

Australian agriculture and productivity

- 2.1 This chapter of the report briefly outlines the structure of the Australian agriculture industry and examines efficiency improvements in Australian agricultural practices due to new technology, with reference to several case studies.
- 2.2 The chapter then discusses slowdown of productivity growth in recent years in the agriculture sector. The chapter concludes with discussion on the scope for further productivity growth in the industry.

The Australian agricultural sector

- 2.3 This section of the chapter outlines the existing policy and research structures within the Australian agricultural sector. First, Commonwealth contributions are outlined, including those of the Department of Agriculture and Water Resources; the *Agricultural Competitiveness White Paper*; the National Primary Industries Research, Development and Extension Framework; and the Commonwealth Scientific and Industrial Research Organisation (CSIRO). Contributions by state governments, industry and research bodies are also discussed.

Department of Agriculture and Water Resources

- 2.4 The Australian Government Department of Agriculture and Water Resources (DAWR) develops policy and provides services to improve the productivity, competitiveness and sustainability of Australian agriculture,

fisheries, forestry and related industries. DAWR also supports farmers in times of hardship and assists with risk management and planning.¹

2.5 Several submissions touched on the role that government should play in providing funding for agricultural research, development and extension.²

2.6 Submissions to the inquiry suggested that DAWR should have:

- a clear role in setting research priorities and supporting research that underpins discovery.³
- a consultative role in facilitating collaborations.⁴
- a role in promoting leadership within the sector by implementing research priorities through the Rural Research and Development (R&D) for Profit Programme.⁵

Agricultural Competitiveness White Paper

2.7 The *Agricultural Competitiveness White Paper* (the White Paper), released in 2015, outlines the Australian Government's five key priorities for the agricultural sector.⁶

2.8 These priorities include: ensuring a fairer go for farm businesses; building the infrastructure of the 21st century; strengthening the approach to drought and risk management; and promoting access to premium markets. The final area of focus, 'farming smarter', is the priority area most relevant to the present inquiry.⁷ In particular, the farming smarter chapter of the White Paper emphasises the need for access to advanced technologies and practices, including better research and development and access to skilled workers.⁸

1 Department of Agriculture and Water Resources, 'Agriculture, farming and food' <www.agriculture.gov.au/ag-farm-food> viewed 13 April 2016.

2 Council of Rural Research and Development Corporations, *Submission 90*, p. 5; Cattle Council of Australia, Sheepmeat Council of Australia and Australian Lot Feeders Association, *Submission 84*, pp. 10, 17; The University of Queensland, *Submission 2*, p. 1; AusBiotech, *Submission 33*, pp. 3, 6, 16.

3 Grain Trade Australia, *Submission 21*, p. 2; Murdoch University, *Submission 37*, p. 3.

4 Murdoch University, *Submission 37*, p. 3.

5 Mr Paul Morris, Acting Deputy Secretary, Department of Agriculture and Water Resources, *Committee Hansard*, Canberra, 17 March 2016, p. 1.

6 DAWR, *Submission 88*, p. 4; Council of Rural Research and Development Corporations, *Submission 90*, p. 10.

7 DAWR, 'Agricultural Competitiveness White Paper: at a glance 2015' <[agwhitepaper.agriculture.gov.au/white-paper/white-paper-at-a-glance](http://agriculture.gov.au/white-paper/white-paper-at-a-glance)> viewed 1 April 2016.

8 DAWR, 'Agricultural Competitiveness White Paper 2015' <agwhitepaper.agriculture.gov.au/> viewed 1 April 2016.

The National Primary Industries Research, Development and Extension Framework

- 2.9 The National Primary Industries Research, Development and Extension Framework was created in 2005, through the then Primary Industries Ministerial Council. The framework was endorsed by primary industries ministers and brings together Commonwealth, state and territory governments, the rural research and development corporations (RDCs), CSIRO, the Bureau of Meteorology, and the university sector through the Australian Council of Deans of Agriculture. The Framework seeks to deliver a more coordinated and collaborative approach to research, development and extension (RD&E) for rural industries in Australia.⁹
- 2.10 The framework has facilitated a process through which national RD&E capacity can be more effectively focused and efficiently deployed through strategies for 14 primary industry sectors, and addressing eight cross-sectoral issues. The process allows RDCs to work with research providers to identify potentially useful emerging technologies and then to strategically invest as and where needed along the pathway to adoption.¹⁰

CSIRO

- 2.11 CSIRO is Australia's leading agricultural research entity, and aims to help Australian farming businesses and industry improve productivity and sustainability across the agriculture sector.
- 2.12 CSIRO's agricultural research arm concentrates on animal science, aquaculture, plant science, digital agriculture, food security and sustainable farm management.¹¹

State government agencies

- 2.13 State government agriculture departments play a key role in the Australian agriculture industry. However, there has been a significant reduction in funding support and extension delivery in the past decade. This is discussed further in Chapter 5.
- 2.14 The South Australian Government's lead agency, Primary Industries and Regions South Australia (PIRSA), is involved in many activities which accelerate the adoption of new and more efficient agricultural practices.¹²

9 Council of Rural RDCs, *Submission 80*, p. 8. See also, National Primary Industries RD&E Framework <www.npirdef.org> viewed 16 April 2016.

10 Council of Rural RDCs, *Submission 80*, p. 8. See also, National Primary Industries RD&E Framework <www.npirdef.org> viewed 16 April 2016.

