Food and Agribusiness

A Roadmap for unlocking value-adding growth opportunities for Australia

JULY 2017

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CSIRO Futures is the strategic advisory arm of Australia's national science agency.

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CSIRO Futures is the strategic advisory arm of Australia's national science agency. We work with senior decision makers in Australia's largest companies – and government – to help them translate science into strategy and plan for an uncertain future. We build on CSIRO's deep research expertise to help our clients create sustainable growth and competitive advantage by harnessing science, technology and innovation.

CSIRO AGRICULTURE AND FOOD

CSIRO Agriculture and Food is transforming productivity, profitability and sustainability in Australia's food and fibre industries and is a leader in the global response to food and nutritional security.

ACKNOWLEDGEMENTS

CSIRO would like to acknowledge the Food and Agribusiness Growth Centre – Food Innovation Australia Ltd – for their input and support in the development of this report.

We are also grateful for the time and input of industry representatives consulted throughout this project and the many researchers who provided invaluable review and feedback on this report.

CSIRO Foreword

Australia has a rich history in food and agriculture and now has an opportunity to transform from the old notion of being Asia's food bowl into a *more realistic and growth-oriented goal* to be the delicatessen of high quality products that meet the needs of billions of informed and discerning customers both here and abroad. Our wealth of raw ingredients paired with our world-class science can help feed a world market hungry for premium food at a price that recognises its value. The food and agribusiness (F&A) sector can become a shining example of Australia exporting unique end products rather than just raw materials.

CSIRO's Strategy 2020 is to be Australia's Innovation Catalyst, which will help us work closely with the sector to create new value by translating world-class science into innovative products. 'Customer First' is the first pillar of our strategy, and we've prioritised the way we work side-by-side with our customers and partners to tackle the big challenges facing their industries. We're committed to responding with agility and creativity to find the right solutions for unique projects, and spending more time understanding the specific requirements of industries and businesses. This customer-centric approach doesn't just extend to how we work with our partners; it is also reflected in our broader research agenda.

CSIRO uses science to conceptualise, predict, and model the major trends shaping Australia's future, including the Australia 2030 Report, Our Future World: Global Megatrends report, and the Australian National Outlook. We believe the F&A sector has a bright and bold future in this country. This Industry Roadmap report identifies a range of opportunities that could secure the future competitiveness and success of F&A in Australia. But more importantly, the report discusses enablers for unlocking these opportunities which rely on a collaborative approach from the research, education, government, industry and investor communities. CSIRO is committed to continuing to

channel resources into this effort, including bringing our world-class science and solutions to the table.

Responding to the disruption facing every part of the Australian landscape requires nothing short of deep collaboration to drive breakthrough innovation. We are proud to stand shoulder to shoulder with Food Innovation Australia Ltd (FIAL) and the other Industry Growth Centres as they further map out their roads to success. Together, we can apply world-class scientific and technological expertise to our unique Australian challenges and chart a course for long term sustainable prosperity for our nation.

Dr Larry Marshall
CSIRO Chief Executive

FIAL Foreword

Never has it been more timely than today for the Australian food and agribusiness sector to unite and work together to grow the share of Australian food in the global marketplace. The size and scale of developing markets reflects the scope of the opportunity for growers, producers and processors up and down the value chain. It is huge and it has come at a perfect time, because our research suggests that business as usual for the Australian food and agribusiness sector is simply not an option.

The Food and Agribusiness Sector Competitiveness Plan, developed by FIAL as part of the Industry Growth Centres Initiative, provides the high-level sector vision for this Roadmap. The plan highlights the need for businesses to be more agile, take calculated risks and apply Australian ingenuity to make what we have go further and capture the value currently wasted at a household and industrial level. Through creating a sense of urgency or burning platforms for change and growth, including improved coordination of government activities, a thriving Australian food and agribusiness sector will be the prize.

At the core of seizing this opportunity are better connections between educational and research institutions with industry, and supporting targeted investment in the Industry Knowledge Priority Areas described in the Food and Agribusiness Sector Competitiveness Plan. The discussions in the CSIRO Roadmap further support and/or provide solutions or enablers to these knowledge priority areas.

The continued investment in research and development is imperative for the competitive advantage of our businesses and industry, and will provide the pathways for more 'new-to-world' innovations with greater industry impact compared to the adoption of innovations already in the marketplace (or 'new-to-firm' innovations).

Tackling global trade, particularly new export markets, will throw up many challenges so industry, researchers and government must partner and support one another towards a common purpose. We are delighted to be partnering with CSIRO in detailing the steps for driving innovation, productivity and competitiveness in the food and agribusiness sector. We are confident that the Food and Agribusiness Sector Competitiveness Plan, together with this CSIRO Roadmap, will provide a stimulus for transformational thinking and innovation, shaping a bright future for Australian food in growing global markets.

Peter R. Schutz
FIAL Chairman

FIAL

Australian Government
Department of Industry, Innovation and Science

Industry Growth Centres

Executive Summary

Executive Summary

The food and agribusiness (F&A) sector is a vital contributor to the Australian economy and presents a key source of growth for the nation over the coming decades. This growth cannot be sustained through productivity improvements alone.

Businesses of tomorrow must unlock greater value from Australia's resources through harnessing science and technology and creating new offerings that meet the emerging needs of global customers. Early signs of this shift have been identified by recent Austrade analysis of the 3 years to 2016 which showed that for the first time in Australia's history value-added foods have accounted for the majority (60%) of food export growth.

Australia's F&A sector has the potential to strengthen its position as a small but significant exporter of sustainable, authentic, healthy, high quality and consistent products. To do this, the entire F&A ecosystem must work together to address cultural challenges and transition businesses towards being more collaborative, globally connected and growth oriented.

As the global sector changes faster than ever before, businesses will need to re-evaluate their role in this changing landscape – ensuring that strategy is underpinned with strong underlying market, business and technology assumptions. This Roadmap, through a process of industry consultation and analysis, aims to support this decision making process by identifying opportunities for products and services that align with Australia's comparative strengths in the global landscape and by providing discussions around the key enabling activities required to unlock them.

The megatrends illustrated in Figure 1 represent five significant trends in the global sector which are already changing the F&A products demanded by consumers and the business models of F&A companies. Consideration of these trends is critical in order for stakeholders in the ecosystem to make strategic decisions that will successfully position the Australian sector for future success.

Geopolitical instability, climate change and technological advances are now impacting the sector more than ever before.

FIGURE 1 – GLOBAL F&A MEGATRENDS

A LESS PREDICTABLE PLANET

Supply of limited resources is being further constrained by more severe and unpredictable climate events and more potent microbes, pests and diseases – causing food producers to more seriously consider the environmental life cycle impact of food production activities.

HEALTH ON THE MIND

An ageing population, rising levels of chronic disease and increasing social awareness around health and wellbeing are creating demand for foods that provide specific and holistic health outcomes.

CHOOSY CUSTOMERS

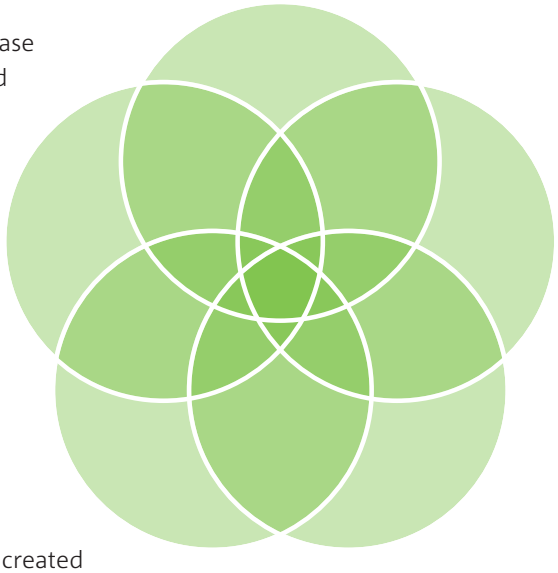
Rising wealth, increasing choice and greater market access are driving demand for a more diverse range of foods and food service options that are tailored to individual preferences and lifestyles.

ONE WORLD

As food and beverage value chains become increasingly global, new market opportunities are created while at the same time introducing competition and supply resilience risks in a volatile world.

SMARTER FOOD CHAINS

Increasing demand for food, the use of big data and more sophisticated e-commerce platforms are driving the creation of leaner, faster, more agile and low waste value chains.

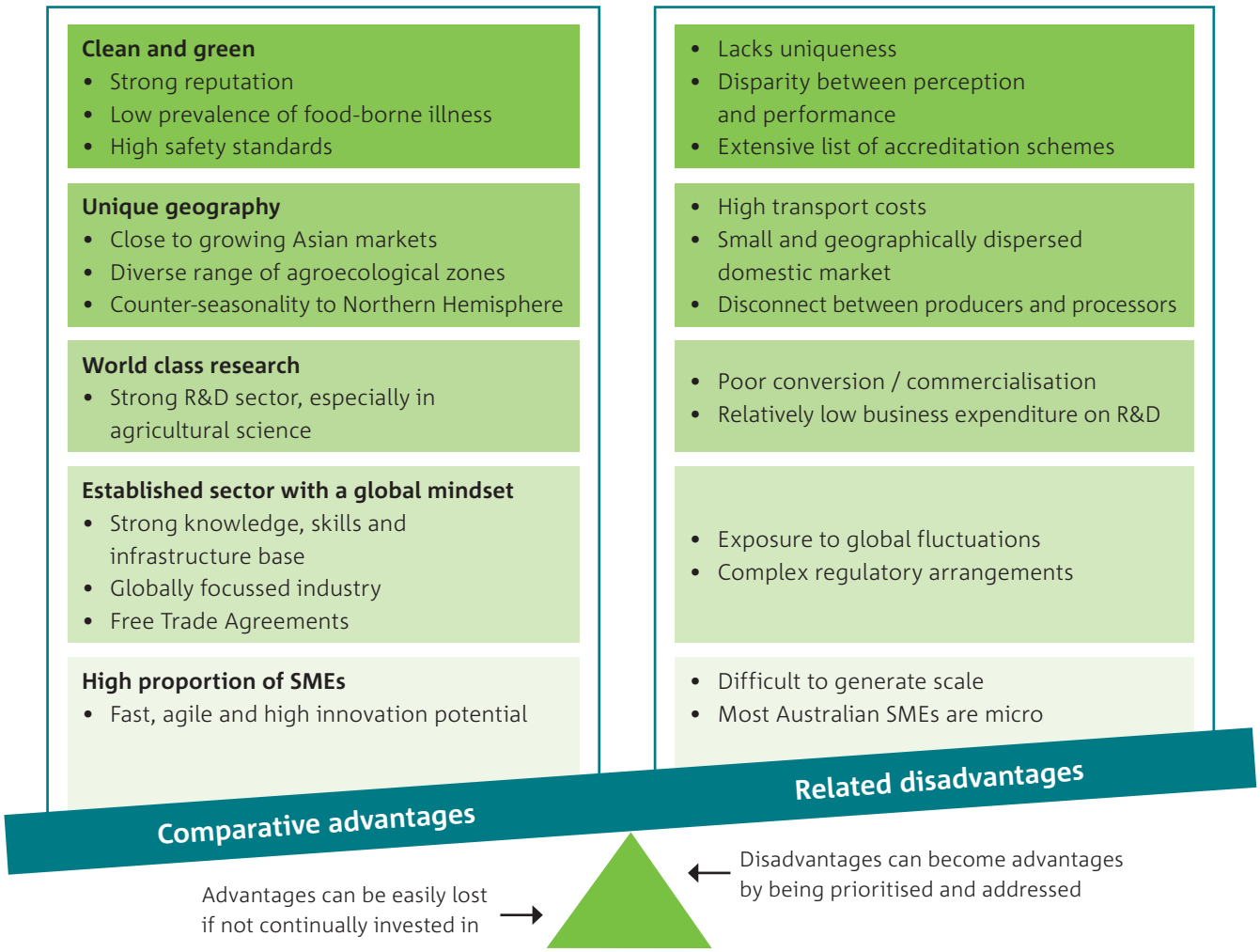


Being a small player in a global market, Australia must work harder to develop and promote unique differentiators.

The increasing pace of change creates global opportunities. To understand where Australia can prosper, the sector must consider the nation's comparative advantages and disadvantages. Australia's clean and green brand is well regarded but is not unique and is poorly differentiated. Businesses – and the sector overall – must focus on developing and marketing more unique offerings that leverage Australia's strengths while avoiding or addressing disadvantages.

> Australia's clean and green brand is well regarded but is not unique and is poorly differentiated.

FIGURE 2 – AUSTRALIAN F&A COMPARATIVE ADVANTAGES AND RELATED DISADVANTAGES



Significant growth can come from pursuing value-adding opportunities domestically and abroad.

In considering Australia's competitive position in this rapidly changing global market, three broad opportunity themes have been identified. Each opportunity leverages existing research strengths and customer demands. Investments most likely to prosper are those that possess characteristics of all three themes.

FIGURE 3 – OPPORTUNITIES FOR GROWTH IN AUSTRALIA'S F&A SECTOR

OPPORTUNITY THEME	INDUSTRY OPPORTUNITIES
Products for health and wellbeing Food or beverage products that provide specific health benefits above and beyond basic nutrition, and target consumers who are either health conscious or have specific medical/dietary needs.	• Free-from and natural foods • Supplements • Fortified and functional • Personalised nutrition
Sustainable solutions Environmentally and socially responsible manufacturing processes and products, and the recovery of novel, value-added products from waste streams.	• Waste conversion • Alternative protein sources • Sustainable packaging • Green and ethical value chains
Premium interactions Products that fetch a premium price due to quality and convenience, luxury status, novel attributes or their integration with food-based experiences.	• Convenience without compromise • Luxury products and gifts • Experiences and tourism • Novel tastes, smells, textures

Science, technology and ecosystem support are critical to unlocking the opportunities and enabling business-led growth.

While there is significant breadth and value to be captured in the offerings under each of the identified growth opportunities, businesses must act quickly or risk losing these future revenue streams to the competitive global market. Sustained growth in the sector will require proactive investment and translation of enabling science and technology, involving transdisciplinary teams and transpartisan relationships. These science and technology investments must be supported by business and ecosystem decisions that improve culture, skills, business models and knowledge within the sector.

Five key growth enablers arose from industry consultation, each requiring a unique mix of science and technology investment, business action and ecosystem assistance (Figure 4).

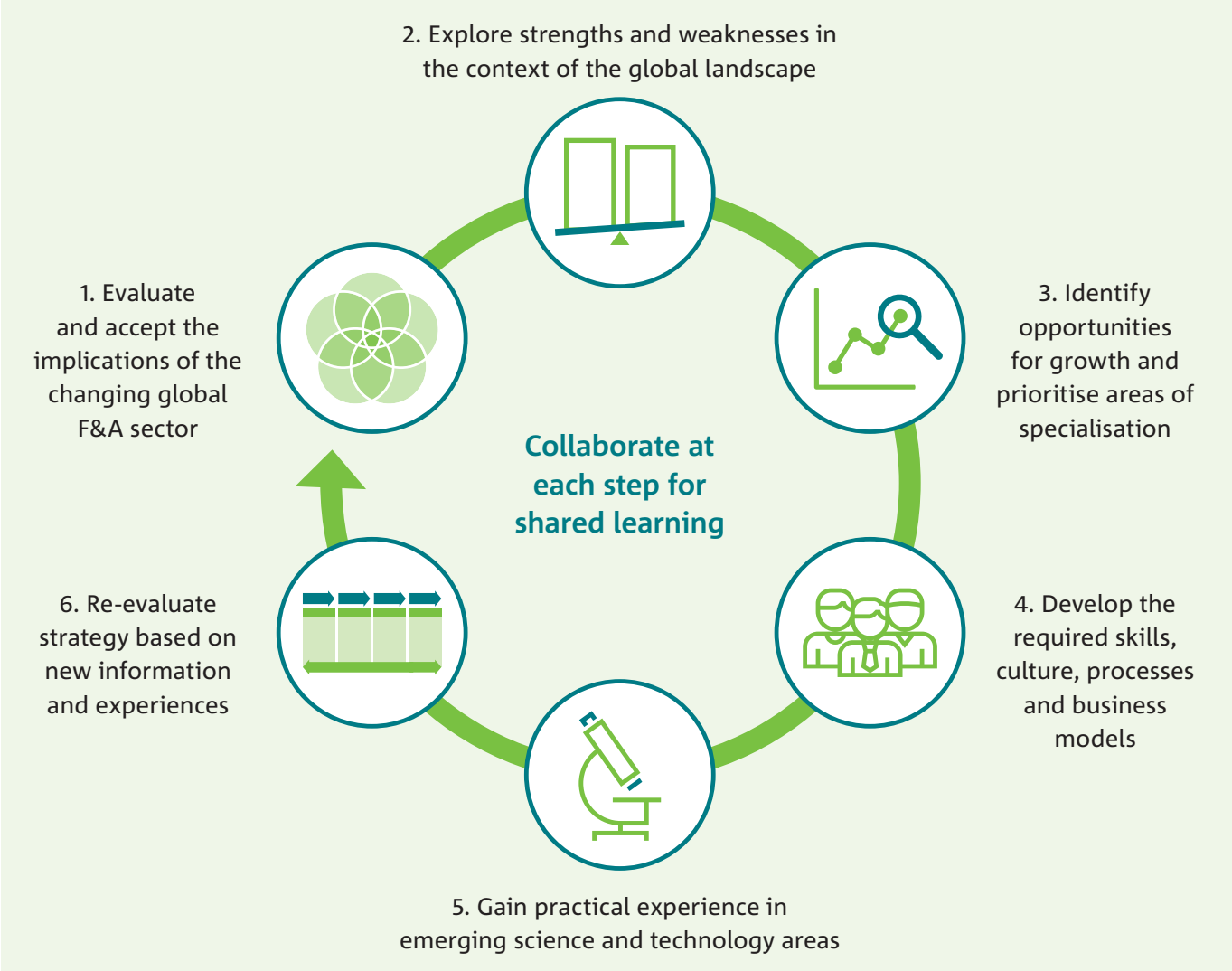
FIGURE 4 – ENABLERS OF GROWTH FOR AUSTRALIA'S F&A SECTOR

ENABLER	EXAMPLE SCIENCE AND TECHNOLOGY SOLUTIONS	BUSINESS ACTIONS	ECOSYSTEM ACTIONS
Traceability and provenance	• Blockchain • DNA-testing • Isotope analysis • Barcoding and image recognition technologies	• Develop data handling arrangements • Understand drivers of demand • Introduce unique identifiers on packaging	• Address domestic fragmentation • Develop and promote brand Australia • Support industry-to-industry collaboration • Retain critical mass of production • Identify key markets for targeted R&D efforts
Food safety and biosecurity	• Hybrid high pressure processing • Advanced packaging • Microwave assisted thermal sterilisation • Blockchain and bio-sensing	• Investigate and consider the impacts of non-tariff barriers to trade • Enhance domestic food testing capabilities	• Harmonise food safety systems • Increase in-process transparency of quality • Develop a national centre of excellence in food safety research and collaboration
Market intelligence and access	• Sensors and data analytics • Artificial Intelligence • E-commerce for perishable products	• Identify export destinations of best fit • Perform ongoing market research • Understand requirements of food service customers • Get feet on the ground • Use local immigrants for consumer research	• Develop publically accessible market analysis • Provide industry seminars and workshops
Collaboration and knowledge sharing		• Develop regional clusters • Identify potential international collaborations • Contract SMEs for new product development • Establish long term agreements	• Coordinate and streamline representative organisations • Develop business consortium • Provide more holistic R&D solutions • Simplify Intellectual Property arrangements • Establish 'end-to-end' pilot plant offering • Leverage state and federal innovation support schemes
Skills		• Increase investment in developing and acquiring skills in general business tasks, leadership, market research and data science •	• Increase practical elements of tertiary courses • Hire more commercially experienced business development staff in research • Mobilise researchers into industry

Call to action

Working together, the Australian F&A sector is well placed to succeed in the global marketplace. However, businesses will need to take calculated investment risks to remain competitive in the future. This Roadmap can be used as a tool to support this decision-making process (Figure 5).

