RURAL INDUSTRY FUTURES

Megatrends impacting Australian agriculture over the coming twenty years

SUMMARY

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Australia’s rural industries will be impacted by significant change at global, national and local levels over the coming decades. This will create opportunities and challenges for small and large farm businesses and have an impact on rural lifestyles and agricultural landscapes. Australian agriculture has demonstrated the capacity to adapt and respond to risks in the past and take advantage of an array of opportunities. The sector will continue to rely on productivity gains underpinned by a strong innovation system to ensure it is well positioned to respond to the future.

In order to help Australia’s agricultural sector anticipate and pro-actively plan for change, the Rural Industries Research and Development Corporation (RIRDC) has partnered with CSIRO to conduct a strategic foresight exercise on the future of Australian agriculture. The aim is to help industries, individuals, companies and governments make informed and strategic choices to secure better outcomes.

This research presents a narrative of the future for Australia’s rural industries built upon a set of interconnected trends and megatrends impacting Australia over the coming 20 years as shown in the interlinked Venn diagram (Figure 1).

Trends may be classified as geopolitical, economic, environmental, social or technological. A megatrend occurs at the intersection of multiple trends and describes a more significant and deep-set trajectory of change with profound implications.
Figure 1: Megatrends impacting Australian rural industries.
Rural Industries

In this research Rural Industries include primarily agricultural and fisheries industries. Australian farms supply 93 per cent of the food needs of the nation. In financial year 2012/13 Australian agriculture produced food and fibre commodities were worth A$48 billion. When adjusted for inflation and expressed in current prices, the gross value of agricultural output in Australia has increased slightly over the past 40 years.

During this time, farmers' terms of trade (the ratio of prices paid to prices received) have fallen substantially. The fact that farmers have increased output despite declining terms of trade attests to the adaptability and innovation of the rural sector.

![Graph showing gross value of farm production and terms of trade](image)

**Figure 3: Gross value of farm production and terms of trade**

Source: Australian Government Department of Agriculture [14]

Based on analysis of Australian rural industries, several themes emerge which represent key opportunities and/or challenges for the industry:

- Continued productivity gains (including labour productivity) are required to deal with competitive terms of trade and an ageing labour force in agriculture
- Australian agriculture is predominantly export-oriented which means the sector benefits from, and is reliant on, the performance of these global markets
- Variability in returns to agriculture has increased significantly due to increased climate variability, volatile exchange rates and fluctuations in market demand.
• The trend to fewer, larger farms continues in response to the need for improved competitiveness. The family farm remains the most common ownership structure and it increasingly faces pressure to grow and to maintain efficiency.

• Growth and diversification of exports is required in response to structural change in emerging economies – for example, an increased middle-income class, especially in Asia, drives stronger demand for a more diverse range of food and fibre products including conventional products.

• Access to quality production resources (arable land, reliable water) and proximity to markets remain major factors in planning for increased production capacity.

Who is interested?

This research seeks to assist individuals, industries, companies and governments make informed and strategic choices to position Australian rural industries for positive outcomes.

The potential audiences for and applications of this research include:

• Individuals and industry participants should use to inform on emerging themes and incorporate active responses in planning

• Research investors can use this to identify areas for new investigation and analysis that will help position rural industries well in the future

• Industry and government policy makers should use to inform policy design and implementation for areas such as innovation and research, agriculture, trade, climate change, land use, energy, food production and infrastructure.

Understanding the Future for Rural Industries

The megatrends describe plausible futures to help decision makers working in rural industries make wiser choices. They have been identified through a strategic foresight process developed by CSIRO and are used to examine the implications for innovation within rural industries.

The time-frame for the analysis is the coming twenty years; roughly out to the year 2035. However, some of the change described is already occurring and much will still be happening into the more distant future. The megatrends are focused on the concerns of industry and the forces which impact commodity markets and production costs and each has supply-side and demand-side implications.

The rural industry megatrends cover both domestic and global change because Australian agriculture is an export oriented industry which sells around two thirds of its produce offshore. Whilst domestic markets will remain important, the big growth opportunities are in emerging markets, especially in Asia, which have doubled or trebled their food and fibre imports in recent years and are set for continued and rapid growth.
A Hungrier World

The world is getting hungrier because it needs much more food and with appropriate innovation in farm production systems, supply chains and governance, agriculture is well positioned to keep pace with growing demand. The "Hungrier World" megatrend tells the story of a rising world population and increasing food consumption accompanied by a shrinking global agricultural land area, water scarcity and spiraling energy demand.

