Almond Irrigation Benchmarking 2002 - 2011

Horticulture Services

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DEPARTMENT OF PRIMARY INDUSTRIES

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Almond Irrigation Benchmarking

Seasons 2002 - 2011

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Executive summary

The DPI Almond Irrigation Benchmarking Project was initiated during the season 2002/03. It was established primarily as a tool for identifying “best irrigation management practices” with the goal of improving irrigators' performance and efficiency.

This annual report contains nine years of growers' data from Victoria, covering seasons 2002/03 to 2010/11. Examples of the main information gathered were the amount of water used per site and crop variety, the irrigation systems and scheduling methods used, the pumping and water costs, and the crop yields and gross returns per site.

Eighteen new sites (336 ha) were included in the study in 2011. This brought the number of participating sites to 53 for a total area of 512 hectares. It should be noted that the data presented in this report does not necessarily reflect the performances of other growers in the industry and care must be adopted when attempting to extrapolate the results to the broader irrigation community.

The almond varieties planted at the different sites were Carmel, Fritz, Mission, Monterey, Ne Plus, Nonpareil, Peerless and Price. In terms of irrigation systems, the growers were using either low level sprinkler or drip irrigation.

The above normal rainfall events during summer 2010/11 affected many almond orchards resulting in water-logging and loss of trees in some patches. The yields results also showed a decline in the median yield value in 2011 (2.29 t/ha) compared to the previous two seasons, i.e. 2009 (2.96 t/ha) and 2010 (3.10 t/ha).

In terms of volume of water applied to the participant sites, the 2011 season had the lowest median of all of the years benchmarked, i.e. 9.7 ML/ha compared to 12.8 ML/ha in 2009 and 13.2 ML/ha in 2010.

A comparison by irrigation system showed the nine-year average yield of drip irrigated sites (2.6 t/ha) was 0.2 t/ha higher than that of low level irrigated sites.

Over the last four years, the seasonal average water applied by drip irrigated sites has been 1.5 ML/ha higher than that of low level irrigated sites. This contrasted with seasons 2004/05 and 2005/06, when drip irrigated sites were using on average 5.5 ML/ha less water than low level irrigated sites.

In the most recent season, a high percentage of sites (85.7% in 2010 and 83% in 2011) had application efficiencies below the 85-90% recommended range and hence were deemed over-irrigating. Over the nine-year period, the application efficiency for drip irrigation systems was on average 8% higher than for low level irrigation systems.

Drip irrigation produced a higher nine-year average crop production per volume of water applied than that for low level sprinkler irrigation. However in 2011, the results for low level irrigated sites (0.38 t/ML) were 0.14 t/ML higher than for drip irrigated sites.

In 2011, except nonpareil all varieties had a crop production per megalitre above their respective nine-year average. Over the nine-year period, varieties Nonpareil and Carmel achieved the highest average results with drip or low level irrigation system type.

In terms of gross return per dollar water input, the median value for gross return per dollar water input for 2011 (18.90), was similar to the pre-drought results, i.e. post 2007. The low results for many participants between 2008 and 2010 were attributed to the combined effect of the reduced price of almonds and the increased cost of additional water purchased in recent years.

The gross return and cost performance indicators should be treated only as technical information, as they were determined using a partial system approach. A sound economic analysis was beyond the scope of the study, since it would have involved a whole system approach and more complex analysis, e.g. marginal analysis.

1 Introduction

1.1 Background

This irrigation benchmarking study was initiated during the season 2002/03 and was established primarily as a tool for monitoring growers' irrigation performances. It contributes to the partnership project “Benchmarking for Irrigated Table Grapes, Dried Vine Fruit, Almonds, Open Hydroponics and Potatoes” between the Department of Primary Industries (DPI) and the Mallee Catchment Management Authority (MCMA). Funded through the Department of Sustainability and Environment (DSE) Sustainable Irrigation Programme (SIP), this current annual study contains nine years of data covering seasons 2002/03 to 2010/11.