FIGURE 5 – USING THE ROADMAP




Weight
Height
Nutrition Scan in Progress
30%
50%
40%
70%
AUG
SEP
OCT
NOV
DEC

Contents

Introduction

1 Introduction

Much of Australia's past research and innovation has focussed on increasing agricultural yields and improving the efficiency of land harvesting and to a lesser extent supply chains. While these breakthroughs continue to be important for maintaining Australia's F&A competitiveness, they alone cannot maintain or improve the nation's global standing indefinitely.

Increased value-adding across the entire F&A value-chain is acknowledged by industry as a key source of more sustainable competitiveness, greater differentiation and higher margins. While Australia's clean and green reputation is a strong foundation, it is not unique and businesses cannot afford to be overly reliant on it.

Failure to consider Australia's changing role in the global landscape and invest proactively in new markets, processes and products will likely result in a sector that experiences a reduction in global significance, economic value and jobs. Now is the time for businesses to identify new sources of growth and ensure continued success of a sector that has been a vital contributor to the Australian economy for decades.

DEFINING VALUE-ADDING

Value-adding typically falls under two categories:

1. *Processing*: Increasing the value of the input through transformation using manufacturing processes. e.g. Increasing nutritional profile or shelf-stability.
2. *Method of production*: Attracting a higher consumer willingness to pay by using differentiated production techniques. e.g. Organic produce, free range livestock or selectively breeding for desirable traits.

1.1 This report

This Roadmap seeks to support Australian food and agribusiness in its transition to a collaborative, growth oriented, high value-adding and clearly differentiated sector by discussing current and emerging trends, ascertaining market opportunities and challenges, and identifying key science, technology and business enablers.

The opportunities highlighted in this report focus on leveraging Australia's existing strengths to deliver consumer-facing improvements in quality, taste, texture and nutrition.

The discussions within this report seek to assist Australian F&A businesses – particularly the many SMEs – who have the desire to pursue growth and new markets but need help.

To achieve this, CSIRO has worked closely with businesses of all sizes to develop this Roadmap which is intended as a bridge between high-level sector strategies and specific technology roadmaps. The ideas expressed in this report represent views collected through industry consultation (see A.3).

To capitalise on these opportunities, businesses and the supporting F&A ecosystem (industry bodies, suppliers, research, education, investors and government) need to invest in a variety of science, technology and business enablers. This report discusses these enablers and recommends actions that are designed to best position Australian industry for the long-term opportunities identified.

The Roadmap aims to build on the *National food and nutrition research and development and technology transfer strategy*[1] and complement the 10-year *Sector Competitiveness Plan* developed by FIAL – the Food and Agribusiness Growth Centre[2]. While the Roadmap distinguishes opportunities (tangible products and services) from enablers (mechanisms for unlocking these opportunities), both chapters provide discussions that support FIAL's four Industry Knowledge Priorities and are strongly tied to the Growth Centre's goal of supporting industry to access new markets.

FIGURE 6 – REPORT STRUCTURE

1 CSIRO, AFGC and MLA (2013). *National food and nutrition research and development and technology transfer strategy.*
2 FIAL (2016). *Industry Growth Centre: Food and Agribusiness Sector Competitiveness Plan.*

1.2 A vision for Australia's food and agribusiness sector

VISION

By 2025, the industry is working together to grow the share of Australian food in the global marketplace (FIAL, 2016).[3]

Australia's F&A sector has the potential to strengthen its position as a small but significant exporter of sustainable, authentic, healthy, high quality and consistent products. Underpinning this status will be local businesses who embrace the existing volatility and possess the agility to continually and proactively seek opportunities to create new markets. Enhancing the proportion of on-shore value-adding will be key to these businesses, whether it be through the creation of unique products for niche markets or through developing varieties of commoditised goods with unmatched quality attributes and competitive production costs. These transformative opportunities will arise through research, planning and relationships that span entire value chains.

Local businesses will be more collaborative with each other, creating an environment of SMEs and contractors who leverage each other for scale and globally unique offerings. SMEs will also work with major multinational companies who have established manufacturing bases in Australia to utilise the un-matched Free Trade Agreements (FTAs) with the Asian region.

Asia will be the key focus of these Australian networks which have become the delicatessen of the region – a small player by volume but providing high-value, high-margin products. Asian markets will be targeted based on fit (how well placed Australian businesses are to service demand) rather than just overall market size or growth.

3 FIAL (2016). *Industry Growth Centre: Food and Agribusiness Sector Competitiveness Plan.*

A changing global landscape

2 A changing global landscape

Variability is not new to food and agribusiness, however climate change, geopolitical instability, and technological advances are now impacting the sector more than ever before.

Both opportunities and challenges arise from this rapid pace of change. Understanding, continually monitoring and making strategic decisions based on long-term changes in global markets will be critical for the sustained success of export focussed businesses.

At the same time, the discrete trends underlying these broader changes can be transient. Building agility and flexibility into business planning to adapt to short-term variations in consumer 'fads' is also important.

Globally, agribusiness is set to grow significantly faster than global gross domestic product over the next 10 to 20 years, with an expected growth rate of 4.06%.[4]

2.1 Global food and agribusiness megatrends

A megatrend is defined as a substantial shift in social, economic, environmental, technological or geopolitical conditions that may reshape the way a sector operates in the long-run.[5] CSIRO has identified five megatrends evident in global F&A that will have significant impact on the sector over the next 20 years.

These were developed by applying a food and agribusiness lens to previous megatrend analysis including CSIRO's global megatrends[6] and the agriculture megatrends developed in partnership with the Rural Industries Research and Development Corporation (RIRDC)[7]. Both industry and research communities were consulted to further refine the megatrends and their more detailed narratives which can be found in A.1 Global food and agribusiness megatrends.

4 Baghai, M. et al (2014). *Positioning for prosperity? Catching the next wave,* s.l.: Deloitte Touche Tohmatsu.
5 Hajkowicz, S. (2015). *Global Megatrends – Seven Patterns of Change Shaping Our Future,* CSIRO Publishing, Canberra.
6 CSIRO Futures (2016). *Australia 2030: Navigating our uncertain future*, CSIRO, Canberra.
7 Hajkowicz, S. and Eady, S. (2015). *Rural Industry Futures – Megatrends impacting Australian agriculture over the coming twenty years*, CSIRO and RIRDC.

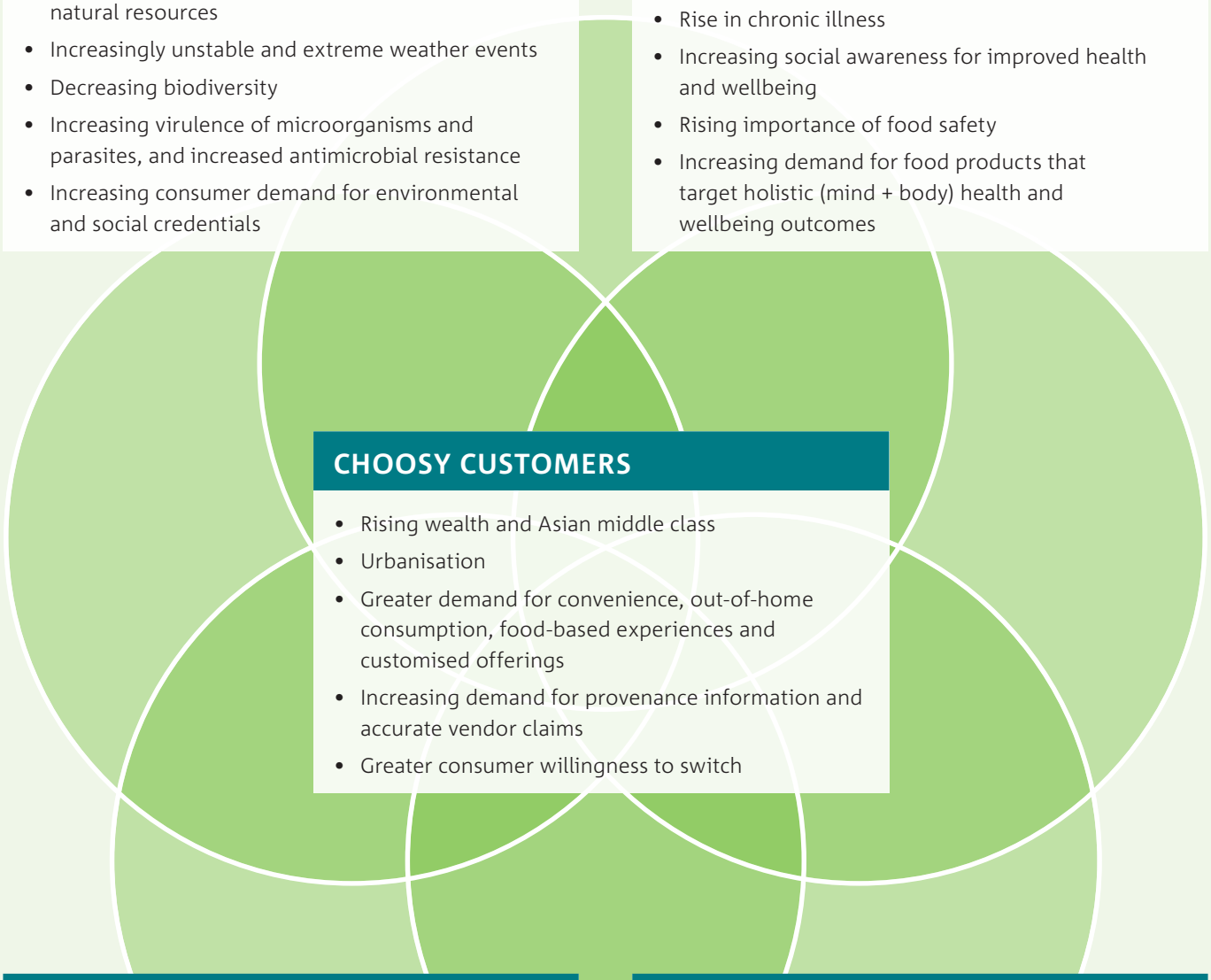
Global food and agribusiness megatrends

A LESS PREDICTABLE PLANET

- Limited amount and decreasing quality of natural resources
- Increasingly unstable and extreme weather events
- Decreasing biodiversity
- Increasing virulence of microorganisms and parasites, and increased antimicrobial resistance
- Increasing consumer demand for environmental and social credentials

HEALTH ON THE MIND

- Ageing population
- Rise in chronic illness
- Increasing social awareness for improved health and wellbeing
- Rising importance of food safety
- Increasing demand for food products that target holistic (mind + body) health and wellbeing outcomes



CHOOSY CUSTOMERS

- Rising wealth and Asian middle class
- Urbanisation
- Greater demand for convenience, out-of-home consumption, food-based experiences and customised offerings
- Increasing demand for provenance information and accurate vendor claims
- Greater consumer willingness to switch

ONE WORLD

- Increasingly connected global value chains
- Greater exposure to foods and beverages from other regions and cultures
- Greater international competition
- Increased biosecurity risks
- Greater susceptibility to supply shocks

SMARTER FOOD CHAINS

- Rising global food demand
- Food security concerns
- Rise of big data and data analysis
- Increasing digital connectedness and use of e-commerce solutions
- Vertically integrated, decentralised, non-linear and more agile value chains

Australia's food and agribusiness sector

3 Australia's food and agribusiness sector

3.1 Overview

The food and agribusiness sector is a vital contributor to the Australian economy and a major driver of economic activity, employment and prosperity for many parts of rural and regional Australia.[8]

Australia's advanced agricultural sector produces a healthy surplus – estimated to feed around 60 million people annually.[9] This export orientation means the sector benefits from, but is also heavily reliant on, the performance of global markets. Australian agriculture also supports Australia's largest manufacturing industry – food, beverage and tobacco product manufacturing – which delivers 27% (~$26 billion) of gross value-added by the manufacturing sector.[10]

Despite the significance of the F&A sector compared to other Australian sectors, it is still a small player in the global trade of food and beverages, accounting for only 2.2% of global food trade in 2014.[11] The domestic production market is also not as profitable as it used to be, with increasing costs and the dominance of large local and international retailers placing increasing pressure on production and processing margins.[12] This is causing businesses to seek new channels to market – from farmers' markets to advanced e-commerce solutions – and new ways of differentiating their products.

The sector is traditionally commodity based, with bulk commodities making up 88% of Australia's food and beverage exports.[13] Comparator regions such as New Zealand and the UK realise more value per kg of exports by keeping a greater share of food processing on shore.

CIE modelling has shown that the largest potential gains to the farming and processing/marketing sectors can come from increases in export demand.[14] Gains from increases in productivity along the chain are generally significant, but in many cases get passed to others along the value chain and to other sectors of the economy.

CIE modelling has shown that the largest potential gains to the farming and processing/marketing sectors can come from increases in export demand.

BUSINESS MIX

The vast majority (99%) of food and agribusiness enterprises are wholly Australian owned with profits going back into the Australian economy.[15] The family farm remains the most common ownership structure in agribusiness and it increasingly faces pressure to grow and to maintain efficiency.[16] This is resulting in farms becoming either very big (profitable and large market share) or very small (lifestyle farms).

Culture is a significant challenge to industry growth. FIAL estimate that of the approximate 57,000 employing F&A businesses, only 5% are 'businesses of tomorrow' that actively pursue new markets, are more inclined to take risks, are more connected to their end markets and continually invest in building both their capability and knowledge of these markets.[17]

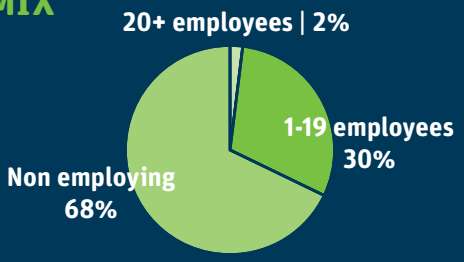
8 Commonwealth of Australia (2014). *Agricultural Competitiveness Issues Paper*, Canberra.
9 Department of Agriculture, Fisheries and Forestry (2013). *National Food Plan, Our food future*, Canberra.
10 ABS (2016). *8155.0 – Australian Industry, 2014-15*, Data Cube: manufacturing industry 'Table 1 Manufacturing industry by ANZSIC class', Canberra.
11 World Trade Organization (2015). *International Trade Statistics.*
12 AFGC and Ernst & Young (2015). *State of the industry 2015*.
13 Business Council of Australia (2015). *Building Australia's Comparative Advantages: A 21st Century Agrifood Sector.*
14 Borrell, B. et al (2012). *Payoffs from research and development along the Australian food value chain: a general equilibrium analysis.* The CIE and CSIRO, Canberra and Sydney.
15 ABS (2015). *8170.0 Characteristics of Businesses in Selected Growth Sectors*, Australia, 2013-14, Canberra.
16 Hajkowicz, S. and Eady, S. (2015). *Rural Industry Futures – Megatrends impacting Australian agriculture over the coming twenty years*. CSIRO and RIRDC.
17 FIAL (2016). *Industry Growth Centre: Food and Agribusiness Sector Competitiveness Plan.*

Australian food and agribusiness sector snapshot

EMPLOYMENT AND BUSINESS MIX

525,900 people

177,139 businesses



80% Agribusiness (farming, growing and fishing)

20% Food and beverage manufacturing

R&D

Business expenditure on R&D as ratio of Gross Value Add

F&A **1.2%**

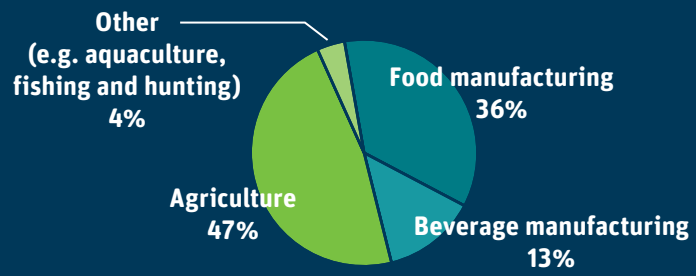
Av. Gov key sectors **3.8%**

$894m
Total business expenditure on R&D

NATIONAL CONTRIBUTION

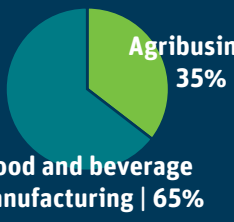
3.32%
of national GDP

$53.9b
Gross Value Added

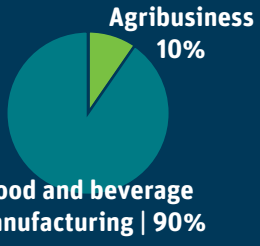


TRADE

Exports of **$41.7b**
(17% of Aus exports)



Imports of **$18.9b**
(7% of Aus imports)



Top 5 export destinations
for Australian processed and unprocessed food

3.2 Australia's comparative advantages and related disadvantages

Analysis of Australia's competitive landscape has indicated that of the 25 sectors assessed, Australia had the greatest advantage in agribusiness, which was also one of the largest global opportunities identified.[18] The food processing sector was also deemed to be in a position of high advantage and opportunity. It is critical that the businesses of tomorrow build upon and exploit this significant potential to secure the future competitiveness of Australia's F&A sector.