11 CSIRO, 'Agriculture research' <www.csiro.au/en/Research/AF> viewed 13 April 2016.

12 Primary Industries and Regions South Australia, *Submission 19*, p. 3.

- 2.15 The research and development arm of PIRSA seeks to deliver robust scientific solutions to support sustainable and internationally competitive primary industries.¹³
- 2.16 The PIRSA submission to the inquiry noted that these activities are usually conducted through partnerships with South Australian industry, the Australian Government and other research organisations such as universities or CSIRO.¹⁴
- 2.17 The Tasmanian Government also recognises the importance of investing in agricultural research, development and extension at the state level, which it does in partnership with the University of Tasmania.¹⁵
- 2.18 The Tasmanian Government's *Cultivating Prosperity in Agriculture* policy sets out its vision to increase the annual farm gate value of Tasmanian agriculture tenfold to \$10 billion per year by 2050.¹⁶
- 2.19 The Tasmanian Government is setting out to achieve this vision through co-investment in irrigation infrastructure, strategic investment in research, development and extension activities and supporting better skills pathways.¹⁷

Research and development corporations

- 2.20 The 15 rural research and development corporations, which are established partnerships between government and industry, play a key role in the agricultural innovation system.¹⁸
- 2.21 The RDCs were created with the objective of sharing funding and setting the strategic direction for investment in R&D. The RDCs also have a role in extension; that is, ensuring new technologies are able to be implemented by farming businesses.
- 2.22 The roles of the RDCs include prioritising and funding the research, development and extension of new technologies that can improve the economic, environmental and social performance of Australia's rural industries.¹⁹
- 2.23 The Council of Rural Research and Development Corporations (Council of Rural RDCs) represents all of the 15 rural RDCs, and exists to support and

13 PIRSA, *Submission 19*, p. 3.

14 PIRSA, *Submission 19*, p. 3.

15 Tasmanian Government, *Submission 58*, p. 2.

16 Tasmanian Government, *Submission 58*, p. 1.

17 Tasmanian Government, *Submission 58*, p. 1.

18 Dr Daniel Walker, Research Director, Agriculture, CSIRO, *Committee Hansard*, Canberra, 26 November 2015, p. 1.

19 Council of Rural RDCs, *Submission 90*, p. 2.

facilitate the RDCs to fulfil their broad purpose where action by any of the individual organisations would be impossible, impractical, inefficient or ineffective.²⁰ The Council of Rural RDCs provides a mechanism for RDCs to combine their resources and networks to share information, amplify and disseminate messages, and engage with common stakeholders.²¹

- 2.24 The Council of Rural RDCs explained that RDCs ensure industry has sufficient and appropriate levels of information to determine whether a technology is suitable and under what circumstances, what benefits it offers, and what risks may need to be managed should it be adopted.²²
- 2.25 The R&D innovation structure and associated issues related to the operation of RDCs are further examined in Chapter 6 of this report.

Levy system

- 2.26 Contributions to research and development investment from the agricultural industry are made through levies on production. The Australian Government collects levies on behalf of the industries, and also provides a matching contribution on a dollar-for-dollar basis, up to a capped limit.²³
- 2.27 Agricultural levies are an important source of funding for agricultural R&D for many commodities.²⁴ The levy system ensures that both industries and the Commonwealth contribute to research with public and private benefits.²⁵ It also ensures adequate investment in industry initiatives, as individual farmers and producers acting in isolation may not obtain a return on individual investments.²⁶
- 2.28 The establishment of a new levy would generally come about through an industry body identifying the need for a levy to address an issue requiring collective industry funding. The organisation would then put a levy proposal to its members, possibly in consultation with DAWR.²⁷
- 2.29 The availability of ‘matched industry money’ as a result of levies gives confidence to investors – including state governments and universities – to

20 Council of Rural RDCs, *Submission 90*, p. 3.

21 Council of Rural RDCs, *Submission 90*, p. 3.

22 Council of Rural RDCs, *Submission 90*, p. 2.

23 Council of Rural RDCs, ‘The Rural RDC Model – funding arrangements’ <www.ruralrdc.com.au/rural-innovation-in-australia/#rural-rdc-model> viewed 13 April 2016.

24 Council of Veterinary Deans of Australia and New Zealand, *Submission 46*, p. 1; Mr Anthony Battaglione, Winemakers’ Federation of Australia, *Committee Hansard*, Canberra, 4 February 2016, p. 1.

25 Council of Veterinary Deans of Australia and New Zealand, *Submission 46*, p. 1.

26 Australian Pork Limited, *Submission 70*, p. 4.

27 DAWR, ‘Levies’ <www.agriculture.gov.au/ag-farm-food/levies> viewed 11 April 2016.

invest in the most significant areas of RD&E.²⁸ Money, effort and confidence are leveraged into the priority innovation areas.²⁹

Rural Research and Development for Profit Programme

- 2.30 The Rural R&D for Profit Programme is a \$200 million competitive grants program which encourages RDC collaboration for innovation. Grants are provided to RDCs and partners for collaborative research which enhances farm-gate profitability and supports the continued innovation of Australia's primary industries.³⁰
- 2.31 One of the conditions of grants under the program is that applicants must be RDCs collaborating with other RDCs.³¹
- 2.32 The program began in 2014–15 as a four year program and was due to conclude in 2017–18. However, the Australian Government has committed to extend the programme by a further four years, with additional funding.³² This program is discussed further in Chapter 6.

