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Productivity of Australian broadacre and dairy industries, 2018–19

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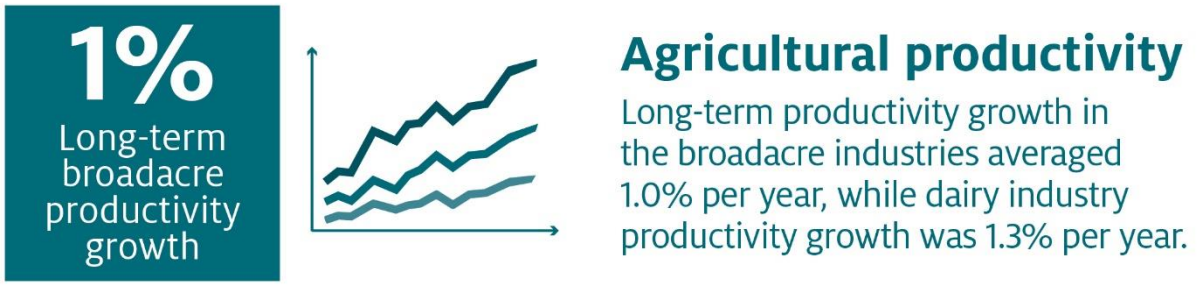


Summary

- Over the period 1977–78 to 2018–19, average annual productivity growth in the broadacre industries was 1.0%. From 1978–79 to 2018–19, average annual productivity in the dairy sector was 1.3%.
- Productivity growth rates varied significantly by industry. The cropping industry experienced the fastest rate of growth at 1.5% per year, whilst productivity growth in the sheep industry was just 0.3% per year.
- Agricultural productivity is sensitive to the effects of climate, with productivity falling in both 2017–18 and 2018–19 largely as a result of widespread drought across much of eastern Australia. Forthcoming ABARES work will identify the effects of climate on productivity estimates, to produce climate-adjusted productivity indexes for each broadacre industry.

Introduction

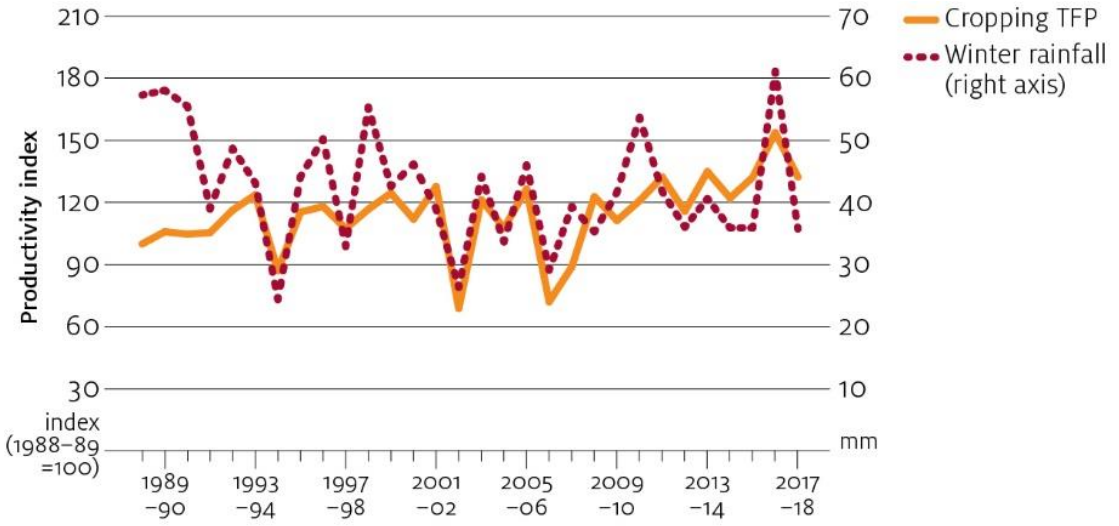
Productivity is an important measure of Australian agricultural performance. It shows how efficiently inputs (labour, capital, land, materials and services) are used to produce outputs (crops, wool, and livestock) over time. Growth in the ratio of outputs produced to inputs used translates to improved profitability and competitiveness for farmers. In the long term, estimates of productivity reflect changes in farm business scale and management practices, and technological progress. However, short-term estimates of productivity are often highly volatile, and influenced by seasonal conditions and other temporary factors. Readers should be cautious when interpreting shorter-term estimates of agricultural productivity.