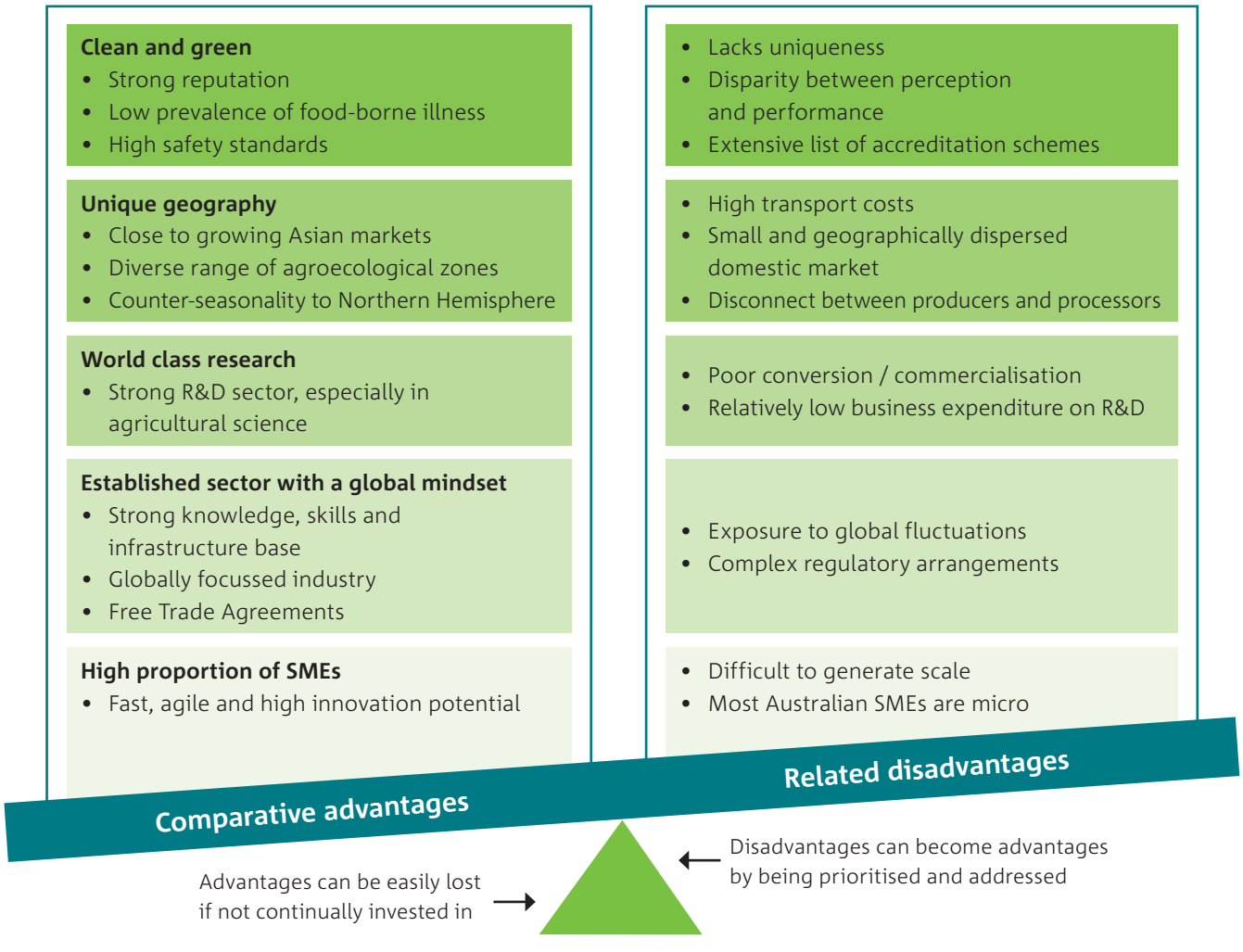
Australia's clean and green brand is well-regarded and provides a strong foundation but is not unique and is poorly differentiated.

Australia's competitive position can be altered rapidly as a result of government policies, global disruptions and other significant events. Both the national brand – and that of individual businesses – need to leverage Australia's competitive advantages to develop a stronger and inimitable reputation. The related disadvantages identified can quickly cripple existing advantages but can also be addressed or turned into advantages through prioritised investment.

In order to strengthen Australia's competitive position globally, businesses, governments and research organisations need to focus on opportunities that leverage (or create new) advantages and either address or avoid the disadvantages highlighted.

Importantly, Australia's points of differentiation vary across products and markets. The themes outlined in Figure 7 – and discussed in more detail in A.2 – relate to characteristics that span the entire F&A sector and were identified through industry consultation and literature review.

FIGURE 7 – COMPARATIVE ADVANTAGES AND RELATED DISADVANTAGES



18 Baghai, M. et al (2014). *Positioning for prosperity? Catching the next wave,* s.l.: Deloitte Touche Tohmatsu.

Opportunities for growth

4 Opportunities for growth

The rapidly changing business and technology environments are resulting in F&A companies that are willing to deploy new products and services to ensure survival in the future.

F&A businesses with desire for significant and sustainable growth acknowledged that this is most likely to arise from value-adding for export markets. In considering Australia's competitive position in the rapidly changing global market, three consumer-facing opportunity themes have been identified – Products for health and wellbeing, Sustainable solutions and Premium interactions.

The time to impact of opportunities within each theme varies, but all are believed to position Australian F&A businesses for sustainable competitiveness over the next 20 years. Each product or service opportunity is considered to be disruptive in terms of the technology utilised; transformative in terms of how products and services are delivered to consumers; or significant in terms of the economic potential that they hold for Australia.

These opportunities are not mutually exclusive; investments most likely to prosper are those that possess characteristics of all three themes. Given the breadth of the F&A sector, each opportunity is illustrated by example product or service offerings and case studies, acknowledging that many other niches exist for creative SMEs. Each discussion concludes with a list of key research questions that industry – in partnership with research – will need to answer in the coming years as well as example enabling technologies. Both of these lists are designed to help businesses initiate conversations about how to unlock more specific opportunities.

FIGURE 8 – OPPORTUNITIES FOR GROWTH IN AUSTRALIA'S F&A SECTOR

DRIVING MEGATRENDS	THEME	OPPORTUNITIES
• Health on the mind • Choosy customers	Products for health and wellbeing	• Free-from and natural foods • Supplements • Fortified and functional • Personalised nutrition
• A less predictable planet • Smarter food chains • Choosy customers	Sustainable solutions	• Waste conversion • Alternative protein sources • Sustainable packaging • Green and ethical value chains
• Choosy customers • One world • Smarter food chains	Premium / high end products	• Convenience without compromise • Luxury products and gifts • Experiences and tourism • Novel tastes, smells, textures

Products for health and wellbeing

Food or beverage products that provide specific health benefits above and beyond basic nutrition, and target consumers who are either health conscious or have specific medical/dietary needs.

DRIVING MEGATRENDS

- **Health on the mind**
- **Choosy customers**

KEY STATISTICS

- Between 2015 and 2030, the proportion of the global population aged 60 and over is projected to grow by 56%.[19]
- The population with diabetes worldwide is expected to grow to 642 million by 2040.[20]
- Worldwide, obesity has more than doubled since 1980 and 65% of people live in a country where overweight and obesity kills more people than underweight.[21]
- Over 46 million people live with dementia globally, and this is estimated to increase to 131.5 million by 2050.[22]
- In Australia, ~10% of adults are avoiding wheat and 10% of infants have a proven food allergy – the highest in the world.[23] [24]

19 United Nations, Department of Economic and Social Affairs, Population Division (2015). *World Population Ageing 2015*.
20 IDF (2015). *IDF Diabetes Atlas, Seventh Edition 2015*.
21 WHO (2016). Fact file - *10 facts on obesity*. Available at: http://www.who.int/features/factfiles/obesity/facts/en/index3.html [Accessed 4 April 2017]
22 Alzheimer's Disease International (2015). *World Alzheimer Report 2015 – The Global Impact of Dementia*, London.
23 Golley, S. (2015). *Understanding the choice to go gluten or wheat-free*, CSIRO blog, 6 November 2015.
24 Prescott, S. et al (2013). *A global survey of changing patterns of food allergy burden in children*, World Allergy Organization Journal, 6 (21).

4.1 Products for health and wellbeing

The ageing population and rising affluence across Asia will see these regions increasingly experience the same chronic illnesses burdening western societies today. Many of these, such as diabetes, obesity, dysphagia, sarcopenia and age-related decline in cognition can be treated and even prevented through nutrition. With Australia's high levels of obesity and diabetes, there are already strong incentives in place for local F&A businesses to develop solutions.

In addition to these medical dietary needs, there is a growing consumer group within all developed regions that are becoming more nutritionally literate and are seeking high quality, fresh and healthy foods that improve general health and wellbeing. These products which target the prevention of illness represent an even larger market than 'treatment' products.

There is a growing consumer group within all developed regions that are becoming more nutritionally literate and are seeking high quality, fresh and healthy foods that improve general health and wellbeing

Future growth in the global health and wellbeing market will be unevenly distributed. Large current markets in developed countries such as USA, Japan and Germany are expected to exhibit slow growth over the next five years (<1%), while high growth is expected for emerging Asian markets including Vietnam (13%), India (13%) and Indonesia (13%) as well as the well-established Chinese market (8%).[25]

With a strong standards-based regulatory regime, clear legislation around the substantiation of health claims and a global reputation for safe products, Australia possesses the high levels of trust required for F&A products consumed for health and wellbeing outcomes.

Case study

Foods from the Earth

Foods from the Earth is a Brisbane-based company with an innovative chemical-free process that neutralises the astringent flavours associated with pulses (particularly mungbean but also chickpeas and fava bean) whilst retaining the nutritional benefits of these functional foods. The technology is used to create a range of raw material ingredients and food products which Foods from the Earth has commercialised both domestically and in SE Asia, supplying ingredients to food processors, and the consumer range, 'Notnuts', to retailers.

Ingredients and products derived from this process maintain the nutritional integrity of pulses without the typical taste, which is often a barrier to their consumption in the domestic market. They also have the added benefit of being allergen-free.

Foods from the Earth's patented technology gives them a leading position in this market which they continue to strengthen through strategic research collaborations and wider relationships, particularly with international partners that help them access export markets.

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INDUSTRY OPPORTUNITIES

FREE-FROM AND NATURAL FOODS

Middle and high-income consumers are looking for as few ingredients as possible aside from what they are buying the product for, leading to higher demand for organic, preservative-free, sugar-free and free from trans fats products. Growth in intolerances (be they medically diagnosed or perceived) are increasing demand for gluten-free, fructose-free and dairy-free processed products. Globally, over 220 million people suffer from food allergies and most countries report an increase in incidence.[26] It is predicted that by 2050 the number of patients affected by allergic diseases in Australia will increase by 70% to 7.7 million.[27] By 2021, the markets for naturally healthy (US$291 billion), food intolerance (US$42 billion) and organic products (US$45 billion) are expected to have grown at up to 4.5% compound annual growth rate (CAGR).[28]

SUPPLEMENTS

As consumers become increasingly health conscious and time poor, dietary supplements are expected to rise in popularity. More diverse options for vitamin and mineral tablets will be sought for those wishing to ensure a better balanced diet however most opportunities exist in addressing specific needs associated with lifestyle. For example protein supplements for muscle development in the ageing, weight loss supplements for the obese and tailored supplements for pregnant women. Global sales of vitamins and dietary supplements is the fastest growing and largest segment of this market, estimated to grow at 3.3% CAGR to US$107 billion by 2021.[27]

FORTIFIED AND FUNCTIONAL

With similar drivers to the demand for dietary supplements, fortified and functional foods and beverages also present as a significant opportunity. This category includes whole products designed to provide a specific health benefit above and beyond basic nutrition. The market for sports and energy drinks has grown at 5.5% CAGR between 2011 and 2016 (to over US$50 billion) and is predicted to continue to grow at 4.2% CAGR to 2021.[27] Prebiotics that naturally occur in many horticulture (bananas, asparagus) and wholegrain (wheat, rye) products could also see growth due to their ability to increase the activity of 'good' bacteria.

PERSONALISED NUTRITION

As consumers seek more customised products and services, designing meals for niche demographics or individuals could be the next disruption to the current F&A value chain. Instead of one-size-fits-all diet plans, consumers could have tailored products or diets created by pairing external information (exercise, weight, age, sleep patterns, environment) with internal information (genetic information of taste and odour sensitivity and responses to food measured through blood glucose readings and microbiome analysis). As the price of genomic screening continues to fall, predisposition to various diseases could also be included. In addition, the fusion of physical, digital and biological disciplines will drive the fourth industrial revolution and may enable improved ways for personalising genotype-based nutrition.

26 WAO (2011). *WAO White Book on Allergy*, 47-53.
27 Australian society of clinical immunology and allergy inc. (2013). *Allergy and Immune Diseases in Australia (AIDA) Report 2013.*
28 Euromonitor International

EXAMPLE PRODUCTS FOR HEALTH AND WELLBEING

NOW	AHEAD
• Lactose free dairy products, gluten-free barley to produce gluten-free cereals and beer. • Organic and low chemical varieties of all major primary produce. • Alternative animal products for different cultural markets such as sheep yogurt for the 1 billion+ HALAL consumers in the APAC region.	• Natural and healthier sweeteners and preservatives to replace artificial ones. • Altered forms of common indigestible ingredients and allergens to aid digestion (i.e. moving from free-from to developing tolerable varieties of lactose, gluten and allergenic free nuts). • Vitamin D, zinc, folic acid and iron.
• Ingredients such as whey protein powder for muscle development or infant formula. • A series of unscientifically validated multivitamins or supplements that provide benefits that can easily be gained through a balanced diet.	• Horticulture produce farmed on marginal land specifically for use in nutraceuticals – cheaper land and farming/ processing practices as qualities such as appearance and taste not important. • Scientifically validated supplement tablets that target a wider range of holistic health outcomes including stress and anxiety. • New and more natural sources of supplements.
• Antioxidant rich processed foods including breads, cereals and beverages. • Reduced digestibility of foods for better gut health. • Probiotics and Omega-3 oils added to fruit juices, milk, yogurt and eggs.	• Yogurt with higher protein ratios and more digestible textures for the elderly. • Omega-3 enriched grains (e.g. canola). • Cereals and grains with higher resistance starch for improved gut health.
• Generic diet plans for certain demographics (athletes, the elderly) but not tailored to individual environments, consumer preferences, lifestyles and genetic makeup. • Increased nutrient absorption and nutrient rich meals for the elderly. • Individual enzyme capsules for food intolerances (e.g. lactase tablets).	• Meat products with structural changes that provide easily chewed, swallowed and digested protein sources for sufferers of dysphagia. • Genetic testing to identify nutritional needs and digital models for analysing food interactions with gut microbiota. • Targeted enzyme formulations for unique deficiencies, medical conditions and digestive health. • Personalised nutrition e-tools that draw on mobile methods and real-time sensor technology.

Case study

Flavour Creations

Flavour Creations is Australia's leading supplier of high tech foods targeted at Dysphagia management (difficulty swallowing). Dysphagia typically affects the elderly and those with neurological conditions of all ages. The condition presents significant dangers of choking and aspiration pneumonia. Additionally, malnutrition and dehydration is commonly caused by loss of appetite. Flavour Creations has established a broad range of nutritious foods and fluids through their in-house research and development (R&D) department and collaborations with external research partners.

Flavour Creations is leading developments in food and beverage thickeners, textured foods and pre thickened fluids, supplying nutritional specialty food products to hospitals, residential aged care facilities and direct to consumers living in the domestic community and internationally. Along with a range of foods and fluids engineered to meet the client's specific needs, in 2016 Flavour Creations launched their patented "Dysphagia Cup" designed specifically to reduce neck extension enabling a safer swallow with 100% of the fluid able to be consumed.

CURRENT RESEARCH QUESTIONS

- How can free-from products, that are manipulated for health reasons (clean labels), such as sugar-free options, maintain their levels of shelf-stability and quality after removing these preservatives?
- How can we use technology to reduce fat content, or reduce the body's absorption of fat, while maintaining flavour?
- How can more advanced forms of technology, such as advanced IT systems and machine logic, be used to develop more sophisticated methods for substantiating product health claims beyond proof of concept?
- What minerals and vitamins are important for our bodies that we aren't yet aware of and what health benefits of existing foods and beverages exist that we aren't yet aware of?
- How can the production time of novel therapeutic foods be reduced to allow efficient clinical trials and a faster route to market?

EXAMPLE EMERGING TECHNOLOGIES FOR USE IN CREATING PRODUCTS FOR HEALTH AND WELLBEING

- Genetic tools including Whole Genome Sequencing, microbiome sequencing, gene editing, RNAi editing, real-time monitoring of health status and predictive modelling will improve understanding of digestive health, our interactions with food and new food formulations.
- Improved synergistic formulations (e.g. synbiotics) and designed systems for delivery of healthy ingredients and bioactives to the desired sites in the body, enabled by micro- and nano-encapsulation technology, for higher bio-efficacy.
- Microencapsulation, inoculation, bilayer tablets and synbiotics that provide better delivery and optimal conditions for healthy ingredients.
- New enzyme technologies for texture modification and improved digestibility of food components, including the development of new enzymes, rational computational design and modelling enzyme activity and its impact on gut health.
- Selective breeding, fermentation and fortification for the creation of new and enhanced functional foods.

Sustainable solutions

Environmentally and socially responsible manufacturing processes and products, and the recovery of novel, value-added products from waste streams.

DRIVING MEGATRENDS

- **A less predictable planet**
- **Smarter food chains**
- **Choosy customers**

KEY STATISTICS

- 312,000 tonnes of food is wasted annually by the Australian food manufacturing industry.[29]
- Agricultural water use is projected to increase by 20% globally by 2050.[30]
- The percentage of global survey respondents who were willing to pay more for sustainable brands increased from 50% in 2013 to 66% in 2015.[31]
- Australia ranks 16th out of 80 countries regarding global perception of a green economy, but only 55th for performance.[32]
- On the 30th June 2016, the Australian Government committed to halving Australia's food waste by 2030.

