online tool helps food companies fight fraud to protect consumers*. Available at: https://www.pwc.com/sg/en/industries/assets/food-fraud-vulnerability-assessment.pdf

267 FAO (2011), *Seeking end to loss and waste of food along production chain*. Available at: http://www.fao.org/in-action/seeking-end-to-loss-and-waste-of-food-along-production-chain/en/

268 MarketsandMarkets (2015), *Food Safety Testing Market worth $24.6 billion by 2023*. Available at: https://www.marketsandmarkets.com/PressReleases/food-safety-testing-market.asp

269 McKinsey & Companies (2015), *Pursuing the global opportunity in food and agribusiness*. Available at: https://www.mckinsey.com/industries/chemicals/our-insights/pursuing-the-global-opportunity-in-food-and-agribusiness

	with Australia's share of total global agricultural production (estimated at 0.9 per cent). **Bottom-up estimate:** A PwC Australia study on food fraud estimated that the food fraud cost to Australia is currently A$2-3 billion each year.[270] **Values from the top-down and bottom-up approaches**: 1) Top-down – A$1 billion 2) Bottom-up – A$6 billion	• Pricewaterhouse eCoopers (PwC)
Opportunity 7: Sustainable fisheries		
Opportunities around finding sustainable production techniques for aquaculture, wild fisheries and bivalve production	**Top-down estimate:** We estimated the size of opportunities for three market components: 1) *Aquaculture market*. Market opportunity from the demand for aquaculture products in 2030. We used the estimates from the World Bank Study and BSDC to determine the current and future value of this opportunity. The World Bank study reported the 2008 value of the global production of aquaculture (in million tonnes) and projected the 2030 value, implying a CAGR of 2.6 per cent.[271] Multiplying the forecasted production value (in million tonnes) by the average price per tonne of aquaculture as per the BSDC report, the market size in 2030 was determined.[272] We then used World Bank research to create a scenario for the future value of a more sustainable aquaculture industry, which assumes improved waste processing, feeding techniques and practices, based on the World Bank group.[273] 2) *Economic gains from sustainable fishing (wild fisheries management)*. Reduction of losses in	• World Bank Business & Sustainable Development Commission (BSDC) • World Bank • Food and Land Use Coalition

270 PwC Australia (2017), *How PwC's Food Trust Platform uses micro tag technology to protect Australian brands from food fraud*.
271 The World Bank Group (2013), *Fish to 2030: Prospects for Fisheries and Aquaculture*. Available at: http://www.fao.org/3/i3640e/i3640e.pdf
272 BSDC (2017), *Valuing the SDG prize in food*. Available at: https://s3.amazonaws.com/aws-bsdc/Valuing-SDG-Food-Ag-Prize-Paper.pdf
273 The World Bank Group (2013), *Fish to 2030: Prospects for Fisheries and Aquaculture*. Available at: http://www.fao.org/3/i3640e/i3640e.pdf

	wild fisheries by 2030 through sustainable fishing. Fishing continues at ecologically unsustainable levels, creating roughly US$83 billion of annual losses to the fishing industry (in 2012).[274] Based on the FOLU report, we obtained a CAGR of 6 per cent to estimate the future value. We assumed that restorative fishing and policy interventions result in 50 per cent of the value lost per year to unsustainable fisheries being recouped.[275]	(FOLU)
	3) *Bivalve market*. Market opportunity from the demand for bivalve molluscs and protection of estuary habitats. Allied Market Research estimated that the market size of bivalve was US$21 billion in 2018.[276] Growing at a CAGR of 3.6 per cent (based on estimated growth in the overall seafood market through 2030), this results in a US$31 billion market.[277] If the market was grown at an accelerated CAGR of 7.4 per cent through 2030, this results in a US$46 billion market. This accelerated growth is contingent on sustained demand and restoration of coastal wetland habitats for production. To determine the size of this opportunity for Australian businesses, we multiplied the global value figures by Australia's share of global fish production (estimated at 0.2 per cent).[278] We also accounted for the export value by using the DFAT and ABARES data on the shares of seafood produced and exported.[279]	• Allied Market Research • Food and Agriculture Organisation of the United Nations (FAO) • World Bank • Australian Bureau of Agricultural and Resource Economics and Science (ABARES) • Department of Foreign Affairs and Trade (DFAT)

274 World Bank (2017), *The Sunken Billions Revisited: Progress and Challenges in Global Marine Fisheries*. Available at: https://www.worldbank.org/en/topic/environment/brief/the-sunken-billions-revisited-progress-and-challenges-in-global-marine-fisheries

275 The Food and Land Use Coalition (2019), Growing Better: Ten critical transitions to transform food and land use. Available at: https://www.foodandlandusecoalition.org/wp-content/uploads/2019/09/FOLU-GrowingBetter-GlobalReport.pdf

276 Allied Market Research (2019), *Global seafood market to garner 155.32 billion by 2023 at 3.6 CAGR*. Available at: https://www.globenewswire.com/news-release/2019/09/17/1916759/0/en/Global-Seafood-Market-to-Garner-155-32-Billion-by-2023-at-3-6-CAGR-Says-Allied-Market-Research.html#:~:text=Portland%2C%20OR%2C%20Sept.,3.6%25%20from%202017%20to%202023.

277 FAO (2016), *The State of World Fisheries and Aquaculture 2016. Contributing to food security and nutrition for all*. Available at: http://www.fao.org/3/a-i5555e.pdf

278 The World Bank Group (2013), *Fish to 2030: Prospects for Fisheries and Aquaculture*. Available at: http://www.fao.org/3/i3640e/i3640e.pdf ; Australian Bureau of Agricultural and Resource Economics and Science (2020), *Australian fisheries and aquaculture production 2018*. Available at: https://www.agriculture.gov.au/abares/research-topics/fisheries/fisheries-and-aquaculture-statistics/production-2018

279 Department of Foreign Affairs and Trade (2019), *State / Territory's Merchandise Exports and Imports*. Available at: https://www.dfat.gov.au/sites/default/files/australia-state-territory-2018-19.pdf ; Australian Bureau of Agricultural and Resource Economics and

	Bottom-up estimate: We used various national sources to obtain bottom-up estimates. Australia's fisheries statistics provide estimates for the current and future values of Australian fisheries and aquaculture production. For instance, ABARES projects the gross value of production for fisheries and aquaculture to 2025.[280] We also accounted for the export value by using the DFAT and ABARES data on the shares of seafood produced and exported.[281] As these are "consumption-driven" opportunities, we accounted for the impacts of the COVID-19 pandemic. **Values from the top-down and bottom-up approaches**: 1) Top-down – A$1 billion 2) Bottom-up – A$5 billion	• Australian Bureau of Agricultural and Resource Economics and Science (ABARES) • Department of Foreign Affairs and Trade (DFAT)
Opportunity 8: Sustainable inputs		
Opportunities related to biopesticides, organic fertilisers and microbial fertilisers	**Top-down estimate:** We estimated the value of opportunities around sustainable inputs by focusing on the following three market components: 1) *Biopesticides*. Market opportunity related to biopesticides. We determined the global size of this market component using estimates from the Biopesticide Industry Alliance and MarketsandMarkets.[282], [283] We used a	• Biopesticide Industry Alliance

Science (2020), *Australian fisheries and aquaculture production 2018*. Available at: https://www.agriculture.gov.au/abares/research-topics/fisheries/fisheries-and-aquaculture-statistics/production-2018

280 Australian Bureau of Agricultural and Resource Economics and Science (2020), *Australian fisheries and aquaculture outlook 2020*. Available at: https://www.agriculture.gov.au/abares/research-topics/fisheries/fisheries-economics/fisheries-forecasts#:~:text=Outlook%20for%20Australian%20fisheries%20and%20aquaculture&text=Fisheries%20and%20aquaculture%20production%20value,2019%E2%80%9320%20to%20%242.81%20billion.&text=Production%20value%20is%20expected%20to%20rise%20by%2021%25%20in%202020,assumed%20normalisation%20of%20export%20markets.