1.2 Irrigation benchmarking

The DPI Almond Irrigation Benchmarking Project aims to identify “best irrigation management practices” in the almond industry with the goal of improving performance and efficiency. It is an expansion of previous successful benchmarking studies undertaken in the Mallee for wine grapes, dried vine fruits, table grapes, citrus and potatoes.

The project has evolved as a result of interest shown by growers, extension officers and policy makers in supporting improvement of irrigation management and water use efficiency.

Information collected during the benchmarking study includes:

- The amount of water used per crop and variety
- Irrigation systems used
- Pumping and water costs
- Yields and returns

1.3 Report style

The report style adopted since last year ensures a consistent and effective mode of communication and is compliant with the Victorian Government Branding Policy and the new DPI visual style guide.

The report uses bar charts to display, in the body of the report and for each site, the last three years of the most important performance indicators as identified by the participants, i.e. crop yield, water applied, irrigation application efficiency and crop production per megalitre of water applied. As all other performance indicators are deemed to be of value, and to allow for trend analysis, all indices for the nine years are included in Appendix C.



2 Method

2.1 Data collection

Almond growers from Victoria completed questionnaires on their irrigation practices for the irrigation seasons 2002/03 to 2010/11. The data collected included irrigation system and pump details, crop varieties, tree spacing, area of the site, age of trees, irrigation scheduling used, soil types and yields. The questions were aimed at developing a better understanding of each grower's current level of irrigation performance.

Weather data was also entered to match site locations, and water costs were calculated using information provided by the participants and by water authorities.

Eighteen new sites (336 ha) were included in the study in 2011 (Table 1). This brought the number of participating sites to 53 for a total area of 512 hectares. It should be noted that the data presented in this report does not necessarily reflect the performances of other growers in the industry and care must be adopted when attempting to extrapolate the results to the broader irrigation community.

Table 1: Number of participating growers, field sites and total area per season

Season	Number of growers	Number of sites	Area (ha)
2002/03	5	25	59
2003/04	6	32	81
2004/05	7	41	651
2005/06	7	41	651
2006/07	6	32	81
2007/08	6	33	155
2008/09	5	29	141
2009/10	6	35	176
2010/11	7	53	512

The irrigation systems used by the growers were either low level or drip irrigation. The almond varieties planted at the different sites were Carmel, Fritz, Mission, Monterey, Ne Plus, Nonpareil, Peerless and Price.

2.2 Indicators of irrigation performance

The data collected was analysed using the "Irrigation Benchmarking Module", database software especially designed for this purpose and released in late May 2006.

The software was developed by the South Australia Irrigated Crop Management Service, Primary Industries and Resources South Australia (PIRSA). A data consistency check of the database and processed data was performed at the end of each crop season.

Performance indicators were defined using the format from previous studies (Skewes and Meissner, 1997). The results from each site were compared and ranked. These allow growers to compare their own irrigation management practices with others and from season to season.

Yield, which is represented in tonnes of kernel per hectare (t/ha), and several other performance indicators were used to assess every site (details of all performance indicators can be viewed in Appendix C). The main indices used were:

- Yield and irrigation water applied
- Application efficiency
- Crop production per megalitre
- Gross return per megalitre
- Cost of water per tonne of almond
- Gross return per dollar of water input

Furthermore, an evaluation study (Pollock, 2009), which had as its objective to review and improve the usability of the graphical data and other information in the annual report, produced the following main recommendations:

- The use of bar charts in the body of the report to display the last three years' results of the following performance indicators:
  - Crop yield
  - Irrigation water applied
  - Irrigation application efficiency
  - Crop production per megalitre of water applied
- The use of tables and box plots to show performance indicators in the body of the report
- The display, for each site, of all performance indicators for all seven seasons in Appendix C

An efficient irrigator is defined in this report as one who applies the correct amount of water at the right time to meet the crop requirement. It is generally recommended to apply no more than 115% of the root zone soil moisture deficit, i.e. to use only 10-15% of the irrigation water for leaching any harmful salts from the root zone.