29 Verghese, K. et al (2013). *The role of packaging in minimising food waste in the supply chain of the future*, RMIT University Centre for Design, 3 (3), Melbourne.
30 UNESCO and World Water Assessment Programme (2016). *The United Nations World Water Development Report 2016 – Water and Jobs*. Perugia, Italy
31 Nielsen (2015). *The sustainability imperative – New insights on consumer expectations*.
32 Dual Citizen LLC (2016). *The Global Green Economy Index 2016*, 5th edition, September 2016.

4.2 Sustainable solutions

Along with the water-energy-food nexus, agriculture sectors across the world are being increasingly challenged by the impacts of climate change. In many F&A industries, maintaining high standards of environmental sustainability (e.g. reduced water, energy, waste and land footprint) and animal welfare have already transitioned from being potential differentiators to accepted costs of doing business. The remaining sources of differentiation typically fall within the social responsibility category, with premium prices still able to be charged for brands and production processes that engage the community, prioritise worker wellbeing and ensure the ethical treatment of livestock.

While reducing inputs and waste presents significant opportunities for reducing the cost of production, these environmental credentials are now considered a baseline requirement for many product categories. While this is reducing the potential for charging price premiums, these credentials are still important to consider in relation to social licence to operate. The exception is the generation of new streams of revenue from waste and sustainable packaging – both of which are likely to become common value-adding practices across the sector in the next 20 years.

Australia currently falls behind Europe in embracing circular bioeconomy concepts, however with the nation's clean and green reputation and extensive knowledge in F&A, the sector has strong potential in becoming a recognised global player in sustainable forms of value-adding.

Case study

Natural Evolution

Every week in Far North Queensland 450-500 tonne of bananas are wasted due to being out of supermarket specification, or over supply. After suffering devastating losses in 2 cyclones, Natural Evolution was born, creating banana flour from 'waste' bananas. Since this time, Natural Evolution has built a pharmaceutical grade green banana processing plant and designed world first technology to take unsaleable produce with a few weeks/ days shelf life and turn it into high value food source which can be stored for many years. The company's NutroLock process has been proven to lock in properties such as antimicrobial characteristics 20-50 times more effectively than conventional practices.

The company has focused on producing large output with minimal energy use. Natural Evolution has grown plantations of bananas which use 25% less water and fertiliser. The company has also scientifically proven that green bananas are the richest source of resistant starch – a prebiotic nutritional supplement. Commercial interest in the product and process has seen representatives from Europe, America, Japan, South Korea, China, and Africa visit the facility and plantation in Walkamin, QLD.

In the near future, Natural Evolution will be expanding into high-antioxidant skin care and banana ointments that have been transformed from their factory's waste (e.g. green banana skins).

INDUSTRY OPPORTUNITIES

WASTE CONVERSION

Roughly one third of the food produced in the world (~1.3 billion tonnes) gets lost or wasted, with fruits, vegetables, roots and tubers having the highest wastage rates.[33] Much of this is caused by the rigid product specification requirements of retailers and export destinations, which will be increasingly harder to meet as farming conditions become more unpredictable and varied.

There are significant opportunities – both at the primary production stage and processing stage – to generate edible and non-edible products from waste streams. Particularly for established sectors operating with traditional (higher waste) processes such as dairy and meat. As these opportunities leverage existing materials, the costs associated with developing a new production line are significantly reduced. For example fish oil can be extracted from fisheries waste – a market expected to reach over US$2.6 billion by 2020.[34]

ALTERNATIVE PROTEIN SOURCES

As Asia's middle class continues to rapidly expand, the demand for protein will explode. With global resource constraints putting limits on meat production, alternative and more sustainable sources of protein offer an opportunity to fill this gap. The most commercially viable alternatives at present are plant-based proteins, with soy leading the way in popularity and price but may experience limitations associated with being a major food allergen. Insects and algae are currently smaller markets but growing rapidly as Asian and African markets seek more sustainable sources of protein. The global edible insect market is expected to grow from US$34 million in 2015, to over US$520 million by 2023.[35]

SUSTAINABLE PACKAGING

Enormous quantities of packaging are heading towards landfills, ending up in waterways or contributing to the 'Great Pacific Garbage Patch'. The F&A sector is a major contributor, using 65-70% of all packaging produced in Australia.[36] Lower impact packaging options like biodegradable plastics, reusable containers or packaging made from recycled material can all act as points of differentiation. The shift towards more sustainable packaging has made minor inroads with over 900 signatories of the Australian Packaging Covenant, committing to designing more sustainable packaging and increase recycling rates. However limitations remain for businesses who import inputs from other countries which can include substantial amounts of non-sustainable packaging.

GREEN AND ETHICAL VALUE CHAINS

Growing concern over environmental impacts and ethical integrity throughout the supply chain is driving the demand for sustainable and ethical production, increasing consumer demand for accreditations such as Fairtrade, free-range and other eco- certifications. The value of goods sold with these accreditations was estimated to be over EU 533 billion in 2015.[37] Consumer information and education is critical to achieving a premium for such credentials, with studies showing that willingness to pay is dependent on how informed consumers are about what these labels actually mean.[38]

33 Food and Agriculture Organization of the United Nations, *SAVE FOOD: Global Initiative on Food Loss and Waste Reduction*. Available at: http://www.fao.org/save-food/resources/keyfindings/en/ [Accessed 28 March 2017].

34 Allied Market Research (2015). *Global Fish Oil Market (Application, Species and Geography) - Country Analysis, Size, Share, Trends, Company Profiles, Demand, Growth, Opportunities, and Forecast, 2014 – 2020*.

35 Global Market Insights (2016). *Edible Insects Market Size Set to Exceed USD 520mn by 2023, With Over 40% Growth From 2016 to 2023.*

36 Environmental Enterprises. *Sustainable Food Packaging For Our Future*. Available at: http://environmentalenterprises.com.au/sustainable-food-packaging-for-our-future/ [Accessed 28 March 2017]

37 Euromonitor International

38 Risius, A. and Hamm, U. (2017). *The effect of information on beef husbandry systems on consumers' preferences and willingness to pay*, Meat Science, 124, 9-14.

EXAMPLE SUSTAINABLE SOLUTIONS

NOW	AHEAD
• Dietary supplements, bioactives and food additives (e.g. sweeteners, colouring and whey) extracted from food processing waste. • Bovine blood cooked into blood meals for fertilisers or animal feed. • Extraction of fish oils and Omega-3 from heads and skeletal remains of aquaculture waste. • Extracting nitrogen and phosphorus from dairy processing waste water for use in low grade fertilisers.	• Higher value uses for crop residue – moving away from fertiliser and towards fodder, biofuels, bio-oils and paper production. • Moving dairy waste products like acid whey and permeate away from uses in pig feed and toward uses in the creation of products for human consumption. • Extraction of nutraceutical ingredients from plant waste, including carotenoids, vitamin D from plant stalks, and functional oils from plant leaves. • Extract immunity boosting compounds from bovine blood for use in dietary supplements and ingredients. • Closed loop production where any 'waste' streams are utilised in other production processes.
• Plant proteins including soy, pea and rice. • Hemp seed and ancient grains such as Quinoa and Chia with added benefits such as Omega-3 and -6 oils and short maturation/rotation time.	• Insect-based ingredients (e.g. flours), snacks and animal feeds that draw on crickets, meal worms, locusts and ants. • Automated offshore aquaculture systems to increase fish production and reduce pressure on wild fish stocks. • Increased use of pulses (e.g. chickpea, faba bean and mungbeans) – which consumers are already very familiar with across SE Asia – in flours, spreads, snack bars, cereals and meat replacers. • Meat and dairy products produced in vitro.
• Biodegradable packaging and bioplastics. • Low embodied energy packaging materials.	• Packaging made from recycled and re-used materials. • Edible protein-based packaging (e.g. casein) that replace plastic films and more effectively combat spoilage.
• Off-grid self-sufficient seawater greenhouse systems. • Feeding algae to ruminants for improved meat quality and reduced methane emissions. • Natural and quality-enhancing prawn feedstocks that replace the need to use decreasing wild fish stocks.	• Precision agriculture systems including drones, networked farms and cloud-based decision support systems. • Urban farms to reduce land use issues and climate challenges. • Crop biofactories that use plant-based oils to produce alternative compounds for specific industrial use (chemicals, plastics and lubricants). • Protected cropping of short life-cycle and high density produce to provide year-round breeding (e.g. microvine table grapes in glasshouses and growth rooms).

Case study

Sundrop Farms

Sundrop Farms is pioneering sustainable greenhouse technologies using seawater and sunlight for commercial horticulture crops. Beginning with a pilot facility in the arid lands north of Port Augusta with support from the SA government, Sundrop secured a 10-year contract with Coles supermarkets to supply 15,000 tonnes of truss tomatoes per year. This first contract led to around $100 million in finance from venture capital firm KKR, enabling the construction of Sundrop's first fully operational 20-hectare farm in Port Augusta. Along with tomatoes Sundrop is trialling new crops and varieties and has new farms in Portugal and the USA.

Products are grown in highly controlled greenhouse conditions and are not genetically modified. These dual benefits of controlled, sustainable production and natural attributes provide Sundrop products with a major differentiating factor for consumers.

CURRENT RESEARCH QUESTIONS

- What production techniques and processes can be used to shift from using waste streams as a secondary source of revenue to generating no waste at all (e.g. improvements to shelf stability)?
- How can we preserve the sensory quality (taste, texture) and nutrition of 'waste' biomass so that it can be stabilised for transport before further processing into food ingredients and products?
- How can existing modelling techniques be used to estimate the land and soil impacts of a zero-waste / closed loop F&A economy?
- How can Australia reduce its reliance on chemicals for pest and disease control (e.g. through the development of pest and disease resistant varieties or sensing devices for early detection)?
- How can Australian research and industry work together to help developing regions improve their resilience to an increasingly volatile world (geopolitical instability, warzones, and climate change) by helping them produce more food domestically, stabilising their markets and ultimately creating a new customer base?

EXAMPLE EMERGING TECHNOLOGIES FOR USE IN CREATING SUSTAINABLE SOLUTIONS

- Biogasification and fermentation can be used to extract remaining value from food waste after high value markets have been prioritised.
- Processes that transform residues from food manufacturing into packaging materials. For example sugar cane bagasse converted into a compostable plastic substitute consisting of lactic acid produced by fermentation and distillation of dextrose.
- Extraction processes such as dry milling, hydrodynamic cavitation and ultrasound-assisted extraction to recover protein from alternative sources such as pea and quinoa to offer better texture, taste and complete amino acid profile.
- Water management technologies including micro irrigation, off-grid desalination, sprayable polymers, hydroponics and aeroponics for increasing sustainability in production and building in environmental credentials to a business's brand.
- Separation science and technology for extraction of bioactives and functional ingredients from food loss and side streams of food processing.
- Microbial conversion (fermentation) of biomass into edible and non-edible products.


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Premium interactions

Products that fetch a premium price due to quality and convenience, luxury status, novel attributes or their integration with food-based experiences.

DRIVING MEGATRENDS

- **Choosy customers**
- **One world**
- **Smarter food chains**

KEY STATISTICS

- By 2022, China's middle class alone could rise to 630 million people, accounting for 45% of China's population.[39]
- By 2030, 60% of global households will be living in urban areas (up from 54% in 2014).[40]
- Spending on dining out in China is expected to grow by 10.2% per year from 2012-2022.[41]
- The global luxury food market is estimated to be between US$50b-$140b.[42]
- The CAGR for luxury sales in Asia between 2009-2014 was 15%.[42]

39 Australian Trade Commission (2015), *Northern Australia: Emerging opportunities in an advanced economy.*

40 United Nations, Department of Economic and Social Affairs, Population Division (2014). *World Urbanization Prospects: The 2014 Revision, Highlights.*

41 Atsmon, Y. and Magni, M. (2012). *Meet the Chinese consumer of 2020*, McKinsey & Company. Available at: http://www.mckinsey.com/global-themes/asia-pacific/meet-the-chinese-consumer-of-2020 [Accessed 7 December 2017].

42 Euromonitor International

4.3 Premium interactions

The rising Asian middle-class is predicted to drive a sharp increase in spending on high-end F&A products, with higher disposable incomes leading to more discretionary spending. The way consumers are seeking to engage with premium offerings is also changing, with convenience and sensory experiences in growing demand.

At the same time, Australia's increasing difficulty in competing on price means that local businesses have little option but to target premium and high quality global markets.

Importantly, the definitions of 'premium' vary across export regions and industries, and need to be considered when developing, branding and marketing such products. The following discussions define premium as the highest quality options within commoditised goods whereas luxury refers to products that hold a particular status due to their rarity and/or association with social class.

The way consumers are seeking to engage with premium offerings is changing, with convenience and sensory experiences in growing demand.

Case study

KitKat

Nestlé's KitKat product range now includes specialty retail pop-up stores where consumers can design their own personalised KitKat which is then produced on site by expert chocolatiers. Product packaging is also custom made. After trialling the concept with a number of pop-up stores around the world Nestle established their first permanent store in Melbourne, followed by Sydney and now has a further eight stores in Tokyo. Nestle have tailored new KitKat flavours for Japanese customers that include green tea, cherry blossom and soybean.

The KitKat brand has a long history of innovation in Japan, including 'postable' KitKats with space to write messages to take advantage of the trend of sending KitKats to university students ahead of exams. KitKats are also available in elaborate packaging which makes them ideal for the large gift-giving market in Japan and China. This personalisation, from cultural down to the individual level, has contributed to KitKat's enormous international success, including being named the 'most influential candy bar of all time' by Time magazine.

INDUSTRY OPPORTUNITIES

CONVENIENCE WITHOUT COMPROMISE

Combinations of increasing wealth, ageing populations, urbanisation and busy lifestyles are driving demand globally for high quality, convenient fresh and packaged products – both for home and out-of-home consumption of snacks and whole meals. Reports of contamination and poor hygiene among independent food service outlets and street vendors in Asia have led to perceptions that ready meals have better standards of safety and hygiene.

Ready meals have experienced significant growth in Japan (over US$15 billion market size) largely due to their growing elderly population.[43] Chilled and frozen ready meals are also seeing growth across Asia with the increasing reach of the cold chain and growing levels of refrigerator ownership in cities.

LUXURY PRODUCTS AND GIFTS

Luxury products are those with limited availability, a high price or hold some form of symbolism (e.g. an indicator of social status). With large numbers of high net worth individuals, significant wealth disparities[44] and a gift giving culture centred around food and beverages, opportunities exist to export luxury food and beverage products across Asia. The luxury food market is dominated by the food service segment (i.e. for consumption in restaurants and hotels) rather than the retail segment, although opportunities in retail are growing.[45]

The CAGR for luxury sales in Asia between 2009 and 2014 was 15%, with cities such as Tokyo, Hong Kong, Beijing, Shanghai and Seoul among the world's top 10 luxury markets.[46]

EXPERIENCES AND TOURISM

With younger generations prioritising experiences over material goods, demand is growing for new ways of interacting with food. These opportunities are not restricted to the retail end of the value chain, with growing interest from tourists and local consumers in combining the rural landscape of Australia's pre-farm gate operations with local produce for enhanced dining experiences. Tourists often continue to eat the cuisines of their travel destinations long after they return home. Expanding into service offerings can add value to existing product lines through brand extension and open up demand in potential export regions.

NOVEL TASTES, SMELLS AND TEXTURES

The ability to continually release products with novel properties is becoming increasingly important to satisfy consumers' demands and differentiate from competitors. This can be done through breeding techniques at the agricultural level or by processing techniques to create exciting new taste, smell and texture profiles. These opportunities need not be restricted to novelty one-off purchases, with scope for improved sensory qualities of more familiar products such as grains, fruits and vegetables.

43 Euromonitor International

44 United Nations University, UNU-WIDER. *World Income Inequality Database*. Available at: https://www.wider.unu.edu/project/wiid-world-income-inequality-database [Accessed 13 January 2017].

45 Frost and Sullivan (2015) *Functional and Luxury Foods Market Analysis,* for Primary Industries and Regions SA, Government of South Australia, Adelaide, Australia

46 The Australian Wine Research Institute, Government of South Australia and SARDI (2015). *Luxury wine opportunities for South Australia in Asia*.

EXAMPLE PREMIUM INTERACTIONS

NOW	AHEAD
• Pre-made slow cooked and smoked meats. • Pre-proportioned cooking ingredients including liquid stock and individually packaged ingredient portions. • On-the-go liquidised breakfast meals. • Ambient yogurt that doesn't require refrigeration.	• Direct delivery of food using automated digital systems. • Portion innovation – packaging, labelling and portioning aligned to daily serve requirements. • Micro-climates in apartment complexes for home grown food in urban areas. • Functional packaging that helps to control microwave performance (evenly heated dishes), provides modified atmosphere and/or is easy to open for frailer hands. • Single convenient meals that contain 2+ serves of fruit and 5+ serves of vegetables.
• Traditional luxury products such as spirits, wines, oysters, oils, truffles and cherries. • Selectively bred cattle for optimised meat quality. • F&A businesses partnering with high-end designers to cross-promote through unique packaging of luxury product lines.	• Blended products that combine luxury items (e.g. truffle infused oils) or uniquely paired gift boxes (e.g. cherries and chocolates).
• Events and tours at vineyards and farms that use local produce for catering. • Experience-based restaurants that incorporate novel ingredients such as gold leaf and liquid nitrogen. • Dietitian or farmer led store/factory/farm tours for consumers to learn more about the benefits of their food and how it is made.	• Virtual reality dining where consumers are immersed in the sights, sounds and smells of the meal's country of origin. • Products customised to an individual's sensory palate. • Restaurants that utilise facial scanning technology to assess mood and suggest a personalised menu.
• Miniaturised fruit and vegetables. • New varieties such as New Zealand's golden kiwi fruit. • Enhancing existing products with flavours from other regions, such as dry pasta infused with chilli, turmeric and saffron.	• 3D printed confectionary with novel shapes and personalised designs. • Carbonated fruits. • Vegetables with altered flavour profiles to encourage children to eat them. • Horticulture vapours.

Case study

Andrews Meat Industries (Creative Food Solutions)

Creative Food Solutions (CFS) is a brand established by Andrews Meat Industries to diversify into value-added meat products including full ready-to-eat meals featuring slow-cooked beef and lamb, centre plate meals and premium sauces and soups. By diversifying into cooked meals, Andrews Meat Industries has been able to capture a greater share of the value chain and with all facilities fully AQIS certified is ready to expand into new export markets. This expansion has been enabled by innovation in high-throughput cooking facilities within Andrews' 'sous vide' industrial kitchen including custom designed and locally built integrated potato cooking/mashing machine, mixer kettle and semi-automated steak cutting system.