According to the United Nations Food and Agriculture Organisation (FAO) the world must increase agricultural output by 70 per cent to feed its growing population by the year 2050. However, the world is estimated to be losing 12 million hectares of agricultural land each year to desertification and urbanisation. In addition to this are the challenges of climate change and water scarcity.

Key insights to the Hungrier World megatrend

- There will be between 2.3 to 2.4 billion more people on earth by the year 2050 which represents an increase of about one third to almost 10 billion people. Most of this increase will be in developing countries – those with the lowest per capita Gross Domestic Product (GDP) and currently a sub-maintenance level food consumption.

- Using 2005 as a baseline, about 60 to 70 per cent more food will be required to meet demand by 2050. The projected increase is based on both predicted population growth (making up 70% of the growth in food demand) and predicted income growth (30% of food demand).

- Forecasts suggest that 80 to 90 per cent of the increase in crop production required will come from improved yields. If yields improve globally by 1 per cent per annum, which appears to be a realistic target given recent trends and yield gaps, this increase would provide the 46 per cent growth required to meet global demand without the need for further expansion of land area under cropping.

- Increased product output in the order of 1.4 per cent per annum is required to meet projected demand for meat by 2050. This is unlikely to be achieved in grazing systems in developing countries without significant technological advances and industry development.

- An assessment of ‘spare’ land at a global level (which excludes forest and protected zones) shows that a number of countries have areas (1.4 billion hectares globally) that could be converted to rain-fed arable agriculture. Estimates of growth in cropland area are in the order of 10-20 per cent.
1. Australia is well positioned – both in terms of geography and comparative advantage – to supply growing overseas markets. Whilst Australia can’t hope to feed Asia or the world it can increase production and increase exports into expanding global food and fibre markets.

2. Improvements in productivity rely on a strong innovation system, which has historically yielded high returns for agriculture with a benefit-cost ratio of 8:12 under Australian conditions. If productivity increments are to supply the majority of the increase in food production required, then continued investment in R&D is critical to ensure that ‘potential’ food turns into ‘real’ food on the ground.

3. Given that over 90 per cent of the food needs will be met by in-country production, Australia makes an important contribution through the export of expertise, innovation and services to countries with high population growth and growing demand for specific food groups.

4. There may be an increase in demand for land to meet the burgeoning market for renewable energy and to achieve greenhouse gas mitigation target which could have implications for agricultural production.

5. Despite recent successes, the food sector in many countries remains highly subsidised and considerable trade barriers exist for Australian exports. Recent free trade agreements with China and other countries will provide growth opportunities for a number of industries. Ongoing efforts for further reform are vitally important, as progress will continue to enhance Australia’s competitiveness and market opportunities.
A Wealthier World

In the megatrend "A wealthier world" the study outlines the impact on global commodity markets and Australia’s rural industry from income growth both domestically and internationally. In the developing Asia region alone some 1.02 billion people will cross an income threshold and move out of poverty and into the middle classes. Average incomes are forecast to rise from US$12,000 per person to US$44,000 per person by the year 2060.

Rising wealth is having impacts on commodity markets. People are increasing their average daily calorie intake which means more food will be demanded and they are moving out of subsistence production so are more reliant on markets for food.

Key insights to the Wealthier World megatrend

• According to data from the Organisation for Economic Cooperation and Development (OECD) the average income for a world citizen – measured as GDP per capita which is the world’s total economic output divided by the number of people – is currently US$14,000 per year. This is forecast to grow to US$17,000 by the year 2020; to US$22,000 by the year 2030 and US$28,000 by the year 2040.

• The world of the future will contain more people who, on average, eat more food. The United Nations Food and Agriculture Organisation (FAO) estimates that per capita kilojoule consumption will increase from 2,358 kcal/person in the year 1966 to 2,940 kcal/person by the year 2015 and 3,050 kcal/person by the year 2030. A key driver is income growth.

• In the future over a billion people living in emerging economies will eat a more diverse range of fruits, vegetables, meats, seafoods, nuts and other foods. Average consumption rates for staple foods such as rice are likely to fall.

• Protein consumption in emerging economies is on the rise. It is estimated by the Australian Government Department of Agriculture that beef consumption in the Association of South East Asian Nations (ASEAN) member States will increase 120 per cent and dairy consumption will double by the year 2050.

