Dealing with irrigation drought

The role of water trading in adapting to water shortages in 2007–08 in the southern Murray-Darling Basin

Thilak Mallawaarachchi and Adam Foster

Research Report 09.6 March 2009

abare.gov.au
ABARE was commissioned by the Department of the Environment, Water, Heritage and the Arts to provide an evaluation of how water trade enhanced irrigators’ ability to deal with low allocations during the 2007-08 drought.

The extended drought in the Murray Darling Basin continued into 2007-08, with the Murray system inflows declining to record lows. The combination of low inflows and low storage levels resulted in a severe reduction in water availability for irrigators in the southern Basin. Faced with unprecedented cuts to water allocations, irrigators have adopted a number of strategies to cope. Water trading has played a critical role, enabling irrigators to adjust to the change in water availability.

In conducting this study, ABARE researchers analysed the water trading records in New South Wales, Victoria and South Australia for 2007-08, and conducted a number of farmer interviews and discussions with water authorities. The analysis provides useful insights into irrigators’ ability and willingness to engage in water trade and related farm management activities to achieve greater benefits from limited water supplies.

Phillip Glyde
Executive Director
January 2009
Contents

Summary 1

1 Introduction 3

2 Water markets: developments and issues 4
   Factors influencing trading behaviour 5

3 Water markets in 2007-08 7
   Economic benefits of water trade 9

4 Farm case studies 11
   Case studies in Victoria 12
   Case Studies in South Australia 18

5 Insights from case studies 25
   Adaptation strategies 25
   Policy implications 28

6 Conclusions 30

References 31

Figures
   a NSW Murray interstate trade prices 2007-08 9
   b Stylised representation of the model, South Australia 9
   c Stylised representation of the model, Upstream 10
Map
   1 Case Study Regions 11
Tables
   1 Diversions from the Murray system 7
   2 Temporary trade in water allocations, Southern Murray-Darling Basin —2007-08 8
   3 Trade patterns in the southern Murray-Darling Basin water market — 2007-08 8
   4 Parameters used in the analysis 9
   5 Key results 10
   6 Average temporary transfer processing time in the southern Basin 29
Summary

• The extended drought in the Murray-Darling Basin (the Basin) continued into 2007-08, with Murray system inflows declining to record lows. The combination of low inflows and low storage levels resulted in a severe water shortage for irrigators in the southern Basin. Faced with unprecedented cuts to water allocations, irrigators have adopted a number of strategies to cope. Water trading has played a critical role, enabling irrigators to adjust to the change in water availability.

• This report examines recent water trading experiences in New South Wales, Victoria and South Australia to capture insights on the nature of water transactions, including the volume and price of trades and the direction of these trades in the 2007-08 irrigation season.

• The analysis shows the bulk of water movements occur via the sale of temporary water allocations. The number of permanent water trades remains relatively low.

• Water markets, based on voluntary exchange, have allowed buyers to reduce the impact of drought on farm production through the purchase of additional water. These sales have allowed irrigators to sell water to earn an interim income during times of low allocations or to purchase additional water for crops. In a voluntary market, water would be expected to be traded toward the highest value uses. Within the Basin, the horticulture industry generally places the highest value on water as an input to production. During drought years, they are likely to purchase water. Analyses in this report confirm this expectation. In 2007-08 in the southern Basin, perennial horticulture farmers were the most common buyers, with broadacre farmers the most common sellers.

• The volume of interstate trade increased from around 70 gigalitres in 2004-05 to 235 gigalitres in 2007-08, representing 18 per cent of the total traded volume. While this is a large increase, a number of irrigators identified delays in processing interstate water trades as a barrier to further desired trade.

• South Australia was the major importing state, while New South Wales was the largest exporter of water in 2007-08. According to the estimates provided in this report, the net benefit of water trade into South Australia in 2007-08 was estimated to be $35 million, with South Australian irrigators benefitting by $31 million and upstream irrigators benefitting by $4 million.

• The price of temporary water was highly variable in 2007-08, both within and between trading zones, ranging from around $200 to $1200 per megalitre. The current availability of irrigation water, irrigators’ expectations regarding future water allocation announcements and changes in the demand for water as a production input are key factors influencing price movements.

• Irrigators’ experience with trading has highlighted the benefits of improving water productivity. The benefits of conserving water have increased because of the drought and the resulting increase in temporary water prices. Farm visits indicate that increasing on-farm water use efficiency has enabled many irrigators to avoid serious losses in severe drought conditions.
The study concludes that irrigators have demonstrated an ability and willingness to engage in trade as a means of achieving greater benefits from limited water supplies. In particular, the active market for water allocations provides irrigators with increased flexibility for coping with water scarcity. While there was a reduction in total water use for irrigation in the southern Basin during 2007-08, the ability to trade water has allowed water to be reallocated to its highest value uses, substantially mitigating the economic impact of low water allocations.
Over the past two decades the Australian irrigation industry has undergone a process of reform which has included the creation of a water market enabling the trade of water entitlements and annual allocations attached to those entitlements. This period is also characterised by advancements in irrigation technology, a high level of investment in irrigated land uses and a growing awareness of the environmental impacts of irrigation.

The 2007-08 irrigation season was one of the driest on record for the Murray-Darling Basin with a combination of low storage levels and low inflows resulting in record low water allocations to irrigators. Water trading has been highlighted under the National Water Initiative as an important response to water scarcity, allowing water to be transferred to its most productive use (National Water Commission, 2007).

This report provides a brief evaluation of markets for water allocations and their influence on irrigators’ ability to manage their farm business during periods of low allocations. This report explores factors influencing trading behaviour and the characteristics of water trade which occurred in 2007-08 using data on water allocation trades, a number of farmer interviews and discussions with water authorities. The influence of water trade for enhancing the effectiveness of farm management during periods of water scarcity is then analysed and some policy insights drawn.

A brief overview of water markets is presented in chapter 2, an analysis of 2007-08 water market transactions in the southern Basin is presented in chapter 3 and chapter 4 presents the results of a set of case studies which explore water trading experience in the southern Basin. Chapter 5 draws insights from case studies to identify key strategies adopted by farmers for adapting to a water shortage. Conclusions are summarised in the final chapter.
Water markets: developments and issues

The Council of Australian Governments (COAG) water reform guidelines of 1994 and the cap on water extractions in the Basin, imposed since 1995, set the initial conditions for trading water allocations and the underlying rights to these allocations. Prior to the cap there was little incentive to trade because increased demands for water were largely met through increased allocations to irrigators. The cap effectively limited entitlement holders’ access to water, forcing them to meet any increases in demand through trade in water entitlements (Goesch 2001).

In the Basin, water use is managed by granting water access entitlements and water allocations. Water users in all states hold a legal entitlement to a water share, which is an ongoing right to exclusively access a portion of water from a specified consumptive pool as defined under the relevant water plan. In periods of low surface water availability, individual water shareholders receive a reduced allocation under the rationing rules developed under the announced allocation system.

Prior to trade, the return irrigators earn from the last megalitre of water they receive under their allocation (the marginal return) may vary significantly across irrigators. Trading provides an efficient means for reallocating water to the point where marginal returns are equalised across irrigators. The benefits of water trading could be substantial, particularly during times of water shortages. In general, the higher the disparity in marginal values the greater the benefits of trade.

Water trade was introduced to encourage the reallocation of water to its highest value uses. This concept is best demonstrated using a simple example of water trade between two farmers. If the benefit to farmer A from using an additional megalitre of water was $200 and the benefit to farmer B from using an additional megalitre was $150, they would have an incentive to trade. Farmer A would buy water from farmer B and the combined benefits from exchanging 1 megalitre would be $50. In the absence of transaction costs, trade would continue until the marginal values of the two farmers were equalised and the potential for mutually beneficial trade was exhausted – indicating an efficient allocation of water.

Both buyers and sellers of water expect to gain from trade, otherwise they would not voluntarily enter into trade agreements. However, there may be positive or negative externalities associated with water trade which may influence future productivity and the overall wellbeing of the community beyond the benefits to those directly involved in trade. For example, trade into a region with saline return flows could generate a negative externality through damage to agricultural crops and valued wetlands downstream.

