Maximising returns from water in the Australian vegetable industry: national report

Hickey, Hoogers, Singh, Christen, Henderson, Ashcroft, Top, O'Donnell, Sylvia & Hoffmann

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Maximising returns from water in the Australian vegetable industry: national report

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Disclaimer

The information contained in this publication is based on knowledge and understanding at the time of writing (July 2006). However, because of advances in knowledge, users are reminded of the need to ensure that information upon which they rely is up to date and to check currency of the information with the appropriate officer of New South Wales Department of Primary Industries or the user's independent adviser.

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EXECUTIVE SUMMARY

This report provides a summary and analysis of water use in the vegetable industry in Australia as at March 2006. It is the compilation of a series of reports on vegetable industry water use at state level, and has been funded by Horticulture Australia Ltd and AUSVEG.

The vegetable sector is the largest segment of the horticultural industry in Australia. The most recent ABS survey (2000/01, ABS 2004) revealed the vegetable industry had a gross value of around $ 2.1 billion, derived from some 2.9 million tonnes of produce. Export value of Australian fresh and processed vegetable products in 2004/05 was in excess of $192 million. The major crop types were potatoes (1.2 million tonnes from 36 800 ha), tomatoes (414 000 tonnes from 8300 ha), carrots (283 000 tonnes from 7000 ha) and onions (247 000 tonnes from 5300 ha).

The 2000/01 ABS survey reported 5300 vegetable establishments Australia-wide with an estimated value of agricultural operations worth $5000 or more, employing 15 621 people directly. These farms were typically run by single unit farming families who specialise in vegetable production. Average farm size is about 25 hectares, from which produce worth $230 000 a year at first point of sale is generated.

Water is an essential input to sustainable vegetable production. The ABS report *Water use on Australian farms 2003–04* (ABS 2005b) stated that, in 2003/04, the vegetable industry accounted for 477 136 megalitres (ML) or just 4.6% of the total water used for irrigation. The report also estimated that average water use per hectare was 4.1 ML/ha, compared with the estimated overall application rate for water across all crops of 4.3 ML/ha. The value return from vegetable production per megalitre increased from $1762/ML in 1996/97 to $3207/ML in 2000/01 (ABS 2002b).

The productivity increases achieved by the vegetable industry can be partly attributed to increased use of water-efficient delivery systems such as drip irrigation, increased use of recycling on-farm, wide scale adoption of irrigation scheduling and soil moisture monitoring and a tendency towards whole farm planning and soil mapping. Although more

difficult to measure, some part of that increase in product value is most likely related to quality improvements as a direct result of improved irrigation practices.

Vegetable growers throughout Australia face a challenging operating environment under the various water reforms that have occurred over the last five years. Indeed, the debate surrounding making the best use of scarce water resources in Australia often quotes vegetables as being one of the best performers in terms of dollar return per megalitre. While gross returns from vegetables often exceed those of other crops, it is simplistic to use this criterion alone in deciding where best to allocate water. A better understanding of the complex nature of the vegetable industry, production methods and product marketing is required before recommendations can be made in areas such as state and federal government water policy.

The vast majority of vegetables produced in Australia are sold on the domestic market, and therefore prices are highly sensitive to increases in production. In addition, large investment and increased farm size are often required for irrigation systems used in vegetable production (such as drip systems), and specialised skills are required to drive those systems to achieve optimal product quality. With vegetable grower numbers in Australia declining, down to 4541 establishments in 2003, and average farm area increasing, there is a greater concentration of production and increased reliance on technology, automation and integration of irrigation and closely related systems (such as soil and nutrition management) at the farm level.

During the same period of water reforms at governmental levels, market factors have also affected grower operations and decision making. Growers have become more aware of the possible effects of poor water management through quality assurance system programs such as Freshcare, for horticultural produce, and environmental management systems (EMS). This has resulted in implementation of on-farm systems and technology which will reduce negative impacts, such as those resulting from use of saline or contaminated water and excess irrigation close to harvest leading to reduced product shelf life and low soluble solids.

Table 1 shows the estimated productivity from water achieved in the vegetable industry in 2001. Economic studies, such as a recent one by CDI Pinnacle Management and Street Ryan and Associates (2004) in Queensland have shown that downstream industries and operations add another 100% of value on the farm gate contribution. Nationally, this equates to $7.7 million of total regional output and 80 jobs for every 1000 ML of water used by the vegetable industry in Australia.

The report for this project presents:

- a detailed description of water use in the major vegetable production regions and associated river catchments
- the value of output and a description of market orientation including domestic, processing and exports
- technology case studies conducted with vegetable growers detailing the costs and benefits which flow from a shift to more efficient irrigation systems. These case studies demonstrate real investments being made in the industry at farm level.
- issues for possible future research which are likely to maximise returns on grower investment of research and development funds.

Table 1 – Estimated productivity from water by the vegetable industry, Australia, 2001

	Farm gate value of industry ($ million)	Water used for vegetable production (ML)	Employment [a] (no. of people)
Queensland	641	109 750	13 500 [b]
Victoria	582	131 000	21 725
NSW	305	96 000	3 100
South Australia	280	74 536	1 603
Western Australia	222	83 000	1 546
Tasmania	140	49 000	3 620
Australia [c]	**2 170**	**564 750**	**45 094**

[a] Employment figures include direct on-farm and indirect downstream processing/value-adding related industry

[b] CDI Pinnacle Management & Street Ryan and Associates 2004

[c] Northern Territory not included

Source: ABS 2002b (ABS 2001, employment and industry value) or ABS 2005a (ABS 2002-03 water use), unless otherwise stated

In future, the irrigation practices in the vegetable industry are likely to undergo further change. Much of the estimated 7500 ha of irrigated vegetables in NSW and Victoria currently under furrow irrigation will be changed over to drip and spray irrigation systems. Some sectors of the vegetable industry, such as the fresh and processing tomato and melon industries, have already embraced high efficiency irrigation systems such as subsurface drip irrigation, and this trend is expected to continue in other vegetable industries.

Due to the impacts of severe droughts, there has been a significant increase in the utilisation of drip systems for vegetable production. In many solanaceous and cucurbit crops, these systems have been common since the late 1980s, but recently the use of drip irrigation has expanded to crops such as potato, sweetpotato, onions, lettuce, brassicas, beans and sweet corn. The move to drip irrigation is often accompanied by a move to automated irrigation controllers.

Irrigation efficiency improvement programs require some extension support, either from a government service or private industry such as a processor (for example, Simplot). As public sector extension is gradually wound back in Australia, the vegetable industry will need to look at alternative means of providing such technical information to growers if it is to seriously address continuously improved water management in the larger regional vegetable production areas.

RESEARCH RECOMMENDATIONS (DRAFT)

Based on analysis of information in the state reports, and discussion with industry at a local level, the authors have compiled the following recommendations for areas of future research in water which would benefit the vegetable industry, and for which industry funding through Horticulture Australia, AUSVEG or other sources could be applied.

Economics of water

1. Conduct regular analysis of industry trends and issues, similar to the HAL/Growcom study *Economic contribution of horticulture industries to the Queensland and Australian Economies* (CDI Pinnacle Management & Street Ryan and Associates 2004).
2. Develop whole farm economic models that incorporate overheads and operating costs, and fluctuating water, yield and price scenarios, as tools to enhance the evaluation and comparison of vegetable enterprises and industries, and impacts of changing technologies and external environments on net farm cash income, farm operating surplus, and business returns on equity at farm level. The value of the owner/operator's time also needs to be recognised.
3. Develop clear economic drivers to support improved irrigation management, including published benchmarks of economic return per megalitre, a statement on the impact of in-field variability and associated costs to growers, and a clear demonstration of potential to improve return per megalitre applied.
4. Develop a program to regularly update regional vegetable crop gross margins as the fundamental building block for enterprise and industry analysis. At the same time, investigate technical reasons for differences in water use efficiency indices between regions for like crops.
5. Conduct a detailed study of the threshold cost of water (the cost beyond which vegetable growing becomes uneconomic). For instance, in the Lachlan Valley (NSW) in 2004/05, it was 'guesstimated' that up to $400/ML could be paid for temporary water before it became unfeasible to grow vegetables. This measure is particularly important where limited resources of good quality water are driving higher land and water prices.
6. Investigate the feasibility and consequences of on- and off- farm water recycling. Significant intensive vegetable growing is centralised around urban centres across Australia, in a prime position to utilise recycled urban water, and where joint government and business investment can be harnessed for efficient and sustainable water use.
7. Develop additional quantitative data on product quality improvements which can be achieved through use of highly efficient irrigation systems such as subsurface drip. Assuming these improvements translate into better product prices in the market, this would be a strong driver for the adoption of highly water-efficient delivery systems and irrigation timing in the vegetable industry, and can be developed through joint investment from the manufacturer and vegetable industry.
8. Seek, where water savings are achieved on-farm, to return those savings to the community through schemes such as the replacement of open channel systems with piping to reduce transmission losses. This will require the vegetable industry to work through all levels of government, irrigator associations and local water companies.

Benchmarking, technology and training

9. Conduct extensive benchmarking of water use in the major crops, as present data is inaccurate, or relevant only to specific regions. Encouragement, such as subsidies, for growers to install flow meters on their pressurised water delivery points to farm and crops would be an excellent start. Benchmarking should be focused on particular factors (e.g. irrigation type, crop, soil, region) and needs to be conducted over a sufficient interval to allow meaningful comparisons to be drawn. Crops other than vegetables that are grown in the regions should be included in the benchmarking study. Metering water use is already compulsory in some growing regions and has facilitated effective resource use and monitoring of pump and irrigation systems for optimum performance. Installation and monitoring of on-farm testwells has also proven an effective learning tool amongst groups in catchment areas, and provides a wider regional measure of water management.
10. Develop recommendations to better manage field variability in terms of yield and product quality and its impact on productivity, water use, and dollar return per megalitre.
11. Extend current irrigation scheduling and irrigation efficiency knowledge and demonstrate best practices for vegetable growers to increase the percentage of establishments using irrigation scheduling (currently 39.9% for all horticulture) and using management practices which account for reduced water allocations under drought.
12. Provide guidelines that vegetable producers, catchment managers and environmental protection agencies can readily adopt to assist them to effectively and sustainably use alternative water sources, such as recycled water or non-potable aquifers.
13. Support irrigation efficiency training and demonstration, particularly skills training to manage 'new' types of irrigation systems and scheduling tools and to manage crops on a wider range of soil types than are traditionally irrigated throughout Australia.
14. Use economic case studies of leading vegetable irrigators as 'showcase' examples of what is being achieved throughout the industry, with irrigation system suitability and benefit–cost analyses included in these studies. Present these case studies to the wider media in order to raise awareness of industry advances in irrigation management, productivity per unit of water and water use efficiency.

