Maximising returns from water in the Australian vegetable industry: Western Australia

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EXECUTIVE SUMMARY

This report is one in a series on vegetable industry water use at state and national levels, and has been funded by Horticulture Australia Ltd and Ausveg. This series outlines how water is used in the major vegetable production regions in Australia, and details the current irrigation practices, water use efficiencies and economics of the vegetable-growing industries in each state.

The vegetable sector is the largest segment of the horticultural industry in Australia. The most recent Australian Bureau of Statistics (ABS) survey (2000/01) 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 (with estimated value of agricultural operations worth $5,000 or more) Australia-wide, directly employing 15,621 people. 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 per annum at first point of sale is generated.

The 2005 ABS report *Water use on Australian farms* stated that, in 2002/03, the vegetable industry accounted for 439,229 ML, or just 4.2% of the total water used for irrigation. The report also estimated that average water use per hectare was 3.9ML/ha, compared with the estimated overall application rate for water across all crops of 4.4 ML/ha. The value return from vegetable production per ML increased from $1762/ML in 1996/97 to $3207/ML in 2000/01 (ABS 2005).

The rate of irrigation technology improvements in the vegetable industry since the mid 1990s has been significant, and has come at a time of increased publicly funded incentive programs (such as WaterWise on the Farm in NSW and Water for Profit in Queensland) for improving irrigation efficiency on farm. This series of reports details the investment made in technology to ensure maximum output and product quality from every megalitre used in vegetable production and processing.

The productivity increases achieved by the vegetable industry can be largely attributed to the 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 increased use of whole farm planning and soil mapping. Although more difficult to measure, some part of that increase in product value and quality is most likely to be the direct result of improved irrigation practices.

VEGETABLE WATER USE IN WESTERN AUSTRALIA

In order to obtain a snapshot of the current Western Australian vegetable industry, its irrigation practices and economics, current water use efficiency and water use economics, a range of relevant data were collected. These included production and export values for main crops, gross margins, value adding, rainfall, water use, water costs and water trading options, information on water resources, irrigation management and irrigation scheduling methods, water quality and sustainability, product quality effects due to water quality, current regulations regarding water use, water allocation compared to other agricultural and horticultural enterprises.

In 2000/2001, the Western Australian vegetable industry was worth $222,365,841, directly employed 1546 full-time equivalents (FTE) and used 83.31 GL of water, or 15.9 % of the Western Australian total agricultural industries' water (522.56 GL).

In the vegetable industry 1 ML of water resulted in the production of $2269.14 worth of product at the farm gate and directly employed 0.01856 persons. Total horticultural water use (vegetables, fruits, grapes, nurseries and olives) in Western Australia was 289.24 GL or 55.35 % of the Western Australian total agricultural industries.

The gross margin per ML of water for the main vegetable crops ranged from $246/ML for broccoli to $1181/ML for tomatoes. The gross margin per ML for potatoes, with $1152/ML, was almost similar to tomatoes. The sequence of major vegetable crops, ranked according to their water economy, was: tomatoes > potatoes > cauliflowers > lettuce > carrots > onions > capsicum > sweet corn > broccoli.

Although rainfall is gently declining in Western Australia, the vegetable industry has still unrestricted access to irrigation water. To date, there is no resource rent on groundwater which is drawn using growers supplied infrastructure. Water charges only apply in areas where government supplies the infrastructure, such as Kununurra, Carnarvon and Harvey.

RECOMMENDATIONS

The officers of the Department of Agriculture and Food, Western Australia, who prepared this report, identified a number of research needs which would benefit the vegetable industry, and for which industry funding through Horticulture Australia or other sources could be applied.

- The feasibility and consequences of on and off farm water recycling needs to be researched.
- Current irrigation scheduling and irrigation efficiency knowledge need to be extended and best practices for vegetable growers demonstrated to improve the figure of establishments using irrigation scheduling.
- The water use data in this report was estimated, and some are in the opinion of the authors very approximate. Real time data collection is recommended to get a better estimate of the current state of water usage in the vegetable industry.
- Some data as estimated by the ABS appear to vary from Department of Agriculture and Food officer's estimates (e.g. tomato yields and water use, capsicum yields). To get a better idea of the actual water value, some more staff time needs to be spent on actual field surveys and spot sampling. This would also yield an idea of the actual growers' irrigation practices and education needs.
- AusVeg should fund a project to relate the ABS statistics to actual field data and coordinate to get a better quality of statistics, which do not completely rely on growers statements and also take into account 'unofficial' products. A clear example of the inaccuracy is the Carnarvon horticultural production figures. Whilst production value figures for vegetables in 2001 are estimated by the ABS to be $11,328,022, data collected from trucking companies state the same value to be $27,410,314, that is142 per cent more. ABS figures rely on growers estimates, trucking data reflect the actual product, leaving the district and do not include private or local sales or movements north of Carnarvon.
- To be less dependent on the ABS, AusVeg could collect independent statistical production data. Growers may have more confidence in the security of data they provide to their own industry than what they provide to a government body.

IRRIGATION DISTRICTS COVERED IN THIS REPORT:

1. Kununurra (ORIA) – Ord River Irrigation Area
    a. East Kimberley
    b. West Kimberley
2. Carnarvon (Gascoyne River)
3. Midwest (Geraldton)
4. Gingin and Wanneroo
    a. Gingin
    b. Metro North
5. Perth
    a. Metro East
    b. Metro South
6. South West WA
    a. Peel Harvey
    b. Whicher (Margaret River, Augusta, Vasse)
    c Preston – Warren – Blackwood (Manjimup, Bridgetown, Pemberton, Donnybook) - PWB
    d. Great Southern (Mt Barker, Albany, Denmark)

Note: The irrigation districts are used by the ABS and in Brennan, 2005 and have been adapted in this project.

Figure 1. Regions analysed for irrigation in Western Australia.

Source: Western Australian Water Assessment 2000 (WRC 2000a)

SECTION 1 – VEGETABLE PRODUCTION IN WESTERN AUSTRALIA

INTRODUCTION

The vegetable industry in Western Australia is almost totally dependent on irrigation. Vegetables are produced year round, due to climates ranging from tropical to temperate in different growing areas. The vegetable industry is the largest horticultural industry in Western Australia and its production value in 2003/2004 (farm gate) was $204 million (ABS). Western Australian vegetable production is highly dependent on export markets due to its small domestic base. However, severe competition from China in the Malaysian market for carrots and cauliflowers, a stronger Australian dollar and a reduction in demand on some commodities resulted in a 36.6 % decline in Western Australian vegetable exports in 2004/2005, representing a value of $55.8 million, compared to $88 million in 2000/2001 (ABS). The decline in overseas exports was offset to an extent by increased sales of carrots to eastern state markets. Increased competition from China and a stronger Australian dollar are likely to continue to have a negative impact on exports and lead to a rationalisation in the growing sector for export crops such as cauliflowers and carrots. This report is based on 2000/2001-data, which were the only data available at the time it was compiled. In that year, the Western Australian vegetable industry used 83.31 GL of water, or 15.9 % of the Western Australian total agricultural industries. Total horticultural water use (vegetables, fruits, grapes, nurseries and olives) in Western Australia was 289.24 GL or 55.35 % of the Western Australian total agricultural industries. Vegetable water use was 28.8 % of the total horticultural water (Brennan, 2004).

Although rainfall is gently declining in Western Australia, the vegetable industry has still free access to irrigation water. Except in areas where water is provided by an irrigation scheme (Ord River, Gascoyne, Harvey), growers provide their own infrastructure and access the water resource (mainly groundwater) without charge. There are currently discussions to introduce some licensing charges, but costs or restrictions won't be as severe as in the Eastern States.

IRRIGATED AREA PLANTED TO MAJOR VEGETABLES (INCL. MELONS)

Table 1. Irrigated area planted to major vegetables (2001)

District Subdistrict	Area planted (ha)
1. Kununurra (ORIA) Ord River Irrigation Area	2,839.88
East Kimberley	2,448.84
West Kimberley	391.04
2. Carnarvon (Gascoyne river	622.48
3. Midwest	114.29
4. Gingin and Wanneroo	2,631.47
Gingin	1,339.78
Metro North	1,291.69
5. Perth	980.61
Metro East	40.42
Metro South	940.19
6. South West WA	4,256.38
Peel-Harvey	895.46
Whicher	763.69
Preston-Warren-Blackwood	2,008.6
Great Southern	588.63
State Total	11,445.11

Note: ABS statistics 2001. The ABS gives two sets of data, area planted and area irrigated, to reflect double cropping. Discussion with irrigators at the State Water Strategy Irrigation Review Steering Committee meeting indicated, that the area planted statistics are more likely to be accurate, and these have been used to represent area irrigated in this report (Brennan, 2004).

