Irrigated agriculture in the Murray-Darling Basin: a farm level analysis by region and industry

Dale Ashton, Mark Oliver, Stephen Hooper, Daniel Mackinnon and Thilak Mallawaarachchi

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Introduction

The Murray-Darling Basin is an important agricultural region in Australia, contributing around 40 per cent of the national gross value of agricultural production (ABS 2008). The Basin supports a large irrigated agriculture sector which accounted for around 65 per cent of the total area irrigated in Australia in 2005-06 (ABS 2008). In 2005-06, the gross value of irrigated agricultural production within the Basin was estimated to be around $4 billion.

Since 2001-02, reduced rainfall has led to lower inflows to the river systems within the Basin relative to historical inflows, while the volume of water held in major storage dams has been at record lows. At the same time, there has been increased demand for scarce water supplies from agriculture, urban, industrial and environmental uses.

Increased demand for water, coupled with forecasts suggesting a likelihood of increased water scarcity, has raised the national policy focus of managing Australia’s water resources over the longer term.

To meet a need for detailed economic information on irrigation industries, ABARE commenced a program of economic surveys of irrigation farms within the Murray-Darling Basin in 2006-07. This survey has provided the first set of comprehensive physical and financial farm performance data for irrigation farms since ABARE’s previous irrigation survey was conducted in 1996-97.

The data collected in the survey will be used to monitor changes in the irrigation sector and provide insights for government and industry decision makers. Three examples are provided in this paper: an analysis of farm financial performance, characteristics of irrigators involved in temporary water trading, and investment in on-farm irrigation infrastructure.

Overall, the survey results show there is considerable variability in financial returns across the Murray-Darling Basin such that there were no industries or regions with significantly better or worse financial results than the others.

The survey results also suggest water trading was effective in reallocating water among uses in 2006-07. The ability to trade water appears to have assisted some irrigators in avoiding substantial financial losses in 2006-07, either by obtaining income from water sales or by purchasing water to maintain production.
Finally, the survey results highlight differences in on-farm investment in irrigation infrastructure among the industries. The dominant strategy for broadacre farms, and to a lesser extent dairy farms, was expansion in the scale of operations by purchasing additional land. For horticulture producers, the dominant strategy appears to have been investment in improving on-farm irrigation infrastructure. Relatively high profitability in the horticulture industry and high security water allocations which provide greater certainty, appear to have been important factors influencing this investment pattern.

Survey of irrigation farms

The 2006-07 ABARE survey of irrigation farms in the Murray-Darling Basin was designed to provide coverage of broadacre (including rice and cotton growers), dairy and horticulture irrigation farms within 10 regions of the Basin (map 1).

The survey regions were chosen to cover the major irrigation regions in the Basin and were based on those defined by CSIRO in its Sustainable Yields Project (CSIRO 2007), namely; Condamine-Balonne, Border Rivers, Namoi, Macquarie-Castlereagh, Lachlan, Murrumbidgee, Murray, Goulburn-Broken, Loddon-Avoca, and Eastern Mount Lofty Ranges. Some of the CSIRO regions were not covered by the survey because of relatively small numbers of irrigation farms.

Throughout the Basin, irrigation water is used on a wide variety of crops and pasture, with the major uses of water being dairy farms (mainly for pasture, hay and silage production), rice, cotton and horticulture (including both perennial and annual crops) (ABS 2008).

In 2006-07, there was marked variation in water application rates, crop yields and per unit crop receipts both across and within the regions. Such variation would normally be expected given differences among farms in factors such as soil types, irrigation technologies, crop varieties, rainfall and so on. In 2006-07, these outcomes would also have been affected by the availability of irrigation water in various regions, as well as the extent to which particular crops required irrigation water to supplement rainfall during the year.