• Despite growing consumption in world and domestic markets Australian seafood exports have fallen from 64,700 tonnes of product in 2000/01 down to 40,500 tonnes in 2011/12. This partly results from competitive pressures associated with Asia’s expanding aquaculture industry.

• China is establishing itself as a net importer of crop and livestock products. During the ten year period from 2002 to 2011 China increased imports of crop and livestock products from US$25 billion to US$128 billion but exports only rose from US$17 billion to US$52 billion.

• There is a possibility of rising demand for organic and/or ethically certified food in China in the future. Although still representing a small fraction of the total market, the China Organic Food Certification Centre (COFCC) estimate that sales volume in organic certified food produce has risen from 135 million tonnes in 2003 to 1.96 billion tonnes in 2006 (with the number of certified products rising from 231 to 3,010).
Implications for rural industry innovation of the Wealthier World megatrend

1. Australian rural industries have a major opportunity to diversify exports and grow new markets.

2. A new wealthy Asian and emerging economy customer is likely to have a much more diverse and westernised diet. This represents an opportunity for Australian rural industries to identify new opportunities and connect to new markets. A diversified rural export base is likely to be more resilient to within-market supply and demand shocks.

3. A critical competitive advantage for Australia is to maintain and extend its reputation as a supplier of high-quality products with high environmental, health and safety standards. Australian farm produce which is perceived as fresher, healthier and responsibly produced is likely to out-compete produce from many other countries.

4. The recent free trade deal with China has helped open up market access for some Australian rural industries, especially dairy, to this very large population of increasingly wealthy consumers. These industries now have an opportunity to establish and grow these markets as the agreement progressively takes effect.
Choosy Customers

The consumer of the future will have great expectations for the food and fibre products they purchase. Today’s consumer has different tastes, preferences and concerns to the consumer of twenty years ago. For example, organic certification, free range eggs, health labels and fair trade logos were much harder to find in the supermarket of 1985 yet in supermarkets of the year 2015 these labels are commonplace. Such trends are likely to continue.

Health is likely to become a particularly prominent driver of food choice and consumption patterns which has impacts both within and beyond the farm gate. Information technology will increasingly enable the consumer to selectively access, share and validate information about products along the whole farm to fork supply chain.

Key insights to the Choosy Customers megatrend

• One of the biggest challenges before Australia and the world is the rising prevalence of obesity and associated lifestyle illness which are linked to both diet and exercise. In Australia, one in two people are overweight and the proportion is projected to rise a further 15 per cent over the next 10 years. The issue also has worldwide impact with estimates that some 904 million people in developing countries are overweight or obese, compared to 557 million in high-income countries. Obesity is likely to be a major factor influencing government policy in coming decades.

• In recent history health perceptions have impacted market demand for crop and livestock products. For example, beef, eggs, pork, seafood, olive oil have both lost and gained market share from changes in consumer sentiment about health impacts. As research continues and consumers become more health literate, the health impacts of food will become an increasingly important consideration for them.

• Consumers across the world are increasingly interested in functional foods, those designed to provide a specific health benefit above and beyond basic nutrition such as pro-biotic yoghurt, with the global market estimated at US$90.5 billion in 2013.

• Food products with ethical labels account for 5 to 10 per cent of the food markets in wealthy economies of Western Europe, North America, Australia and parts of Asia. Ethical labels cover fair trade, free range, animal welfare friendly and environmentally responsible production.

• Provenance refers to the origins of food and can include claims about socially responsible production and authenticity. This includes the geographic region, the plant and animal species and the methods of production. Provenance is likely to play a larger role in consumer choices about agricultural products in the coming decades.

• Farmers markets are on a pathway of growth. Since their commencement in 1999, the Australian Farmers Market Association estimates there are now over 160 markets in operation. Farmers markets are estimated to account for 7 per cent of total market share for fresh food compared to supermarkets at 50 per cent.

• Social media will accelerate and magnify the role of provenance, ethics and health in agricultural markets and food markets. The rise of internet communication and social media use is changing the way people access information and make choices.
Implications for rural industry innovation of the Choosy Customers megatrend

1. The implication of this megatrend is that Australian rural industries have an opportunity to increase and maintain market share by communicating the provenance, ethics, environmental performance and healthiness of their crop and livestock products.

2. Farmers and fishers will be able to look for opportunities to advance supply chains in different ways using social media and information technology to communicate product information.

3. There is an opportunity for rural industries to demonstrate ‘credence’ characteristics, traceability and quality control using technologies including sensory and communication technologies for customer needs, to help build trust and respond to preferences in order to grow these markets and increase value.