Reliable industry data

15. To be less dependent on the ABS, AUSVEG could collect independent statistical production data. Growers would have more confidence in the security of data they provide to their own industry than any they provide to a government body. To resolve the issue of inaccurate industry data, AUSVEG could then relate the ABS statistics to actual field data and coordinate these to get better quality statistics which do not completely rely on growers' statements and also take into account 'unofficial' products.
16. Investigate methods to increase the collection frequency of consistent, reliable, verifiable volumes and prices of production inputs and outputs for vegetable industries across Australia.

1. INTRODUCTION

The Australian vegetable industry is distributed across a diverse range of landscapes, from the tropical north of Queensland and north-western Australia to the cool temperate regions of Tasmania. The major production areas are concentrated in regions that provide a comparative advantage: close proximity to population centres and markets, fertile, well-drained soils, favourable climate and abundant irrigation water are the major factors that have led to the establishment of the key production regions.

The advent of efficient cool storage road transport and highly efficient drip irrigation and plastic mulch growing systems in the 1980s saw a rapid expansion of vegetable production into central and northern Queensland, where the bulk of Australia's winter production of warm season crops such as fresh tomatoes, capsicums and cucurbits now occurs.

The thirteen largest regions, as ranked in order of value of production in the most recent ABS survey in 2000/01, are listed in Table 2 and graphed in Figures 1 and 2.

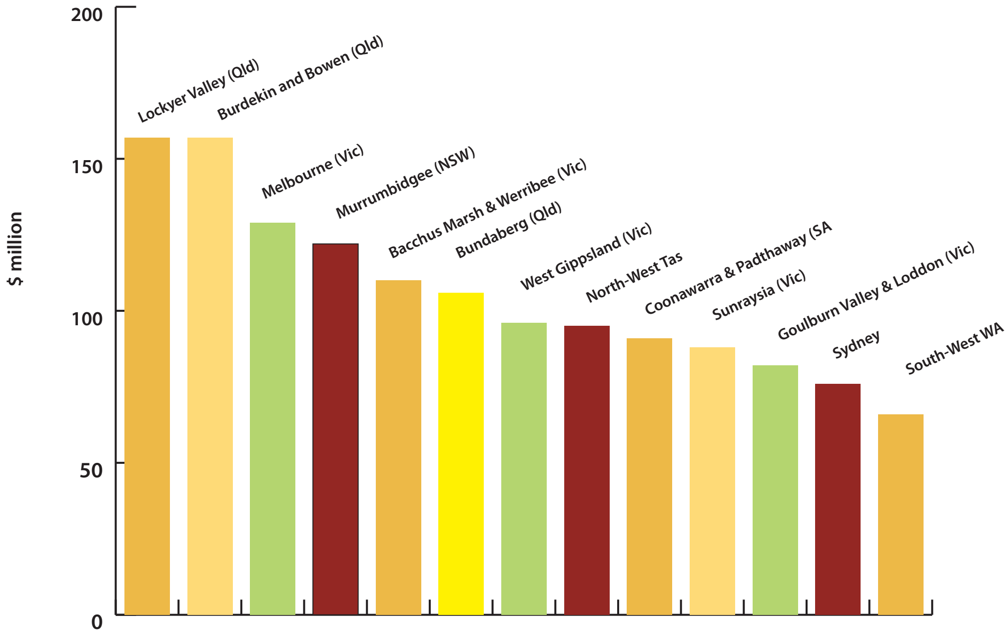
The vegetable sector is the largest segment of the horticultural industry in Australia. It had a gross value of around $2.1 billion in 2000/01, from 2.9 million tonnes of produce. Vegetable enterprises are typically run by single unit farming families who specialise in vegetable production. Average farm size is about 25 hectares, from which produce worth $230 000 a year at first point of sale is generated. The ABS 2001 survey reported 5300 vegetable establishments Australia-wide with an estimated value of agricultural operations worth $5000 or more, directly employing 15 621 people and a further 28 000 indirectly through flow-on industries such as vegetable processing, marketing, and transport. Major crop types are potatoes (1.2 million tonnes from 36 800 ha), tomatoes (414 000 tonnes from 8300 ha), carrots (283 000 tonnes from 7000 ha) and onions (247 000 tonnes from 5300 ha).

Table 2 – Vegetable-growing regions by value, Australia, 2000/01

Horticultural region	Total vegetables ($ million)
Australia – total	2171
Lockyer Valley (Qld)	157
Burdekin and Bowen (Qld)	157
Melbourne	129
Murrumbidgee (NSW)	122
Bacchus Marsh and Werribee (Vic)	110
Bundaberg (Qld)	106
West Gippsland (Vic)	96
North-West Tasmania	95
Coonawarra and Padthaway (SA)	91
Sunraysia (Vic)	88
Goulburn Valley & Loddon (Vic)	82
Sydney	76
South-West Western Australia	66

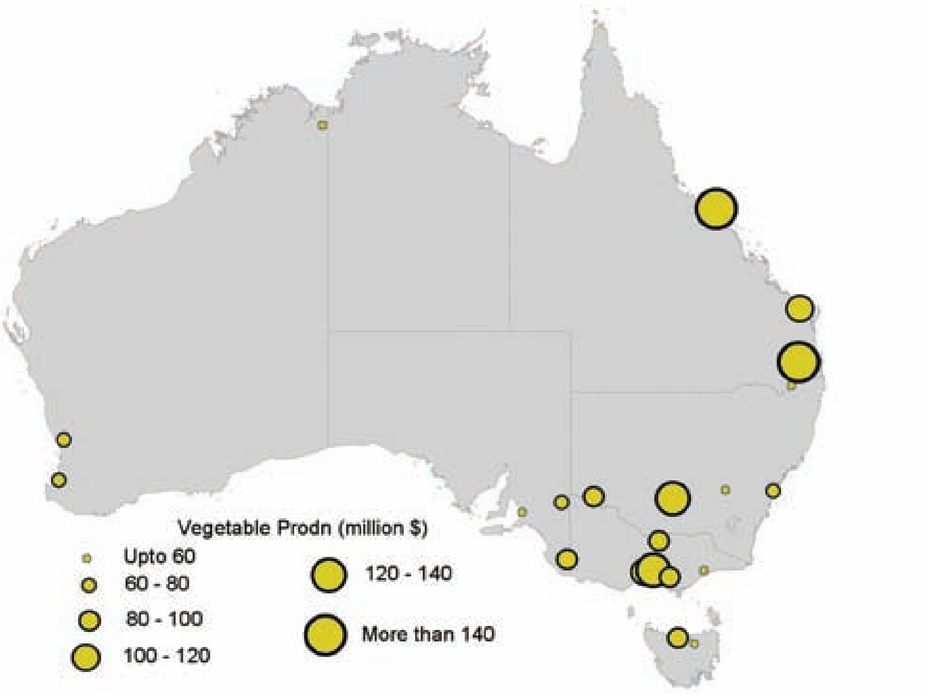
Source: ABS 2002a (2001 figures)

Figure 1 – Vegetable production ($ million) by region, Australia, 2000/01



Source: ABS 2001

Figure 2 – Relative size, in terms of value of vegetable production ($ million), by region, Australia, 2000/01



EDITOR'S NOTE REGARDING STATISTICS USED IN THIS REPORT

During the process of drawing together the vast amount of information to compile this report on water use in the Australian vegetable industry, several key data sources were used. Most of the data was extracted from Australian Bureau of Statistics (ABS) reports published between 2000 and 2005. In most cases the most recent and most reliable data is quoted, but as the last comprehensive and most accurate ABS survey was conducted during the most recent census in 2001, much of the industry value and production data is drawn from the period 2000/01. The industry landscape has obviously changed between 2001 and 2006. It has been a period of rapid change in the Australian vegetable industry following drought and the loss of significant export markets, while new markets were opened elsewhere.

In using ABS data, several questions arose about the accuracy and relevance of the information, given that five years has elapsed since that information was collected. However, the authors agreed that in the absence of more accurate or recent data from another source, ABS figures would be used.

Key reports on water such as the ABS Cat 4618.0 *Water use on Australian farms 2003-04,* published in October 2005, while giving a useful national picture of water usage in a particular year, do not necessarily match up with state agency estimates. For instance in Tasmania, where there are licences for water extractions of 378 000 ML each year, in 2003/04, just over 15 000 ML or less than 1% of the national total were reported on. There is some inconsistency between the different regions, as some supplies are scheme-based with mandatory reporting in place, while others are not scheme-based, and therefore not reported on at all.

In reading the report, it will be apparent that although much of the data is quoted from 2000/01, more recent years are quoted where the data is regarded as relevant and reasonably accurate. The authors have used their best judgement in deciding which figures are most relevant, and hence some inconsistency in years reported can be found.

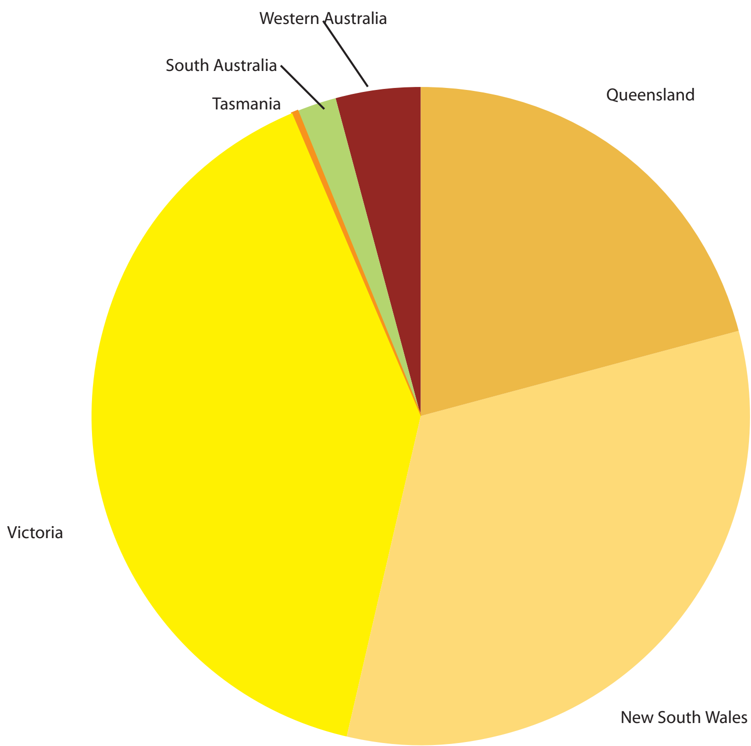
2. IRRIGATED AGRICULTURE IN AUSTRALIA

Agriculture accounted for 67% of total water consumption in Australia. Water used by agriculture in Australia includes water used for irrigating crops and pastures or maintaining livestock. Usually water has either been directly extracted from the environment for use by farmers from bores, on-farm dams and rivers, or supplied by water providers. It excludes the use of rainwater (ABS 2005c, *Year Book Australia 2005*).