In most rural water systems in Australia, the vast majority of water users pay for harvesting, storing and water delivery, but pay nothing for the water itself. There is often a significant disparity between the costs of supplying water and the benefit of water in alternative uses. An
important benefit of water trading is that it establishes a value of water. This price, determined by supply and demand, signals the net economic benefits of water in alternative uses, which in turn creates incentives for the reallocation of water. The equilibrium value of water also gives public and private investors information about the potential returns from investing in technologies that conserve and augment water supplies.

Factors influencing trading behaviour

Trade occurs because the costs of producing a good or service differs between two locations owing to differences in initial water entitlements, land use, technology and factor use intensities. A recent study into economic and social impacts of water trading (Frontier Economics 2007) concluded, that water trading:

- allows more flexible risk management and farm decision making, including the decision to leave agricultural production;
- increases the social capacity to react to changes in circumstances;
- is a catalyst for change to accommodate the consequences of drought, variation in commodity markets and rural adjustment;
- gives farmers greater flexibility in making decisions about their priorities for water use, offers a means of managing risk and cash flow (particularly in dry times) and facilitates business growth and development in an agricultural system that has both annual and perennial crops; and,
- can have positive and negative social and economic effects for the local communities.

Frontier Economics (2007) also noted that there is some community opposition to permanent trading out of a district.

Trading behaviour is likely to vary across regions, over time and under different seasonal conditions as water users maximise returns from all inputs used in their water consuming activities.

Current use patterns

When considering efficient water use, farmers select cropping patterns and irrigation methods to maximise profit subject to the prevailing water price and the flexibility within their current enterprises. Their decisions are also driven by a host of other factors, such as the cost of machinery and labour, and environmental conditions such as climate and soil quality. As water becomes increasingly limited, the opportunity costs of water revealed in water markets induces change. While trading patterns will reflect the profitability of different industries, trading patterns will also be influenced by productivity differences between farmers within an industry.

The differential in water values between existing uses and potential uses in other locations is often sufficient to stimulate trade. However, in practice development of water markets can introduce a number of complications.
As with using many other natural resources, water use can involve a number of externalities or third-party effects. For instance, while water trades may increase overall efficiency within a water region, there can be both positive and negative impacts on third-parties through changes in income, employment opportunities and delivery charges. Other potential externalities associated with water trade include changes in reliability of supply and timeliness of delivery (Heaney et al. 2005).

Further, trade induced reductions or redirected flows on a waterway could affect both the quantity and quality of water downstream. When the effects are negative, and are likely to be substantial, regulatory agencies may act to ensure non-market values placed on the waterways by society are taken into account in proposed water transactions. These protections, although necessary to ensure the adverse effects of negative externalities in trade would not exceed the socially efficient levels, may add to transaction costs.

**Uncertainty**

In managing supply uncertainty, water markets act as a secondary source of water guiding longer term decisions and as a means of enhancing farm revenues in the short term through tactical trading responses. The level of trading is likely to differ depending on the confidence that irrigators place in the water market and their chances of pursuing tactical responses to deal with supply uncertainty (Calatrava and Garrido 2005). When trading water, a farmer’s decisions will be based on expectations about seasonal allocations and rainfall, and how the seasonal water price, and input and output markets, may respond to these seasonal conditions. Moreover, it can be expected trading volumes and water prices will vary as the season progresses and information about the seasonal conditions becomes available.

During drought, when there is increased supply uncertainty, many irrigators with permanent plantings are likely to purchase water where their own supplies are inadequate to protect their capital investments (Appels et al. 2004). A major benefit of temporary water purchases is that they have a guaranteed reliability of supply (that is, a purchase of 1 megalitre on the temporary market ensures the availability of 1 megalitre of irrigation water for the farmer). This is in contrast to the purchase of permanent entitlements where attached future allocations are uncertain. This uncertainty may mean most water transfers are leases or trades of water allocations until longer term supply and demand expectations for water are sufficiently informed to generate a new equilibrium in the market.

There are some alternatives to allocation trading including a specific type of leasing, known as option agreements which are currently used in California (Howitt and Hansen 2005). Under an option agreement, the purchaser pays an option fee in the autumn, before the winter precipitation, for the right to purchase a specific quantity of water in the spring should the water year turn out to be dry. By paying the option fee, the buyer manages supply risk by avoiding last minute spring contract negotiations for water, which may no longer be available at a reasonable price. Buyers can further reduce transaction costs by negotiating long-run, multiple exercise options. The benefits of options are explored in relation to irrigation and the environment in the Murrumbidgee valley by Heaney and Hafi (2005).
In this chapter the 2007-08 water market in the southern Murray-Darling Basin is analysed by drawing on data from the Murray Valley region of New South Wales and the Goulburn-Murray region of Victoria.

The 2007-08 irrigation season was one of the driest on record for the Basin. The 2220 gigalitre total inflow into the Murray River system during 2007-08 was the sixth lowest in 117 years of records, when the Darling inflows and Snowy Scheme releases are excluded. This represented only 25 per cent of the long-term average of 8900 gigalitres. The 2007-08 year was also preceded by record low inflows of 970 gigalitres in 2006-07, with the combined two year total of 3190 gigalitres being the lowest on record, representing only 53 per cent of the previous minimum in 1914-1916 (MDBC 2008).

The combined effect of low storage levels and low inflows resulted in record low irrigation allocations across the Murray River system for 2007-08. While high reliability users received some allocation (Victorian Murray 43 per cent; NSW Murray 25 per cent and South Australia Murray 32 per cent), general security users in the Murray system received a zero allocation in 2007-08.

The Murray-Darling Basin Commission estimates that 1480 gigalitres of water was diverted from the Murray system in 2007-08. This represents around 55 per cent of 2006-07 diversions and around 40 per cent of average diversions between 1997 and 2008 (table 1). A further 400 gigalitres of water were unused and carried over by individual water license holders for 2008-09.

### Diversions from the Murray system

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>New South Wales</td>
<td>250</td>
<td>615</td>
</tr>
<tr>
<td>Victoria</td>
<td>820</td>
<td>1380</td>
</tr>
<tr>
<td>South Australia</td>
<td>415</td>
<td>625</td>
</tr>
<tr>
<td>Total</td>
<td>1485</td>
<td>2620</td>
</tr>
</tbody>
</table>

*a* includes lower Darling, excludes Murrumbidgee and Goulburn, and not adjusted for trade.  
In 2007-08, 1298 gigalitres of temporary water was traded in the Southern Murray-Darling Basin (table 2). The volume of temporary sales in the year represents around 87 per cent of the total water diverted from the Murray system during the year, with interstate temporary trades accounting for about 18 per cent of the total trade volume. It should be noted some trades include water carried over from the previous year, 2006-07.

There has been a nearly 50 per cent increase in the volume of water allocations traded since 2004-05. The volume of interstate trade has increased from around 70 gigalitres in 2004-05 to 235 gigalitres in 2007-08 (ABS 2006). There were no recorded interstate permanent water trades in 2007-08. South Australia was the major importer of water while New South Wales was the largest exporter of water in 2007-08 (table 3).

### Temporary trade in water allocations, Southern Murray-Darling Basin —2007-08

<table>
<thead>
<tr>
<th>Water traded within</th>
<th>Water traded into</th>
<th>Water traded out</th>
<th>Total water traded</th>
<th>Average price</th>
</tr>
</thead>
<tbody>
<tr>
<td>no.</td>
<td>GL</td>
<td>no.</td>
<td>GL</td>
<td>no.</td>
</tr>
<tr>
<td>New South Wales</td>
<td>1 800</td>
<td>338.62</td>
<td>460</td>
<td>14.59</td>
</tr>
<tr>
<td>Victoria</td>
<td>15 393</td>
<td>464.07</td>
<td>1 212</td>
<td>73.17</td>
</tr>
<tr>
<td>South Australia</td>
<td>762</td>
<td>259.82</td>
<td>3 655</td>
<td>147.74</td>
</tr>
<tr>
<td>Total MDB</td>
<td>17 955</td>
<td>1 062.51</td>
<td>5 327</td>
<td>235.50</td>
</tr>
</tbody>
</table>

a Murray Valley only; b Based on reported median price; c Based on sales from NSW only. Source: NSW Department of Water and Energy, Victorian Department of Sustainability and Environment, South Australian Department of Water, Land and Biodiversity Conservation.