MAJOR VEGETABLE CROPS (% AREA PLANTED)

Table 2. Percentage area planted to major vegetable crops (2001)

Rank	Top three vegetables – Percentages of total area planted						Cumulative	Count of major vegetable products in the district
	1	%	2	%	3	%	%	
1.Kununurra (ORIA) Ord River Irrigation Area	Melons	72%	Pumpkins	19%	Beans	7%	98%	
East Kimberley	Melons	69%	Pumpkins	20%	Beans	8%	97%	9
West Kimberley	Melons	87%	Pumpkins	13%	nil	-	100%	3
2. Carnarvon	Tomato	23%	Melons	19%	Capsicums	16%	58%	13
3. Mid-West	Melons	76%	Sweet Corn	13%	Marrows	5%	95%	6
4. Gingin and Wanneroo								
Gingin	Carrots	67%	Cauliflower	10%	Lettuce	8%	85%	20
Metro North	Lettuce	25%	Broccoli	23%	Tomatoes	13%	60%	22
5. Perth								
Metro South	Carrots	41%	Potatoes	13%	Celery	9%	63%	16
Metro East	Melons	76%	Tomatoes	11%	Peas	6%	93%	5
6. South West WA								
Peel-Harvey	Carrots	35%	Potatoes	33%	Onions	14%	82%	17
PWB	Cauliflower	42%	Potatoes	36%	Pumpkins	5%	82%	22
Great Southern	Peas	66%	Potatoes	11%	Cauliflowers	10%	87%	23
Whicher	Potatoes	63%	Carrots	16%	Pumpkins	9%	87%	17
State Level	Potatoes	16%	Carrots	16%	Cauliflower	11%	42%	28

Major vegetables are defined as having a value. $100,000. Source: Data from ABS

VALUE OF PRODUCTION OF VEGETABLES (FARM GATE /2001)

Table 3 Farm gate value of production of vegetables ($) (2001)

Horticultural region	Total vegetables	Asparagus	Beetroot	Broccoli	Brussels sprouts	Cabbages	Capsicum	Carrots	Cauliflower	Celery	Chinese cabbage
1. Kununurra	33,368,412	11,136									
2. Carnarvon	11,328,022	214,150		3,115		1,809	1,269,062				
3. Mid-west	13,582,640	1,458,790	2,516	102,217	4,160	7,916	5,236	17,420	549,416	4,302	
4. Gingin & Wanneroo	65,467,097	85,660	94,238	3,504,839		2,384,379	125,156	25,477,516	4,491,196	1,422,984	864,426
5. Perth	37,907,984	73,668		189,106	5,967	1,518,296	649,761	5,908,656	2,484,241	514,808	
6. South West - WA	66,326,842	5,140	18,118	465,628	23,404	54,844	52,394	11,624,296	13,409,107	7,732	31,478
Total	227,980,997	1,848,544	114,872	4,264,905	33,531	3,967,244	2,101,609	43,027,888	20,933,960	1,949,826	895,904

Source: ABS.

Value of production continued

Horticultural region	Cucumber	French and runner beans (total)	French and runner beans (fresh market)	French and runner beans (processing)	Green peas (fresh market)	Green peas (processing)	Leeks	Lettuce	Marrows and squashes	Melons nec	Onions
1. Kununurra	231,424	1,904,332	1,904,332						588,448	7,862,249	190,915
2. Carnarvon	482,771	410,834	400,331	10,503			99,468				
3. Mid-west	4,405	14,700	14,700			167,545	8,428	20,527	24,207		5,395
4. Gingin & Wanneroo	437,328	280,715	280,715				340,495	8,320,393	208,062		165,151
5. Perth	764,214	24,051	22,226			146		2,187,563			1,529,631
6. South West - WA	17,812	60,428	59,781	647	3,173		16,164	56,885	3,785		7,092,475
Total	1,937,954	2,695,060	2,682,085	11,150	3,173	167,691	464,555	10,585,368	824,502	7,862,249	8,983,567

Value of production continued

Horticultural region	Parsley	Parsnips	Potatoes	Pumpkins	Rock melons	Snow peas	Spring onions	Swedes	Sweet corn	Tomatoes (total)	Tomatoes (fresh market)
1. Kununurra				4,941,851	9,681,653						
2. Carnarvon	724		7,354	567,078	748,084				393,856	4,685,427	4,608,083
3. Mid-west			410,704	555,219	1,573,779			4,580	115,767	11,345	11,345
4. Gingin & Wanneroo		198,432	1,410,879	59,192	852,572		14,214	94,234	188,230	1,865,415	1,818,186
5. Perth		319,272	1,879,671	313,243	295,338					102,749	14,739
6. South West – WA			26,805,756	1,470,636	325,236	1,620		64,349	1,724,108	2,231,327	2,231,327
Total	724	517,704	30,514,364	7,907,219	13,476,662	1,620	14,214	163,163	2,421,961	8,896,263	8,683,680

Value of production continued

Horticultural region	Tomatoes (processing)	Vegetables nec	Water melons	Zucchini
1. Kununurra			7,907,576	20,235
2. Carnarvon	77,344	703,143	867,798	849,884
3. Mid-west		2,888,551	4,085,704	1,429
4. Gingin & Wanneroo		10,006,065	48,252	166,576
5. Perth	379	11,479,748	99,954	
6. South West – WA		188,471	491,590	80,887
Total	77,723	25,265,978	13,500,874	1,119,011

VEGETABLE VALUE AFTER VALUE ADDING

Islam (1997) studied the value adding of the horticultural industries and found the average ratio of farm to post-farm value added components in Western Australia to be 1:3.7. The term 'Value added' refers to the difference between the gross value of production and the value of materials and services used in production (ABS 1994*). In Islam's report, the term 'value added' is equal to the gross value of output less the total value of purchased inputs except the value of wages, salaries, supplements paid and operating surplus received in production.

There are farm and non-farm value added components. Post–farm value adding refers to other sectors that contribute to the value of the final product. They vary from industry to industry, but broadly can be classified into a) transport and handling (including storage); b) wholesale marketing; c) initial processing; d) packaging and distribution; e) further processing; f) retail marketing and g) export marketing.

*It was assumed, that the relationship between the gross value of production and the value of materials and services used in production remained unchanged since 1994 as no other statistics were available.

For some vegetable crops details were given by Islam (1997):

Table 4. Value added to main vegetable crops (2001)

Product	Farm gate value (ABS 2001	Value added (multiplier)	Value added in chain ($)	Chain contains:
Carrots	43,027,888.00	1.27	54,817,529.31	Growers, fresh markets, retail, exports.*
Cauliflowers	20,933,960	1.51	31,673,081.48	Growers, fresh markets, processor, retail, export by air, exports by sea.
Potatoes	30,514,364	3.69	112,598,003.16	Growers, wholesale, processor, distribution, retail, fast food, exports.

SUMMARY OF CLIMATE IN WESTERN AUSTRALIA

In Western Australia, vegetables are grown in Kununurra, Carnarvon and in the Mid-West from autumn to spring. In summer, the conditions in these areas are too harsh to grow vegetables. In the metro area, vegetables can be grown year round, provided overhead sprinklers are used for cooling in summer and to combat the occasional frost in winter. In inland areas of South-West Australia (Manjimup) cold temperatures and heavy rainfall, strong winds and occasional hail limit cropping in winter to cauliflowers.

Table 5. In season rainfall

District rainfall	Summer	Autumn	Winter	Spring	Total
1. Kununurra (ORIA) Ord River Irrigation Area	486	160	6	86	738
2. Carnarvon	35	66	111	18	230
3. Mid-West	25	111	274	60	470
4. Gingin and Wanneroo	33	171	477	158	839
Gingin					
Metro North					
5. Perth	30	168	473	140	811
Metro South					
Metro East					
6. South West WA					
4Peel-Harvey	43	215	554	198	1010
PWB	65	232	505*	234	1036
Great Southern	71	193	335*	209	808
Whicher	48	264	624	220	1156

Source: Calculated from the Western Australian Department of Agriculture and Food's climate data.

Shading = vegetable growing season.