Cooperative Research Centres

- 2.33 Cooperative Research Centres (CRCs) are structures through which participants within the research system, particularly at the provider end, come together to work on a specific problem within a defined period.³³
- 2.34 Mr Tim Lester, from the Council of Rural RDCs, suggested that CRCs are important mechanisms to drive collaboration, however their role is different to that of RDCs, being both time bound and limited in scope.³⁴
- 2.35 The Committee was told that one of the jobs of RDCs was to position the role of a particular CRC within the strategic priorities of the industry with which they work, and the broader context of the rural innovation system.³⁵
- 2.36 Professor James Rowe, Chief Executive of the CRC for Sheep Industry Innovation, noted that RDCs were research investors, in contrast to CRCs, which were 'research doers'.³⁶

28 Council of Veterinary Deans of Australia and New Zealand, *Submission 46*, p. 1.

29 Council of Veterinary Deans of Australia and New Zealand, *Submission 46*, p. 1.

30 DAWR, *Submission 88*, p. 5.

31 DAWR, 'Rural Research and Development for Profit' <www.agriculture.gov.au/ag-farm-food/innovation/rural-research-development-for-profit> viewed 6 April 2015.

32 DAWR, *Submission 88*, p. 5.

33 Mr Tim Lester, Operations Manager, Council of Rural RDCs, *Committee Hansard*, Canberra, 25 February 2016, p. 2.

34 Mr Tim Lester, Operations Manager, Council of Rural RDCs, *Committee Hansard*, Canberra, 25 February 2016, p. 2.

35 Mr Tim Lester, Operations Manager, Council of Rural RDCs, *Committee Hansard*, Canberra, 25 February 2016, p. 2.

History of innovation and productivity performance

- 2.37 Submissions to the inquiry discussed at length the growth in productivity in the Australian agricultural industry over the last several decades. Each of those submissions explained that productivity growth has been underpinned by advances in technology.
- 2.38 PIRSA argued that agriculture is one of the most efficient industries in Australia due to a long history of adopting new technological innovation.³⁷ PIRSA stated that, from 1989–90 to 2013–14, multifactor productivity in agriculture had been increasing annually at 2.7 per cent, which is considerably higher than the market sector average.³⁸
- 2.39 Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES) research reports support the commonly held notion that past growth has been underpinned by adoption of technology.³⁹ In particular, adoption of new technologies has been responsible for such growth over and above changes in the scale of farms.
- 2.40 The Ag Institute Australia (AIA) stated that productivity and efficiency gains have been derived from a mix of transformational and incremental innovations, with the source of these innovations being varied and unpredictable.⁴⁰
- 2.41 The AIA submission explained that all productivity and efficiency gains have depended on strong strategic investment in public sector and private sector research, effective collaboration between the sectors and close engagement with producers.⁴¹
- 2.42 The submission added that, in many cases, the transformational technologies have been created in the public sector – often at universities, CSIRO and state government agriculture departments – and have subsequently been developed and commercialised by the private sector and embraced by primary producers.⁴²

36 Professor James Rowe, CEO, CRC for Sheep Industry Innovation, *Committee Hansard*, Armidale, 13 April 2016, p. 30.

37 PIRSA, *Submission 19*, p. 3.

38 PIRSA, *Submission 19*, p. 3.

39 Sheng, Y., Gray, E.M., Mullen, J.D. and Davidson, A. (2011) *Public investment in agricultural R&D and extension: an analysis of the static and dynamic effects on Australian broadacre productivity*. ABARES research report 11.7, Canberra; Gray, E.M., Oss-Emer, M. and Sheng, Y. (2014) *Australian agricultural productivity growth: past reforms and future opportunities*. ABARES research report 14.2, Canberra.

40 Ag Institute Australia, *Submission 73*, p. 2.

41 Ag Institute Australia, *Submission 73*, p. 2.

42 Ag Institute Australia, *Submission 73*, p. 2.

- 2.43 The submission from Southern Farming Systems and the Australian Controlled Traffic Farming Association discussed increased productivity performance and a key reason behind that improvement:

Australian agricultural productivity has increased steadily by about two per cent per year since the 1950s and much of this can be attributed to improvements in cultivars, agronomy, farming systems and technologies brought about through structured research and development conducted either directly or indirectly through Australia's Rural Research and Development Corporations.⁴³

- 2.44 A 2011 research report produced by ABARES provided evidence of the important contribution of public research and development to broadacre total factor productivity in Australia.⁴⁴ The report found that:

... over the past 50 years, knowledge and technology accumulated from past public investments in [research, development and extension] in Australia and overseas have accounted for almost two thirds of average annual broadacre productivity growth.⁴⁵

- 2.45 ABARES, in its analysis for the report, calculated that every \$1 in public investment in research, development and extension produces \$12 in benefits to farmers in the long term.⁴⁶

Trends and variability

- 2.46 Several inquiry stakeholders noted that there is variability in productivity growth across different sectors of the agricultural industry, and across different periods of time. Furthermore, productivity growth can be driven by different factors in different sectors.
- 2.47 For example, the AIA noted that cotton industry productivity gains have exceeded 1.5 per cent per annum, while productivity gains in grains and sugar have been less than one per cent per annum over the same period.⁴⁷

43 Southern Farming Systems and the Australian Controlled Traffic Farming Association, *Submission 61*, p. 2.

44 Sheng, Y., Gray, E.M., Mullen, J.D. and Davidson, A. (2011) *Public investment in agricultural R&D and extension: an analysis of the static and dynamic effects on Australian broadacre productivity*. ABARES research report 11.7, Canberra.

