Sustainable irrigation

4

Wayne S Meyer and Kathleen H Bowmer

In Australia irrigation efficiency has increased and water use has stabilised. Irrigation produces about half of the total profit from less than 0.5% of the agricultural land area.

Irrigation produces about 30 percent of the world's food and 50 percent of the staple wheat and rice. Maintaining irrigated food supply and creating sustainable irrigation systems is therefore imperative for global security and wellbeing. The prospects for irrigation in Australia are extremely good, given that the crops are produced to specification and valued as exports. Salt management and efficient use of water are critical for sustainable irrigation. Australian scientists and engineers can design irrigation systems that match the application of water to the needs of crops, thereby avoiding salinisation of farmland and river systems. Water policy sets irrigation in a context that provides principles for sharing water between irrigation and other uses and builds on democratic principles of public participation.

Opposite page: Centre pivot irrigation. Image courtesy of MDBC. Photograph by Arthur Mostead

Irrigation in Australia

Value

Irrigation is profitable:

- Farm gate production value – about $AU10 billion per annum (about 30 percent of total agricultural production)
- Value adding – about four to seven times farm gate production
- Profit generated – $AU3.8 billion (about 50 percent of total agricultural profit)

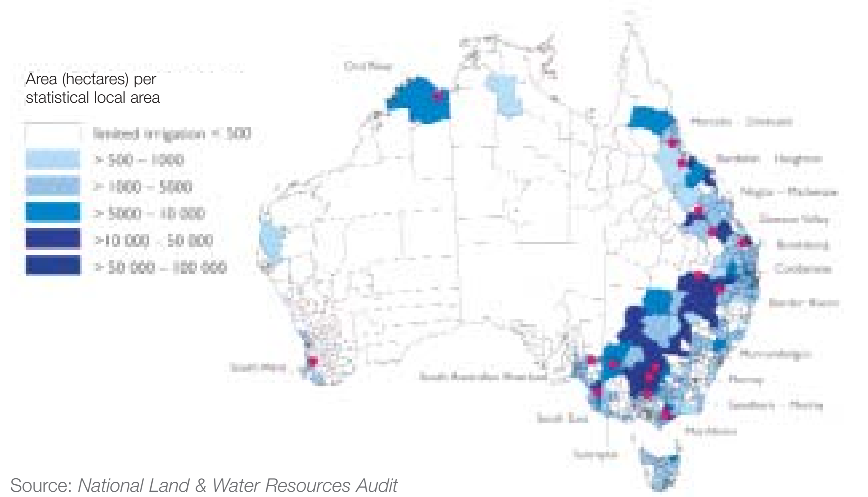
Area irrigated

2.4 million hectares (about 0.5 percent of dryland agriculture area).

Location

- South-eastern Australia: associated with the large inland river systems in the Murray-Darling Basin – dairy pastures, cotton, rice, horticulture including wine, vegetables, cereals, oilseeds and fodder pastures
- Queensland coastal regions and the Burdekin River area south of Townsville: sugar cane and horticulture
- Western Australia: the Ord River in the north – tropical fruit, vegetables and a range of seed crops; and the Swan Coastal plain around Perth – fruit, vegetables and dairy

FIGURE 4.01 Irrigation areas of Australia



Source: *National Land & Water Resources Audit*

Water use by commodities

- Dairying, with substantial areas of irrigated pastures and fodder crops, uses about 40 percent of the water
- Cotton uses 16 percent
- Rice uses 11 percent
- Sugar cane uses 8 percent

Increasing intensification

- Since 1985, the area irrigated increased by 30 percent, and the water diverted by 75 percent
- Irrigation uses about 72 percent (18,000 gigalitres) of all water used in Australia

TABLE 4.02 Water Suppliers

New South Wales	Coleambally Irrigation Cooperative Limited (CICL), Coleambally	466[1]	Murrumbidgee River; open channels; grower-owned (shareholders); rice, viticulture, summer grain crops, sunflowers, winter wheat
	Murray Irrigation, Deniliquin	1250	River Murray and Edwards River; open channels; grower-owned (shareholders); rice, dairying, grains and mixed crops
	Murrumbidgee Irrigation, Griffith	900	Murrumbidgee River; open channel being replaced with pipes; grower-owned; rice, viticulture, summer grain crops, sunflowers, winter wheat
Queensland	SunWater	NA	Major water supplier for North, Central and South Queensland; 25 major dams; pipeline and open channels; government-owned corporation administered through Queensland Department of Natural Resources, Mines and Energy; sugar cane, cotton, horticulture, industrial (power, mining), urban
	North Burdekin Water Board, Townsville	99	Burdekin River; open channel and groundwater pumping; grower-owned; sugar cane
Victoria	Goulburn-Murray Water, Tatura	2100	Broken, Goulburn, Campaspe and Loddon Rivers; open channel and pumped; manages 70 percent of Victoria's stored water; dairying
	Wimmera Mallee, Horsham	NA	Wimmera and Glenelg Rivers; services 22,000 farms; cereals, sheep
	Sunraysia Rural Water Authority, Irymple	111	River Murray; piped; supplies Merbein Red Cliffs and Robinvale Irrigation Districts; high intensity horticulture, especially viticulture
	First Mildura Irrigation Trust, Mildura	51	River Murray; open channel and pipes; viticulture
	Southern Rural Water, Maffra and Werribee	180	Macalister and Werribee Rivers; open earthen and concrete channels with some pipes; Gippsland & Southern Rural Water Authority; supplies Macalister, Werribee and Bacchus Marsh Irrigation Districts; pastures and crops
South Australia	Central Irrigation Trust, Loxton	NA	River Murray; pressurised pipes; 2,000 farms, eight private irrigation trusts; owned by the Australian Government; horticulture and supply for four towns
Western Australia	Harvey Water		Harvey River; mainly open channel (10 percent piped); 1,570 metres privately owned; dairy, beef, citrus and grapes

[1]Gigalitres supplied per annum

Source: ANCID

CSIRO Land and Water

A move to sustainable irrigation

Irrigation areas are complex biophysical, social, economic and political systems. Better management requires the ability to consider a variety of land-use options; soil, groundwater, geological and climatic conditions; and economic factors.

CSIRO Land and Water delivers a world-recognised integrated approach to sustainable irrigation research, drawing on innovative hydrologic, economic, and social sciences to strike a balance between environmental concerns and economic demands.

Researchers are developing novel solutions for sustainable and economically viable irrigated agriculture. Modelling tools, better irrigation delivery applications, more productive irrigated cropping systems, and new drainage technologies are helping to improve water demand management and the quality of return flows from irrigation.

With laboratories located in Griffith and Townsville, CSIRO is ideally positioned to conduct the research needed to ensure viable irrigation in both southern and northern agricultural systems.

Putting modelling tools into regional practice

Modelling tools help irrigators make management decisions that produce the best outcomes for farm business as well as the environment:

- The SWAGMAN® (Salt Water and Groundwater MANagement) suite of models was designed by CSIRO to help irrigators, resource managers and regions make informed decisions that increase productivity and profitability, while maintaining the resource base. In the Coleambally Irrigation Area in the Murray-Darling Basin, SWAGMAN® Farm (a farm profit and resource use model) has changed land use practices on a number of farms to better match recharge with the capacity of groundwater outflow
- In northern Australia, an economic model called Dam Ea$y (developed in conjunction with the Cooperative Research Centre for Sustainable Sugar Production) is helping sugar growers make decisions about investments in on-farm water storage, irrigation system installation and upgrades to existing systems, by simulating a variety of irrigation and dam options. Nitrate leaching (and hence groundwater pollution) is reduced through better management of water and nitrogen
- The Murrumbidgee Natural Resource Model layers information about every aspect of natural resources to help farmers and irrigation managers plan water applications and determine the impacts of local land and irrigation management decisions. Murrumbidgee Irrigation is using the CSIRO model to build its understanding of groundwater in the region as a basis for assessing on-farm management actions that achieve smarter management practices, improve water-use, and address watertable and salinity problems. Similar models are being developed for other irrigation areas in Australia, as well as for international irrigation regions

Vineyard with evaporation ponds for drainage water. Griffith, New South Wales. Image courtesy of ©CSIRO Land and Water

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CSIRO

Innovation 1: Principles and policy

Several principles shape water management policy and law in Australia:

