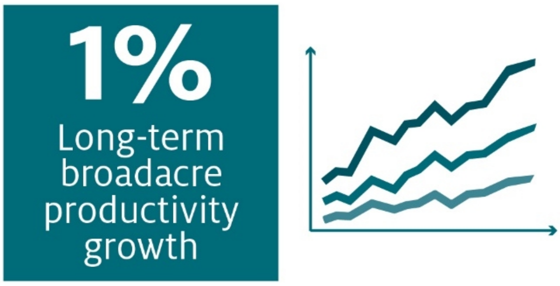
Productivity of Australian broadacre and dairy industries, 2017–18



Agricultural productivity

Long-term productivity growth in the broadacre industries averaged 1.0% per year, while dairy industry productivity growth was 1.6% per year.

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Summary

- Over the period 1977–78 to 2017–18, average annual productivity growth in the broadacre sector was 1.0%. From 1978–79 to 2017–18, average annual productivity growth in the dairy sector was 1.6%.
- In 2017–18 the ABARES broadacre productivity index declined sharply by 12.2%, reversing the previous increase of 9.1% in 2016–17. This largely reflects fluctuating seasonal conditions and commodity prices over the past two years, including the impact of drought across eastern Australia.

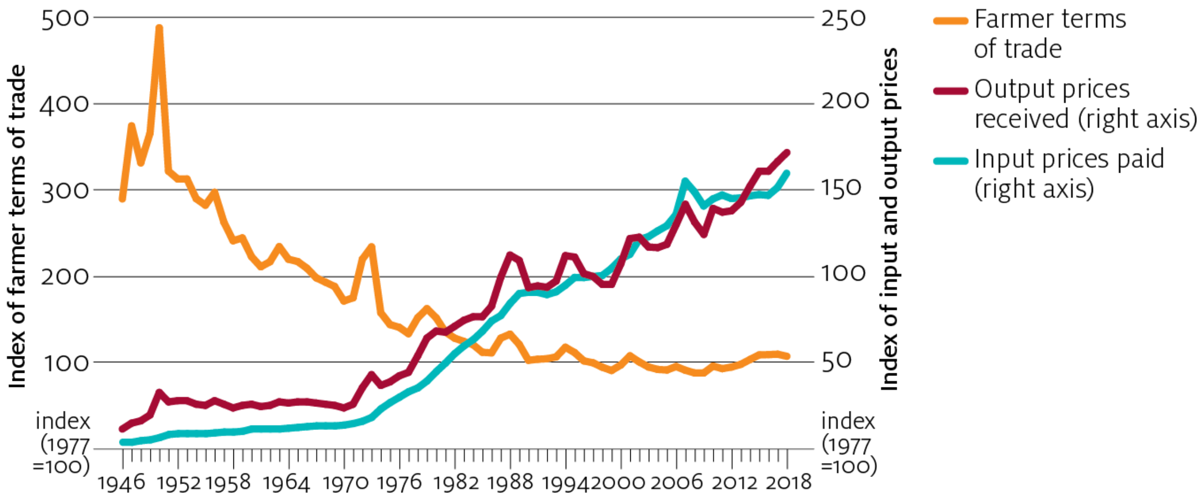
Introduction

Productivity is an important measure of industry performance. For Australian agriculture, productivity reflects long-term changes in the efficiency with which farmers use land, labour, capital and intermediate inputs (for example, chemicals, fodder and purchased services) to produce outputs such as crops, meat, wool and milk. At the farm level, an improvement in productivity is generally achieved when outputs (for example, tonnes of wheat) increase relative to inputs used (for example, labour hours, capital, fuel, seed and fertiliser). Productivity is a ratio of outputs generated relative to inputs used. Any improvement in this ratio translates to an improvement in productivity. ABARES generates annual indexes of total factor productivity (TFP) using a growth accounting approach (Zhao, Sheng & Gray 2012). See Sheng and Jackson (2015) for a full description of the ABARES productivity methodology.

