Irrigated agriculture in the Murray–Darling Basin
An economic survey of irrigators, 2012–13 to 2014–15
Dale Ashton and Mark Oliver

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Summary

In this report data from the ABARES Murray–Darling Basin Irrigation Survey (MDBIS) are presented from 2006–07 to 2014–15, particularly 2012–13 to 2014–15. The results include key farm performance measures for horticulture, dairy, rice and cotton farms, including data on water trading and use of irrigation technologies.

Key performance results
Changing commodity prices, costs of farm inputs, and varying seasonal conditions and irrigation water availability are key drivers of annual changes in farm incomes. These tend to differ across the industries over time.

The first three survey years (2006–07 to 2008–09) were severely affected by drought, with record low inflows to river systems and low irrigation water allocations. Incomes of horticulture, dairy, rice and cotton farms were relatively low throughout this period. Incomes mostly improved in 2010–11 as seasonal conditions improved and water allocations increased.

From 2012–13 to 2014–15 average farm cash income of cotton growing farms declined. For horticulture and rice growing farms, average farm cash income was comparatively even while dairy farms recorded their highest average farm cash income in real terms since 2006–07.

The average rate of return to capital over the survey period (2006–07 to 2014–15) for horticulture farms was 1.8 per cent, dairy farms 2.2 per cent, rice farms 1.5 per cent and cotton farms 4.9 per cent.

Water trading and irrigation technology
Water trading was an important tool for irrigators to manage low water allocations during severe drought, particularly between 2006–07 and 2008–09. As water availability declined and prices rose between 2006–07 and 2008–09, horticulture farms tended to account for a large proportion of the farms that were net buyers of allocation water, whereas net sellers were predominantly irrigated broadacre or dairy farms. When seasonal conditions improved and water allocations increased in 2009–10 and 2010–11, the proportion of surveyed irrigators participating in allocation water trading declined.

From 2006–07 to 2013–14 a relatively small proportion of irrigators in the Murray–Darling Basin sold permanent water access entitlements. An average of 4 per cent of horticulture farms, 9 per cent of dairy farms and 3 per cent of irrigated broadacre farms sold entitlements each year.

In 2014–15, more than 90 per cent of dairy, rice and cotton farms used flood/furrow irrigation systems to apply water to crops. Travelling irrigators were used by 28 per cent of dairy farms and 19 per cent of cotton farms.

On horticulture farms, the most used irrigation systems were drip/trickle (62 per cent of farms) and low throw sprinklers (28 per cent of farms). A further 11 per cent of horticulture farms used flood/furrow irrigation in 2014–15. The least used irrigation systems across all four industries were overhead sprinklers, moveable spray lines and micro spray systems.
1 Introduction


The MDBA is gathering information to better understand and assess the effect of Murray-Darling Basin Plan water reforms on Basin industries and communities. ABARES irrigation farm data will assist the MDBA with its assessments. Changing commodity prices, costs of farm inputs, and varying seasonal conditions and irrigation water availability are also important drivers of annual changes in farm incomes.

Irrigated agriculture in the Murray-Darling Basin is an important contributor to the Australian and regional economies. In 2012–13 the Basin accounted for 66 per cent of Australia’s total irrigated area and 40 per cent of the nation’s irrigating agricultural businesses (ABS 2014). These businesses undertake a variety of irrigated farm activities, including vegetable crops, tree and vine crops, pastures for grazing, hay, rice, cotton, cereals and oilseed crops. In some locations, many of these enterprises could not be undertaken without irrigation water, while other enterprises use irrigation to supplement rainfall.

This report summarises results for dairy, rice, cotton and horticulture (wine grapes, citrus, pome fruits and a range of vegetable crops) farms in the Murray-Darling Basin. ABARES has also prepared individual industry reports for irrigated cotton, dairy, horticulture (excluding wine grapes), rice and wine grape farms in the Basin. These single industry reports provide more detailed information for each farm type than is possible here.

The period covered in this report is from 2012–13 to 2014–15 with references to earlier periods to provide context. Detailed survey results for years before 2012–13 are provided in Ashton & Oliver (2008, 2009, 2011, 2012), Ashton, Valle & Oliver (2013) and Ashton (2014). The results presented in this report provide an industry-level overview of farm performance measures, including data on water trading and use of irrigation technologies.

The ABARES irrigation surveys are designed to provide good coverage of broadacre, dairy and horticulture irrigation farms in up to 10 regions throughout the Murray-Darling Basin (Map 1). The survey regions were chosen to cover the major irrigation regions in the Basin and were based on those used by the CSIRO in its Murray-Darling Basin Sustainable Yields Project (CSIRO 2007). Some of the CSIRO regions were not covered by the survey because of relatively small numbers of irrigation farms. Not all industries or major regions were surveyed in all years since 2006–07.