281 Department of Foreign Affairs and Trade (2019), *State / Territory's Merchandise Exports and Imports*. Available at: https://www.dfat.gov.au/sites/default/files/australia-state-territory-2018-19.pdf ; Australian Bureau of Agricultural and Resource Economics and Science (2020), *Australian fisheries and aquaculture production 2018*. Available at: https://www.agriculture.gov.au/abares/research-topics/fisheries/fisheries-and-aquaculture-statistics/production-2018

282 Biopesticide Industry Alliance (2015), *Biopesticides: Some Industry Perspectives on Research and Demonstration*. Available at: https://ir4.rutgers.edu/Biopesticides/workshoppresentations/BPIA.pdf

283 MarketsandMarkets (2016), *Biopesticides Market worth $8.5 billion by 2025*. Available at: https://www.marketsandmarkets.com/PressReleases/biopesticide.asp

	MarketsandMarkets forecast of a 17.4 per cent growth rate per annum to estimate the global biopesticide market's future value.[284] 2) *Microbial fertilisers*. Market opportunity related to microbial fertilisers. We used estimates from McKinsey to determine this market's global size.[285] We then used McKinsey's forecast growth rate of 25 per cent to determine the global market's value by 2030.[286] 3) *Organic fertilisers*. Market opportunity related to organic fertilisers. We used estimates from a medGadget report to determine the global size of this market and applied an estimated growth rate of 13.3 per cent for future values.[287] To calculate the size of the opportunity for Australian businesses, we multiplied the global value estimates by Australia's share of global fertiliser production (estimated at 0.4 per cent in 2019). We also accounted for the export value by statistics from Fertiliser Australia on the shares of fertiliser produced and exported.[288] As these are "consumption-driven" opportunities, we accounted for the impacts of the COVID-19 pandemic. **Values from the top-down and bottom-up approaches**: 1) Top-down – A$1 billion 2) Bottom-up – NA	• MarketsandMarkets • McKinsey • medGadget • Food and Agriculture Organisation of the United Nations (FAO) • Fertiliser Australia

284 MarketsandMarkets (2016), *Biopesticides Market worth $8.5 billion by 2025*. Available at: https://www.marketsandmarkets.com/PressReleases/biopesticide.asp

285 McKinsey & Companies (2015), *Pursuing the global opportunity in food and agribusiness*. Available at: https://www.mckinsey.com/industries/chemicals/our-insights/pursuing-the-global-opportunity-in-food-and-agribusiness

286 McKinsey & Companies (2015), *Pursuing the global opportunity in food and agribusiness*. Available at: https://www.mckinsey.com/industries/chemicals/our-insights/pursuing-the-global-opportunity-in-food-and-agribusiness

287 medGadget (2016), *Biological organic fertilisers global market by microorganism, organic residue, application and geography*.

288 Fertiliser Australia (2020), "Australian Fertiliser Market". Available at: https://www.fertilizer.org.au/Fertilizer-Industry/Australian-Fertilizer-Market

Opportunity 9: Soil, water and land management		
Opportunities to improve soil health and the sustainability of farm practices, including rehabilitation of degraded land, cropland nutrient management, cover cropping, agroforestry, no-till / low-till agricultural methods, holistic grazing, biochar market, water trading and water saving techniques linked to drip irrigation and sprinklers	**Top-down estimate:** We used six components to determine the size of opportunities in Australia: 1) *Economic cost of land degradation.* Cost savings from restoring degraded land. This measure describes the loss in agricultural yield on degraded farmland (from FAO and MGI insights).[289, 290] We calculated the global cost of land degradation currently and then estimated the future cost in 2030 using FAO estimates on the hectares of farmland that degrade each year.[291] 2) *Sustainable agriculture and micro-irrigation estimates (including agro-forestry).* Capital cost for agroforestry and the value of water savings from a more efficient application of water in crop irrigation. We used the average per-hectare cost of capital employed to cultivate agricultural land, as well as estimates for water savings from using micro-irrigation systems to determine the impact of improved water efficiency in farming globally.[292,293,294] We considered the growth in global food demand, proxied by the increase in the rate of land use for agro-ecological purposes (1.5 per cent per annum historically) and the potential future impact of improved water efficiency measures, such as drip irrigation and sprinklers, to estimate this market component's value in 2030.[295] 3) *Cropland nutrient management*. Avoided nitrogen loading through reduced fertiliser use and improved application methods on croplands. A cost-based approach has been used to estimate the opportunity. It is assumed that there is the capture of benefits of avoided nitrogen emissions from better application of fertiliser valued at 0.635 $GtCO_2e$ per year through 2030 – all of which is achievable through "low-cost"	• Food and Agriculture Organisation of the United Nations (FAO) • McKinsey Global Institute (MGI) • SLM Partners • Tropical Forest Alliance (TFA) 2020 • Business & Sustainable Development Commission (BSDC) • Bronson Griscom et. al

289 Food and Agriculture Organisation (2015), *Status of the World's Soil Resources*. Available at: http://www.fao.org/3/i5199e/i5199e.pdf

290 McKinsey Global Institute (2011), *Resource Revolution: Meeting the world's energy, materials, food, and water needs*. Available at: https://www.mckinsey.com/business-functions/sustainability/our-insights/resource-revolution

291 Food and Agriculture Organisation (2015), *Status of the World's Soil Resources*. Available at: http://www.fao.org/3/i5199e/i5199e.pdf

292 J. Pretty & Z. Bharucha (2014), *Sustainable intensification in agricultural systems*. Available at: https://academic.oup.com/aob/article/114/8/1571/210078

293 Tropical Forest Alliance 2020 (2016), *Better Growth with Forests*. Available at: https://www.tropicalforestalliance.org/en/about-tfa/publications-and-annual-reports/

294 BSDC (2017), *Valuing the SDG prize in food*. Available at: https://s3.amazonaws.com/aws-bsdc/Valuing-SDG-Food-Ag-Prize-Paper.pdf

