

Responding to scarcity: Lessons from Australian water markets in supporting agricultural productivity during drought

Will Fargher, General Manager, Water Markets and Efficiency Group, National Water Commission

Introduction

Water trading has been progressively introduced in Australia since the late 1980s. The introduction and subsequent expansion of water markets was based on the premise that trading provides economic benefits to buyers and sellers, and to society as a whole, by reallocating scarce water resources to higher valued uses.

From the mid 1990s, water markets have expanded considerably and market activity has grown exponentially, particularly in the southern Murray-Darling Basin (MDB). Through this period, water trading became entrenched as a key instrument in managing water scarcity, particularly in dealing with the severe and prolonged reduction in water availability through the millennium drought.

Water markets now allow water users, rather than governments, to make complex decisions about who should use water, where, and for what. Markets allow water to be reallocated between uses, and give water users the flexibility to respond to changes in their operating environment, including seasonal conditions and water availability; and water market prices are providing a signal for users to consider the opportunity cost of their water-use decisions and make decisions in their own best interests.

This paper examines the extent to which these benefits have been realised, focusing on the allocative and dynamic efficiency benefits observed in the southern MDB. This paper demonstrates that water trading has proved to be a major success in supporting agricultural productivity. While the focus of the paper is on the agricultural sector, benefits to regional and urban communities and the environment are mentioned. This paper also summarises lessons learnt from the Australian experience which could be instructive for other countries facing the challenge of water scarcity.

Background

The 1980s and 1990s saw the first tentative, but far-reaching, reforms to water access and rights to enable water trading. However, there were reservations about the treatment of water as an economic good, leading to a very closely controlled and incremental approach to introducing water trading. In many areas 'temporary' seasonal allocation trading was allowed before 'permanent' entitlements could be bought and sold. Trading was also initially confined to geographically-defined areas, such as within public irrigation districts.

The adoption of nationally-agreed water reforms, most importantly the 2004 intergovernmental agreement on a National Water Initiative (NWI), facilitated the expansion of water markets across connected valleys and eventually state borders in the MDB.

Box 1: Water market reforms under the National Water Initiative

The NWI provides a consistent framework and set of definitions for the implementation of best practice cap-and-trade systems of water management across Australia. Specifically, the states agreed that their water market and trading arrangements would:

- define water access entitlements as ‘a perpetual or ongoing entitlement to exclusive access to a share of water from a specified consumptive pool as defined in a relevant water plan’;
- facilitate the operation of efficient water markets and opportunities for trading, within and between states and territories, where water systems are physically shared or hydrologic connections and water supply considerations permit water trading;
- minimise transaction costs of water trades, including through good information flows in the market and compatible entitlement, registry, regulatory and other arrangements across jurisdictions;
- enable the appropriate mix of water products to develop, based on access entitlements that can be traded either in whole or in part, and either temporarily or permanently, or through lease arrangements or other trading options that may evolve over time;
- recognise and protect the needs of the environment; and
- provide appropriate protection of third-party interests.

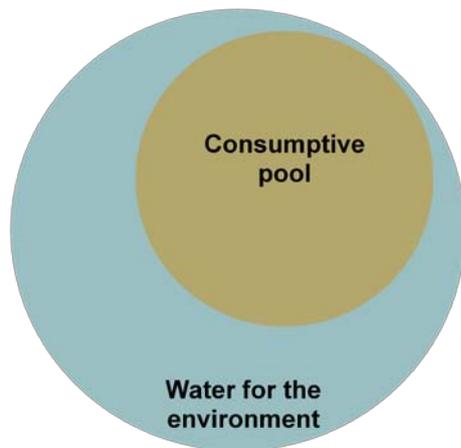
The basic idea and objectives of water markets

As illustrated in Figure 1, water markets stem from the basic idea of a ‘cap and trade’ system in which:

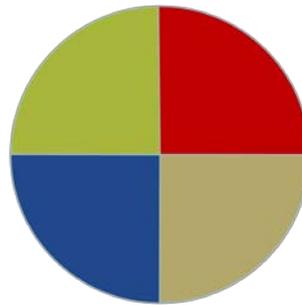
- the cap represents the total pool of water available for consumption, consistent with sustainable levels of extraction;
- bulk and individual water users are provided with entitlements to a share of the total consumptive pool;
- water entitlements are tradeable, so that ownership can change over time; and
- the price is determined in the market by the value placed on water by many buyers and sellers.

Figure 1: The 'cap and trade' approach to establishing water markets

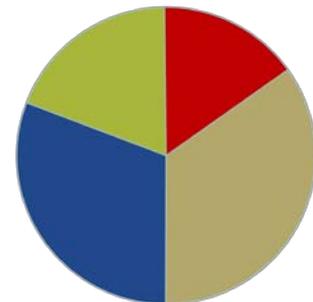
1) Limit total extractions from water resource



2) Limit/specify extractions for each user



3) Trade allows individual water use to be reallocated



The objective of the cap and trade water market approach is to facilitate the economically-efficient allocation of water while ensuring environmental sustainability.

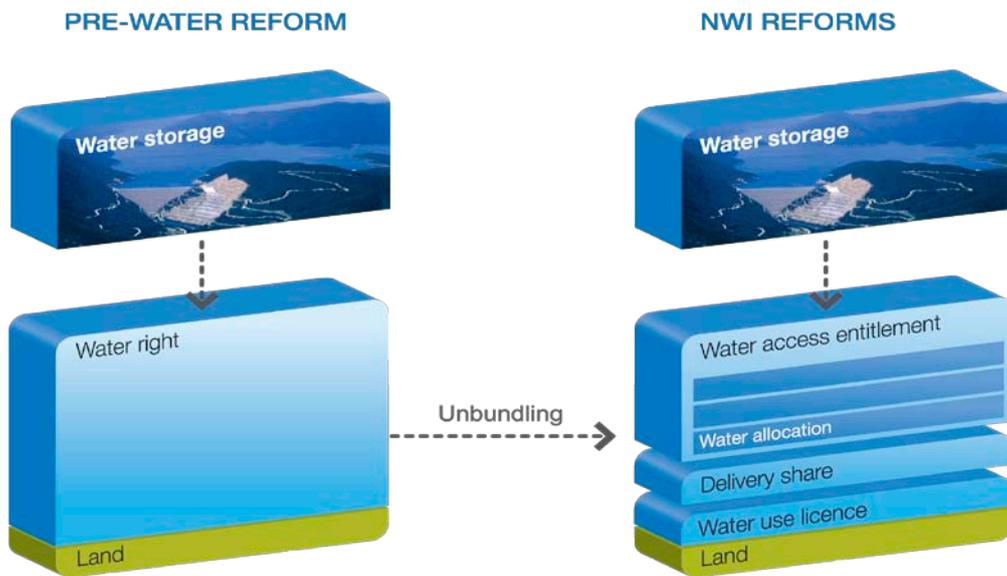
The nature of unbundled water entitlements and water trading

An important element of the NWI related to the 'unbundling' of water rights from land. When property rights for water were tied to land, farmers had to buy or sell water and land together. The separation or unbundling of water rights from land allowed farmers the option of buying and selling water entitlements independent of land, increasing their options for change.