- Ownership: Water is owned by the 'the crown' (government) rather than individuals. All states and territories have adopted this principle
- Integrated Catchment Management: ICM recognises the interactions between landscape management and river health, which in turn affects the quality and availability of water for water users and the environment downstream. The Murray-Darling Basin Ministerial Council developed an ICM strategy, recognising that water management for irrigation and other uses needs to occur within catchments, even if catchments transcend state boundaries
- The 'Cap': In 1994/95, the 'Cap' on water use was established in the Murray-Darling Basin with the objective of preserving the health of the Basin's river systems by limiting the volume of water that could be diverted for consumptive uses. The 'Cap' does not constrain new developments provided the water for them is obtained by using water more efficiently or by purchasing water from existing developments
- Water reform: In 1994, the Council of Australian Governments (COAG) agreed to separate land property and water access. This was a major innovation that opened up the possibilities for free trade and markets in water. The 1994 COAG agreements have been refreshed recently by the *National Water Initiative*, which encourages the expansion of water markets and trading across and between districts and States. The expansion of water markets has focused many water users, especially irrigators, on the economic value of water (pages 19-20)
- The *Living Murray*: In response to increasing concern about the ecological value of rivers in the Murray-Darling Basin the Ministerial Council is developing the *Living Murray* initiative to acquire and manage water to protect six selected icon sites, including several red gum forests and wetlands along the River Murray main stem (pages 21-22, 96)
- Community participation: The *COAG Water Reform Framework* and the adoption of integrated catchment management principles provide the opportunity for water users to assume greater responsibility for managing their own affairs. Irrigators are taking increasing responsibility for stewardship of natural resources through *Land and Water Management Plans* that contribute to the sustainability of their industries and the communities in their region (page 117)
- Security of access to water: With the reform processes for water affecting both rural and urban areas, irrigators have been very concerned about water allocation and the definition of access rights. The variable availability of water makes defining a water property right much more difficult than defining a land property right. It is gradually being accepted that the 'property' is an entitlement to water access that will have well-defined conditions of risk and security, and be registered centrally. These changes will help give irrigators and investors more surety

Furrow irrigation. Image courtesy New South Wales Department of Infrastructure, Planning and Natural Resources. Photograph by Bruce Cooper

Innovation 2: Combined use of surface and groundwater

Greater competition for water, compounded by drought in recent years, has focused attention on increasing water-use efficiency and on using groundwater in conjunction with surface water.

Groundwater replenishment (recharge) rates are often low, so careful management is required to avoid over-exploiting the supply. Examples of changed irrigation practices and substitution of groundwater with alternative water sources include:

- *The Lower Burdekin Initiative (LBI)*: A range of partners are working together to manage surface and groundwater to prevent the encroachment of a salty seawater wedge (Figure 4.03). LBI partners include CSIRO Land and Water, the North and South Burdekin Water Boards, Canegrowers, the Queensland Department of Natural Resources, Mines and Energy, SunWater, *Landcare* and the Burdekin Shire Council
- The North Adelaide Plains: Virginia is a district about 35 kilometres north of Adelaide. Horticulture – nursery, cut flowers, broad-acre vegetables, greenhouses, tree crops and vineyards – cover almost 7,000 hectares, with value-added processing of over $AU200 million. Production is expected to increase by 2,000 hectares, using 30 gigalitres of reclaimed effluent from the Bolivar Virginia pipeline and 18 gigalitres of water from the underlying aquifer. The Virginia Horticulture Centre is a community-based organisation that promotes and develops horticultural industries in partnership with the Virginia Irrigation Association, and the Northern Adelaide & Barossa Catchment Water Management Board
- The Willunga Basin: This is a good example of the use of reclaimed water to replace the use of over-exploited groundwater

  A group of vine growers in the McLaren Vale region south of Adelaide addressed the problem by forming the Willunga Basin Water Company to build, administer and operate a pipeline to bring reclaimed water from the Christies Beach Wastewater Treatment Plant into the Willunga Basin

  The reclaimed water comes from an urban area that services over 150,000 people and treats 27 megalitres of household and industrial effluent each day. The Class B reclaimed water is suitable for drip and subsurface drip irrigation, but cannot be used for spray irrigation

  The Willunga Basin Water Company has implemented safety measures to minimise the health risks of using reclaimed water. There are warning signs at every property linked to the reclaimed water scheme, colour-coded pipes to distinguish those used for the reclaimed water, and a continuing education and information program for growers.

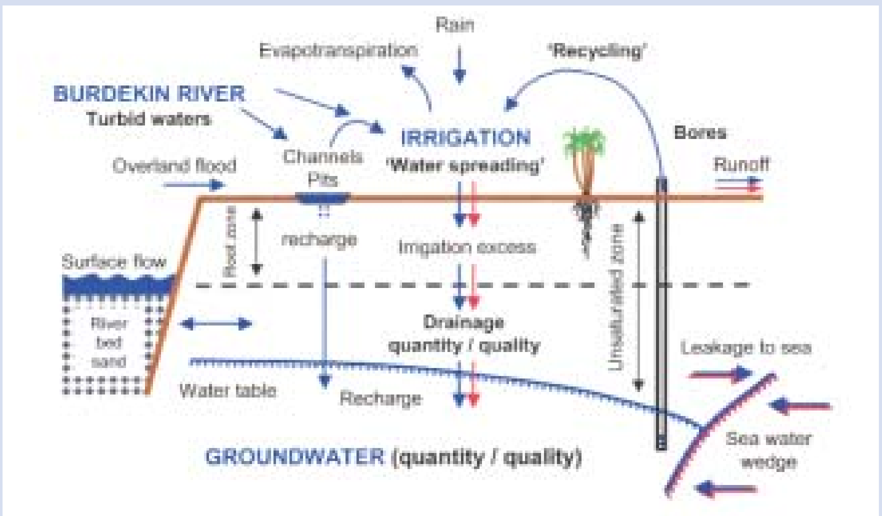
  Hydro-Plan designed the pipeline system to supply the water at pressure so growers can access the desired volume of water as needed

  The plant has an annual discharge of 9 gigalitres. The company can now provide 3 gigalitres of reclaimed water to the growers each year

  The additional nutrients within the reclaimed water are generally considered to be beneficial, while the salt content is only slightly greater than the groundwater it has largely replaced. As long as the irrigation applied is seen as supplementary and winter rainfall is used to advantage for soil leaching, salt accumulation should be of minimal concern. The success of this venture has ensured that other regions, particularly those with ready access to large urban areas, will consider using reclaimed water as a valuable source of irrigation water.

Framework showing inter-connectedness of water balance components and the need for a systems approach to assess impacts of changed management practices.
Image courtesy of *Lower Burdekin Initiative*

FIGURE 4.03 Water balance – surface water, groundwater and seawater wedge



Innovation 3: Reusing water

Groundwater and aquifer storage

As the demand for water grows, novel approaches are being employed to harness and reuse water. Leading practitioners include Peter Dillon of CSIRO Land and Water and his team, who were awarded the prestigious Great Man-Made River International Water Prize (UNESCO Science Prize) for advancing applications for aquifer storage and recovery.

The Centre for Groundwater Studies is an international research and education consortium that specialises in groundwater recharge and discharge, contamination and remediation. Australian Groundwater Technologies, based in South Australia, is linked to the Centre for Groundwater Studies and offers experience and provides skills in aquifer storage and recovery, wastewater reuse, and remediation of groundwater contamination (contact: Zac Sibenaler, Flinders University).

Reuse of urban effluent

Treated effluent from urban and industrial areas provides a small but increasing component of the water used for irrigation. Melbourne releases 12 gigalitres of treated effluent to inland rivers every year, and 327 gigalitres to coastal waters. Sydney releases 44 and 368 gigalitres respectively. Reuse has the dual benefits of environmental protection and resource recovery. Treated wastewaters from large cities are low in pollutants and pathogens and contain nutrients that benefit agricultural production. They can be used successfully if irrigation systems are designed to minimise direct water contact with plants, and salt loads are carefully managed. New enterprises in Werribee, Melbourne and Bolivar, Adelaide successfully use recycled water from urban areas for intensively managed horticultural crops. Consultants and engineers specialising in appropriate technology are accredited by the Irrigation Association of Australia.

Managing public and industry perceptions underpins acceptable water reuse (contact: the Australian Research Centre for Water in Society, the University of South Australia Water Policy and Law Group, CSIRO Land and Water, and Darryl Stevens of ARRIS Pty Ltd).

Reuse for environmental protection

The quality of irrigation drainage waters (pesticides, salinity, turbitity, nutrients and pathogens) is strictly monitored by environmental protection agencies or their equivalents.

For some rice farms, licences require that the first rainfall run-off be captured and recycled. For cotton, the toxicity of the pesticides used drove regulators to require a closed system. While water quality concerns initially drove the move to recycling, farmers now see advantages of water saving, and recycling is becoming more popular. About half the farms in the Murrumbidgee and Shepparton irrigation systems recycle water. In the Berriquin Irrigation District, about 90 percent of the farms will recycle water by 2010.

Intensive rural industries

Effluent waters from intensive rural industries, such as poultry or piggery operations, abattoirs, wineries and urban sewage are also being recycled in irrigation with the twin objectives of avoiding pollution and turning waste into wealth. With support from the *Natural Heritage Trust*, PIRSA Rural Solutions consultants Wayne Mossop and Trevor Clark assessed the vast amount of literature available and developed a manual and interactive decision-support software package for spreading a nutrient-rich waste on agricultural land. These are suitable for piggeries, cattle feedlots, dairy sheds, sheep feedlots, winery and distillery wastes, poultry shed wastes and processing of olives, fruit and vegetables.

A range of decision support programs is available. These include MEDLI and PIGBAL from the Queensland Department of Primary Industries, ERIM from the New South Wales Environment Protection Authority, and BEEFBAL and WASTLOAD from PIRSA Rural Solutions. FSA Environmental provides consulting services (contacts: Peter Watts and Robyn Tucker).