295 Estimates have been derived from case studies, interviews, and academic literature.

	pathways.[296] This primarily involves reducing the over-application of fertiliser (improving timing, placement, form of application, and improved efficiency in manure usage), which can be done without decreasing crop yields.	
	4) *Cover cropping*. Additional carbon sequestration by planting cover crops in post-harvest seasons. A cost-based approach has been used to estimate the opportunity. It is assumed that there is the capture of benefits from additional soil carbon sequestration by planting cover crops during the part of the year when the main crop is not growing valued at 0.372 $GtCO_2e$ per year through 2030 – 0.248 $GtCO_2e$ of this opportunity is available through "low-cost" pathways with the remainder being cost-effective.[297] Commonly referred to as conservation agriculture, this opportunity excludes land planted with perennial crops, climate systems requiring a fallow period, or benefits from no-till agriculture which have mixed impacts on nitrogen emissions.	• Bronson Griscom et. al
	5) *Biochar market*. Market opportunity related to biochar (the additional sequestration by amending agricultural soils with biochar). Grand View Research and Zion Research provides estimates for the global biochar market and CAGRs of 13 per cent and 15 per cent.[298]	• Grand View Research • Zion Research
	6) *Water trading*. Market opportunity related to water trading. We used estimates from Water Online to determine the global size of this market and applied an estimated growth rate of 4 per cent for future values.[299]	• Water Online
	To calculate the size of this opportunity for Australia, we multiplied our global results by Australia's latest estimated share of global agricultural production (0.9 per cent in 2017).	• Food and Agriculture Organisation of the United Nations (FAO)
	Bottom-up estimate: For component 6, we took the local	

296 Bronson Griscom et. al (2017), *Natural climate solutions*. Available at: https://www.pnas.org/content/pnas/early/2017/10/11/1710465114.full.pdf
297 Bronson Griscom et. al (2017), *Natural climate solutions*. Available at: https://www.pnas.org/content/pnas/early/2017/10/11/1710465114.full.pdf
298 Grand View Research (2019), *Biochar Market Size Worth $3.1 Billion By 2025*; Zion Research (2019), *Global Biochar Market Size Worth US$ 3.82 Billion By 2025*. Available at: https://www.zionmarketresearch.com/news/biochar-market
299 Water Online (2018), *Global Water Market To Reach $915B By 2023 As Oil And Commodity Prices Recover, New GWI Forecasts Reveal*.

	estimates for Australia. Reuters estimated that the Australian water trading market was A$3 billion in 2010.[300] In 2017-18, according to the Bureau of Meteorology (BOM), the total estimated turnover of the water market in Australia (entitlement and allocation trade) was A$2.4 billion.[301] We used a CAGR of 6 per cent to estimate future values. **Values from the top-down and bottom-up approaches**: 1) Top-down – A$17 billion 2) Bottom-up – A$7 billion	• Reuters • Bureau of Meteorology (BOM)
ENHANCED PRODUCTION AND VALUE ADDITION		
Opportunity 10: Food loss and waste		
Opportunities to reduce food loss and waste throughout the supply chain, as well as consumer waste, and to develop viable end products for this waste	**Top-down estimate:** Potential reduction in food loss and waste as well as market opportunity related to biogas. We calculated the size of the global market for solutions tackling food waste using current FAO estimates on the amount of food wasted globally and the amount that is diverted to landfill.[302],[303] We estimated the future value of the opportunity by considering the expected growth in demand for food (1.5 per cent per year, according to the FAO). In our calculations, we considered targets set by the UN's Sustainable Development Goals (SDG), the European Union (EU) and various initiatives such as YieldWise to reduce food waste by 50 per cent by 2030.[304] We also used MGI's lower-range estimate of a 30 per cent reduction in food waste to determine the opportunity's value in 2030. In addition, we also calculated the market opportunities for converting agricultural waste to biogas and composting. The market for agricultural waste to create biogas was estimated to be US$13 billion in 2018, and this is forecast to grow at the same rate of food demand	• Food and Agriculture Organisation of the United Nations (FAO) • Environmental Protection Agency (EPA) • Business Insider • McKinsey Global Institute (MGI) • Future Market Insights • Ellen MacArthur Foundation (EMF)

300 Reuters (2011), "Factbox: Water trading schemes around the world." Available at: https://www.reuters.com/article/us-water-trade/factbox-water-trading-schemes-around-the-world-idUSTRE7772GM20110808

301 Bureau of Meteorology (2019), *Water in Australia, 2017-18*. Available at: http://www.bom.gov.au/water/waterinaustralia/files/Water-in-Australia-2017-18.pdf

302 Food and Agriculture Organisation (2011), *Food Loss*. Available at: http://www.fao.org/nr/sustainability/food-loss-and-waste/en/

303 Environmental Protection Agency (2015), "Waste feature stories". Available at: https://www.epa.gov/pacific-southwest-media-center/converting-food-waste-renewable-energy

304 Business insider (2016), "An American initiative is investing $130 million in cutting food waste." Available at: https://www.businessinsider.com.au/yieldwise-initiative-aims-to-cut-food-waste-2016-1

	of 1.5 per cent through 2030 (more conservative estimate) and 6.5 per cent based on relevant reports.[305] The Ellen MacArthur Foundation (EMF) estimates that composting 230 million tonnes of inedible food between 2018- 2030 results in avoided costs of food waste disposal averaging US$127 per tonne.[306] We used composting rates estimated by reports from the World Resources Institute (WRI) and the Food and Land Use Coalition (FOLU) to determine the global value.[307] To gauge the value of the opportunity for Australian businesses, we multiplied the global value figures by Australia's share of global food waste (0.8 per cent). **Bottom-up estimate**: In this calculation, we used research by the Department of Environment and Energy that estimates the annual cost of food waste in Australia at A$20 billion (based on current recovery and recycling rates of 12 per cent).[308] We then calculated the value of the future food waste opportunity using the estimates of waste recovery rates (between 30 per cent to 50 per cent) used in the top-down approach. **Values from the top-down and bottom-up approaches**: 1) Top-down – A$7 billion 2) Bottom-up – A$25 billion	• World Resources Institute (WRI) • Food and Land Use Coalition (FOLU) • World Resources Institute (WRI) • Department of Energy and Environment research
Opportunity 11: Energy smart food		
Opportunities around	**Top-down estimate:** We measured the size of this opportunity in Australia using two components:	

305 Future Market Insights (2017), "Report Global Biogas to Reach $50 billion by 2026." Available at: https://www.futuremarketinsights.com/press-release/biogas-market

306 Ellen MacArthur Foundation (2019), *Cities and Circular Economy for Food: Technical Appendix – Global Modelling*. Available at: https://www.ellenmacarthurfoundation.org/assets/downloads/Cities-and-Circular-Economy-for-Food-Appendix.pdf

307 World Resources Institute (2013), *Reducing Food Loss and Waste*. Available at: https://pdf.wri.org/reducing_food_loss_and_waste.pdf; The Food and Land Use Coalition (2019), Growing Better: Ten critical transitions to transform food and land use. Available at: https://www.foodandlandusecoalition.org/wp-content/uploads/2019/09/FOLU-GrowingBetter-GlobalReport.pdf