The general approach now adopted in Australia is that water rights are specified as a perpetual entitlement to a share of water from a specified consumptive pool. The specific volume of water allocated to a water entitlement in a given year, or water allocation, can then change from year to year depending on annual seasonal availability¹. In addition, a non-tradeable and site-specific water use licence usually defines the terms and conditions under which water can be used. This unbundled entitlement system is illustrated in Figure 2.

¹ For example, a water right (or water access entitlement) of 10 megalitres (ML) is not guaranteed to provide 10ML each year. The 10ML will only be available when there is an allocation of 100 per cent. For example, when resource availability is 80 per cent, the entitlement would only yield 8ML that year, and so on.

Figure 2: Simplified example of an unbundled entitlement system



As shown in Figure 3, both water entitlements (the perpetual or ongoing entitlement to access a share of water from a specified consumptive pool) and water allocations (the specific volume of water allocated to water entitlements in a given season) can be traded in Australian water markets under this system.

Figure 3: Simplified example of trading in an unbundled entitlement system



Source: NWC 2011a

Once water becomes scarce and aggregate caps are in place, water markets represent an individually-based approach to allocating water rights. Subject to rules and regulations, water users can either choose to: use the water allocated to their entitlements; buy additional water allocations; sell part or all of their allocation; buy or sell entitlements; and/or lease entitlements. The alternatives to water markets are that governments determine how water should be assigned to competing users under varying conditions or that users cooperate to make these decisions.

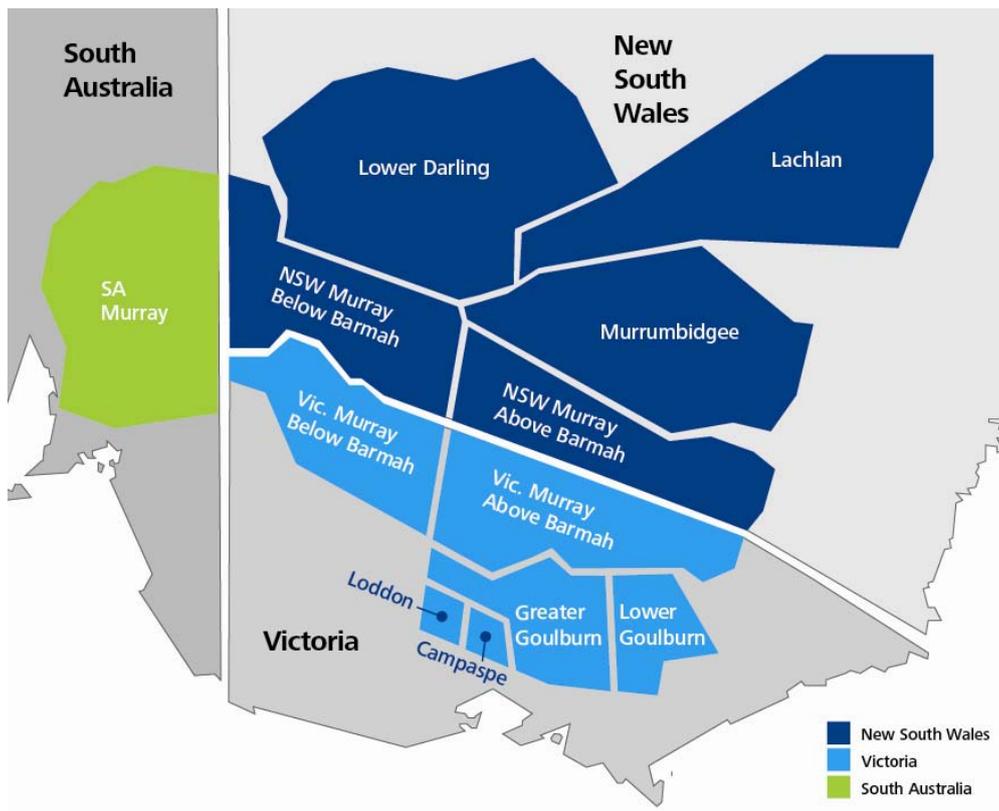
The scope of water trading

Across Australia, there are water markets in different water systems and different segments within these markets, which have developed at varying speeds and to different degrees. Market activity is mostly concentrated in the MDB – Australia’s largest irrigated agriculture area – and comprising of the:

- Southern connected MDB, which is operated as a connected resource comprising distinct water trading zones including the Murray (in South Australia, Victoria and New South Wales), Murrumbidgee, Goulburn, Campaspe, Loddon, and Lower Darling river catchments, (see Figure 4); and
- Northern MDB, including the upper Darling, Macquarie-Bogan, Castlereagh, Namoi, Border Rivers, Moonie, Condamine-Balonne, Paroo and Warrego river catchments, characterised by unregulated rivers or rivers controlled by single storages.

Water trading has expanded rapidly in the southern MDB over the past decade of drought and trading in both water entitlements and allocations is now possible over large distances and both intrastate and interstate (see Figure 4).

Figure 4: Trading zones in the southern MDB²



Source: National Water Commission 2011a.