Novel low-technology solutions for treating and reusing effluent have been developed by CSIRO Land and Water scientists, John Blackwell, Tapas Biswas, Nihal Jayawardane and others. FILTER (Filtration and Irrigated Cropping for Land Treatment and Effluent Reuse) combines the use of nutrient rich wastewater for intensive cropping with filtration through the soil to a subsurface drainage system. It can be used in tandem with Sequential Biological Concentration, which in addition, concentrates the salt into a manageable volume for use in aquaculture or evaporation.

FILTER has been demonstrated in partnership with Griffith City Council, New South Wales, for treating secondary sewage; with Riverina Wines for winery effluent; and with domestic effluent schemes in India and China using ACIAR support.

Philmac **Driving water efficiency**

Achieving greater efficiency in water use is a driving force behind the research and development being undertaken by South Australian based specialist pipe fitting manufacturer Philmac.

The company is a world leader in the design, manufacture, marketing and distribution of high quality valves and fittings for pipeline systems and irrigation products and has developed a range of specialist products ranging from micro sprinklers through to horticultural sprinklers and fittings.

Philmac is also the Australian distributor for some of the world's leading irrigation brands, including Hunter and NaanDan, providing a one-stop shop service for irrigators and turf and landscape specialists.

Making better use of water

Philmac's General Manager – Sales and Marketing, Mr Mal Brown, said that making better use of water was now a primary focus across Australia.

'In recent years, water restrictions have become a way of life, with most major Australian cities now having restraints on when or what can be watered during the summer months. These limitations are only likely to increase in the future, which means consumers in particular are having to make better use of the water that is available.'

'This has increased demand for equipment that can make water delivery as efficient as possible. The development of modern drippers, micro-sprinklers, weather sensors, pop-up gear driven rotors and sprays has been part of this process, and Philmac is placing considerable effort into securing distribution for these types of products.'

Mr Brown said this focus had been one of the main reasons that Philmac had sought to be appointed as a distributor for the Hunter range, which was recognised as a world-leader in this field.

Gaining world-wide recognition

Philmac's own range of precision-made plastic compression fittings, threaded fittings and high quality valves have gained world-wide recognition, not just in the irrigation and landscaping fields, but for plumbing, mining, municipal and industrial purposes.

Philmac has established export markets worldwide, including the United Kingdom, Europe, the Middle East, South East Asia, North Asia and North America. Philmac is based in South Australia and has recently celebrated its 75th anniversary.

Above: Philmac manufacturing plant, Adelaide, South Australia

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Innovation 4: Salt management and interception

Salt management is a critical aspect of sustainable irrigation that requires a delicate balance in the application of water. A downward movement of water is required to leach out salt and avoid accumulation in the root zone, while applying too much water can create high groundwater tables that waterlog the soil and bring salt to the surface. Dealing with salty drainage water is a major challenge that requires technological solutions at a local and regional level, and policy and strategies that control salinity on a river-basin scale. Critically, control of water application and the design and efficient operation of supply and drainage systems underpins effective salt management.

Intercepting salt

Salt interception schemes are large-scale groundwater pumping and drainage projects that intercept saline water and dispose of it, generally by evaporation. As part of the *Murray-Darling Basin Commission Salinity and Drainage Strategy*, the states of New South Wales, Victoria and South Australia have pumped about 55 gigalitres of saline water from aquifers each year since 1988, thus keeping about 550,000 tonnes of salt out of the River Murray. A combination of drought and salt interception has reversed the trends on increasing salt concentration measured at Morgan, the monitoring reference point in the river.

Guidelines have been developed for on-farm and community-scale salt disposal basins (contact: Ian Jolly and Evan Christen, CSIRO Land and Water).

Pyramid Salt in Kerang, Victoria and Cheetham Salt in Wakool, New South Wales produce salt by evaporation from drainage water. Pyramid Salt sells the product as healthy salt in supermarkets. Salt is also sold for cattle licks and for the plastics and PVC industry. Some saline waters, for example in the Mallee Region, are richer in magnesium and sulphate ions. SunSalt has investigated the use of a mobile plant to recover magnesium sulphate from this bittern.

Saline aquaculture is being trialed by New South Wales Department of Primary Industries in collaboration with Murray Irrigation Limited at Wakool (contact: Stewart Fielder) and SARDI (contact: Anthony Cheshire) for prawns and trout, and explored in India as an important source of protein.

Sequential Biological Concentration

Sequential Biological Concentration (SBC), developed by CSIRO Land and Water at Griffith, New South Wales, is an inexpensive system for farmers and communities to achieve environmentally-sound management of salt while generating income streams from cropping, aquaculture and salt harvesting. Salty water progresses through a series of increasingly salt-tolerant crops to a pond for production of fish, crustaceans or eels. Discharge from the aquaculture pond can be used in a solar pond to generate electricity, and finally, can be evaporated for salt harvesting (Figure 4.04).

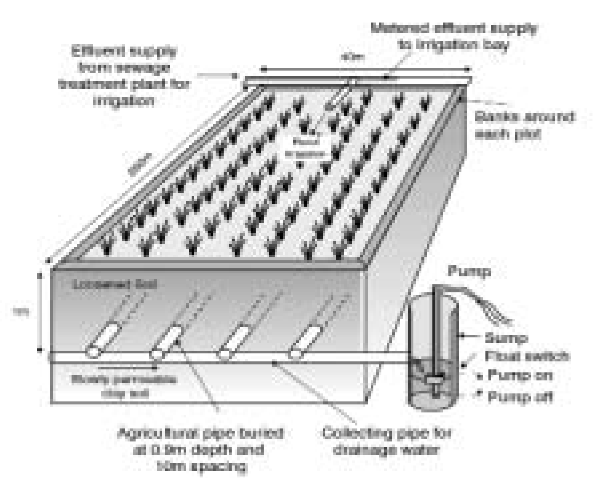
Partners include GHD; Griffith City Council; New South Wales Department of Infrastructure, Planning and Natural Resources; the *Natural Heritage Trust*; the MIA Sustainable Development Committee; and ACIAR.

Tools to aid decision making

Increasingly, computer simulation is being used to fine-tune irrigation management practices. SWAGMAN® is a suite of aids to decision making developed by CSIRO Land and Water to optimise productive cropping while managing salt and water tables. SWAGMAN® is also being used in Pakistan and Bangladesh in partnership with ACIAR. UNESCO *HELP (Hydrology for Environment, Life and Policy) Program* has been developed in partnership with Coleambally Irrigation Cooperative Limited and focuses on the Murrumbidgee Catchment as the first global reference basin (page 113).

The FILTER technique provides effective sewage treatment for nutrient and pollutant removal. Image courtesy of ©CSIRO Land and Water (NS Jayawardane)

FIGURE 4.04 Schematic layout of a typical FILTER Bay



IRRIGATION + WATER MANAGEMENT + ENVIRONMENT + PEOPLE + POLICY = WORLD'S BEST PRACTICE

BOX 4.05

The Murrumbidgee River in New South Wales is one of Australia's most reliable sources of irrigation water. Surface water from the river and extensive groundwater is used to irrigate large areas of rice, grains, vines, citrus and other horticulture.

CSIRO Land and Water, through its Griffith Laboratory, has been working in the Murrumbidgee, Coleambally and Murray Irrigation Areas with irrigators, commodity organisations, community groups and state agencies to provide options for successfully managing irrigation areas and to address issues such as:

- Rising watertables
- The growing number of salt-affected areas
- Greater restrictions on water availability
- Increased environmental requirements

Actions

The building blocks of the solutions developed via this collaboration include:

- Establishing and maintaining the regional weather record
- Precise measurement of crop water use and water balances
- Quantifying watertable influences and salinity changes
- Using rural sociology knowledge to encourage stakeholder engagement
- Developing the SWAGMAN® series of models to educate, propose and assess options and to make the links between climate, irrigation, crops, salinity, groundwater and economics
- Education and training programs
- Scientists as change agents, working with multi-disciplinary teams
- Remaining engaged with the community and its issues and recognising the different levels of relationship building and decision making

Results

Many of the results of this process have been included in the *Land and Water Management Plans* for the regions.

The structure, impact and success of this program is recognised internationally through the UNESCO *HELP* (*Hydrology for Environment, Life and Policy*) *Program*, which is designed to recognise and promote those catchments in which science, people and policy come together to look after the environment and production. The Murrumbidgee is the first reference catchment to be recognised as an example to the rest of the world.

Shahbaz Khan from CSIRO providing options for successfully managing irrigation. Image courtesy of ©CSIRO Land and Water

Nominated HELP Pilot Drainage Basins

North and Central America

– Lake Ontario (USA, Canada)
– Red-Arkensas/Little Washita (USA)
– San Pedro (USA, Mexico)
– Luquillo Mountains (Puerto Rico)
– Panama Canal (Panama)
– Yakima (Washington USA)
– Hudson (New York and New Jersey, USA)

Asia

– NE Thailand and Vietnamese Delta (subbasins of Mekong)
– Subernarekha (India)
– Yasu or Tama (Japan)
– Aral Sea (Central Asia)
– Uda Walawe (Sri Lanka)
– Tarim (China)

South America

– Rio Jau and/or Rio Branco or Ji-parana (Brazil)
– Rio Jequetepeque Peru)

Africa

– Olifants (South Africa, Mozambique)
– Thukela (South Africa)

Europe

– Herault (France)
– Upper Danube (five countries in Europe)
– Spree-Havel (Germany)
– Upper Severn (UK)
– Thames (UK)

Australasia

– Motueka (New Zealand)
– Mount Lofty (Australia)
– Murrumbidgee (sub-basin of Murray-Darling)

Innovation 5:
Managing catchments to maintain water supplies

Salinity and run-off

Changes in land use and tree planting or afforestation can help manage erosion and salinity but may also reduce run-off of good quality water. Recent research by the Cooperative Research Centre for Catchment Hydrology and CSIRO Land and Water documents and predicts the effects of changing vegetation patterns on the yield of run-off water in catchments. This modelling capability will underpin policy on plantation forestry, and provides regional communities and agencies with the information required to target tree planting to manage salt while maintaining run-off of good quality water.