Potential to inform policy

ABARE’s irrigation survey results can also be used to inform policy. For instance, figure a highlights the difficulty in taking a more interventionist approach to allocating water across industries. The significant variation in rates of return on capital employed within each irrigated industry in figure a illustrates there are operators generating high and low returns in each industry. While the distribution of returns differs between industries, it is not possible to classify some industries as relatively poor performers.

In addition, the view that some industries use water inefficiently is perpetuated by inappropriate and misleading measures of economic efficiency, such as megalitres of water used per hectare (or unit of output) or revenue earned per megalitre of water used. Clearly, some irrigated activities will require more water than others. Irrigated activities involve the use of multiple inputs, of which water is just one, and water is no different to any other input which
has value. The demand for water in any irrigated activity is a function of its price. Given this, the best way to ensure water is used efficiently across regions and industries is to let price signals prevail.

Farm financial performance in 2006-07

Overall, the survey results show there were groups of irrigators in all regions and industries that had strong financial performance in 2006-07. At the same time, some irrigators had relatively poor financial results, but a strong underlying farm equity position in 2006-07. A third group of irrigators had both poor financial results and low farm equity in 2006-07.
Broadacre farms

The financial performance of Australian broadacre farms, including both dryland and irrigated farms, fell sharply in 2006-07 as severe drought across most of southern Australia led to a significant reduction in farm production and incomes.

Farm cash income for dryland broadacre farms in the Murray-Darling Basin is estimated to have averaged around $36,530 per farm, with an average rate of return of minus 1.1 per cent in 2006-07. In comparison, farm cash income for irrigated broadacre farms in the Murray-Darling Basin averaged around $62,690 a farm, with an average rate of return of 0.5 per cent in 2006-07.

The best performing regions for irrigated broadacre farms, by rate of return, were the Macquarie-Castlereagh and Loddon-Avoca regions, while the Goulburn-Broken and Murray regions had the lowest average rates of return (figure b). However, there was wide variability in financial performance among broadacre farms in all regions in 2006-07.

Dairy farms

Dairy farmers’ incomes fell substantially in 2006-07 because of the drought and consequently lower milk production, higher fodder costs and slightly lower farm-gate milk prices. Results from ABARE’s Australian dairy industry survey show that dairy farmers responded to the drought in a variety of ways, such as increasing their use of purchased feeds to replace pasture, and reducing herd sizes.

As a result of lower cash receipts and higher cash costs, farm cash income for Australian dairy farmers is estimated to have declined by 61 per cent to average around $33,730 a farm in 2006-07 (Mackinnon 2008). In comparison, farm cash income for irrigated dairy farms in the Murray-Darling Basin averaged around $33,640 a farm in 2006-07. As with broadacre farms, there was wide variability in financial performance among irrigated dairy farms across the Murray-Darling Basin in 2006-07 (figure c).
Incomes for horticulture producers were affected by drought, reduced water allocations, and frost in some regions in 2006-07. Farm cash income for horticulture producers in the Murray-Darling Basin averaged around $54,760 a farm, with an average rate of return of 1.8 per cent in 2006-07.

The best performing region for irrigated horticulture producers by rate of return was the Condamine-Balonne region in 2006-07, while the Macquarie-Castlereagh region had the lowest average rate of return (figure d).

Farm performance in 2007-08

Although 2007-08 financial data for irrigation farms in the Murray-Darling Basin are not yet available, it is likely overall farm financial performance would have remained weak in 2007-08.

The 2007-08 irrigation season was among the driest on record for the Basin. In some regions, irrigation water allocations were lower in 2007-08 than in 2006-07, with some licence holders in many regions receiving record low allocations depending on the source of water supply and type of licence (table 1).

The combined effect of low storage levels and low inflows resulted in the lowest ever irrigation allocations in the Murray region for 2007-08. While high reliability users received some allocation (Victoria, 43 per cent; New South Wales, 25 per cent and South Australia, 32 per cent), general security users in the New South Wales Murray region received a zero allocation in 2007-08 (Mallawaarachchi and Foster 2009).