The present study focuses solely on irrigation management practices and not on other aspects that could be affecting crop production. For example, soil water holding capacity, crop load, canopy size, crop and emitter spacing, fertiliser and herbicide application practices, age of the trees, soil types and variation in environmental conditions are not discussed in this report.

Irrigation benchmarking is best viewed over a number of years to derive more interpretable results and to minimise inevitable seasonal variation. Such variation can be seen in cyclical pricing that can influence gross returns in any particular year. The results should not be interpreted as being definitive since this report was compiled from data covering a limited time span and a small sample of industry growers, who operate in a district of great diversity.

2.3 Site locations

Growers were located in Boundary Bend, Cullulleraine, Lindsay Point, Merbein, Mildura and Nangiloc as indicated on the map depicted in Figure 1.

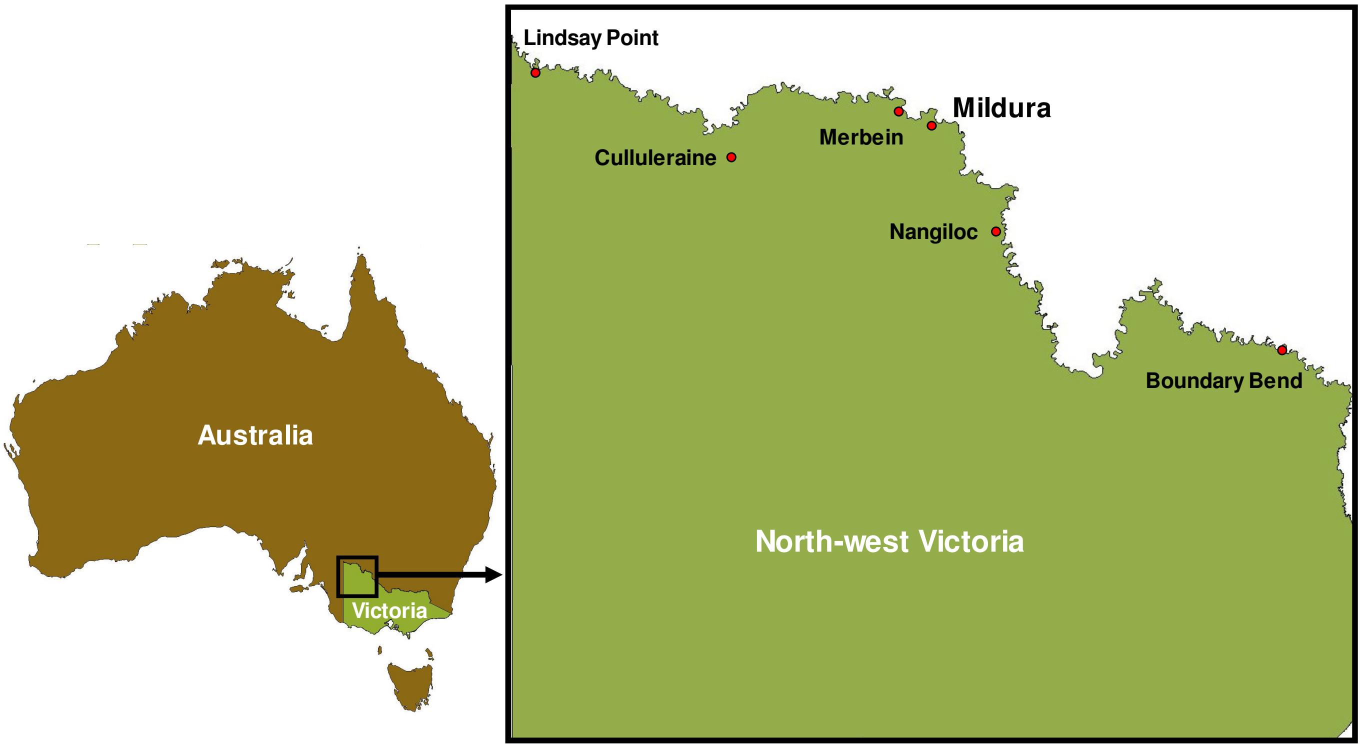


Figure 1: Site locations included in study

3 Results and discussion

3.1 Yield and irrigation water applied

The kernel yield and irrigation water applied at all sites for each season are shown as box plots in Figures 2 and 3 respectively. The lower and upper ends of the coloured box indicate the 25th and 75th percentiles respectively with the inside band indicating the median (50th percentile). In other words, these percentiles respectively indicate the level below which 25%, 