* Cauliflowers are grown in winter

VALUE OF PRODUCTION AND EXPORTS, MAJOR VEGETABLES (> 2,000,000)

Table 6. Value of production and value of exports of vegetable crops > $2,000,000

	Value of Exports (FOB) 2000/2001	Value of Exports (FOB) 2004/2005	Value of Production 2001 (farm gate)
Carrots	$34,578,576	$32,322,227	$43,027,888
Melons	$4,630,763	$2,653,924	$34,927,981
Potatoes	$5,462,553	$8,629,273	$30,514,364
Cauliflowers	$27,267,872	$4,405,456	$20,933,960
Lettuce	$1,937,010	$736,366	$10,585,368
Tomatoes	$503,518	$61,185	$8,896,263
Onions	$1,828,673	$20,500	$8,983,567
Pumpkin	$876,054	0	$7,907,219
Vegetable seeds	$5,200	0	$5,504,665
Broccoli	$540,743	$643,534	$4,264,905
Cabbages	$617,305	$242,590	$3,978,137
Sweet corn	$91,290	$4,174	$2,421,961
Celery	$2,053,679	$1,741,121	$1,949,826
Cucumbers	$199,352*	$32,917	$2,348,986
Capsicum	$52,935	$34,298	$2,101,609
Vegetable other	$5,186,203.00	4,231,080	$34,019,142.00
Total	$85,632,374	55,758,645	$222,365,841

Source: Department of Agriculture and Food, unpublished report, originally from ABS.

* Export data for cucumbers was 2002 data as 2001 data appeared erroneous.

Notes: Categories are ranked in order of value of production. Export value is FOB which includes the value of packing, cooling and cartons see ABS definition of FOB. Trade data are based on financial year. Data is sorted according to the value of production. Of the major commodities, carrots and cauliflowers have a high export dependency. The groups shown in the table include all categories exceeding a value of $2m in 2000/2001; the 'Other' category includes a substantial range of less important crops. At the aggregate level, almost half the produce grown in Western Australia was exported to international markets in 2000/2001 according to the gross value data.

2001 data is used here because it was the last year that ABS conducted a survey in the vegetable industry.

2004/2005 export data are shown to illustrate declining exports. Note that carrot exports have not significantly declined since 2001. Carrot exports peaked in 2001/2002 with $43.3 million value and have since decreased by 25.3%. This shows that the carrot industry is relatively resilient to the Chinese imports.

SECTION 2 – WATER USE IN THE WESTERN AUSTRALIA VEGETABLE INDUSTRY

TOTAL WATER USE AND HORTICULTURAL WATER USE:

Table 7. Total and horticultural water use in Western Australia (2001)

District Subdistrict	Total Agriculture (GL)	Horticulture (GL)	%
1. Kununurra (ORIA) Ord River Irrigation Area	131.65	35.12	26.67
East Kimberley	128.17	31.82	24.82
West Kimberley	3.48	3.30	**94.82**
2. Carnarvon (Gascoyne River)	18.60	10.14	**54.52**
3. Midwest	7.57	2.89	**38.17**
4. Gingin and Wanneroo	72.43	61.48	**84.88**
Gingin	44.81	37.52	83.73
Metro North	27.62	23.96	**86.75**
5. Perth	77.86	70.69	90.79
Metro East	54.48	50.89	93.41
Metro South	23.38	19.80	**84.47**
6. South West WA	214.43	108.93	50.8
Peel-Harvey	109.42	16.69	15.25
Whicher	24.04	18.62	77.45
Preston-Warren-Blackwood	62.07	55.95	90.14
Great Southern	18.90	17.67	93.49
State Total	522.56	289.24	**55.35**

Source: Calculated from area statistics (ABS 2001), and estimated water use (Wright 2004).

Note: Crop water use benchmarks were estimated by Wright (2004) and these were used by Brennan (2004) to calculate total water use by category, for the year 2000-2001, which is the most recent year for which crop area planted is available.

Horticultural water use includes tree crops, vines, vegetables and flowers. The districts where a high percentage of use would be applied to vegetables include: Gingin/Wanneroo, Perth (Metro South), Midwest, Kununurra and Carnarvon.

TONNES/ML/CROP

For a given crop, water use is different between regions and dependent on the time of planting. A computer model developed by (Aylmore *et.al.* 1994) calculates total water use for a number of vegetable crops. The following table shows the water usage of the most important vegetable crops

Table 8. Predicted or estimated total water use (ML/ha) of vegetables by district and planting date for major WA crops as defined in Table 2

Crop	District	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Average water use (ML/ha/crop)
Beans	Kununurra	na	na	3.7	5.5	6.0	5.6	5.7	na	na	na	Na	na	5.30
Broccoli	Gingin and Wanneroo	9.1	8.1	5.6	2.2	0.5	1.0	2.7	4.4	5.8	8.0	8.8	9.3	5.46
Capsicums	Carnarvon	na	14.9	13.2	13.8	16.2	18.0	16.1	14.8	13.1	na	na	na	15.01**
Carrots	Gingin and Wanneroo	13.7	9.1	5.0	2.2	2.3	4.6	7.6	10.2	12.2	13.9	15.2	15.5	9.29
Carrots	Perth	11.0	7.1	3.8	1.6	1.8	3.7	6.0	8.0	9.7	11.1	12.2	12.6	7.38
Cauliflower	Gingin and Wanneroo	9.1	8.1	5.6	2.2	0.5	1.0	2.7	4.4	5.8	8.0	8.8	9.3	5.46
Cauliflower	South West WA Manjimup	5.7	4.3	2.2	0.7	0.1	0.1	0.9	1.9	2.7	4.4	5.8	6.4	2.93
Cauliflower	South West WA Albany	5.4	4.4	2.3	0.7	0.2	0.3	1.3	2.4	3.3	4.8	6.1	6.6	3.15
Celery	Perth	11.1	9.5	5.8	2.1	0.5	1.3	2.7	4.7	7.8	9.8	11.1	11.3	6.48
Lettuce	Gingin and Wanneroo	6.2	6.2	5.3	2.4	0.5	0.1	0.5	1.5	2.9	4.2	5.4	6.0	3.43
Marrows	Mid-West	na	na	7.4	4.6	na	na	na	na	9.6	na	na	na	7.20
Melons	Kununurra	na	na	5.0	6.4	7.0	7.9	8.4	9.3	na	na	na	na	7.33
Onions	South West WA Peel-Harvey	na	na	na	2.4	2.3	4.4	5.7	7.7	10.3	11.8	11.7	na	7.04
Potatoes	Perth	na	na	3.7	1.4	0.8	1.6	3.2	5.2	na	na	na	na	2.65
Potatoes	South West WA Peel-Harvey	na	na	na	na	na	na	na	na	5.7	7.7	7.9	7.3	7.15
Potatoes	South West WA Manjimup	na	na	na	na	na	na	na	3.1	4.9	6.5	7.5	7.3	5.86
Potatoes	South West WA Albany	na	na	na	na	na	na	na	na	6.0	7.9	7.8	7.4	7.28
Pumpkins	Kununurra	na	na	5.8	7.1	7.9	9.0	9.1	9.9	na	na	na	na	8.13
Pumpkins	South West WA Peel-Harvey	6.0	na	na	na	na	na	na	na	6.3	7.1	7.3	6.8	6.70
Pumpkins	South West WA Manjimup	na	na	na	na	na	na	na	na	na	6.4	6.8	6.4	6.53
Sweet Corn	Mid-West	na	9.9	7.2	na	na	na	na	5.6	7.2	9.0	10.4	na	8.22
Tomatoes	Carnarvon	na	12.0	9.8	8.3	8.6	10.6	10.6	10.7	10.5	na	na	na	10.1(6)*

Note: * Crop water use of tomatoes, variety Floradade, planted in April and August was measured by Hoffmann, 1985 to be 3.5 to 4.5 ML (Trial 85G11). Department of Agriculture and Food estimate of average tomato water use in Carnarvon is 6 ML/crop and this figure is used in tables 9, 10a and 11. This also agrees with other state's water use data for tomatoes in this report.

** Capsicum water use appears high. This is because main Capsicum production happens in the cooler period in Carnarvon and the irrigation data cover growing periods up to 7 month.

Note: Carnarvon is a winter tomato production district only and part of the season temperatures and evaporation are sub-optimal for good growth.

Table 9. Water use efficiency t/ML/crop

Crop	District	2001 State average yield (t/ha)	Water use efficiency (t/ML)
Broccoli	Gingin and Wanneroo	10.4	1.9
Capsicums	Carnarvon	8.7	0.6
Carrots	Gingin and Wanneroo	46.4	5.0
Carrots	Perth	46.4	6.3
Cauliflower	Gingin and Wanneroo	15.9	2.9
Cauliflower	South West WA Manjimup	15.9	5.5
Cauliflower	South West WA Albany	15.9	5.0
Celery	Perth	15.0	2.3
Lettuce	Gingin and Wanneroo	54.0	15.9
Marrows	Mid-West	8.4	1.2
Melons	Kununurra	21.3	2.9
Onions	South West WA Peel-Harvey	57.4	8.2
Potatoes	Perth	42.5*	15.7*
Potatoes	South West WA Peel-Harvey	42.5	5.9
Potatoes	South West WA Manjimup	42.5	7.2**
Potatoes	South West WA Albany	42.5	5.8
Pumpkins	Kununurra	17.1	2.1
Pumpkins	South West WA Peel-Harvey	17.1	2.6
Pumpkins	South West WA Manjimup	17.1	2.6
Sweet Corn	Mid-West	10.1	1.2
Tomatoes	Carnarvon	36.9	6.2 (9.2)***

Source: ABS 2000/2001 Agricultural Commodities report and Table 8.