Total factor productivity is an indicator of underlying farm business efficiency. Short-term variations in TFP can be volatile and often reflect changes in seasonal conditions and other temporary factors, rather than permanent productivity improvements. Long term measures of TFP are preferred, as the measure captures improvement in technical progress, scale, management practices and other measures of efficiency.

Productivity is an important determinant of profitability, and is therefore a useful measure in farm management. This relationship between productivity and profitability is based on improving the ratio of inputs used relative to outputs generated—demonstrated in Figure 1. Since the 1940s, the need to improve agricultural productivity has been spurred on by declining farmer terms of trade. From 1946 to 2018, the prices farmers were paying for their inputs generally increased at a faster rate than the prices received for their outputs —thereby impacting profitability. By improving productivity and producing 'more with less', farmers are able to remain profitable despite falling farmer terms of trade.

Figure 1 Farmer terms of trade, 1946 to 2018



Note: Terms of trade index reflects prices received versus prices paid for all agricultural industries.
Source: ABARES

Farm managers play a pivotal role in improving their own farm productivity. Farmers require industry knowledge and a broad range of skills to navigate prevailing seasonal conditions, emerging technologies and price movements. The ability to make use of information, adapt to changing conditions, manage risks, adopt technology and adjust their business when it is advantageous to do so demonstrates a high level of management skill. This allows farmers to optimise efficiency and produce maximum output from a given set of inputs, leading to higher productivity.

This article provides updates of ABARES productivity statistics to include data for 2017–18 and summarises some of the previous research on the drivers of agricultural productivity.

Drivers of agricultural productivity growth

Lifting productivity growth at both the individual farm level and the broader industry level depends on external factors and farm drivers. Technological progress is one important driver that can generate improvements in productivity. However, large farms have historically benefited from technological progress more than smaller farms due to their financial capacity for investment.

Short-term measures of agricultural productivity are sensitive to climate variability. The significant impact of climate on cropping productivity is demonstrated by Hughes, Lawson and Valle (2017), who found evidence of a significant deterioration in climate conditions for cropping over the past 15 to 20 years, particularly in southern Australia. Productivity shocks in the cropping industry during the mid 1990s and 2000s were driven by prevailing seasonal conditions.

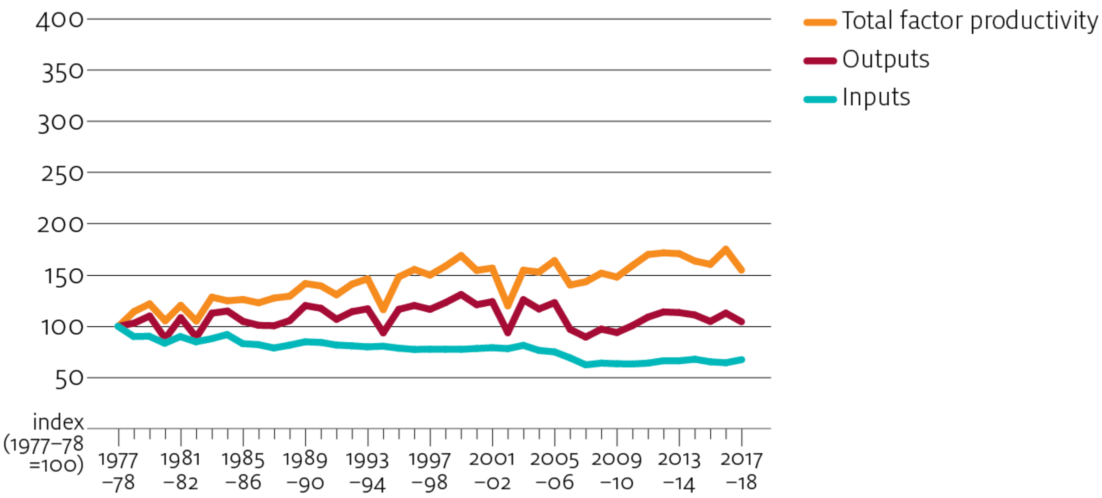
Policy reform is also likely to have affected agricultural productivity. The removal of marketing and price support mechanisms contributed directly and indirectly to productivity growth in the broadacre industries (Gray, Leith & Davidson 2014). These reforms led to structural change through the amalgamation of farms, improvements in risk management and changes in the mix of agricultural commodities produced. This altered the allocation of resources between farms, with more efficient producers tending to gain a greater market share over time (Sheng, Jackson & Gooday 2016).