### Trade patterns in the southern Murray-Darling Basin water market — 2007-08

<table>
<thead>
<tr>
<th>Gross trade</th>
<th>Net trade</th>
<th>Diversions in 2006-07</th>
<th>Net trade as a proportion of 2006-07 diversions</th>
</tr>
</thead>
<tbody>
<tr>
<td>GL</td>
<td>GL</td>
<td>GL</td>
<td></td>
</tr>
<tr>
<td>New South Wales</td>
<td>353.21</td>
<td>–156.51</td>
<td>1569</td>
</tr>
<tr>
<td>Victoria</td>
<td>537.24</td>
<td>11.15</td>
<td>2206</td>
</tr>
<tr>
<td>South Australia</td>
<td>407.56</td>
<td>145.36</td>
<td>628</td>
</tr>
<tr>
<td>Total Southern Basin1</td>
<td>298.01</td>
<td>0</td>
<td>4403</td>
</tr>
</tbody>
</table>

a Includes Urban and metropolitan use. Source: NSW Department of Water and Energy, Victorian Department of Sustainability and Environment, South Australian Department of Water, Land and Biodiversity Conservation.
The trading prices of water allocations in 2007-08 varied widely, ranging from around $200 to $1200 a megalitre for interstate trade from the NSW Murray system (figure a). The peak price period from late September through to December coincides with the critical period of water demand for horticulture. The trading price for water averaged $366 a megalitre in Victoria and $700 a megalitre in NSW over the 2007-08 irrigation season (table 2). The comparable price for water allocations in 2004-05 was around $60 a megalitre.

**Economic benefits of water trade**

In this section a simple model is constructed to estimate the benefits of trade between South Australia and upstream states in 2007-08.

Separate demand curves were estimated for each region (see figures b and c). The point e(trade) in figures b and c shows the equilibrium combination of water prices and quantities, based on observed water trade data. This gives a point on the demand curve. The other points along the demand curve were generated assuming a constant price elasticity of demand for water. The elasticity can be interpreted as the percentage change in water demand associated with a 1 per cent increase in the price of water. It is assumed that South Australia uses Murray River water to produce grapes (with a price elasticity of –1.0), while upstream regions produce irrigated pastures and grains (with a price elasticity of –1.4). These elasticity estimates were derived from Bell et al. (2007) and are reported with other parameters in table 4.

**Parameters used in the analysis**

<table>
<thead>
<tr>
<th>parameter</th>
<th>value</th>
<th>source</th>
</tr>
</thead>
<tbody>
<tr>
<td>South Australia allocations without trade</td>
<td>153 gigaL</td>
<td>Calculations based on MDBC (2008)</td>
</tr>
<tr>
<td>Upstream allocations without trade</td>
<td>1218 gigaL</td>
<td>Calculations based on MDBC (2008)</td>
</tr>
<tr>
<td>Total volume of trade into South Australia</td>
<td>148 gigaL</td>
<td>NSW DWE (2008)</td>
</tr>
<tr>
<td>Price of allocations with trade</td>
<td>$593 a megalitre</td>
<td>NSW DWE (2008)</td>
</tr>
<tr>
<td>Price elasticity of demand, South Australia</td>
<td>–1.0</td>
<td>Bell et al. (2007)</td>
</tr>
<tr>
<td>Price elasticity of demand, upstream</td>
<td>–1.4</td>
<td>Bell et al. (2007)</td>
</tr>
</tbody>
</table>
The total value of water in each region was estimated with and without trade, based on the area under the water demand curve (d). In figure b, the difference (area a + b) reflects an increase in the total value of water as a result of trade. The transfer to sellers (area b) represents a loss to South Australians and is subtracted, resulting in a net benefit of area a. In figure c, the difference (area f) reflects a reduction in the total value of water as a result of trade. The transfer from buyers (area g + f) represents a gain to upstream regions that more than compensates for the loss of water. Thus, the net benefits to upstream regions are given by the area g.

The main results are presented in table 5. The net benefit to South Australian irrigators was around $31 million, whereas the net benefit to upstream irrigators was estimated to be $4 million. The distribution of benefits favoured South Australian farmers and reflects differences in elasticities and initial allocations of water.

Interstate trade also had distributional implications within regions, benefiting buyers and making some sellers in South Australia less well-off, and having the opposite impact in upstream regions. It is estimated that without interstate trade, the average price of water in South Australia would have been substantially higher, while water in upstream regions would have been cheaper.

This analysis considers only the benefits of selected trades. The gains from water trade more generally, such as between other states and within state boundaries, are likely to be substantially higher. Also, any transaction costs and externalities associated with trade have not been considered. For these and other reasons, the results should be interpreted with caution.

### Key results

<table>
<thead>
<tr>
<th>Benefits of trade</th>
<th>South Australia</th>
<th>$31 million</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Upstream</td>
<td>$4 million</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Price without trade</th>
<th>South Australia</th>
<th>$1136 a megalitre</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Upstream</td>
<td>$541 a megalitre</td>
</tr>
</tbody>
</table>
Analysis of ABARE farm survey data for the irrigation season 2006-07 indicates irrigator behaviour in response to drought management has varied widely. To better understand strategies adopted by irrigators in responding to water shortages, individual follow-up interviews were conducted with a small sample of randomly selected irrigators who were part of the ABARE irrigation survey and who also participated in water trading in 2006-07. The sample included five irrigators from Victoria and five from South Australia (map 1). The information collected, during farm visits through semi-structured interviews, is presented in this chapter.
Case studies in Victoria

Case study one — Goulburn Murray dairy

This 200 hectare property has been operated by the family for more than 30 years and currently supports around 350 dairy cattle with a turnover of around $700 000 in 2006-07. Feed is a major input component of milk production, accounting for 50 to 60 per cent of gross milk expenditure. To remain competitive, dairy operators rely on the use of cost-efficient pasture and forage crops in combination with more expensive supplementary feeds, particularly hay and feed grains. As drought impacts on the quality and quantity of pasture, a major challenge for dairy operators is managing the variability in forage quality and availability between and within seasons to ensure cow nutrition, milk yields and overall profitability.

As a consequence of the drought, this farm has moved to having more annual pasture and lucerne where previously having perennial pastures. Pastures cut for hay are being put into silage where possible to store for the future. In 2007-08, the farm used about 350 megalitres of irrigation water on the property, including 50 megalitres of water purchased on the temporary market. Under normal climatic conditions, water use would have been at least double this amount. The property is able to produce about 2.7 tonnes of feed from 1 megalitre of water under normal conditions.

The operator stated the drought had made farm planning much more difficult. Normally he would make plans with a three-year time horizon, but with the current conditions it is difficult to estimate water allocations for the upcoming season, so planning ahead involves a lot of uncertainty. Consequently, he has had to be more opportunistic in his practices to make use of resources and seasonal conditions as they emerge. For example, a crop of dryland oats was sown after rain, as was done on many properties in the vicinity. These opportunistic crops can supplement on-farm feed availability and reduce the need to purchase feed. However, as these decisions involve significant day-to-day planning they add to the management tasks.

The operator noted the extensive nature of the drought being experienced in many parts of the country meant dryland and irrigated activities were affected at the same time, pushing up the price of purchased feed. While the current high price for dairy products has been of some assistance, escalating feed and operating costs made managing through the drought a difficult experience. It was also noted by the operator that reduced economic activity around the region has forced people away from the region, causing difficulties in securing labour.