45 DAWR, *Submission 88*, p. 10.

46 DAWR, *Submission 88*, p. 10.
Sheng, Y., Gray, E.M., Mullen, J.D. and Davidson, A. (2011) *Public investment in agricultural R&D and extension: an analysis of the static and dynamic effects on Australian broadacre productivity*. ABARES research report 11.7, Canberra.

47 Ag Institute Australia, *Submission 73*, p. 1.

- 2.48 Similarly, the Cattle Council of Australia, Sheepmeat Council of Australia and Australian Lot Feeders Association stated that, over the long term, beef enterprises were maintaining productivity growth at 0.9 per cent per annum, while sheep enterprises grew at 0.5 per cent per annum.⁴⁸
- 2.49 A 2014 research report produced by ABARES stated that average productivity growth across all broadacre agriculture (non-irrigated cropping and extensive livestock industries) has been around one per cent per annum for more than three decades. The report explained that this has largely been due to reduced input use rather than output growth.⁴⁹
- 2.50 The AIA added that, in the grains, sugar and animal production industries, gains in the efficiency of water use and labour efficiency have been substantial, relating these gains directly to innovation.⁵⁰
- 2.51 The ABARES report explained that trends among individual broadacre industries varied markedly over time:
- Productivity growth of cropping specialists averaged 1.5 per cent a year between 1977-78 and 2010-11, higher than the rate observed over the same period on farms in the beef (0.9 per cent) and sheep (0.0 per cent) industries. However, following the dismantling of the wool reserve price scheme in 1991, sheep industry productivity has increased at an average rate of 1.4 per cent a year since the mid-1990s ... The dairy industry has realised average annual productivity growth of around 1.6 per cent since the late 1970s.⁵¹
- 2.52 The report also stated that productivity growth varies considerably across farms, industries and regions.⁵²

Technological advances in agriculture

- 2.53 The Warren Centre for Advanced Engineering explained that agriculture has historically benefitted from technology adoption, with the industrial age bringing mechanisation and synthetic fertilisers, and the technology

48 Cattle Council of Australia, Sheepmeat Council of Australia and Australian Lot Feeders Association, *Submission 84*, p. 7.

49 Gray, E.M., Oss-Emer, M. and Sheng, Y. (2014) *Australian agricultural productivity growth: past reforms and future opportunities*. ABARES research report 14.2, Canberra, p. 9.

50 Ag Institute Australia, *Submission 73*, p. 1.

51 Gray, E.M., Oss-Emer, M. and Sheng, Y. (2014) *Australian agricultural productivity growth: past reforms and future opportunities*. ABARES research report 14.2, Canberra, p. 10.

52 Gray, E.M., Oss-Emer, M. and Sheng, Y. (2014) *Australian agricultural productivity growth: past reforms and future opportunities*. ABARES research report 14.2, Canberra, p. 10.

age delivering genetic engineering and automation.⁵³ The Warren Centre added that the information age brings the potential for integrating technology advances into a precision agriculture that drives growth and productivity.⁵⁴

2.54 The University of Sydney considers that new technologies encompass new physical instruments and products along with new knowledge, skills and management techniques. Its submission explained that the latter are essential for the former to succeed.⁵⁵

2.55 The Rural Industries Research and Development Corporation (RIRDC) submission stated that agricultural productivity gains have been driven by technology:

Since the 1960s, agriculture has benefited from increased use of agrochemicals, advances in crop and animal genetics, agricultural mechanisation and improved management practices. These technologies have driven productivity increases and will continue to provide future incremental improvements.⁵⁶

2.56 The Charles Sturt University submission provided examples of large-step changes and incremental changes that have contributed to productivity growth in agriculture:

Notable examples of large step-changes include the introduction of no-till farming (facilitated by the availability of new herbicides), which greatly reduced input costs, retained more soil moisture and improved crop yields; and the introduction of subterranean clover in southern Australian livestock systems which improved soil fertility and increased livestock growth rates and carrying capacity. Incremental improvements (through plant and animal breeding, improved management practices) have built on these large changes to result in further production gains through improved water use efficiency, stress tolerance (e.g. disease and frost), feed conversion efficiency and product quality.⁵⁷

53 Warren Centre for Advanced Engineering, *Submission 43*, p. 2, referencing Whelan, B. M. (1997). *The Impact of Precision Agriculture. Proceedings of the ABARE Outlook Conference, 'The Future of Cropping in NW NSW'*, p. 5. Moree, UK.

54 Warren Centre for Advanced Engineering, *Submission 43*, p. 2, referencing Zhang, N. M. (2002). Precision agriculture - a worldwide overview. *Computers and Electronics in Agriculture*, 113-132.

55 University of Sydney, *Submission 40*, p. 4.

56 Rural Industries Research and Development Corporation, *Submission 74*, p. 3.

57 Charles Sturt University, *Submission 17*, p. 2.

- 2.57 Submissions to the inquiry provided examples of advances in technology that have benefited agriculture in Australia. The examples were extensive and quite comprehensive. A list of examples can be found in Appendix D.