Public and private investment in research, development and extension (RD&E) has also contributed to agricultural productivity growth in Australia (Sheng, Gray & Mullen 2011). In 2014–15 RD&E funding in the rural sector was $3.3 billion, of which around half was private RD&E investments (Millist, Chancellor & Jackson 2017). RD&E funding grew in real terms by 2.6% per year over the 10 years to 2015–16. Farmers have captured developments in technology and knowledge by investing in higher-yielding, pest and disease-resistant crop varieties, superior harvesting techniques, and livestock genetics. Other drivers of farm productivity include farm size, management skill, financial capacity, regulation, infrastructure and seasonal conditions.

Broadacre productivity

Productivity growth in the broadacre industries averaged 1.0% per year between 1977–78 and 2017–18, primarily as a result of declining input use and modest output growth (Table 2, Figure 2). Total input use in the broadacre industries declined between 1977–78 and 2017–18 at an average annual rate of 0.9% per year. Over the same period, broadacre output increased by 0.1% per year. Short term estimates of productivity are more volatile—mostly because of changing seasonal conditions. In 2016–17 favourable conditions saw a 9.1% annual increase in broadacre productivity, driven largely by increases in output. However, deteriorating seasonal conditions in 2017–18 drove a 12.2% annual decline in broadacre productivity.

Figure 2 Total factor productivity, output and input, all broadacre industries, Australia, 1977–78 to 2017–18



Source: ABARES Australian Agricultural and Grazing Industries Survey

Between 1977–78 and 2017–18 a decline in total input use occurred in beef, sheep and mixed crop–livestock industries, but not in the cropping industry (Table 1). The pattern of change in specific inputs (land, labour, capital, materials and services) also varied between industries. For example, all industries used less labour in 2017–18 than in 1977–78 and most reduced the inputs of land (except cropping) and capital (except beef). However, use of materials increased significantly in cropping (3.9% per year) and moderately in beef (1.9% per year) and mixed crop–livestock (0.5% per year). This suggests that production in these industries has become more heavily reliant on the use of intermediate inputs such as chemicals, fertilisers, seeds, fuel and electricity.

Table 1 Broadacre growth in input use, average annual change, by industry, Australia, 1977–78 to 2017–18

Inputs	All broadacre (%)	Cropping (%)	Beef (%)	Sheep (%)	Mixed crop–livestock (%)
Land	–1.0	1.1	–0.2	–2.9	–1.5
Labour	–2.1	–0.9	–0.7	–3.2	–2.9
Capital	–1.6	–0.4	0.3	–3.7	–3.0
Material	1.7	3.9	1.9	–0.6	0.5
Services	–0.6	1.0	0.3	–2.4	–1.7
Total inputs	–0.9	1.1	–0.1	–2.9	–1.8

Source: ABARES Australian Agricultural and Grazing Industries Survey

Table 2 Total factor productivity, output and input growth, broadacre industries, Australia, 1977–78 to 2017–18