308 Department of Environment and Energy (2017), *Working together to reduce food waste in Australia*. Available at: https://www.environment.gov.au/system/files/resources/29c0f94d-92ac-44d7-ac43-3051cff75162/files/food-waste-fact-sheet.pdf; Department of Environment and Energy (2018), *National Waste Report 2018*. Available at: https://www.environment.gov.au/system/files/resources/7381c1de-31d0-429b-912c-91a6dbc83af7/files/national-waste-report-2018.pdf

• greater energy efficiency in food production and manufacturing • diversification towards renewable energy sources	1) *Energy efficiency opportunity.* Energy savings from using adopting energy-saving technology. We estimated the value businesses could seize if they become more energy efficient. Our calculations considered current research on energy use across the agricultural value chain (energy accounts for 15-30 per cent of the cost of crop production), as well as FAO estimates on the amount of energy that can be saved in agricultural production and processing (at least 20 per cent).[309,310] We projected the future value of energy-efficient production using World Bank data on the expected increase in agricultural production globally (2.4 per cent). Our estimates are based on a higher take-up rate in energy-saving technology, which would see the share of "energy smart" agricultural production and processes increase from 25 to 50-100 per cent.	• Business & Sustainable Development Commission (BSDC) • Congressional Research Service • World Bank
	2) *Renewable energy opportunity.* Energy savings from using more renewable energy. This estimate seeks to measure the value of using more renewable energy to run farms and food production. Our estimate is based on IEA research and assumes that energy use in the agricultural sector is equivalent to the global pattern, with roughly 13.8 per cent of primary energy supply from renewables.[311] We used this figure to calculate the size of the renewable energy opportunity in 2030. Our forecast assumes an increase in the share of renewable energy, ranging from 18 per cent (linked to the 2020 IEA forecast) to as high as 23.5 per cent of primary energy supply (equivalent to the EU targets).	• International Energy Agency (IEA)
	To estimate the size of the opportunity for businesses in Australia, we multiplied the global value by Australia's share of agricultural production in 2016 (0.9 per cent).	• Food and Agriculture Organisation of the United Nations (FAO)

309 Congressional Research Service (2004), *Energy use in agriculture: Background and issues*. Available at: https://nationalaglawcenter.org/wp-content/uploads/assets/crs/RL32677.pdf

310 Food and Agriculture Organisation (2011), *Energy-smart food for people and climate*. Available at: http://www.fao.org/3/a-i2454e.pdf

311 International Energy Agency (2016), *Renewable energy continuing to increase market share*. Available at: https://www.iea.org/newsroom/news/2016/july/renewable-energy-continuing-to-increase-market-share.html

	Bottom-up estimate: We substituted the global numbers with Australia-specific ones.[312] The Department of Industry, Science, Energy and Resources has estimated that energy costs account for at least 15 per cent of total costs of food businesses while the Organisation for Economic Co-operation and Development (OECD) estimated savings of 24 per cent in Australia from energy smart farm production.[313] **Values from the top-down and bottom-up approaches**: 1) Top-down – A$6 billion 2) Bottom-up – A$5 billion	• AgriFutures • NSW Farmers Association • Department of Industry, Science, Energy and Resources • Organisation for Economic Co-operation and Development and International Monetary Fund (OECD)
Opportunity 12: Animal feed and health		
Opportunities around • control of transmissible diseases • smart feed supplements • industrialised feeding and health monitoring systems	**Top-down estimate:** Opportunities in this market can be broadly divided into two areas of value 1) *Animal feed additives and health products.* Market opportunity related to animal feed additives and health products. Vetnosis and Global Market Insights provide values for the global market in 2015.[314] We estimated the market's future value using P&S Market Research estimates of a 7 per cent growth rate.[315] 2) *Animal health monitoring and diagnostic systems.* Market opportunity related to animal health monitoring and diagnostic systems. We estimated the current and future value of the global veterinary diagnostics market using the MarketsandMarkets forecast growth rate of 8.6 per cent per annum.[316]	• Vetnosis • P&S Market Research • Markets and Markets

312 AgriFutures (2019), *Agriculture– A $100b sector by 2030?* Available at: https://www.agrifutures.com.au/wp-content/uploads/2019/08/19-025.pdf; NSW Farmers Association (2015), *Renewable energy in agriculture A farmer's guide to technology and feasibility*. Available at: https://www.aginnovators.org.au/sites/default/files/Renewable%20energy%20in%20agriculture.pdf

313 OECD (2017), *Improving energy efficiency in the agro-food chain*. Available at: https://read.oecd.org/10.1787/9789264278530-en?format=pdf

314 Global Market Insights (2016), *Animal Healthcare Market Size: 2016 – 2024 Available at:* https://www.gminsights.com/industry-analysis/animal-healthcare-market

315 P&S Market Research (2018), *Animal Healthcare Market*. Available at: https://www.psmarketresearch.com/press-release/animal-healthcare-market

316 MarketsandMarkets (2016), *Veterinary diagnostics market*. Available at: https://www.marketsandmarkets.com/PressReleases/veterinary-diagnostics.asp

	To calculate the size of the market opportunity in Australia, we multiplied the global value estimates by Australia's share of global livestock production (estimated at 1.6 per cent). **Bottom-up estimate:** We compared our results with estimates by Business Wire and IBIS world for the size of Australia's current and future animal feed and health market.[317],[318] For instance, Business Wire estimated that the animal feed market in Australia was worth US$4.2 billion in 2018. **Values from the top-down and bottom-up approaches**: 1) Top-down – A$2 billion 2) Bottom-up – A$11 billion	• Food and Agriculture Organisation of the United Nations (FAO) • Business Wire • IBIS world
Opportunity 13: Precision agriculture and big data		
Using innovative technology to improve the productivity on large farms	**Top-down estimate:** Economic value of hectares of land saved from the deployment of precision agriculture and big data in farms bigger than 2 hectares. We measure the size of this market by analysing the benefits of using advanced technology on farms bigger than 2 hectares (based on BSDC research) in 2030.[319] MGI estimates intervention will lead to yield improvements over the base case of 15 per cent in developed countries, and 50 per cent in developing countries. Producing the same amount of food will, therefore, require between 150 million and 180 million fewer hectares – the cost savings opportunity is the economic value of the land saved.[320] To determine the value of the opportunity in Australia, we used Australia's estimated share of global agricultural	• Business & Sustainable Development Commission (BSDC) • McKinsey Global Institute (MGI) • Food and Agriculture Organisation of

317 Business Wire (2019), *Australia Animal Feed Market - Forecasts from 2019 to 2024*. Available at: https://www.businesswire.com/news/home/20190627005714/en/Australia-Animal-Feed-Market---Forecasts-2019

318 IBIS World (2019), *Veterinary Pharmaceutical Manufacturing in Australia - Market Research Report*. Available at: https://www.ibisworld.com/au/industry/veterinary-pharmaceutical-manufacturing/5019/; IBIS World (2019), *Veterinary Laboratory Testing Services in Australia - Market Research Report*. Available at: https://www.ibisworld.com/au/industry/veterinary-laboratory-testing-services/4218/

319 Farms above 2 hectares are used to estimate the opportunity as it may be less feasible for smallholder farms to deploy precision farming and big data techniques. Research used: BSDC (2017), *Valuing the SDG prize in food*. Available at: https://s3.amazonaws.com/aws-bsdc/Valuing-SDG-Food-Ag-Prize-Paper.pdf.