The Murray-Darling Basin Commission estimated that 1480 gigalitres of water were diverted from the Murray system in 2007-08, representing around 55 per cent of 2006-07 diversions and around 40 per cent of average diversions between 1997 and 2008 (MDBC 2008).

The responses of individual farmers to this situation will have been varied. Overall, farmers will have based their management decisions on the availability of irrigation water allocations,
Irrigated agriculture in the MDB

Water trading played a critical role in helping irrigators cope with changes in water availability, by allowing buyers to reduce the effect of drought on farm production, through the purchase of additional water. In 2007-08, 1298 gigalitres of temporary water was traded in the Murray system, with interstate temporary trades accounting for about 18 per cent of the total trade volume (Mallawaarachchi and Foster 2009).

Farm performance by income and equity

To gain greater insight into the financial performance of irrigation farms in each region, farms were allocated to one of four groups based on income (farm cash income above or below $50 000) and equity (farm business equity above or below 80 per cent) high income/high equity, high income/low equity, low income/high equity and low income/low equity.

The Namoi, Goulburn-Broken and Murray regions had the highest proportions of irrigation farms classified to the low income/low equity group with around one-third of farms in each region in this group (table 2). The Condamine-Balonne and Eastern Mount Lofty Ranges regions had the lowest proportions of farms classified in the low income/low equity group.

Generally, farms in the low income/low equity group are likely to be facing the greatest financial pressures, often because of large farm business debts and poor debt servicing ability. However, many of these farm businesses were supported by off-farm income in 2006-07. Farms in the high income/high equity group had strong cash flows and relatively high profits and rates of return in 2006-07. Many producers in each group made significant investments in new capital during 2006-07, including land purchases and new irrigation infrastructure.
Water trading

Irrigators can respond to reduced water availability in a number of ways. For example, increasing water productivity by making more efficient use of available water supplies or increasing water availability by accessing alternative sources of supply.

Water trading is the transfer of water access entitlements (permanent trade) and seasonal water allocations (temporary trade) between buyers and sellers. Water trading is important because it allows scarce water resources to be transferred to their most productive uses. Water trading also allows water resources to be reallocated over time in response to changes in commodity prices, environmental conditions, competing demands for water and the availability of water.

Generally, water purchases will be driven by those irrigators which are able to produce agricultural outputs for which the benefits of using additional water outweigh the market costs of acquiring that water. Conversely, water will be made available for sale by those irrigators for which the benefits of using additional water are less than the water market price. These latter irrigators will find it more profitable to sell water and reduce irrigated production in times of water scarcity.

The water market has grown considerably in the past decade as a consequence of institutional reforms to facilitate trade, and changes in relative marginal returns as a result of increasing scarcity of water and strong competing demands. The large majority of trades are for temporary water.

There has been a nearly 50 per cent increase in the volume of water allocations traded since 2004-05. South Australia was the major importer of water, while New South Wales was the largest exporter of water in 2007-08 (Mallawaarachchi and Foster 2009).
Results from ABARE’s survey of irrigation farms in the Murray-Darling Basin show an estimated 2 per cent of irrigation farms were involved in trading permanent water entitlements, either buying or selling, while around one-quarter of irrigation farms traded water, either buying or selling on a temporary basis in 2006-07 (table 3).

### 3 Water trading by irrigation farms, Murray–Darling Basin, 2006-07

<table>
<thead>
<tr>
<th>Percentage of farms trading</th>
<th>dairy</th>
<th>broadacre</th>
<th>horticulture</th>
<th>Murray-Darling Basin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Permanent entitlements</td>
<td>%</td>
<td>3</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Temporary irrigation water</td>
<td>%</td>
<td>31</td>
<td>20</td>
<td>23</td>
</tr>
</tbody>
</table>

An estimated 31 per cent of dairy farms, 20 per cent of broadacre farms and 23 per cent of horticulture farms participated in temporary water trading in 2006-07. By region, the proportion of farms participating in trading was between 40 and 50 per cent in the Murrumbidgee, Murray, Goulburn-Broken and Loddon-Avoca regions. In the Eastern Mount Lofty Ranges region, an estimated 17 per cent of farms participated in temporary water trading in 2006-07. There was a relatively small number of farms participating in water trading in each of the remaining regions of the Murray-Darling Basin.