Loddon demonstration

Sinclair Knight Merz was commissioned by the Victorian Government to develop a scheme for modelling tributaries to reduce salt downstream by selecting priority areas for tree planting. The Loddon catchment was used as a pilot (Figure 4.06). The REALM model was used to develop a series of maps for interception of salt and water, and by combination, effects on stream salinity. The approach is being extended to the Campaspe, Goulburn and Broken catchments in Victoria.

New South Wales Department of Infrastructure, Planning and Natural Resources is implementing a suite of salinity models to predict the mobilisation of salt in the landscape and its movement into streams. In particular, CATSALT can integrate information from the paddock to provide simulations at the catchment scale. It provides results through the Land Use Options Simulator, and will be used as input for the hydrological model, IQQM (Integrated Quantity and Quality Model), to assess the cumulative effects of multiple catchments to meeting within-valley and end-of-valley targets for salt.

FIGURE 4.06 Map of tree planting in the Loddon catchment showing optimised planting to manage salinity while maintaining run-off

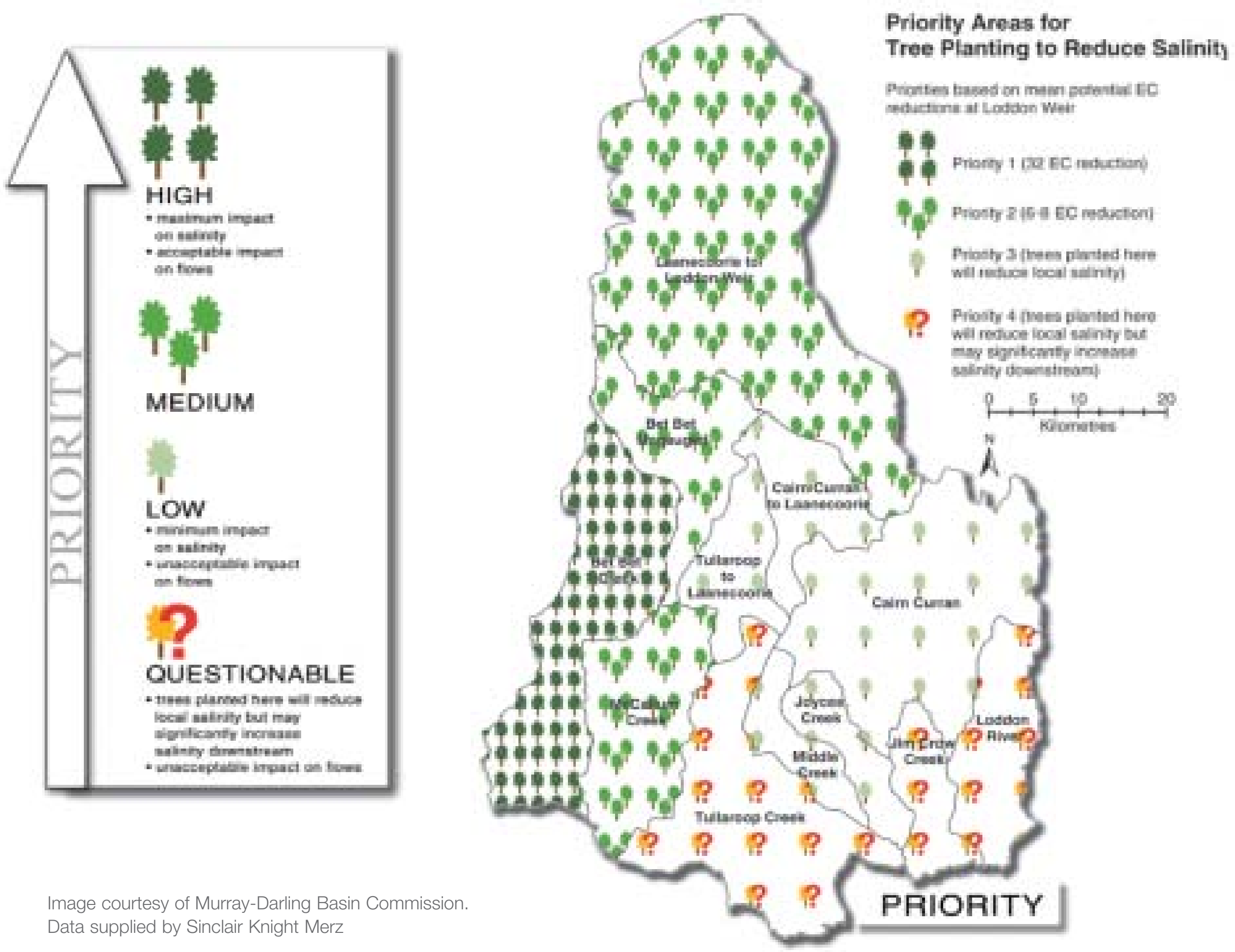


Image courtesy of Murray-Darling Basin Commission.
Data supplied by Sinclair Knight Merz

Innovation 6: Minimising losses of water

Improved supply infrastructure

With a combined replacement value of the irrigation asset – control structures, channels and storage facilities – of more than $AU15 billion, it is little wonder that managers are keen to make the most of these assets. Almost all the major irrigation water delivery companies and private diverters have upgraded their supply systems in the past few years – for example, the highland irrigation areas of the Murray in South Australia.

In recent years, improved automation of surface irrigation has allowed a much greater control of water onto bays. Controls include pneumatic and electronic sensors positioned in bays close to the supply gate; timers that open and close irrigation gates at set times; and fully automated centralised control of multiple gates and channels using hydraulic control, such as those supplied by Padman Stops Pty Ltd.

Surge irrigation is a recent variation of surface irrigation that improves efficiency of row crop irrigation on freely draining soils.

The major south-eastern companies – Coleambally Irrigation Cooperative Limited (CICL), Goulburn-Murray Water and Murray Irrigation – have invested heavily in identifying excessively leaky supply channels and installing automatic control structures with remote monitoring and control.

CICL has worked extensively with Rubicon Systems to upgrade the monitoring and control of channels in a $AU6.9 million program called *Total Channel Control*. This has involved the installation of remote monitoring and control stations based on radio telecommunications and a web-based ordering and distribution control system. The companies have implemented systems to optimise distribution and to use channel capacitance to advantage by applying the latest mathematical developments, such as genetic algorithms developed by Optimatics (contact: Dr Angus Simpson, University of Adelaide).

In the dairy pasture areas of northern Victoria AWMA Pty Ltd has developed irrigation system controls and on-farm automation solutions for broad-acre farms. They have demonstrated water savings of at least 10 percent through automated water control systems. A significant number of farms have taken up the system in the last two years and rollout continues to increase (contact: Brett Kelly at AWMA).

Goulburn-Murray Water is working with the University of Melbourne Department of Engineering and new Melbourne Centre for Water Research to find ways of operating open channel systems to give flow and delivery characteristics that are much more like piped delivery.

All the major supply companies have implemented telephone or computer-based ordering systems to improve scheduling, smooth delivery peaks and troughs, and decrease overflow losses. Ways of measuring water delivery at the farm gate are also changing.

The robust Dethridge Wheel, while reasonably accurate when meticulously installed and maintained, is notorious for underestimating water volume in less than ideal conditions and has a delivery error of plus or minus 20 percent. It is being replaced in the Coleambally Irrigation Area by Rubicon's FlumeGate™, a device used to control and measure flow through a structure (flume) using differential pressure sensors. The flumegate is automated, solar powered, safer to use, more accurate, cheaper to maintain and continuously monitored and controlled. In the Murrumbidgee Irrigation Areas a program of replacing Dethridge wheels with pipe outlets equipped with ultrasonic depth meters is in place. Murray Irrigation Limited is trialling other pipe meter solutions.

Pratt Water is investigating ways of changing delivery systems to reduce losses. The company is working with Murrumbidgee Irrigation on options ranging from changing open channels to pipes, to increased off-river and on-farm storages. Pratt Water, in association with the ANZ bank, has recently announced a low-interest loan of $AU100 million to assist growers in adopting improved irrigation technology.

Low cost flexible plastic piping under trial near Griffith, New South Wales, as part of the Pratt Water study into water savings and efficiency opportunities in the Murrumbidgee Irrigation area. The piping, laid in existing open irrigation channels, has demonstrated significant reductions in losses from seepage and evaporation, and enabled better management of water flows. Image courtesy of Pratt Water

BOX 4.07

MODERNISING AN IRRIGATION SYSTEM IN THE MURRAY OF SOUTH AUSTRALIA

Work on modernising the original open channel supply systems in the highland irrigation areas began in the 1970s. By 1983, 63 percent of the 10,000 hectares of orchards and vineyards had been upgraded. In 1992, a seven-year $AU35 million program to replace old channels and pipelines was initiated by a tripartite agreement between the state and national governments and irrigators.