* Crop receives winter rainfall.

** The water use efficiency figure for Manjimup was directly measured in an October planting, using Russet Burbank Potatoes (Department of Agriculture and Food Trial No. 92MC22), which determined optimum water use efficiency using tensiometers.

*** Figure in brackets was experimentally determined, measuring water use efficiency in an August planting using the variety Floradade (Department of Agriculture and Food Trial No 85G11).

WATER COSTS TO FARM BOUNDARY

Notes:

- Compared to the Eastern States, there is no high security water for permanent horticulture in Western Australia.
- In Western Australia farmers get water allocations though a time limited licensing system. This system is equal to all water users. Compared to the Eastern States, water resources have not declined yet.
- In Carnarvon, water allocations are transferable.
- Water is metered in Carnarvon.
- In the Metro area, farms using more than 500 ML of bore water are metered.
- Western Australia-wide, water drawn from bores is not levied by government.*.
- Scheme water prices are given in Table 10.
- In Carnarvon the price of water decreases with the amount of water used
- In the Peel-Harvey irrigation district as well as in Carnarvon, farmers have to be shareholders in the cooperatives to get that price.

*Proposals are currently under way to charge for licences (State Water Strategy Irrigation Review Steering Committee, 2005)

Table 10. Cost of water to the farmers (source Brennan, 2004, Department of Agriculture and Food estimates)

District subdistrict	Prices of scheme water $/ML and main water supply system	Pumping cost $/ML
1. Kununurra (ORIA) Ord River Irrigation Area	11 (Aqueducts)	Scheme water $11/ML
2. Carnarvon (Gascoyne river	150 - 250 (Most farms have bores)	Pumping costs 80-120 Scheme water $70/ML
3. Midwest	Bores	80-120
4. Gingin and Wanneroo		80-120
Gingin	Bores	80-120
Metro North	Bores	80-120
5. Perth		80-120
Metro East	Bores	80-120
Metro South	Bores	80-120
6. South West WA		80-120
Peel-Harvey	22.47 (Aqueducts)	80-120
Whicher	Bores and surface dams	80-120
Preston-Warren-Blackwood	Surface dams	80-120
Great Southern	Bores and surface dams	80-120

GROSS RETURNS $/ML/CROP

Note: The figures for gross value/ML in Table 11 have been derived from data in tables 3, 8 and 9 and crop areas as given in AMIC for 2000/2001.

Table 11. Gross value/Ml (Farm gate) for main Western Australian **vegetable crops**

Vegetable	Value ($)	Area (ha)	2001 State average yield (t/ha)	Water use per crop ML/ha	Total water used (ML)	Gross value/ML (Farm gate $/ML)
Total Vegetables	227,980,997.00	11,445.11			83,310.00	2,736.54
Broccoli	4,264,905.00	308.00	10.40	5.46	1,681.06	2,537.03
Capsicum	2,101,609.00	148.00	8.70	15.01	2,221.48	946.04
Carrots	43,027,888.00	1,731.00	46.40	8.34	14,433.08	2,981.20
Cauliflower	20,933,960.00	1,211.00	15.90	3.85	4,658.72	4,493.50
Celery	1,949,826.00	300.00	15.00	6.48	1,942.50	1,003.77
French and Runner Beans (Total)	2,695,060.00	308.00	2.90	5.30	1,632.40	1,650.98
Lettuce	10,585,368.00	467.00	54.00	3.43	1,603.21	6,602.60
Onions	8,983,567.00	289.00	57.40	7.04	2,033.98	4,416.74
Potatoes	30,514,364.00	1,778.00	42.50	5.73	10,194.70	2,993.16
Pumpkins	7,907,219.00	864.00	17.10	7.12	6,153.41	1,285.01
Sweet Corn	2,421,961.00	215.00	10.10	8.22	1,767.30	1,370.43
Tomatoes (Total)	8,896,263.00	360.00	36.90	6.00	2,160.00	4,118.64
Other vegetables not in table	83,699,007.00	3,466.11			32,828.16	2,549.61

GROSS MARGINS $/ML CROP (MAIN CROPS)

Table 12. Average Gross Margin estimation per ML for selected crops in Western Australia

Horticultural region	Marketable yield per ha	Price $	Total net return $	Total variable costs $	GM per ha ($)*	Water use ML/ha	GM per ML ($)
Broccoli (8 kg box)	1,223.00	15.00	18,340.00	16,995.00	1,345.00	5.46	246.43
Capsicum (10 kg tubs)	2,700.00	10.00	27,000.00	20,415.00	6,585.00	15.01	438.71
Carrots (kg)	50,050.00	0.32	15,840.00	10,189.00	5,651.00	8.34	677.74
Cauliflower (kg)	16,575.00	0.70	11,603.00	8,361.00	3,242.00	3.85	842.73
Lettuce (12 kg crates)	3,900.00	6.00	23,400.00	20,628.00	2,772.00	3.43	807.46
Onions (kg)	71,100.00	218.17	15,512.00	11,482.00	4,030.00	7.04	572.61
Potatoes (Ware, kg)	42,800.00	363.79	15,570.00	8,964.00	6,606.00	5.73	1,152.12
Sweet Corn (kg)	13,860.00	0.60	8,316.00	5,121.00	3,195.00	8.22	388.68
Tomatoes (Total) (kg)	76,500.00	0.75	57,375.00	50,289.00	7,086.00	6.00	1,181.00

* Gross margins as estimated by Gartrell, 1999.

Brennan (2004) did a comprehensive economic analysis of the value of water in vegetable production in the South West, using current prices, budgets prepared by Gartell, 1999, ABS stats, land values, labour - and transport costs for the different districts for the main crops potatoes, carrots and cauliflowers. After accounting for everything, she came out with the following results:

Table 13. Gross margins per ML of major vegetable crops as determined by Brennan, 2004

	Potatoes	Carrots	Cauliflower
Expected gross margin per ha	$6,211.55	$4,749.69	$2,468.74
Water application rate (ML/ha)	4	8	7.2
Mean GM $ per ML	$1,552.89	$593.71	$342.88
Low GM, $ per ML	$1,014.91	$289.59	-$35.24
High GM, $ per ML	$2,090.86	$932.55	$768.85

Notes: Expected gross margin is expected revenue less total variable costs. The high and low gross margins have a 10% chance of occurring and illustrate the risk associated with vegetable production.

Gross margins for vegetables in the northern regions

Table 14. Vegetable gross margins in the Northern regions

Region, Commodity	Gross Margin per ML	Includes water cost of:
Ord, JD pumpkin	$62	$11/ML including levies
Ord, Butternut pumpkin	$104	$11/ML including levies
Ord, Rockmelon	$186	$11/ML including levies
Carnarvon, Mixed*	$1,359	$70/ML

* The Carnarvon budgets supplied by the WA Department of Agriculture and Food included capital cost values, and these were used to convert the gross margin to an estimated return to water. A value of $114 per ML was obtained for the mixed enterprise.