2.1 WATER DIVERSIONS FOR AGRICULTURE

In 2003/04, a total of 7 802 102 ML was applied to 1 200 779 ha throughout Australia (Figure 3). NSW was the largest water user, diverting 3570 GL or 34% of total water for agricultural use to irrigate 171 370 ha. Together, the eastern mainland states of Queensland, NSW and Victoria applied 85% of the total volume of irrigation water, and contributed 86% of the total irrigated area (ABS 2005b).

Figure 3 – Total water diversions (ML), by state, 2003/04



Source: ANCID 2005

Table 3 shows the proportion of water diverted to farms via irrigation water providers in 2003/04. The bulk of Australia's water was supplied via irrigation systems, with direct extraction from rivers, farm dams and bores accounting for the remainder. (Note that the 2003/04 season in most regions received below-average rainfall, and evapotranspiration levels were also higher than long-term averages.)

Table 3 – Irrigation Areas and total diversions, by state, 2003/04

State	Systems (number reported)	Area in systems (ha)	Area irrigated (ha)	Total diversions (ML)
Queensland	30	396 390	289 584	1 863 756
New South Wales	8	1 658 543	310 145	3 570 088
Victoria	15	1 035 403	536 945	3 228 842
Tasmania	3	35 975	6 925	15 095
South Australia	8	120 754	33 341	936 528
Western Australia	3	127 500	23 840	454 086
Total (all data provided)	**67**	**3 374 565**	**1 200 779**	**7 802 102**

Source: ANCID 2005

Note: These are the total areas and volumes from data provided by systems which participated in the survey, not the overall totals for each state. In Queensland, NSW and Victoria, not all participating systems provided data on irrigated area. Also, 'area irrigated', as reported, understates the total area irrigated. The area irrigated was not reported by all of the data providers, and, where reported, the figures do not include any area irrigated from private diversions from streams and private groundwater systems.

2.2 WATER USE IN AGRICULTURE

The most extensive use of irrigation in Australia (Table 4) was on pasture for grazing. Nationally, in 2003/04, pasture for grazing was irrigated on 784 000 hectares, 33% of the total area of irrigated crops; 12 981 establishments, or almost one-third (32%) of irrigating establishments, used 3 084 393 ML for irrigated pasture, nearly 30% of the total volume of irrigation water applied. The average application rate to pasture for grazing was 3.9 megalitre per irrigated hectare.

Table 4 – Water use in agriculture (number of establishments, area, and volume, estimates) for vegetables and some selected non-vegetable crops only, Australia, 2003/04

Crop/enterprise	ALL AGRICULTURE: Agricultural estab's[a] (no.)	ALL AGRICULTURE: Area under pasture or crop[b] ('000 ha)	IRRIGATION ENTERPRISES: Agricultural estab's irrigating[a] (no.)	IRRIGATION ENTERPRISES: Area irrigated[b] ('000 ha)	IRRIGATION ENTERPRISES: Volume applied (ML)	IRRIGATION ENTERPRISES: Average app. rate (ML/ha)
Pasture for grazing	100 714	367 634	12 981	784	3 084 393	3.9
Cotton	838	227	623	185	*1 248 924	6.7
Sugar cane	4 822	559	2 359	241	1 210 243	5.0
Cereal crops for grain or seed	39 709	20 148	2 855	326	865 566	2.7
Rice	1 028	66	973	65	813 812	12.4
Vegetables for human consumption	5 084	126	4 541	116	477 136	4.1
Nurseries, cutflowers, cultivated turf	2 999	16	2 811	*16	*95 384	6.1
Vegetables for seed	556	5	415	*5	11 858	2.6
Total all crops and pastures	**130 526**	**440 110**	**40 400**	**2 402**	**10 441 515**	**4.3**

* Estimate has a relative standard error of 10% to less than 25% and should be used with caution.

[a] 'Total agricultural establishments' does not equal sum of total establishments, as many grow or irrigate more than one crop or pasture.

[b] 'Total area of agricultural land' does not equal the sum of area under pasture or crop as not all agricultural land is under pasture or crop.

Source: ABS 2005b

Table 4 includes estimates of agricultural water use from all sources, and therefore differs from the amounts reported in Figure 3, which are from participating systems and exclude groundwater users and river pumpers (see note to Table 3).

After pasture for grazing, cotton was the next biggest water user nationally, accounting for 12% of the volume applied and 8% of the total area of crops and pasture irrigated (ABS 2005b).

By comparison, irrigated vegetables (including melons) accounted for just 4.6% of total water used in irrigated agriculture, with 4541 of the 5084 vegetable-growing establishments irrigating, using 477 136 ML of water.

In 2003–04, as well as the 477 136 ML of irrigation water for vegetable production, 11 858 ML was used in vegetable seed production. In this report, the figures for 'irrigated vegetables' are for 'vegetables for human consumption' only, as the vegetable seed industry is regarded as a totally separate industry to fresh produce (ABS 2005b).

2.3 CHANGES IN WATER USE IN AGRICULTURE

Table 5, taken from the ABS Water Account Australia (1996/97 and 2000/01, ABS 2004) shows the change over time in estimates of net water use and the value of crops grown with that water. The net water use figure represents actual water delivered to crops, but does not take into account system delivery losses.

Table 5 shows a significant improvement in estimated productivity from water for the vegetable industry between the 1996/97 census and the 2000/01 census. The returns per megalitre exceed those of other crop types, including grapes and tree crops (fruit). Changes in the vegetable industry are likely to have contributed to the improved water use figures. Productivity increases in vegetable production have been largely in response to development of integrated marketing structures e.g. supermarkets and consolidators, but it is the availability of suitable and necessary inputs such as water and land which has enabled it to occur.

Some of the change could be explained by seasonal variability, but other factors, such as the shift during this period from low efficiency systems such as furrow and travelling gun spray irrigation towards computer-controlled spray and drip systems, have resulted in higher water use efficiency at the farm level. In many cases, vegetable growers are upgrading systems to reduce labour costs (that is, switching from furrow to automated drip).

While upfront capital costs for high efficiency systems such as drip are significantly higher, improved net returns, from a combination of higher crop yields, better pack-out percentages and the resulting higher quality, are also likely. In the long term, these higher net returns enable further investment in 'high tech' irrigation systems, and wider adoption of such systems throughout the industry.

Table 5 – Water use and gross value of production for irrigated agriculture in Australia (estimates, volume), 1996/97 and 2000/01

	Net water use		Irrigated area		Gross value per ML	
	1996/97 GL	2000/01 GL	1996/97 '000 ha	2000/01 '000 ha	1996/97 $/ML	2000/01 $/ML
Vegetables	635	556	89	116	1 762	3 270
Grapes	649	729	70	133	945	1859
Fruit	704	803	82	116	1459	1213
Dairy	–	2834	–	–	–	529
Cotton	1 841	2 908	315	437	613	420
Livestock, pasture, grains and other agriculture	8 795	8 403	1 175	1 403	289	373
Sugar	1236	1311	173	211	418	217
Rice	1 643	1 951	152	179	189	179
Total	**15 503**	**16 660**	**2 057**	**2 506**	**–**	**–**

Source: ABS 2004

2.4 VEGETABLE WATER USE BY STATE AND INDUSTRY

Water use in vegetable regions within states (Table 6) reflects both the irrigation systems used, and the main crops grown.

For instance, in the biggest vegetable-growing state, Queensland, total water use was lower than both Victoria and Western Australia, and only marginally higher than NSW. The average amount of water used per hectare for irrigating vegetables in Queensland is just under 3 ML/ha, with a slightly higher figure for North Queensland, Upper Burnett and Western Downs, and a lower figure (e.g. 2.7 ML/ha/crop) in the southern coastal districts. In the Burdekin, the cropping system typically includes plastic mulch and drip irrigation, and furrow irrigation is rarely used anywhere in Queensland.

By contrast, water requirements for crops such as carrots and potatoes under centre pivot irrigation generally exceed 5 ML/ha/crop, and furrow-irrigated crops such as melons and sweet corn in the Murrumbidgee in NSW can range from 5 to 7 ML/ha.

Table 6 – Water use (GL) in agriculture, by state and industry, 2000/01

	NSW	Vic	Qld	SA	WA	Tas	NT	Australia
					(GL)			
Vegetables	96	131	103	65	111	49	1	**556**
Livestock, pasture, grains and other agriculture	2590	1435	779	474`	176	85	30	**5568**
Cotton	1921	–	985	–	3	–	–	**2908**
Dairy	401	1685	288	320	65	76	–	**2834**
Rice	1924	27	–	–	–	–	–	**1951**
Sugar	1		1186		124			**1311**
Fruit	214	209	107	161	65	10	36	**803**
Grapes	174	238	6	284	23	1	3	**729**
Total	**7322**	**3725**	**3454**	**1302**	**565**	**222**	**70**	**16660**

Source: ABS 2004

2.5 WATER IN THE NATIONAL CONTEXT

As stated previously, the vegetable industry consumes a relatively small proportion of the total water used by irrigated agriculture on an annual basis, at around 4%. Water for irrigation in Australia is subject to regulation by the various state government agencies, and, in recent years, those regulations have undergone change.

The process of water reform began in 1994. It was then that the Council of Australian Governments (COAG) agreed on a strategic water management framework aimed at developing a more sustainable water industry.

adapted from the National Water Commission website www.nwc.gov.au

In 2004, with the signing of an intergovernmental agreement on a national water initiative (NWI), COAG continued its commitment to water reform in all the states and territories, except Tasmania, which joined in June 2005, and Western Australia, which joined in 2006. The National Water Commission was formed to drive the reform process.

The NWI will enable Australia's water management arrangements to adapt responsively and fairly to future changes in water availability in the rural and urban areas. When fully implemented it will result in:

- expanded water markets for greater permanent trade in water, promoting more profitable and flexible use of water
- more confidence for those investing in the water industry
- more transparent and comprehensive water planning
- allocation of water to meet specific environmental outcomes and improved management of water for those outcomes
- over-allocated systems addressed as a matter of urgency, and
- more efficient management of water in urban environments.