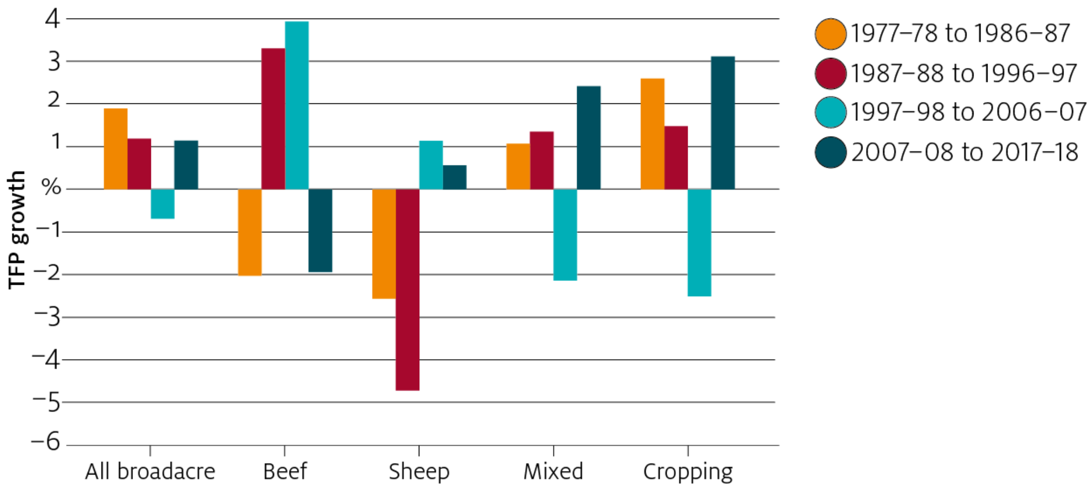
Industry	Growth rate between 1977–78 and 2017–18 (%)	Year-on-year growth rate in 2016–17 (%)	Year-on-year growth rate in 2017–18 (%)
All broadacre			
Total factor productivity	1.0	9.1	–12.2
Output	0.1	7.7	–7.5
Input	–0.9	–1.4	4.7
Cropping			
Total factor productivity	1.5	16.8	–13.2
Output	2.6	19.5	–20.8
Input	1.1	2.7	–7.6
Mixed crop–livestock			
Total factor productivity	0.9	20.1	–11.2
Output	–0.9	13.2	–8.6
Input	–1.8	–6.9	2.5
Sheep			
Total factor productivity	0.3	3.4	–17.5
Output	–2.6	1.4	2.5
Input	–2.9	–2.0	20.0
Beef			
Total factor productivity	1.0	–8.0	6.4
Output	0.9	–7.7	11.4
Input	–0.1	0.3	5.1

Note: Care should be taken when interpreting this data because single year agricultural productivity estimates are susceptible to volatility induced by climate and seasonal conditions.
Source: ABARES Australian Agricultural and Grazing Industries Survey

Three key trends can be identified from the varying productivity growth rates across broadacre industries (Table 2). First, the cropping industry has had higher average productivity growth than livestock industries over the long term, averaging 1.5% per year between 1977–78 and 2017–18, compared with mixed crop–livestock (0.9%), beef (1.0%) and sheep (0.3%). Higher productivity growth in the cropping industry could be a result of more rapid developments in cropping technologies and reallocation of resources towards crop production (Mullen 2007; Sheng et al. 2016).

Second, the difference in productivity growth rates between cropping and livestock industries is narrowing (Figure 3). This can be attributed to a slowdown in the productivity growth of the cropping industry since the late 1990s (Sheng, Mullen & Zhao 2011), productivity improvement in the beef industry between 1988–89 and 2000–01 (Figure 3) and increased productivity growth in the sheep industry between 2000–01 and 2017–18. The declining trend of sheep industry productivity slowed after the removal of the wool reserve price scheme in 1991 and became positive in the years after 2000–01. This improvement in productivity can be explained by industry consolidation and shifts by farmers from wool production to cropping and sheep meat production.

Figure 3 Total factor productivity growth, average annual change, by broadacre industry, Australia, 1977–78 to 2017–18