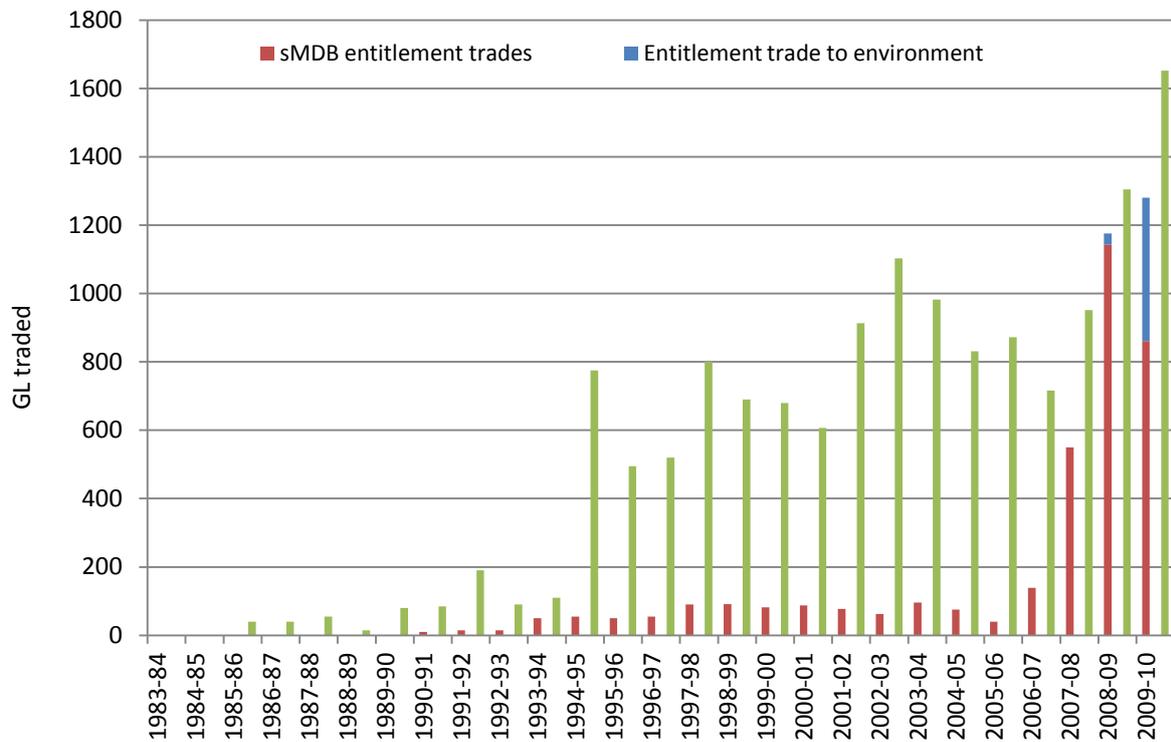
The growth of water markets in the southern MDB is at least partially a result of the underlying characteristics of the water resources and industry mix. In particular, the large interconnected water systems, extremely variable inflows, and diverse mix of agricultural industries (with different water demands) make it conducive to water trading (see NWC 2010b).

² While considered part of the southern MDB, the Lachlan catchment is not sufficiently hydrologically connected to enable trading with other trading zones in the southern MDB.

An overview of water trading activity

The volume of water entitlement and allocation trade has grown significantly since its introduction (see Figure 5). A large increase in market activity was registered in 1994-95, the first year that there was a significant drop in seasonal water availability since the introduction of water trading.

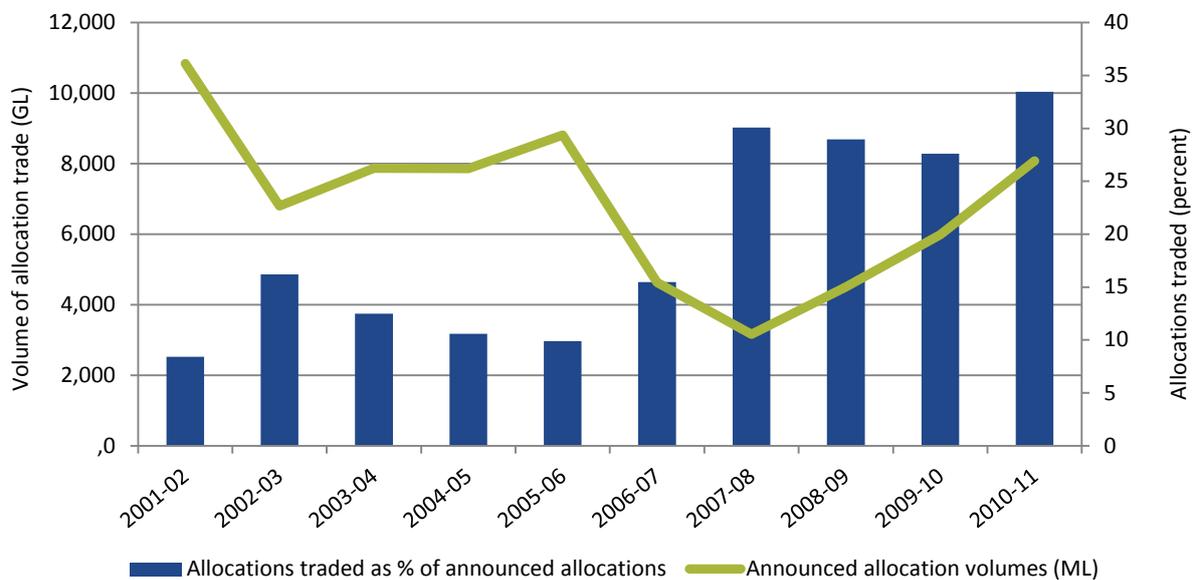
Figure 5: Volume of allocations and entitlement trade in the southern MDB (1983-84 to 2009-10)



Source: National Water Commission 2011a

Another major increase in water trade occurred in 2002-03, when severe drought conditions drove an increase in the proportion of water allocations that were traded from around seven per cent to almost 15 per cent (see Figure 6).

Figure 6: Water allocation sales as a percentage of water allocated in the southern Murray-Darling Basin, 1998-99 to 2009-10



Source: NWC 2011a

Another major increase in water trade occurred in 2007-08, following very dry seasonal conditions in 2006-07 across most of the MDB. These dry conditions persisted in the southern MDB in 2007-08 and 2008-09, in some regions the driest on record, and the proportion of total water allocated that was traded more than doubled again to 41 per cent. These higher levels of allocation trading activity were maintained despite improved water availability conditions in 2009-10 and 2010-11 (see Figure 5 and Figure 6).

Allocation trade has traditionally accounted for the majority of water trade in the southern MDB by volume. However, total entitlement trade volumes increased substantially from 2007-08. Though entitlement trading included government purchases of entitlements for the environment, in 2008-09 and even more so in 2009-10, much of the observed increase is attributable to entitlement trading between irrigators (see Figure 5).