Productivity growth and improvement: case studies

Wheat

- 2.58 The CSIRO submission to the inquiry provided details on the historical improvement in wheat yields in Australia:

... yield progress has been characterised by phases of gain interspersed with 'plateau periods' where progress slows. The intermittent periods of rapid yield improvement occurred where packages of improved management combined to allow the underlying improvements in genetic yield potential to be realised.⁵⁸

- 2.59 The submission further explained that, according to the history of progress in wheat yields, there is no single technology that has contributed to jumps in yield.⁵⁹

Cotton

- 2.60 The Committee heard that the Australian cotton industry is an exemplar for productivity growth in Australian agriculture. The CSIRO submission stated that the Australian cotton industry is worth \$2.5 billion per annum in exports, supports up to 10,000 jobs,⁶⁰ and relies heavily on science-based innovation.⁶¹

- 2.61 Cotton Australia explained that the Australian cotton industry is recognised internationally as innovative and dynamic, largely due to industry investment in RD&E:

Australian cotton is world leading for yield and quality and is underpinned by a world-class best management practice system that aligns with global initiatives for delivery of responsibly produced cotton. This success is due to industry investment in

58 CSIRO, *Submission 55*, p. 8.

59 CSIRO, *Submission 55*, p. 8.

60 Cotton Australia, *Submission 72*, p. 1.

61 CSIRO, *Submission 55*, p. 14.

world-class research and rapid adoption of emerging science, innovations and technology to drive profitability.⁶²

2.62 Mr Adam Kay, Chief Executive Officer of Cotton Australia, described the rise of the Australian cotton industry over the last two or three decades:

... we are now the number one country for yield around the world, so we produce about three times the global average in yield of cotton, and we are up there as the highest quality of cotton out there, which means that Australian cotton is in demand.⁶³

2.63 Mr Kay explained that the cotton industry is recognised for innovation, being open to change and being prepared to take risks with technology.⁶⁴ He discussed some of the reductions in water and pesticide use in the cotton industry, due to the adoption of new technologies:

... we have been able in the last 20 years to reduce the amount of pesticide we use in the Australian cotton industry by 92 per cent. That is moving from back in the days of a dozen insecticide sprays onto a crop down to sometimes one these days – there are a lot of growers with none. We have been able to increase our water use efficiency in the last decade by 40 per cent.⁶⁵

2.64 Mr Kay also explained that a key development has been a significant improvement in land use efficiency, producing twice the amount of fibre from the same area of land.⁶⁶

2.65 The Cotton Research and Development Corporation (CRDC) outlined benefits of the introduction of biotechnology to the cotton industry, the environment, and society more broadly:

- increased populations of beneficial insects and wildlife in cotton fields;
- reduced pesticide run off;
- improved farm worker and neighbour safety;
- a decrease in labour and fuel usage;
- improved soil quality;
- reduced production costs;
- increased yield;

62 Cotton Australia, *Submission 72*, p. 1.

63 Mr Adam Kay, Chief Executive Officer, Cotton Australia, *Committee Hansard*, Canberra, 29 February 2016, p. 7.

64 Mr Adam Kay, Chief Executive Officer, Cotton Australia, *Committee Hansard*, Canberra, 29 February 2016, p. 7.

65 Mr Adam Kay, Chief Executive Officer, Cotton Australia, *Committee Hansard*, Canberra, 29 February 2016, p. 7.

66 Mr Adam Kay, Chief Executive Officer, Cotton Australia, *Committee Hansard*, Canberra, 29 February 2016, p. 7.

- reduced risks; and
 - further opportunities to grow cotton in areas of high pest infestation.⁶⁷
- 2.66 The CSIRO submission stated that productivity growth in the Australian cotton industry has continued, with yields improving at two per cent per annum, which is greater than in any other agricultural sector in Australia.⁶⁸ CSIRO added that 45 per cent of the improvement is due to better cotton varieties, and 55 per cent due to better management.⁶⁹
- 2.67 When asked if the significant reduction in pesticide use was solely down to genetically modified cotton breeds, Mr Kay explained that integrated pest management programs play a significant role:
- Yes, the Bt cotton handles a couple of the pests, but there are still other pests there and our growers are using integrated pest management as well as some area-wide management techniques. It is all part of a package.⁷⁰
- 2.68 Similarly, when asked about water use efficiency improvements being a result of the genetics of the crop, Mr Kay explained that it is a part of a better farming system:
- With water-use efficiency, part of it is the genetics but part of it is a whole lot of infrastructure things like the scheduling and the delivery to the farm. There were a lot of losses, so I think a lot of the infrastructure upgrades and the like have been critical there. It is a combination, and some of it is genetics. There is ongoing work in getting more water-use efficient varieties.⁷¹
- 2.69 Mr Kay emphasised the role of the research and development system in taking the Australian cotton industry to world leader status.
- I do not think we can highlight enough how the R&D system has helped this industry move to a world-leading industry. It is all on the back of R&D. Yes, we have innovative farmers who are prepared to pick up the R&D and run with it, but it has been the R&D that has allowed us to address some of these key issues: the pesticide-use issues and the water-use issues were things that were impacting on our social licence in our own communities, let