320 McKinsey Global Institute (2011), *Resource Revolution: Meeting the world's energy, materials, food, and water needs*. Available at: https://www.mckinsey.com/business-functions/sustainability/our-insights/resource-revolution

	production in 2016 and Australia's estimated share of the global value highlighted in the BSDC report (0.4 per cent). **Values from the top-down and bottom-up approaches**: 1) Top-down – A$1 billion 2) Bottom-up – NA	the United Nations (FAO) • Business & Sustainable Development Commission (BSDC)
Opportunity 14: Sustainable packaging		
Opportunities to • reduce packaging waste • reduce stress on the environment • enhance packaging waste recovery	**Top-down estimate:** Market opportunity for packaging plastics and recycling. We used research by the Ellen MacArthur Foundation (EMF) to size the global market for packaging plastics and recycling.[321] To estimate the market's value in 2030, we relied on a report by BSDC that expects the plastic packaging economy to double in value by 2030.[322] We also considered research that estimates the value captured by recycling to grow to 30 per cent by 2030.[323] This increase in value capture is composed of an increase in amount captured for recycling from 15 per cent to 50 per cent, and an increase in yield of recycled product from 30 per cent to 60 per cent.[324]	• Ellen MacArthur Foundation (EMF) • Business & Sustainable Development Commission (BSDC)
	To understand the size of the opportunity for Australian businesses, we multiplied the global value figures by Australia's share of the world's GDP in 2030 (1.5 per cent), as forecast by the International Monetary Fund (IMF) and the World Bank.	• International Monetary Fund (IMF) • The World Bank
	Bottom-up estimate: Mordor Intelligence estimated that the Australian plastic packaging market is worth US$4.3 billion in 2025.[325] Projecting this to 2030, using the forecast CAGR of 3.8 per cent and Australia's projected	• Mordor Intelligence

321 Ellen MacArthur Foundation (2016), *The New Plastics Economy: Rethinking the future of plastics and catalysing action*. Available at: https://www.ellenmacarthurfoundation.org/assets/downloads/publications/NPEC-Hybrid_English_22-11-17_Digital.pdf

322 BSDC (2017), *Valuing the SDG prize in food*. Available at: https://s3.amazonaws.com/aws-bsdc/Valuing-SDG-Food-Ag-Prize-Paper.pdf

323 Ellen MacArthur Foundation (2016), *The New Plastics Economy: Rethinking the future of plastics and catalysing action*. Available at: https://www.ellenmacarthurfoundation.org/assets/downloads/publications/NPEC-Hybrid_English_22-11-17_Digital.pdf

324 BSDC (2017), *Valuing the SDG prize in food*. Available at: https://s3.amazonaws.com/aws-bsdc/Valuing-SDG-Food-Ag-Prize-Paper.pdf

325 Mordor Intelligence (2019), *Australia Plastic Packaging Market*. Available at: https://www.mordorintelligence.com/industry-reports/australia-plastic-packaging-market

	recycling rates, we obtained the value of recycling plastics. **Values from the top-down and bottom-up approaches**: 1) Top-down – A$1 billion 2) Bottom-up – A$3 billion	
Opportunity 15: Advanced breeding and fertilisation		
Opportunities to increase animal productivity with techniques such as crossbreeding and precision phenotyping	**Top-down estimate:** We estimated the value of this opportunity by analysing two market components: 1. *Agricultural biotechnology:* Market opportunity related to agricultural biotechnology. This market comprises live products and technology, and we used BCC Research to estimate its current and future value under a forecast growth rate of 11 per cent per year.[326] *Animal genetics:* Market opportunity related to animal genetics. We used MarketsandMarkets research on the global animal genetics market to estimate the current and future value of this component with a projected average annual growth rate of 8-9 per cent by 2030.[327] To gauge the size of the business opportunity for Australia, we multiplied the global value estimates by Australia's share of planted acreage of genetically modified crops in 2018 (0.4 per cent).[328]	• BCC Research • MarketsandMarkets • International Service for the Acquisition of Agri-Biotech Applications (ISAAA)

326 BCC Research (2014), Agricultural Biotechnology*: Emerging Technologies and Global Markets*. Available at: https://www.bccresearch.com/market-research/biotechnology/agricultural-biotechnology-technologies-markets-report-bio100b.html

327 MarketsandMarkets (2016), *Global Animal Genetics Market*. Available at: https://www.marketsandmarkets.com/Market-Reports/animal-genetic-market-12462093.html?gclid=Cj0KCQjwg8n5BRCdARIsALxKb97nhpm9GEINjrdM-RTybGw3ZLg_oleDogBExi5ZL6K-vNiTG2FHcMYaAmy9EALw_wcB

328 ISAAA (2018), *Executive Summary, Biotech Crops Continue to Help Meet the Challenges of Increased Population and Climate Change*.Available at: https://www.isaaa.org/resources/publications/briefs/54/executivesummary/default.asp

	Values from the top-down and bottom-up approaches: 1) Top-down – A$1 billion 2) Bottom-up – NA	
Opportunity 16: Technology in smallholder farms		
Opportunities around deriving value of land savings from yield improvements on smallholder farms (<2 hectares)	**Top-down estimate:** We measure the size of this market by analysing the benefits of using technology on smallholder farms which are smaller than 2 hectares (based on BSDC research).[329] MGI estimates technology intervention will lead to cumulative yield improvements over the base case of 15 per cent in developed countries, and 50 per cent in developing countries.[330] Producing the same amount of food will, therefore, require between 75 million and 105 million fewer hectares of land – the cost savings opportunity is the economic value of the land saved. Price assumptions derived from BSDC analysis. To determine the value of the opportunity in Australia, we used Australia's estimated share of global agricultural production in 2016 and Australia's estimated share of the global value highlighted in the BSDC report (0.8 per cent). **Values from the top-down and bottom-up approaches**: 1) Top-down – A$1 billion 2) Bottom-up – NA	• Business & Sustainable Development Commission (BSDC) • McKinsey Global Institute (MGI)
Opportunity 17: Protected cropping		
Size of potential productivity gains linked to the production of horticultural crops within, under or sheltered by	**Top-down estimate**: We estimated the global potential vegetable and fruit area suitable for protected cropping but have not been used for such purposes yet. Based on studies from the University of New England and Graeme Smith Consulting, past research indicated that protected cropping is suitable for certain crops (e.g., tomatoes, capsicum, cucumbers).[331] We derived the estimated	• Food and Agriculture Organisation of the United Nations (FAO)