SA Water introduced Water on Order, a computerised system that allows water to be available within two hours of lodging an order, and a new Irrigation Act. The Act allowed water to be transferred between irrigators and districts, provided for retirement of unsuitable horticultural land, and reviewed the suitability of irrigated properties to remain sustainable.

The Irrigated Crop Management Service (ICMS) at Loxton, South Australia, pioneered irrigation equipment testing. This led to the formation of the Australian Irrigation Technology Centre, now run by the University of South Australia Urban Water Resources Centre. ICMS also developed a systematic soil survey to match proposed irrigation to soil characteristics and permeability, an approach since promoted by private service providers such as Dr Ken Wetherby of Soil Survey Specialists and Phillip Binden of Yandilla Park Agriculture Division.

The Central Irrigation Trust (CIT) has now assumed management of the highland areas and is currently rehabilitating the Loxton Irrigation District. The River Murray Catchment Management Board is facilitating education and training to help growers meet the target water-use efficiency.

The results of these activities include great improvements in both water delivery and grower management. Growers can manage irrigation with control and precision. Savings of 30 percent in the distribution system have been achieved and drainage to the sensitive river environment has been reduced.

BOX 4.08

GOULBURN-MURRAY WATER

Farms in the Goulburn-Murray Irrigation District generate $AU1.8 billion at the farm gate. The agribusiness firms servicing irrigation farms contribute $AU10 billion to regional economies.

Current research indicates that within the Goulburn-Murray Irrigation District:

- Over 50 percent of irrigated land has been laser graded
- Over 60 percent of dairy farms now have water reuse systems
- Over 45 percent of farms are subject to whole-farm plans adopted voluntarily by farmers to improve natural resource management

Increasingly, farmers are using micro-irrigation technology and automatic irrigation systems. Pressures from declining commodity prices and increasing costs provide a powerful incentive to use water productively.

Throughout Australia, channel water supplies are being replaced and supplemented with pressurised pipe systems. Good examples are the rehabilitation of the highland irrigation areas in South Australia (Box 4.07); the Angas Bremer scheme, also in South Australia (Box 4.08); and the Euston Cooperative high-pressure pipeline in south-western New South Wales. Growers have funded the Angas Bremer and Euston schemes.

Leading Australian companies in pipe manufacture and fittings include Vinidex (pages 56, 57) and Philmac (page 111). The *Know the Flow* website hosted by ANCID provides comprehensive information on flow metering equipment for rural water supplies, including water suppliers, testing laboratories, manufacturers and distributors.

Murray Irrigation Limited (MIL), Australia's largest privately-owned irrigation company, has developed a world-leading policy on setting limits on irrigation intensity according to soil permeability, local groundwater conditions and irrigation method used.

MIL delivers 1.2 million megalitres of water to 2,400 landholdings in southern New South Wales each year. The company needed to manage rising watertables and the associated threat of salinity by encouraging water-use efficiency and best management practices.

In 1997, Murray Irrigation introduced a world first, total farm, water balance policy and set limits on irrigation intensity to prevent long-term degradation of the groundwater and soil resources. CSIRO Land and Water researchers used SWAGMAN® Destiny, a decision-support software program, to map the intensity of water application that could be made safely and avoid excessive groundwater accessions (page 113).

The policy is part of the extensive *Land and Water Management Plan* for the region, which includes components to restore significant wetlands and remnant vegetation. In related activities since 1995, the company has also:

- Spent $AU3.45 million on seepage control and channel sealing to decrease irrigation delivery system losses
- Spent around $AU16 million on telemetry systems that monitor and provide control on channel and diversion structures. (There are 14 environmental monitoring sites that are monitored remotely)

Combined with an education program, irrigators and other community members are taking renewed responsibility for their area. Watertables are generally in decline, wetlands are receiving managed water supplies and there are many revegetation projects underway. In 2003, the company and community effort was recognised with an Australian Water Association Environmental Merit Award.

Laser levelling and layout design

Surface irrigation is still the main form of irrigation in Australia, although with water supplies becoming more valuable, there is increased interest in using more controlled forms of irrigation, especially on high-value horticultural crops. For some soil types and well-designed irrigation layouts, well-managed surface irrigation can be efficient in minimising loss of water into the deeper soil layers that are inaccessible to plant roots.

The advantages of improved surface irrigation design and layout are often fully realised when they are implemented within a whole-farm plan to optimise use of soils and design the best layout for supply and drainage systems. Consultants, TAFEs, state departments of agriculture and primary industries, Cooperative Research Centres and university short courses all provide training or services.

BOX 4.09

OPTIMATICS

Optimatics is a small company specialising in the optimisation of water distribution networks. The Adelaide-based company, which was created to commercialise world-leading research by the University of Adelaide into the use of genetic algorithms for the water industry, provides a specialist engineering service to water authorities and their consultants.

The Optimatics Genetic Algorithm (OGA) adds one step to the analysis of complex water distribution systems in order to find better solutions than would otherwise be possible. Invariably, the result is more reliable service, better hydraulic performance, and significant cost savings.

Project specific software is developed to 'breed' the best solutions by evaluating millions of potential solutions and allowing only the fittest to survive. It is a valuable and easily integrated extra step in all planning, design and investigation processes. Compatible with all hydraulic network models, the OGA automates the traditional, manual trial-and-error processes. Each proposed new hydraulic component is subjected to a rigorous cost-benefit analysis that takes into account all existing components and overall objectives and constraints.

The technique has been successfully applied to many water distribution systems in Australia and the USA with proven cost savings. As a result, Optimatics has built a considerable reputation with major urban and rural water authorities in Australia and North America.

BOX 4.10

ANGAS BREMER

The Angas Bremer District is located near Strathalbyn, beside Lake Alexandrina, about 30 kilometres from the Murray Mouth and 60 kilometres south east of Adelaide. The 160 growers irrigate 7,100 hectares dedicated mainly to wine grapes (5,400 hectares), lucerne and potatoes. In 1981, groundwater use for irrigated agriculture reached 27 gigalitres per year – four times the annual groundwater recharge and totally unsustainable.

Led by Ray McDonald on the Angas Bremer Water Management Committee, the growers planned and funded an alternative water source: a pipeline from the River Murray. It was designed and installed by Hydro-Plan Irrigation Consultants, with director John Gransbury.

Agrilink International installed a set of telemetry monitored test wells to help monitor the impact of irrigation on the lower lying areas. Tony Thompson from the South Australia Department of Water, Land and Biodiversity Conservation helped introduce irrigation annual reporting to highlight the wide variation in irrigation practices and to provide accurate district irrigation statistics. Growers use these in a self- and peer-learning process to improve their management practices. Recently, Tony has worked with growers and Richard Stirzaker from CSIRO to adapt the simple FullStop™ wetting front detector device.

The combination of better measurement and real-time information about water movements in the soil has changed irrigation practice and benefited growers and the environment. Remotely monitored metering and sophisticated control systems have resulted in a very well controlled supply of water.

After 20 years of determined effort, use of groundwater has fallen by more than 90 percent to 2 gigalitres per year. Both the farm-gate dollar income and the area of land irrigated have increased, with less use of irrigation water.

Aquatek Irrigation consultants are prominent in the design of recycling systems in the summer rainfall cotton areas of northern New South Wales. Water is stored in large dams and 'ring tanks' to provide distribution channels, and in recirculation storages to collect drainage run-off and rainfall run-off.

Laser-assisted levelling combined with layout design has been a boon to irrigation, in particular to surface irrigation. Good grades improve the evenness of distribution and speed of irrigating, and reduce labour costs to manage water. Australian operators have optimised layout design to minimise the volumes of soil that need to be shifted, and to deliver water efficiently around the farm.