CURRENT RESEARCH QUESTIONS

- What types of food safety risk management steps need to be created to ensure novel food ingredients, products and technologies are safe prior to commercial sale?
- With the growing amount and complexity of information that can be captured when creating novel products, how can the user interface remain simple and informative?
- Which breeding/harvesting times and conditions optimise taste and quality attributes, and how can real-time sensing be used to best monitor these attributes?
- What new varieties of fresh produce can be bred that provide a long shelf life for fresh cut products?
- What sorts of packaging designs and innovation will help promote the consumer's food experience in premium markets?

EXAMPLE EMERGING TECHNOLOGIES FOR USE IN CREATING PREMIUM INTERACTIONS

- Processing technologies are key to enabling products with novel properties and include 3D printing, high pressure processing, sonication, shockwave technology and pulsed electric fields.
- Predictive modelling and data science are critical in formulation science when attempting to improve the quality of products through enhanced textures and flavours. This modelling is required to better understand the impacts of altering the traditional compositions of foods.
- Packaging technologies such as nanocomposite films, intelligent packaging, electrospinning and tunable materials enable greater convenience and product presentation – particularly important for the gift-giving culture in key Asian export markets.

Enabling growth

5 Enabling growth

For many businesses, pursuing the opportunities presented in the previous chapter will involve transitioning to new product lines and business models.

This chapter highlights cross-cutting enablers that are key to unlocking all of the strategic growth opportunities discussed. The topics were informed by interviews with both industry and research, with some being primarily driven by advances and investment in science and technology while others require broader operational changes at the business and ecosystem level.

The five enabler topics in this chapter do not represent an exhaustive list for unlocking value-adding opportunities. Broader concepts like capital financing and regulation are also critical in supporting sectoral growth however are not within the scope of this report. Other reports such as the Australian Food and Grocery Council's *State of the Industry 2016* report and the Business Council of Australia's *Building Australia's Comparative Advantages: A 21st Century Agrifood Sector* discuss these themes.

ENABLING SCIENCE AND TECHNOLOGY

Future growth opportunities for Australia's F&A sector will be underpinned by significant technological innovation from public and private research communities. Science and technology is playing a bigger role than ever before in creating new markets. Sustained growth in the sector will require proactive investment and translation of enabling science and technology, involving transdisciplinary teams and transpartisan relationships.

Transdisciplinary science will be at the heart of major breakthroughs over the next 20 years; providing significant competitive advantage to businesses that pursue the fast and efficient adoption of new technologies.

Sustained growth in the sector will require proactive investment and translation of enabling science and technology, involving transdisciplinary teams and transpartisan relationships.

Like the opportunities, the enabling science and technology areas discussed are not an exhaustive list and should not be considered in isolation as there are synergies in combining them. Much of the enabling technology is already available in some form, but is yet to be applied by industry for specific F&A applications or consistently across the F&A sector.

Further, as per the scope of this report, the science and technology areas discussed focus on unlocking value-adding activities or markets, rather than improving productivity on-farm/factory or over the value chain. Technologies that relate to the latter, such as the myriad of Internet of Things applications that can significantly improve margins and efficiency, should also be considered among R&D portfolios.

New breeding techniques

GMOs (genetically modified organisms) are a part of Australia's history, with selective breeding, hybridisation and the addition of exogenous genes still being used today (e.g. Australia's cotton industry is >99% GM). They are also part of Australia's F&A future, with industry noting the importance of GMOs in supporting the survival of primary agricultural production as climate change harshens farming conditions and global biosecurity threats evolve.

Without doubt, there will be many opportunities and challenges that cannot be addressed without GMO technology. However, largely because of consumer acceptance issues, and the high costs of deregulation, the commercial use of GMO technology in Australian crops is limited. Both domestically and globally, the transition to consumer acceptance of GMOs as staple crops (e.g. rice and wheat), or for livestock and aquaculture production, is a roadblock.

With consumer appetites shifting towards more 'natural' offerings, there is renewed commercial interest in new non-GMO breeding techniques – such as gene editing – which have the potential to give rise to a range of products with enhanced quality and novel attributes. This area of science clearly demonstrates the need for enabling technologies and ecosystem actions to be considered together in order to unlock the benefits for Australian businesses and consumers.

ACTIONS

Each of the discussions concludes with a list of recommended actions for unlocking the enablers. All of these actions can benefit from a unified and collaborative approach across the F&A ecosystem, however the lists have been separated into:

- Business actions – those that can be proactively led by businesses; and
- Ecosystem actions – those requiring a more collaborative effort across businesses, industry bodies, suppliers, research, education, investors and/or government.

5.1 Traceability and provenance

Rising product fraud, non-linear value chains and increasing requirements from overseas customers for authenticity and transparency are driving the demand for increased traceability and authenticated provenance claims.

Food fraud costs the global food industry an estimated US$40 billion each year[47], with the United States (29.8%), China (13.6%) and India (12.6%) being the largest sources of fraudulent production.[48]

Assuring provenance can assist in avoiding or minimising fatalities and illnesses attributed to inferior product substitution as well as create additional capacity to export as fraudulent suppliers are removed from the market. Authenticity checks should not be restricted to the product content, with process and marketing fraud also prevalent.

Trust is a critical factor for export markets. Traceability systems provide the opportunity for Australian agribusinesses not only to effectively leverage the nation's clean and green reputation, but also to build a strong image of being environmentally sustainable and socially responsible. Australian businesses will need to invest in both virtual and physical technologies that provide greater transparency around product origin, production inputs, suppliers, processing materials, transport and distribution.

Developing solutions that provide assurance of provenance and rolling the systems out across entire value chains is not cheap and will require whole-of-industry support and facilitation. Currently, not all industries stand to gain equally from these solutions, with the highest needs among industries with high levels of fraud (olive oil, fish, milk, grains and honey[48]) or where products are being sold with premium or organic credentials that require validation.

Australia falls in the middle of OECD rankings on food traceability due to having a high quality or mandatory system for specific commodities, such as livestock identification, but not all commodities.[49]

FIGURE 9 – INFORMATION REQUIRED OF F&A BUSINESSES FROM DOWNSTREAM PARTNERS

NOW TOP RESPONSES FROM GLOBAL SGS SURVEY[50]		AHEAD ADDITIONAL FUTURE INFORMATION SOUGHT
Analytical test results (78%)		Nutrient profile
Country of origin (76%)	+	Production technique
Packaging specifications (75%)		Genetic makeup
Site certification information (64%)		Environmental impacts
Allergen/free-from status of ingredients (58.2%)		

47 PwC (2016). *Food Fraud Vulnerability Assessment and Mitigation - Are you doing enough to prevent food fraud?*

48 Johnson, R. (2014). *Food Fraud and "Economically Motivated Adulteration" of Food and Food Ingredients.* Congressional Research Service.

49 Charlebois, S. et al. (2014). *Comparison of Global Food Traceability Regulations and Requirements,* Comprehensive Reviews in Food Science and Food Safety, 13(5) 1104-1123.

50 Komitopoulou, E. (2015). *Supply Chain Management. How well do you know your supply chain?.* SGS, Geneva, Switzerland.

ENABLING SCIENCE AND TECHNOLOGY

The following discussions provide examples of key technologies that can unlock traceability solutions in the F&A sector. Ideal solutions will likely be a combination of digital tracking (RFID chips, bar codes, QR codes, blockchain) and biological readings (isotopic analysis, DNA fingerprinting, biomarker compounds).

Blockchain

A blockchain is an impenetrable, timestamped ledger of all transactions or events – in this instance across the value chain from farm to fork – that are added in a linear, chronological order. Coupled with smart contracts – legally binding computable code – this technology can be applied to automate and digitise business transactions. Blockchain is not limited to purely transactional data, with other viable features including tracking whether the package has been opened or tampered with at any point along the value chain and whether duties were paid.

Unlike biological readings, there is no need to tamper with the product itself or purchase expensive equipment for readings. With complex and often intermediated international value chains, blockchain solutions allow exporters to view where and when their product is traded once it leaves Australia; providing greater customer insights compared to the near zero transparency received today. This will reduce the rates of disintermediation and subsequent fraud.

At present, Blockchain is not commonly used in F&A value chains. Current limitations of the technology are that it is not suited to products that undergo transformation off-shore (difficult to continue tracking) and investment in significant digital infrastructure is required. In the future, larger multinational retailers could facilitate the adoption of this technology by requiring suppliers to use it, or governments could facilitate the move, but the initial outlay and risk is too great for an SME to adopt.

DNA-testing

Many traceability solutions begin at the packaging stage, either as a label on the product itself or its packaging. DNA-testing allows full chain traceability – beginning at the birth of the animal or the planting of the crop and continuing past transformation (a limitation of protein-based approaches). DNA barcoding[51] is effective in certifying both origin and quality of raw materials, and can detect adulterations (e.g. mixing products from different taxa). Genetic markers can also be added to foods for traceability purposes.

Consumer demand for animal welfare and safe meats, and the sophistication of existing systems[52], means that the most viable applications are in animal production industries. Application of this technology area can provide consumers access to information such as the weight, age and health of the animal in their meal as well as the conditions it was raised, transported and slaughtered under. Applications in fish products are also suitable due to the high number of species (high genetic variation) and difficulty in differentiating fish once filleted.

Plants, which are often clones or exhibiting limited variation, are more difficult to screen effectively. However in the distant future (20+ years), genetic screening could become so commoditised that DNA-testing is an economically viable provenance offering for all product types.

51 Galimberti, A. et al. (2013). *DNA barcoding as a new tool for food traceability,* Food Research International 50, 55-63.

52 Meat and Livestock Australia (2016). *About the National Livestock Identification System.* Available at: https://www.mla.com.au/meat-safety-and-traceability/red-meat-integrity-system/about-the-national-livestock-identification-system/ [Accessed 30 March 2017].

Isotope analysis

Elements exist as one of a number of isotopes[53]. Many elements found within F&A produce possess these natural variations that result in different physical, chemical and biochemical processes. Identifying these locally specific variations can assist in mapping products to regions, but not down to the individual plant or animal. The best isotopes to compare will differ depending on where the most variation occurs for any given product.

This approach to authenticating provenance is applicable across many F&A products, including horticulture, seafood and meat.[54] Isotopic analysis can also test for other incidents of fraud and substitution, such as the dilution of beverages with water, distinguishing between freshly squeezed and concentrate juices and distinguishing between organic and conventional cultivation of crops.[55]

Utilising this approach requires the development of a virtual global library of produce fingerprints (isotope ratios). Collecting and regularly updating these data sets comes at significant cost. Without publically available databases globally, businesses will typically create their own libraries that are limited to products and/or export regions that are considered at high risk of fraud.

Barcoding and image recognition technologies

As consumers demand more information about their product (provenance being only one category of information), labels on packaging are becoming increasingly dense with words. Some product lines and businesses have already shifted much of this information onto 2D QR codes that can be scanned by a consumer's smartphone and hold significantly more information than the slowly disappearing 1D barcode. Another form – DataBar barcodes – are used in fresh produce at the point of sale to provide information around weight and expiry date but could be extended to include more provenance information.

A possible disruption to these solutions in the packaged food industry is the rise of image recognition technologies, which can allow products to become their own digital barcode. This approach imperceptibly embeds the barcode across the entire surface of the package, freeing up more space for branding.

At present, these retail-side offerings do not converge with barcoding technologies such as RFID that are used across the value chain for product tracking and inventory management. While it may not be practical to use a single barcode for both purposes, implementing interoperable systems will allow businesses to draw on the tracking data to demonstrate provenance to consumers.

53 Atoms with the same number of protons but different number of neutrons.

54 Griffiths, S. (2014). *Stable isotope analysis for authenticating food origin.* Food Science & Technology.

55 FERA (2017). *Stable Isotope Analysis.* Available at: http://fera.co.uk/food-safety-quality/testing-analytical-services/isotope.cfm [Accessed 30 March 2017].

ENABLING BUSINESS ACTIONS

- **Develop data handling arrangements** – While much of the technology is available today, businesses along any given value chain must adopt systems in order for traceability solutions to be implemented. This will involve coming together to demonstrate how such an initiative would be in the best interest of all involved, agree on who owns data and how it will be used and governed, and develop secure systems for the sharing of data.
- **Understand drivers of demand** – Businesses must research current and intended export markets to identify whether provenance is a key purchasing decision for their product type. The driver of this demand is also important, with solutions differing depending on whether provenance is desired to address safety concerns or confirm authenticity of a premium status-related product.
- **Introduce unique identifiers on packaging** – Introducing sophisticated provenance tests or in-built trackers into value chains is not the only way for businesses to prove authenticity. Using unique and inimitable identifiers on packaging may provide a more cost effective solution and works under the assumption that if the packaging is authentic and has not been opened – so is the product inside. This is only suitable for products that do not undergo re-packaging across the value chain.

ENABLING ECOSYSTEM ACTIONS

- **Address domestic fragmentation** – In order for traceability solutions to be implemented effectively across value chains, efforts are needed in relation to the connection and streamlining of local industry. While advanced tracking systems exist in some industries, these leading systems need to be integrated across value chains by adopting interoperable digital systems and greater knowledge sharing.
- **Develop and promote brand Australia** – While Australia holds a reputation for producing safe, high quality products, the nation lacks a strong and unique brand that spans all states, territories and regions. While certain regions are known for specific products, this does not carry through to all Australian products and so limits the weight of a '100% Australian' provenance claim. To be effective, an Australian brand will require a more unified brand message and adaptive positioning of Australian food to be promoted to overseas markets by Austrade, FIAL, peak bodies and all levels of government.
- **Support industry-to-industry collaboration** – Having buy-in from end product markets is essential for the success of provenance tracking solutions. To facilitate adoption of these systems across global value chains, the co-creation of solutions may prove critical. Given the complexity of any single industry, it is likely that this collaboration will be more beneficial if industry-led rather than government-led.
- **Retain critical mass of production** – In order to attain benefits around '100% Australian' provenance claims, Australian businesses may require government support to economically justify keeping manufacturing or primary agriculture on-shore. Support can range from investing in systems or technologies that improve productivity and reduce the unit cost of production through to financial incentives. This is more likely to be needed where domestic businesses do not reap sufficient value from product transformation in domestic markets.
- **Identify key markets for targeted R&D efforts** – With traceability and provenance requirements and solutions varying significantly, Australia needs to target R&D towards specific markets and products rather than spreading efforts too thinly. Further investigation is needed to identify the most rational areas of focus.

5.2 Food safety and biosecurity

In many Asian markets, highly publicised food scares and an overall distrust in the safety and authenticity of local products is driving the growing consumer groups in middle and high income demographics to seek imported foods and beverages.

In absolute terms, South East Asia is the worst affected global region with 175,000 deaths a year attributed to food borne illnesses.[56]

The ability to provide consistent product, reliable supply and regular and transparent assurance that Australian food products are safe not only allows market access in these regions, but also enables the charging of premium prices and decreases the potential for non-tariff barriers.

TABLE 1 – THE GLOBAL BURDEN OF FOOD BORNE DISEASE IS OF A SIMILAR ORDER OF MAGNITUDE TO EACH OF THE 'BIG THREE' INFECTIOUS DISEASES

DISEASE	DISABILITY-ADJUSTED LIFE YEARS
HIV/AIDS	92 million
Malaria	55 million
Tuberculosis	44 million
Food Borne Disease	33 million

Source: Havelaar, A. et al (2015). *World Health Organization Global Estimates and Regional Comparisons of the Burden of Foodborne Disease in 2010*, PLoS Med 12(12): e1001923.

Science and technology that increases product shelf-stability will allow Australian produce to safely travel longer distances into Asian value chains, which often lack a complete cold chain. Solutions that remove or reduce the need for frozen storage and distribution will reduce energy costs, improve customer perception of freshness and nutrition, and provide businesses with a greater capacity to manage stock.

The key will be developing solutions that provide improved safety and stability without harming Australia's natural and high quality image.

In addition to improving the differentiation of Australian products in existing markets, creating safer and more stable products can open up access to niche markets, such as products for remote mining camps, military rations or servicing remote developing regions in South East Asia.

As discussed in Chapter 3, Australia's clean and green reputation is a vulnerable brand, with biosecurity risks and comparatively poor OECD food safety ratings[57] threatening the marketing strategy of many key product categories. While Australian consumers are trusting of products sold within Australia, the F&A sector should be investing in food safety and biosecurity solutions to preserve the nation's global reputation and keep the domestic market safe.

Better understanding microorganisms will be key to food safety solutions over the coming decades – both in terms of identifying ways to combat harmful foreign microorganisms found along value chains but also by better understanding the communities of microorganisms that naturally occur within fresh produce and the beneficial role they play.

56 World Health Organization (2015). *WHO estimates of the global burden of foodborne diseases,* Foodborne disease burden epidemiology reference group 2007 – 2015, Switzerland.

57 Charlebois, S. (2014). *2014 World Ranking Food Safety Performance*, The Conference Board of Canada.

ENABLING SCIENCE AND TECHNOLOGY

The following discussions provide examples of key technologies that can increase food safety in the F&A sector. Ideal solutions will likely be a combination of advanced production processes (creating safer and more stable products) and rapid real-time testing to identify contaminants before they spread or reach the end-customer.

Data analysis and modelling will be key to all combination approaches on the production side. Understanding the safety trade-offs inherent in changing ratios of elements such as heat treatment, acid content and preservative levels will allow production to be tailored towards the specific requirements of the end-product.

Advanced packaging

Focussing on packaging modifications can offer cost effective benefits when compared to product alteration. These solutions typically require less investment in R&D and have lower consumer acceptance hurdles as familiar products can remain unchanged.

There are a range of technologies that can be applied to packaging to improve food safety. Sensors can monitor environments to ensure products are kept within required temperature conditions. These can be linked to labels which change colour depending on temperature or time. Active packaging can be used to release preservatives in a controlled fashion or absorb moisture and odours during transport.

Hybrid high pressure processing

High pressure processing (HPP) is a relatively mature technology that is used routinely in almost 300 industrial units worldwide, mainly for cold pasteurisation of smallgoods, meals, beverages, dips and sauces. Many vegetative flora (i.e. bacteria, viruses, yeasts, moulds and parasites) are inactivated by subjecting products to pressures up to 600 MPa. This extends shelf-life, reduces the need for frozen storage and distribution and reduces the reliance on preservatives, with the absence of heat treatment maintaining colour, flavour and fresh-like characteristics.