Figure 5 shows the proportion of survey farms which participated in temporary water trading which were net buyers or net sellers in 2006-07. However, these estimates should be used with caution. As they were based on a subset of the survey sample, they are likely to differ from the estimates which would have been obtained if all water trading farms had been surveyed.

Nevertheless, the survey results suggest a majority of the farms involved in temporary water trading in the Goulburn-Broken and Murray regions were net buyers of temporary water, while in the Murrumbidgee region, most water trading farms were net sellers of temporary water (figure e).

The main buyers and sellers varied by industry. Overall, dairy farmers were prominent buyers of temporary water in 2006-07, as they sought to offset relatively low seasonal allocations. Conversely, horticulture farms, with generally more reliable irrigation water entitlements, tended to be prominent water sellers in most regions. In 2007-08 in the southern Basin, perennial horticulture farmers were the most common buyers, with broadacre farms the most common sellers (Mallawaarachchi and Foster 2009).
A regional comparison of selected farm performance estimates for net buyers and net sellers is shown in table 4. Net buyers of irrigation water operated larger farms on average, with higher overall irrigation water use than net sellers.

The survey results also show that in terms of average rate of return and equity position, net sellers of water performed slightly better than net buyers of water.

Water traders in the Murrumbidgee region purchased the largest net volume of water and irrigated the largest area in 2006-07. The proportion of water used by net buyers which was obtained from purchases, ranged from 33 per cent in the Eastern Mount Lofty Ranges region to just under 50 per cent in the Murray region.

There was little difference in the net volume of water sold per farm among the regions, with around one-third of the water available to net sellers being sold in 2006-07.

The average cost of temporary water purchases for net buyers ranged from around $44 000 a farm in the Goulburn-Broken region (9 per cent of total cash costs) to about $72 000 a farm in the Eastern Mount Lofty Ranges and Murray regions (6 per cent and 11 per cent of total cash costs respectively). Temporary water purchases as a proportion of total cash costs was highest in the Loddon-Avoca region (14 per cent).