4. As provenance, ethics, environmental performance and biosecurity become more important from the customer’s perspective, the development of standards and accreditation systems industry-wide will become more critical offering significant opportunities, and challenges, for Australian rural industries.

5. There are likely to be increased opportunities to make foods functional. For example, the health benefits of fibre are well established and as the health benefits of a high fibre diet become more widely known, consumption rates may rise with corresponding increases in the demand for agricultural products which have high fibre content.

6. The large health benefits and cost effectiveness of policy interventions in health may cause governments to regulate and/or tax foods which are harmful to health e.g. high sugar or fat. The agribusiness sector is likely to be increasingly concerned with identifying and communicating the health benefits of particular products.
Transformative Technologies

Advances in technology within the fields of digital, genetics and materials science will change the way food and fibre products are created. Genetic technology will allow crop and pasture yields to improve and become more resistant to weeds, pests and climate risks. Advanced sensory systems and data analytics will permit advanced and highly integrated farm to fork supply chains. Customers will be able to readily trace food and fibre products from their origins and supermarkets will have increased tools for quality assurance.

Satellite and other remote monitoring technologies will allow governments and “the crowd” to access information about farm condition and management practices at low cost. Lastly, the world of synthetics is likely to advance rapidly as breakthroughs occur in the field of advanced materials science and food manufacturing.

Key Insights into Transformative technologies megatrend

- Since the mid-1990s the global area of genetically modified crop has grown to 150 million hectares, mainly in the Americas but also in Asia, incorporating genes for pest, herbicide and disease resistant into a range of crops (cotton, maize, canola, potatoes). This trend is set to grow as new technologies are applied in plant breeding.

- The era of harvesting information from embedded devices and putting it to use to improve systems is only just commencing. Coined the Internet of Things (IoT) – this technology can change the way farms are operated by providing farmers with real time information about the locations and status of farm animals and automatically run spraying, planting, harvesting and irrigation systems.

- Increasingly we will see the application of robotics to agriculture. There is a trend towards the application of single task robots (e.g. to move pots in nurseries) and the same principles are being applied using natural systems (e.g. bees used to deliver fungicide to cherry blossoms). Farming will be less manual and more digital - fast broadband, robotics and sensors will improve labour productivity and farming precision.

- Synthetic textiles continue to challenge natural fibres such as cotton. The growth in synthetic textiles will be far greater in the developing country markets over the next three decades. A shifting pattern of wealth may temper this but the large expansion in textiles is going to be for synthetic rather than cellulosic fibre.

- There is a possibility that synthetic foods, at some point, will take some portion of the market share occupied by natural foods. How far this trend goes may depend more on consumer sentiment than on technology with some resistance being noted to modified animal products.

- Technology advances in the field of energy will see continued expansion of biofuel production. The growth liquid biofuels has been rapid – from 68.3 million tonnes in 2006 to 130 million tonnes in 2011, utilising over 45 million ha of land for production of feedstock. Up to 2020 the market will be dominated by first generation biofuels, based on food products (maize, canola, soybeans, sugar, wheat), as technologies for second generation fuels (based on cellulose, hemicellulose or lignin) are yet to reach industrial scale.
Implications for rural industry innovation of the Transformative Technologies megatrend

1. Farmers and fishers will increasingly have sophisticated tools to assist with decision making. Big data systems and digital technologies will bring better risk management approaches to Australian agriculture; weather and yields will be much more predictable.

2. Farming will be a much more transparent activity. Agriculture will need to respond to the greater scrutiny - from the community, governments and consumers - that internet technologies, robots and earth-observation systems enable.

3. Many new business models will develop in the agri-business sector. The need for inter-operability of smart devices, and the systems built around them, will open up first-mover advantage to innovative agri-businesses.

4. The concept of farming will be expanded to non-food land use as new markets and opportunities for land-based products emerge in response to climate change and the need for renewable energy.
A Bumpier Ride

Risk is an ever present characteristic of Australian agriculture but the risk profile is set to change. The coming decades will see changes in the global climate, environmental systems and world economy which create new and potentially deeper risks for farmers. This is largely due to the interconnectedness of worldwide environmental and socio-economic systems.

Climate change is elevating the frequency and severity of extreme weather (e.g. droughts, floods, bushfires). The globalisation of supply chains, which provide inputs (e.g. fertilisers, fuel, chemicals) critical for agriculture, increases the number of links in the production system, and therefore, the risk of supply chain breakdowns. A challenge is posed by increased weed and pest resistance to herbicides and pesticides which is reducing their effectiveness.