75% and 50% of the sites fall. Conversely, the same percentiles can also be interpreted as the level above which 75%, 25% and 50% of the sites are located. The ends at the vertical broken lines indicate the range of observed values while single dots represent outliers (see Appendix D for an example of how to interpret box plots).

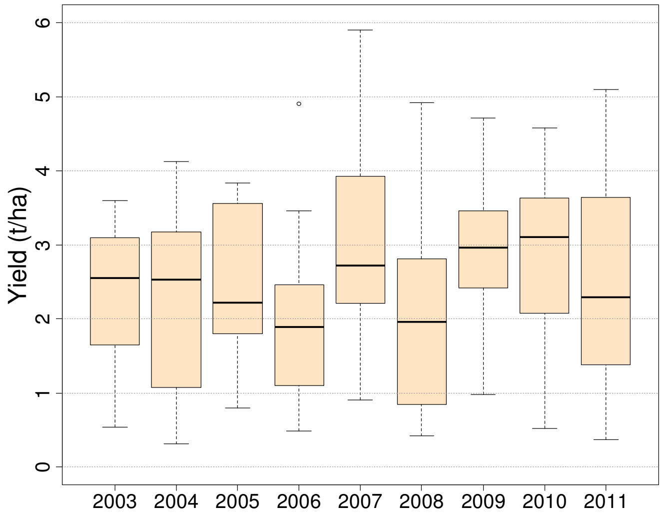


Figure 2: Box plot of yield between 2003 and 2011

Figure 2 shows that there was a decline in the median yield value for the 2011 season (2.29 t/ha) compared to the previous two seasons, i.e. 2009 (2.96 t/ha) and 2010 (3.10 t/ha). A wider range of yield was reported in 2011 (0.37 t/ha to 5.10 t/ha) than in the previous two years. The box plots also indicate that 75% of the participants reported yields of at least 1.38 t/ha in 2011 compared to 2.42 t/ha in 2009 and 2.08 t/ha in 2010.

In 2011, the volume of water applied to the participant sites had the lowest median of all of the years benchmarked (Figure 3) at 9.7 ML/ha compared to 12.8 ML/ha in 2009 and 13.2 ML/ha in 2010. The range for 2011 was 3.0 ML/ha to 11.6 ML/ha, with the highest application rate being below the median value for all of the previous years benchmarked. In part this may be due to the three extreme rain events and cooler conditions during the growing season.

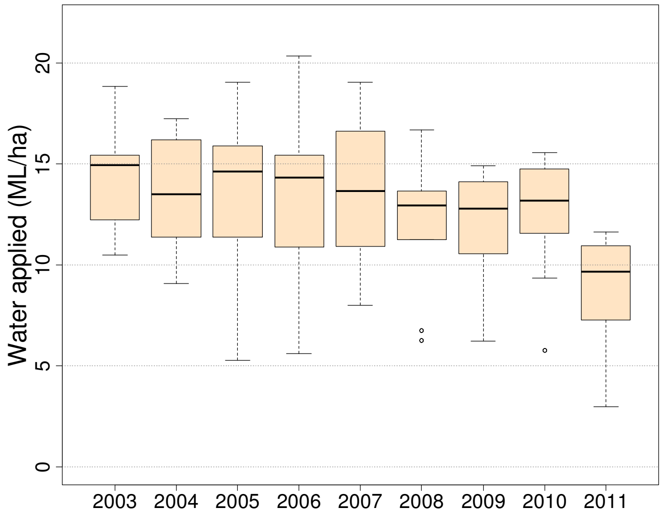


Figure 3: Box plot of water applied between 2003 and 2011

Table 2: Number of sites, average seasonal amount of water applied and yield - Irrigation system type comparison