There is clear evidence showing that water market price signals adjust to seasonal conditions. Figure 7 demonstrates the strong and inverse relationship between the availability of water and prices for allocation trades. Allocation prices peaked in early 2007-08 on the back of concerns that extremely low allocations in 2006-07 may be repeated. In contrast, 2010-11 was characterised by substantially lower prices given the improved water availability situation. Prices decreased steadily over that season as water availability increased further.

Figure 7: Average water allocation and average allocation price in the southern MDB 2007-08 to 2010-11³



Source: NWC 2011a

While seasonal variations in water availability and short and long-term changes in the fortunes of different agricultural activities were major drivers of the volumes and prices of water trades, the willingness of irrigators to participate in the market increased significantly over this period. This reflects growing acceptance of water trading, a greater understanding of how the market operates, and that irrigators have developed farm management strategies that involve the use of water trading (NWC 2010b). Growing adoption of water trading can also be attributed to improvements in the functioning of the water market that have reduced transaction costs, and increased the confidence of buyers and sellers in the market mechanisms.

Results

There is strong evidence of the benefits realised from water trade. At an aggregate level, economic modelling of the irrigation sector undertaken for the National Water Commission (NWC) estimated that water trading maintained production and productive capacity in the southern MDB during the millennium drought (see, for example, NWC 2010b). At an individual producer level, survey data from the Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES) irrigation survey⁴ shows that over 90 per cent of irrigators in the MDB felt the ability to trade water had

³ Allocation levels shown are the total announced allocations by week, aggregated for all the trading zones in the southern MDB, for regulated entitlements. Aggregation includes only tradeable regulated entitlements. Allocation levels are calculated as (volume allocated to regulated entitlements each week (cumulative total)) ÷ (volume of regulated entitlements on issue).

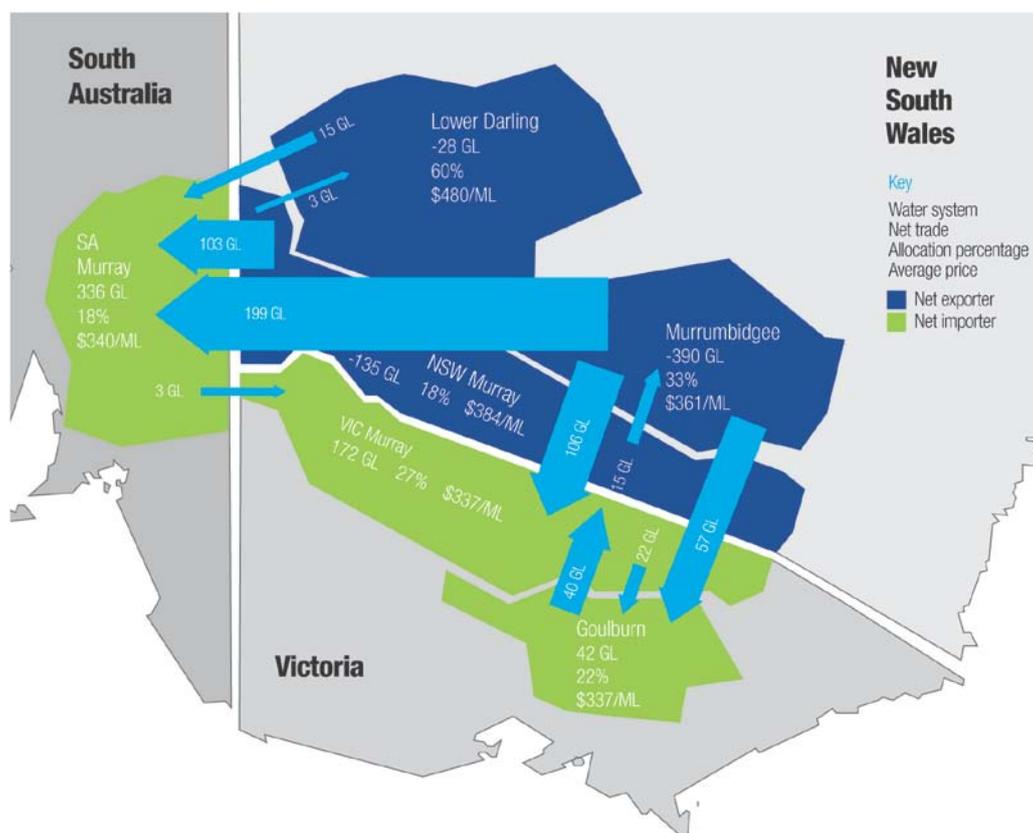
⁴ The ABARES irrigation survey is designed to collect information from broadacre (including rice and cotton), dairy and horticulture irrigation farms within the major irrigation regions in the MDB. The full results of the supplementary survey will be released in early 2012 as part of the NWC updated assessment of the impacts of water trading in the southern MDB.

helped their farm business (ABARES forthcoming). And at industry level, water trading has been vital for rice, cotton, dairy and horticulture in the southern MDB.

These key industries are geographically concentrated, with rice primarily located in the New South Wales Murray and Murrumbidgee area, dairy predominantly in the Victorian Goulburn-Murray Irrigation District and horticulture in South Australia and the Victorian Sunraysia region. In drought years, a clear pattern of water movement associated with inter-regional allocation trading has emerged. As shown in Figure 8, in 2008-09, water generally moves downstream to horticulture in Sunraysia and South Australia predominantly from rice growers in New South Wales.

This pattern of trade is indicative of significant allocative efficiency gains as the limited water available moves from those producers with flexible irrigation demands to those with inflexible demands including long-lived perennial horticultural assets. The movement of water is complemented by a compensating flow of payments in the other direction which helped maintain the viability of individual farm businesses.

