IRRIGATION IN PERSPECTIVE
Irrigation in the Murray and Murrumbidgee Basins

water for a healthy country
KEY OPPORTUNITIES

The findings presented in this booklet are based on research into irrigation by the Water for a Healthy Country National Research Flagship and the Cooperative Research Centre for Irrigation Futures.

MEASUREMENT

- Increase measurement of all water supplied and applied in each irrigated field—needed for effective management
- Better measurement of surface and subsurface drainage

INTERACTIONS

- Better understanding of irrigation interactions with groundwater in each region—critical to avoid degradation and exploitation, and to identify conjunctive use opportunities

INFRASTRUCTURE

- Distribution and application systems need to be upgraded for greater water control

MANAGEMENT

- Development of multi-objective river management that connects irrigators with water management practices and business arrangements that selectively change flow and floods in local reaches of the rivers for defined environmental outcomes

INFORMATION GAPS

We do not yet have all the information needed for a comprehensive picture of the irrigation industry. There is a need for nationally consistent reporting that enables water productivity change over time to be aggregated by crop and region.

As the case study in the Murrumbidgee Valley through the Pratt Water study has shown, there is still confusion at the most fundamental level. For example, the sum of the total water access entitlements within regions or across the Basins is not clear; nor is the relationship between entitlement, annual allocation and actual diversion. Improvements in water budgeting and then water accounts will go a long way towards addressing these issues.

Drainage volumes and interactions with groundwater require improved knowledge as does monitoring of groundwater condition. The state of soils for salinity and sodicity levels is another key information gap.

KEY MESSAGES FROM IRRIGATORS

- Irrigation provides fresh and affordable food.
- The irrigation industry supports vibrant and profitable regional communities and industry.
- A diversity of products and enterprises leads to greater economic stability and is important to crop farming systems.
- Irrigation is valuable, profitable, contributes to the balance of payments and is important to Australian’s exports.
- There is a variety of profitability and performance in and between industries.
- Irrigated water productivity has improved in recent years through improved distribution and application systems and further improvement is possible with supportive economic conditions.
- Continued investment in irrigation efficiencies needs a secure water supply.
- The irrigation industry wants to contribute to a healthy Murray–Darling Basin and River Murray.
- Available water resources must be equitably shared and efficiently managed by irrigation and environmental managers.
- Irrigation has impacts on the natural resource base, some of which are unacceptable (e.g. salinity) while others are desirable (social, vibrant community, employment, recreation).
- Different players (national, state, community, farm, urban, rural) value irrigation and the River Murray in different ways. The challenge is how to measure the value.
All Australians benefit from irrigation, both directly through the supply of quality fresh fruit and vegetables, grains and fibre; and economically from the irrigated production that is a significant contributor to national wealth generation. Irrigation requires suitable land, water, capital, infrastructure, skill and the institutional arrangements to supply, manage and monitor water use. Limits on any of these vital inputs will affect the benefits.

As management improves, so the demand for information on water use increases from water users and the national water reform process (see below). Information about irrigation—its water use; and social, economic and environmental benefits in the Murray and Murrumbidgee Basins—is only available in a fragmented way through individual commodity group or water supply body reporting.

**Table 1. Irrigation across Australia (ABS 2004).**

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total irrigated area</td>
<td>2,506,000 ha</td>
</tr>
<tr>
<td>Proportion of Australian agricultural area</td>
<td>&lt;1%</td>
</tr>
<tr>
<td>Proportion of world irrigated area</td>
<td>1%</td>
</tr>
<tr>
<td>Water diverted for irrigation</td>
<td>16,660 GL</td>
</tr>
<tr>
<td>Proportion of total water used</td>
<td>67%</td>
</tr>
<tr>
<td>Irrigated farm gate revenue</td>
<td>$9.6 billion</td>
</tr>
<tr>
<td>Proportion of total agricultural production</td>
<td>28%</td>
</tr>
<tr>
<td>Irrigated farm profit as proportion of total agricultural profit</td>
<td>51%</td>
</tr>
</tbody>
</table>

**Figure 1.** Irrigated areas of Australia shown in the major drainage divisions (with permission from the Australian Bureau of Statistics 2004).
IRRIGATION IN THE REGION

The Murray and Murrumbidgee river basins are iconic Australian river systems. The Murray River rises in the Australian Alps and flows for 2530 km through three states to the sea. The Murrumbidgee rises close to the Murray source, joining it downstream of Balranald in New South Wales.