By combining a thermal treatment with the HPP process, most of the HPP benefits relating to shelf-life and quality can be retained (compared to retorting and canning), with the additional benefit of inactivating the toxic bacterium *Clostridium botulinum*. Thereby extending refrigerated shelf-life or even allowing shelf-stable distribution.

Limitations of HPP include the current price (more expensive than conventional thermal treatment) and low throughput which restricts scaling.

Microwave assisted thermal sterilisation

This approach applies microwave at a frequency of 2450 MHz to heat products to sterilisation temperatures, resulting in a shorter heating time compared to conventional food processing techniques. This improves the retention of sensitive nutritional components, flavour, texture and appearance, and improves energy efficiency. In addition to these benefits, which can reduce a product's reliance on canning and refrigeration, the technology can also be applied for disinfestation of insects living in fruit.

Microwave assisted thermal sterilisation has been used for disinfestation of fruit fly infected fruit and vegetables with some initial success and may be suitable for a wider range of products, insects and postharvest plant pathogens. Further validation work on microwave technology is required to obtain quarantine approval from Australian and overseas authorities.

Blockchain and bio-sensing

While both of these technology areas alone can improve food safety across a value chain, there are tremendous synergies in pairing them. Blockchain, as mentioned under Traceability and Provenance, can be used for more than just contract management. It can provide an impenetrable register of a product's movements across the value chain. When coupled with emerging bio-sensing solutions, a range of information can be timestamped and reported in a reliable way that describes how the product is changing over this time.

Biosensors work by detecting a biological element (enzymes, whole cells or affinity biomolecules such as antibodies) and relaying the information through an electrical, optical or thermal signal. These tools can detect harmful microorganisms or chemical and physical contaminants. Rapid in-situ or in-packaging solutions may be supplemented with other rapid technologies such as rapid evaporative ionization mass spectrometry and desorption electrospray ionisation.[58]

58 Balog, J. et al. (2016). *Identification of the Species of Origin for Meat Products by Rapid Evaporative Ionization Mass Spectrometry.* J. Agric. Food Chem., 64 (23), 4793–4800.

ENABLING BUSINESS ACTIONS

- **Investigate and consider the impacts of non-tariff barriers (NTBs) to trade** – Government regulations and requirements differ substantially across export markets, as do the practices of retailers. Examples of NTBs include auditor costs, market access restrictions and shelf-life requirements that compel customers to freeze goods well before necessary and in doing so, removing the 'fresh' branding of the product. Navigating these requirements can be extremely costly to a business. Non-tariff barriers cost the red meat industry $3.4 billion annually, which equates to 15% of the red meat processing industry's gross domestic product.[59]
- **Enhance domestic food testing capabilities** – At present, many products are sent great distances to be safety tested. This is costly, takes longer and exposes Australia's food information (including potential risks) to export markets. Bringing this testing on-shore, or doing it in collaboration with trusted nearby partners such as New Zealand, will reduce both the risks and costs.

ENABLING ECOSYSTEM ACTIONS

- **Harmonise food safety systems** – Significant amounts of food safety data is collected under the various systems that exist across Australian jurisdictions, industries and individual businesses. Harmonisation of these systems will enable the sharing and aggregation of this data and help to unlock valuable knowledge for industry decision making. While a single system for all F&A stakeholders is not practical, having an over-arching system that can accept different forms of data and combine for insights in real-time is needed.
- **Increase in-process transparency of quality** – Greater transparency of the food safety levels of individual businesses is needed to keep businesses accountable and help consumers with purchasing decisions. Australia does not have a national whole-of-sector public reporting system like the USA Food and Drug Administration or the European Food Safety Authority. While these systems typically report on final product tests, the development of any similar Australian programs should investigate the use of emerging technologies to instead base the reporting around in-process real time monitoring. This will allow food safety issues to be identified earlier and remove the need for intense in-product testing at the end of the value chain.
- **Develop a national centre of excellence in food safety research and collaboration** – This entity would ensure Australia maintains world-class capability in food safety research. It would focus on addressing emerging food safety issues to protect Australian consumers and 'action priorities' put forward by the National Food Safety and Integrity Taskforce[60] as well as ensuring market access for Australian businesses. It would develop an engaged and innovative food safety culture within F&A businesses, act as an Asia-Pacific regional hub for food safety, innovation and regulation and be central to industry-led collaborative groups involving training, science and technologies for integrity assurance.

59 Williams, R. (2016). *International Competition: Reducing Non-Tariff Barriers*. Australian Meat Industry Council.
60 National Food Safety and Integrity Taskforce (2016). *Priorities & Collaborative Actions for Impact 2016 – 2021: Background*, 17 February 2016.

5.3 Market intelligence and access

One of the most common themes to arise from industry interviews was the significant lack of market intelligence – and related market scanning research skills – within Australian F&A SMEs.

While industry and government bodies provide some level of public information, it is typically high level and scattered across the many organisations at each level of industry and government. Further, many businesses are unaware of the support that exists, possibly again due to the complex network of supporting organisations and initiatives.

While external support could be improved, businesses need to intensify their efforts in collecting market intelligence tailored to their business's products and markets and use it to make evidence-based decisions. These efforts need to shift from focussing on local markets and competitors towards the global landscape. Understanding and continually monitoring consumer trends, demographics, supply chain shifts, their business implications and trade requirements is essential for establishing or growing exports.

Asia unquestionably presents key growth opportunities for Australian F&A. Fast growing economies of China and India, a former powerhouse in Japan, an increasingly affluent South Korea, and the fast-growing Association of South East Asian Nations (ASEAN).[61] Each possessing multiple regions and demographics that demand varying tastes, sizes, prices, packaging and branding, as well as differing in standard business practices, routes to market and competitive landscapes.

Businesses must unpack the hundreds of unique markets within Asia before tailoring their products for markets that best fit with the business's strengths.

In considering the opportunity themes, regions also vary in nutritional needs and definitions of healthy, sustainable and luxury. At the same time, Australian food companies must develop the capacity to exploit these market insights including developing cross-regional relationships, allocating dedicated internal resources and optimising operational processes.

ENABLING SCIENCE AND TECHNOLOGY

- **Sensors and data analytics** – Using sensors to track products through complicated international value chains that lack transparency can help businesses understand exactly where their product ends up, who the end consumer is and how the product is being used.
- **Artificial Intelligence** – Machine learning technologies can be used to monitor customer orders and better understand purchasing decisions (timing, quantity) as well as offering increased engagement with customers by reminding them when they are due for a new order and making recommendations based on previous orders.
- **E-commerce for perishable products** – While e-commerce distribution channels are common for non-perishable food and beverage products, they remain largely unutilised for perishable products due to their shorter shelf-life (more difficult to treat like stock). Digital infrastructure will be a critical enabler to support e-commerce, provenance and market access for extended shelf-life perishable goods that are developed through science and technology.

61 Barua, A. (2015). *Packing a mightier punch: Asia's economic growth among global markets continues,* Deloitte University Press, India.

ENABLING BUSINESS ACTIONS

- **Identify export destinations of best fit** – For businesses yet to begin exporting to Asia, it is critical to consider characteristics such as geographic proximity (distance for transport costs and time zones for communication), prevalence of English and similarity of laws and regulations. While size and growth of markets are important, this often comes with complexity. It may make more sense for a business to consider Hong Kong, Singapore, Japan or Malaysia over a giant like China or India to learn and develop export opportunities before progressing into faster growing markets.
- **Perform ongoing market research** – Asian markets often have dynamic regulatory arrangements, with requirements on imports changing frequently. While the bulk of market research is necessary prior to establishing an export route, ongoing research is required to stay on top of market movements and identify emerging trends in demand, enabling science and technology, competition, regulatory environments and the ever changing ways in which people are accessing food.
- **Understand requirements of food service customers** – With consumers in key Asian export markets shifting towards increased out-of-home dining, businesses need to increase their understanding of the differences between selling into food service value chains rather than retail. These changes in trade channels and end uses may require changes to packaging sizes, product sizes and shelf-life.
- **Get feet on the ground** – While transactions can occur through e-commerce platforms, Asian buyers in particular require face-to-face contact and relationship building before entering long term contracts. Businesses should attempt to invest in a local representative in each export destination to handle these relationships and any urgent issues that arise. These individuals are not just a conduit, but essential in building the local market and collecting market intelligence around changes in consumer demand, cultural practices that drive demand and regulatory requirements.
- **Use local immigrants for consumer research** – Australia is home to large populations who have migrated from a range of Asian countries. In the early stages of product development, businesses can utilise the palates of recently-arrived immigrants from target export destinations to refine the tastes, smells and textures of their offerings for a fraction of the cost and time of having the testing performed overseas.

ENABLING ECOSYSTEM ACTIONS

- **Develop publically accessible market analysis** – Given much of the market intelligence sought by SMEs is relevant across industries and product categories, there are opportunities to streamline the collection and distribution of this information, including: tariffs, regulatory requirements, channels to market and biosecurity protocols such as requirements for heat treatment, quarantine and irradiation. These differ across export destinations but also within Australia.
- **Provide industry seminars and workshops** – Provide free or low cost workshops for SMEs to learn about what you need to take into account when looking at Asian markets, understand the available funding sources for Australian businesses and hear real experiences from other similar businesses. Importantly, these cannot be one-off workshops but instead need to be part of a continual conversation between ecosystem players.

5.4 Collaboration and knowledge sharing

With a small domestic market and an industry predominantly consisting of small businesses, collaboration is essential for generating scale, efficiency and agility across rapidly changing value chains and markets.

Most businesses cannot access all the information required to be competitive, so the depth and quality of a company's networks and interactions is critical to its competitiveness.[62]

Current levels of business-to-business collaboration in the sector are typically unsophisticated and focus on relationships up or down the value chain. While these relationships are important, businesses need to expand their approach to include knowledge and resource sharing with local competitors and international peers. Such networks allow those involved to identify innovative solutions faster through pooled knowledge and experience. This will require a cultural shift – driven by stronger and more strategic business leaders – away from the existing environment of price-based competition and fear of local competitors.

Also enabling future consumer facing growth opportunities will be improved collaborative efforts between businesses and the research community. At present Australia ranks the lowest across OECD countries in terms of collaboration between industry and research.[63] Only a small proportion of Australian F&A businesses have a strong awareness of the breadth of capabilities that lie within the research community and even fewer have structures in place to take advantage of them.

At present Australia ranks the lowest across OECD countries in terms of collaboration between industry and research.

Australia's research community is frequently characterised as too complex and difficult to engage with. Common reasons provided by industry included overly complicated intellectual property arrangements, priority misalignment (publications and grants of research vs commercial outcomes of industry) and a lack of quality translators who can understand both business needs and scientific solutions.

There are a number of existing initiatives aimed at facilitating business-to-research collaboration, including Cooperative Research Centres, regional partnerships and innovation networks. While this type of support can provide an effective framework for such interactions, industry noted that the long list of organisations established with these responsibilities is often added to with little regard to existing programs, creating a complex network that is difficult to understand and access.

ENABLING BUSINESS ACTIONS

- **Develop regional clusters** – Decentralised production and geographic clustering of peer businesses can be used to enhance knowledge sharing, resource flows and scale. This scale can be used to reduce input costs through bulk ordering and reduce transport costs through the shared shipping of exports and utilisation of previously empty vehicles on their return journeys.

  However clustering need not be restricted to F&A businesses. Significant value can be created when research, ancillary services, supply chain partners and education are also in the region and working together on shared problems.
- **Identify potential international collaborations** – Most of Australia's key challenges are of a global nature. Domestic R&D and collaboration should be complemented by developing relationships and projects with established international networks to facilitate the rapid adoption of international technology best practice into Australian farms and processing facilities. Connecting with businesses in other jurisdictions with similar demographics (consumer drivers) and sector challenges could also provide Australian businesses with capital, experience in export markets, contacts and distribution channels.

62 Withers, G. et al. (2015). *Australia's Comparative Advantage, report for the Australian Council of Learned Academies*. Melbourne, Australia.
63 Ferris, B. et al. (2016). *Review of the R&D Tax Incentive*, Department of Industry, Innovation and Science, Canberra, Australia.

- **Contract SMEs for new product development** – Increasingly multinationals and large Australian businesses are turning to SMEs to develop and test new products and technologies or perform more exploratory innovation. With pre-existing infrastructure in place, larger businesses can find it difficult to invest in new science and technology solutions, however the agility of SMEs allows these activities to occur more efficiently and allows the risks associated with the failure of a new product to be taken by another brand. At the same time, SMEs can benefit from the arrangement by obtaining capital, scale and exposure to global value chains.
- **Establish long term agreements** – Technology investments underpinned by long term collaboration contracts and partnerships can help combat the uncertainty of both funding cycles and the broader rapid pace of change in markets.

ENABLING ECOSYSTEM ACTIONS

- **Coordinate and streamline representative organisations** – The current landscape of overlapping organisations and initiatives designed to support industry is counter-productive and difficult for SMEs to navigate. There is a need to map these initiatives and perform a gap analysis to identify potential areas for improving access and engagement between food businesses, research and business networks.
- **Develop business consortium** – Pre-competitive consortium provide the leaders of SMEs access to other business leaders and an opportunity for peer-to-peer learning. Businesses that understand the biggest competitors are global and not local can greatly benefit from sharing market insights, management perspectives and testing ideas in a confidential environment. These trusted networks should not be restricted to groups of businesses that fall into an industry niche, as innovative lessons about how to run or build your business or the application of novel technology often comes from those operating in different markets but that have experienced similar challenges. While these networks can be self-sustainable in the long run, the initial set-up and identification of guest speakers (e.g. researchers) can require assistance from government, research or representative bodies.
- **Provide more holistic R&D solutions** – When collaborating with research, industry noted the need for a more comprehensive service that goes beyond proof of concept. In addition to validating the scientific backing of a food innovation, businesses would greatly benefit from – and be willing to pay for – advice relating to execution of the innovation, including where and how to purchase ingredients and equipment, the types of technical personnel required to run the machines and a summary of the IP/commercial landscape.
- **Simplify Intellectual Property arrangements** – One of the most commonly mentioned challenges during industry interviews was the complex and dated nature of intellectual property (IP) arrangements when collaborating with research. While it is critical that each party is adequately protected, there is a significant opportunity to enhance industry's desire to collaborate through developing and advertising more simplified IP engagement templates.
- **Establish 'end-to-end' pilot plant offering** – Australia needs to provide industry with a complete 'end-to-end' facility for businesses to perform pilot scale manufacturing and packaging of new beverages, ingredients and meals, including subsequent market testing in export markets. Following the example of the FoodBowl in New Zealand[64], Australian SMEs could benefit substantially from having affordable access to pilot plants that allow 'end-to-end' manufacturing and packaging under the appropriate food and export regulations.
- **Leverage state and federal innovation support schemes** – These schemes – such as the National Innovation and Science Agenda and the CSIRO ON program – are designed to exploit new opportunities for national growth. It is critical that the F&A ecosystem ensure the opportunities identified through these programs are well communicated to industry and that start-ups and entrepreneurs are effectively connected with them.

64 New Zealand Food Innovation Network. Available at: http://foodinnovationnetwork.co.nz/locations [Accessed 3 April 2017].

5.5 Skills

Technologies and business models matter little without quality leaders and workers to implement them.

As the sector continues to evolve, so too will the required skillsets. Increasingly, multidisciplinary skillsets will be required. For example, staff with combined deep technical knowledge complemented by an understanding of supply chains, relationship management skills and experience with digital platforms.

While shifts towards increased value-adding will create more urban-based F&A jobs, the regional and rural location of many businesses is a disincentive to young graduates. Coupled with Australia's ageing workforce, this suggests the sector will be increasingly reliant on a flexible workforce and adoption of sophisticated automation processes and mechanisation – both requiring specific education and training.[65]

It is not essential for all skills gaps to be addressed through tertiary education. Many from industry suggested their best recent hires were those with no formal F&A training (which can be learnt on the job) and instead held STEM generalist degrees or degrees that provided them with general business skills such as commerce, law and marketing.

ENABLING BUSINESS ACTIONS

The following skill areas were highlighted by industry as the most important areas of focus for training and recruitment over the coming decades.

- **General business skills** – With many tertiary courses focussing on narrow elements of agricultural production or food manufacturing processes, industry noted that most graduates lack everyday business skills such as understanding cash flows, time management, running meetings, training others and writing (including developing strong grant applications).
- **Leadership** – Innovative, high growth SMEs are typified by strong leaders with long-term visions and the ability to communicate these visions to staff, customers and collaboration partners alike. The sector would benefit from more leaders who are entrepreneurial, willing to take calculated risks, think strategically and proactively explore new technologies through engaging in R&D.
- **Market research** – As discussed under Market intelligence and access, a global and more nuanced understanding of markets and how they are changing is required for Australian businesses to develop more effective long-term strategies and tailored products. Market research skills will be critical in identifying information and developing analysis that is tailored for any given business.
- **Data science** – Data is relevant to all opportunities and enablers discussed in this report and is essential in the convergence of technological solutions. While the world is capturing an increasing amount of data, the gap is in the ability to analyse it and use it to effectively inform decision making. Required data science skills in the F&A sector include data matching, predictive modelling, formulation modelling, machine logic, genomics and control analytics. Businesses can also be built around the provision of digital services and data analytics.

ENABLING ECOSYSTEM ACTIONS

- **Increase practical elements of tertiary courses** – While developing additional courses that are specific to food manufacturing and agribusiness was not found to be a critical enabler in addressing the skills gap, providing students with exposure to the industry application of existing, highly theoretical courses was. Guest speakers, site tours and industry placements should all be enhanced in order to produce graduates who are more familiar with the practical challenges and needs of the sector.
- **Hire more commercially experienced business development staff in research** – Industry noted that many business development staff in the research community came from an academic background and did not adequately understand the business drivers that were at play. In order for effective collaboration, individuals in these roles need to have a stronger familiarity of what drives the objectives of any given R&D project, timeline pressures and contract requirements.
- **Mobilise researchers into industry** – In order to play the increasingly important role of translator between technical solutions and business needs, researchers need to experience firsthand the impacts of challenges faced by industry. Spending time at farms and production facilities will allow researchers to understand the environments in which potential solutions need to be executed in.

65 Australian Academy of Science (2016). *Decadal Plan for Australian Agricultural Sciences 2017-26*. Final Consultation Draft.

The road forward

6 The road forward

Australia's F&A sector must proactively explore new offerings and business models today to ensure sustainable competitiveness in the rapidly changing global environment.