Key Insights into Bumpier Ride megatrend

- The global mean temperature of the earth has increased by 0.85 degrees Celsius since 1880. During the forthcoming period during 2016 to 2035 average temperatures are forecast to rise between 0.3 to 0.7 degrees. By the year 2100 global temperatures may have increased by 2 degrees Celsius compared to historic averages. The Australian and global climate is expected to be hotter and subject to more frequent and severe extreme weather events (heatwaves, droughts, floods, bushfires).

- There has been a strong upward trend in the number of people arriving in Australia over the last 50 years. While there is currently no clear trend for an increase in incursions of exotic disease and pests, largely due to Australia’s strict and effective quarantine measures, global trends such as travel and trade increase biosecurity risk for our agricultural industries.

- Australia is increasingly reliant on offshore supply chains needed for agriculture for example, year by year Australia has continued to source a greater portion of fertiliser from overseas. Australian farmers used 1,099 kt of nitrogen in the year 2012 and of this 86 per cent was imported. In the same year 54 per cent of phosphorus and 90 per cent of potassium were imported.

- Approximately 50 per cent of the world’s nitrogen, phosphate and potash fertilisers come from only five countries: China; India; Russia; United States; and Indonesia. The Middle East is becoming an increasingly important region supplying fertiliser to Australia. Geopolitical disturbances in these areas could pose a risk of fertiliser supply chain disruptions.

- Oil prices have a significant impact on food prices. Over the past ten years the world crude oil price has experienced periods of extreme volatility. Long term forecasts suggest oil prices will continue to rise out to the year 2050. Future oil price shocks will impact food commodity prices and farm production costs.

- Weed and pest resistance to herbicides and pesticides is reducing their effectiveness and increasing farm vulnerability to these problems. More than 450 arthropod species worldwide have been reported to have resistance to one or more pesticides. A recent international survey finds 437 unique types of herbicide resistant weeds in existence with Australia alone having 104 weed species with herbicide resistance.
Implications for rural industry innovation of the Bumpier Ride megatrend

1. The risk profile for Australian rural industries will continue to change into the future. This will call for new and deeper levels of resilience to withstand shocks associated with climate change, environmental change and globalisation.

2. Production systems that can be designed to anticipate, prepare for and respond to these changes are essential for a growing sector. Skills and systems to effectively anticipate and manage these increasing risks are also a crucial component of the future for the sector.

3. The effects of climate change on food production will vary geographically but overall there are more negative than positive impacts. As the certainty grows around how climate change will play out in terms of regional rainfall and temperatures, there will be a concerted effort to better quantify the impacts on food production.

4. Globalisation of supply chains increase the cost-effectiveness of inputs required by rural industries but if the supply chains are narrow they do create risks to supply. Understanding the risks will help mitigate them and build more secure and efficient supply chains.

5. Pest and weed resistance to insecticides and herbicides is likely to continue worsening. Ongoing innovation in chemicals, alternative approaches such as genetic technologies (e.g. BT cotton) and in the identification of new management strategies (e.g., integrated pest management) is a vital risk management strategy.

6. Whilst they may not be immediately competitive with traditional methods, the identification of viable options for ‘indoor farming’ may become important in the future if severe climate and environmental risks materialise. These could include techniques such as hydroponics, hot houses and synthetic foods that are insulated from the climate.
Method

This project was undertaken by CSIRO in collaboration with RIRDC. The CSIRO has highly regarded techniques to identify future trends and this paired with expertise in the CSIRO Agricultural Flagship was invaluable for this foundational study.

This research project is the first foresighting study conducted under the National Rural Issues program, it lays the foundation for further exploration and insights into future trends, themes and insights. RIRDC intends to build on this work to regularly provide knowledge to support agricultural and rural industry decision making.

Key Research Steps

Strategic foresight is a cross-disciplinary field of study which aims to explore plausible futures and help people make wiser choices. Over the past six years, CSIRO has developed a generic strategic foresight process pioneered through multiple megatrends, scenario planning and strategy projects delivered in diverse industry sectors. This process has been applied in the formulation of this research.

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Full report

This document provides a summary of the findings and approach used in the development of Rural Industry Futures - Megatrends impacting Australian agriculture over the coming twenty years. A separate full report document has been prepared with the details of the analysis undertaken in the project and is commended to the reader for further information in support of the issues outlined in this document.

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