The rivers supply water to agriculture, rural towns and cities through southern New South Wales, northern Victoria and southeastern South Australia.

Irrigation is an important industry in the Murray and Murrumbidgee basins, and is reliant on the rivers for its wealth and continuation.

The upstream riverine areas, where flat river plains dominate, provide annual crops and pastures. The downstream mallee areas, where water must be lifted from the river trench, have a greater focus on horticultural crops. One-third of all the fresh fruit and vegetables traded in Australia is provided by these irrigated regions (19% of all vegetables, 50% of all fruit and nuts, 63% of all grapes).

Irrigated areas were aggregated into ten separate regions each with similar characteristics (see Figure 1). Between 1996/97 and 2000/01, the total irrigated area in the study regions increased by 21% to reach 1.25 million hectares or 49% of Australia’s total irrigated area. Projections for irrigated land use in 2004/05 indicate a decline to around 950 000 ha, mainly because of restricted allocations from drought-affected storages (see Figure 2).

Figure 1. Study area showing regions.

Supplying agriculture, rural and urban users in New South Wales, Victoria and South Australia

One-third of all the fresh fruit and vegetables traded in Australia is provided by these irrigated regions

Makes up 49% of all Australia’s irrigated land

water for a healthy country
Not all available land is irrigated in any one season

No ‘new’ water is available

Only about one-third of the potential area (not including Sunraysia and the Riverland where perennial horticulture crops predominate) is irrigated in any irrigation season, especially in regions with a high proportion of pastures and annual crops. A substantial area, particularly irrigated pasture, is not irrigated to the maximum productivity level.

Regulation of the river through storages, diversion structures and weirs provides water for irrigation and town supplies, and a range of dependent activities such as tourism and recreation. The major run-off catchment areas of the Murray and Murrumbidgee are ‘fully developed’—building new storages would yield little additional water. Effectively there is no ‘new’ water to be had.

The irrigation industry is Australia’s most significant water user and is contributing to the long-term wellbeing of the river systems. But rights of access to water brings an obligation to use the water responsibly—an obligation that is being embraced and acted on through the many land and water management plans of the region.

The industry is also beginning to explore community agreements, and commercial and trading possibilities for achieving a new balance in water for production and water for environmental purposes.

**Figure 2.** Estimated distribution of different irrigated land uses ('000 ha) for 1996/96 and 2000/01 together with an estimate for 2004/05. This estimate is based on existing trends and the likely impact of reduced water availability.
IRRIGATION FACTS

Land area
The total area of land in the Murray/Murrumbidgee basins is 33.3 million hectares. Of this 1.25 million hectares is irrigated.

Population
The population of the irrigated regions is more than 580,000. Irrigated districts support three to five times more people and have three to five times the economic activity compared with the adjacent rain-fed districts.

River flows
Prior to development, an average of 12,900 GL/yr of water was discharged from the mouth of the Murray across an estimated range of 1600 to 54,200 GL/yr.

An average of 11,580 GL is diverted each year in the Murray–Darling Basin. Flows at the Murray mouth are highly variable—ranging from 0 to 27,464 GL/yr in the last 35 years. Diversions from the rivers grew from 8000 GL in 1984 to nearly 12,000 GL in 1994.

Crops
The main crops are pasture for dairy, meat and wool; cereals; rice; grapes; fruit and nuts; and vegetables (listed from larger to smaller by area of land used).

Infrastructure
Total value of supply and drainage channels and pipes is $3.77 billion; value of on-farm assets, channels, pipes, irrigation systems and established irrigated crops is $6.38 billion. Other investments include on-farm equipment, and crop and product processing facilities.

Revenue
The estimated total farm gate revenue from irrigated production is $3.1 billion (2001); in addition every $1000 of farm gate revenue generates at least $3500 of economic activity (for details refer to Section 4.6, Table 18 of the main report).

Figure 3. Total and irrigation water diversions (MDBC 2004).
Figure 4. Distribution of irrigated land (2000/01) in the Murray and Murrumbidgee basins.

Table 3. Summary of regional characteristics associated with irrigated agriculture.