ABARES publishes estimates of total factor productivity (TFP) using the growth accounting approach outlined in Zhao, Sheng and Gray (2012). In this article, data used to calculate productivity indexes are sourced from ABARES Australian Agricultural and Grazing Industries Survey (AAGIS) and the Australian Dairy Industry Survey (ADIS).

Impact of climate and drought on productivity performance

In the short term, measures of agricultural productivity are highly sensitive to climate and seasonal conditions. For example, Australia's cropping industry is dominated by the production of winter grain and oilseeds which rely heavily on winter rainfall (Figure 1). The effect on productivity can be significant because climate influences both farm inputs (such as fodder or fertiliser) and farm outputs (such as crops and livestock products).

Figure 1 Total factor productivity (cropping specialists) and average winter rainfall, 1988–89 to 2017–18



Source: Author's estimates and ABARES farmpredict model (Hughes et al. 2019)

Recent drought conditions across much of eastern Australia have contributed to short-term declines in agricultural productivity. In 2018–19 productivity in the broadacre industries fell by 11.5%, compounding a fall of 10.3% in 2017–18. These declines followed broadacre productivity gains in 2016–17 resulting from widespread rainfall across key cropping areas.

While short-term measures of agricultural productivity tend to be volatile, long-term measures are more stable. Short-term measures are subject to the influences of temporary factors, but long-term measures tend to reflect sustained technological progress. Readers should be cautious when interpreting short-term estimates of agricultural productivity.

Previous ABARES research has highlighted the importance of controlling for climate when estimating agricultural productivity (Hughes, Lawson & Valle 2017). A forthcoming ABARES study will present a new 'climate-adjusted' series of productivity estimates for Australian broadacre farms. The estimates will distinguish between the effects of climate variability and those of long-term technological change on 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.

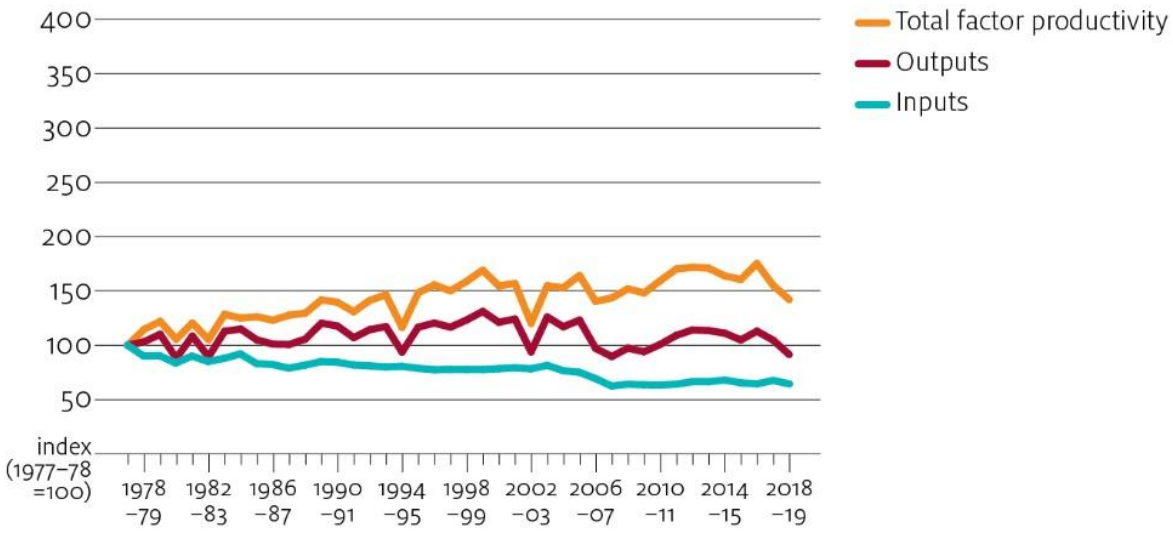
Policy reform is also likely to have affected agricultural productivity. The removal of marketing and price support mechanisms contributed directly and indirectly to productivity growth in the broadacre industries (Gray, Oss-Emer and Sheng 2014). These reforms led to structural change through the amalgamation 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