At a basin scale the Murray–Darling Basin Ministerial Council established the Living Murray program in 2002 in response to evidence of decline of the River Murray. The program, funded by the New South Wales, Victorian, South Australian, ACT and Australian governments, is one of the world's most significant river restoration projects. Initial action to protect and improve the health of the River Murray started with the 'First Step' decision. This involves investing $500 million in water recovery over five years from 2004–05 and spending $150 million over eight years on environmental works and measures.

The water reforms that have been implemented by federal and state governments over the last twelve years shaped the way water is now used by all agricultural industries, including the vegetable industry. As the reforms will continue to impact on these industries well into the future, it is important to understand the many reasons for the continued push for water reform. These include:

- the urgent need to address the cumulative adverse environmental impacts which are the legacy of poor water management systems
- a heightened understanding of the impact of land use change on water resource allocation, use and quality
- a more holistic view of the interaction between economic, social and environmental dimensions of water use
- steady increases in irrigated agriculture and the increased demand for environmental water
- improving scientific understanding of surface and groundwater systems
- improving certainty in water use entitlements to underpin existing and new investment
- disparate progress in water reform across the states and territories, and intractable differences between them
- growing urban water demand
- preventing further decline in the health of our rivers, and
- an opportunity to capitalise on new techniques and technologies to improve the efficiency and effectiveness of water management.

3. VALUE OF THE VEGETABLE INDUSTRY

In 2000/01, the total gross value of irrigated agricultural production in Australia was $9618 million (ABS 2004). This represents 28% of the gross value of all agricultural production.

Vegetables were the largest contributor to that value ($1817 million or 19%) followed by fruit ($1590 million or 17%) and dairy farming ($1499 million or 16%). Vegetables represented around 5.4% of the total revenue produced by the Australian agricultural sector (ABS 2002a).

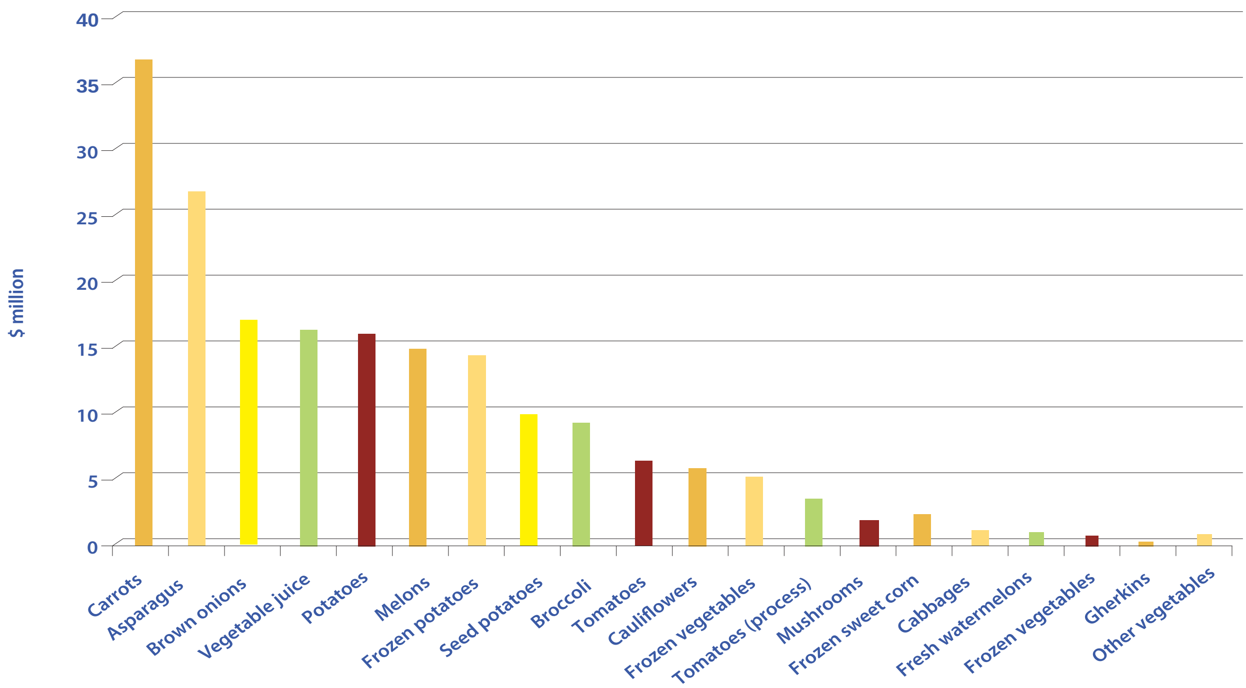
IBISWorld Industry Report, *Vegetable growing in Australia AO113* (Dec. 2005), reported that in 2004/05 approximately 91% of vegetable sales were from the domestic market. IBISWorld estimates that 60% of Australian vegetables are consumed fresh, while the remainder are sold to processors.

In the five years to June 2004, value adding declined at an annualised rate of 5% per year. Slow growth coincided with stagnant per capita consumption, caused by a rising consumption of processed foods. IBISWorld estimates that imported vegetables accounted for less than 5% of fresh market consumption, although there has been a steady increase in the percentage of imported processed vegetables in the market since 2004.

3.1 VALUE OF VEGETABLE EXPORTS

The value of Australian vegetable exports for the year 2004/05 (Figure 4) exceeded $207 million. This represents about 10% of total output.

Figure 4 – Australian vegetable exports ($ million), 2004/05



Source: Special request export trade data from ABS AHECC July 2004 to June 2005

Australian exports are sold primarily to Japan, Singapore, Malaysia, UK, Germany, New Zealand, USA and the Arabian Gulf. Over the past five years, industry exports have totalled between 9% and 12% of industry revenue, and have declined over the same period. Drought, the gradual rise in the value of the Australian dollar in relation to the US dollar, and loss of markets to overseas competitors have contributed to a reduction in the overall volumes and value of Australian fresh and processed vegetable exports. Despite this, Australia remains a net exporter of vegetable products, with the value of imports, mainly processed vegetables, around $73 million (AUSVEG 2005).

3.2 VALUE OF PROCESSED VEGETABLES

Approximately 40% of Australia's vegetable crop undergoes some form of processing. While the value of processed vegetables is generally 200% of the value of the fresh product, this will vary depending on the commodity and processed product produced, and the target market it is produced for. The scale of the increase in value through processing in South Australia, for example, is more accurately demonstrated in Table 7. (The information in this table has been sourced through widespread industry consultation and other published sources, so no multipliers have been used.)

Table 7 – Processed vegetables ($ million), South Australia, 2003/04 and 2004/05

	2003/04		2004/05	
Vegetable group	Farm gate value ($ million)	Processed value (wholesale or FOB) ($ million)	Farm gate value ($ million)	Processed value (wholesale or FOB) ($ million)
Potatoes	96.00	213.09	74.90	235.76
Other heavy vegetables, (onions, carrots, pumpkin, beetroot)	53.68	79.14	37.50	59.86
Cucumber and capsicum	27.77	52.72	30.90	58.04
Tomatoes	24.00	50.64	22.60	47.61
Brassicas (broccoli, cabbage, cauliflower, brussels sprouts, lettuce, spinach)	15.81	28.84	13.40	25.36
Other vegetables (celery, spring onion, sweet corn, zucchini, marrow, squash, parsnip)	6.68	13.46	7.90	15.55
Melons	2.73	3.32	2.70	3.30
Total vegetables	**226.67**	**441.21**	**189.90**	**445.49**
Total horticulture	478.19	838.93	472.60	913.38

Source: Sylvia 2006

Vegetables represent approximately half of the farm gate and processed value of horticulture in South Australia (excluding wine). Processed value of vegetables is approximately double that of farm gate value.

3.3 VEGETABLE INDUSTRY CONTRIBUTION TO REGIONAL ECONOMIES

If we consider the flow-on business from vegetable production, including transport, wholesale marketing, initial and secondary processing, retail marketing and export marketing, the vegetable industry contributes significantly to the economy of rural and regional Australia. A recent study (CDI Pinnacle Management & Street Ryan and Associates 2004) in Queensland estimated that downstream industries and operations added another 100% of value on the farm gate contribution from the vegetable industry.

If we consider Queensland, the 'Big 3' vegetable production regions of Bowen–Mackay, Wide Bay and Lockyer–Fassifern between them produce over 60% by value of Queensland's vegetables. There are, in addition, $40 million to $70 million industries in the Burdekin/Far North, South Coast, Darling Downs and Granite Belt regions (Table 8).

Table 8 – Value, irrigation return, regional economic and employment contribution, vegetable regions, Queensland

Vegetable report region	Vegetable irrigation water return ($/ML)	Vegetable production value at the farm gate ($m)	Vegetable value, value added ($m)	Vegetable output ($m)	People employed in vegetable industry (no.)
	Project-supplied statistical data [a]		Economic contribution report [b]		
Far North	2 945	25.6	33.1	29.6	62.5	746
Burdekin	5 190	43.9	21.6	19.8	41.6	462
Bowen–Mackay	7 187	119.0	131.9	79.4	250.3	2 389
Central	4 362	10.6	12.6	9.0	24.3	196
Wide Bay	8 951	125.9	109.3	108.9	207.6	2 643
Upper Burnett	4 370	10.4	7.3	7.5	14.0	177
South Coast	4 936	46.7	66.0	114.7	245.0	2 741
Lockyer–Fassifern	4 528	133.7	159.3	159.1	302.5	3 044
Darling Downs	3 438	32.7	48.1	39.1	91.3	467
Granite Belt	5 345	46.3	42.0	33.9	80.2	516
Total	**5 420**	**594.8**	**640.8**	**601.1**	**1 319.3**	**13 381**

[a] ABS 2001

[b] CDI Pinnacle Management & Street Ryan and Associates 2004

Using the same conversion factor of 100% increase on the farm gate values, this would give a total industry worth to Queensland of $1.3 billion a year, providing 13 500 jobs in regional Queensland. This equates to **$1.2 million of total vegetable regional output**, and **12 regional jobs,** for every **100 ML** of irrigation water applied to vegetables.

The farm gate return for each megalitre of irrigation water applied to vegetables (Table 8) reflects the differences in regional crop mixes. For example, the high returns in Bowen and Wide Bay reflect a strong influence of tomatoes and capsicums, whilst lower values on the Atherton Tableland are due to a concentration on potatoes and heavy cucurbits.