329 BSDC (2017), *Valuing the SDG prize in food.* Available at: https://s3.amazonaws.com/aws-bsdc/Valuing-SDG-Food-Ag-Prize-Paper.pdf

330 McKinsey Global Institute (2011), *Resource Revolution: Meeting the world's energy, materials, food, and water needs.* Available at: https://www.mckinsey.com/business-functions/sustainability/our-insights/resource-revolution

331 University of New England (2017), *Controlled Environment Horticulture Industry Potential in NSW.* Available at: https://www.une.edu.au/about-une/faculty-of-science-agriculture-business-and-law/unebs/centre-for-agribusiness/ceh-report; Graeme Smith Consulting (2008), *An Overview of the Australian Protected Cropping Industry*. Available at: https://www.graemesmithconsulting.com/images/documents/An%20Overview%20of%20the%20Australian%20Protected%20Cropping%20Industry%20Compatibility%20Mode.pdf

structures to provide modified growing conditions and / or protection from pests, diseases and adverse weather	share of protected cropping currently and in 2030 based on data from FAO and Horti Daily.[332] We obtained the average global yield of fruits and vegetables from FAO and estimated the yield volumes of the land area if field cropping is used. Studies have shown that protected cropping could lead to between 250 per cent and 845 per cent in yield increases.[333] Based on the additional crop yield from protected cropping and the average plant crop price from FAO, we calculated the size of potential productivity gains in 2030. To understand the size of the protected cropping opportunity for farms in Australia, we multiplied Australia's share of global harvested area for fruits and vegetables in 2018 (0.3 per cent - latest available data, according to FAO Statistics) by the global value estimates. **Bottom-up estimate:** We followed the same steps in the top-down estimate with Australia-specific figures in terms of land area for fruits and vegetables, the share of fruits and vegetables suitable for protected cropping, percentages of protected cropping in farm and the average yield of fruits and vegetables. As there would be some overlaps with "Health and wellness", when all the opportunities were summed, we accounted for the overlap and took this estimate out. **Values from the top-down and bottom-up approaches**: 1) Top-down – A$2 billion 2) Bottom-up – A$1 billion	• University of New England (UNE) • Graeme Smith Consulting • Horti Daily • Food and Agriculture Organisation of the United Nations (FAO) • Food and Agriculture Organisation of the United Nations (FAO) • University of New England (UNE) • Graeme Smith Consulting

332 Horti Daily (2019), *World Greenhouse Vegetable Statistics updated for 2019*. Available at: https://www.hortidaily.com/article/9057219/world-greenhouse-vegetable-statistics-updated-for-2019/

333 University of New England (2017), *Controlled Environment Horticulture Industry Potential in NSW*. Available at: https://www.une.edu.au/about-une/faculty-of-science-agriculture-business-and-law/unebs/centre-for-agribusiness/ceh-report; Graeme Smith Consulting (2008), *An Overview of the Australian Protected Cropping Industry*. Available at: https://www.graemesmithconsulting.com/images/documents/An%20Overview%20of%20the%20Australian%20Protected%20Cropping%20Industry%20Compatibility%20Mode.pdf

A GLOBAL MARKETPLACE		
Opportunity 18: Direct to consumer models (B2C)		
Developing new digital channels to provide food to consumers, including through e-commerce and promoting agro-tourism	**Top-down estimate**: We analysed the value of the following three market components: 1) *Global B2C e-commerce food sales.* Market opportunity for B2C e-commerce foods. To determine the global value of B2C sales, we used data by UNCTAD and eMarketer on the food and beverage industry's share of total e-commerce spending using the ratios for the US (2.3 per cent) as a proxy.[334,335] 2) *Direct farm sales to consumers.* Market opportunity related to direct farm sales. Our value calculations started with identifying the share of direct sales from farms to customers, which account for around 1 per cent of total farm sales in the US.[336] Assuming such sales are largely a high-income opportunity, we then applied this percentage to the total agricultural GDP in high-income countries. Based on findings from the USDA, direct-to-consumer food sales doubled between 1997 and 2007.[337] This implies a CAGR of 7.2 per cent over the decade, which was used to forecast future values. 3) *Agro-tourism revenues*. Market opportunity related to agro-tourism. Future Market Insights estimated that the Agro-tourism market will be worth US$622 billion in 2029.[338] To understand the size of the B2C business opportunity for farms in Australia, we used two different scaling	• eMarketer • United Nations Conference on Trade and Development (UNCTAD) • United States Department of Agriculture (USDA) • Future Market Insights • eMarketer

334 The Economics Times (2016), "Global e-commerce market is worth $22 trillion: UNCTAD". Available at: https://economictimes.indiatimes.com/industry/services/retail/global-e-commerce-market-is-worth-22-trillion-unctad/articleshow/53274475.cms?from=mdr

335 eMarketer (2014), "US Retail Ecommerce Sales Highest for Computers, Consumer Electronics". Available at: https://www.emarketer.com/Article/US-Retail-Ecommerce-Sales-Highest-Computers-Consumer-Electronics/1010759

336 US Department of Agriculture (2015), Facts on Direct-to-Consumer Food Marketing. Available at: https://www.ams.usda.gov/services/local-regional/farmers-markets-and-direct-consumer-marketing

337 US Department of Agriculture (2009). *Facts on Direct-to-Consumer Food Marketing (Incorporating Data from the 2007 Census of Agriculture)*. Available at: https://apps.ams.usda.gov/MarketingPublicationSearch/Reports/stelprdc5076729.pdf

338 Future Market Insights (2020), Agritourism Market. Available at: https://www.futuremarketinsights.com/reports/agritourism-market

	factors – one for e-commerce and direct farm sales to consumers, and another one for agro-tourism. For the first two components, we multiplied Australia's share of global B2C e-commerce spend in 2019 (1.3 per cent - latest available data) by the global value estimates.[339] For the last component, we used Australia's share of the global travel and tourism market in 2018 (1.8 per cent).[340] As the global estimates of e-commerce food sales and direct farm sales to consumers include production for domestic consumption only (do not include exports), we also added Australia's export share, using CSIRO data on the shares of convenience meals exported and domestically consumed as proxies.[341] To distinguish between domestic consumption and exports for agro-tourism, we used CSIRO data on the shares of agri-tourism revenues from domestic and foreign visitors.[342] **Bottom-up estimate:** We validated our findings using several Australia-specific estimations. For e-commerce food sales, we obtained e-commerce sales, estimated to be A$29 billion in 2018, from Web Alive.[343] Another data source was from Inside Retail, which has estimated Australia's grocery market to be A$5.6 billion in 2023 with a growth rate of 15 per cent.[344] For agro-tourism, we used the estimates from CSIRO agri-tourism 2030 sizings.[345] As these are "consumption-driven" opportunities, we accounted for the impacts of the COVID-19 pandemic.	• Asendia • World Travel & Tourism Council (WTTC) • Commonwealth Scientific and Industrial Research Organisation (CSIRO) • Web Alive • Inside retail • Commonwealth Scientific and Industrial Research Organisation (CSIRO)