The property currently has about 150 hectares under irrigation via a gravity-fed system with a land-formed, border-checked irrigation layout. Farm paddocks were laser levelled about 10 years ago and this helped improve irrigation efficiency. Water is also recycled on farm. Run-off from irrigation flows into dams on the property and can then be pumped back up to the irrigation head to be used again when required. In addition, the farm has a number of rain water tanks and care is taken to use water efficiently. For example, water used to cool the milk in the milking shed is then used to wash out the milking yard after milking. The farmer has considered upgrading his irrigation technology to centre pivot or subsurface, but at current milk prices these options are not viable.
The operator considers water trading offers him greater flexibility as he prefers to grow his own feed over the alternative of buying in feed. He monitors trade prices in the temporary market on a weekly basis throughout the irrigation season. His assessment is that for his operation, when the water price moves higher than $300 a megalitre on the temporary market, buying in feed becomes the preferred option. Their experience in buying water on the temporary market has been positive with the process considered to be relatively quick and the administrative costs of around $60 per trade reasonable. However, because of the high price of water and feed during the drought, herd numbers have been reduced.

The operator concluded that while water trading has given him the flexibility to manage his farm through the drought, he is concerned about ‘water trading out of the area, further and further from reservoirs, which increases water losses along the way’. He added that ‘10 megalitres of water bought from the Goulburn Valley and taken to Mildura or South Australia requires more than 10 megalitres by the time it gets there because of evaporation, etc. along the way’.

Case study two — Goulburn Murray dairy

This family owned and operated farm business includes two properties with a total area of about 260 hectares. Around half of this area is currently setup for irrigation, with the dryland areas being less productive. The family runs about 360 head of dairy cattle and produced about 113,000 litres of milk in 2007-08. Prior to the drought, the operation used about 750 megalitres of water, whereas in 2007-08 only 400 megalitres was available, making it necessary to purchase additional feed. As a result of the continuing drought the farm has to buy in considerably more feed than it would have under normal climatic conditions, and as a consequence, the feed bill for the operation has risen substantially. They have invested in a mixer wagon (an on-farm feed mixing facility) and hay rings, to minimise feed wastage and cut long-term costs.

The operation has also now moved entirely into annual pasture, to reduce water use. The family does not intend to water perennial pasture in the summer at anytime in the foreseeable future, unless conditions improve substantially. They also used a $20,000 government grant to laser level paddocks, which has improved water use efficiency. The operators estimate that in 2007-08 they were able to produce approximately 280 litres of milk for each megalitre of water used.

At the start of 2006-07 the farm had debts of about $1 million. During the year, the operator’s bank convinced them to sell 250 megalitres of water entitlements. While it was not their preferred choice, the decision reduced their interest commitments and increased their equity position. As a consequence, they have been more active in the market for temporary water than they would have liked. The family both bought and sold water on the temporary market in 2007-08. They sold water early in the season for $700 a megalitre, buying back later in the season, following rains, for $200 a megalitre.

In making these decisions, the operator monitors temporary water prices on a weekly basis throughout the irrigation season. They have found transacting in the water market to be
a relatively simple and affordable process. The operators also anticipate they will have to continue buying water on the temporary market until they are in a position to buy back 250 megalitres of water shares on the permanent market.

Each of the two properties operated by the family has its own water share entitlement with the family trading water between these licences where necessary. With the drought continuing, the family is also considering exploring further options to make their business more water efficient, such as water recycling.

In making these adjustments, the operators felt the current water pricing structure, with its high fixed charge component, is too inflexible. They would prefer a more variable cost orientated pricing structure where irrigators pay per megalitre of water used. In that way ‘we can pay less during drought conditions when allocations are low,’ they concluded.

**Case study three — Goulburn Murray dairy**

This 116 hectare dairy farm has experienced considerable change induced by drought. Prior to the drought, between 160 and 170 dairy cows were on the property, but as a result of the continued drought that number has been reduced to between 120 and 130. Cows were also sent offsite for dry period management, but were returned in poor condition and the operators would be reluctant to do this again.

The operators have maintained some perennial pasture despite the drought, but this area is less than 10 per cent of the pre-drought area under perennial pasture. An additional adversity occurred in 2007-08 was when their groundwater source became dry. Normally this would provide about 100 megalitres a year of water to the farm. The property is irrigated via land-formed - border checked layout and run-off is recycled via farm dams for reuse. This practice was established in the 1970s on the property when paddocks were levelled to improve irrigation efficiency. The operators feel this early investment in improving water use efficiency on the property has better equipped them to manage this lengthy period of drought.

In 2007-08 the operators purchased 30 megalitres of irrigation water on the temporary market for around $300 a megalitre coming into autumn. The operators monitor prices in the temporary market on a weekly basis. The farm used about 230 megalitres of irrigation water last year. Under normal conditions, the property would use about 600 megalitres of water. The farm has also had to buy in feed to manage through the drought. In a normal year the feed bill for the property would be about $40 000. In 2007-08 the feed bill was $240 000. Operators believe the widespread drought, affecting the dryland operations from where much of the hay is being sourced from, has contributed to the increased feed bill faced. Currently the operators face a decision on whether to buy in more feed or to buy in water. The operators consider the costs and benefits of both options before making their decision but their preference, if prices were to remain around $300 a megalitre, is to buy in water to grow their feed requirements on-farm.

The operators have established a drought planning prioritisation strategy. Their first option is to prioritise watering on the property and to buy in water or feed where possible. If the
drought continues, and the price of water continues to rise, they will sell water and buy in fodder as a substitute. When this practice becomes cost prohibitive they will sell their cows and then machinery and then elect to leave farming and utilise their off farm assets to sustain themselves. They would like to be able to retain their water entitlement to trade on the temporary market in this scenario.

The operators have found buying water on the temporary market to be a simple process. They recognise it has allowed their farm to continue to operate through the drought. However, if the drought continues and the price of water remains high they may have to make some more drastic changes under the strategy previously outlined. In both 2006-07 and 2007-08 the farm made a -$200 000 loss and the owners have been drawing down on their savings to finance the business. The operators concluded that ‘dairy farming has been good to us in the past, and we only hope that we can adapt sufficiently to allow it to be good to us in the future’.

Case study four — Goulburn Murray horticulture

This horticulture farm operates approximately 20 hectares of trees, most of which are apples and pears with a small area of stone fruit. In 2006-07 the property produced about 740 tonnes of fruit. The oldest trees on the property are between 70 and 80 years of age. In a normal year the property would use between 140 and 150 megalitres of irrigation water but in 2007-08 only 96 megalitres was available. This included purchases on the temporary water market of about 50 megalitres over September, October and November at an average price of $800 a megalitre. The property converted to water efficient micro-jet sprinkler irrigation in 1997 and the operator feels this conversion has assisted to significantly maintain some level of profitability during the drought.

Early in the drought the operator had some less productive trees cut out. He then established these areas with Tatura trellis systems and has waited two years for weather conditions to improve. He is now replanting in 2008-09 despite drought conditions continuing as he feels he cannot afford to keep the ground idle any longer. The new Tatura trellis systems (of which the farm has about 7.5 hectares) can have a much higher planting density (up to 1000 trees per hectare) than the traditional system of single row planting across the rest of the farm. While the setup costs for the trellis system are higher, it is less labour intensive in the long run and safer to pick and prune. The older stands were planted to suit the furrow irrigation adopted at that time. The entire area is now under a pressurised irrigation setup. Among other management practices to remain water efficient during the drought, the operator has suspended watering a stand with poor rootstock. This area will now be planted to newer varieties with better market appeal.

As a result of the drought, the operator has reduced watering especially after flowering. He has also used moisture deficit irrigation on his trees and turned down the pressure on the irrigation system. Trees have been pruned harder than usual and thinned. While these practices utilised have reduced the quantity of fruit produced, the operator feels the improvements in fruit quality have been of greater benefit. This enabled him to target more fruit to the fresh market with better turnover instead of a fair proportion going to juicing under the previous practice with lower average returns.
Dealing with irrigation drought

While the operator has carried some water over from 2007-08, if allocations are again very low he will have no choice but to buy more water. While practices such as pressure regulation to reduce the wetting area, summer pruning and the spring mowing of grass along the interrow have made the property more water efficient, the operator currently faces the choice of buying water or letting trees become stressed and potentially dying if allocations are low. It is critical for fruit production on the property to have water available for the trees in September for cell division to occur. Water trade has allowed the farm to survive financially and keep trees going when they otherwise would have been lost.