3.4 ECONOMICS OF VEGETABLE PRODUCTION

One method used to estimate the returns from water from specific crop types is to combine benchmark water use figures with gross margin budgets for that commodity.

While it is reasonable to compare the water use efficiency of various crop types in one production region using gross margin budgets, the authors of this report are reluctant to compare a single crop type grown in different states under different irrigation system types, soils and climate. Contrasting methods used to determine gross margins, along with productivity variations due to climatic, soil or other regional factors, would make such state comparisons inappropriate, and somewhat misleading.

If we look at individual state economic water use efficiency figures and consider various vegetable commodities, however, it is possible to draw some conclusions.

Economics Case Study 1: Returns from vegetable production in Queensland

In Table 9, the authors have contrasted 2 methods of determining economic water use efficiency (WUE[e]) for the major vegetable crops in Queensland.

- In the left columns ('From ABS statistics'), the total industry farm gate value is divided by the total amount of crop irrigation, derived from the ABS statistics supplied for this project. ABS-derived crop yields are provided as a reference point.
- In the right columns ('From DPI&F statistics'), the farm gate revenue is developed from DPI&F gross margin sheets for the applicable crop, and this value is divided by the benchmark irrigation volumes (as shown) input to those same gross margin sheets. The values in brackets use best-practice yields or irrigation volumes, rather than general regional values.

For the 12 highest total value crops (from tomato to zucchini), there was good agreement between the 2 methods, although ABS overestimated tomato WUE[e] by 50%, and lettuce, sweetpotato and pumpkin by 25–30%, and underestimated French bean WUE[e] by 25%, compared with the DPI&F method. For the 5 crops described with values less than $15 million (carrot, eggplant, onion, cabbage and celery), the ABS method overestimated WUE[e] by 50% to 150%.

Utilising the DPI&F values, the best WUE[e] figures were achieved with tomato, capsicum, and zucchini (depending on irrigation value used), with farm gate revenue of around $9500/ML. The next highest revenues, with WUE[e] of $6200–$7200/ML, were lettuce, french beans, sweetpotato, melons and celery. Eggplant was out by itself at $4500/ML, and then a group comprising potato, watermelon, sweet corn, broccoli, onion and cabbage had WUE[e] of $3000–$3500/ML. At $1500–$2000/ML, carrots and pumpkins were the least efficient crops for converting irrigation into farm gate revenue.

Table 9 – Economic water use efficiency (farm gate $/ML) of vegetable crops comprising 90% of Queensland production by value (based on ABS statistics)

	From ABS statistics [c]					From DPI&F statistics [d]			
Vegetable crop	Crop value ($m)	Crop area (ha)	Crop yield (t/ha)	Total crop irrigation (ML)	Farm gate return ($/ML)	DPI&F yields (t/ha)	Nominal farm gate revenue ($/ha)	Nominal irrigation use (ML/ha)	Nominal farm gate return ($/ML)
Tomato	134.7	2 672	37.4	9 351	14 403	40 [i]	$37 250 [m]	4.0 [g]	$9 312 [m]
Capsicum	59.5	2 043	18.0	5 689	10 450	25 [g] (32 [j])	$22 723 [m] ($29 320 [m])	3.0 [g]	$7 574 [m] ($9 773 [m])
Potato	46.8	4 761	24.3	16 067	2 911	32 [g]	$8 632 [m]	3.0 [g]	$2 877 [m]
Lettuce	42.9	1 729	27.8	4 335	9 868	30 [l]	$18 000 [m]	2.5 [g]	$7 200 [m]
French bean	32.1	3 267	4.6	6 534	4 910	7 [g]	$14 259 [m]	2.0 [g]	$7 130 [m]
Watermelon	28.9	3 065	20.2	9 820	2 946	40 [g]	$6 000 [m]	2.0 [g]	$3 000 [m]
Sweetpotato	28.8	980	26.7	3 034	9 478	26.6 [h]	$24 843 [m]	3.5 [g]	$7 098 [m]
Melons*	28.3	1 515	20.5	4 913	5 764	27.0 [g]	$19 206 [m]	3.0 [g]	$6 402 [m]
Sweet corn	24.0	2 274	11.6	8 035	2 992	11 [m] (18 [g])	$7 689 [m] ($12 582 [g])	3.5 [g]	$2 197 [m] ($3 595 [m])
Pumpkin	20.6	4 576	11.0	10 089	2 044	20 [g]	$2 900 [m]	2.0 [g]	$1 450 [m]
Broccoli	17.6	1 471	7.2	4 413	3 993	7.2 [o]	$12 150 [o]	3.5 [o]	$3 471 [o]
Zucchini	16.9	1 410	8.3	2 115	8 005	20 [m] (25 [g])	$15 250 [m] ($19 062 [g])	3.0 [m] (2.0 [g])	$5 083 [m] ($9 531 [g])
Carrot	14.2	758	31.5	3 033	4 695	32 [m]	$7 824 [m]	4.0 [m]	$1 956 [m]
Eggplant	12.0	295	36.3	1 180	10 170	35 [m]	$18 025 [m]	4.0 [m]	$4 506 [m]
Onion	11.9	573	34.1	2 304	5 179	40 [m]	$11 888 [m]	4.0 [m]	$2 972 [m]
Cabbage	9.1	404	41.9	1 414	6 485	40 [o]	$12 000 [o]	4.0 [o]	$3 000 [o]
Celery	8.3	223	53.3	891	9 320	60 [m]	$24 934 [m]	4.0 [m]	$6 234 [m]

* includes rockmelons, honeydews, excludes watermelons
[c] ABS 2004
[d] various DPI&F Agrilink publications, DPI&F Gross Margin spreadsheets, Water for Profit fact sheets, personal communications
[g] Water for Profit fact sheets
[h] Eric Coleman (pers. comm.)
[i] Des McGrath (pers. comm.)
[l] Lettuce Agrilink
[m] DPI&F gross margins
[o] Brassica Handbooks

When crop gross margin, rather than total farm gate revenue, is used as the measure of economic performance, the picture changes markedly (Table 10).

Table 10 – Economic return/ML (gross margin/ML) of crops comprising 90% of Queensland production by value (based on ABS statistics)

Vegetable crop	Nominal gross margin [m] ($/ha)	Nominal gross margin, 20% lower unit price ($/ha)	Nominal irrigation use [d] (ML/ha)	Nominal gross margin per megalitre ($/ML)
Tomato	$9 502	$702	4.0	$3 167
Capsicum	$3 714	–$1 711	3.0	$1 238
Potato	$2 349	$367	3.0	$ 783
Lettuce	$5 378	$1 178	2.5	$2 151
French bean	$7 472	$4 413	2.0	$3 736
Watermelon	$3 134	$1 734	2.0	$1 567
Sweetpotato	$16 066	$10 921	3.5	$4 590
Melons	$6 627	$2 541	3.0	$2 209
Sweet corn	$1 552	–$87	3.5	$443
Pumpkin	$1 500	$820	2.0	$750
Broccoli	$1 880	–$640	3.5	$537
Zucchini	–$2 696	–$5 836	3.0	–$899
Carrot	$524	–$1 300	4.0	$131
Eggplant	$3 618	–$477	4.0	$905
Onion	$7 616	$5 079	4.0	$1 904
Cabbage	$2 526	–$274	4.0	$632
Celery	$2 611	–$2 919	4.0	$653

[d] various DPI&F Agrilink publications, DPI&F Gross Margin spreadsheets, Water for Profit Fact sheets, personal communications

[m] DPI&F Gross Margins

Sweetpotato becomes a standout performer, delivering $4500/ML of gross margin profit. French bean and tomato yield $3200–$3700/ML. Melons, lettuce and onions are also solid performers, producing $1900–$2200/ML of irrigation. Although a high revenue earner per megalitre, the high costs of producing capsicum means it only delivers a gross margin WUE of $1200/ML, similar to watermelon ($1600/ML).

There is a significant drop in irrigation investment return with crops like eggplant, potato, pumpkin, celery and cabbage, which yield gross margin efficiencies of $630–$900/ML. Broccoli and sweet corn returns are even lower ($440–$540/ML), whilst carrots barely break even ($131/ML), and DPI&F gross margins suggest zucchinis are simply unprofitable.

Interestingly, a simple sensitivity analysis demonstrates that dropping vegetable farm gate prices by 20% means 8 (capsicum, sweet corn, broccoli, zucchini, carrot, eggplant, cabbage and celery) of the 17 described crops become unprofitable, and thus return a negative gross margin water use efficiency. This shows the importance of having a profitable and resilient market for product, in terms of getting a return on increased investment in irrigation improvements, or indeed in switching to supposedly more ‘water-efficient’ crops.

Economics Case Study 2. Southern Murray–Darling Basin irrigation industries

(based on Meyer 2005)

A study conducted in the Murray and Murrumbidgee systems in 2004 by Bryan and Marvanek estimated that the value of irrigation production rose 50% between 1997 and 2001. The major contributors to this increase were dairy, rice, grapes, fruit, cotton and vegetables. The increase was largely attributed to increases in the area of production and to buoyant commodity prices. In terms of returns per megalitre (farm gate value) for the same period, Meyer (2005) calculated that vegetables produced the highest return of over $3000/ML followed by fruit and tree nuts ($1990/ML), grapes at $1850/ML and cotton at $590/ML.

Using data from the Bryan and Marvanek study, Meyer compared the relationship between return per unit of water and profit: this is illustrated in Figures 5 and 6. The figures demonstrate that while returns from vegetables per unit of water are high, the estimated profit at full equity for the region is less than for dairy, grapes, fruit and tree nuts. Meyer also comments that

> while this analysis does not give a direct breakdown at the individual enterprise level, it serves to illustrate why aspirations and business choices of irrigators don't necessarily align with resource managers in governments that use total revenue generated from a resource use as a comparative yardstick: that is, there is no direct alignment of the motivators and drivers for change.