### Selected estimates, temporary water traders, by region, 2006-07

<table>
<thead>
<tr>
<th></th>
<th>Net volume of water bought or sold a</th>
<th>Water applied to crops and pasture</th>
<th>Water application rate</th>
<th>Farm cash income</th>
<th>Rate of return</th>
<th>Equity ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ML</td>
<td>ha</td>
<td>ML/ha</td>
<td>$</td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td><strong>Net water buyers</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Murrumbidgee</td>
<td>460</td>
<td>311</td>
<td>1 163</td>
<td>3.7</td>
<td>64 230</td>
<td>3.5</td>
</tr>
<tr>
<td>Murray</td>
<td>240</td>
<td>97</td>
<td>512</td>
<td>5.2</td>
<td>42 807</td>
<td>0.8</td>
</tr>
<tr>
<td>Goulburn–Broken</td>
<td>113</td>
<td>95</td>
<td>244</td>
<td>2.6</td>
<td>20 311</td>
<td>–1.0</td>
</tr>
<tr>
<td>Loddon–Avoca</td>
<td>197</td>
<td>102</td>
<td>460</td>
<td>4.5</td>
<td>16 314</td>
<td>–0.9</td>
</tr>
<tr>
<td>Eastern Mt Lofty Ranges</td>
<td>167</td>
<td>111</td>
<td>512</td>
<td>4.6</td>
<td>159 271</td>
<td>4.6</td>
</tr>
<tr>
<td><strong>Net water sellers</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Murrumbidgee</td>
<td>–92</td>
<td>39</td>
<td>204</td>
<td>5.2</td>
<td>54 500</td>
<td>1.8</td>
</tr>
<tr>
<td>Murray</td>
<td>–82</td>
<td>43</td>
<td>190</td>
<td>4.3</td>
<td>70 430</td>
<td>1.6</td>
</tr>
<tr>
<td>Goulburn–Broken</td>
<td>–71</td>
<td>64</td>
<td>150</td>
<td>2.3</td>
<td>–16 790</td>
<td>–0.9</td>
</tr>
<tr>
<td>Loddon–Avoca</td>
<td>–96</td>
<td>99</td>
<td>158</td>
<td>1.6</td>
<td>194 060</td>
<td>2.3</td>
</tr>
<tr>
<td><strong>Non-water traders</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Murrumbidgee</td>
<td>0</td>
<td>116</td>
<td>425</td>
<td>3.7</td>
<td>38 950</td>
<td>0.1</td>
</tr>
<tr>
<td>Murray</td>
<td>0</td>
<td>75</td>
<td>253</td>
<td>3.4</td>
<td>50 155</td>
<td>1.5</td>
</tr>
<tr>
<td>Goulburn–Broken</td>
<td>0</td>
<td>69</td>
<td>133</td>
<td>1.9</td>
<td>14 400</td>
<td>–0.6</td>
</tr>
<tr>
<td>Loddon–Avoca</td>
<td>0</td>
<td>110</td>
<td>360</td>
<td>3.3</td>
<td>84 760</td>
<td>1.0</td>
</tr>
<tr>
<td>Eastern Mt Lofty Ranges</td>
<td>0</td>
<td>31</td>
<td>91</td>
<td>2.9</td>
<td>52 530</td>
<td>1.4</td>
</tr>
</tbody>
</table>

* A negative figure represents net sales.
In all regions, revenue from water sales provided a substantial boost to farm incomes for many net sellers. The average receipts per farm from temporary water sales for net sellers ranged from $22,400 a farm in the Murray region (8 per cent of total cash receipts) to $90,800 a farm in the Loddon-Avoca region (19 per cent of total cash receipts).

**On-farm investment in irrigation infrastructure**

Despite relatively low average incomes, an estimated 10 per cent of irrigation farms in the Murray-Darling Basin made capital investments during 2006-07.

The dominant strategy for broadacre farms, and to a lesser extent dairy farms, was expansion in the scale of operations by purchasing additional land.

For horticulture producers, the dominant strategy appears to have been investment in improving on-farm irrigation infrastructure. Relatively high profitability in the horticulture industry and high security water allocations, which provide greater certainty to water, appear to have been important factors influencing this investment pattern.

A farmer’s decision to invest in irrigation technology depends on the trade-off between the present value of water, water conservation benefits of new technology and the costs associated with implementing the technology change. In determining water conservation benefits, the price of water becomes a critical factor. In general, other input costs being held constant, the higher the price of water the greater the value of water savings and, hence, greater incentives to invest in water saving measures.

A farmer’s motivation for investment is also influenced by factors which affect net returns from the alternative options available to improve productivity. In making investment choices, a farmer would most likely invest in those activities which offer the greatest capacity to contribute to productivity improvements and, hence, farm profitability.

Some irrigation investments, such as installing drip irrigation systems, involve large and irreversible capital investments where the returns are generated over many years. However, uncertainty regarding the returns or benefits arising from such investments, can be significant.

Changes in irrigation management practices, such as monitoring water needs and scheduling watering, can also lead to gains in water use efficiency. Implementing such changes is often cheaper than making investments in irrigation infrastructure. As a consequence, some irrigators will implement changes to management practices before making large infrastructure investments.