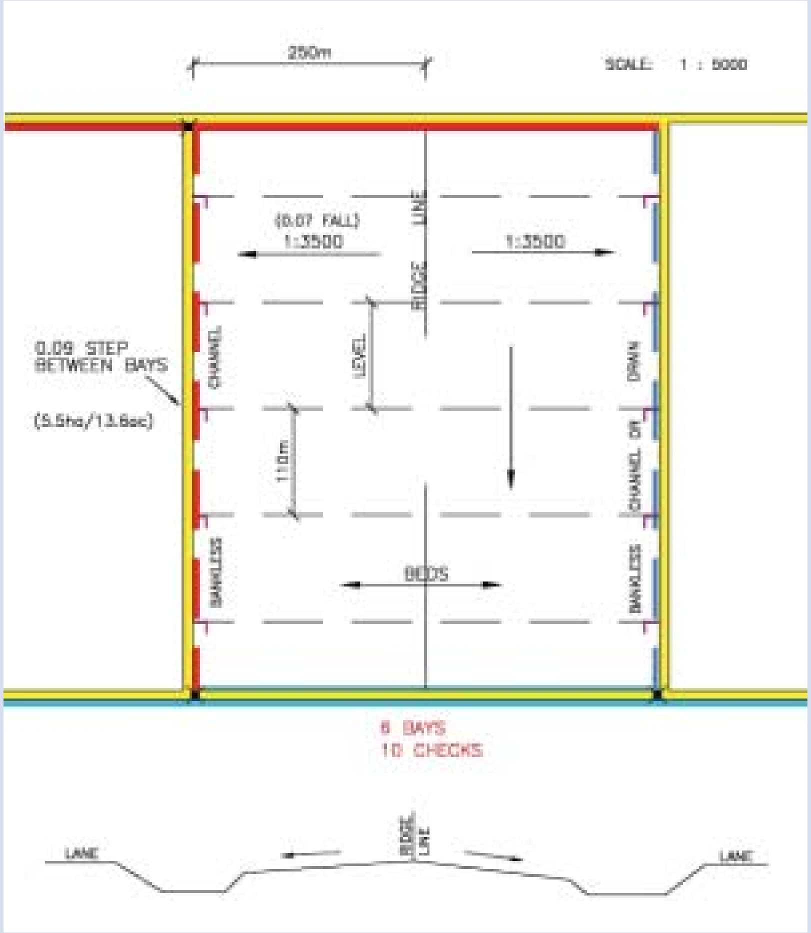
The latest development in this area is the 'bankless channel' system (Figure 4.11). The bays are graded flat, with a rooftop in the centre of the bay and a gradient of 1:3500 from the centre to the bankless channel, with bays stepped down the slope. The layout is suitable both for crops grown on the flat, such as rice, and row crops such as maize. Benefits include less labour, less drainage, more even application of water across the field, deep ponding for weed control, and automation of water control.

Global positioning systems (GPS) are used on earth-moving plant to give very precise grades with a minimum of soil disturbance. Irrigation surveyors have greatly assisted in improving surveys of soil and topography and in providing design and construction plans for effective surface irrigation. The Surveyors Board of Victoria provides information on designing GPS surveys and accredits professional surveyors.

The National Land and Water Resources Information Management Toolkit prepared by the *National Land & Water Resources Audit* and ANZLIC – the Spatial Information Council, also provide best-practice guidelines for use of GPS and mapping. Consultants and engineers are accredited by the Irrigation Association of Australia, and are listed at the Association's web page.

FIGURE 4.11 • Photograph and plans for bankless channels

Bankless channel irrigating trees on beds – Tim Commins, Whitton, Murrumbidgee Irrigation Area. Image courtesy of B. Polkinghorne



Bankless channel design for rice and other crops with roof top (ridge line). Prepared for CSIRO Land and Water, Griffith laboratory. Image courtesy of PHL Surveyors

Innovation 7: More crop with less water

In Australia, a variety of new irrigation methods and techniques have been developed by CSIRO, state agencies, Cooperative Research Centres, irrigation corporations, private irrigation agronomists and consultants, and by enterprising farmers themselves. Several commodity group industries have proudly demonstrated improvements in water-use efficiency and crop quality over recent years.

Industries using water wisely

Dairy

Irrigation of dairy pastures is the single biggest user of water in Australia. Large dairy areas, such as the Goulburn region around Shepparton in Victoria, are highly dependent on assured water for irrigation. Murray Dairy, one of the regional groups associated with Dairy Australia, has worked closely with the Goulburn-Broken Catchment Management Authority to improve irrigation practice and cope with the recent drought.

Murray Dairy is measuring water-use efficiency for milk and butterfat production. Baseline studies of current and best management practices show that individual farm performance is improving. The Victoria Department of Primary Industries at Tatura has compared irrigation methods and found that sprinkler and subsurface drip is more efficient than border check and surge irrigation methods. The emphasis on best management practices means that the dairy industry is well placed to continue adapting and innovating (contacts: Dr Peter Doyle, Kyabram Research Institute; Ken Sampson, Goulburn-Broken Catchment Management Authority; Maurice Incerti, Murray Dairy; Matthew Bethune, Department of Primary Industries, Tatura).

Viticulture

Shortage of water is the factor most likely to limit the growth of the Australian wine industry. Regulated deficit irrigation (RDI) and partial root zone drying (PRD), are techniques that save water while improving production and grape quality. These novel techniques are being tuned by the Cooperative Research Centre for Viticulture in a major project with the Murray-Darling Basin Commission, CSIRO Plant Industry, the Victoria Department of Primary Industries, the National Wine and Grape Industry Centre, and SARDI (contacts: Anne-Maree Boland, Department of Primary Industries, Victoria and Rob Walker, CSIRO Plant Industry).

Rice

Typically, up to 150,000 hectares of temperate varieties of rice are sown each year in the Murray Valley of New South Wales and Victoria, and in the Murrumbidgee Valley of New South Wales, producing about 1.2 million tonnes of rice annually. Including flow-on effects, the industry generates over $AU4 billion annually for regional communities and the Australian economy.

Over the past twenty years, water-use efficiency has more than doubled as a result of increased yield combined with reduced water use (Figure 4.12).

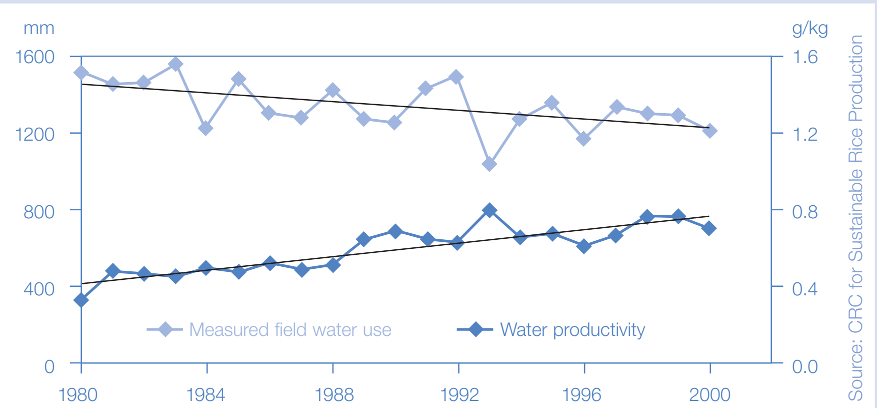
Yield has increased through an effective breeding program conducted by New South Wales Department of Primary Industries agronomists and CSIRO Plant Industry scientists. Water use has been reduced by restricting rice growing to less leaky soils, by reducing the length of ponding of floodwaters, and by using precision agriculture to manage salinity and fertilisers. The industry has developed the *Environmental Champions Program* to accredit growers and encourage them to maintain and develop best practice (contacts: Rice CRC, SunRice and Rice Growers Association of Australia).

Cotton

By world standards, the Australian cotton industry ranks highly in water-use efficiency, producing high yields per hectare and per megalitre of water. The industry has invested in a breeding program for high yield and pest resistance. Water management is tightly controlled through laser levelling of fields, water recycling, improved use of weather forecasting, and precision scheduling.

Efficiencies in irrigation application generally exceed 80 percent. Most cotton soils are suited to surface furrow irrigation, with drip and lateral move overhead irrigation systems used to a smaller extent. Farm and channel design, and the use of on-farm water storages and off-farm water infrastructure, are all carefully managed to optimise water-use efficiency.

FIGURE 4.12 Rice irrigation water use efficiency trend – Murrumbidgee Irrigation Areas (MIA)



Declining use of water (mm) and increase yield of rice over the last 20 years results in a doubling of water use efficiency (g/kg).

Australian cotton growers are optimising water use and yield using new software, HydroLOGIC, developed by CSIRO Plant Industry with the Australian Cotton Cooperative Research Centre (Cotton CRC). Growers provide information on soil moisture, cotton boll numbers and leaf area and the software integrates long-term climate data to predict crop yields and advise on optimum dates for irrigation.

Auscott is one of Australia's largest agribusinesses, with extensive irrigation enterprises in central and north-west New South Wales. Auscott processes and markets cotton from about 300 Australian cotton growers (contacts: Cotton CRC; David Anthony, Auscott Limited).

Weather data and water use estimates

Daily weather information is vital to better manage irrigation. Weather stations such as the Campbell Scientific Weatherhawk can be connected to a range of soil water measurement devices to inform irrigation decisions. In many irrigation areas, the measured and derived values of daily evaporation rates posted through the Australian Bureau of Meteorology (page 85) are available in the media and in electronic formats.

Companies such Agrilink International (page 142), Servag, Measurement Engineering Australia, and Environment Information Technology are advising growers about water-use equipment, servicing and irrigation scheduling.

Expert advice is provided by the Bureau of Meteorology through the *Climate Services Program* and Special Services Unit. Services include real-time forecasting, climate analysis and severe weather forecasting. Australian Rainman, a software package on CD-ROM, contains monthly and daily rainfall for 3,800 locations and streamflow records for 9,500 locations. FARMWEATHER™ contains expert commentaries, synoptic charts, satellite images and four-day forecasts of temperature, rainfall and wind speed to help people make better decisions about planting, irrigation, spraying and harvesting.

Soil water monitoring and linked systems

Australian technology has led the world in the recent development and application of electrical capacitance sensors that operate on similar principles to neutron probes. Their advantages are reduced cost, no radiation hazard, and the ability to continuously monitor changes in water content through the soil profile. Sentek Sensor Technologies, based in Adelaide, has pioneered the development of an extensive range of sensors. These now come with user-friendly software to assist in analysis of real-time information and in irrigation management.