Long-term broadacre productivity growth averaged 1.0% per year between 1977–78 and 2018–19. This modest growth is primarily a result of declining input use (Table 2, Figure 2). During that period, total input use in the broadacre industries declined at an average annual rate of 0.9% per year. Broadacre output was flat, recording no growth. Short-term estimates of productivity are more volatile—mostly because of changing seasonal conditions. In 2016–17 favourable conditions saw a significant lift in broadacre productivity, driven largely by increases in output. However, deteriorating seasonal conditions in 2017–18 drove a 10.3% annual slowdown in broadacre productivity. This was followed by a further 11.5% reduction in 2018–19.

Figure 2 Total factor productivity, outputs and inputs, all broadacre industries, Australia, 1977–78 to 2018–19



Source: ABARES Australian Agricultural and Grazing Industries Survey

Between 1977–78 and 2018–19, total input use declined in the 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 2018–19 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 (3.8% per year) and moderately in beef (1.9%) and mixed crop–livestock (0.4%). This suggests that production in these industries has become more 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 2018–19

Inputs	All broadacre (%)	Cropping (%)	Beef (%)	Sheep (%)	Mixed crop–livestock (%)
Land	–1.0	1.1	–0.2	–2.9	–1.5
Labour	–2.1	–1.0	–0.7	–3.1	–2.9
Capital	–1.6	–0.4	0.4	–3.6	–3.0
Material	1.6	3.8	1.9	–0.4	0.4
Services	–0.6	1.0	0.4	–2.2	–1.7
Total inputs	–0.9	1.0	–0.1	–2.8	–1.8

Source: ABARES Australian Agricultural and Grazing Industries Survey

Table 2 Total factor productivity, output and input growth rates, broadacre industries, Australia, 1977–78 to 2018–19

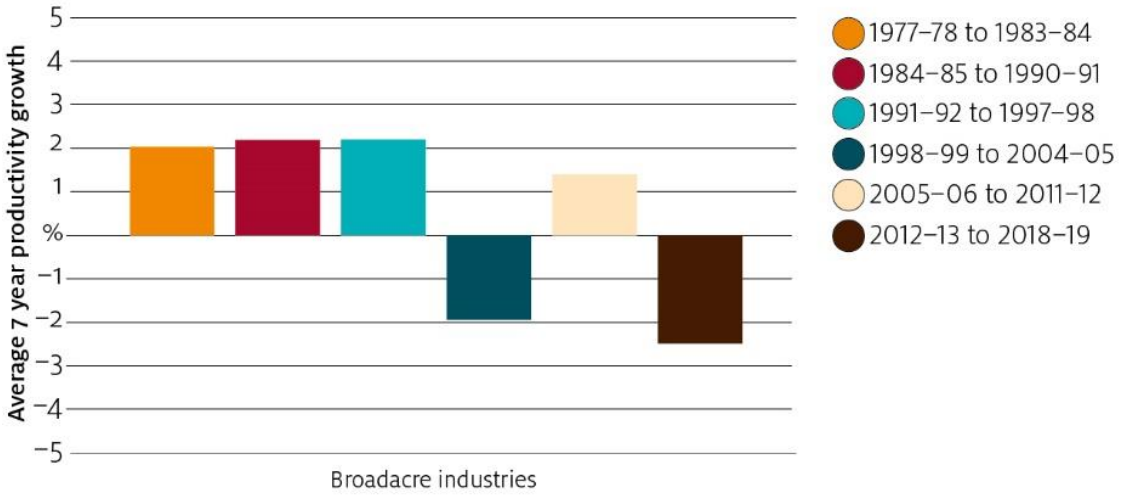
Industry	Growth rate, 1977–78 to 2018–19 (%)	10 year average growth to 2018–19 (%)
All broadacre		
Total factor productivity	1.0	–0.5
Output	0.0	0.0
Input	–0.9	0.4
Cropping		
Total factor productivity	1.5	1.5
Output	2.5	0.9
Input	1.0	–0.5
Mixed crop–livestock		
Total factor productivity	0.8	0.0
Output	–1.0	–2.3
Input	–1.8	–2.1
Sheep		
Total factor productivity	0.3	–0.9
Output	–2.5	1.6
Input	–2.8	2.5
Beef		
Total factor productivity	1.0	–1.5
Output	0.9	0.1
Input	–0.1	1.5