Currently the operator plans to buy water again on the temporary market in 2008-09 but if the drought continues beyond this he may consider removing some older and less productive varieties. The operator feels it will not be sustainable for his farm to buy water at $800 a megalitre each year over the long run. Unfortunately, cutting back on water use on the property would also result in a loss of output and subsequent farm income.

In addition to the problems caused by the drought, the property has also experienced problems recruiting and retaining labour. Other input costs such as fuel and fertiliser have also risen, while export markets for fruit have experienced declining demand because of the high Australian dollar. As such, combined with the rising cost of water, the farm has experienced a significant fall in net returns on the property in recent years.

While this farm did not experience problems in trading in the water market, the operator did raise concerns about water moving away from farms into other developments such as managed investment schemes.

Case study five — Goulburn Murray vineyard

This commercial vineyard was established in 1997 and planted to a number of grape varieties including cabernet sauvignon, shiraz, chardonnay and merlot over about 45 hectares. The property is on a gentle slope with predominately with red soils in the upper slopes, and the bottom paddocks having mainly black soils. In 2006-07, the property produced about 190 tonnes of grapes in total with part of this going into the vineyard’s own labels and the remainder sold commercially to other wineries.

The vineyard has found the cabernet sauvignon copes the best with drought conditions while the shiraz and merlot varieties are less tolerant and need regular watering. Red varieties require about 4.5 megalitres per hectare while chardonnay needs between 5 megalitres and 5.5 megalitres per hectare. Ideally, the vineyard would have a flexible irrigation setup that allowed different levels of watering between varieties and between commercial and their own fruit. The vineyard also has three different soil types (red, red/black and black) which require different watering regimes. Currently their irrigation is setup with hydro command lines and uses a diesel pump. With different sized blocks, pump pressure must be changed to manage water flow which is not ideal. However, upgrading to a different command system, such as electric, is currently prohibitively expensive.

A more flexible irrigation system would allow the vineyard to adopt partial root zone drying over larger areas, which is a time and labour intensive practice under the current irrigation system.
Under drought management, the operator’s focus is to reduce the water stress on vines by manipulating the factors that influence the demand by the vine for water and the supply of water to meet that demand, particularly at critical growth periods. In response to the drought, the vineyard has moved predominantly to night watering to reduce evaporative losses. The operation has also been using more mulch under the vines to save water. Prior to the drought the vineyard was using about 120 megalitres of water a year. In the past couple of years the amount of water used on the property has been between 50 and 70 megalitres with watering levels cut across all parts of the vineyard.

The vineyard has been active in the temporary water market. The vineyard considers their allocation and the potential for rain before deciding how much water they need to buy for the season. After a volume has been decided, the vineyard then endeavours to acquire the water at the best possible price early in the irrigation season. The critical time for watering is between September and November so the vineyard has to make their decision on purchases by then. Because of the vineyard having its own branded wine, they place a high value on maintaining production for their own label.

Other options available to manage through water shortages are to reduce canopy size and shape, which will reduce transpiration demand, and to reduce the crop load which also reduces the demand for water for fruit assimilation. These practices, however, increase labour costs and will only become viable if returns can justify them. If water was not available for the vineyard to buy on the market they would have had to let some vines go dry. Consequent losses in production could have a severe detrimental effect on the brand value of the winery. If allocations are again low, the vineyard will have no choice but to buy in water. This practice becomes increasingly costly for the vineyard. The property manager has witnessed the price of water rise in the past five years from about $66 a megalitre to more than $1000 a megalitre. Over the same period, the price of grapes has fallen. This has made it difficult to manage the business profitably.
Case Studies in South Australia

Case study six — Riverland vineyard

This operator manages two separate properties in the Riverland region. Both properties are primarily used to grow wine grapes with some cattle also run to utilise dryland areas. The main varieties grown are chardonnay, cabernet sauvignon and shiraz for the commercial market. These have been raised on drought and salt tolerant rootstock to match conditions in the region.

The home property has about 60 hectares of vines and the second property has about 75 hectares under vines. The home property receives its water via an irrigation trust while the second property is irrigated from water pumped directly from the River Murray. Both properties are laid out for advanced irrigation with a system of soil monitoring probes and a drip irrigation setup. The setting allows the operator to remotely monitor conditions at his second property from his home base.

Both properties have been converted to drip irrigation from the previous overhead irrigation to minimise water losses from wind and evaporation. While the operator has always attempted to water at night to take advantage of cheaper electricity, the increasing cost of water has further increased the attractiveness of this option. At the second property the operator has his own private water delivery system with the flexibility to water when he likes. The home property is served through the Central Irrigation Trust where he coordinates with member irrigators on a roster system. While it is not always possible to water at his chosen times, the operator believes ‘it is an excellent system where most people comply’.

Conversion to drip irrigation at the distant property had additional costs as river water needs treatment and filtering to make it suitable for drips. However, savings through improved water use efficiency and lower labour costs have offset the initial cost disadvantage.

This operation was able to remain in production because it was able to buy water during this period of low allocations. The operation is designed to use about 400 megalitres of water per year across the two properties with the remaining unused water flowing down river for environmental use. However, in 2007-08 only about 250 megalitres was used and some water was carried over to this year to provide additional security to supply. About 50 per cent of water used in 2007-08 was purchased from New South Wales on the temporary water market.

The operator has found buying water through a broker to be a relatively simple process. The paperwork for the trade can be completed fairly quickly and faxed through to the broker. However, it takes on average six weeks for interstate trades to be processed and the water made available to the purchaser. Because of this long waiting time, the operator must be able to forecast his water needs at least six weeks in advance. In addition, the six week wait places an additional level of uncertainty upon the irrigator as it may rain or allocations may be increased during this time. This imposes a price risk on the operator and has the affect of reducing the offer price for water and its value to the irrigator.
However, considering all things, the operator prefers to secure his water early in the season, if the price is right, so he ‘can go to bed knowing that you have the water secured’.

The operator feels trade would be more beneficial for him if he could ‘access the water once the bid is taken, while the paperwork is still moving through the system’. He considered that with the current situation, vine growers face considerable planning pressures to ensure adequate water during the critical times of vine growth, flowering and fruit development (September through November). As such, it is prudent to purchase water early in the irrigation season to ensure adequate water for the crop when it is needed.

When making the purchasing decision, the first step for the operator is to monitor the selling price of water and then estimate what return he may be able to earn by using that water. In 2007-08 this process was made easier as the wineries announced the prices they would pay for grapes in advance. The operator feels this is unlikely to be the case in 2008-09 and so he will have to make his own estimate early in the season of the likely price he will receive at the time of harvest.

Having access to irrigation water is essential for the operator to continue to grow wine grapes. The operator has used the temporary market to buy water to keep his vines in production but does not feel this is a viable practice if water prices were to rise further. In addition, the uncertainties in relation to water allocations make planning difficult and add to management and planning costs, while they also face other cost-price pressures.

The operator has also noticed changes in the river environment which he attributes to reduced flows, including the deteriorating health of native flora surrounding the river and the continued slowing of river flows.

Commenting on the general region, the operator remarked that during the drought ‘early movers’ who planned to buy water earlier in the season were rewarded with reasonable crops and returns. Banks supported the growers through this exercise. However, those who ‘procrastinated’ and waited for the water price to fall, which happened only in late January, did not do well. ‘The vines were already stressed and did not get a good return.’ In his experience those vines will be impacted this year too because of poor growth in the previous year.