This latest ABARES irrigation survey targeted rice farms in the Murrumbidgee and Murray; horticulture farms in the Goulburn-Broken, Murrumbidgee and Murray; dairy farms in the Goulburn-Broken and Murray; and cotton farms predominantly in the northern Basin.
Map 1 Reporting regions, Murray-Darling Basin

Source: ABARES
2 Overview of farm performance

Irrigators in the Murray–Darling Basin have faced a number of changes in their operating environment since ABARES began surveying irrigation farms in 2006–07. Australian and state governments have introduced policy and programme initiatives, including reducing barriers to water trading, making changes to pricing for water storage and delivery, funding for more efficient irrigation infrastructure, purchasing permanent water access entitlements and developing the Murray–Darling Basin Plan. Irrigators also face variable farmgate prices and availability of irrigation water.

Commodity prices

Farmgate prices for agricultural products can vary widely from year to year. Figure 1 shows published ABARES price data for selected commodities from 2006–07 to 2014–15. Prices are expressed as indexes, showing proportional changes from a base year of 2006–07.

Cotton prices almost doubled in 2010–11 and then lost most of this gain the following year. Rice prices rose sharply in 2008–09, declined in the following two years and then rose by 25 per cent in both 2013–14 and 2014–15. Lamb prices increased for four consecutive years from 2006–07 onwards, fell significantly in 2012–13 and then increased again the following year.

Farmgate milk prices tended to fluctuate from year to year in line with changes in world prices for dairy products, rising in 2007–08, 2010–11 and 2013–14 but falling in all other years. Milk prices rose by 27 per cent in 2013–14 before falling by an estimated 14 per cent in 2014–15.

In the horticulture sector there have been significant variations in prices for individual fruit crops. For example, wine grape prices declined by around 50 per cent from 2006–07 to 2009–10 with little recovery since then. Average vegetable prices fell by 6 per cent in 2013–14 before rising by around 2 per cent in 2014–15. The vegetable price index comprises a basket of individual vegetable types. Prices for individual vegetables may have fluctuated more than the vegetable price index.
Figure 1 Index of prices for selected commodities, 2006–07 to 2014–15

Source: ABARES (2015)
Seasonal conditions and water availability

In 2012–13 average annual rainfall in the Murray–Darling Basin was generally well below average, particularly in Queensland and Victorian areas of the Basin (Map 2). Total area-averaged rainfall for the Murray–Darling Basin in 2012–13 was 377 millimetres, almost 20 per cent below the long-term average of 471 millimetres (BOM 2015b). Below average rainfall in 2012–13 resulted in decreased inflows into storages throughout the Basin (Figure 2). Total storage fell to 64 per cent and 70 per cent in the northern and southern portions of the Basin, respectively (BOM 2015b).

In 2013–14 much of the southern Basin received generally average rainfall, while Queensland and northern New South Wales regions received below average to very much below average rainfall (Map 2). Total area-averaged rainfall for the Basin was 388 millimetres in 2013–14, similar to the previous year (BOM 2015a). As a result of ongoing below average rainfall, total water storage in the northern Basin fell to 30 per cent in 2013–14, down from 64 per cent the previous year. Reflecting comparatively better conditions in the southern Basin, total water storage fell from 70 per cent to 63 per cent in 2013–14 (BOM 2015a).

National Water Account information from the Bureau of Meteorology is not currently available for 2014–15. However, rainfall in the northern Basin improved from the previous two years and rainfall in the southern Basin deteriorated. Victoria and South Australia, in particular, received below average to very much below average rainfall in 2014–15 (Map 2).


2012–13
Within the context of changes in seasonal conditions, the total volume of irrigation water applied in the Murray–Darling Basin during 2013–14 was 6 per cent lower than the previous year.
Irrigated agriculture in the Murray–Darling Basin (ABS 2014). The total volume of water used for irrigation is estimated to have fallen further in 2014–15.

Figure 2 Water held in selected storages, Murray–Darling Basin, 2012 to 2015

Percentage of storage full at 30 June

Source: Bureau of Meteorology 2015a, 2015b

Financial performance

Changing commodity prices, costs of farm inputs, varying seasonal conditions and irrigation water availability are key drivers of annual changes in farm incomes.