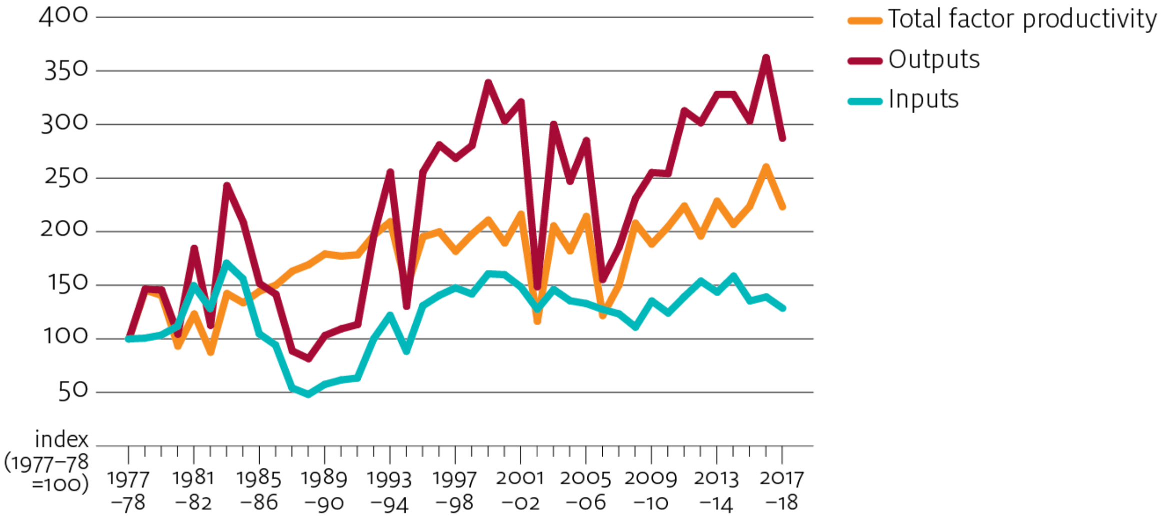
Source: ABARES Australian Agricultural and Grazing Industries Survey

Third, between 1977–78 and 2017–18 the mixed crop–livestock industry experienced modest productivity growth of 0.9% per year on average. The increase in productivity in this industry was a result of a fall in output (–0.9% per year) and a greater decline in the use of inputs (–1.8% per year). In the past two decades mixed crop–livestock farms have tended to specialise in either crop or livestock enterprises (McKenzie 2014). This structural change has shifted inputs away from this industry and into specialised crop and livestock production.

Cropping

Productivity for cropping specialists grew on average by 1.5% per year between 1977–78 and 2017–18. This was driven by strong output growth (2.6% per year) relative to input use growth (1.1% per year). Sharp declines in output (and TFP) tend to correspond with unfavourable seasonal conditions (Table 2, Figure 4).

Figure 4 Total factor productivity, output and input, cropping industry, Australia, 1977–78 to 2017–18



Source: ABARES Australian Agricultural and Grazing Industries Survey

Jackson (2010) and Knopke, O'Donnell and Shepherd (2000) attributed strong productivity growth in the cropping industry in the 1980s and 1990s to developments in technology such as larger machinery, new plant varieties, improved water management and a better understanding of harvesting and planning strategies. After the mid 1990s the strong productivity growth in cropping subsided. Sheng, Mullen and Zhao (2011) largely attribute this turning point in broadacre productivity to climate factors and stagnating R&D investment. Climate factors were also identified by Hughes, Lawson and Valle (2017) as having a significant effect on productivity. In particular, crop farms were found to be heavily affected by climate variability and drought, which in turn impacted productivity.

Cropping industry output has grown strongly since 1977–78, whereas input use remained relatively stable. From 1977–78 to 2017–18, labour inputs have tended to decline, whereas capital and intermediate inputs have tended to increase. Between 1977–78 and 2017–18 cropping farms have become larger, with average farm sowing areas increasing nearly threefold. Material inputs including fertiliser, fuel, crop chemicals and seed have increased by an average of 3.9% per year. Improved understanding of cropping systems, including plant physiology and determinants of soil fertility, has expanded the use of fertiliser and crop chemicals (especially nitrogen and soil ameliorants such as lime and gypsum).

Increases in material, services, and land inputs have been offset partially by falls in labour and capital inputs (Table 1). However, between 1977–78 and 2017–18 total input growth in the cropping industry increased by 1.1% per year on average—the only broadacre industry to record an increase in average annual total input growth. Additionally, the cropping industry was the only industry to record an increase in land input, suggesting a shift in land use towards cropping and away from livestock and mixed broadacre production.