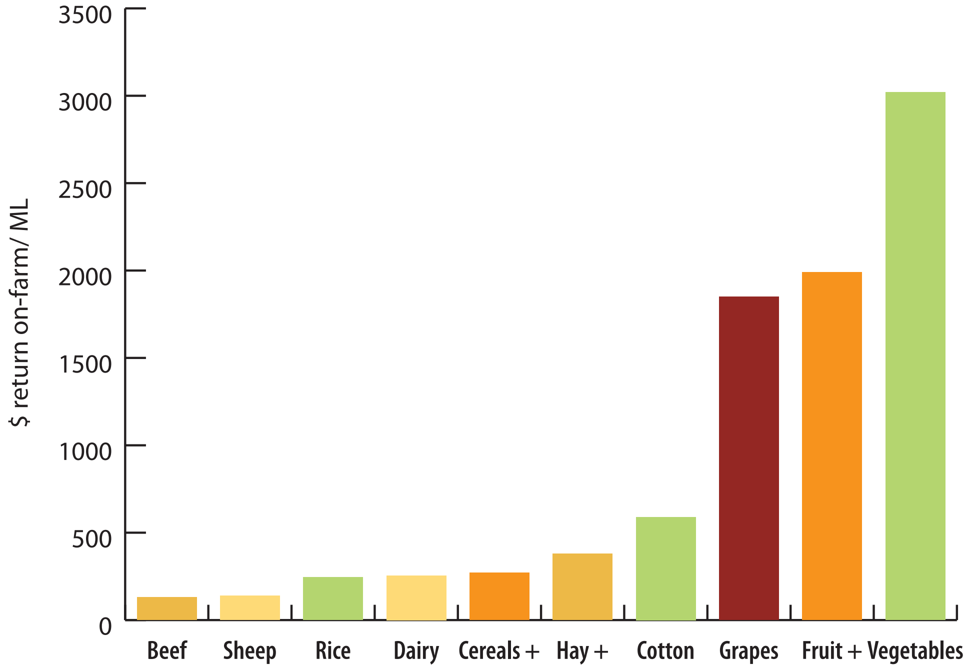
The study posed the question as to why more irrigators are not moving into vegetables. Apart from the market effects that would flow from an oversupplied vegetable market, Meyer identifies several sensible reasons why this does not happen:

- generating more revenue/ML is not the most successful business or lifestyle choice
- the level of profit is more important than total revenue per megalitre
- the security and sustainability of each enterprise needs consideration
- vegetable production demands particular levels of skill and risk
- irrigators make conscious decisions on lifestyle choice and production preferences
- the farming system needs to be accounted for. Residual moisture (for example, for wheat after rice) can be quite significant.

In this type of study, it should be noted that downstream value adding and industry activity associated with the vegetable industry (wholesale, retail, processing, export) should also be taken into account when considering value to the regional economy, which extends beyond the farm business enterprise level.

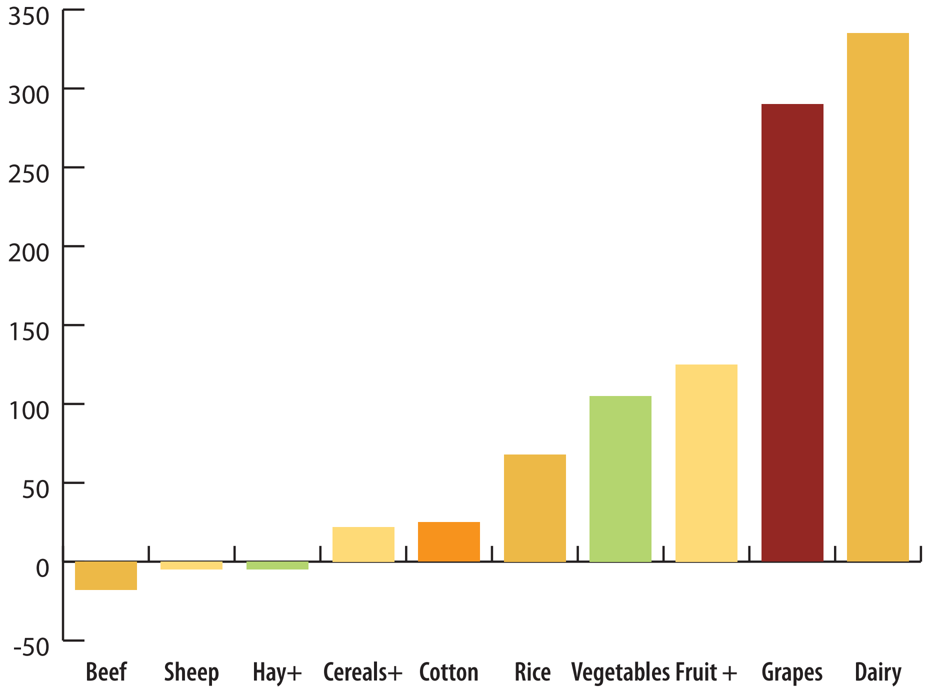


Figure 5. Revenue ($/ML) from land use and volume of water, Murrumbidgee–Murray–Goulburn, 2000/01



Cereals + = cereals and coarse grains
Hay + = hay, legumes and oilseeds
Fruit + = fruit and tree nuts

Figure 6. Profit ($ million) by commodity, Murrumbidgee–Murray–Goulburn irrigated regions, 2000/01, total profit at full equity



Economics Case Study 3. Water use in Western Australia

There are few national studies on economic and production trends in the vegetable industry and how these relate to the future demand for water. The most recent study on the Western Australian irrigation industry was conducted in 2004 (Brennan 2004): an extract from this study follows.

Future demand for irrigation

The potential demand for irrigation water in Western Australia depends on growth in markets for currently produced crops, changes in production technology, especially water productivity gains, and new market opportunities. Demand will also be affected by water policies that impact upon the opportunity cost of water use in irrigation activities.

A characteristic of water use in Western Australia is that a large amount of the water is used in horticultural industries (Table 11), which have high returns. Even if water opportunity costs approached those evident on the water markets of eastern states, it is unlikely that farmers would respond by reducing production of these high valued crops.

Table 11 – Estimated water use (GL) by activity, South-West and Northern regions, WA, 2001

	South-West	Northern
Vegetables	62.04	21.27
Fruits	119.12	14.51
Grapes	21.11	0.73
Nurseries	19.85	8.74
Olives	21.86	0.00
Subtotal, horticulture	*243.98*	*45.26*
Pasture	106.05	16.34
Other	2.42	79.91
Total	**352.46**	**141.50**
Percent horticulture	**69%**	**32%**

Asset values are summarised in Table 12. For example, if the asset (water) is valued at $6620 per ML, carrot growers can achieve a 5% rate of return, but if the asset value is lower ($3838), carrot growers can achieve a 7.5% rate of return.

Table 12 – Indicative asset values ($/ML) for water in the South-West, WA

	Rate of return	
	5%	7.5%
Carrots	$6 620	$3 738
Apples	$14 350	$4 678
Wine grapes	$9 000	$6 000
Dairy – high productivity	$2 000	$1 333
Dairy – low productivity	zero or negative	
Beef	zero or negative	

In the South-West, dairy production is also a potential high value water use, although anecdotal evidence suggests that, in some areas, water is not being used as productively as it could be. Estimates of 'typical' pasture productivity on dairy farms in Western Australia indicate that the annual value of water could range from more than $100 per megalitre to zero or a negative value, depending on farm characteristics.

In the following section, some projections regarding the growth in demand for horticulture crops and dairy are provided, based on recent trends in domestic and export markets.

Assumptions regarding market growth

Prospects for expanding horticultural production for the domestic market are limited by the low price elasticity for food.

For example, in a report on the Yandoo Creek proposal to supplement supplies in Carnarvon, Kingwell and Brennan (1985) found that the potential price impacts were so high that producers would have been worse off from the expansion, whereas consumers would have been better off from the lower prices.

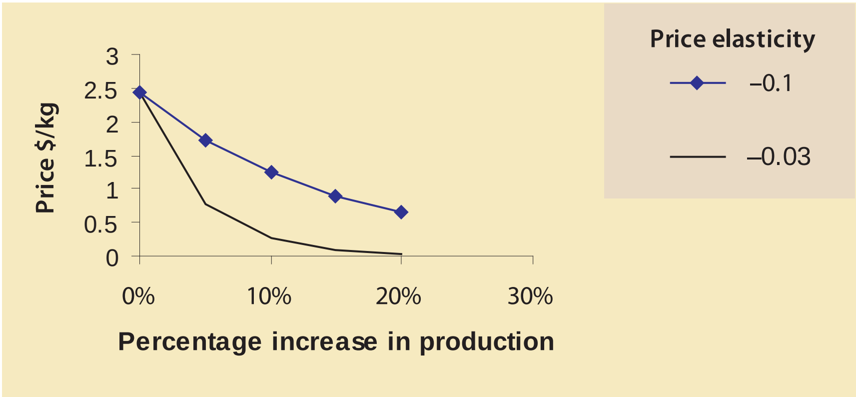
The potential impact of expanding domestic supplies is illustrated using the case of capsicums in Carnarvon. The Carnarvon growers supply 70 per cent of the domestic market over the period July to December, and this means that any increase in production through, for example, a water supply augmentation, affects price.

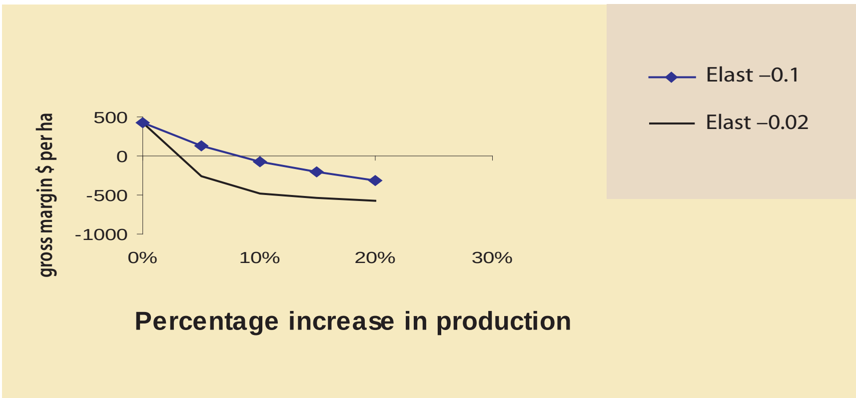
Vegetables are known to have a low price elasticity. Price elasticity of demand is a measure of the percentage change in quantity demanded associated with a percentage change in price.

You, Epperson and Huang (1998) estimated the price elasticity of fresh vegetables in the US market at around -0.03. The inverse of this value (the percentage change in price that will have to occur in order to sell an additional one per cent of product) is 33.3%.

The impact of increasing production of capsicums for sale on the domestic market is illustrated in Figure 7 using two different price elasticities that are indicative of demand for vegetables.