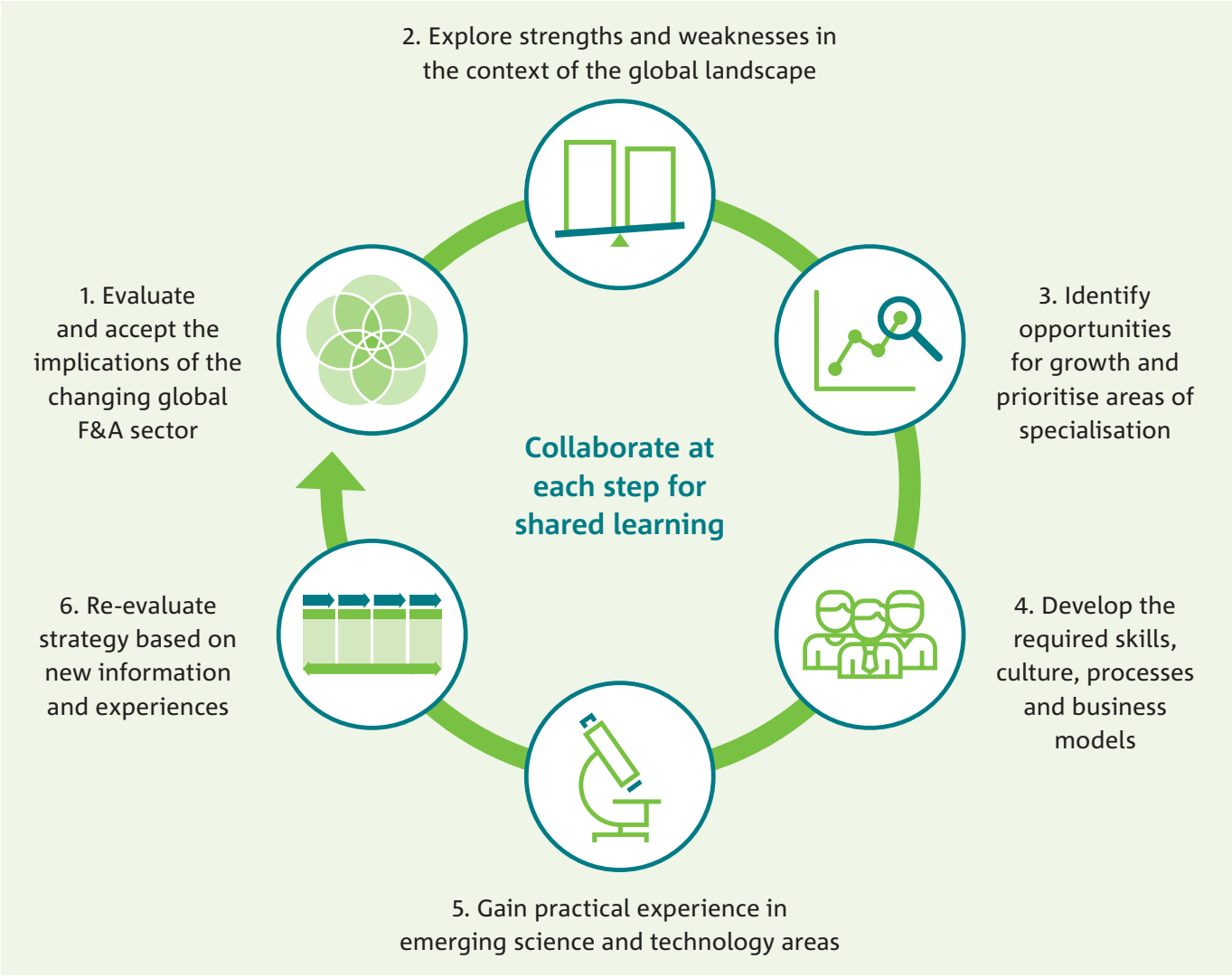
Growth cannot be sustained by productivity improvements alone. Identifying sustainable sources of growth can be led by businesses applying the concepts presented in this report to their own planning and operations – proactively seeking new ways of differentiating and exploring how science and technology can be harnessed to create new offerings in the global marketplace (Figure 10). This will ensure that scarce resources (labour, capital) are appropriately allocated, that business decisions are underpinned with strong underlying market and technology assumptions and that innovation is proactively applied.

Further detail on applying these steps at an individual business level, and incorporating volatility into strategic business planning through the use of scenario planning, can be found in CSIRO's *Australia 2030* report.

The broader F&A ecosystem also has an important role to play, being responsible for creating an environment that supports growth by reducing existing barriers to export, strengthening food safety and biosecurity systems, assisting with knowledge sharing and promoting Australian F&A at a national level. Consumer education is also key in realising the full potential of customer-driven investments in value-added products and enabling technologies. Independent and trusted sources must effectively communicate how these advances provide value through validated health outcomes or improved safety to ensure appropriate willingness to pay for these premium products.

Businesses, in collaboration with the F&A ecosystem, must act quickly or risk losing future revenue streams to the competitive global market.

FIGURE 10 – USING THE ROADMAP

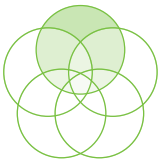


Appendix

Appendix

A.1 Global food and agribusiness megatrends

A LESS PREDICTABLE PLANET



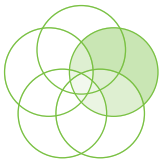
A rising world population and economic growth is placing an increasing burden on the world's limited natural resources such as water, energy and land. For example, agricultural water use is projected to increase by 20% globally by 2050.[66] These operational constraints are worsened by the impacts of climate change, with increasingly unstable and extreme weather conditions impacting crop yields, livestock health, biodiversity and the predictability of product quality and amount.

At the micro-level, the food and agribusiness sector is seeing an increase in the virulence of microorganisms and parasites, known pathogens spreading to novel geographies, and the continued rise of antimicrobial resistance.[67] Global use of antimicrobials in livestock is expected to rise by 67% by 2030 to 105,596 tons.[68] China's livestock industry alone could soon be consuming almost one third of the world's available antibiotics.

Global environmental change and biodiversity losses have the potential to create food price and supply shocks. For example, the loss of pollinators could cost the global economy over £300 billion per year.[69]

With growing concerns around the known and unknown consequences of greenhouse gas emissions and climate change on natural systems, food producers are experiencing greater consumer demand for environmental and social credentials as well as various decarbonisation initiatives from governments. Customers are increasingly demanding products that were grown or manufactured sustainably – using less energy and fewer materials. In addition to supply side constraints, this is encouraging producers and processors to shift towards lifecycle cost management and differentiating their offerings through cleaner and greener processes.

HEALTH ON THE MIND



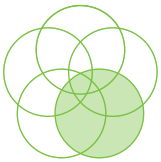
The world's population is ageing. Between 2015 and 2030, the proportion of the global population aged 60 and over is projected to grow by 56%, from 901 million to 1.4 billion.[70] Alongside this, the incidence of chronic disease is rising globally due to increased life expectancy, changed diets and increasingly sedentary lifestyles.[71] These factors all influence the types of food and beverage products demanded.

In addition to servicing the dietary needs of the elderly and chronically ill, there is a rising social awareness for improved health and wellbeing among younger generations. These individuals look to food and beverages (among other lifestyle choices) to provide holistic health and wellbeing outcomes. As greater insights into the health benefits of foods are discovered, and consumer knowledge of these grows, the impact of food on wellbeing is becoming an increasingly important consideration in purchases. A potential disruption to the increasing use of food as medicine is the development of affordable and user-friendly personalised medicines and health services which could provide more targeted solutions to health and wellbeing concerns.

While many consumers wish to enhance their health through food, diet and lifestyle, a greater and increasing concern is the direct harm and illness caused by unsafe food products. An estimated 600 million – almost 1 in 10 people in the world – fall ill after eating contaminated food and 420,000 die every year, with the impacts greatest in Africa and South East Asia.[72] In these regions, trust in local products is continuing to fall with those who can afford imported products looking to increase their share of imports from regions and countries with reputations for cleanliness and safety.

66 UNESCO and World Water Assessment Programme (2016). *The United Nations World Water Development Report 2016 – Water and Jobs*, Italy.
67 World Health Organization (2014). *Antimicrobial Resistance – Global Report on Surveillance 2014*, France.
68 Food and Agriculture Organization of the United Nations (2017). *Antimicrobial Resistance.* Available at: http://www.fao.org/antimicrobial-resistance/background/what-is-it/en/ [Accessed 10 March 2017].
69 Schroders (2014). *The Bee and the Stockmarket*, Research Paper, London, UK.
70 United Nations Department of Economic and Social Affairs (2015). *World Population Ageing 2015*, New York, USA.
71 OECD (2015). *Health at a Glance 2015: OECD Indicators*, OECD Publishing, Paris.
72 World Health Organization (2015). *Food Safety Fact Sheet No. 399.*

CHOOSY CUSTOMERS



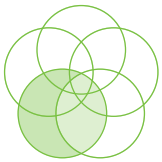
The rapid growth of emerging economies will see billions of people transition out of poverty and into the middle income classes.[73] By 2022, China's middle class alone could rise from 300 million to 630 million, accounting for 45% cent of China's population.[74] This income growth will occur in parallel with urbanisation. By 2030, 60% of global households will be living in urban areas (up from 54% in 2014).[75]

As incomes grow, so do expectations. Urbanised consumers will increasingly demand quality convenient foods that require low preparation or can be eaten on-the-go. Especially as they move away from the traditional '3 square meals' and towards a higher number of smaller meals/snacks over the day. Consumers will also demand improvements and optionality in the way they interact and engage with food – be it fine dining, artisan markets, food-based experiences, or direct-to-consumer ordering of customised offerings.

With dwelling sizes falling in many cities due to space constraints and decreasing affordability, the prevalence of micro kitchens or completely kitchen-less apartments will rise in Asia. Paired with the internet-enabled extension of work into an individual's home (limiting time for food preparation), dining out will become an increasingly common source of food. In Singapore 67% of survey respondents eat out at least once a week.[76]

As issues around food security and sustainability grow, customers will demand products with greater provenance information and accurate vendor claims. This, in turn, will increase the stringency of standards regulating the manufacturers' claims about their foods, including health benefits and nutritional content.

ONE WORLD



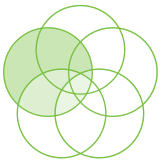
Improved preservation technologies, Free Trade Agreements and faster distribution channels are globalising food value chains and opening up markets that were previously inaccessible. The emergence of more globalised value chains means that product development, distribution and sales is now a 24 hour business. These trends, coupled with increased migration, are exposing consumers to a range of foods and beverages from different regions and cultures. Further facilitating this exposure are major global retailers like Amazon and Aldi who have no loyalty to local produce.

While these changes provide significant opportunity to sell novel products domestically and abroad, a smaller world also introduces a number of threats. New competition – often from high quality suppliers in developing regions – will make differentiating products and services more important than ever before. One potential disruption is that Australia's exports fuel the growth of the Asian food processing industry to such an extent that they will develop competitive food safety and quality solutions that eliminate opportunities for Australian businesses. Further, as people and products travel further and to a wider variety of locations, biosecurity risks will also become more critical in business and national planning.

Finally, the increasing volatility of this 'one world' (climate change, geopolitical instability and the changing landscape of international governance) will result in greater susceptibility to price and supply shocks.

73 CSIRO Futures (2016). *Australia 2030: Navigating our uncertain future*, CSIRO, Canberra.
74 Australian Trade Commission (2015). *Northern Australia: Emerging opportunities in an advanced economy.*
75 United Nations Department of Economic and Social Affairs (2014). *World Urbanization Prospects 2014 Revision* New York.
76 Weber Shandwick (2014). *Food Forward,* Singapore.

SMARTER FOOD CHAINS



Food production will need to double by 2050 to meet the rising demands of a growing population and growing income.[77] [78] Coupled with the supply constraints discussed under *A less predictable planet*, and the high levels of food waste and food loss, value chains are being forced to become more efficient. This doesn't always mean simpler, with many value chains becoming more complex and non-linear to improve agility and resilience.

Enabling the transition toward smart food chains is the rise of digital solutions, big data and data analysis. Advances in the amounts of data that can be stored, analysed, interpreted and used as input in decision making are driving more efficient value chains and production processes with more streamlined logistics and reduced food wastage.[79]

F&A value chains will also become shorter, with processing occurring on-farm and processors acquiring primary producers. To further relieve logistical and operational costs, and create scale, many F&A industries will become more decentralised with clusters of multiple producers, processors and transporters emerging. As stronger collaboration ties develop within these clusters, their level of agility – to respond to changes in product type and amount – will increase.

In retail, the demonetarisation of society is already pushing the adoption of online tools for shopping and payment – changing the way consumers purchase and receive food. E-commerce offerings for food is growing rapidly with 2015-2020 CAGR estimated at 14.5% in major markets,[80] particularly in China which was home to US$48 billion in total online food sales in 2015 and according to a Nielsen survey more than half of Chinese consumers are willing to buy groceries online[81]. While this trend is already occurring across many food and beverage products, it is yet to take off for fresh food offerings where customers place high value on being able to see, touch and smell their food prior to purchasing. In the long run, the growth of such digital services may push larger retailers to become distributors rather than retailers.

77 United Nations Sixty-fourth General Assembly, Second Committee Panel Discussion, 9 October 2009 AM.
78 Odegard I.Y.R. and van der Voet, E. (2014). *The future of food – Scenarios and the effect on natural resource use in agriculture in 2050* Ecological Economics.
79 Frost & Sullivan (2016). *Internet of Things in Connected Agriculture*, Mountain View.
80 Euromonitor International (2016). *Online, Mobile and Delivery: What we can Learn from Four Key Markets* Global Briefing.
81 The Nielsen Company (2015). *Global survey on e-commerce and new retailing.*

A.2 Australia's comparative advantages and related disadvantages

CLEAN AND GREEN

Australia's clean and green brand is well regarded but is not unique and is poorly differentiated.

Australian F&A has established a strong global reputation for producing consistently safe, sustainable and healthy foods, supported by a highly regulated and transparent food chain and a pristine natural environment (see Table 2). These characteristics position Australia well in light of increasing food safety concerns – particularly in many Asian regions.

Australia's strong legal framework and comparatively low prevalence of food-borne illnesses signals consistent safety and is reassuring for consumers. Completely surrounded by water and with high biosecurity protocols, Australia has an absence of many of the most undesirable pests, diseases and weeds, allowing products to be sold at a premium price in overseas markets. Studies have found the profits of beef, dairy and sheep enterprises would be 8 to 12% lower, pig enterprises 15% lower, and cropping enterprises 7% lower without an effective biosecurity system.[82]

One study rated Australia's ability to respond to food safety and other emergencies 'Superior' and found no gaps in the Labelling of Food and Indication of Allergens.[83]

The untouched and unique Australian environment also acts as a differentiator amongst foreign markets where local pollution and environmental degradation are clearly evident. When a range of factors were considered, from air quality, to agriculture, to biodiversity, Australia was ranked 3rd out of 80 countries for the perception of the natural environment, behind only the United States and New Zealand.[84]

Related disadvantages

While global trust in Australia's clean and green reputation offers an advantage, this reputation is also vulnerable. One major risk is the disparity between the perception (3rd) and performance (35th) of the environment ranking.[85]

Further, although Australia has high food safety standards when compared to many Asian export markets, it was only ranked 14th out of 17 OECD countries, outscored by competitor nations within Europe and North America.[86] Industry interviews suggested this was largely due to poor R&D support from government, the patchwork of auditors and poor information flow across the country.

Local safety scares have provided insight into the potential impact on foreign trade. For example hepatitis cases linked to frozen blueberries in February 2015 and salmonella found in locally produced salads in 2016 were extremely damaging for the companies involved. If similar breaches were to reach export markets, the impact would be damaging to the entire Australian food industry.

TABLE 2 – CUSTOMER ASSOCIATION OF DESIRABLE ATTRIBUTES FOR KEY COUNTRIES PROMOTING A CLEAN AND GREEN BRAND

	AUSTRALIA (%)	MALAYSIA (%)	USA (%)	CHINA (%)	FRANCE (%)	BRAZIL (%)	CANADA (%)
Good value	32	21	30	31	20	24	24
High quality	37	14	41	12	42	18	34
Safe	39	17	34	13	31	19	36
Sustainable	31	15	19	13	20	21	25
Healthy	30	13	21	12	22	18	26

Source: Adapted from Reputation Institute, Country Reptrak Study, February-March 2013.

82 Hafi, A. et al (2015). *The value of Australia's biosecurity system at the farm gate: an analysis of avoided trade and on-farm impacts,* ABARES research report 15.2, Department of Agriculture.
83 Charlebois, S. (2014). *2014 World Ranking Food Safety Performance*, The Conference Board of Canada.
84 Tamanini, J. and Valenciano, J. (2016). *The Global Green Economy Index*TM*: GGEI 2016*, Dual Citizen LLC.
85 Tamanini, J. and Valenciano, J. (2016). *The Global Green Economy Index*TM*: GGEI 2016*, Dual Citizen LLC.
86 Charlebois, S. (2014). *2014 World Ranking Food Safety Performance*, The Conference Board of Canada.

In an assessment of 124 countries threatened by a biosecurity invasion, Australia was classified as 'high risk' and ranked 15th for the potential cost of an invasion (US$7.8 billion) based upon the likelihood of arrival and establishment of a new pest.[87] With the USA and China identified as the biggest threats to global biosecurity due to their existing pests, Australia's high levels of trade with these nations and comparatively pest free status significantly increases the risk.

Also detracting from the clean and green advantage is that these attributes are also connected with other countries such as the USA and France (see Table 1).[88] While Australia often has the strongest association with these attributes, the relative advantage is not as strong as many within the industry believe.

It is important Australia presents a unified and differentiated brand to the world that clarifies Australia's strengths. Similarly positioned competitor, New Zealand has done this with the strong international marketing campaign, 100% Pure New Zealand.

UNIQUE GEOGRAPHY

Australia's abundance and diversity of agricultural land offers many opportunities but also presents relatively unaddressed challenges around transport costs.

As an island continent situated in the Asia Pacific region, Australia has a unique set of favourable geographical features distinct from all of its competitors. Australia's large amount of land covers a range of agroecological zones including tropical, subtropical and temperate farming regions.[89] This allows a wide variety of products to be produced within Australia, both in processed and unprocessed forms, allowing complete paddock to plate provenance. While climate change will challenge growing and farming conditions globally, Australia's large and diverse landscape also provides some level of resilience to these emerging production challenges.