Note: Input and output growth reported in this table may not sum to TFP growth in some cases due to rounding.
Source: ABARES Australian Agricultural and Grazing Industries Survey

Productivity growth rates vary significantly over time and across industries. The cropping industry has experienced higher average annual productivity growth than livestock industries over the long term. Between 1977–78 and 2018–19, productivity growth in the cropping industry averaged 1.5% per year, compared with mixed crop–livestock (0.8%), beef (1.0%) and sheep (0.3%). Higher productivity growth in the cropping industry is partly due to developments in cropping technologies and reallocation of resources towards crop production (Sheng, Jackson & Gooday 2016).

Productivity growth rates have changed significantly over time (Figure 3). Between 1977–78 and 1997–98, productivity growth was positive. Growth slowed down in the 7-year window between 1998–99 and 2004–05, partly as a result of the severe drought during the early 2000s. Productivity returned to positive growth between 2005–06 and 2011–12 before slowing again in the 7-year window between 2012–13 and 2018–19. The recent medium-term slowdown appears to have been driven by deteriorating climate conditions and drought across eastern Australia.

Figure 3 Total factor productivity growth, average 7-yearly change, broadacre industries, Australia, 1977–78 to 2018–19

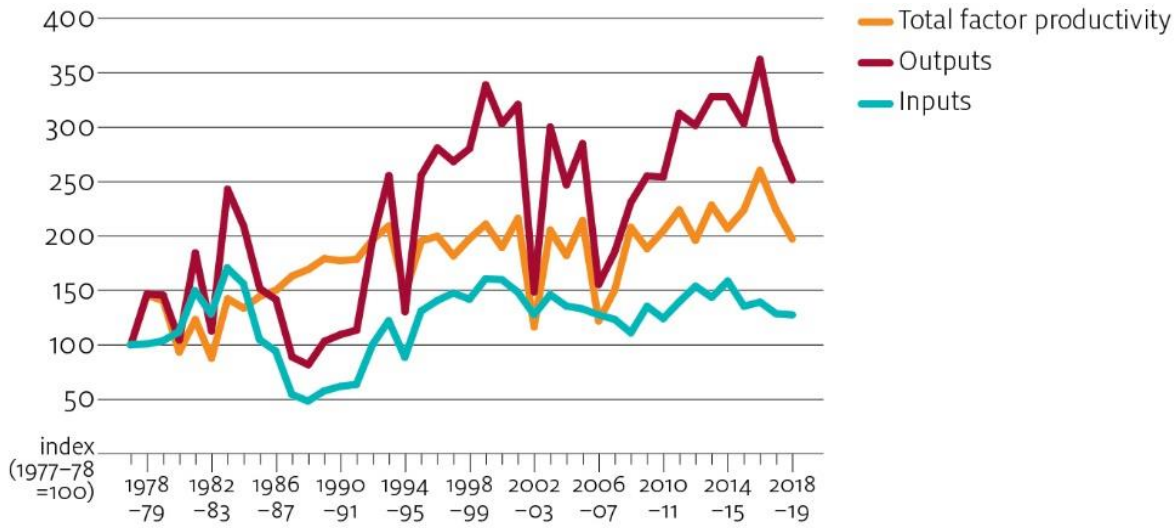


Source: ABARES Australian Agricultural and Grazing Industries Survey

Cropping

Productivity for cropping specialists grew on average by 1.5% per year between 1977–78 and 2018–19. This was driven by strong output growth (2.5% per year) relative to input use growth (1.0%). Sharp declines in output and productivity tend to correspond with unfavourable seasonal conditions (Table 2, Figure 4).