An alternative way of managing irrigation is to measure when the soil has sufficient water for plant growth. A deceptively simple device, FullStop™ (page 121) enables the soil-wetting front to be measured through location of a pair of detectors, one half-way down

BOX 4.13

UNDERSTANDING THE HYDRAULICS OF SURFACE IRRIGATION

Major problems of surface irrigation are non-uniformity of water application and over-irrigation. A range of complex interactions need to be understood and optimised to achieve greater irrigation efficiency. These include field length, slope, flow rate, infiltration characteristics, hydraulic resistance, and water advance and recession times during irrigation. A comprehensive study through field trials is difficult but the use of simulation models is an alternative approach. A number of complex models are currently available for simulating irrigation events, but the suitability of these models under field conditions is not known.

Associate Professor Basant Maheshwari of the University of Western Sydney and his group evaluated a number of surface irrigation models, including SIRMOD and SRFR, for the prediction of advance and recession times, run-off and volume balance error using field data of over 100 irrigation events monitored under a range of field conditions. It was found that the SIRMOD was the most suitable for the field conditions with prediction error generally less than 15 percent. The study also led to a better methodology for estimation of infiltration characteristics and hydraulic resistance values and a design manual for use by irrigation practitioners and rural water authorities.

This research has potential benefit world-wide, providing the opportunity to increase irrigation efficiency, reduce costs, and improve environmental conditions.

Understanding the hydraulics of surface irrigation. Image courtesy of University of Western Sydney

Sprinkler irrigation. Image courtesy of MDBC. Photograph by Arthur Mostead

and another near the bottom of the root zone. A visible signal at the surface helps farmers adjust irrigation to plant needs as they grow through the season. FullStop™ is being used by about a hundred farmers in the Angas Bremer (page 117) region to share information on best practice and develop their own accreditation system. The technology is owned by CSIRO Land and Water. It is being marketed in South Africa by Agriplas Ltd under licence, with further markets being developed in South Africa, Europe, China and South America (contacts: Richard Stirzaker and Paul Hutchinson, CSIRO Land and Water).

Controlling plant water status

Surface drip irrigation continues to be developed, adapted and better managed in a wider range of crops throughout Australia. Companies such as Philmac (page 111, 123) and Netafim are providing improved sprinkler and dripper technologies that give more uniform distribution and improve water-use efficiency.

Precision farming

Electromagnetic surveys (EMS) are used in whole-farm planning to provide information about the location of salts stored in the soil. EMS can identify suitable land for drains, on-farm channels, storages, paddock irrigation design, cropping and pasture planting, as well as providing information on where to make remedial applications of gypsum. The methods have been developed and tuned by the Cooperative Research Centre for Sustainable Rice Production (contact: Geoff Beecher).

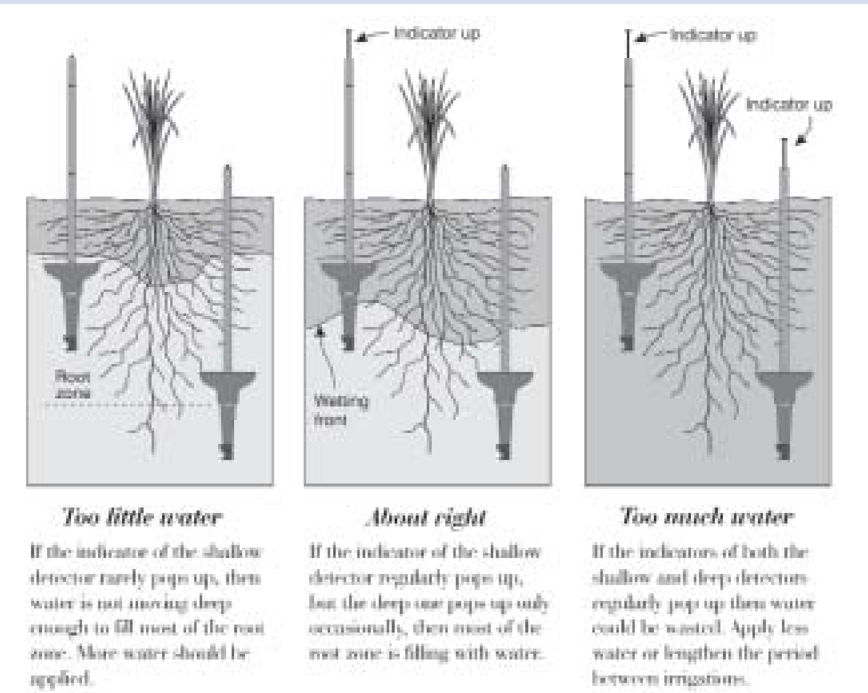
With assistance from New South Wales Department of Primary Industries, Murray Irrigation Limited and Coleambally Irrigation have included soil sodicity criteria in assessing soil permeability for rice-growing approvals, and for rejecting leaky soils. This improves the accuracy of results obtained by EM survey and clay content alone.

Precision farming uses global positioning systems (GPS) in combination with EMS and airborne video mapping or satellite imagery. Increasingly, producers, professional agronomists and water suppliers are able to map areas of different crops and understand variations in soil character and water within fields, and so design land and farming system to match the variation. This technology could support a redesign of agriculture and support the concept 'double the yield in half the area' that has been proposed as a target.

In Australia, Wingara Wine Group, Deakin Estate near Mildura in Victoria (contact: Jeff Milne), Katnook Estate, Coonawarra in South Australia, (contact: Chris Brodie), Vasse Felix in the Margaret River region, Western Australia (contact: Bruce Pearse), and the Southcorp Group (page 122) use precision farming commercially to improve water-use efficiency and improve grape quality. Interest in Australian technology is being shown by vignerons in Chile, New Zealand, South Africa and the USA.

Specterra, based in Perth, provides precision agricultural services nationally (contact: Andrew Malcolm). CSIRO Land and Water (contact: Rob Bramley) and the University of New England (contact: David Lamb) are active in refining the techniques.

FIGURE 4.14 The FullStop™ Wetting Front Detectors

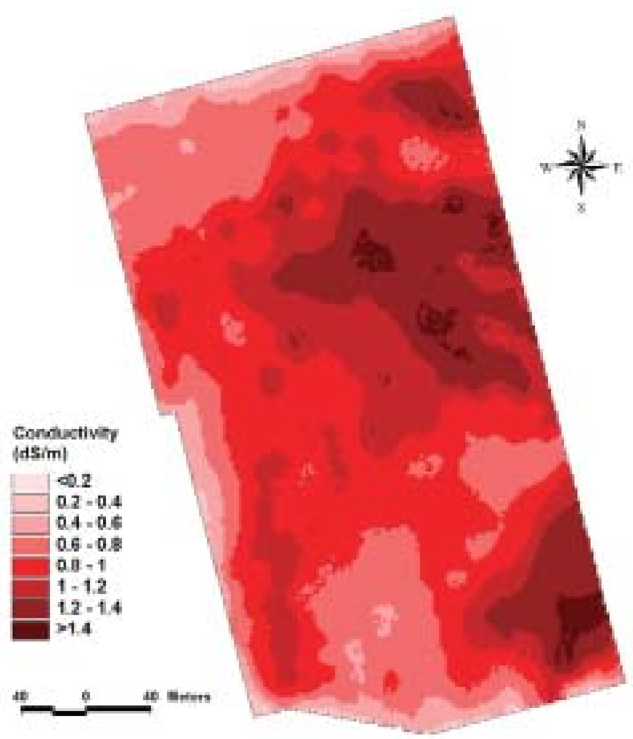


Matching irrigation to the plants' needs. Image courtesy of Richard Stirzaker, ©CSIRO Land and Water

BOX 4.15

SOUTHCORP EM SURVEY

A2 – EM survey
Horizontal mode, December 2000



Southcorp, Australia's largest premium wine company, has more than 8,000 hectares of vineyards. To ensure that it manages these vineyards sustainably, the company has introduced vineyard salinity mapping using electro-magnetic induction (EM38). The EM38 is an instrument that measures the electrical conductivity of the soil, which is a measure of the salt concentration. Survey positions are recorded to an accuracy of one metre by a global positioning system through a receiver mounted on a bike. This allows the elevation and other geographical features of the vineyard to be mapped at the same time.

The information obtained from EM38 survey has accurately identified the location of salinity problems in the Company's Clare Valley vineyard in South Australia. As a result, vineyard management has changed to ensure that problems are repaired. The changes include strategic application of gypsum, modified water storage to lessen seepage losses from farm dams, and improved irrigation practice.

Map showing variation in bulk electrical soil conductivity, as measured using electromagnetic induction (EM38) survey, in a Clare Valley vineyard. In this instance, variation in the signal from the EM38 sensor has been shown to predominantly reflect variation in soil salinity (Bramley, 2003). Image courtesy of Richard Hamilton, Southcorp Wines; Susie Williams and Rob Bramley, ©CSIRO Land and Water

BOX 4.16

IMPROVING WATER-USE EFFICIENCY IN RURAL QUEENSLAND

The Queensland Government initiated the *Rural Water Use Efficiency Initiative* (RWUEI) in 1999 as a partnership between industry and government. The objectives were to improve the use and management of available irrigation water, thereby improving the competitiveness, profitability and environmental sustainability of Queensland's rural industries. Specific aims included reducing water losses from storages on farm and in the distribution system, and extracting more value from the irrigation water used.