<table>
<thead>
<tr>
<th>Region</th>
<th>Population</th>
<th>Number of irrigated farms</th>
<th>Irrigated area ('000 ha)</th>
<th>Irrigation infrastructure value ($million)</th>
<th>Farm gate revenue ($million)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Actual 2000/01</td>
<td>Off-farm</td>
<td>Irrigated activity plus rainfed agriculture</td>
</tr>
<tr>
<td>Upper Murrumbidgee</td>
<td>68 585</td>
<td>269</td>
<td>10</td>
<td>10</td>
<td>21</td>
</tr>
<tr>
<td>NSW Murray</td>
<td>33 091</td>
<td>2 500</td>
<td>1 013</td>
<td>730</td>
<td>3 773</td>
</tr>
<tr>
<td>Goulburn Broken</td>
<td>115 682</td>
<td>7 000</td>
<td>1 151</td>
<td>1 030</td>
<td>2 475</td>
</tr>
<tr>
<td>Lower Murray</td>
<td>33 968</td>
<td>3 000</td>
<td>35</td>
<td>193</td>
<td>3 773</td>
</tr>
<tr>
<td>Total</td>
<td>583 030</td>
<td>25 064</td>
<td>3 095</td>
<td>2 444</td>
<td>2 475</td>
</tr>
</tbody>
</table>
IRRIGATION WATER USE

Water diverted for irrigation in the ten study regions in the Murray and Murrumbidgee basins accounted for 79% in 2001/02 and 81% in 2002/03 of all water diverted for irrigation in the Murray–Darling Basin.

Water diverted and used for irrigation* in the Murray and Murrumbidgee Basins in 2001/02 (see also Table 4) comprised:

- 10 960 GL – the total diverted for irrigation in the Murray–Darling Basin;
- 8608 GL – the proportion diverted for irrigation in the ten study regions Murray and Murrumbidgee basins;
- 6700 GL – the amount delivered to the farm gate (or 78% of the water diverted);
- 5200 GL – the amount applied to crops (or 60% of the water diverted); and
- 3600 GL beneficially used through crop transpiration (42% of total water diverted).

Losses at each stage are significant (totalling some 5000 GL/yr). They occur in both the distribution and on-farm application systems.

Water for irrigation is directed through an extensive channel and drainage system that varies significantly between regions. Overall, the ratio of areas irrigated with different application systems (Figure 5) is surface 83%, sprinkler 10% and micro 7%, respectively. The value of production from these different systems is heavily weighted to the more controlled forms of application—an estimated 40% of the total value comes from the 17% of the irrigated area in horticultural and vegetable production using micro and sprinkler systems.

Figure 5. Regional distribution of irrigation application systems.

* These figures are subject to the uncertainty of the reported figures: ± or – 6 to 10% by the states and MDBC.
WATER USE AND REVENUE

There is a substantial difference between the regions upriver and those downstream. In a full water supply year:

- the NSW Murray region uses more than 2000 GL to irrigate 321 000 ha and produces irrigated revenue of about $310 million; while
- the Riverland uses 311 GL to irrigate 36 000 ha and produce irrigated revenue of $555 million.

In other words, one sixth of the water on one tenth of the land area in the Riverland produces 1.8 times the revenue. This difference in cropping and production systems can be attributed to fundamental differences of geology, soils, and viability of surface irrigation methods.

Downstream distribution systems have been upgraded to pipes. Pressurised water on demand has led to increased on-farm investment in the Sunraysia and Riverland regions, including trebling the area covered by drip irrigation systems. Drainage to groundwater has been reduced and test wells show increased depth to groundwater. Similar improvements to irrigation infrastructure and on-farm techniques in the Upper Murray and Murrumbidgee will lead to similar increases in benefits.

Table 4. Water entitlements, diversions and estimated requirements by region for 2001/02.