- end of excerpt -

IRRIGATION MANAGEMENT AND END PRODUCT QUALITY

Table 15. Method of irrigation by district and product quality

District	Main Irrigation method	Product quality
1. Kununurra (ORIA) Ord River Irrigation Area	Flood, weed problems, water supply from Ord River dam.	Good, export quality
2. Carnarvon (Gascoyne River)	Drip and polythene mulch, good for weed control - water supply from Gascoyne river bores or scheme water.	Mostly good but sometimes sunburned
3. Midwest	Sprinklers, used for cooling and moving sand control – water supply from bores.	Good
4. Gingin and Wanneroo	Sprinklers, used for cooling and moving sand control – water supply from bores.	In some carrot farms, high nitrogen levels in the ground water, which is then used to irrigate, increase top growth and cause 'lodging' tops which makes harvest difficult. However, carrot quality is still good.
5. Perth	Sprinklers, used for cooling and moving sand control – water supply from bores.	Good
6. South West WA		
Peel-Harvey	Sprinklers or travelling irrigators, used for cooling and moving sand control – water supply from scheme water supplied in aqueducts or ground water.	Good
Whicher	Sprinklers or travelling irrigators, used for cooling and moving sand control – water supply from surface dams, rivers or bores.	Good
Preston-Warren-Blackwood	Sprinklers or travelling irrigators, used for cooling – water supply from surface, gully dams or rivers.	Good
Great Southern	Sprinklers or travelling irrigators, – water supply from surface dams, soaks or rivers. Crops are partly or fully rain fed. In Albany the same amount of rainfall as Perth (800mm) is more evenly distributed through the year. Frankland and Mt Barker get much less.	Good

SALINITY IMPACTS ON PRODUCTION

Table 16. Salinity impacts on production and product quality

District	Salinity impacts on production	Impact on product quality
1. Kununurra (ORIA) Ord River Irrigation Area	Some over-irrigation causes ground water to rise, causing salinity in some parts.	Not known
2. Carnarvon (Gascoyne River)	Some overdrawing from river near ocean causes salt water wedge to move into irrigation district, but generally water quality is very good.	
3. Midwest	Unknown to author.	
4. Gingin and Wanneroo	Overdrawing from ground water table is causing water tables to fall but salt intrusion and salinity. is rare	
5. Perth	No significant problems so far. There are some instances of salt intrusion from over pumping in the south metropolitan area.	
6. South West WA		
Peel-Harvey	Reduced rainfall and over clearing causes salinity rise, salinity of Wellington dam water 2 to 3 times higher than the Murray-Darling system - 2.5 times the acceptable irrigation limit. Some over pumping and saline intrusion on the coastal plain.	
Whicher	Reduced rainfall causes mild salinity rise	
Preston-Warren-Blackwood	Blackwood River and Warren River were used for irrigation in the past, now too salty. In some parts of region surface dam water is increasingly saline.	Salty water reduces specific gravity of processing potatoes.
Great Southern	Many water courses are saline but winter flows are pumped to 'Turkey nest' dams upslope.	

OTHER WATER QUALITY IMPACTS ON PRODUCTION

On sandy soils, where bore water is used for irrigation, nutrient pollution can become an issue. Nitrates and other nutrients can leach to the groundwater and be recycled in the future. This unplanned fertigation can sometimes have a devastating effect on the crop. Carrot tops can 'lodge' making them un-harvestable due to high water nitrate.

ACCESS TO WATER IMPACTS ON PRODUCTION

Kununurra, Carnarvon and the Mid-West districts are totally dependent on irrigation; Perth and the South West require irrigation from September onwards. In the great Southern districts, some crops such as processing peas are grown just on rainfall. There are currently no reduced bore allocations due to drought effects or short term aquifer decline around Perth.

NUMBER OF FULL TIME EQUIVALENT JOBS

The ABS reported in 2001 that 1546 persons were employed in vegetable growing, 999 males and 547 females (ABS Census 2001).

WATER TRADING FLEXIBILITY (PRICE)

Water trading is currently happening on a permanent basis in Carnarvon and temporarily in the South West.

In Carnarvon, the Gascoyne Water Cooperative has taken over brokering water-trading from the Water Authority. Growers access water either from their own bores, from bores owned by the Department for the Environment or from scheme water. Their total water allocation from all sources is 72,000,000 litres, which is enough for roughly 3.5 ha of bananas.

Water trading is only happening with scheme water. The Gascoyne Water Cooperative had 5 GL allocated for the district by the Water Corporation. Each farm using scheme water gets an allocation, based on the previous 5 years usage, multiplied by 1.543. If this is greater than 5000 kL, they get a minimum of 5000 kL. Each farm pays 8 cents/kL base cost, and a further 15 cents/kL if the water is used up, i.e. a total of 23 c/kL if the water is used.

In 2004, the first year the Gascoyne Water Cooperative has been in place, 250,000 kL were traded. The deal is between the parties, who also set the price, but it is understood that most farmers just cover their cost of 23 c/kL. Trades are either temporary or permanent.

Most farmers like the system, but some want to go back to the time when water was managed by the Water Corporation. Some are not happy with their water allocation (pers. comm. Edward Garrett, manager Gascoyne Water Cooperative).

In 2003-04, Harvey Water traded 3 gigalitres of high grade water from its Samson Dam in return for the use of the integrated water scheme infrastructure. This volume of water trade is expected to be ongoing, and a proposal has been submitted by Harvey Water to yield 50 gigalitres in the medium-term to long-term (www.watercorporation.com.au search for water trading).

ON FARM METERING AND WATER LICENSING

Table 17. Licenses (2004), by region.

District Subdistrict	Total licenses (GL)
1. Kununurra (ORIA) Ord River Irrigation Area	10.15
East Kimberley	7.3
West Kimberley	2.85
2. Carnarvon (Gascoyne river	16.03
3. Midwest	8.51
4. Gingin and Wanneroo	128.18
Gingin	84.29
Metro North	43.89
5. Perth	196.2
Metro East	109.75
Metro South	86.45
6. South West WA	335.16
Peel-Harvey	255.24
Whicher	35
Preston-Warren-Blackwood	44.1
Great Southern	0.82

Source: Department of Agriculture and Food, Peter Tille, 2004 unpublished report

Notes: Scheme water is metered in Carnarvon. In the Metropolitan area and some South West properties, water is metered if the farm uses more than 500 ML, but soon all water will be metered.

BENCHMARKING DATA – GENERAL

Irrigation trials were conducted in various parts of the state on selected vegetable crops. Bench mark - crop water usage as well as irrigation thresholds were determined.

BENCHMARK EVAPOTRANSPIRATION (ET) REQUIREMENTS

Results of irrigation trials:

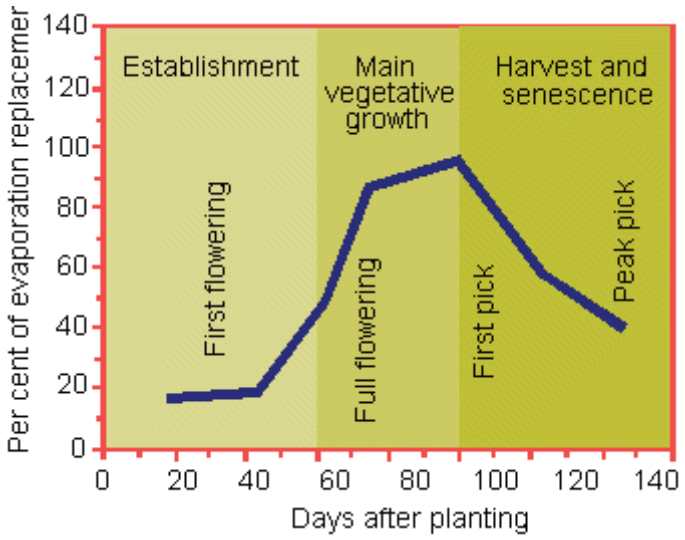
Tomatoes (Carnarvon trials 1985–1994)

Total crop water usage

Tomatoes in Carnarvon planted in April or August: Water Usage 350–450 mm (including rainfall).

Evaporation replacement:

Figure 2 below shows the optimum water usage during the growth period.



Irrigation threshold

Irrigate to field capacity when soil moisture tension at centre of root zone (30-50 cm) is -40 kPa.

Potatoes (Manjimup trials 1989–1993)

Total crop water usage

Potatoes in Manjimup planted in September: Water Usage 550–650 mm.

Evaporation replacement

The crop used 60–130 percent of Class A pan evaporation during the season.

Irrigation threshold

Irrigate to field capacity when soil moisture tension at centre of root zone (30 cm) is -25 to -40 kPa

Cauliflowers (Manjimup trial 2002)

Total crop water usage

Cauliflowers in Manjimup planted in December: Water Usage 400 – 500 mm, evaporation replacement 108–150 per cent.

Other Benchmarking

Aylmore *et.al.* 1994 used crop factors and growing periods determined by the Department of Agriculture and Food for different vegetable crops to define benchmark irrigation requirements. These factors have been incorporated into software 'Crop irrigation requirement calculator' which is available on the WA Department of Agriculture and Food Website www.agric.wa.gov.au (search for 'Crop irrigation requirement calculator'). Benchmarks for major vegetable crops were calculated in Table 8. Note that this program is currently revised.

USE OF SOIL MOISTURE MONITORING

Extensive work has been done on soil moisture monitoring by the Department of Agriculture and Food in most irrigation districts.

The use of the neutron probe for the determination of minimum available soil moisture deficit before irrigation is triggered for an optimum plant performance, was replaced by the use of tensiometers, gypsum blocks and other soil moisture measuring devices (which use capacitance or other techniques).