Figure 8: Inter-regional water allocation trade in the southern MDB in 2008-09⁵



Source: NWC (2011b)

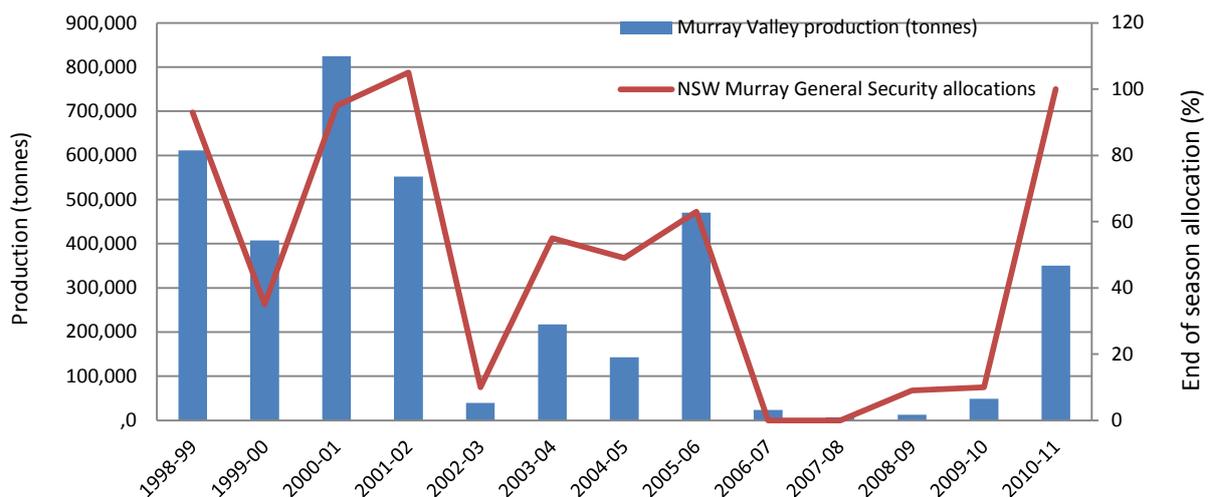
⁵ The movement of water to South Australia includes significant purchases for urban water users in Adelaide.

Rice

Rice production in Australia is concentrated in the Riverina area of the MDB, along the Murray and Murrumbidgee Rivers in New South Wales. Rice is an annual crop so it only needs water if the crop is planted. Rice growers can produce when water is relatively abundant and sell water on the market to provide them with additional income when water is scarce. The flexibility of rice production is well suited to the annual variability in water availability in the MDB and complemented by the flexibility of water markets.

As shown in Figure 9 and Figure 10, rice production is extremely dependent on the volume and price of water allocations. Rice growers make decisions early in the irrigation season about how much rice to grow based on initial water allocation announcements, the expected price of water, and the price on offer for rice. In some years, this may involve selling their water rather than using it to grow rice. But when water is plentiful, rice production expands.

Figure 9: NSW Murray rice production and end-of season allocations, 1998-99 to 2010-11



Source: NWC 2011c

Rice production peaked at record levels in 2000-01 (see Figure 9). However, the prolonged drought had a massive impact on rice production from 2002-03 onwards. Production fell even more significantly in the four years from 2006-07 to 2009-10. In 2007-08, just 19,000 tonnes of rice were produced in the Riverina. Despite the fact that rice prices increased to encourage production, drought induced low water availability and high water prices made it unviable to grow a crop.

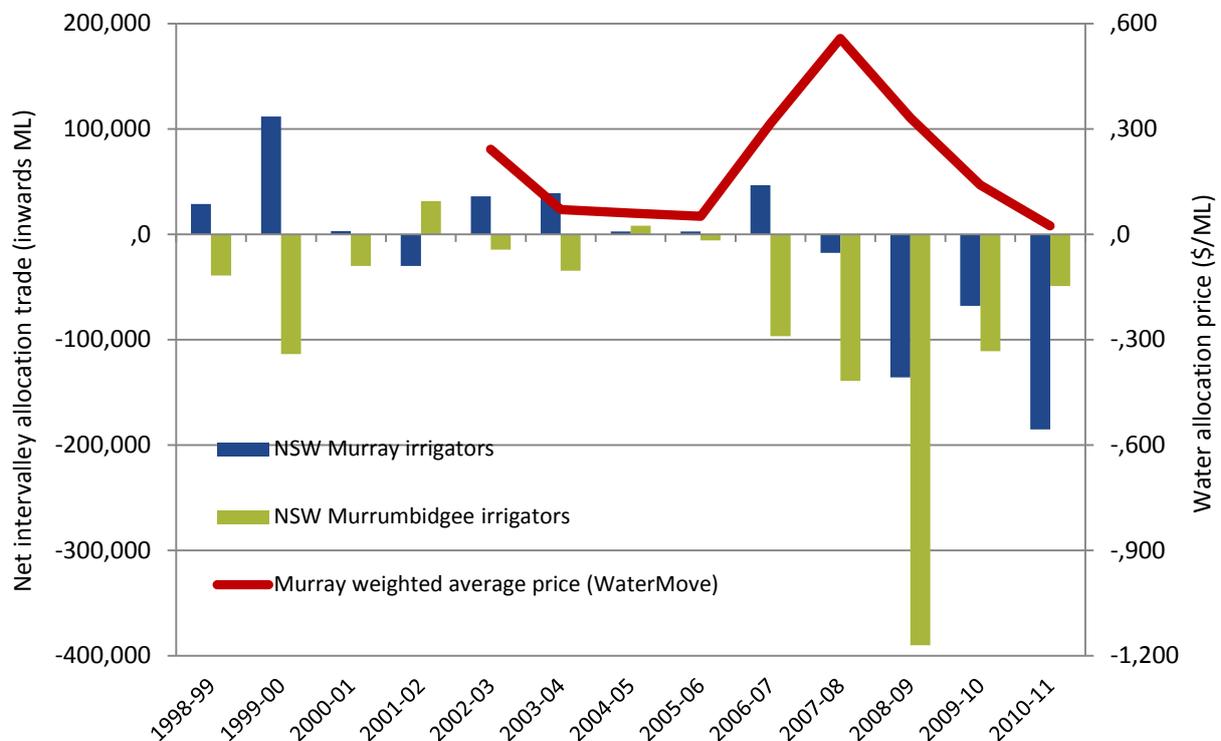
Water trading has been vital to help rice growers respond to seasonal conditions and provide them with much needed income. As the price for water allocations rose above the threshold determined by individual rice growers as viable for use in rice production, they tended to sell allocations. During the drought years, rice growers could make more money, with less risk, by selling their water.

This was observed in the Murrumbidgee when:

- In 2007-08, a net volume of 139,096ML was traded out, the mean water price was \$495/ML while the expected gross margin for rice was \$150/ML; and
- In 2008-09, when 390,000ML was traded out, the mean water price was \$375/ML while the expected gross margin for rice was \$260/ML.