In the period 2012–13 to 2014–15 dairy farms recorded their highest average farm cash incomes (Box 1) in real terms since 2006–07. Farm cash incomes of rice farms were similar to that in 2010–11, while for horticulture farms, average farm cash incomes fell slightly from 2011–12 (Figure 3). After peaking in 2011–12, average farm cash income for cotton growers fell in subsequent years as cotton prices declined and drier seasonal conditions affected crop production.
Irrigated agriculture in the Murray–Darling Basin

Figure 3 Farm cash income, by industry, 2006–07 to 2014–15

Box 1 Key financial performance measures

<table>
<thead>
<tr>
<th>Financial Performance Measure</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Farm cash income</strong></td>
<td>Total cash receipts (revenues received by the farm business during the financial year) less total cash costs (payments made by the farm business for materials and services and for permanent and casual hired labour, excluding owner, manager, partner and family labour). Farm cash income is the surplus farm-based income available after paying for cash operating costs.</td>
</tr>
<tr>
<td><strong>Farm business profit</strong></td>
<td>Refines farm cash income by adding changes in trading stocks and deducting depreciation and imputed value of family labour. Farm business losses do not necessarily mean negative cash flows. In practice, positive cash flows can be maintained by reducing expenditure on capital asset replacement and forgoing wages for family labour.</td>
</tr>
<tr>
<td><strong>Rate of return</strong></td>
<td>Farm business profit with interest, lease and rent payments added (adjusted to full equity basis) expressed as a percentage of total farm capital. It represents the ability of the farm business to generate a return to all capital used by the business, including borrowed or leased capital.</td>
</tr>
</tbody>
</table>

**Horticulture farms**

Average farm cash income of irrigated horticulture farms in the Murray–Darling Basin is estimated to have been $92 374 in 2013–14, around 27 per cent higher than in 2012–13 (Table 1). Average income was similar in 2014–15 at $92 222, as lower receipts for apples, pears, stone fruit, wine grapes and vegetables were offset by increased receipts for citrus and nut crops.
The average rate of return (excluding capital appreciation) for irrigated horticulture farms increased to 2.7 per cent in 2013–14, before declining slightly to 2.4 per cent in 2014–15 (Figure 4). In comparison, the average rate of return (excluding capital appreciation) from 2006–07 to 2014–15 was 1.8 per cent.

The survey results show that, while farm financial performance of irrigated horticulture farms has improved on average, improvements have not occurred equally across all farms. The distribution of rate of return in 2014–15 shows around 60 per cent of horticulture farms recorded negatives returns. Forty per cent of farms recorded a rate of return of −5 per cent or less (Figure 5). Most of the farms with low rates of return grew crops with falling prices, such as wine grapes, while those with high rates of return grew crops with rising prices such as nuts.
Dairy farms

In 2013–14 total cash receipts for irrigated dairy farms in the Murray–Darling Basin rose by an estimated 38 per cent, as a result of high milk prices and increased milk production. Total cash costs rose by 32 per cent with increased expenditure on all major cost items, particularly fodder, hired labour and purchases of seasonal water allocations. As a consequence, farm cash income of irrigated dairy farms in the Basin rose in 2013–14 to average $296,233 (Table 2). Irrigated dairy farms recorded an average farm business profit of $186,319 in 2013–14, compared with $43,082 in 2012–13.

Table 2 Financial performance, dairy farms, Murray–Darling Basin, 2012–13 to 2014–15

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<tbody>
<tr>
<td>Farm cash income</td>
<td>$</td>
<td>180,121</td>
<td>296,233</td>
<td>197,909</td>
</tr>
<tr>
<td>Farm business profit</td>
<td>$</td>
<td>43,082</td>
<td>186,319</td>
<td>76,553</td>
</tr>
<tr>
<td>Rate of return</td>
<td>%</td>
<td>3.1</td>
<td>6.1</td>
<td>3.7</td>
</tr>
</tbody>
</table>

Note: 2014–15 data are provisional estimates. Rate of return excludes capital appreciation.
Source: Murray–Darling Basin Irrigation Survey

In 2014–15 total cash receipts for irrigated dairy farms in the Murray–Darling Basin fell by 7 per cent, largely because of lower milk prices which were down by about 10 per cent. Total cash costs rose by less than 1 per cent. Farm cash income of irrigated dairy farms in the Basin fell by 33 per cent to an estimated average of $197,909 in 2014–15. Irrigated dairy farms recorded a reduced average farm business profit of $76,553 in 2014–15.

In line with the recorded changes in farm cash income and farm business profit, the average rate of return (excluding capital appreciation) for irrigated dairy farms in the Murray–Darling Basin was estimated to have increased from 3.1 per cent in 2012–13 to 6.1 per cent in 2013–14.
(Figure 6). In 2014–15 the average rate of return for dairy farms was 3.7 per cent. The average annual rate of return to capital (excluding capital appreciation) for dairy farmers over the period from 2006–07 to 2014–15 was 2.2 per cent.

Figure 7 shows the variation in rates of return for dairy farms in 2014–15. More than 40 per cent of dairy farms recorded a positive rate of return up to 5 per cent and 30 per cent of farms recorded returns greater than 5 per cent. Around one-quarter of dairy farms recorded negative rates of return.