Case study seven — Riverland horticulture

The operator has run this 17 hectare horticulture farm for about 20 years. About 7 hectares of the property are under wine grapes, the rest is planted to a mix of horticulture including oranges, mandarins and avocados. The property is currently on the market and the operator bought water in 2006-07 and 2007-08 to maintain the property in a saleable condition. Water purchases from interstate irrigators have taken between a fortnight and two months to be processed.

The operator has a 150 megalitre water entitlement for the property and draws water directly from the Murray River. Prior to the drought, the operator used between 90 and 100 megalitres of his entitlement and let the remaining one-third flow down the Murray. In 2007-08 South
Australian irrigators received only 32 per cent allocation, only the second time in his memory when water allocations were cut; the first being 2006-07.

This property has been using about 90 megalitres to maintain production and keep trees in a healthy condition. As such the operator had to purchase water on the temporary market early in the season to secure water. The operator spent about $50 000 buying 70 megalitres of water over the 2007-08 irrigation season. These purchases were financed by drawing down on the operator’s retirement savings. While there are currently no debts on the property, the operator does not see the practice of purchasing large volumes of water on the temporary market for the property as sustainable over the longer term.

The operator has increased farm water use efficiency by changing from overhead to drip irrigation on grape vines. Reduced throw sprinklers are used for citrus trees to minimise water loss. These upgrades have been made progressively over the past three to four years. The operator has also pruned and hedged his trees more severely in the past few years to reduce water demand. The property also uses moisture monitoring probes to maximise irrigation efficiency. These efficiency improvements, in conjunction with buying water, have allowed the operator to keep his trees alive and productive during the water shortage.

A major problem for the operator has been the continuing sharp increase in input costs while increases in the price of farm outputs have not kept pace. The property used to provide some income to the operator to supplement his off-farm income. In the past couple of years the farm has been unprofitable and the operator has had to put money into the farm to buy inputs. The farm has also recently experienced some problems with river salinity. While the property can tolerate some fluctuations in salinity, if the salinity persists, the operator considers this will have severe productivity impacts.

Making decisions under these uncertain conditions was also an issue for this operator. Last year the operator was fortunate to have forward price commitments from wineries which allowed the growers to work out how much they were prepared to pay for water. Without such information this year, planning would be more difficult.

Case study eight — Riverland horticulture

This 40 hectare property has about 35.5 hectares of almonds and the remaining area is used for wine grapes. The operator has made a large investment on commercial almond plantings incorporating the latest technology. Being a salt sensitive crop, the irrigation layout and field automation is geared to ensure optimal achievable productivity within the water quality and availability constraints facing the operator.

The intensive irrigation system, along with detailed soil and leaf monitoring, provides for precision application of water and nutrients to meet crop demand. Technology adopted includes soil moisture monitors, soil salinity probes, kernel measurement and crop removal analysis, where the nutrients removed in the harvest are assessed to determine replacement needs. Monitoring salinity and managing the wetting profile are particularly important when irrigating below recommendations, because roots could grow out in search of additional
moisture and may draw on salty areas of the property. Careful records on input and outputs are kept for the property to support this precision farming.

In 2007-08, when water application was limited to 60 per cent of the recommended level for almonds, a reduction in almond yield of between 10 and 15 per cent for the year was recorded, giving an average of about 32 tonnes per hectare. The 60 per cent rule was observed following a trial at a smaller almond plantation on a different soil type.

For almonds, the drips which deliver irrigation are linked to a pulse irrigation system which is operated for only one hour at a time, followed by a one hour break to avoid water logging and to promote efficient water absorption. During fertigation, when fertilisers are applied through the irrigation system, two hours break is allowed before irrigating to flush out excess fertilisers.

The plantation is young with about half of the 10,000 trees at a bearing age. As the plantation matures, more water would be needed. In the first year trees need about 1 megalitre of water per hectare per year, which increases to 2 to 3 megalitres by the second year. Mature, bearing trees need at least 10 megalitres. The optimal watering is 16 megalitres per hectare per year.

About half the property draws water from an irrigation trust. In the trust, all irrigators receive the same per hectare allocation regardless of the crop grown. The other half of the property is connected to a private irrigation supply. The operator has a 420 megalitre allocation and would like to have access to about 80 per cent of this. In 2007-08, about 260 megalitres of water was bought on the temporary water market to meet the shortfall at a cost of about $250,000. This was a significant investment for the operator and kept the young trees alive and the mature stands in production. With only a 32 per cent allocation in 2007-08, the operator would have had to let less productive stands die if he had not been able to purchase additional water on the market.

The operator monitors water trades online throughout the season, and only commits to purchase water after considering costs and potential returns from water use activities in the current season, as well as the longer term benefits of maintaining the permanent plantings. The online trading is fairly simple and the operator can see where the water is coming from, enabling him to schedule purchasing decisions knowing purchases from interstate could take 30 to 60 days to process. The operator has considered purchasing water entitlements on a permanent basis. However, regulations prohibit an irrigator from holding water entitlements exceeding 10 per cent of crop needs. In addition, he would still face the problem of uncertain allocations. In contrast, with temporary water trades the operator is assured of exactly how much water he will receive. The operator also uses information on water storage levels and rainfall forecasts on the internet to anticipate if South Australian allocations may be increased.

This property has large capital investments and the water purchases have offered flexibility to protect these investments. However, at current almond prices and with a high exchange rate, it is not sustainable for the operator to spend $250,000 a year on temporary water. With other input costs such as fuel, fertiliser and labour also increasing, the operator has found it increasingly difficult to manage his business profitably. Last year he had to sell some of his property to cover costs. While the operation is currently going through a period of uncertainty,
the operator is confident that with river management improving conditions for irrigators will also improve.

The operator believes labour costs and water availability will dictate future land uses, and as the irrigation industry adjusts to a low water availability scenario over the medium to long term, availability of temporary water could come down.

Case study nine — Mid-Murray horticulture
This 400 hectare family run property on the Murray River has supported farming over six generations. The property used to be dryland, until receiving a water allocation in the 1960s. Access to irrigation enabled intensive cropping on the property and increased productivity, such that the majority of income is now from growing irrigated onions. The operator is part of a cooperative which runs a nearby onion packing operation, which employs between 35 and 40 staff.

Water shortages associated with the ongoing drought forced the operator to purchase water on the temporary market in 2006-07 to support onion production. However, his experience was negative as he had to wait nine weeks for the trade to be processed, at which time he was told the water could not be made available. Subsequently he had to purchase water at a higher price and the delay caused the operator to miss the optimal watering window for onions, resulting in production losses and quality downgrading. He does not intend to purchase water on the temporary market again.

In response to the uncertainty surrounding water allocations for South Australian Murray irrigators, the operator has resorted to an alternative resource access arrangement which safeguards the supply contracts and packing operation while also giving the operator the flexibility to utilise the precision planting equipment dedicated for onion production. This arrangement involves relocating onion production onto leased properties with access to groundwater in the south-east of South Australia.

Onions grown on these properties are transported to the central packing facility for processing. After accounting for all expenses such as rental, fuel and transport costs the operator estimates it is a cheaper option for him to rent land with an assured water supply than to buy water to grow onions on his home property. This allows the operator to scale down production on the home property to match water availability. For instance, in 2008-09 he is planning to grow only 12 to 16 hectares of onions on the home property with the balance is being used to raise a cereal crop to ‘keep the soil clean’ (of pests and weed infestations). In addition, given the low level of the River Murray, the operator has invested in submersible pumps to draw water for the property.

However, this arrangement is only a temporary solution for the operator. The onion packing operation which was originally established at a central location to take advantage of surrounding onion farms, is relatively distant from where most of the onions are currently sourced. The operator’s family is also forced to commute between their home property and
the grow-out farms on a regular basis, to supervise the planting, maintenance and harvesting of onions. This adds to transport costs and places an additional burden on the operator and his family.

While relocating onion production has helped the operator keep his business afloat, the additional costs associated with the renting land mean there is little income left after expenses to service loans on the operator’s property. Consequently, farm equity has suffered over the past couple of years. Ideally, the operator would prefer to grow onions on his home property given its good soil and location, but the uncertainties regarding River Murray water allocations means this may not be sustainable in the medium to long run.