In the field, farmers have adapted tensiometers for heavier soils. They are used on tomatoes, capsicums and other vegetable crops in Carnarvon, and on potatoes and cauliflowers in Manjimup/Pemberton and on the South West coast.

Environscans ®, which use capacitance to monitor soil moisture, are installed in the South West by consulting companies on bigger farms.

The neutron moisture probe is virtually phased out, due to the inconvenience and perceived health hazards of the system.

On sandier soils, in the metropolitan area, sand-tensiometers have been successfully tested and adopted by some farmers, but environscans ® are also used. Trials are currently being conducted with TDR (Time Domain Resonance) probes with good results.

Most farmers in the metro area and in the South West however, still rely on the evaporation replacement method or just 'kick the dirt'.

In Table 18 results from an ABS 2002–2003 Survey are given. This table shows that 17.6% of establishments in Western Australia use tensiometers, 8.9 % use other soil moisture probes and 1% use scheduling services to do irrigation scheduling

Table 18. ABS survey on irrigation scheduling tools in Western Australia (out of 2731 establishments)

Tools used	
Evaporation figures on graphs	^360
Tensiometers	^483
Soil probes	^245
Government or commercial scheduling service	**27
Calendar or rotational scheduling	^418
Knowledge or observation	2430
Other	*78

^Estimate has a relative standard error of 10% to less than 15% and should be used with caution.

** Estimate has a relative standard error greater than 50% and is considered too unreliable for general use.

*Estimate has a relative standard error of 25% to 50% and should be used with caution.

(b) Agricultural establishments reporting more than one tool are shown against each tool reported.

Source: ABS 2002/2003 4618 Water Use on Australian Farms.

Table 19 shows the changes of irrigation practices. A large number of growers (63.7 %) stated that they improved their irrigation management to become more efficient.

Table 19. ABS survey of changes in irrigation practices – five years to 30 June 2003

Number of Establishments	
Total irrigating	2731
Made no changes	991
Made one or more changes	1739
Type of change	
More efficient irrigation application techniques	1144
More efficient irrigation scheduling	1082
Piping or covered open channels to reduce water loss	^174
Laser levelled	^138
Irrigation water re use or recycling	*63
On-farm soil moisture monitoring	^312
Documented farm water plan	^148
Other	^242

^Estimate has a relative standard error of 10% to less than 15% and should be used with caution.

*Estimate has a relative standard error of 25% to 50% and should be used with caution.

(b) Agricultural establishments reporting more than one tool are shown against each tool reported.

Source: ABS 2002/2003 4618 Water Use on Australian Farms.

USE OF WEATHER BASED SYSTEMS FOR SCHEDULING

Evaporation replacement is a traditional method recommended by the WA Department of Agriculture and Food. The software by Aylmore *et.al.* (1994) uses crop factors, which were developed in past trials.

Many publications (farmnotes, bulletins) which describe methods, to irrigate vegetables using evaporation replacement, are available.

TOTAL CATCHMENT WATER USED FOR VEGETABLE CROPS

na

AVERAGE WATER ALLOCATION/FARM (TYPE, HIGH/LOW SECURITY)

Water allocations are currently managed as follows (see table 20).

Table 20. Water allocation/farm by district

District	Water allocation/farm
1. Kununurra (ORIA) Ord River Irrigation Area	No restrictions.
2. Carnarvon (Gascoyne river.	72,000 kL/farm plus transfer, and other increase options. The water allocation is tied to the title independent of land size. A grower with two titles gets 144,000 kL.
3. Midwest	Licensed by the area of crop grown. Growers are limited to a total area of crop.
4. Gingin and Wanneroo	As for Midwest, farms > 500 ML are metered.
5. Perth	As for Midwest, farms > 500 ML are metered. All allocations are licensed by area of crop grown.
6. South West WA	
Peel-Harvey	Licensed by the area of crop grown. Growers are limited to a total area of crop.
Whicher	Licensed by the area of crop grown. Growers are limited to a total area of crop, farms > 500 ML are metered.
Preston-Warren-Blackwood	No restrictions, most farms irrigate from dams.
Great Southern	No restrictions, farms > 500 ML are metered.

Source: Department of Agriculture and Food officers, pers. comm.

There is currently no differentiation of water with regard to security (pers. comm. Ron Gorman, Department of Environment)

Possible future development

The State Water Strategy Irrigation Review Steering Committee (2005) recommended in their final report that irrigators pay a fee for their licences. This issue is currently being debated and is quite controversial. Growers are arguing that they shouldn't have to pay anything, since they are the ones who put in the infrastructure (mainly bores) in the first place. They also want the current licensing system changed, i.e. perpetual -, not use it or loose it licenses.

AVERAGE PERCENT ALLOCATION /FARM OVER LAST 10 YEARS

Historically, water allocations have not been restricted. Occasionally Carnarvon is drought affected, depending on the flow of the Gascoyne River. This may lead to water restrictions, but this has not occurred in the last 10 years.

AVERAGE ALLOCATION OVER LAST 3 YEARS (DROUGHT AFFECTED)

Table 21. Average allocation over last 3 years (Source Water and Rivers Commission licensing database)

District Subdistrict	Total licenses	No of farms	Average licenses per farm
1. Kununurra (ORIA) Ord River Irrigation Area			
East Kimberley			
West Kimberley	2.85		
2. Carnarvon (Gascoyne river	16.03	74	0.22
3. Midwest	8.51		
4. Gingin and Wanneroo	128.18	113	1.13
Gingin	84.29		
Metro North	43.89		
5. Perth	196.2	18	10.90
Metro East	109.75		
Metro South	86.45		
6. South West WA	335.16	172	1.95
Peel-Harvey	255.24		
Whicher	35		
Preston-Warren-Blackwood	44.1		
Great Southern	0.82		

CROP TYPES/FARM

Table 22. Trend of crop types /farm in the districts

District	Crop types/farm
1. Kununurra (ORIA) Ord River Irrigation Area	Mixed fruit and vegetables
2. Carnarvon (Gascoyne river	Mixed fruit and vegetables
3. Midwest	Mainly vegetables
4. Gingin and Wanneroo	Mainly vegetables, some mixed
5. Perth	Mainly vegetables, some mixed
6. South West WA	
Peel-Harvey	Mainly vegetables, some mixed
Whicher	Mainly vegetables, some mixed
Preston-Warren-Blackwood	Mainly vegetables, some mixed
Great Southern	Mainly vegetables, some mixed

PERCENTAGE TOTAL ALLOCATION DEVOTED TO VEGETABLES VS OTHER CROPS

Table 23. Water usage by enterprise type

Water usage (GL)	Vegetables	Fruits	Grapes	Nurseries	Olives	Total Horticulture	Percentage water allocated to vegetables
1. Kununurra (ORIA) Ord River Irrigation Area							
East Kimberley	16.23	7.08	0	8.5	0	31.81	51.0
West Kimberley	2.55	0.72	0.01	0.03	0	3.31	77.0
2. Carnarvon	2.49	6.71	0.72	0.21	0	10.13	24.6
3. Mid-West	0.86	0.04	0.22	1.2	0.58	2.9	29.7
4. Gingin and Wanneroo						0	
Gingin	14.57	5.22	1.52	6.48	9.73	37.52	38.8
Metro North	11.52	4.63	4.75	2.72	0.35	23.97	48.1
5. Perth						0	
Metro South	8.84	9.31	0.16	1.47	0.02	19.8	44.6
Metro East	0.7	45.22	1.99	2.87	0.1	50.88	1.4
						0	
6. South West WA						0	
Peel-Harvey	7.16	7.25	0.67	1.35	0.25	16.68	42.9
PWB	8.56	44.14	1.53	0.91	0.81	55.95	15.3
Great Southern	3.59	1.05	3.85	0.71	8.47	17.67	20.3
Whicher	6.25	2.25	6.42	2.15	1.55	18.62	33.6
State	83.32	133.62	21.84	28.6	21.86	289.24	28.81

(Source: Brennan 2004 and ABS 2001.)

TREND (% CHANGE) IN HIGH TECH ADOPTION, PAST 5 YEARS

In parts of WA, larger concerns have employed irrigation consultants, which use 'environscan' or other high tech technology to schedule irrigation.