Figure 4 Total factor productivity, cropping industry, Australia, 1977–78 to 2018–19



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 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. Hughes, Lawson and Valle (2017) also identified climate factors as having a significant effect on productivity. Crop farms were found to be particularly affected by climate variability and drought, which in turn affected productivity.

Cropping industry output has grown strongly since 1977–78, but input use has remained relatively stable. Between 1977–78 and 2018–19 labour and capital inputs tended to decline, however intermediate inputs tended to increase. Between 1977–78 and 2018–19 cropping farms became larger, with average farm sowing areas increasing nearly threefold. Material inputs, including fertiliser, fuel, crop chemicals and seed, have increased by an average of 3.8% per year.

Increases in material, services and land inputs have been partially offset by falls in labour and capital inputs (Table 1). However, between 1977–78 and 2018–19 total input growth in the cropping industry increased by 1.0% per year on average. The cropping industry was the only broadacre industry to record increases in average annual total input growth and land input. Increased land input suggests a shift in land use towards cropping and away from livestock and mixed broadacre production.

The cropping industry consists of 3 distinct regions: southern, northern and western (GRDC 2015). Productivity growth in the cropping industry exceeded average broadacre productivity growth across all regions (Table 3). Inter-regional productivity differences were driven by structural and climatic differences.

Table 3 Total factor productivity, output and input growth, cropping industry, by GRDC region, Australia, 1977–78 to 2018–19

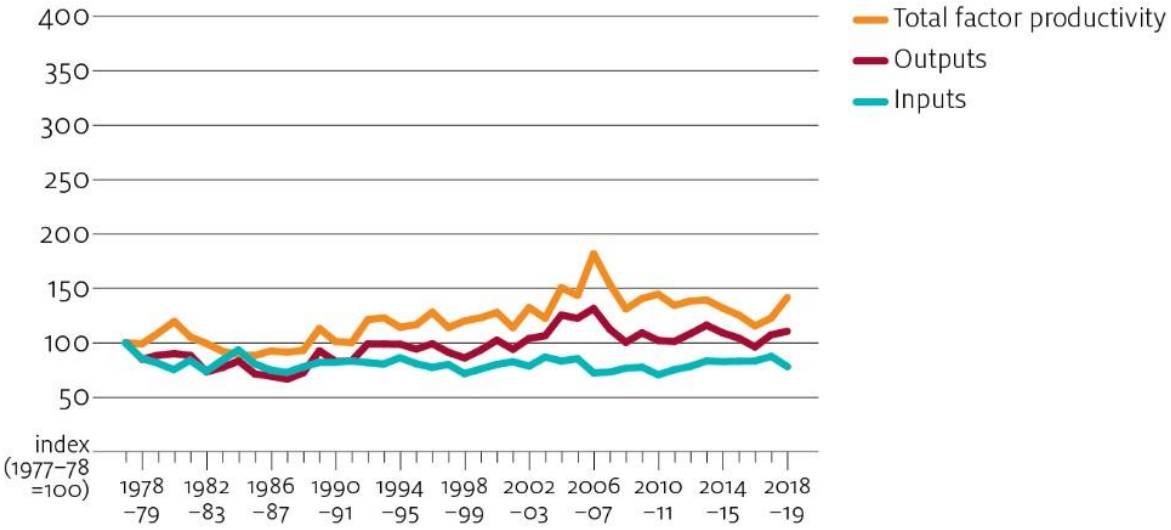
Region	TFP (%)	Output (%)	Input (%)
Northern	1.2	1.6	0.4
Southern	1.8	2.6	0.7
Western	1.4	3.7	2.3

Note: Grains Research and Development Corporation regions. Input and output growth reported in this table may not sum to TFP growth in some cases due to rounding.
Source: ABARES Australian Agricultural and Grazing Industries Survey

Beef

Beef productivity growth averaged 1.0% per year between 1977–78 and 2018–19. 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 2018–19 average productivity growth in the beef industry 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, beef industry, Australia, 1977–78 to 2018–19



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 2018–19. This was the smallest decline in labour input use of any broadacre industry. The beef industry was the only broadacre industry to record an increase in annual capital input growth between 1977–78 and 2018–19 (0.4%).