Case study 10 — Lower Lakes dairy

The operator has run this 1600 hectare property since the early 1980s. The property has dairy and beef cattle and 240 hectares of land setup for centre pivot irrigation. Over the past few years, changes in water quality and reduced water availability have affected operations at the property. In response to the changing conditions, the operator has been forced to scale back operations over the same period. Prior to the 2005-06 irrigation year, when allocations were at 100 per cent, the property ran 700 head of dairy cattle and the operator had plans to increase herd numbers to 1000. However in 2005-06, the property received only an 80 per cent allocation and the operator reduced herd numbers by 100 and purchased $25 000 of temporary water.

The operator has installed moisture probes on his property and by the end of the 2005-06 irrigation season these probes had begun to show high saline readings, and the declining water quality affected production on the property. In 2007-08 the operation received a 30 per cent allocation, with the salinity levels reaching 38 000 EC units. This made water unsuitable for a continued dairy operation. With the closure of the dairy, the property now maintains a small herd of 150 dairy cattle to preserve dairy genetics and relies on its herd of about 850 beef cattle to provide an interim income. The operator has access to a small amount of groundwater with which to support the current activities.

In 2007-08 the operator sold his allocation on the temporary water market to two upstream users for about $950 a megalitre. This allowed the operator to generate some income from the water he would not have been able to use because of the high salt content at this point of access. The operator intends doing the same in 2008-09. These trades are handled through a water broker for a small fee and involve a simple process. However, without access to suitable quality water, the operator is prevented from gaining a reasonable level of return on his significant capital investments, including a dairy, feed storage, farm layouts and an extensive irrigation infrastructure with centre pivot irrigators. Under the current situation many of his farm assets, including the farm dairy and more than $2 million in irrigation infrastructure, are sitting idle.

The operator notes that this property has been regarded an industry leader in terms of dairy innovation, herd management and quality assurance, and has earned industry praise over the years. Following the deterioration of water quality the dairy has been forced to cease
operating, leaving the property owner no opportunity to capture the full benefits from his innovation and development expenditure in the farm business. The operator considers that while availability of water trading has provided a mechanism to reduce his ongoing losses, the returns available from water trading are insignificant compared with the loss of returns from the dairy.
Recent drought-induced water shortages have forced many irrigators to seek new ways to reduce their dependence on water. Economic theory suggests that, other things being equal, a reduction in the supply of surface water will lead to an increase in the price of surface water which will in turn create an incentive for farmers to increase their reliance on groundwater (where available), to adopt water-conserving measures, to reduce water application rates, to move away from water-intensive crops, or to leave land as fallow (Caswell and Zilberman 1985; Mallawaarachchi et al. 1992). The intensity of these responses is likely to increase with the severity of the water shortage and vary with the production systems in place. The observed behaviour in the analysis of water trades and farmer interviews is consistent with these predictions.

Adaptation strategies

Key management strategies identified and adopted by irrigators to deal with insufficient irrigation water availability included:

Increasing water productivity by making more efficient use of available water supplies:

• reducing the total area irrigated
• reducing water application rates
• irrigation scheduling
• substituting towards crops which use less water
• using cover crops
• substituting other inputs for water

Increasing water availability by accessing alternative sources of supply:

• water trading
• increased ground water pumping
• water recycling
Increasing water productivity

Some irrigators responded to water shortages by reducing the total area irrigated which allowed some land to revert to dryland production. This allowed these irrigators to maintain application rates and attain normal yields on a smaller area of land. In the case of dairy, some areas reverted to dryland pasture where, with rain, these pastures still produced some feed.

Almost all irrigators reduced the amount of water applied per hectare and attempted to make the best use of any rainfall which occurred. Coupled with other measures to maximise soil moisture retention, yield reductions have been minimised. For example, the adoption of water saving irrigation technologies and application methods, such as pressure regulation and partial root zone drying, have made water savings possible while limiting any adverse impacts on production.

Moreover, applying only enough water to meet evapotranspiration losses during normal growth and managing crop needs at critical stages have enabled more efficient use of available water, with minimal impacts on production, particularly for permanent horticulture. Some crops, such as grapes, pome fruits and almonds have critical water requirements during flowering, fruit setting and fruit development stages. During the vegetative growth phase which follows fruit development, some moisture stress can be tolerated and when coupled with appropriately managed cover crops, mulches and summer pruning, the best use of the available soil moisture can be achieved.

A number of operators also reported they now schedule irrigation to avoid water losses associated with evaporation and wind drift. Often this means watering trees and vines at night, which had the additional advantage of using low cost, off-peak electricity. Operators also noted the importance of performing frequent maintenance on their irrigation system to minimise water wastage. Also reported by some dairy operators was the effort to significantly reduce the area of perennial pasture, or to move away from perennial pasture altogether, substantially reducing water use per hectare.

As water availability declines some irrigators have adapted to capture moisture through opportunistic cropping activities. More irrigators are now using cover crops planted in the inter-row space in vineyards and orchards, to conserve residual soil moisture. These cover crops are cut during summer to be used as mulch or sprayed over and left alone as ground cover. These cover crops intercept rainfall and irrigation water, enhancing infiltration and reducing soil evaporation.

It should be noted that some of the measures adopted by irrigators may lead to reduced on-farm feed production. The drought has effectively increased the cost of an important input into dairy production – on-farm pasture production. Case study farmers reported they had increased their use of substitute inputs, including buying in feed. All surveyed operators stated they bought additional water to grow their own feed, but that this option becomes unattractive at water prices more than about $300 a megalitre, with farmers then substituting towards purchased feed. Higher production costs have in turn led to a contraction in dairy output, with all dairy operators surveyed reporting reducing herd numbers as a key response to low water allocations. This response is a relatively simple way for dairy farmers to reduce their overall need for water and feed while increasing farm liquidity.
Increasing water availability
Both the analysis of the water market and farmer interviews confirm a large proportion of irrigators have augmented their low water allocations through purchases on the temporary water market. Apart from water trading, irrigators have also increased ground water pumping where available. On-farm water recycling is also becoming more widely adopted as irrigators attempt to extract the maximum benefit from each unit of water they receive. All operators reported irrigation run-off from their properties was negligible and they were attempting to be as frugal as possible with their water use.

How much did trade help?
All operators surveyed reported the impact of reduced water availability would have been more severe if they had not had the ability to purchase additional water on the market. Being able to purchase water gave operators more flexibility to maintain their operation, while providing an interim income for other operators who chose to cut back their operations and sell their water.

For permanent horticultural farmers, the ability to purchase water on the market allowed flexibility to protect their capital investments during the drought. Without access to additional water, farmers would have had to let some trees and vines go without water. This would stress the trees and potentially result in their death, depending on the level of drought tolerance and the length of time exposed to water stress.

In addition, the ability to purchase water significantly reduced the extent of production losses incurred by horticulture farmers. Such losses could have had a detrimental impact on the farm business, potentially resulting in unfulfilled or partially filled supply contracts and the erosion of any business goodwill, such as for case studies four and five. By buying water in, irrigators were able to maintain production at a higher level than would otherwise have been possible. Water trading therefore offered a mechanism to manage current productivity impacts, while also reducing longer term risks to production.

Another important aspect of water trade for surveyed irrigators was the certainty it provided in planning their business activities involving long-lived assets. In years when allocations are low, irrigators can purchase additional water on the market. This provides a higher level of future water supply certainty to irrigators when making planning decisions. This was supported by the operator in case study six who noted that after purchasing temporary water he could ‘go to bed knowing that you have the water secured’.

For dairy farmers surveyed in this study, the ability to buy and sell water on the temporary market gave them additional flexibility when determining how to meet the feed requirements of their herd. Many of these farmers reported monitoring water prices throughout the irrigation season. By doing so they were able to work out whether they were better off buying in additional feed or purchasing water for on-farm pastures to meet their feed requirements. All interviewed dairy operators expressed a preference for growing their own feed, with the water market providing them with the option to buy in additional water to assist in growing their own feed. However, when the price of water increased to more than about $300 a megalitre,
purchasing feed became the preferred option. Trade had also been utilised by one surveyed dairy farmer (case study 10) to derive an interim income from his water allocation where water salinity made it unusable on his property. The option to sell water upstream where salinity was less of an issue provided this farmer with an opportunity to recoup some losses.