67 Cotton Research and Development Corporation, *Submission 49*, p. 1.

68 CSIRO, *Submission 55*, p. 14.

69 CSIRO, *Submission 55*, p. 14.

70 Mr Adam Kay, Chief Executive Officer, Cotton Australia, *Committee Hansard*, Canberra, 29 February 2016, p. 8.

71 Mr Adam Kay, Chief Executive Officer, Cotton Australia, *Committee Hansard*, Canberra, 29 February 2016, p. 8.

alone state and nationally. We have been able to address them effectively, and doing that has given us global recognition.⁷²

Dairy

- 2.70 Submissions from Australian Dairy Farmers and Dairy Australia (ADF-DA) and DAWR summarised an ABARES publication that examined productivity in the Australian dairy industry.
- 2.71 ABARES conducted a comprehensive assessment of Australian dairy farm performance.⁷³ The research report found that, on average, productivity growth in the Australian dairy industry has been 1.6 per cent per annum, for the period 1978–79 to 2010–11.⁷⁴
- 2.72 The report noted that rates of productivity growth differ across regions, reflecting relative differences in regional industry structures, the extent of uptake of new technologies, and the characteristics of each region that affect the types of farming systems used.⁷⁵
- 2.73 The report explains that two key drivers of the observed growth in dairy farm productivity have been the exit of relatively less efficient farms from the industry, and the widespread adoption of new technologies and management practices that have allowed dairy farmers to reduce the quantity of inputs required to produce a given quantity of output.⁷⁶
- 2.74 A 2011 report commissioned by Dairy Australia and the Victorian Department of Primary Industries also provided a comprehensive assessment of the impact of innovation for dairy.⁷⁷
- 2.75 ADF-DA provided details from the 2011 report, explaining that major increases in on-farm production are estimated to have increased Victorian dairy farm profitability by around \$10 billion over the three decades from 1980 to 2010.⁷⁸
- 2.76 The report found that nearly half of the increase could be attributed to on-farm innovation; it was estimated to have increased farmers' profitability

72 Mr Adam Kay, Chief Executive Officer, Cotton Australia, *Committee Hansard*, Canberra, 29 February 2016, p. 8.

73 Ashton, D., Cuevas-Cubria, C., Leith, R. and Jackson, T. (2014) *Productivity in the Australian dairy industry: pursuing new sources of growth*. ABARES research report 14.11, Canberra.

74 Australian Dairy Farmers and Dairy Australia, *Submission 65*, p. 2; DAWR, *Submission 88*, p. 12.

75 DAWR, *Submission 88*, p. 12.

76 DAWR, *Submission 88*, p. 12.

77 Centre for International Economics (2011) *The impact of innovation on the dairy industry over the last 30 years Evaluating the contribution of industry and government investment in pre farm gate RD&E*. Prepared for Dairy Australia and the Victorian Department of Primary Industries.

78 ADF-DA, *Submission 65*, p. 2; DAWR, *Submission 88*, p. 12.

by around \$7.7 billion in net present value terms, whilst only costing approximately \$2.3 billion in net present value terms. That represents an estimated cost-benefit ratio of \$3.30 economic benefit for each dollar invested in R&D.⁷⁹

2.77 The report discusses some of the factors that drove the recorded increases in productivity:

... increased pasture production and utilisation, increased supplementary feeding, and more efficient cows, all of which have been – and remain – key areas of focus for the dairy industry’s RD&E program.⁸⁰

2.78 The report explains that milk production in Victoria more than doubled despite cow numbers remaining the same, and with a 35 per cent reduction in effective grazing area. Milk yield per cow almost doubled and production per hectare increased by 192 per cent.⁸¹

Slowdown of productivity growth

2.79 Several submissions to the inquiry stated that agricultural productivity growth has stalled in recent years.

2.80 CSIRO stated that rates of productivity increase for broadacre agriculture, as a whole, have stalled in the last 20 years. It did acknowledge notable exceptions, including cotton, dairy and large grain farms.⁸²

2.81 CSIRO discussed some of the possible reasons for the stalling productivity growth, including declining investment in R&D (in absolute and research intensity terms); the relatively low contribution of private sector R&D; the notable lack of public-private partnerships compared to countries such as Israel, the Netherlands, and Denmark; and the inability of various industries to adapt to a drying and warming climate, reduced irrigation supplies, and soil management issues.⁸³

2.82 The Australian Farm Institute stated that broadacre agriculture has experienced a marked slowdown in annual productivity growth rates since 1997.⁸⁴ Further, the Institute concurred that the slowdown is due to a

79 ADF-DA, *Submission 65*, p. 2; DAWR, *Submission 88*, p. 12.

80 ADF-DA, *Submission 65*, p. 2; DAWR, *Submission 88*, p. 12.

81 ADF-DA, *Submission 65*, p. 2; DAWR, *Submission 88*, p. 12.

82 CSIRO, *Submission 55*, p. 7.

83 CSIRO, *Submission 55*, p. 7.

84 Australian Farm Institute, *Submission 85*, p. 3.

number of different factors, with an important one being the level of investment in agricultural R&D in Australia.⁸⁵