Figure 6 Rate of return, dairy farms, Murray–Darling Basin, 2006–07 to 2014–15

average per farm

Note: 2014–15 data are provisional estimates. Rate of return excludes capital appreciation.
Source: Murray–Darling Basin Irrigation Survey
Irrigated agriculture in the Murray–Darling Basin

Irrigated broadacre farms

Rice growing farms

The irrigation survey includes broadacre farms in the Murrumbidgee and Murray regions that normally grow rice and other broadacre crops. Some of these farms did not grow rice in some years, particularly 2006–07 to 2008–09.

In 2013–14 total cash receipts of farms that grew rice rose by an estimated 13 per cent, with higher receipts for irrigated crops being offset by lower receipts for dryland crops and livestock. Total cash costs rose by around 14 per cent, with increased expenditure on purchases of seasonal water allocations, fertilisers, repairs and maintenance, electricity and contracts. Farm cash income rose by around 10 per cent to average $187 026 in 2013–14 (Table 3).

In 2014–15 total cash receipts fell by just over 3 per cent, with lower receipts for rice being partly offset by higher receipts for wheat and other cereal crops. Total cash costs rose by around 2 per cent, with reduced expenditure on seasonal water allocations partly offsetting increases in other major cost items. As a consequence, farm cash income fell by around 7 per cent to average $173 933 in 2014–15.

Table 3 Financial performance, rice growing farms, Murray–Darling Basin, 2012–13 to 2014–15

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</tr>
</thead>
<tbody>
<tr>
<td>Farm cash income</td>
<td>$</td>
<td>169 722</td>
<td>187 026</td>
<td>173 933</td>
</tr>
<tr>
<td>Farm business profit</td>
<td>$</td>
<td>27 982</td>
<td>80 361</td>
<td>58 405</td>
</tr>
<tr>
<td>Rate of return</td>
<td>%</td>
<td>2.2</td>
<td>3.2</td>
<td>2.7</td>
</tr>
</tbody>
</table>

Note: 2014–15 data are provisional estimates. Rate of return excludes capital appreciation.
Source: Murray–Darling Basin Irrigation Survey
The average rate of return (excluding capital appreciation) of rice growers was estimated to have been 3.2 per cent in 2013–14 and 2.7 per cent in 2014–15, compared with an average of 2.2 per cent in 2012–13 (Figure 8). In comparison, the average rate of return over the entire period of the survey—from 2006–07 to 2014–15—for these farms was around 1.5 per cent.

The distribution of rates of return of rice growers in 2014–15 is shown in Figure 9. Around half of rice farms recorded positive rates of return and half negative rates of return. A majority of farms recorded returns between –5 per cent and 5 per cent.

**Figure 8** Rate of return, rice growing farms, Murray–Darling Basin, 2006–07 to 2014–15 average per farm

![Bar chart showing the rate of return for rice growing farms in the Murray–Darling Basin from 2006–07 to 2014–15.](image)

Note: 2014–15 data are provisional estimates. Rate of return excludes capital appreciation.

Source: Murray–Darling Basin Irrigation Survey
Cotton growing farms

The irrigation survey includes broadacre farms in regions that normally grow cotton and other broadacre crops. Some of these farms did not grow irrigated cotton in some years, particularly 2006–07 to 2008–09.

Cotton growers’ incomes are estimated to have fallen in 2013–14 and again in 2014–15 (Table 4). In 2013–14 an increase in total cash receipts was more than offset by higher total cash costs, resulting in an 8 per cent decline in farm cash income. In 2014–15 total cash receipts fell by around 8 per cent as lower receipts from cotton were partly offset by higher receipts from sorghum. Total cash costs fell by around 4 per cent resulting in an 18 per cent reduction in farm cash income in 2014–15.

Table 4 Financial performance, cotton growing farms, Murray–Darling Basin, 2012–13 to 2014–15

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</thead>
<tbody>
<tr>
<td>Farm cash income</td>
<td>$</td>
<td>650 936</td>
<td>597 125</td>
<td>489 689</td>
</tr>
<tr>
<td>Farm business profit</td>
<td>$</td>
<td>487 429</td>
<td>441 541</td>
<td>332 494</td>
</tr>
<tr>
<td>Rate of return</td>
<td>%</td>
<td>6.8</td>
<td>5.7</td>
<td>4.9</td>
</tr>
</tbody>
</table>

The average rate of return (excluding capital appreciation) for cotton growers was estimated to have been 5.7 per cent in 2013–14 and 4.9 per cent in 2014–15, compared with an average of 6.8 per cent in 2012–13 (Table 4). In comparison, the average rate of return over the entire period of the survey—from 2006–07 to 2014–15—for cotton growing farms was around 4.9 per cent (Figure 10).
Despite the declines in farm financial performance in the latter years, the proportion of farms with positive rates of return was 72 per cent. Around 60 per cent of cotton growers recorded rates of return greater than 5 per cent (Figure 11).