<table>
<thead>
<tr>
<th>Region</th>
<th>Irrigation water entitlement (GL)</th>
<th>Surface water diversion 2001/02 (GL)</th>
<th>2002/03 (GL)*</th>
<th>Groundwater diversion 2001/02 (GL)</th>
<th>Assumed delivery efficiency (%)</th>
<th>Irrigation water at farm gate 2001/02 (GL)</th>
<th>Estimated irrigation water 2001/02 Requirement (GL)</th>
<th>Use (GL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper Murrumbidgee</td>
<td>40</td>
<td>39</td>
<td>45</td>
<td>37</td>
<td>85</td>
<td>33</td>
<td>19</td>
<td>–</td>
</tr>
<tr>
<td>Murrumbidgee</td>
<td>1 748</td>
<td>1 638</td>
<td>1 248</td>
<td>83</td>
<td>78</td>
<td>1 277</td>
<td>1 532</td>
<td>–</td>
</tr>
<tr>
<td>Coleambally</td>
<td>629</td>
<td>662</td>
<td>492</td>
<td>101</td>
<td>80</td>
<td>529</td>
<td>447</td>
<td>–</td>
</tr>
<tr>
<td>Upper Murray</td>
<td>25</td>
<td>21</td>
<td>33</td>
<td>28</td>
<td>85</td>
<td>18</td>
<td>29</td>
<td>–</td>
</tr>
<tr>
<td>NSW Murray</td>
<td>1 954</td>
<td>2 092</td>
<td>879</td>
<td>256</td>
<td>76</td>
<td>1 590</td>
<td>2 271</td>
<td>2 456</td>
</tr>
<tr>
<td>Goulburn Broken</td>
<td>1 619</td>
<td>2 167</td>
<td>1 515</td>
<td>45</td>
<td>75</td>
<td>1 625</td>
<td>2 031</td>
<td>–</td>
</tr>
<tr>
<td>Loddon Campaspe</td>
<td>790</td>
<td>1 029</td>
<td>828</td>
<td>16</td>
<td>75</td>
<td>771</td>
<td>1 417</td>
<td>–</td>
</tr>
<tr>
<td>Sunraysia</td>
<td>362</td>
<td>467</td>
<td>478</td>
<td>6</td>
<td>80</td>
<td>374</td>
<td>213</td>
<td>253</td>
</tr>
<tr>
<td>Riverland</td>
<td>349</td>
<td>311</td>
<td>336</td>
<td>5</td>
<td>95</td>
<td>295</td>
<td>247</td>
<td>275</td>
</tr>
<tr>
<td>Lower Murray</td>
<td>218</td>
<td>183</td>
<td>196</td>
<td>25</td>
<td>78</td>
<td>143</td>
<td>137</td>
<td>–</td>
</tr>
<tr>
<td>Total</td>
<td>7 734</td>
<td>8 608</td>
<td>6 049</td>
<td>602</td>
<td>–</td>
<td>6 656</td>
<td>8 343</td>
<td>–</td>
</tr>
</tbody>
</table>

* For comparison, the surface water diversion for 2002/03 is included to show the effects of reduced storage and allocation under drought conditions.
CROPS AND COMMUNITIES

ECONOMIC AND COMMUNITY ACTIVITY

On average, irrigated areas receive 2.4 times the total water input of adjacent dryland areas. Revenue in irrigated areas is 13.1 times greater. More people live in irrigation areas and there are more businesses, more total employment and significantly more services (banks, medical and recreation facilities) in the irrigated communities.

People in the irrigated regions live in medium-sized towns and small cities—populations that cannot be supported without irrigation in these low rainfall (< 500 mm) areas. Many people are either directly associated with the irrigation industry or are involved with dependent services and associated industries. The number and size of irrigated farms is strongly related to the type of irrigation activity—larger farms cultivate pasture and crops; smaller, more intensively managed farms grow grapes and fruit.

Downstream, fruit and grapes dominate; in Victoria, south of the Murray, dairying is the biggest activity, while in New South Wales rice and pastures are predominant (see Figure 6).

Figure 6. Regional distribution of different irrigated land uses.
Between 1997 and 2001, farm gate revenue generated in the irrigated regions rose by 50%. The major contributors were dairy (64% increase), grapes (100% increase), fruit, rice and vegetables. The increased revenue is due to the increased area under cultivation and reasonably buoyant commodity prices.

The combined estimated revenue for irrigation-dependent fruit, nuts, vegetables and grapes is $1.7 billion or 40% of all production of these commodities in Australia.

Irrigation-dependent economic activity includes the supply of goods and services to produce irrigated produce and value adding processing such as cheese making from dairy production or wine making from grapes.

The highest levels of revenue generated on a per hectare and per megalitre basis were the intensive horticultural activities, vegetables, grapes, fruit and nut trees (see Figure 7).