339 eMarketer (2019), "Global Ecommerce 2019: Ecommerce Continues Strong Gains Amid Global Economic Uncertainty." Available at: https://www.emarketer.com/content/global-ecommerce-2019; Asendia (2019), *Australia B2C E-commerce Report 2019*. Available at: https://www.asendia.com/asendia-insights/australia-b2c-e-commerce-report-2019/

340 World Travel & Tourism Council (2019), *Travel & Tourism Global Economic Impact & Trends 2019*. Available at: http://ambassade-ethiopie.fr/onewebmedia/Tourism-WTTC-Global-Economic-Impact-Trends-2019.pdf

341 Commonwealth Scientific and Industrial Research Organisation (2019), *Growth opportunities for Australian food and agribusiness*. Available at: https://www.csiro.au/en/Do-business/Futures/Reports/Ag-and-Food/Opportunities-for-Food-and-Agribusiness

342 Commonwealth Scientific and Industrial Research Organisation (2019), *Growth opportunities for Australian food and agribusiness*. Available at: https://www.csiro.au/en/Do-business/Futures/Reports/Ag-and-Food/Opportunities-for-Food-and-Agribusiness

343 Web Alive (2019), "The State of Australia's E-commerce in 2019". Available at: https://www.webalive.com.au/ecommerce-statistics-australia/#:~:text=As%20of%20February%202019%2C%2080.8,online%20will%20be%2022.0%20million.

344 Inside Retail News (2018), "Online grocery market to grow to $4.2bn by 2023". Available at: https://insideretail.com.au/news/australians-online-grocery-market-to-grow-to-4-2bn-by-2023-201810

345 Commonwealth Scientific and Industrial Research Organisation (2019), *Growth opportunities for Australian food and agribusiness*. Available at: https://www.csiro.au/en/Do-business/Futures/Reports/Ag-and-Food/Opportunities-for-Food-and-Agribusiness

	Values from the top-down and bottom-up approaches: 1) Top-down – A$21 billion 2) Bottom-up – A$29 billion	
Opportunity 19: Supply chain transformation (B2B)		
Opportunities around using technologies to improve logistics and achieve efficiency gains	**Top-down estimate:** Cost savings from using IoT technologies (e.g., savings in inventory holding costs). We estimated the value of opportunities that could vastly improve supply chains by identifying the current and future spread of IoT technology worldwide. We used a report by Digital Trends to source global IoT spending figures and their projected growth rate of 16.7 per cent to determine the technology's current penetration rate (21 per cent of 2025).[346] We applied this ratio to the estimated 2025 potential for IoT in retail (as estimated by McKinsey Global Institute) to calculate the current value of the global opportunity. For the future forecast, we again made use of the MGI findings and analysed the size of the cost savings from using IoT technologies – in particular the cost of selling goods and holding inventory.[347] To determine the future impact of IoT technologies on the food and agribusiness sector, we used estimates that food retail accounts for roughly 20-30 per cent of all retail trade. To project the values to 2030, we assume the same growth rate of 16.7 per cent. In a final step, we calculated the size of the opportunity in Australia by multiplying the global value estimates with Australia's share of global agriculture imports and exports in 2017 (about 2 per cent - latest available data, according to FAO statistics). **Bottom-up estimate:** We considered two areas – 1) the reduction of cost of goods sold (COGS) and 2) increased revenues from the avoidance of sales lost due to stock outs. For the first sizing, we estimated the COGS based	• Digital Trends • McKinsey Global Institute (MGI) • Food and Agriculture Organisation of the United Nations (FAO) • Australian Bureau of Statistics (ABS) • Reserve Bank of Australia • Productivity Commission

[346] Digital Trends (2015), "Internet of Things spending will grow from $699 billion in 2015 to nearly $1.3 trillion in 2019". Available at: https://www.digitaltrends.com/cool-tech/internet-things-spending-will-grow-699-billion-2015-nearly-1-3-trillion-2019/

[347] McKinsey Global Institute (2015), *The Internet of Things: Mapping the value beyond the hype.* Available at: https://www.mckinsey.com/~/media/McKinsey/Industries/Technology%20Media%20and%20Telecommunications/High%20Tech/Our%20Insights/The%20Internet%20of%20Things%20The%20value%20of%20digitizing%20the%20physical%20world/Unlocking_the_potential_of_the_Internet_of_Things_Executive_summary.pdf

	on food retail data.[348] The Reserve Bank of Australia has estimated that the COGS component accounts for about 50 per cent of the final sale price. Based on case studies by Finlistics Solutions on the benefits of using IoT technology (up to 20 per cent savings of the COGS), we estimated the potential cost savings.[349] These benefits include improvements in collaboration in the supply chain, workforce efficiency, procurement costs and warehouse operations. For the second sizing, we considered the potential increase in revenues if companies were to use IoT to improve their inventory management. These benefits include better inventory management and operational process improvements. McKinsey Global Institute (MGI) estimates that 4 per cent of retail sales are lost due to stock outs, and that 35 per cent to 40 per cent of this value may be recaptured using IoT.[350] **Values from the top-down and bottom-up approaches**: 1) Top-down – A$8 billion 2) Bottom-up – A$31 billion	• Finlistics Solutions • McKinsey Global Institute (MGI)

348 Australian Bureau of Statistics (2020), "8501.0 - Retail Trade, Australia, May 2020." Available at: https://www.abs.gov.au/ausstats/abs@.nsf/mf/8501.0; Reserve Bank of Australia (2012), "Costs and Margins in the Retail Supply Chain." Available at: *https://www.rba.gov.au/publications/bulletin/2012/jun/2.html*; Government Productivity Commission (2014), "Relative Costs of Doing Business in Australia: Retail Trade, Australia". Available at: https://apo.org.au/node/39961

349 Finlistics Solutions, *The IoT-Financial Connection: Manufacturing*. Available at: https://www.finlistics.com/resources/the-iot-financial-connection

350 McKinsey Global Institute (2013), *Disruptive technologies: Advances that will transform life, business, and the global economy*. Available at: https://www.mckinsey.com/business-functions/mckinsey-digital/our-insights/disruptive-technologies; McKinsey Global Institute (2014), *China's digital transformation*. Available at: https://www.mckinsey.com/industries/technology-media-and-telecommunications/our-insights/chinas-digital-transformation

Appendix D: Methodology for the sizing of jobs

This section describes in detail the methodology we used to calculate the number of jobs associated with each opportunity.

Step 1: Determining 2015 labour productivity

1) *Estimating overall industry income.* Based on data from the Australian Bureau of Statistics, we identified the total income and wages in 2015 for all relevant industries that fall under the Bureau's industry category level 2 (for example: Agriculture, Forestry and Fishing is level 1; Agriculture is level 2; and Nursery production, Outdoor growing etc. is level 4).

2) *Adjusting for inflation.* We adjusted the income figures for each industry for inflation, using a producer price index from the Australian Bureau of Statistics.