Figure 10 Rate of return, cotton growing farms, Murray–Darling Basin, 2006–07 to 2014–15 average per farm

Note: 2014–15 data are provisional estimates. Rate of return excludes capital appreciation. Source: Murray–Darling Basin Irrigation Survey

Figure 11 Distribution of cotton growing farms by rate of return, Murray–Darling Basin, 2014–15 proportion of farms

Note: 2014–15 data are provisional estimates. Rate of return excludes capital appreciation. Source: Murray–Darling Basin Irrigation Survey
3 Water trading and irrigation technology

Ongoing water policy reforms over the past decade have reshaped the landscape for irrigators and other water users. Reforms have included reducing barriers to water trade, changes to pricing for water storage and delivery, funding for more efficient irrigation and water infrastructure, government purchases of permanent water access entitlements and development and implementation of the Murray–Darling Basin Plan.

Monitoring the effects of changes in water policies on irrigation farm businesses—the major users of water—is important to help ensure the objectives of policies and programmes are being met. The survey results allow farm-level analysis of the way irrigators adjust their farm business operations to address changes in their operating environment by recording changes in crop or livestock production, farm receipts and costs, and financial performance.

Irrigation farm data pertinent to three key aspects of water policy reform on farm performance are reported in this chapter:

- trade in seasonal water allocations
- trade in permanent water access entitlements, including sales to the Australian Government
- investment and adoption of irrigation technologies.

Water policies are part of a wide range of interrelated factors that shape the overall business operating environment faced by irrigators. Identifying the influence of any one factor on farm performance can be difficult. These results should be considered within the broader context of changes in commodity prices, seasonal conditions and other factors, as discussed in chapter 2.

Water allocation trading

Growth in the use of water trading has been a key outcome sought from water policy reform in Australia, with various government initiatives and policies contributing to the development and expansion of markets for permanent water access entitlements and temporary water allocations.

Water trading was an important tool for irrigators to manage low water allocations during severe drought, particularly between 2006–07 and 2008–09. The survey results show that the ability to trade water allocations has also been important in seasons of higher water availability.

The characteristics of buyers and sellers have changed over time, reflecting changes in the availability and price of water as well as wider business considerations such as commodity prices, taxation provisions and input cost changes.

As water availability declined and prices rose between 2006–07 and 2008–09, horticulture farms tended to account for a large proportion of the farms that were net buyers of allocation water, whereas net sellers were predominantly irrigated broadacre or dairy farms.

When seasonal conditions improved and water allocations increased in 2009–10 and 2010–11, the proportion of irrigators participating in water allocation trading declined. However, the total volume of water traded increased in aggregate and on a per farm basis as cotton and rice
growers responded to increasing water availability and lower prices by purchasing larger volumes of water.

In 2012–13 and 2013–14 increased proportions of irrigators began trading water allocations (Figure 12, Figure 13, Figure 14, Figure 15), because of hot and dry seasonal conditions and a change in business strategy for many irrigators to source water from temporary markets rather than holding permanent water entitlements. Feedback from industry workshops with dairy farmers, grape growers and citrus growers also suggested that many irrigators were becoming more familiar with using water markets.

Figure 12 Proportion of horticulture farms trading temporary water allocations, 2006–07 to 2013–14

Note: Net buyers/sellers are farms that bought/sold more water than they sold/bought.
Source: Murray–Darling Basin Irrigation Survey
Figure 13 Proportion of dairy farms trading temporary water allocations, 2006–07 to 2013–14

Note: Net buyers/sellers are farms that bought/sold more water than they sold/bought.  
Source: Murray–Darling Basin Irrigation Survey

Figure 14 Proportion of cotton farms trading temporary water allocations, 2006–07 to 2013–14

Note: Net buyers/sellers are farms that bought/sold more water than they sold/bought. Cotton farms were mostly located in the northern Basin. Water trade data for cotton farms is not available for 2011–12 and 2012–13.  
Source: Murray–Darling Basin Irrigation Survey
The effect of water allocation trading on irrigators’ farm financial performance varies depending on whether an individual is a net buyer or net seller. The effect for net sellers is an increase in farm cash receipts from the sale of water allocations. This increase from water receipts is likely to be at least partially offset by a reduction in receipts from irrigated agricultural commodities where production is scaled back because of less water. Changes in commodity prices may lessen or exacerbate this production effect. The effect for net buyers includes additional production and receipts from crop or livestock sales that would otherwise not have been generated, which is offset to a degree by additional costs from purchasing water allocations.

Reflecting increased water availability, the volume of water applied per farm rose from 2009–10 to 2013–14 for most industries. Percentage increases in the volume of water applied were greatest for irrigated broadacre (rice and cotton) farms over the period (Figure 16). Of the water applied, the proportion that was sourced from water allocation purchases varied by industry and from year to year.
Sale of permanent water entitlements

The market for permanent water access entitlements has also provided irrigators with an important tool for managing their farm businesses. Fewer trades in entitlements have occurred than in water allocations because decisions on whether to buy or sell permanent entitlements are generally based on longer term considerations than decisions to trade water allocations.