The cropping industry consists of three distinct regions—southern, northern and western (GRDC 2015). Productivity growth in the cropping industry was strong across all regions, with inter-regional productivity differences driven by structural and climatic differences. Between 1977–78 and 2017–18 productivity growth was strongest in the southern region at 1.9% per year. The northern and western regions recorded growth at 1.4% and 1.3% per year respectively.

Table 3 Total factor productivity, output and input growth, cropping industry, by GRDC region, Australia, 1977–78 to 2017–18

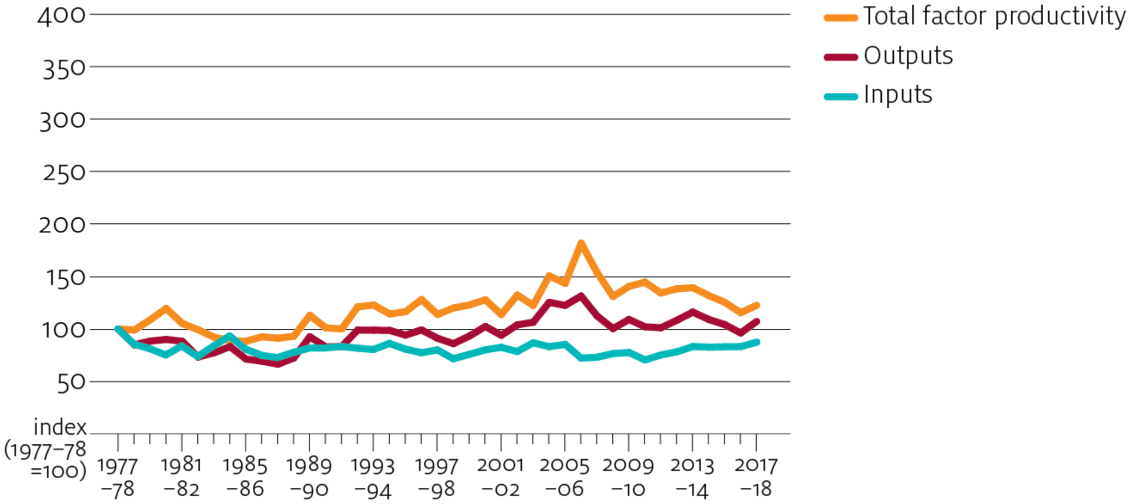
Region	TFP (%)	Output (%)	Input (%)
Northern	1.4	1.9	0.5
Southern	1.9	2.8	0.8
Western	1.3	3.6	2.3

Note: Grains Research and Development Corporation regions.
Source: ABARES Australian Agricultural and Grazing Industries Survey

Beef

Beef productivity growth averaged 1.0% per year between 1977–78 and 2017–18. Output increased by 0.9% and inputs declined by 0.1% per year (Table 2, Figure 5). Productivity improvements in this industry were partly realised through improved pastures, herd genetics and disease management, which lowered mortalities and increased branding rates (calves marked as a percentage of cows mated) (Jackson, Dahl & Valle 2015). Between 1977–78 and 2017–18 average productivity growth in the beef industry (1.0% per year) remained lower than the productivity growth rate for the cropping industry (1.5% per year), despite outpacing that of the sheep industry (0.3% per year).

Figure 5 Total factor productivity, output and input, beef industry, Australia, 1977–78 to 2017–18



Source: ABARES Australian Agricultural and Grazing Industries Survey

Labour input use in the beef industry declined by an average of 0.7% per year between 1977–78 and 2017–18. This was the smallest decline in labour input use of any broadacre industry. Additionally, the beef industry was the only broadacre industry to record an increase in capital input between 1977–78 and 2017–18 (0.3% per year).

Climate, pastures, industry infrastructure and proximity to markets vary significantly for beef enterprises in northern and southern Australia. These factors have contributed to differences in production systems such as in herd structure and farm operations. Beef farms in the southern region face a more varied climate and are more sensitive to drought conditions. This can lead to increased feed costs and destocking and restocking cycles that affect output growth. Beef farms in the southern region are also smaller and less profitable. This is likely to contribute to lower average productivity growth (Jackson & Valle 2015).