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, which is likely to contribute to lower average productivity growth (Jackson & Valle 2015).

Between 1977–78 and 2018–19 annual productivity growth was higher for northern beef farms (1.0%) compared with their southern counterparts (0.8%) (Table 4). Output growth was similar for the northern and southern regions, at an average of 0.8% per year for northern beef farms and 1.1% for southern beef farms. The primary difference between the 2 regions was a result of reduced input use in the north (–0.1% per year) and increased input use in the south (0.3%), particularly of fertiliser and chemicals.

Table 4 Total factor productivity, output and input growth, beef industry, by region, Australia, 1977–78 to 2018–19

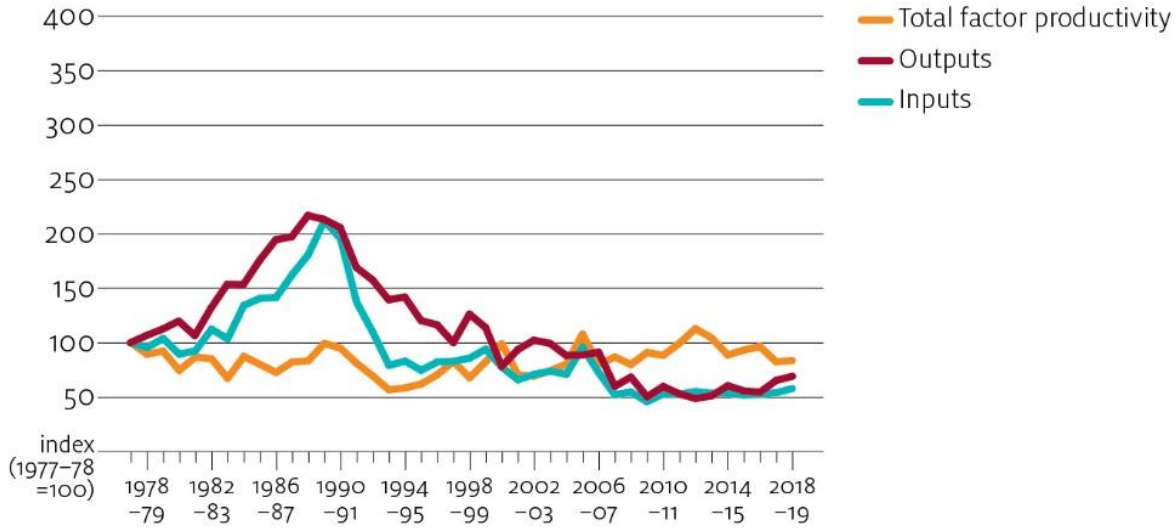
Region	TFP (%)	Output (%)	Input (%)
Northern	1.0	0.8	–0.1
Southern	0.8	1.1	0.3

Note: Input and output growth reported in this table may not sum to TFP growth in some cases due to rounding.
Source: ABARES Australian Agricultural and Grazing Industries Survey

Sheep

Productivity growth in the sheep industry averaged 0.3% per year between 1977–78 and 2018–19 (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 5 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, sheep industry, Australia, 1977–78 to 2018–19



Source: ABARES Australian Agricultural and Grazing Industries Survey

Sheep industry productivity over the long term differed for farms of different sizes (Table 5). Between 1977–78 and 2018–19 average annual productivity growth was marginal for small sheep farms (–0.2%) and medium sheep farms (0.2%). Large sheep farms performed much better—recording an increase in average annual productivity growth of 1.3% per year.