From 2006–07 to 2013–14 a relatively small proportion of irrigators in the Murray–Darling Basin sold permanent water access entitlements. Over this period, an average of 4 per cent of horticulture farms, 9 per cent of dairy farms and 3 per cent of irrigated broadacre farms sold entitlements each year (Figure 17). Smaller proportions of irrigators purchased entitlements each year—1 per cent of horticulture farms, 3 per cent of dairy farms and 3 per cent of irrigated broadacre farms.

While some irrigators sold entitlements and ceased irrigating or farming altogether, the survey results show that other irrigators used the proceeds from entitlement sales to reduce debt and continue farming. Irrigators selling water entitlements to the Australian Government recorded reduced average debt over the survey period, while those not selling entitlements recorded an increase in average debt. Many of those that continued farming accessed irrigation water by purchasing water allocations or entitlements (Marsden Jacobs 2012).
Results from the survey show movements toward more efficient irrigation technologies in some industries (particularly citrus, wine grapes and vegetables). The survey results also show overall reductions in water application rates for many individual farms within the Basin, but these can vary significantly from year to year because of changes in seasonal conditions and water availability.

Around 5 per cent of irrigators made additions to irrigation capital each year over the period 2006–07 to 2013–14. On average, those farms making investments added more than $80 000 in new irrigation capital in most years.

New investment in fixed irrigation infrastructure accounted for around 5 per cent of the average opening value of irrigation capital over the period. A number of farms in the survey made new investments in on-farm irrigation infrastructure that were significantly higher than the opening value of their irrigation capital. Many of these farms appear to have been completely replacing existing irrigation systems with newer technologies.

In 2014–15, more than 90 per cent of dairy, rice and cotton farms used flood/furrow irrigation systems to apply water to crops (Table 5). Travelling irrigators were used by 28 per cent of dairy farms and 19 per cent of cotton farms.

On horticulture farms, the most used irrigation systems were drip/trickle (62 per cent of farms) and low throw sprinklers (28 per cent of farms). A further 11 per cent of farms used flood/furrow irrigation in 2014–15.
The least used irrigation systems across all four industries were overhead sprinklers, moveable spray lines and micro spray systems. The highest use of any of these three systems in any of the four industries was just 5 per cent.

Table 5 Irrigation system used, by industry, Murray–Darling Basin, 2014–15

<table>
<thead>
<tr>
<th>System</th>
<th>Unit</th>
<th>Horticulture</th>
<th>Dairy</th>
<th>Rice</th>
<th>Cotton</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flood/furrow</td>
<td>%</td>
<td>11</td>
<td>92</td>
<td>100</td>
<td>90</td>
</tr>
<tr>
<td>Travelling irrigators</td>
<td>%</td>
<td>1</td>
<td>28</td>
<td>1</td>
<td>19</td>
</tr>
<tr>
<td>Overhead sprinklers</td>
<td>%</td>
<td>2</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Low throw sprinklers</td>
<td>%</td>
<td>28</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Moveable spray lines</td>
<td>%</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Drip/trickle</td>
<td>%</td>
<td>62</td>
<td>0</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>Micro sprays</td>
<td>%</td>
<td>5</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Note: 2014–15 data are provisional estimates.
Source: Murray–Darling Basin Irrigation Survey

Over the survey period changes in water application rates largely varied in line with changes in total water availability and seasonal conditions. For most crops and pasture, water application rates rose in 2011–12 and 2012–13 because of greater water availability (Figure 18). For some crops, particularly rice and irrigated pasture, increased availability of water—through increased allocations and increased purchases of water—also contributed to higher water application rates per hectare from 2010–11 to 2012–13.
Figure 18 Water application rate, by commodity, Murray–Darling Basin, 2006–07 to 2014–15

average per farm (ML/ha)

Note: 2014–15 data are provisional estimates.
Source: Murray–Darling Basin Irrigation Survey
Appendix A Survey methods and definitions

The ABARES survey of irrigation farms in 2014–15 collected information from broadacre (including rice and cotton), dairy and horticulture irrigation farms in the Murray–Darling Basin. The survey covered around 83 per cent of irrigation farms in the Basin. Regional coverage was based on those defined by the CSIRO in its Sustainable Yields Project (CSIRO 2007) (Map 1).

ABARES field officers conducted the irrigation survey using face-to-face interviews between March and May 2015. The farm financial and physical information collected included land area and value, crop and livestock production and sales, irrigation water use by crop type and pasture, irrigation water delivery methods, farm receipts and costs, labour use, debts and assets and market values of farm capital.

The survey also included questions on types of water licences held, participation in water trading, types of irrigation infrastructure, basis for irrigation scheduling decisions and future intentions.