Between 1977–78 and 2017–18 productivity growth was higher for northern beef farms (1.0% per year) compared with their southern counterparts (0.7% per year) (Table 4). Output growth was similar for the northern and southern regions, at an average of 0.9% per year for northern beef farms and 1.1% per year for southern beef farms. The primary difference between the two regions was a result of reduced input use in the north (-0.2% per year) and increased input use in the south (0.4% per year), particularly of fertiliser and chemicals.

Table 4 Total factor productivity, output and input growth, beef industry, by region, Australia, 1977–78 to 2017–18

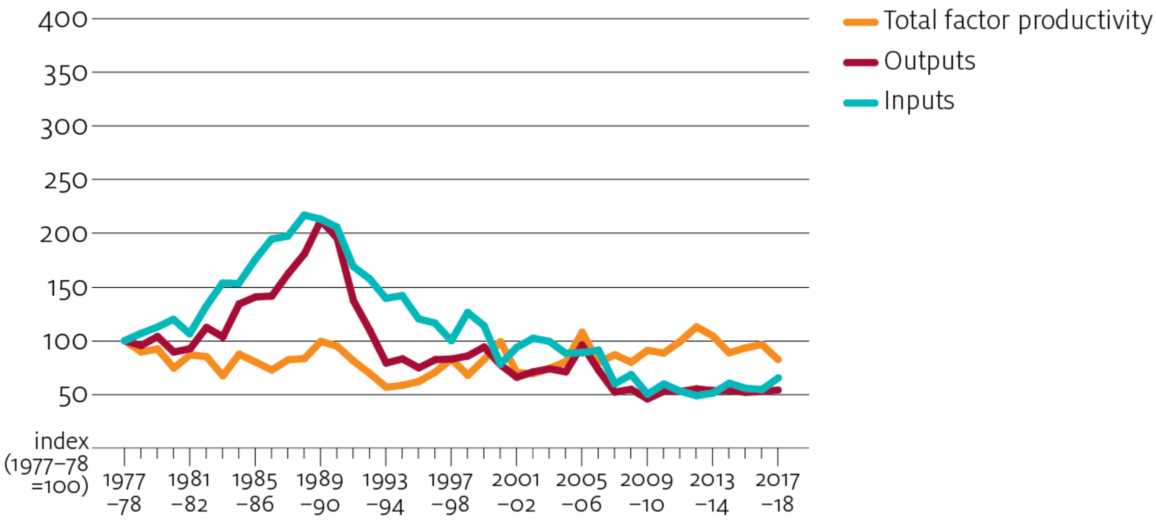
Region	TFP (%)	Output (%)	Input (%)
Northern	1.0	0.9	–0.2
Southern	0.7	1.1	0.4

Source: ABARES Australian Agricultural and Grazing Industries Survey

Sheep

Productivity growth in the sheep industry averaged 0.3% per year between 1977–78 and 2017–18 (Figure 6, Table 2). The Australian sheep industry has undergone significant adjustment since the early 1990s, when price support mechanisms for wool were removed. Many farmers shifted their enterprise mix from wool to cropping, resulting in lower sheep numbers and reduced use of all the five categories of inputs (labour, capital, land, materials and services). Sheep numbers were further reduced by farmers destocking their properties during periods of drought.

Figure 6 Total factor productivity, output and input, sheep industry, Australia, 1977–78 to 2017–18



Source: ABARES Australian Agricultural and Grazing Industries Survey

Long run sheep industry productivity differed for farms of different sizes (Table 5). Small and medium farms both experienced corresponding declines in their outputs and inputs, achieving average annual productivity growth of 0.0% from 1977–78 to 2017–18. Large sheep farms did however experience an increase in productivity on 0.9% per year with inputs decreasing by more than outputs over this same period.