- 2.83 Similarly, the ABARES research report from 2014 also suggested that growth has slowed in the broadacre industries, particularly the cropping and mixed crop livestock industries, and the agriculture sector more broadly. The report stated that slower growth has been largely attributed to a combination of adverse seasonal conditions and stagnating investment in public agricultural R&D.⁸⁶
- 2.84 The Charles Sturt University submission reflected on the ABARES 2014 report, providing thoughts on total factor productivity (TFP) gains and the more recent slowdown:
- It can be argued that much of the large TFP gains in cropping in the 1977-1988 period cited in this report were attributable to the R&D investment that allowed no-till cropping to become widespread, combined with largely good seasonal conditions allowing crops to approach their yield potentials. Much slower TFP growth in the 1999-2010 period coincided with the millennium drought and reduced public expenditure on R&D ...⁸⁷
- 2.85 The Charles Sturt University submission added that slower growth in the most recent decade has refocused R&D efforts towards breeding more drought tolerant varieties, conservation of soil moisture, and practices to improve risk management.⁸⁸
- 2.86 The ADF-DA submission noted that, despite favourable productivity increases, in the last decade productivity growth has slowed and the dairy industry has struggled to compete with the productivity gains of its major international competitor, New Zealand.⁸⁹
- 2.87 The DAWR submission referred to workshops conducted by ABARES and the Grains Research and Development Corporation (GRDC), where productivity slowdown in the grains industry was discussed. The main causes of productivity slowdown were considered to be:
- drought;
 - slower spread and adoption of new technologies;
 - smaller advances in farming systems and technologies;

85 Australian Farm Institute, *Submission 85*, p. 3.

86 Gray, E.M., Oss-Emer, M. and Sheng, Y. (2014) *Australian agricultural productivity growth: past reforms and future opportunities*. ABARES research report 14.2, Canberra, p. 10.

87 Charles Sturt University, *Submission 17*, p. 2.

88 Charles Sturt University, *Submission 17*, p. 2.

89 ADF-DA, *Submission 65*, p. 2; DAWR, *Submission 88*, p. 12.

- knowledge constraints; and
 - shifts in research priorities away from productivity.⁹⁰
- 2.88 R&D funding issues are discussed in Chapter 5 of this report.

Scope for future improvements

- 2.89 This section of the chapter examines the uptake of the current technology, transformational change in technology and innovation, and predicted productivity growth for the agricultural sector.

Reaching full potential of existing technology

- 2.90 CSIRO suggested that there is scope for improvements in farm production through better application or wider adoption of existing technology.⁹¹ The Tasmanian Institute of Agriculture also suggested that there are many technologies to which farming businesses have access, however little adoption has occurred in many instances.⁹²
- 2.91 Deakin University pointed out that most innovation does not result from a new invention, but rather from the adoption of existing technology applied differently.⁹³ Consistent with this view, Soil Science Australia suggested that the present inquiry focus not only on the potential of emerging and new technologies, but also the need to raise the adoption rate of proven technologies.⁹⁴
- 2.92 The GRDC noted that adoption is hampered by the fact that:
- ... we only truly understand benefits and costs at the regional level whereas growers require data and exposure to technology at the sub-regional and local levels to make an informed decision on adoption.⁹⁵
- 2.93 CSIRO stated that there are considerable opportunities for productivity gains through better adoption of current technology:
- Recent work by CSIRO and GRDC has shown that current national average yields for grain crops are at about 50 per cent of what is potentially possible with current technology. We know that

90 DAWR, *Submission 88*, pp. 11-12.

91 CSIRO, *Submission 55*, p. 5.

92 Tasmanian Institute of Agriculture, *Submission 44*, p. 2.

93 Deakin University, *Submission 28*, p. 3.

94 Soil Science Australia, *Submission 41*, p. 1.

95 GRDC, *Submission 87*, p. 15.

potential yields are possible because studies with elite farmers show that they are at this frontier now.⁹⁶

- 2.94 Deakin University also noted opportunities presented by high performing farmers who use existing technology with excellent results:

Such farmers are often significantly more productive than their peers. The obvious opportunity is to identify who they are, understand what makes their enterprises so productive, and replicate their practice into the broader industry.⁹⁷

- 2.95 The CSIRO submission explained that the adoption of new technology is influenced by its complexity, ease of use, and readily identifiable benefits.⁹⁸

- 2.96 The CSIRO submission noted the variability in the adoption of technologies across the grain growing sector, with some technologies being widely adopted (for example, 90 per cent adoption of autosteer and guidance on farm vehicles) while other technologies are less widespread (for example, 10 per cent adoption of the use of decision support systems for risk management). CSIRO also noted that a 'significant cluster of technologies', currently with an adoption rate of approximately 30 per cent, could have their adoption rate increased to 70 per cent or more.⁹⁹

- 2.97 CSIRO added that there is a distinct lack of yield gap studies for many industries and a greater focus on this would highlight the scope for improvement.¹⁰⁰

- 2.98 The Australian Academy of Technological Sciences and Engineering (ATSE), however, explained that simply improving the uptake of best practice and current technologies is an insufficient strategy for ongoing progress, and that sound investment in new research was also required to produce the next generation of improvements.¹⁰¹ Indeed, the ATSE stated that investment in the fundamental research which enables new technologies must be recognised as the key to future growth in Australia's agricultural sector.¹⁰²