Every effort was made to interview the same farms in most years, but this was not possible in all regions and industries. In some cases, changes in the composition of the sample resulted in relatively large differences in estimates between years. Relative standard errors can be used to indicate whether changes in the estimates are statistically significant or not.

Target populations

ABARES surveys are designed, and samples selected, on the basis of a framework drawn from the Business Register maintained by the Australian Bureau of Statistics (ABS). This framework includes agricultural establishments (farms) classified by size and industry in each statistical local area. To be eligible for this survey, farms had to have engaged in irrigated agricultural activities during 2013–14, had an estimated value of agricultural operations of $40 000 or more, and be defined as broadacre, dairy or horticulture industry farms.

The industry definitions used in this report are based on the Australian and New Zealand Standard Industrial Classification (ANZSIC). This classification is consistent with an international standard and permits comparisons between industries, both within Australia and internationally. Farms assigned to a particular ANZSIC class have a high proportion of their total output characterised by that class (ABS & SNZ 2006).

The ANZSIC industry classes and codes associated with the broadacre, dairy and horticulture categories used for this study were:

<table>
<thead>
<tr>
<th>Category</th>
<th>Subcategory</th>
<th>ANZSIC code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Broadacre</td>
<td>Sheep farming</td>
<td>ANZSIC code 0141</td>
</tr>
<tr>
<td></td>
<td>Beef cattle farming</td>
<td>ANZSIC code 0142</td>
</tr>
<tr>
<td></td>
<td>Sheep–beef cattle farming</td>
<td>ANZSIC code 0144</td>
</tr>
<tr>
<td></td>
<td>Grain–sheep and grain–beef cattle farming</td>
<td>ANZSIC code 0145</td>
</tr>
<tr>
<td></td>
<td>Rice growing</td>
<td>ANZSIC code 0146</td>
</tr>
<tr>
<td></td>
<td>Other grain growing</td>
<td>ANZSIC code 0149</td>
</tr>
<tr>
<td></td>
<td>Cotton growing</td>
<td>ANZSIC code 0152</td>
</tr>
<tr>
<td>Dairy</td>
<td>Dairy cattle farming</td>
<td>ANZSIC code 0160</td>
</tr>
<tr>
<td>Horticulture</td>
<td>Vegetable growing (under cover)</td>
<td>ANZSIC code 0122</td>
</tr>
</tbody>
</table>
Survey design

The farm population to be surveyed was stratified by operation size using the estimated value of agricultural operation (EVAO). The size of each stratum was determined using the Dalenius–Hodges method (Lehtonen & Pahkinen 2004). The sample allocation to each stratum was performed using a mixture of the Neyman allocation, which takes into account variability within strata of the auxiliary variable (in this case EVAO), and proportional allocation, which only considers the population number in each stratum. The Neyman allocation allocates large proportions of sample to strata with large variability—in the case of this survey, strata of larger farms (Lehtonen & Pahkinen 2004).

Sample weighting

Farm-level estimates published by ABARES are calculated by appropriately weighting the data collected from each sample farm and then using the weighted data to calculate population estimates. Sample weights are calculated so that population estimates from the sample for numbers of farms, areas of crops and numbers of livestock correspond as closely as possible to the most recently available ABS estimates from agricultural census and surveys data. The weighting methodology uses a model-based approach, with a linear regression model linking the survey variables and the estimation benchmark variables. The details of this method are described in Bardsley and Chambers (1984).

Generally, larger farms have smaller weights and smaller farms have larger weights, reflecting both the strategy of sampling a higher fraction of large farms than small farms (the former having a wider range of variability of key characteristics and accounting for a much larger proportion of total output), and the relatively lower number of large farms.

Reliability of estimates

Reliability of the estimates of population characteristics presented in this report depends on design of the sample and accuracy of the measurement of characteristics for the individual sample farms.

Sampling errors

Only a small number of farms out of the total number of farms in a particular industry or region are surveyed. The data collected from each sample farm are weighted to calculate population estimates. Estimates derived from these farms are likely to be different from those that would have been obtained if information had been collected from a census of all farms. Any such differences are called sampling errors.

The size of the sampling error is most influenced by the survey design and the estimation procedures, as well as the sample size and variability of farms in the population. The larger the sample size, the lower the sampling error is likely to be. Therefore, national estimates are likely to have smaller sampling errors than industry and region estimates.
Sampling errors are a guide to the reliability of survey estimates and have been calculated for all estimates in this report. These sampling errors, expressed as percentages of the survey estimates and termed relative standard errors, are provided next to each estimate in parentheses.

**Calculating confidence intervals using relative standard errors**

Relative standard errors can be used to calculate confidence intervals; these indicate how close the actual population value is likely to be to the survey estimate.

The standard error is obtained by multiplying the relative standard error by the survey estimate and dividing by 100. For example, if average total cash receipts are estimated to be $100 000 with a relative standard error of 6 per cent, the standard error for this estimate is $6 000. One standard error is equal to $6 000 and two standard errors are equal to $12 000.