Figure 7 – Impact of increased sales on domestic market on gross margin, capsicum, Carnavon, WA





On the horizontal axis is the percentage increase in production at Carnarvon, which is assumed to be sold on the domestic market. Price falls as more produce is sold, and it takes only a 5 and 10 per cent increase in production at Carnarvon to reduce prices enough to reduce gross margins to zero. The domestic market for fresh produce cannot support significant increases in production, unless demand grows.

Potential growth in domestic demand for fruit and vegetables will come from growth in per capita consumption and population growth. In the past 3 to 4 decades, per capita consumption (Table 13) has shown steady growth, and this growth could continue as the result of promotional efforts from the Health Department, such as the '2 + 5' campaign.

Table 13 – Trends in per capita consumption of fruit and vegetables, and population growth, WA

Item	Annual growth rate
Vegetables	0.81%
Fruit	1.3%
Population WA – low	0.7%
Population WA – high	1.5%

Source: Consumption rates estimated from ABS data (catalogue 4306.0; population rates from 3222.0)

These data can be used to forecast growth in domestic demand. For example, if trends in per capita fruit and vegetable consumption were to continue for the next 10 years, then the total increase in demand for fruit would increase by 8.96 per cent over the period under the high population growth scenario:

$$(1.013 \times 1.015)^{10} - 1 = 8.96\%$$

Growth scenarios for irrigation

To estimate potential growth in demand for irrigation, cropping activities were split according to the ratio of domestic and exported production (2000/01); these areas were then multiplied by estimated growth in domestic and export markets respectively. Table 14 shows the projected figures at the end of 10 years. To estimate the potential growth in demand at the regional level, it was assumed that overall market growth was spread evenly across space (for example, a 5% growth in demand for carrots meant that 5% expansion in Gingin, 5% expansion in Myalup, and so on).

In fact, localised water limits, changes in relative land prices, and other relative price changes will affect the spatial mix of activity, so the project demand growth is better interpreted at the aggregate level. For example, even if expansion cannot occur in peri-urban areas, there is an opportunity for supplying the domestic vegetable market from areas in the South-West, and some of these regions have a good comparative advantage in vegetable production.

Table 14 – Projected growth at the end of 10 years (ratio of current demand)

Demand growth	Low	High	Source
Domestic			
Vegetables	1.073	1.166	Recent per capita consumption trends and high and low population growth assumptions.
Fruit	1.076	1.172	
Dairy	1.069	1.157	
Wine	1.209	1.458	ABARE 2004[1]
Export			
Vegetables	1.286	1.644	High demand, based on recent trends; low demand is half this value.[2]
Fruit	1.629	2.594	
Dairy	1.411	1.967	
Wine	2.367	5.234	ABARE 2004[1]

[1] ABARE estimates are the 'high scenario', they are 5-year projections and may be high for 10 years.

[2] Recent trends in export growth are an optimistic forecast.

Growth in horticultural water use

Based on these growth assumptions, the estimated total increase in water use required for horticultural industries is shown in Table 15.

The 'high growth' scenario can be considered an upper bound on growth for existing industries, because it is based on recent export performance, which has been assisted by favourable exchange rates; and because the wine estimates are rather high.

Moreover, it is assumed that there is no change in productivity over the 10-year period. It is not unreasonable to expect a productivity gain of 10 per cent over a 10-year period, which could be achieved through a combination of yield increases and reduced water application rates per hectare. Under such productivity growth, even if market demand grows as strongly as the 'high demand' scenario indicates, the actual impact on water demand could be closer to the 'low demand' scenario results.

Table 15 – Potential growth (%) in water use through produce market growth, WA

Water usage	Vegetables	Fruits	Grapes	Nurseries	Olives	Subtotal	% regional growth
Water use in 2001 (GL)							
Gingin	14.57	5.22	1.52	6.48	9.73	37.52	
Metro North	11.52	4.63	4.75	2.72	0.35	23.96	
Metro East	0.70	45.22	1.99	2.87	0.10	50.89	
Metro South	8.84	9.31	0.16	1.47	0.02	19.80	
Mid-West	0.86	0.04	0.22	1.20	0.58	2.89	
Peel Harvey	7.16	7.25	0.67	1.35	0.25	16.69	
Whicher	6.25	2.25	6.42	2.15	1.55	18.62	
Preston-Warren-Blackwood	8.56	44.14	1.53	0.91	0.81	55.95	
Great Southern	3.59	1.05	3.85	0.71	8.47	17.67	
East Kimberley	16.23	7.08	0.00	8.50	0.00	31.82	
West Kimberley	2.55	0.72	0.01	0.03	0.00	3.30	
Gascoyne	2.49	6.71	0.72	0.21	0.00	10.14	
Total state	**83.31**	**133.64**	**21.84**	**28.60**	**21.86**	**289.24**	
Low demand growth							
Gingin	17.75	6.47	1.86	6.95	10.47	43.51	16%
Metro North	13.17	5.57	5.84	2.92	0.37	27.88	16%
Metro East	0.80	57.28	2.45	3.08	0.11	63.72	25%
Metro South	10.49	11.72	0.20	1.57	0.03	24.00	21%
Mid-West	0.96	0.06	0.26	1.28	0.62	3.18	10%
Peel-Harvey	8.37	9.17	0.86	1.45	0.27	20.12	21%
Whicher	7.19	2.77	8.51	2.31	1.66	22.43	20%
Preston-Warren-Blackwood	10.05	55.28	2.03	0.97	0.88	69.21	24%
West Kimberley	2.81	0.83	0.01	0.03	0.00	3.68	11%
Gascoyne	2.74	7.62	0.86	0.23	0.00	11.45	13%
Total state	**96.29**	**166.10**	**27.98**	**30.69**	**23.52**	**344.57**	
% growth, state level	**16%**	**24%**	**28%**	**7%**	**8%**	**19%**	

Table 15 – *continued*

Water usage	Vegetables	Fruits	Grapes	Nurseries	Olives	Subtotal	% regional growth
High demand growth							
Gingin	21.75	8.31	2.38	7.55	11.41	51.41	37%
Metro North	15.26	6.95	7.48	3.17	0.41	33.26	39%
Metro East	0.92	75.19	3.14	3.35	0.12	82.72	63%
Metro South	12.55	15.29	0.25	1.71	0.03	29.83	51%
Mid-West	1.09	0.07	0.32	1.39	0.68	3.55	23%
Peel-Harvey	9.89	12.03	1.16	1.57	0.29	24.94	49%
Whicher	8.37	3.53	11.78	2.51	1.81	28.00	50%
Preston-Warren-Blackwood	11.92	71.78	2.81	1.06	0.95	88.52	58%
Great Southern	4.73	1.62	7.06	0.83	9.93	24.17	37%
East Kimberley	19.96	9.40	0.00	9.91	0.00	39.28	23%
West Kimberley	3.14	1.00	0.01	0.03	0.00	4.18	26%
Gascoyne	3.06	8.89	1.05	0.25	0.00	13.25	31%
Total state	**112.63**	**214.06**	**37.44**	**33.35**	**25.62**	**423.10**	
% growth, state level	**35%**	**60%**	**71%**	**17%**	**17%**	**46%**	

Thus, a state level estimate of growth in horticulture demand for water of about 20 per cent is reasonable, based on the available evidence, and assuming no new enterprise boom. (A boom in olive and grape planting drove irrigated area expansion in the late 1990s.)

3.5 WATER USE BENCHMARKS IN THE VEGETABLE INDUSTRY

The most recent and detailed study into benchmarking crop water use in the vegetable industry was as part of the HAL project VG04015 'Benchmarking vegetable industry water use' (Ashcroft et al. 2005). The study was conducted during the 2004/05 growing season, to benchmark water use in vegetable crops from a total of 25 sites in two contrasting areas of Victoria: peri-urban Melbourne (Cranbourne, Mornington Peninsula and Werribee), and the Mallee (Mildura and Swan Hill). An approach successfully used in other horticultural crops was combined with a set of water use efficiency indicators.

Most participants used fixed sprinkler irrigation systems, and the crops included lettuce, broccoli and carrots near Melbourne, and carrots, pumpkins, squash and zucchinis in the Mallee.

While the information on water use was a useful starting point, the major focus of the study was to evaluate the value of the benchmarking process. Inconsistencies in on-farm recording of water use cast doubts over the validity of some measurements obtained. Seasonal and market influences also influenced project results.

Average marketable yields reported by growers included:

- 13.3 t/ha for broccoli
- 50.8 t/ha for carrots in the Mallee.

The average water use reported for the target crops spanned:

- 1.2 ML/ha in broccoli
- 3.3 ML/ha in carrots, around Melbourne
- 1.7 ML/ha in squash
- 3.1 ML/ha in zucchini, in the Mallee.

Average crop water use efficiencies ranged from 9.2 t/ML for broccoli to 28.4 t/ML for lettuce around Melbourne, and from 2.3 t/ML for pumpkins to 24.5 t/ML for carrots in the Mallee.

Statistically meaningful comparisons between crops and regions could not be made because of the limited data set. Growers were provided with the reports from their particular crops and region, and then asked to comment on the value of the process and how it might be improved. Water use efficiency was generally not seen as a high priority at a time of depressed market prices and ample water supply, but most agreed that it may become so. The comparative results were of interest, but accuracy and values were rightly questioned due to the limited sample and obvious differences in cropping circumstances.

These were the recommendations from the study:

- Future studies need to collect a comprehensive set of information over several seasons.
- Factors such as region, crop type and management system need to be taken into account for meaningful comparisons to be made.
- Growers need adequate support to ensure that information collected is accurate and worthwhile.
- Benchmarking activities should link with any national program for improving water use efficiency in vegetable crops so that regions or issues of greatest need can be targeted and addressed.

3.6 WATER COSTS IN THE MAJOR VEGETABLE PRODUCTION REGIONS

In Australia, charges for water vary considerably between regions. A range of private and government schemes manage the water, and numerous governing bodies are responsible for collection of levies, access, supply or delivery charges and excess water use costs which are applicable to vegetable-growing districts. Seasonal fluctuations may also change water costs: in a low 'authorised use of allocation' period or year, the fixed costs will be proportionally higher, leading to higher overall charges per megalitre. Additional pumping costs may be incurred where growers need to re-pump water from low pressure irrigation schemes to increase the head pressure to match their irrigation system requirements.

In general, water costs in peri-urban zones surrounding major cities are substantially higher than in some of the more remote inland irrigation districts. For example, Tier 1 (town) water used for greenhouse vegetable production in Sydney is around $1200/ML, scheme water in Werribee is around $125/ML, and, on the Northern Adelaide Plains, reclaimed water retails for around $116/ML during summer. By contrast, in a good allocation year (80% allocation) in the Murrumbidgee in NSW, general security water is around $22/ML, and, for the Central Goulburn Irrigation Area in central Victoria, charges are approximately $25/ML.