Despite the limited allocations available to sell, rice growers particularly benefited from the high water allocation prices on offer in 2007-08 and 2008-09 (see Figure 10). Figure 10 shows the strong correlation between the price of water allocations and the volume of water allocations traded out of rice-growing regions. Even though prices for rice were up at this time, it still made financial sense for rice growers to sell their limited water allocations and cease rice production.

Figure 10: Water allocation sales and water allocation prices (1998-99 to 2010-11)



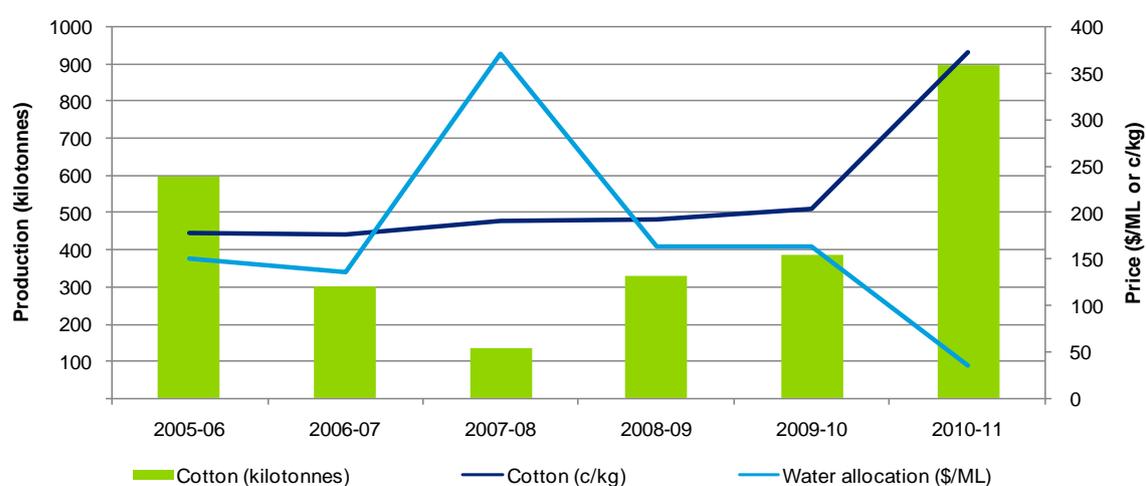
Source: NWC 2011c

For many, water sales were their only source of income for four dry years from 2006-07. Trade helped these irrigators survive and they are now able to respond to improved conditions. Improved water availability in the Murray and Murrumbidgee systems, combined with low water prices, means rice growers have resumed using the water allocated to their entitlements and bought allocations to expand production. Rice production is back online and once again making a significant contribution to Australian agricultural exports and rural economies.

Cotton

The story of cotton is similar to rice, and so is not repeated in detail here. Like rice, cotton is typically an opportunistic crop that is planted widely when water is abundant. Because growers can decide to reduce the area they plant when water availability is limited, cotton production varies significantly between years. Market conditions for cotton also influence the area planted. After a number of years of lower production during drought, increased water availability and lower water allocation prices resulted in substantial increases in cotton plantings in 2010–11.

Figure 11: Cotton production, cotton prices and water allocation prices, Macquarie, 2005–06 to 2010–11



Source: NWC 2011a.

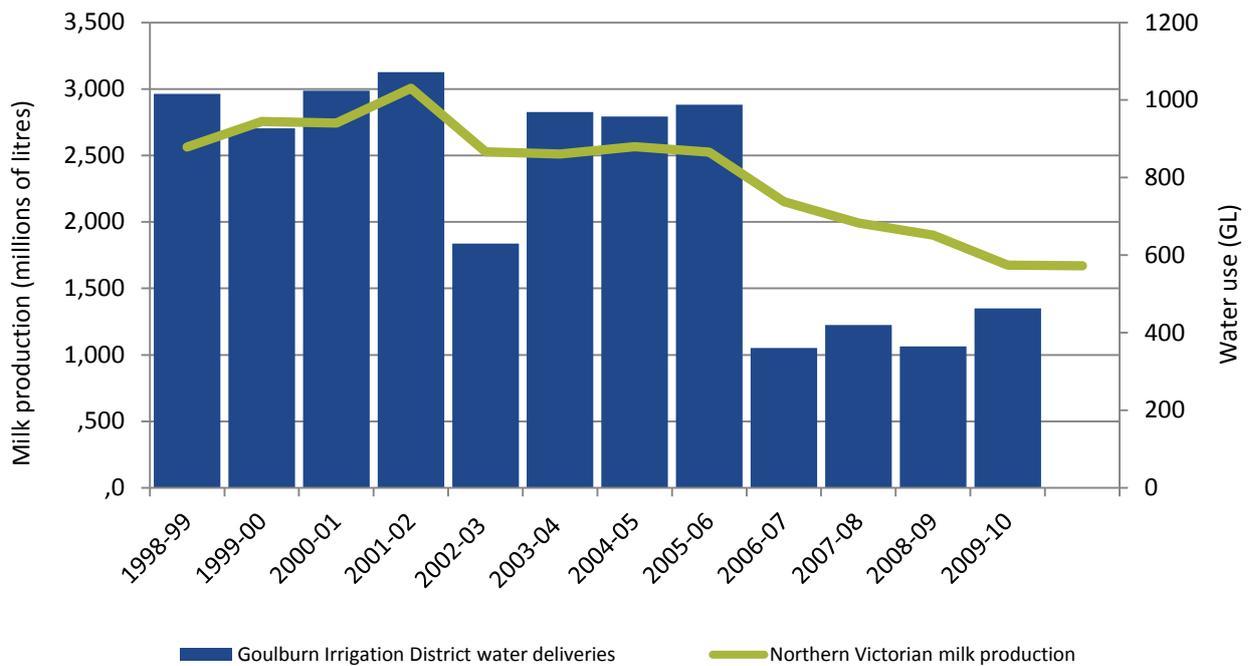
Dairy

Australia's major export-oriented irrigated dairy industry is located in northern Victoria and southern New South Wales. Water is a key input in irrigated dairy production and the drought over the last decade has had a big impact. However, irrigated dairying can be thought of as a semi-interruptible production process, as there are opportunities for dairy irrigators to avoid using water to grow fodder. Instead they can purchase fodder, move cattle elsewhere, and vary their herd size. Dairy farmers can also switch between annual and perennial pastures based on their exposure to water availability risk. Therefore, water use and trading decisions for dairy farmers can be more complex than for irrigators in other industries.