3) *Deriving level 4 industry (sub-industry) income by using a weighted average.* The income for each sub-industry level was not available, but there was data for wages and the number of employees for each sub-industry. We used the share of wages for each sub-industry to calculate the income for each sub-industry (i.e. *share of wages of each sub-industry x PPI adjusted overall L2 industry income).*

4) *Determining labour productivity.* The sub-industry income was divided by the total number of employees to determine labour productivity in 2015.

5) *Identifying relevant industries by opportunity. We identified the relevant sub-industries that match* each of the 19 opportunities.

6) *Identifying overall productivity for each opportunity.* Given that many of the sub-industries we identified for each opportunity spread across different industries overall, we calculated the productivity weighted by employees (i.e. *sum of [employee share for each sub industry x productivity of sub industry]).* For example, health and wellness includes sub-industries from agriculture, manufacturing and retail.

Step 2: Projecting the number of opportunity-related jobs in 2019 and 2030

1) *Calculating the productivity in 2019 and 2030.* We used historical data on productivity growth in each overall industry (level 2) to calculate the productivity for 2019 and 2030.

2) *Determining jobs in 2019 and 2030.* We divided our opportunity value estimates for 2019 and 2030 (explained in Appendix C) by the productivity for each opportunity in 2019 and 2030 to estimate the number of supported jobs.[351]

[351] Adjustments have been made to isolate the agriculture and manufacturing jobs for the FIAL 2019 and 2030 estimates. The FIAL 2019 actual job estimate excludes retail jobs and accounts for 58 per cent of the total jobs in the value chain. The same ratio is applied to the potential 2019 and 2030 estimates to obtain comparable estimates. Out of the opportunities, there are three opportunities which have or could lead to significant food retail jobs. They are 1) Health and wellness; 2) Traditional proteins (meat, egg and dairy) and 3) Plant-based and alternative proteins. We adjusted the potential jobs of these three opportunities, using the abovementioned ratio, to remove the food retail job component.

Appendix E: Methodology for estimating the opportunity-related shift in occupations

This section describes in detail the methodology used to calculate the relative share of occupations associated with each opportunity.

Step 1: Determining historical occupational shift

1) *Identifying the 2011 and 2016 occupational breakdown.* Based on data from the Australian Bureau of Statistics census (available for 2011 and 2016 only), we identified the number of employees for each occupation type (managers, professionals, sales workers, technicians and trade workers, community and personal service workers, clerical and admin workers, machine workers and labourers) within the sub-industries that support each opportunity.

2) *Calculating the year-on-year change.* We identified how occupation types change across each sub-industry from year to year, i.e. *[(2016 value – 2011 value)/5].*

Step 2: Determining the change in the occupational mix in 2019 and 2030

1) *Calculating the occupation shares in each sub-industry for 2019 and 2030.* We calculated the 2019 and 2030 occupation split for each sub-industry by taking the 2016 composition split as the basis and then applied the annual change rate (calculated in Step 1) to forecast forward by 3 and 11 years.

2) *Calculating 2019 and 2030 occupation shares by opportunity.* We applied the results of the occupation split (as calculated above) to the 2016 employment level for each sub-industry under each opportunity. We added these absolute values for each occupation type (i.e. manager, professional, labourer etc.) and then determined the occupational split expressed as a share for each opportunity.

3) *Calculating the relative share of occupation for the jobs projected* in 2019 and 2030. We then applied the split calculated above to the number of jobs for each opportunity (as calculated in Appendix D).

4) *Conducting a deep dive on manual labour.* To better understand the impact of opportunities on manual labour, we repeated Steps 1 and 2 outlined in this appendix at a level 4 (for example: Agriculture, Forestry and Fishing is level 1; Agriculture is level 2; and Nursery production, Outdoor growing etc. is level 4) for manual labour. This level includes 55 categories of manual labour, and

we divided these further into farm labour, machine and factory labour, warehouse labour and support services.

Appendix F: Methodology used to understand shifting skill needs

This section describes in detail the methodology used to calculate the potential skill shift in job types and occupations relevant for each opportunity.

Step 1: Converting the O*NET database code to the Australian Bureau of Statistics code

1) *Linking the Australian census to Australian Bureau of Statistics (ABS) data.* The data on occupations at level 4 is available on the Australian census database. However, this data does not assign codes to each job type within an occupation. The Australian Bureau of Statistics, on the other hand, does not provide data at that level of detail, yet it provides codes for all job types. In the first conversion step, we linked the census data to ABS codes.

2) *Linking ABS codes to Standard Occupation Codes (SOC).* Since there is no direct link between ABS codes and O*NET codes, ABS codes first need to be linked to SOC codes. However, 1 ABS code is associated with multiple SOC codes (as SOC codes are at a greater level of detail).

3) *Linking SOC codes to O*NET codes*. In the next step, we linked the SOC codes to the O*NET codes.

Step 2: Understanding skill requirements by occupation

1) *Identifying relevant job types in the O*NET database for each opportunity.* Based on Appendix C, each opportunity is associated with a set of sub-industries, and each sub-industry has relevant jobs associated with them. Using the converted codes from Step 1, we identified the relevant jobs for each opportunity.

2) *Refining the selection of relevant jobs.* The O*NET database is significantly more granular in comparison to ABS: each ABS code corresponds to multiple O*NET codes, some of which may be irrelevant. Hence, we needed to manually check that we only selected relevant jobs for each opportunity.

3) *Identifying relevant skills for each occupation.* O*NET's seven skill categories were used to identify the relevant skills for each occupation.

4) Determining the change in skill requirements by occupation between 2012 and 2019. We used the O*NET data to determine the annual change in skills across all relevant job types, e.g. [(2019 value – 2012 value)/7].

Step 3: Forecasting the level of skills required today and in 2030 for food and agribusiness

1) *Forecasting the level of skills required for each job type in 2030.* We used the historical change in skills required for each job (described in Step 2) to estimate the level of the relevant skills in 2030.

2) *Refining estimates based on insights from expert interviews.* Experts identified the skills that are likely to become increasingly important in the future, as opposed to those that will become only slightly more important or not more important at all. We assigned a score to each of these answers. This helped us refine the estimates in the step above. For example, on average most experts believe that critical thinking will become increasingly important. Hence, if our quantitative analysis showed that a certain skill would increase in importance, we accelerated that increase if expert views backed it up.

3) *Identifying the number of jobs for which the specific skills are critical.* In order to identify the change in the skills ranking between 2019 and 2030, we defined the number of jobs for which a particular skill was considered critical based on a scale from 1 – 7 (if the ranking was >2.5, the skill was considered critical) for 2019 and 2030 (the scale is from the O*NET database). We used the result to calculate the growth in the level of required skills as well as its overall ranking.

4) *Identifying the occupation types that require a substantial shift in skills.* We determined the number of jobs that require a significant shift in skills as a result of the opportunity-related occupational changes. We consider a shift significant when the skill change between 2019 and 2030 is greater than the average level of skill change for that particular skill across all relevant occupations in the food and agribusiness sector.