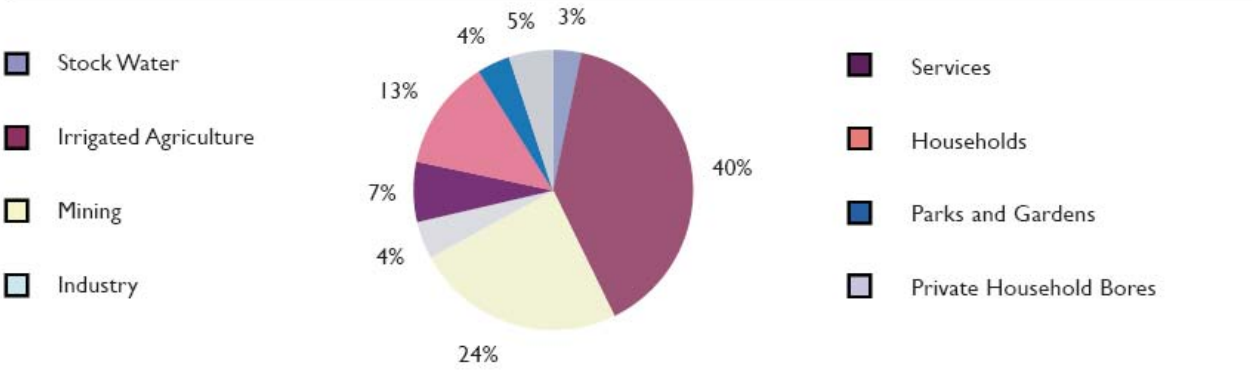
Table 24. Estimated adoption of high tech devices by farmers in last 20 years (Source Department of Agriculture and Food officers pers. comm.)

District	Water allocation/farm
1. Kununurra (ORIA) Ord River Irrigation Area	None.
2. Carnarvon (Gascoyne river	Change happened in the 1980s with most farmers converting from flood irrigation to trickle + polythene mulch or micro sprinklers and using irrigation scheduling.
3. Midwest	In the 1990s, bigger farms converting to centre pivot or other travelling irrigators.
4. Gingin and Wanneroo	In the 1990s, bigger farms converting to centre pivot or other travelling irrigators, but most market gardens still on permanent sprinkler irrigation. Some tried to convert to trickle but this was only successful for tomatoes as sprinklers were needed to cool crops.
5. Perth	In the 1990s, bigger farms converting to centre pivot or other travelling irrigators, but most market gardens still on permanent sprinkler irrigation. Some tried to convert to trickle but this was only successful for tomatoes and capsicum as sprinklers were needed to cool crops.
6. South West WA	
Peel-Harvey	In the 1990s, bigger farms converting to centre pivot or other travelling irrigators. Quote: Water distribution losses from open channel systems were over 30% at privatisation in 1996. Investment in a range of technologies, including piping, has reduced this to 5% in some areas (Geoff Calder, General Manager, Harvey Water, WATER SYMPOSIUM 2004)
Whicher	In the 1990s, bigger farms converting to centre pivot or other travelling irrigators.
Preston-Warren-Blackwood	In the 1990s, bigger farms converting to centre pivot or other travelling irrigators, but not very successful due to topography (undulated country) and infiltration problems. Some farmers started using irrigation scheduling.
Great Southern	None.

DELIVERY CAPACITY OF IRRIGATION SCHEMES

Generally, most irrigators use underground reservoirs as water supply. Some water sources are quite variable and depend on the season (Carnarvon, south west). The Water Corporation claims that 40 per cent of its water is used by irrigators.

Below is some information, as published by the Water Corporation of WA:



Source: Western Australian Water Assessment 2000 (WRC 2000a)

Figure 3. Water use by use group in Western Australia in 2000

The irrigated agricultural sector accounts for approximately 40 per cent of Western Australia's total water demand (Figure 3). This proportion is less than that encountered in other states, where typically irrigated agriculture accounts for 70 to 80 per cent of total water use.

STORAGE LEVELS FOR SOME DAMS USED BY IRRIGATORS.

Dam Name	Current storage	As at	Storage capacity	% Capacity
Argyle Dam (Ord River)*	8,902,460 ML	05/09/2005	10,763,000 ML	82.71%
Wellington Dam*	158,339 ML	05/09/2005	186,000 ML	85.13%

- end of excerpt -

DELIVERY RELIABILITY OF SCHEMES

General:

As rainfall is declining in Western Australia (see CLIMATE CHANGE - Risk assessment and grasping the opportunities, most water schemes except the Ord River have become unreliable. In the Carnarvon area, water supply is reliant on the Gascoyne River flow, which relies on cyclonic rainfall in the catchment. There have been no water restrictions in Carnarvon in the last 10 years.

The current trend for all other irrigation areas is, that water supply is declining and new sources and efficiency gains are sought.

INFORMATION ACCESSIBILITY

As mentioned in point 20, a crop irrigation requirement calculator is available for growers on the Department of Agriculture and Food website www.agric.wa.gov.au.

A large amount of extension material ranging from irrigation scheduling methods for specific crops to irrigation system designs to water quality is also available to growers on this website. Apart from electronic information, the extension material is also available as hardcopies in the form of Farm- or Gardennotes and bulletins. The Department of Agriculture and Food has been doing irrigation research since the 1970s and a lot of information material has been published since. There are also private irrigation consultants working with growers to improve their irrigation scheduling methods and irrigation system design.

SERVICE (COMMERCIAL AND GOVERNMENT) PROVISION, SURROUNDING INFRASTRUCTURE

Water storage facilities are maintained and serviced by the Water Corporation of WA, there is no private investment.

DRAINAGE/RECYCLING CAPACITY/FARM

On sandy soils, farms are indirectly recycling their irrigation water, through their bores. Drained irrigation water seeps back into the water table and gets redrawn by the bores. This may lead to a build up of nutrient levels in the irrigation water. However, direct recycling of irrigation water is not a common practice in Western Australia, in Table 19, 2.3 per cent of irrigators stated that they re used or recycled water.

PRODUCTION TREND/CATCHMENT

The following excerpt is from Brennan (2004).

Future demand for irrigation

The potential future demand for irrigation water in Western Australia will depend on growth in markets for currently produced crops, changes in production technology especially water productivity gains, and emergence of new market opportunities. Demand will also be affected by water policies that impact upon the opportunity cost of water use in irrigation activities. However, a characteristic of water use in Western Australia is that a large amount of the water is used in horticultural industries, which have high returns, and even if water opportunity costs approached those evident on eastern states water markets, it is unlikely that farmers would respond by reducing production of these high valued crops. Asset values are summarised in Table 25. In the south west of the State, around 70 per cent of water is used in horticulture, as shown in Table 26.

Table 25. Indicative asset values for water in the South West, $ per ML

	Rate of return	
Crop	5%	7.5%
Carrots	$6,620	$3,738
Apples	$14,350	$4,678
Wine grapes	$9,000	$6,000
Dairy – high productivity	$2000	$1,333
Dairy – low productivity	Zero or negative	
Beef	Zero or negative	

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

Pasture production for beef in the South West is a marginal activity and it is likely that farmers would be very responsive to water prices. Whilst it is difficult to accurately estimate the amount of pasture production that is dedicated to beef, about 30 per cent of pasture irrigated in the South West Irrigation Area (SWIA) scheme in 1990/2000 was beef (SWIA Invest for Success). This could represent about 65 GL of water.

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

Table 26. Estimated water use in 2001 by activity, GL

	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
Sub total, Horticulture	243.98	45.26
Pasture	106.05	16.34
Other	2.42	79.91
Total	352.46	141.50
Percent Horticulture	69%	32%

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

The impact of increasing production of capsicums for sale on the domestic market is illustrated in Figure 4 using two different price elasticities that are indicative of demand for vegetables. 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 only takes a 5 and 10 per cent increase in production at Carnarvon to reduce prices enough to reduce gross margins to zero.

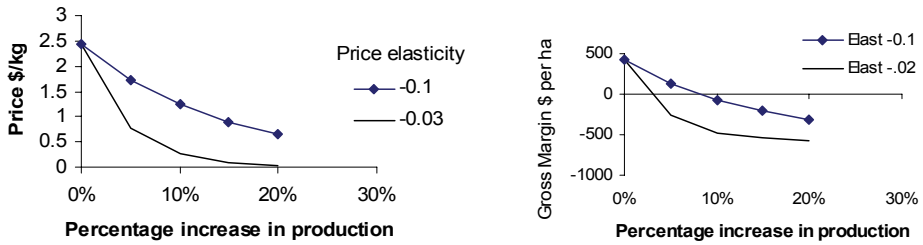


Figure 4. Impact of increased sales on domestic market on gross margin

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 3-4 decades per capita consumption 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 27. Trends in per capita consumption of fruit and vegetables, and population growth

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

In order to estimate potential growth in demand for irrigation, cropping activities were split according to the ratio of domestic and exported production (2000/1); these areas were then multiplied by estimated growth in domestic and export markets respectively. 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, and 5% expansion in Myalup, etc.). 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 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, as discussed in section 4.