From an individual enterprise perspective, generating more revenue is not necessarily the most successful business or lifestyle choice. Success measures are more likely to be influenced by:

- profit (which is not necessarily directly related to total revenue per megalitre of water);
- a sense of sustainability and security;
- the level of skill and risk involved; and
- conscious decisions on lifestyle.

The largest estimated profits are generated from dairy ($329 million), grapes ($289 million), and fruit and tree nut crops ($126 million) (2000/01 figures; see Figure 8).

Reliable profit numbers at an enterprise level are difficult to obtain and so estimates were derived using known land-use areas, generalised farm and commodity costs and returns, and assuming farm land was fully owned.

Measures of farm productivity show considerable variation between apparently similar enterprises, ranging from exceptional to very ordinary. This may suggest that significant improvements can be made in irrigation productivity, the use of water and in profitability of irrigated enterprises.
NATURAL RESOURCES

RIVER HEALTH

Altered river flow regimes have affected both in-river and riverine ecosystems:

- weirs and diversion structures have often drowned nearby wetlands and floodplains;
- changed flooding regimes, indicated by the reduction of small and medium floods from a frequency of eight years in ten, to less than four years in ten have reduced the size and diversity of flood plain vegetation and wetlands in many areas.

Recognition of the need to manipulate flow and flood conditions for improved maintenance of in-stream and dependent riverine ecosystems has lead to The Living Murray Initiative being developed through the Murray-Darling Basin Commission.

SALINITY AND GROUNDWATER

The difficult dilemma of managing a river, both as a landscape drain and as a water supply system is nowhere better illustrated than in managing salt. Exporting salt from irrigated and rain-fed areas and discharging into the river is, in part, mimicking a natural process. However, for people and systems further downstream, this can cause unacceptable water quality decline. As the demand for quality water grows, it also becomes more difficult to successfully run a drain and supply system. Dealing with this dilemma in the Murray is the focus of the salinity and drainage strategy of the Murray-Darling Basin Commission.

Almost all irrigated areas in the study regions have or will develop unconfined aquifers (watertables) that come close (< 2 m) to the ground surface. Water, especially from surface flooding of pastures and rice, has filled the unsaturated soil layers below the irrigated area. It has resulted in prolonged wet soil conditions and a predisposition to increasing salinisation. In almost all other areas, irrigation has contributed significant volumes of water (and salt) to the upper layer groundwater system.

Management of salt accumulation and mobilisation associated with irrigation still remains critical. Salt, accumulated during transpiration and evaporation of water must be removed from the rootzone of crops. It is estimated that 200 000 ha, or 17% of the irrigated area, already has some form of subsurface drainage. This area is likely to increase by at least 20 000 ha involving a capital expenditure of $55 million to $75 million as greater areas of high value crops are planted.

The total area of salt storage ‘disposal’ basins is nearly 14 000 ha, or 1.1% of the area that is irrigated. Almost all these basins have slow and extended leakage back into the groundwaters.
WATER FOR THE RIVERS

Concern has been expressed that the amount of water available for irrigation will be reduced due to increased demand for environmental flows through initiatives such as The Living Murray. At present, demands for this water are being met from investment in the upgrade of infrastructure in New South Wales and Victoria, and in reductions in sales allocations to Victorian irrigators. Various options are available for finding environmental water. They include:

- donations of water to (and management by) environmental trusts;
- sale by environmental managers of environmental allocations to irrigators in dry periods followed by repurchase in wet periods;
- investment in projects that reduce evaporation losses, reduce distribution losses and/or improve water use efficiency;
- market buy-back schemes;
- irrigator agreements to supply water in wet periods, with first call on it during dry periods;
- reductions in allocations; and
- compulsory acquisitions.

All options are possible and it is likely that the solution will require a mix of them all.

SOIL

Survey information for the irrigated regions showed a common concern that irrigated soils were subject to:

- a loss of physical structure (compaction);
- increasing salinity and sodicity (increased sodium content); and
- evidence of increasing acidity in the upper river regions.

Most of these degrading processes can be managed and agricultural practices are changing to meet these challenges.
THE FUTURE

Sharing our natural resources – seeking the balance

MOTIVATORS FOR CHANGE

A primary motivator for water policy reform at both Australian and state government levels is to encourage more economic activity from the use of limited water supplies. On the surface, this could mean encouraging production of high value commodities such as vegetables and fruit. However, generation of greater profit, especially if this is accompanied by lower risk from production and market volatility is a greater motivator.