**Use of irrigation technologies**

Irrigators in the Murray-Darling Basin have access to a range of irrigation technologies. The choice of technology is largely determined by crop requirements, source of water (eg groundwater or surface water), infrastructure costs and expected returns.
Broad scale enterprises, such as rice, cotton, and pasture, require technologies which apply large volumes of water across relatively large areas. Such application methods include flood/furrow, overhead fixed sprinklers, low throw fixed sprinklers, travelling irrigators and moveable spray lines.

Intensive enterprises, such as most horticultural applications, allow technologies which apply water to specific points, such as plant root zone, over relatively small areas. Such application methods include microjet fixed sprinklers, or drip/trickle systems, although broad scale technologies may also be used for horticultural enterprises.

As part of the ABARE survey, data were collected on the type of irrigation technology used, including flood/furrow, overhead fixed sprinklers, low throw sprinklers, microjet fixed sprinklers, drip/trickle, travelling irrigators, moveable spraylines and other methods.

In 2006-07, an estimated 69 per cent of irrigation water used in the Murray-Darling Basin was applied using flood/furrow systems, with a further 13 per cent of water applied using drip/trickle systems (table 5).

### Percentage of water applied, irrigation application method by industry, Murray-Darling Basin, 2006-07

<table>
<thead>
<tr>
<th>Method</th>
<th>Dairy %</th>
<th>Broadacre %</th>
<th>Horticulture %</th>
<th>Murray-Darling Basin %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flood/furrow a</td>
<td>89</td>
<td>93</td>
<td>9</td>
<td>69</td>
</tr>
<tr>
<td>Overhead fixed sprinklers</td>
<td>2</td>
<td>0</td>
<td>8</td>
<td>3</td>
</tr>
<tr>
<td>Low throw fixed sprinklers</td>
<td>0</td>
<td>1</td>
<td>24</td>
<td>7</td>
</tr>
<tr>
<td>Microjet fixed sprinklers</td>
<td>0</td>
<td>0</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>Drip/trickle</td>
<td>0</td>
<td>1</td>
<td>46</td>
<td>13</td>
</tr>
<tr>
<td>Travelling irrigators</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Moveable spray lines</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Other</td>
<td>2</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

a Flood/furrow systems were the most common method for applying water on dairy and broadacre farms. Drip/trickle systems and low throw fixed sprinklers were the most common method for applying water on horticulture farms.

### Conclusion

Irrigated agriculture makes an important contribution to the Australian economy, with the Murray-Darling Basin supporting a large irrigation sector. Prolonged and severe drought throughout much of the Basin has reduced inflows into river systems and, subsequently, the volume of water held in major water storages.

The current and likely future water situation in the Murray-Darling Basin, and across Australia more broadly, has focused attention on a range of challenging and often interrelated water issues, including government administrative responsibility for water management, the environment, trade-offs between water uses and more efficient water use.
The overall results of ABARE’s survey of irrigation farms in the Murray-Darling Basin show there is a diverse range of physical characteristics, irrigation water use and financial performance among individual farms across regions and industries.

The financial performance of broadacre, dairy and horticulture farms in the Murray-Darling Basin was generally weak in 2006-07. In 2007-08, historically low irrigation allocations in some regions is likely to have resulted in overall farm financial performance remaining weak.

The responses of individual farmers to this situation will have been varied. For example, increasing water productivity by making more efficient use of available water supplies or increasing water availability by accessing alternative sources of supply.

Water trading played a critical role in helping irrigators cope with changes in water availability in 2006-07 and 2007-08 by allowing buyers to reduce the effect of drought on farm production through the purchase of additional water. Other farmers were able to earn additional income by selling water.

Other adaptation strategies included investment in new technologies, adoption of water use efficient management techniques, and changes in farm enterprise mix. In making these choices, a farmer would most likely invest in those activities which offer the greatest capacity to contribute to productivity improvements and, hence, farm profitability.

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