Given the substitutability of irrigated pasture and purchased fodder as feed sources, the water trading behaviour of dairy producers depends on water allocation prices and prevailing fodder prices (as well as milk prices). Most dairy farmers now understand the price in the water allocation market where they should move from buying more water to selling water. This breakeven point depends on the prevailing price of alternative feed sources and the milk price. In 2007-08, when allocations in the Murray system dropped dramatically and horticulturalists purchased large volumes of water, the decision to sell allocations was straightforward. The high prices for water provided much-needed income which could be used to purchase feed and maintain production.

Figure 12 shows that the proportionate reduction in milk production in northern Victoria was much less than the reduction in water availability (in the Goulburn system). This was primarily due to the potential to sell remaining water allocations at a high price and instead purchase fodder.

Figure 12: Northern Victorian dairy production and water use in the Victorian Goulburn irrigation district, 1998-99 to 2009-10



Source: NWC 2011c.

Water allocation trading has proved to be central to the decision making of dairy farmers, helping them increase or maintain production, maintain herd size, and generate additional income. The ability to trade water provides flexibility to determine the best mix of inputs at any point in time.

Horticulture

There has been a significant expansion of horticulture in the southern MDB over the last decade, particularly in wine grapes, almonds and olives in the Victorian Sunraysia, NSW Riverina and SA Riverland. For example, Australia’s almond industry is one of Australia’s fastest growing horticultural sectors. Wine grapes also developed rapidly in the early to mid 2000s but a glut in the wine grape market has since led to a significant restructuring of the industry.

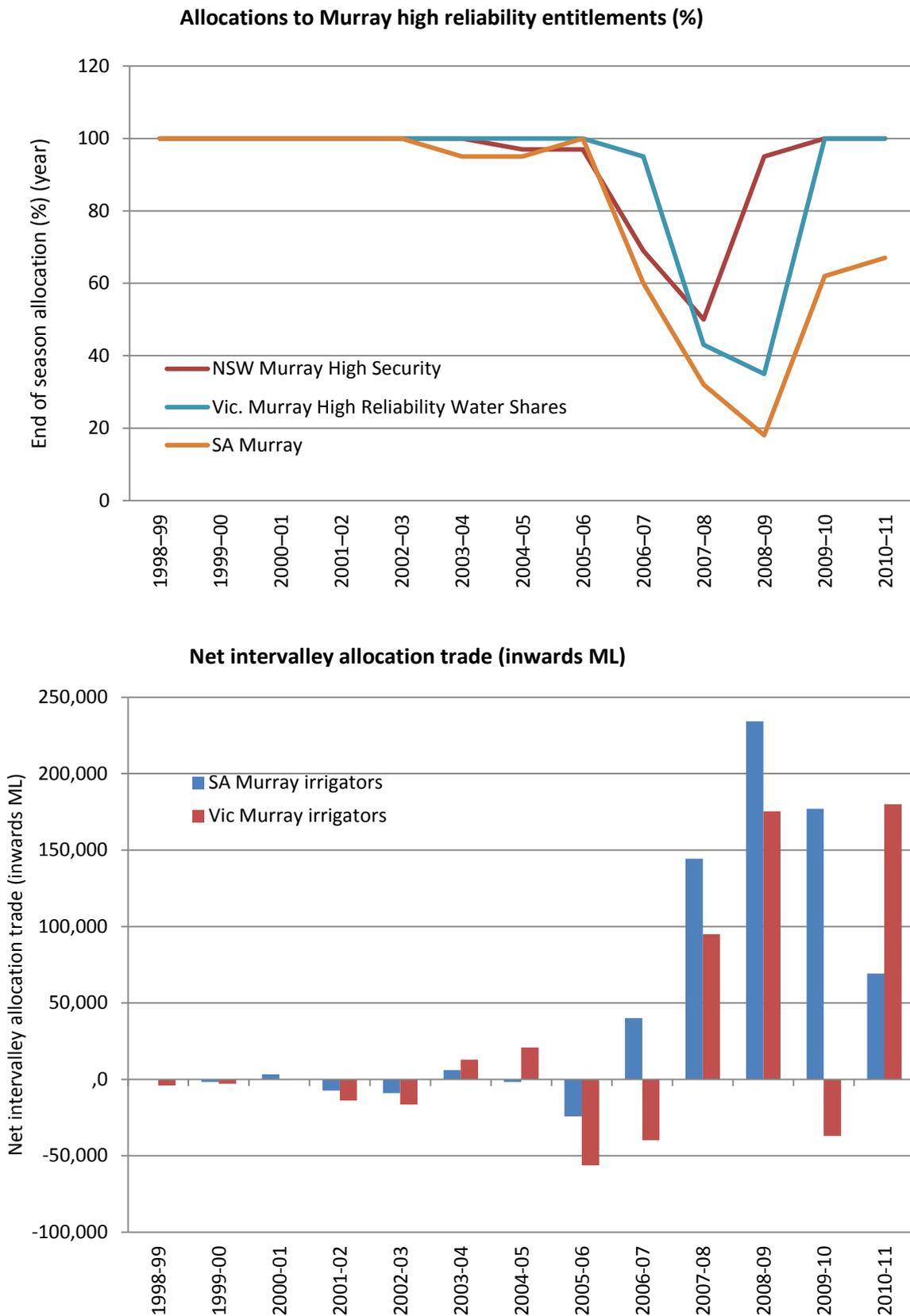
Water trading has played a key role in the horticultural industry. Access to irrigation water is essential, and with a cap on total water use in place in the MDB, the ability to purchase water enabled the new development on greenfields sites. The horticultural industry could not have developed in the same way in the MDB over the past decade without water markets.

During the investment phase, horticulturalists generally prefer to purchase high reliability entitlements. Unlike annual crops like rice, the water requirements of almond trees and wine grape vines are relatively fixed. Unlike dairy production where farmers can buy in fodder to substitute for irrigated pasture, there are no alternatives to watering via irrigation. The purchase of high reliability entitlements provides a means of managing the risk of needing to purchase allocations at high prices in dry years to meet all their water requirements. Farm managers have been able to purchase water entitlements progressively in accordance with development plans and increasing water requirements.