Intended outcomes were to generate an extra $AU280 million in agricultural production by saving and making better use of up to 180 gigalitres of water. This additional production was expected to generate an extra 1,600 jobs in regional Queensland, while improved control and management of irrigation water was expected to reduce losses of pesticides and nutrients into rivers and groundwaters.

Action

RWUEI provides financial assistance to cotton, sugar, horticulture and dairy farmers, through their industry organisations, to purchase water equipment and the latest irrigation technology and services to achieve best practice in irrigation water management. It has also funded a working party to address farm water-storage issues. In the first four years, the government has spent $AU41 million, with irrigators making complementary contributions.

RWUEI was scheduled to end in December 2003. It has been extended for two years, with a budget of $AU7.5 million.

The results

An evaluation in 2003 indicated that the initiative had more than met its aims. Queensland Fruit & Vegetable Growers branded their component 'Water for Profit' and concluded that substantial gains in irrigation efficiency had been made, with over $AU160 million in water savings and productivity gains. Queensland Canegrowers said that the $AU3.4 million investment by government resulted in total purchases by growers of around $AU14.7 million.

RWUEI won an award at the 2003 Irrigation Awards staged by the Australian National Committee – International Commission on Irrigation and Drainage (ANCID). The award recognised RWUEI's leadership role in helping farmers improve their rural water-use efficiency.

PHILMAC: MORE PECANS WITH LESS WATER

Philmac products have helped turn Queensland pecan nut farm, Bromelton House, from a marginal concern into a water-smart, highly efficient and profitable operation. Two years ago, the farm, which is south of Brisbane, had ten different types of sprinklers, making it impossible to accurately determine how much water was being applied to each tree. Cleaning and clearing sprinkler heads blocked by insects was also a time-consuming, labour-intensive and costly exercise.

Solution

Installing Philmac StreamMaster sprinklers enabled farm operators to standardise the amount of water applied to each tree and accurately determine the amount of water each tree received. StreamMaster sprinklers, which are designed to resist blockage by insects, considerably reduced the labour costs in clearing clogged sprinklers and helped overall efficiency.

The source of water to the property was also broadened from a single bore to include a large lagoon, two more bores and the nearby Logan River. This required a filter capable of handling high volumes of water without power. Philmac solved the problem by recommending the installation of its popular Lama Calado automatic self-cleaning screen filter. Philmac pipe fittings were used to link up the entire system.

Success

The changes enabled a new fertigation regime to be introduced, significantly improving overall farm efficiency. In just two years, production from the plantation's 1,700 mature trees and 1,900 immature trees rose from 9 tonnes per hectare to more than 31 tonnes, with a future target of 40 tonnes.

Philmac StreamMaster sprinkler. Images courtesy of Philmac

Professional associations and networks

Profession associations

The Irrigation Association of Australia has supported innovation as a way of helping the industry take up the challenges of moving to more efficient water use by:

- Raising professional skills through developing and providing training, eg its certification program for the design, auditing and installation sectors
- Developing and promoting standards for irrigation equipment and processes
- Providing access to the latest irrigation technology and information through its quarterly journal, website, conferences and exhibitions
- Working with organisations and groups to implement water use efficiency programs eg *WaterWise Garden Irrigation Program* developed with WA Water Corporation
- Developing a vision for water use in the Murray-Darling Basin with World Wildlife Fund (WWF), called FutureWater
- The IAA's quarterly journal, *Irrigation Australia*, is the definitive source of information about new equipment and practices for the Australian irrigation sector

As the direct involvement of state government agencies in managing the irrigation water delivery has decreased, the roles of private companies and state-owned corporations have increased (page 106). Many of the companies are now part of the Australian National Committee on Irrigation and Drainage (ANCID), which is linked to the International Committee on Irrigation and Drainage.

The National Farmers Federation hosts the Young Irrigators Network, another indication of more active interest and involvement in shaping the future of Australian irrigation.

Extension and outreach

Each state has recently developed outreach and extension programs to aid irrigation management. For example, the Queensland *Rural Water Use Efficiency Initiative (RWUEI)* has worked closely with the major irrigated commodity groups to improve returns from irrigation (page 122). New South Wales Department of Primary Industries hosts the Waterwise program and state agencies share a specialist unit on water-use efficiency hosted by the Department of Infrastructure, Planning and Natural Resources at Dubbo.

In Victoria, the centre of irrigation research and advice is at Tatura in the Goulburn region; and in South Australia, the Loxton Irrigation Centre on the Murray serves this role. Other good examples include the Irrigation Research and Extension Committee, Griffith, farm prizes and demonstration initiative, and the *Research-to-Practice™* series of the Cooperative Research Centre for Viticulture.

With the development of sophisticated *Land and Water Management Plans (LWMP)* in many regions of southern New South Wales and Victoria over the last decade there is now a significant, regional-based support network. This network provides on-ground education, training and support to improve irrigation and drainage practices.

Universities and research

Several Australian universities have developed courses related to irrigation. Charles Sturt University appointed the first professor of irrigation, and several universities are working closely with industry and government through the *National Program for Sustainable Irrigation* commissioned by Land & Water Australia, and through the Cooperative Research Centres.

Flooded rice. Image courtesy of Charles Sturt University

National Program for Sustainable Irrigation

The driving force behind the *National Program for Sustainable Irrigation (NPSI)* is the development and adoption of sustainable irrigation practices in Australian agricultural industries.

The program, which is managed by Land & Water Australia, includes ten research projects involving at least 55 researchers. Projects include:

- Northern Australian Irrigation Futures: To build a basis for developing sustainable irrigation across tropical Australia (contact: Keith Bristow, CSIRO Land and Water)
- Understanding and Developing Effective Knowledge Management Systems: To assist public and private sector organisations in irrigation decisions (contact: Graham Harris, Queensland Department of Primary Industries)
- Changing Irrigation Systems and Management in the Harvey Irrigation Area: To increase water-use efficiency and reduce ecological impacts (contact: Kenneth Moore, Boorara Research and Management; with Harvey Water; Horizon Farming, WA Ltd; Kuzich & Co; Dale Hanks Farming Enterprise; and the Western Australia Department of Agriculture)

Cooperative Research Centre for Irrigation Futures

This new Cooperative Research Centre will focus on generating information to double productivity and halve rural and urban irrigation water use in Australia. Core partners are:

- Universities, and research providers: CSIRO Land and Water, Charles Sturt University, University of Southern Queensland, University of Melbourne, University of South Australia, University of Western Sydney, Land & Water Australia
- Water suppliers: Goulburn-Murray Water, SunWater
- Agencies: Department of Primary Industries, Victoria; New South Wales Agriculture; Queensland Department of Natural Resources, Mines and Energy; Department of Primary Industries and Resources, South Australia (PIRSA)

Research program themes are:

- Irrigation futures and developing new industries: Maximising irrigated production from limited resources in highly variable climates
- Efficient urban and irrigation reuse: Including web-based Decision Support Systems, devices for irrigation scheduling, and public health issues of effluent reuse in urban areas
- Planning for change: Including capacity of dairy farmers to respond to changing markets, learning communities, and improved management of flood irrigation
- Sustainability: Including impact of irrigation and drainage on river water quality, effects of global climate change, identification of sustainability indicators in the tropics and winter-rainfall dominant irrigation systems, improved seasonality of flows in rivers through better demand management and water trading, and a regional framework for irrigation investment
- Irrigation and water policy: Including incentives and development of property rights

International connections

The Cooperative Research Centre for Sustainable Rice Production (Rice CRC) develops and promotes sustainable water use in the Yellow, Indus and Ganges Basins in China, Pakistan and India, respectively. ACIAR supports the Yellow River project in collaboration with the International Water Management Institute, the International Rice Research Institute, and Wuhan University, China. The project is exploring novel methods of growing rice without flooding, using saturated beds and alternate wetting and drying. The Punjab Agricultural University partners the Rice CRC scientists in India. Another project in Rechna Dore, Pakistan is developing an optimum nodal network and surface-groundwater models of a three-million-hectare rice and wheat region.

Other international examples are profiled in chapter 5.

Centre pivot irrigator.
Image courtesy of Charles Sturt University

Summary

Australian expertise in irrigation covers a range of industries and climates, from tropical to temperate. Irrigation systems range from long-established, gravity-based systems to pressurised high technology and specialised precision farming technology.

Experienced and accredited consultants, engineers and planners are developing environmentally sensitive solutions through improved design and management of supply and drainage systems that deal with salt and other pollutants. Agronomists and scientists are developing new cropping systems that use water more efficiently while retaining profitability and regional employment.

Irrigation in Australia is embedded in a holistic policy and planning framework that includes a commitment to integrated catchment management and equitable water sharing principles. Australia is already acknowledged as a world leader in community participation in integrated catchment management through the *Landcare* movement and the development of *Land and Water Management Plans* at community level.

Australian expertise is already sought all over the world, and is given benchmarking status by UNESCO.