WATER ACCESS

Continuing access to sufficient water of adequate quality—primarily water with a low salt content—is needed for irrigation to prosper. There is thus a coincidence of irrigator and river environment concerns in managing salinity in the rivers. Irrigators will need to become more involved as managers of the rivers, where management is both ensuring the supply of water for irrigation and maintenance and repair of the rivers’ natural assets (see box on Banrock Station).

BANROCK STATION

Banrock Station Wines, a BRL Hardy brand, has developed a successful cause-marketing program for its wines. Part of the proceeds from every bottle or cask sold are donated to Landcare Australia and Wetland Care Australia for wetland restoration projects around the country.

Banrock Station’s commitment to wetlands began in the mid-1990s when it worked with Wetland Care Australia to restore bushland, including 400 ha of wetlands and floodplains on its own property.

The success of this project motivated the company to take the concept to the broader community and in 1995 Banrock Station joined forces with Landcare Australia to support wetlands restoration projects throughout Australia. Donations generated by the sale of their wines have now exceeded $2 million.

Banrock Station now supports wetlands restoration and habitat preservation projects in other countries where it sells its wines including New Zealand, Sweden, Finland, the Netherlands, Canada, the United States and the United Kingdom.
PRODUCTIVITY

Every irrigated commodity can improve its median water productivity and this will be of benefit to regional communities, especially if accompanied by increased diversity of commodity production and service industries. Irrigated production increases a region’s resilience through retaining and increasing diversity, flexibility and adaptability.

- Increased productivity can be stimulated and accompanied by greatly improved water distribution systems.
- Excessive losses need to be fixed.
- Small volume, long earthen channels can be replaced with pipes and some uneconomic areas can be retired.
- Modified systems can be designed to increase flexibility of supply through combinations of greater control, some pressurised with water on demand and with on-farm and near-farm storage.
- Conversion of application systems can free between 30 and 40% of current water use and provide opportunity for expansion or trading for environmental or production uses.

The biggest opportunities lie with the biggest water users: pasture production for dairy and grazing, and annual cropping. Industry examples of improved fodder production systems include:

- benefit in annual row crop production from adopting furrow control techniques as developed in the cotton industry; and
- increased flexibility resulting from on-farm storage, both on the surface and in groundwater.

Realising the opportunities requires collective action at a regional level so that irrigators, delivery systems and institutional arrangements all work together.

REFERENCES


The Cooperative Research Centre for Irrigation Futures has 14 core partners and is the largest grouping of agencies, corporations and universities examining irrigation issues that has ever formed in Australia. Research in the cooperative research centre focuses on doubling irrigation productivity, improving profitability, and protecting and enhancing our irrigated landscapes.

**Water for a Healthy Country National Research Flagship**

The Water for a Healthy Country National Research Flagship is a research partnership between CSIRO, state and Australian governments, private and public industry, and other research providers. The Flagship was established in 2003 as part of the CSIRO National Research Flagship Initiative.

This study of the Murray and Murrumbidgee Basins was undertaken by the Water for a Healthy Country Flagship and the Cooperative Research Centre for Irrigation Futures.

Information in this booklet is based on *The Irrigation Industry in the Murray and Murrumbidgee Basins, Technical Report June 2005* prepared by the Cooperative Research Centre for Irrigation Futures. It can be obtained from <www.csiro.au/healthycountry/publications.htm>. Research for this report was conducted by Wayne Meyer, Steve Marvanek, Brett Bryan, Evan Christen, John Hornbuckle, Shahbaz Khan, Tian Shi, Mike Young, KBR and QED Pty Ltd.

**Copyright**

© Commonwealth of Australia 2005. All rights reserved.

This work is copyright. Apart from any use as permitted under the Copyright Act 1968, no part may be reproduced by any process without prior written permission from the Commonwealth.

**Disclaimer**

You accept all risks and responsibility for losses, damages, costs and other consequences resulting directly or indirectly from using this report and any information or material available from it.

To the maximum permitted by law, CSIRO excludes all liability to any person arising directly or indirectly from using this report and any information or material available from it.

**Publishing details**

Images: CSIRO Land and Water, Cooperative Research Centre for Irrigation Futures

Design: Themeda

Printing: Elect Printing