96 CSIRO, *Submission 55*, p. 15.

97 Deakin University, *Submission 28*, p. 2.

98 CSIRO, *Submission 55*, p. 8.

99 CSIRO, *Submission 55*, p. 8.

100 CSIRO, *Submission 55*, p. 15.

101 Australian Academy of Technological Sciences and Engineering, *Submission 56*, p. 6.

102 ATSE, *Submission 56*, p. 6.

Transformational change

- 2.99 The University of Queensland stated that the majority of Australian farmers are operating close to the limits of technical efficiency.¹⁰³ It added that the next step-change of improvement will come from longer term transformational research, which is usually a very long term investment, with higher risk but producing very high returns.¹⁰⁴
- 2.100 Similarly, the University of Sydney stated that technology will bring about innovation-driven increases in efficiency and productivity and the development of new and more attractive markets.¹⁰⁵
- 2.101 Professor Stewart Lockie suggested that the complexity of agricultural systems will ensure no single technology holds the key to transformative change.¹⁰⁶ Professor Lockie added that technologies must be embedded within a holistic understanding of the landscape-scale ecological and hydrological processes in which agriculture is situated.¹⁰⁷ Professor Lockie concluded that innovation in ‘systems management’ at higher scales is as important as – and must be integrated with – innovation at the genetic, field, and enterprise scales.¹⁰⁸
- 2.102 Transformative technologies are examined in further detail in Chapter 3 of this report.

Outlook and predicted growth

- 2.103 The CSIRO submission to the inquiry stated that Australia’s agricultural food and fibre sector is poised for significant growth, with a doubling in demand in key export markets and significant domestic market growth over the next 30 years.¹⁰⁹
- 2.104 The ABARES Outlook 2016 Conference¹¹⁰ reported complex facts and figures, revealing mostly good news for the Australian agricultural industry. Some of the key findings include:
- farm production will be worth \$60.3 billion in 2016–17, a three per cent increase on this financial year;
 - farm export earnings will be steady at around \$45 billion for 2016–17;

103 University of Queensland, *Submission 2*, p. 1.

104 University of Queensland, *Submission 2*, p. 1.

105 University of Sydney, *Submission 40*, p. 1.

106 Professor Stewart Lockie, *Submission 100*, p. 3.

107 Professor Stewart Lockie, *Submission 100*, p. 3.

108 Professor Stewart Lockie, *Submission 100*, p. 3.

109 CSIRO, *Submission 55*, p. 5.

110 DAWR, ‘ABARES Outlook 2016 Conference – Programs and Presentations’ <www.agriculture.gov.au/abares/outlook-2016/Pages/Conference-Program.aspx> viewed 4 April 2016.

- domestic prices for livestock will keep growing as conditions improve;
 - gross value of all Australian crop production will increase four per cent next year, as long as seasonal conditions continue to improve; and
 - Australian milk production is expected to increase by two per cent to 9.8 billion litres next year, reversing a one per cent decline in production for 2015–16 due to dry conditions in the major milk producing states of Tasmania, Victoria and South Australia.¹¹¹
- 2.105 A 2015 report from the Australian Council of Learned Academies (ACOLA), entitled *Australia's Agricultural Future*, suggested that the outlook for Australian agriculture is very positive.¹¹² It highlighted some of the circumstances that will support agricultural productivity growth, including the end of the mining boom, more favourable exchange rates, fewer rural labour shortages, and rising demand for food exports. The report added that improvements in productivity growth through increasing technological inputs and technical efficiency are necessary to increase production and profitability.¹¹³
- 2.106 The ACOLA report's major conclusions for Australia's agricultural future included:
- Australia's agricultural sector has a comparative advantage in the export of bulk commodities and opportunities presented by the growth in demand for high-value products domestically and in Asia;
 - Australia's reputation for 'safe, clean and green' food is a major comparative advantage;
 - to meet increased demand, the sector will need to efficiently manage its soil and water resources;
 - the sector will need to attract capital and skilled labour in competition with other sectors of the Australian economy;
 - accelerating the uptake of advanced technologies, communications and knowledge systems, and integrated workflows for decision making and planning, are critical for success along the whole value chain;
 - ongoing investment in R&D, both private and public, is vital to underpin this uptake; and

111 ABC Rural News, 'Value of Australian agricultural production tipped to pass \$60 billion for the first time next year: ABARES' <www.abc.net.au/news/2016-03-01/abares-outlook-2016/7209506> viewed 4 April 2016.

112 Daly, J., Anderson, K., Ankeny, R., Harch, B., Hastings, A., Rolfe, J. and Waterhouse, R (2015) *Australia's Agricultural Future*. Report for the Australian Council of Learned Academies, www.acola.org.au.

113 Daly, J., Anderson, K., Ankeny, R., Harch, B., Hastings, A., Rolfe, J. and Waterhouse, R (2015) *Australia's Agricultural Future*. Report for the Australian Council of Learned Academies, p. 18.

- a range of community concerns with regulatory, social and political implications important to the future development of agriculture need to be acknowledged and managed sensitively.¹¹⁴

2.107 One of the paths to reinvigorating productivity growth in agriculture is clearly through the development and adoption of existing and emerging technologies. A range of key emerging technologies are canvassed in the following chapter.

¹¹⁴ Daly, J., Anderson, K., Ankeny, R., Harch, B., Hastings, A., Rolfe, J. and Waterhouse, R (2015) *Australia's Agricultural Future*. Report for the Australian Council of Learned Academies, p. 16.