Table 5 Total factor productivity, output and input growth, sheep industry, by size, Australia, 1977–78 to 2018–19

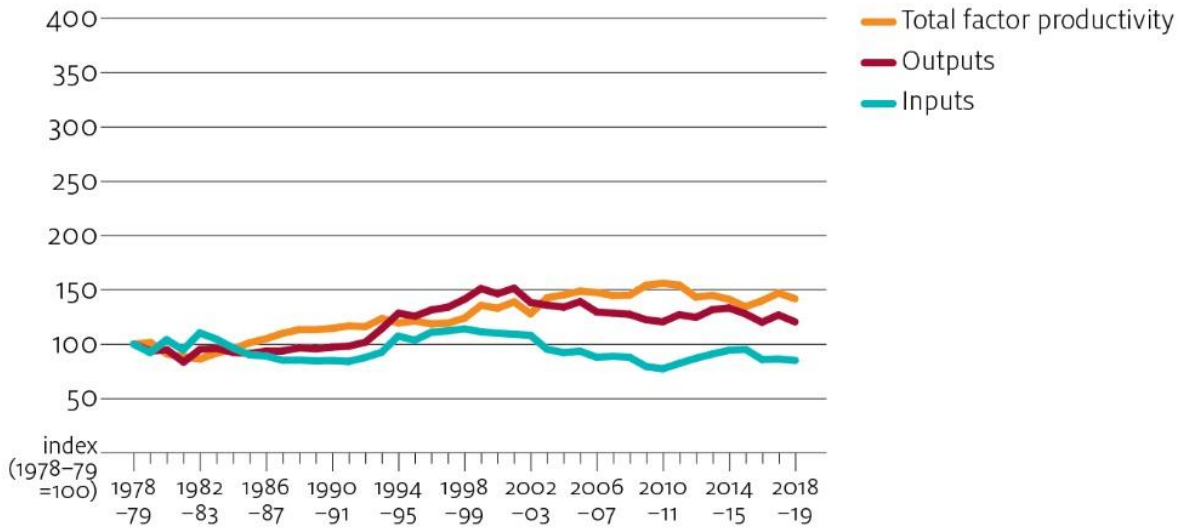
Farm size category	TFP (%)	Output (%)	Input (%)
Small – total cash receipts $0 to $200,000	–0.2	–3.4	–3.2
Medium – total cash receipts $200,001 to $500,000	0.2	–3.2	–3.4
Large – total cash receipts greater than $500,000	1.3	0.7	–0.7

Note: Input and output growth reported in this table may not sum to TFP growth in some cases due to rounding.
Source: ABARES Australian Agricultural and Grazing Industries Survey

Dairy

Productivity growth in the Australian dairy industry averaged 1.3% per year between 1978–79 and 2018–19 (Figure 7). This was driven by output increasing by an average of 1.0% per year and input use declining by (–0.3% 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 (–1.5%), and land (–1.2%). These falls have been offset by increases in the inputs of materials (3.1%) and services (0.3%).

Figure 7 Total factor productivity, output and input, dairy industry, Australia, 1978–79 to 2018–19



Source: ABARES Australian Dairy Industry Survey

The drivers of productivity growth in the dairy industry have varied significantly over time. Throughout the 1980s and 1990s many dairy farms transitioned to more intensive production systems. This reduced labour and land requirements, however it resulted in increased use of material inputs such as fertiliser and supplementary feed (Ashton et al. 2014). Productivity improvements during this period were driven by output increasing at a faster rate than input use as farmers adopted new technologies such as rotary dairies and artificial insemination, and improved pastures (Harris 2011).

After the advent of deregulation in 2000, the dairy industry underwent a significant period of adjustment. Prior to deregulation, dairy was the most heavily subsidised agricultural industry in Australia (OECD, 2001). In the period following, an environment of growth and innovation provided long term incentives for investment. As a result, the adjustments supported productivity growth across the industry (Sheng, Chancellor and Jackson 2019).

Dairy industry productivity growth can be attributed to two sources following deregulation: growth on individual farms (practice change, new technologies, more efficient use of resources etc); and growth from resource reallocation between farms (where resources move to more productive farms, boosting growth overall). In the decade prior to deregulation, price subsidies meant that resource reallocation between farms detracted from productivity gains from individual dairy farms. After deregulation, that changed—resource reallocation between farms contributed to, rather than detracted from, productivity growth that occurred within farms.

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