Table 28. Projected growth at 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 – analysis of recent trends, low half this.2
Fruit	1.629	2.594	
Dairy	1.411	1.967	
Wine	2.367	5.234	ABARE (2004).

[1] ABARE (Australian Bureau of Agriculture and Resource Economics) 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 given exchange rate discussion in this report.

Horticulture

Based on these growth assumptions the total increase in water use required for horticultural industries in estimated in Table 29. 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 strongly as the 'high demand' scenario, the actual impact on water demand could be closer to the 'low demand' scenario results. 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 (it was a boom in olive and grape planting that drove irrigated area expansion in the late 1990s).

Table 29. Potential growth (%) in water use through produce market growth

Water usage	Veges	Fruits	Grapes	Nurseries	Olives	Sub total
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	83.31	133.64	21.84	28.60	21.86	289.24

Table 29 continued …..

Water usage	Veges	Fruits	Grapes	Nurseries	Olives	Sub total	% growth at regional level
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%
Great Southern	4.09	1.28	5.10	0.76	9.12	20.35	15%
East Kimberley	17.88	8.05	0.00	9.12	0.00	35.05	10%
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 at State level	**16%**	**24%**	**28%**	**7%**	**8%**	**19%**	
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%

Water usage	Veges	Fruits	Grapes	Nurseries	Olives	Sub total	% growth at regional level
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	112.63	214.06	37.44	33.35	25.62	423.10	
% growth, State level	**35%**	**60%**	**71%**	**17%**	**17%**	**46%**	

- End of excerpt -

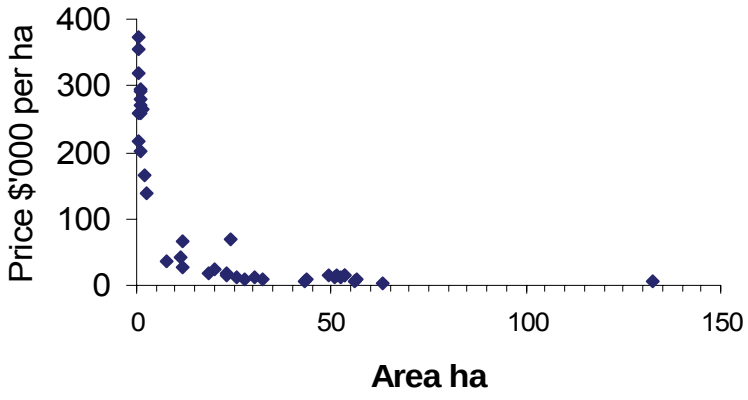
LAND VALUE

Excerpt from Brennan (2004)

Evidence on land values

An analysis of land prices obtained from Valuer Generals Office was conducted to examine the variation in land prices for horticultural areas in the South West. The data were based on the most recent land transactions for farming land, which reports the value of the transaction which can include the value of all sunk capital infrastructure, including buildings, irrigation and other farm specific investments. A high degree of dispersion in land prices was observed, reflecting competition from 'rural lifestyle' investors, as well as the value of sunk capital on intensive horticultural plots. An example is shown for Margaret River-Augusta in Figure 5.

Figure 5. Land price dispersion in recent rural land transactions, Margaret River-Augusta



In order to examine the impact of land prices on the profitability of horticulture, particularly on the resource rent to water used in horticulture, it is necessary to estimate the value of an unimproved hectare of land that accounts for the land only, not the premium associated with access to water. The impact of access to irrigation (of particular types) on land values can demonstrated from the study of unimproved land values in the Harvey region, reported by the SWIA and reproduced in Table 30. A comparison of the price premiums on land immediately east of SWIA ($5750) and within the SWIA ($6500) may reflect a premium on access to irrigation water; similarly, the $30,000 per hectare paid for access to scheme water near Harvey will reflect that value of 24 hour access to pressurised water. In order to distinguish between land value and the value of water attached to land, Australian Bureau of Agriculture and Resource Economics - ABARE suggest using the price of nearby dryland agriculture (Heaney et al 2001).

Table 30. Land price values in the Harvey region, excluding buildings

Area	Price $ per ha
Myalup	10,000
Coastal outside Myalup	7,500
SWIA	6,500
Piped area within SWIA	30,000
East of SWIA	5,750
Dardanup Dry	5,000

Source: SWIA Invest for success.

Data obtained on recent farm transactions, presented in Table 31, includes the price of buildings and improvements. In order to distinguish some of the effects of price dispersion caused by lifestyle and sunk capital that was demonstrated in Figure 4, the land price data was summarised in categories according to size. The price of large blocks > 20 ha will be used to indicate the opportunity cost of land in the following analysis.

Table 31. Land prices of recent transactions (includes improvements)

Zone	Local Government Area (LGA)	Total size of transaction ha					
		> 20 ha		5-20 ha		< 5 ha	
		Land Prices $ per hectare					
		Average	Median	Average	Median	Average	Median
Gingin	Gingin	3,517	3,360	16,901	14,937	57,274	61,341
Metro North	Swan	13,435	12,256	64,061	33,786	231,299	98,500
Metro East	Chittering	8,755	5,541	8,021	8,021	59,826	37,500
Metro South	Serpentine	12,520	14,990	43,652	37,944	209,687	172,961
Whicher	Augusta-Margaret River	14,239	11,940	35,372	31,188	262,928	266,724
PWB	Manjimup	11,271	6,193	19,272	17,249	35,514	35,356
PWB	Donnybrook	7,513	7,491	20,543	19,059	145,897	79,836
Great Southern	Plantagenet	3,309	3,457	11,753	6,704	24,815	9,065

Source: Analysis of VGO data.

- End of excerpt -

NUMBER OF GROWERS, COMPLETED IRRIGATION TRAINING

Fifty-six growers participated in Waterwise courses which were held in the metro and Peel/ Harvey district by the Western Australian Department of Agriculture and Food.

Approximately 80 growers participated in irrigation workshops organised by Harald Hoffmann in Carnarvon and Manjimup in the last 20 years. These workshops emphasised the use of tensiometers for irrigation scheduling, and resulted in an approximately 90 % uptake of irrigation scheduling methods.

OTHER INITIATIVES

Source: from 'State water strategy'

Waterwise on the farm workshops

Department of Agriculture and Food

The aim of the Waterwise on the Farm project is to increase the skill level of irrigators to:

- Improve on-farm productivity and water use efficiency;
- Improve on-farm water management;
- Adopt practices which sustain land and water resources on and off the farm. Five training courses delivered, with 56 farmers;
- Development of training material specific for Western Australia;
- Three Department of Agriculture and Food staff trained in the delivery of Waterwise on the Farm for Western Australian conditions;
- Subsidised by FarmBis and farmers contribute to the cost as required under the FarmBis rules.

Waterwise on the Farm workshops

Department of Agriculture and Food

Features:

- Developed a CD for Wanneroo irrigators showing soils on participants' farms and providing other information relevant to water and nutrient management.
- Use of a water use computer program based on local research information to calculate and help schedule water needs for use in Western Australia.
- Support from Department of Environment on allocation, policy and water efficiency aspects.
- Formation of an Industry Steering Committee to ensure the training stays relevant to each of the irrigation industries.

DEPARTMENT OF AGRICULTURE AND FOOD

Drivers for change in irrigated agriculture

- Policy reforms: monitoring, title security, and regulated markets that help reveal the real value of water, and capital support to upgrade old systems to allow more efficient application.
- State-wide review of land suitability for irrigation development – unlike much of the eastern states Western Australia still has scope to develop. Pressure on water supplies in the south will shift development north.
- Overviewing water use data to better understand for planning purposes (distribution, economic value in different regions, future demands of water).
- Farm/rural water supplies - ongoing research and advice for better water supply management produced. Tools to assist farmers to evaluate and design on-farm water supplies.

Commitment to 20 per cent water recycling in Perth region by 2012:

- Water Reuse Steering Committee established with representatives from government agencies and CSIRO to develop strategies.
- Recycling Strategy submitted to Government 4 August.
- Broad market assessment of other possible opportunities for water recycling on the swan coastal plain completed 4 August.
- Grey water reuse (encourage research and development through guidelines, rebate scheme).
- Strategic alliances with CSIRO and Department of Health.

In summary, we have set ourselves some ambitious but vital long-term targets, as outlined in the State Water Strategy. We aim to:

- Ensure we have adequate water resources within a sustainable framework for the future.
- Achieve a 14 per cent reduction in consumption per person per year (i.e. 155 kL) by 2012 for Perth region (with unrestricted supply).
- Establish a 20 per cent recycling of wastewater by 2012.

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