For private diverters accessing non-pressurised water from rivers or bores, costs depend on the head and distance over which the water is drawn. On-farm pumping costs for a centre pivot irrigator, for example, would be in the vicinity of $45–$55/ML (fuel only). As fuel costs steadily increase, water costs for pumpers will continue to rise significantly.

Table 16 compares the water charges between 3 major irrigation valleys in NSW.

Under the Rural Water Pricing Policy (1999), the NSW government announced cross-subsidies for irrigation services would be removed, with full recovery of costs of all service operations as well as the establishment of an asset replacement fund. Under the new arrangements, horticultural and large area farms now pay fixed and variable water charges using separate systems of water pricing.

To illustrate this, in 2004/05, on the Murrumbidgee system, when general security allocations were just 43%, a large area farmer with an general security allocation of 1500 ML in the MIA paid a fixed price of $6.73/ML. This price is unrelated to the amount of water used, and includes charges such as administration, bulk water, asset levy, entitlement fee and Land and Water Management Plan costs. The variable cost related to water volume used was $12.92/ML, giving a total of $28.57/ML for 645 ML of water used.

High security water users in the MIA also pay fixed and variable costs. Based on 2004/05 allocations of 95%, high security water users on a 10 ha horticultural farm would pay a fixed price of $13.36/ML and variable costs of $19.05 /ML, giving a total of $33.11 /ML for actual water used.

Table 16 – Irrigation water costs, Coleambally, Lachlan, Murray and Murrumbidgee rivers, 2004/05

	Fixed water costs ($/ML)		Variable water costs ($/ML)		Total volumetric charge (variable costs, $/ML)			
System	High security	General security	High security	General security	High security		General security	
Annual allocation					**100%**	**95%**	**100%**	**43%**
Coleambally (average farm size 250 ha)		$19.98		$6.61			$26.61	$53.08
Coleambally: sprinkler irrigation		$14.31		$18.55 (pumping costs)			$32.86	$51.83
Coleambally: river pumper		$3.88		$5.04			$8.92	$14.06
Lachlan: river pumper	$7.09	$4.72	$5.41	$5.41	$12.50	12.87	$10.13	$16.39
Murray (average farm size 500 ha)		$11.10		$11.64			$22.74	$37.45
Murray: river pumper	$5.23	$4.75	$1.27	$1.27	$6.50	$6.78	$6.02	$12.32
Murrumbidgee (average farm size 350 ha)	$13.36	$6.73	$19.05	$12.92	$32.41	$33.11	$19.65	$28.57

Table 17 – Water charges for wet year (100%) compared with dry year (43%) on large area and vegetable farms in the MIA

	Large area farm (general security)		Vegetable farm (general security)		Small vegetable farm (high security)	
Annual allocation (ML)	*1500 ML*		*1500 ML*		*150 ML*	
Fixed water costs						
Administration	$285.00		$285.00		$285.00	
Rice monitoring	$145.00					
LWMP	$145.19		$145.19		$145.19	
Asset levy	$65.00		$65.00		$50.00	
Total allocation	$5.89		$5.89		$9.65	
Envirowise levy/ML	$0.51		$0.51		$0.51	
Total fixed costs for total allocation	**$10 240.19**		**$10 095.19**		**$2 004.19**	
Actual allocation (ML)	*wet year 1500 ML*	*dry year 645 ML*	*wet year 1500 ML*	*dry year 645 ML*	*wet year 150 ML*	*dry year 142.5 ML*
Actual allocation as % of total allocation	100%	43%	100%	43%	100%	95%
Total fixed costs	$6.83	$15.88	$6.73	$15.65	$13.36	$14.06
Total variable costs/ML	$12.92	$12.92	$12.92	$12.92	$19.05	$19.05
Total water costs/ML	$19.75	$28.80	$19.65	$28.57	$32.41	$33.11

Source: Rajinder, Mullen and Jayasuriya 2005

Table 17 gives an example of the typical charges applied to irrigators in the Murrumbidgee Irrigation Area (MIA).

In the Sydney Basin, most vegetable growers rely on town water only, or a mix of on-farm dam water and town water when supplies run low. Of approximately 3000 irrigators in the Sydney Basin, growing crops including field and protected vegetables, turf nurseries, cut flowers and fruit, approximately 50% are river pumpers, 25% draw from farm dams and the remaining 25%, mainly vegetable growers, use town water (pers. comm. B Yiasoumi 2006).

For the river pumpers, a change in the licensing system has recently been introduced, and flow meters are now mandatory for larger irrigation farms. Table 18 indicates the system of monitoring used by NSW Department of Natural Resources (DNR) to monitor water use. Although it appears there are plans for volumetric charging for water, as of January 2006, water charges on a per megalitre extraction from the river were not in place.

Charges for town water used by the vast majority of vegetable growers in the Sydney Basin are based on Tier 1 rates. As of October 2005, Tier 1 charges were $1.20/kL, equivalent to $1200/ML, but it should be remembered that this water is often used in high value operations such as hydroponic systems, and requires little if any treatment prior to use.

Table 18 – Monitoring methods, DNR

Volume extracted from river per annum	System of metering	Licence required
More than 200 ML	Flowmeter	Yes
21–200 ML	Power consumption record	Yes
Less than 20 ML	Diary entries	Yes

While town water is used by many vegetable growers, water from on-farm dams is used when possible to reduce water costs. Water bills for Sydney Basin vegetable growers can be anywhere from $10 000 to in excess of $20 000 per annum, so an on-farm water source, where available, is the preferred option when adequate supply and water quality permits.

3.7 WATER TRADING

Across Australia in 2002/03, 5429 irrigating agricultural establishments purchased 991 GL of extra water on a temporary basis, costing $124 million, an average cost of $125/ML. Fifty-seven per cent of the water temporarily purchased was in New South Wales, contributing 47% of the amount spent nationally. The highest average cost for water purchased on a temporary basis was in South Australia at $242/ML.

Extra water purchased on a permanent basis, including transfers of entitlements, was more expensive, with the highest cost, again in South Australia, at $1109/ML. Nationally 140 GL was purchased on a permanent basis, costing $92 million, at an average of $652/ML.

Of the 944 ML of water sold nationally by irrigating establishments, on both a temporary and permanent basis, more than two-thirds was sold by establishments in Victoria (ABS 2005a).

In NSW, the bulk of inter-valley trading occurs between the Murrumbidgee and the Murray.

- During the low allocation years of 2002/03 and 2003/04, water ownership moved from the Murrumbidgee to the Murray. As the rice crop in the Murray Valley was drastically reduced, much of this water was used to irrigate high value vegetables such as processing tomatoes and potatoes.
- In 2002/03, 14 789 ML of water was transferred from the Murrumbidgee to the Murray, while a further 21 297 ML was transferred into the Murray Valley (in NSW) from Victoria. In the same year, a total of 198 023 ML of temporary allocation was sold within the Murrumbidgee Valley.
- In the Lachlan, during the period 2001–04, intervalley transfers were limited, and most vegetable growers, unable to pump from the river system, either pumped from bores or leased land with bore access.

It is expected, in areas such as southern NSW, that, as trading rules become more flexible under the new water reforms, more investment in high return crops such as vegetables should take place.

3.8 REUSE AND RECLAIMED WATER IN THE VEGETABLE INDUSTRY

Reuse water is defined as waste water that may have been treated and then reused before being discharged into the environment. It includes water supplied as discharge from industry such as mining, food processing and manufacturing, effluent from sewerage treatment plants, and water supplied through regional reuse schemes. It also includes water that is recycled on-farm, including drainage water that is re-pumped for use elsewhere on the farm.

In 2000/01, vegetables used 16 670 ML of the 423 264 ML of total agricultural water classified as 'reuse' (Table 19). Reuse water accounted for less than 3% of total water use for vegetables (total consumption), and a large proportion of this was sourced from rural irrigation regional reuse schemes (ABS 2004, 2005c).

Reclaimed water is the term generally given to effluent from sewerage treatment plants which is made available for industry or domestic use. The use of reclaimed water is increasing every year, and a proportion of this water is used in vegetable crops. Reclaimed water is increasingly being seen as a valued commodity as competition for high quality fresh water increases. Several factors, including the 2001–04 drought, the water reform process in some states and increasing consumer awareness, have combined to highlight the possibilities of reclaimed water, and caused the industry to reconsider it as a viable alternative water resource.

Some of the largest reclaimed water schemes operate in vegetable-growing districts. The nation's largest, the Virginia pipeline scheme in South Australia, delivers 10 gigalitres per annum from the Bolivar sewerage treatment plant to horticulturists on the Northern Adelaide Plains. The reclaimed water is used by 230 vegetable growers, and this could increase, as the system is designed to deliver up to 23 GL/annum (Hamilton et al. 2005). Several other smaller schemes have the potential to deliver to vegetable growers, including the Werribee scheme and the South-East Queensland Recycled Water Project.

Some of Australia's major vegetable production districts (Gatton, Werribee, Sydney Basin) are close to major cities. Collectively, Australia's 22 largest cities consume 1800 GL of water per annum. Policy changes being pursued through COAG are encouraging increased water recycling from Australia's cities; the horticultural industries, as high value users, are increasingly likely to be targeted as customers for this recycled water (Hamilton et al. 2005).

Table 19 – Water use (ML), Australia, 2000-01

	Self-extracted [b]	Mains water [c]	Reuse water [d]	Water in-stream [e]	Total consumption [a]
Vegetables	422 008	117 033	16 670	-	555 711
Agriculture	9 132 095	7 105 022	423 264	-	16 660 381

[a] Water consumption = self-extracted use + mains water use + reuse water use – mains water supply – in-stream use.

[b] Includes water extracted directly from the environment for use.

[c] Includes water supplied to a user usually through a non-natural network (piped/open channel or other carrier) where an economic transaction has occurred for the exchange of water regardless of method of delivery. Mains water is a subset of the self-extracted total.

[d] Refers to wastewater that may have been treated to some extent and supplied to another user. It excludes water reused on-site.

[e] This is a subset of self-extracted water use.

Source: Table 2.9, page 17 in *Water Account Australia 2000-01*, ABS Catalogue 4610.0, publ. May 2004.

NSW DEPARTMENT OF
PRIMARY INDUSTRIES

Maximising returns from water in the Australian vegetable industry: National report

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Maximising returns from water in the Australian vegetable industry

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