Table 5 Total factor productivity, output and input growth, sheep industry, by size, Australia, 1977–78 to 2017–18

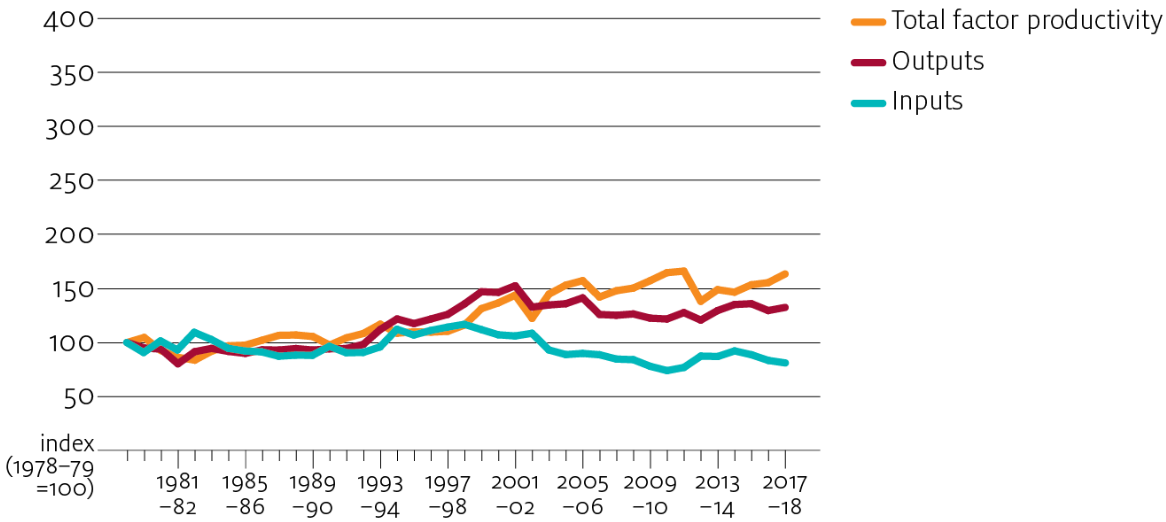
Farm size category	TFP (%)	Output (%)	Input (%)
Small	0.0	-3.1	-3.1
Medium	0.0	-3.3	-3.3
Large	0.9	-1.6	-2.5

Note: Farm size categories—Small: total cash receipts $0 to $200,000, medium: total cash receipts $200,001 to $500,000, large: total cash receipts greater than $500,000
Source: ABARES Australian Agricultural and Grazing Industries Survey

Dairy

Productivity growth in the Australian dairy industry averaged 1.6% per year between 1978–79 and 2017–18 (Figure 7). This was driven by output increasing by an average of 1.2% per year and input use declining by an average of 0.4% per year. The decline in input use in the dairy industry has been driven by declines in the use of labour (-2.4% per year), capital (-1.4% per year), land (-1.2% per year) and services (-0.3% per year). These falls have been offset by increases in the inputs of materials (3.9% per year).

Figure 7 Total factor productivity, output and input, dairy industry, Australia, 1978–79 to 2017–18



Source: ABARES Australian Dairy Industry Survey

The drivers of productivity growth in the dairy industry were substantially different after deregulation reforms were implemented in 2000. Throughout the 1980s and 1990s many dairy farms transitioned to more intensive production systems. This reduced labour and land requirements but increased material inputs such as fertiliser and supplementary feed (Ashton et al. 2014). Productivity improvements during this period were driven by output increasing faster than input use as a result of farmers adopting new technologies such as rotary dairies, artificial insemination and improved pastures (Harris 2011).

In the 2000s many smaller farms exited the dairy industry following deregulation — a decline in total output followed. However, productivity growth during this period was driven by input use declining faster than output because resources such as land, labour and capital shifted towards the most efficient farms. In particular, deregulation appears to have facilitated the movement of resources from farms using the year-round production system, in which calving and milk production are spread evenly throughout the year, to those using the seasonal production system, in which production periods are more synchronised with pasture availability. This resource reallocation effect boosted industry productivity at a time when on-farm technological progress was slowing (Sheng, Jackson & Gooday 2016).

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