Overall, most operators reported their experiences with water trading had generally been positive. Irrigators surveyed in Victoria reported trades were generally processed within a week and transaction costs were low. While most irrigators surveyed in South Australia also had a positive experience with trade, there were some concerns over lengthy processing times for interstate trades. Carryover was also an important mechanism which irrigators used to manage their water supply constraints over time.

It should be noted that one irrigator had a particularly poor experience with water trading. The operator in case study nine entered the water market in 2006-07 to purchase additional water for his onion crop. He waited about nine weeks for this interstate water trade to be processed before receiving notice it was rejected. Subsequent to this he had to re-enter the market, but by then the price had risen and he had missed the optimal watering time for his crop. This negative experience with trade, coupled with the uncertainty of future South Australian Murray allocations, led the operator to lease properties with secure groundwater entitlements to continue his operation.

Are current water purchasing strategies sustainable?

Some irrigators, such as the irrigator in case study seven, do not see their current water purchasing strategies as sustainable at 2007-08 water prices. Escalating water costs incurred in attempting to keep properties in production have depleted financial reserves and increased debt for many irrigators, those irrigators interviewed in this study considering these responses as short-term measures only.

In addition, all irrigators surveyed reported they are currently irrigating at a level substantially below what is recommended for their chosen farming activity. As such, they are not meeting the drainage requirement necessary to limit salinity impacts. If this practice continues it is likely to generate salinity management problems which will have a negative impact on the future productive capacity of these farms.

Policy implications

Water trade has provided irrigators with a voluntary mechanism to achieve a greater return from limited water supplies in the connected Murray-Murrumbidgee system during the drought. The dominance of temporary trades and the trading patterns within the irrigation season also suggests these trades are primarily supporting within season water management decisions rather than a permanent response to reduced water availability. The case study analyses also support this position.
Temporary trade in seasonal water allocations is generally less restricted than permanent trade in entitlements. While restrictions on temporary trade in the southern Basin have been reduced in recent years, some impediments remain. For example, there can be significant delays in getting temporary transfers processed, with transfers in the Victorian part of the Basin often taking more than a month (table 6). Some irrigators surveyed in this study noted these delays created substantial uncertainty and tended to deter otherwise beneficial trades.

Access to carryover provisions is providing irrigators with additional flexibility in managing their supply of water between seasons, particularly in conjunction with water trading. Management of irrigation water entitlements over time involves a consumption–storage decision, where the benefits of consuming water today are to be evaluated against the uncertain benefits of storing water in dams for future use. Traditionally, state governments have centrally managed water storages, making decisions on the volume of water held in storage and expected future inflows. This centralised decision-making process does not take into account that many irrigators may have a different attitude to risk than that assumed by the government on irrigators’ behalf. While some jurisdictions have eased restrictions on water use over time, by introducing carryover and other reforms, there are significant restrictions remaining. Furthermore, recent history has highlighted the potential for sovereign risk to restrict irrigators’ access to water when carryover provisions have not been honoured (Goesch et al. 2008).

There is the potential to further reduce irrigators’ drought risk by providing them with greater control over the management of their water allocations over time. Further work on the feasibility and effectiveness of capacity sharing strategies being trialled in the northern catchments for application in the Southern Murray-Darling connected system may prove useful in this regard. Under a capacity sharing system, rather than allocating users a share of the pool of water available for consumption in the current period, each user is allocated a share of the total storage capacity, as well as a share of the inflows and losses from the storage. It should be noted a carryover facility is significantly different from capacity sharing, since carryover provisions do not define explicit property rights to storage capacity (Goesch et al. 2008). Other voluntary risk management approaches such as option markets could also prove useful in mitigating interseasonal supply uncertainties in the water market (Howitt and Hanson 2005; Heaney and Hafi 2005).

6 Average temporary transfer processing time in the southern Basin

<table>
<thead>
<tr>
<th></th>
<th>current days</th>
<th>2006-07 days</th>
<th>2005-06 days</th>
</tr>
</thead>
<tbody>
<tr>
<td>Murrumbidgee Irrigation</td>
<td>1.7</td>
<td>1.9</td>
<td>1.6</td>
</tr>
<tr>
<td>Murray Irrigation Limited</td>
<td>8.0</td>
<td>2.5</td>
<td>5.4</td>
</tr>
<tr>
<td>First Mildura Irrigation Trust</td>
<td>31.8</td>
<td>4.2</td>
<td>2.0</td>
</tr>
<tr>
<td>NSW State Water – Murray</td>
<td>38.2</td>
<td>72.2</td>
<td>8.7</td>
</tr>
<tr>
<td>NSW State Water – Murrumbidgee</td>
<td>38.4</td>
<td>18.0</td>
<td>7.4</td>
</tr>
<tr>
<td>Lower Murray Water</td>
<td>39.2</td>
<td>5.8</td>
<td>3.3</td>
</tr>
<tr>
<td>Goulburn Murray Water</td>
<td>41.1</td>
<td>6.1</td>
<td>2.7</td>
</tr>
</tbody>
</table>

* Estimates based on intra and interregional transfers through Waterexchange.
Recent reduced water availability in the Murray-Darling Basin has had a significant impact on both irrigated and dryland farming enterprises. Water availability for irrigation has fallen substantially, with the limited allocations being increasingly reallocated through water markets. The way in which some irrigators have responded to recent reduced water availability in the Basin in 2007-08 is illustrated in this paper. In particular, it was found that:

- water prices and water scarcity affect water management strategies, and
- there are gains from trade, for both buyers and sellers.

As the drought became more severe, farmers increasingly used their knowledge and experience to increase water productivity by making more efficient use of available water supplies.

The water trading system in the Basin enabled many irrigators to survive consecutive years of drought with varying levels of impact. The benefits of water trade into South Australia estimated in this study indicate South Australian irrigators gained around $31 million in 2007-08. In the absence of trade these irrigators, who are mainly horticulture farmers, would have been severely impacted. While water trading did mitigate the severity of the impacts of the in 2007-08, some irrigators indicated purchasing water at 2007-08 prices would not be sustainable in the long run. A more detailed study would be needed to quantify the impacts over different industries, regions and production systems. For example, it may be useful to extend the analyses to cover other irrigated industries, such as rice and cotton.

The observations in this paper confirm previous research regarding the direction of change in water use and trade in the event of an increase in water scarcity and price. However, it should be noted that while trade was a significant management strategy during the drought, delays in processing trades have the potential to limit the benefits of trade. As well as removing impediments to trade, there may also be gains from providing irrigators with greater flexibility to manage water allocations across seasons so they can better manage drought risk. This could extend beyond reliable carryover rights for irrigators to provide capacity sharing of dam storages by individual irrigators.
References


RESEARCH FUNDING

ABARE relies on financial support from external organisations to complete its research program. As at the date of this publication, the following organisations had provided financial support for ABARE’s research program in 2007-08 and in 2008-09. We gratefully acknowledge this assistance.

AusAid
Australian Fisheries Management Authority
Australian Government Department of Climate Change
Australian Government Department of the Environment, Water, Heritage and the Arts
Australian Government Department of Resources, Energy and Tourism
CRC Plant Biosecurity
CSIRO (Commonwealth Scientific and Industrial Research Organisation)
Dairy Australia
Department of Primary Industries, Victoria
DN Harris and Associates
European commission
Fisheries Research and Development Corporation
Fisheries Resources Research Fund
Forest and Wood Products Australia
Grains Research and Development Corporation
Grape and Wine Research and Development Corporation
Horticulture Australia
International Food Policy Research Institute
Land and Water Australia
Meat and Livestock Australia
National Australia Bank
OECD
Rural Industries Research and Development Corporation
The Treasury