Further, Australia's position in the Southern Hemisphere allows the supply of counter-seasonal produce to the Northern Hemisphere, where the majority of Australia's export markets are located.

By 2030, China will have one billion people with the purchasing power of an average Australian.[90] Geographic proximity to this substantial source of growth over the coming decades offers a substantial advantage. Reduced shipping times allows the delivery of fresh produce in optimal condition. Australia also enjoys proximity to Asia in other forms, with strong cultural and economic ties through the transfer of people and established trade routes. Asia is the destination for 63% of Australian food exports, with eight out of ten of the top export locations situated there.[91]

87 Paini, D. et al (2016). *Global threat to agriculture from invasive species,* PNAS, 113 (27), 7575-7579.
88 Business Council of Australia (2015). *Building Australia's Comparative Advantages: A 21*st *Century Agrifood Sector*.
89 Commonwealth of Australia (2015). *Agricultural Competitiveness White Paper*, s.l.: Commonwealth of Australia.
90 Ernst & Young (2013). *Hitting the sweet spot, The growth of the middle class in emerging markets.*
91 Includes ANZSIC codes for Agriculture, Aquaculture, Beverage & Tobacco, Fishing, hunting and trapping, and food product manufacturing without any exclusions.

Related disadvantages

While geographic size offers an advantage, it can be costly, with the transport of goods across Australia often inefficient and expensive due to the long distances and small dispersed value chains and domestic markets. The Australian domestic freight task measured almost 600 billion tonne kilometres in 2011-12 (one tonne moved one kilometre) with 35% carried by road, 49% by rail and 17% by coastal shipping, with air freight less than 0.01%.[92] Fonterra reported the cost of collecting raw milk from farms in New Zealand was NZ$0.02 per litre (~$A0.02 per litre), while in Australia the Australian Dairy Industry Council suggested that farm milk collection charges average $A0.025 – 0.03 per litre, 25 – 50% more expensive than in New Zealand.[93]

Anecdotal evidence has suggested there is a large disconnect in many Australian F&A industries between producers and processors, limiting the adaptability and mutual benefit which comes from collaboration and cohesive action. Consultations suggested that increased trust and communication between these two parts of the value chain is needed to improve efficiency across the supply chain and limit issues associated with scale.

Though proximity to Asia is widely cited as a considerable advantage, the magnitude of this advantage is highly dependent on which Asian country, or region within a country, is the destination. Transport distances, the existence of established trade routes and market intelligence levels vary significantly across Asia and even within countries (e.g. Chinese regions). Further, advanced preservation techniques are opening these markets to more distant competitors, diminishing the advantage.

WORLD CLASS RESEARCH

Improved commercialisation and increased effort in food processing developments will help Australia profit from the nation's world leading research in agricultural systems.

Australia boasts strong education and R&D sectors, which provide the local talent critical for continual innovation and solution development. In particular, Australian R&D is world leading in a number of pre-farm gate fields including animal production, plant biology and environmental management (see Table 3). Furthermore, in the 2016 global innovation rankings conducted by Cornell University, INSEAD and WIPO, Australia ranked 11th for innovation input.[94]

The nation's food research sector is also backed by government priorities. Food has been named as a National Science and Research Priority for Australia, with emphasis ranging from global and domestic supply chains, to enhanced food production through novel technologies.

92 Mitchell, D. (2014). *Freightline I – Australian freight transport overview*, BITRE.
93 Productivity Commission (2014). *Relative Costs of Doing Business in Australia: Dairy Product Manufacturing*, Research Report.
94 Cornell University, INSEAD and WIPO (2016). *The Global Innovation Index 2016 – Winning with Global Innovation*, Ithaca, Fontainebleau, and Geneva.

TABLE 3 – AUSTRALIA'S GLOBAL RANKINGS FOR A SELECTION OF F&A RESEARCH FIELDS

SUBJECT AREA	RANKING	PRE OR POST FARM GATE
Agriculture, land and farm management	3rd	Pre-farm gate
Environmental science and management	3rd	Pre-farm gate
Soil Sciences	4th	Pre-farm gate
Animal production	6th	Pre-farm gate
Horticultural production	6th	Pre-farm gate
Fisheries sciences	6th	Pre-farm gate
Crop and pasture production	7th	Pre-farm gate
Agriculture biotechnology	12th	Pre-farm gate
Food sciences	12th	Post-farm gate
Physical chemistry	12th	Post-farm gate
Analytical chemistry	13th	Post-farm gate
Organic chemistry	15th	Post-farm gate
Nanotechnology	19th	Post-farm gate

Source: Custom analysis from InCites Analytics by Thomson Reuters (2016)

Related disadvantages

Despite the government advocating increases in post-farm gate R&D, Australia's research strengths are primarily focused pre-farm gate, and include agricultural biotechnology, plant science and biosecurity. This balance has the potential to limit Australia's ability to capture value-adding opportunities across the value chain.

Further, while Australia's business spend on food and agribusiness R&D has grown over recent years in absolute terms, it is still well below that of other key sectors as a proportion of gross value-added (see *sector snapshot*).

The translation of Australia's high level of innovation input is also an issue. Global innovation rankings placed Australia only 26th for innovation output (11th for input).[95] These difficulties are magnified by the relatively low percentage of graduates in science and engineering, for which Australia ranks 79th in this index.[96] Further, for businesses seeking to collaborate with the research community, many feel it is difficult to identify the most relevant research organisation to engage. In combination these factors may hinder Australia's comparative advantage in R&D into the future.

95 Cornell University, INSEAD and WIPO (2016). *The Global Innovation Index 2016 – Winning with Global Innovation*, Ithaca, Fontainebleau, and Geneva.
96 Cornell University, INSEAD and WIPO (2016). *The Global Innovation Index 2016 – Winning with Global Innovation*, Ithaca, Fontainebleau, and Geneva.

ESTABLISHED SECTOR WITH A GLOBAL MINDSET

Australia's F&A sector is globally facing with a strong base but is not well positioned to respond to future market opportunities.

Over the last couple of decades, Australia's agriculture sector has outperformed most other sectors and was key, along with mining, to avoiding recession during the Global Financial Crisis. Having long been a significant contributor to Australia's economy, the food and agribusiness sector has extensive water and transport infrastructure in existing agricultural regions, contributing to productivity and food security. The existing value chains – with the associated knowledge, experience and skills – provide a strong base for capitalising on new opportunities and building added value.

Further, Australian food businesses are already global-facing with established trading partners and a widely held understanding that sustainable future growth needs to come from the export market. Australia has food exports of over $30 billion per year, almost three times more than the value of food imports.[97] Also, the extensive network of FTAs aids competitiveness and signifies Australia's valued status as a trading partner to importers.

Related disadvantages

The long term stability arising from an established industry does bring disadvantages. As discussed in the Megatrends, the world is rapidly changing demographically and technologically, meaning Australia needs to be dynamic and agile. Australia's high proportion of F&A exports means that businesses are more exposed to currency fluctuations and other international affairs.

Despite high volumes, Australia's historically commodity-based markets have low margins, with high labour costs decreasing competitiveness and significant competition in saturated markets driving down prices.

Complex and extensive regulatory standards are also restrictive, blocking or slowing the introduction of new products and approaches with high costs and compliance requirements. For example in 2013 it was estimated that the Australian Front of Pack labelling star rating system would cost the industry $200 million, in addition to the $72 million already invested in the Daily Intake Guide on packaging.[98] In the food and groceries manufacturing industry, modelling has shown a $100 million reduction in regulatory burden would be expected to increase GDP by $243 – $485 million.[95] For the average farm business, the cost of red tape was estimated at 14% of net farm profit.[95]

Adding to the complex nature of regulation is the equally complex landscape of representative bodies and government initiatives. Navigating the fragmented and overlapping industry support bodies and accreditation schemes that exist at all three levels of government as well as for various industry segments is near impossible for most SMEs and is impractical for a small country like Australia. Coordination and streamlining of this environment is required to prevent these organisations fighting for the same pools of funding and ultimately diminishing the assistance they can provide to the businesses they are set up to service.

HIGH PROPORTION OF SMES

Australian SMEs rank amongst the most innovative in the world.

With the rapid rate of technological expansion and changes in consumer demands globally, agility is increasingly important to stay ahead of competitors. Australia's relative abundance of F&A SMEs (99.9% of all F&A businesses[99]) can leverage this, out manoeuvring larger competitors and targeting small niches with higher margins.

Further, Australian SMEs are innovative by OECD standards, ranking 5th out of 29 OECD countries in business innovation.[100]

97 Department of Agriculture and Water Resources. 2013. *Australian food statistics 2012-13.* Available at: http://www.agriculture.gov.au/SiteCollectionDocuments/ag-food/publications/food-stats/australian-food-statistics-2012-13.pdf [Accessed 16 January 2017].

98 Deloitte Access Economics (2013). *Reforming regulation of the Australia food and grocery sector*, commissioned by the Australian Food and Grocery Council.

99 Australian Bureau of Statistics (2016). *8165.0 – Counts of Australian Businesses, including Entries and Exits, Jun 2011 to Jun 2015,* Canberra.

100 Hendrickson, L. et al (2014). *Australian Innovation System Report 2014,* Department of Industry, Commonwealth of Australia, Canberra.

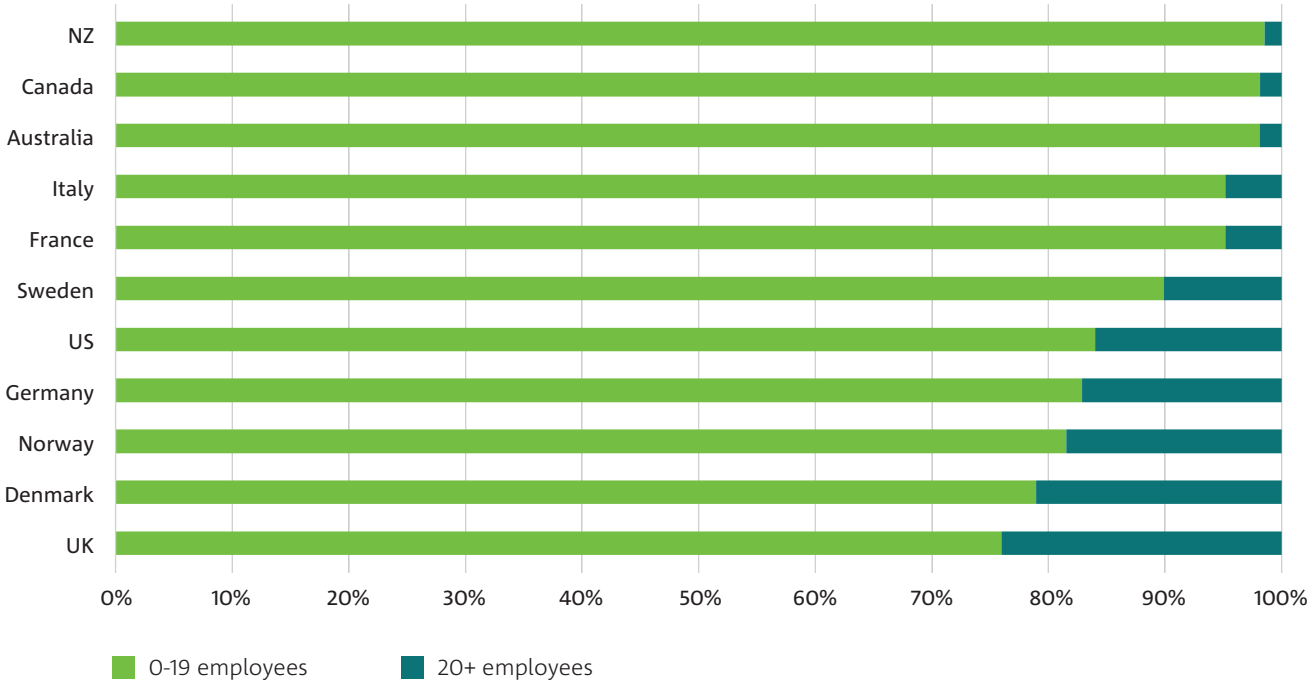
Related disadvantages

While an SMEs small size is one of its greatest advantages, it also brings challenges. Difficulty in generating scale can be a significant impediment on profitability, growth, and even survival. This effect is particularly significant in the F&A sector, with many small family owned farms dispersed around the country. Many of these businesses have no desire to export, with 90% of F&A businesses receiving no income from exports in 2014/15.[101]

When SMEs do look to export they find relevant market insights lacking. An understanding of consumer trends and how to gain market access is essential and many SMEs do not have the resources to dedicate to export goals.

For SMEs looking to scale up or access the world class R&D in Australia, raising sufficient capital is also a major obstacle. Compared to large corporates, external financing is limited and at a higher cost. While lack of access to additional funds was labelled as one of the biggest barriers to innovation for between 16 – 20% of SMEs, for organisations with over 200 employees only 10% saw it is as a major challenge.[102]

FIGURE 11 – PERCENTAGE OF F&A ENTERPRISES WITH 0–19 EMPLOYEES



Source: CSIRO analysis drawing on individual country reports (2017). Note: Data for European countries is for food manufacturing only.

101 ABS (2015). *8170.0 - Characteristics of Businesses in Selected Growth Sectors, Australia, 2013-14,* Data Cube: selected characteristics of businesses in Food and agribusiness, by ANZSIC class, 2013-14 'Table 4 Income received from exporting goods and services, by Food and agribusiness businesses, by ANZSIC class, 2013-14', Canberra.

102 ABS (2016). *8158.0 – Innovation in Australian Business, 2014-15,* Canberra.

A.3 Industry consultation

The development of this Roadmap was industry-led with Australian F&A companies and multinationals providing direction and input across all chapters. While contributing parties primarily consisted of F&A businesses (of varying sizes), peak bodies, governments and individuals with significant experience across the sector were also consulted.

In addition to the significant input from CSIRO experts, over 40 individuals from external organisations were consulted, including representation from the following organisations:

Agribusiness Gippsland

APAL

Australian Food and Grocery Council

Australian Meat Processor Corporation

Bega

Favco

Flavour Creations

Fonterra

Food Agility CRC

Food for Health

Food Innovation Australia Ltd.

Food SA

Foods from the Earth

Grains Research and Development Corporation

High Performance Consortium

JBS

Modern Olives

Mondelez International

Natural Evolution

Sanitarium

Simplot

Sundrop Farms

Swisse

ThankYou

The Yield

Treasury Wine Estates

Warrnambool Cheese and Butter

XPotential

A.4 Co-contributing funding schemes for Australian SMEs and start-ups

Many of the activities recommended in this report require investment in R&D. The table below lists national and state based funding schemes available to Australian SMEs and start-ups that support innovation and commercialisation.[103]

TABLE 4 – NATIONAL AND STATE-BASED FUNDING SCHEMES

PROGRAM NAME	STATE	PROJECT FUNDING	SME CONTRIBUTION	ELIGIBILITY / NOTES
Innovation Connections	All	< $50k	1:1 cash	• $1.5m – $100m turnover, 3+ years in business. • Grants available for researcher, business researcher and graduate placements.
CSIRO SIEF STEM-Business	All	< $105k p.a.	1:1 cash	• $1m – $100m turnover. • Projects delivered by early-career researchers.
CSIRO Kick-Start	All	$10k-50k	1:1	• < $1.5m turnover. • Research/development/testing with CSIRO.
Accelerating Commercialisation	All	< $1 mil	1:1	• < $20m turnover. • Funds commercialisation, not research and development.
ICon Proof of Technology grant	ACT	$5k-30k	1:1 cash and/or in-kind	• < $2m turnover.
ICon Accelerating Innovation grant	ACT	$5k-10k	1:1 cash and/or in-kind	• < $2m turnover.
TechVouchers	NSW	< $15k	1:1 cash	• < $30m turnover, < 20 employees, 1+ years in business. • Preference for companies not previously engaged in research.
BISI Innovation Voucher	NT	< $25k	40%	• < 100 employees.
Knowledge Transfer Partnerships	QLD	< $50k	1/3 cash	• < 200 employees, 2+ years in business. • Research performed by KTP eligible graduates.
Innovation Voucher program	SA	$10k -$50k	1:2 or 1:1	• < $200m turnover, 1+ years in business. • Contribution 1:2 for SMEs below $5m.
Business Transformation Voucher	SA	< $50k	1:1 cash	• 1+ years in business. • Can include developing new business models or R&D.
BioSA Industry Development program	SA	$50k-250k repayable		• Early-stage/start-ups. • Bioscience and related industry sectors.
SBDF Start-up business grant	SA	< $20k	1:1 cash	• To contribute to starting a new business or buying a business.
SBDF Business Expansion grant	SA	$10k-100k	1:1 cash	• < 20 employees, 1+ years in business.
Innovation Vouchers	WA	< $20k	At least 20%	• < $500k turnover, < 200 employees.

103 For more information on the funding schemes available to Australian SMEs and start-ups see CSIRO's SME Connect Program http://www.csiro.au/SMEConnect

A.5 Further reading

The following publications provide deeper insights into some of the specific trends and concepts covered in this Roadmap or important matters considered outside the scope of this report:

1. Business Council of Australia (2015). *Building Australia's Comparative Advantages: A 21*st *Century Agrifood Sector.*
2. KPMG (2015). *Nutraceuticals: The future of intelligent food. Where food and pharmaceuticals converge.*
3. Sanchez, D. (2015). *Genetically modified crops: how attitudes to new technology influence adoption,* ACOLA.
4. Australian Food and Grocery Council (2016). *State of the industry 2016. Sustaining Australia.*
5. AlphaBeta (2016). *Valuing the SDG prize in food and agriculture. Unlocking business opportunities to accelerate sustainable and inclusive growth.* Business and Sustainable Development Commission.
6. Commonwealth of Australia (2015). *Agricultural Competitiveness White Paper*, Canberra.
7. National Plant Biosecurity Status Report (2014). *Plant Health Australia*, Canberra.

OTHER ROADMAPS IN THE CSIRO SERIES

This report is the fourth of a series of roadmaps that are being developed by CSIRO.

- Advanced Manufacturing – A Roadmap for unlocking future growth opportunities for Australia.
- Medical Technologies and Pharmaceuticals – A Roadmap for unlocking future growth opportunities for Australia.
- Mining, Equipment, Technology and Services – A Roadmap for unlocking future growth opportunities for Australia.
- Oil and Gas – A Roadmap for unlocking future growth opportunities for Australia (*in development*).

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