Most of the entitlements acquired during the horticultural development phase were purchased from dairy farmers in the Victorian Goulburn Murray Irrigation District. Importantly, entitlement purchases by horticulturalists provided these sellers with a return on their water assets as they made adjustment decisions.

Despite these investments in water entitlements, water allocation trading played a critical role in ensuring that horticulturalists could survive the severe drought, particularly in 2007-08 and 2008-09 when seasonal allocations dropped below 100 per cent. To make up for the shortfall, horticulturalists had to enter the market and buy water allocations (Figure 13).

Figure 13: Allocations available to Murray high reliability water entitlements and net allocation purchases in the Victorian Murray system



Source: NWC 2011c.

A recent ABARES survey suggests 63 per cent of horticulture farms in the Murray region traded water allocations in the three years to 2010-11 (ABARES forthcoming). Purchases of additional water allocations kept almond trees and vines alive, and helped maintain production. Without the water market, it is likely that many trees and vines would have died.

Two of the original drivers of the development of water markets in the MDB were to enable new development within a system with overall caps on water use, and to allow water to move to where it is most needed in response to seasonal water availability. The horticultural industry illustrates that these goals are being met.

Brief overview of results in other areas

In addition to enhancing agricultural productivity, water markets have made a contribution to other areas:

- *Managing risks for urban water supplies:* Water security in cities and towns has been enhanced where it is possible to access the water market. For example, SA Water purchased large volumes of allocations at the peak of the drought to meet demand and limit the impact of water restrictions in Adelaide. In other areas, policy barriers to rural-urban water trading are likely to contribute to inefficient supply augmentation and sourcing decisions.
- *Healthy ecosystems:* As found by the Productivity Commission and others, the Australian Government buy-back program represents a cost-effective means of acquiring water for the environment and transitioning the irrigation sector to more sustainable levels of extraction. Water recovery through buy-back is far more cost-effective than through off-farm irrigation infrastructure projects. Over 1,000GL of water entitlements have already been purchased in the MDB.
- *Regional economies:* Sustainable irrigation communities need sustainable irrigators. Water trading has helped many irrigators survive the drought and this has flow-on benefits for industries and regional communities. Structural adjustment is an ongoing process in the irrigation sector, and it is resulting in change in some communities. Water trading allows individuals to respond to changing needs. Moreover, the key lesson of the success of the Australian agricultural sector is that structural adjustment is necessary to maximise the beneficial use of scarce resources in response to changing market, policy and environmental conditions.

Key challenges in developing water markets

Despite the real benefits, the development of water markets has not been without problems. There have been a number of impediments that have prevented the full potential of water trading being realised. The key challenges can be categorised as:

- *technical:* for example, the difficulty of acquiring necessary information to establish workable registers of water of entitlements and to account for water use;
- *political:* for example, the parochialism of individual states;

- *social*: for example, community concerns about loss of water from some regions and the possible emergence of ‘water barons’ attempting to exert control over supply; and
- *cultural and managerial*: for example, water management agency personnel typically had science or engineering backgrounds, and were unaccustomed to the use of market-based mechanisms.

What can be learnt from water market reform in Australia for other settings?

Australia now has around two decades of experience in the establishment and operation of water markets. It can legitimately be seen as a world leader in the market-based allocation and management of scarce water resources.

The main lessons from that experience include the following:

1. It is feasible to develop working water markets in complex hydrological systems, including across jurisdictional boundaries.
2. Well-designed water markets can deliver tangible benefits in a system where water access is scarce by signalling the value of water.
3. There are universal physical and economic characteristics that suggest where water trading will be most beneficial. They include situations where:
 - resources are fully developed for consumptive use;
 - there is variability in seasonal water availability and variability between connected systems within seasons;
 - there are a large number of connected water users;
 - users have varying demands and degrees of flexibility to respond to water shortages;
 - water users are exposed to fluctuations in global agricultural markets;
 - demands for urban and environmental water are increasing; and
 - there is pressure for change in the existing structure of water-using industries.
4. Despite these universal characteristics, water market design needs to be informed by the history and specific characteristics of local water resource management.
5. Universal prerequisites for effective water markets include:
 - setting an effective cap on total sustainable water extractions (preferably before scarcity becomes acute);
 - establishing entitlements that are clearly specified, monitored and enforced so that users know exactly what they can buy and sell;

- having a sound regulatory and governance framework within which water trading can take place; and
 - implementing fundamental elements of good water management, such as metering and water accounting.
6. An incremental approach to water market development is appropriate to manage uncertainty and stakeholder concerns, but benefits will be forgone if suboptimal arrangements are left in place too long.
 7. Measures to address environmental and social outcomes that could be affected by water trading should be carefully considered and targeted to limit interference with the operation of the market. Some interventions, such as restrictions imposed on trade, are costly and have unintended negative consequences.
 8. Market participants learn quickly and make decisions based on the rules that are in place. Any efforts to stifle market development or impede progress inevitably lead to creativity by market players, which may have unintended consequences for property right holders.
 9. As water markets mature and develop, roles and responsibilities influencing market outcomes need to be assigned carefully to avoid conflicts of interest, which can undermine effective market operation.

Conclusion

This paper demonstrates that water trading has proved to be a major success in supporting agricultural productivity; helping irrigators respond to seasonal conditions and manage risk; promoting more sophisticated farm management practices; providing irrigators with income when crops failed; underpinning the expansion of some industries and maintenance of permanent plantings; enabling irrigators to reduce debt levels and restructure their businesses; and facilitating structural change in irrigation industries.

While the drought has had a significant economic and social impact on the irrigated agricultural sector, the ability to trade water means that remaining irrigation businesses are in much better shape than they otherwise would be. The existence of water markets makes for a more resilient and responsive irrigation sector which is better placed to adapt to seasonal conditions and other pressures for change.

Australia's experience shows that water markets can provide an autonomous mechanism for supporting the agricultural sector, and that benefit for irrigators translates into benefits for industries, regional communities and the economy as a whole. Into the future, water markets will be vital in minimising the economic and social cost of moving to environmentally sustainable levels of extraction, adapting to climate change, and managing fluctuating conditions in input and commodity markets.

With this in mind, lessons learnt from Australia's experience of introducing a market-based mechanism for allocating scarce water resources should be informative for other countries facing the challenge of water scarcity.

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