For a 66 per cent confidence interval, there is roughly a two-in-three chance that the census value (the value that would have been obtained if all farms in the target population had been surveyed) is within one standard error of the survey estimate. This range of one standard error is described as the 66 per cent confidence interval. In this example there is an approximately two-in-three chance that the census value is between $94 000 and $106 000 ($100 000 plus or minus $6000).

For a 95 per cent confidence interval, there is roughly a 19-in-20 chance that the census value is within two standard errors of the survey estimate (the 95 per cent confidence interval). In this example, there is an approximately 19-in-20 chance that the census value lies between $88 000 and $112 000 ($100 000 plus or minus $12 000).

**Comparing estimates**

When comparing estimates between two groups, it is important to recognise that the differences are subject to sampling error. A conservative estimate (an overestimate) of the standard error of the difference can be found by adding the squares of the estimated standard errors of the component estimates and taking the square root of the result.

For example, estimates of farm cash income are $139 210 for farms in New South Wales and $162 020 for farms in Queensland; the relative standard errors are 33 per cent and 26 per cent, respectively. The difference between these two estimates is $22 810. The standard error of the difference is estimated as:

$$\sqrt{(33 \times 139 210 / 100)^2 + (26 \times 162 020 / 100)^2} = 62 330$$

A 95 per cent confidence interval for the difference is:

$22 810 +/–1.96 \times 62 330 = (–$99 357, $144 977)

Hence, if 100 different samples are taken, in 95 of them the difference between these two estimates would be between minus $99 357 and $144 977.

**Definition of terms**

*Owner–manager:* Primary decision-maker for the business. This person is identified by discussion between interviewer and interviewee as (one of) the key decision-maker(s). This person is usually responsible for the day-to-day operation of the business and may own or have a share in the business.
Area of land at business premises: Includes all land operated by the business, whether owned or rented.

Labour: Measured in work-weeks, as estimated by the owner–manager. Includes all work on the business by the owner–manager, partners, family, hired permanent and casual workers, but excludes work done by contractors.

Hired labour: Excludes owner–manager, partners and family labour, and work undertaken by contractors. Expenditure on contract services appears as a cash cost.

Capital: Value of capital employed by the business is the market value of all assets used including leased items but excluding machinery and equipment either hired or used by contractors. Market valuations were provided by the owner–manager of surveyed businesses and included the market value of land and fixed improvements used by the business, excluding the value of the owner–manager’s house. House value deducted from total value of land and fixed improvements was the present day replacement cost, depreciated for age.

Debt: Estimated as business debt. Includes all debts attributable to the business excluding personal debt and underwritten loans. Information collected at the survey interview was supplemented by information in the business accounts.

Total cash receipts: Total of revenues received by the business during the financial year, including revenues from the sale of crops, livestock and livestock products. Includes revenue received from royalties, rebates, refunds, plant hire, contracts, insurance claims and compensation, and government assistance payments.

Total cash costs: Payments made by the business for materials and services and for permanent and casual hired labour (excluding partner and other family labour). Includes value of any lease payments on capital, produce purchased for resale, rent, interest, cropping and livestock related purchases. Capital and household expenditures are excluded from total cash costs. Handling and marketing expenses include commission and levies for business produce sold. Administration costs include accountancy fees, banking and legal expenses, postage, stationery, subscriptions and telephone. Other cash costs include relatively small cost items like stores, advisory services and travelling expenses.

Depreciation: Estimated by applying diminishing value depreciation method to market value of capital items at 30 June. Capital items are categorised into several groups and relevant depreciation rates are applied. Capital groups include vehicles; handling, harvesting and packing equipment; cultivation and sowing equipment; computers, electronic and communications equipment; other plant and equipment; and buildings on the business premises.

Imputed labour cost: Payments for owner–manager and family labour may bear little relationship to actual work input. An estimate of the labour input of the owner–manager, partners and their families is calculated in work-weeks and a value is imputed at the relevant Federal Pastoral Industry Award rates.

Farm business profit: Cash operating surplus plus build-up in trading stocks, less depreciation, less the imputed value of the owner–manager, partner(s) and family labour.

Profit at full equity: Return to capital and management plus interest, rent and finance lease payments. It is the return produced by all the resources used in the business.
Rate of return: Return to all capital used. Computed by expressing farm business profit as a percentage of total opening capital of the business.

Equity ratio: Calculated as business equity as a percentage of owned capital at 30 June.

Off-farm income: Income not derived from the surveyed farm business. Includes all off-farm income from wages and salaries, other businesses, other investments and Commonwealth social support payments. Estimated for the owner–manager and spouse only.
References

Unless otherwise indicated, ABARES publications listed here are available at agriculture.gov.au/abares/publications.