	Season	Drip	Low level
Number of sites	2002/03		25
	2003/04		32
	2004/05	9	32
	2005/06	9	32
	2006/07		32
	2007/08	12	21
	2008/09	18	11
	2009/10	24	11
	2010/11	37	16
Average yield (t/ha)	2002/03		2.4
	2003/04		2.3
	2004/05	2.1	2.6
	2005/06	2.0	2.0
	2006/07		3.0
	2007/08	2.5	1.7
	2008/09	2.9	3.0
	2009/10	3.1	2.4
	2010/11	2.4	2.6
	Average	**2.6**	**2.4**
Average water applied (ML/ha)	2002/03		14.1
	2003/04		13.5
	2004/05	8.6	14.5
	2005/06	8.9	14.0
	2006/07		13.9
	2007/08	13.3	10.7
	2008/09	12.3	11.5
	2009/10	13.2	11.0
	2010/11	9.6	8.1
	Average	**11.1**	**12.9**

3.1.1 Yield and water applied per irrigation system type

Table 2 shows the average yield and average water applied per irrigation system type over the nine crop seasons. While the majority of sites were using low level irrigation prior to 2008/09, the last three seasons had more sites using drip irrigation compared to low level irrigation. The growers already in the benchmarking project in 2010 added 13 additional drip sites and five new low level sites for the 2011 benchmarking season.

As can be seen in Table 2, there is no clear trend between the yields for drip and low level irrigated sites. The average yields for low level irrigated sites in 2011 (2.6 t/ha) out performed the drip irrigated sites (2.4 t/ha) but was opposite to the long term average. The low level irrigated sites also reported the third best average across all of the years benchmarked. The drip irrigated sites in 2011 averaged lower yields than the previous three years.

In 2011, the drip irrigated sites average water use (9.6 ML/ha) was 1.5 ML/ha higher than the low level sites (8.1 ML/ha). That difference between the two irrigation systems is opposite to the nine-year average but consistent with the trends over the last four years. This 8.1 ML/ha for low level irrigated sites was also the lowest average water use across all of the seasons benchmarked. The drip irrigation water use was lower than the previous three years but higher than the 2005 and 2006 seasons. Again the high summer rainfalls and cooler growing season may be the reason for the lower averages reported.

The box plots in Figures 4 and 5 give respectively an indication of the variation of yield and water applied for the different irrigation systems in 2009, 2010 and 2011. Figure 4 shows that the yield range for the drip irrigated sites was greater in 2011 (0.37 t/ha to 4.64 t/ha) than for the years 2009 and 2010 (1.25 t/ha to 4.40 t/ha and 1.31 t/ha to 4.36 t/ha respectively). This may indicate a difference in impact from the extreme weather events between sites. The 2011 median and overall yields of the low level irrigated sites (2.44 t/ha median and range 0.91 t/ha to 5.10 t/ha) were slightly higher than the previous year (2.02 t/ha and 0.52 t/ha to 4.58 t/ha) but lower than the record yields of the 2009 season (3.01 t/ha and 0.98 t/ha to 6.88 t/ha).

Once again the range in water applied (Figure 5) was smaller over the drip irrigated sites (4.5 ML/ha with the range 7.1 ML/ha to 11.6 ML/ha) than the low level irrigated sites (8.6 ML/ha with the range 3.0 ML/ha to 11.6 ML/ha). With the wet weather and cooler growing conditions, the median amount of water applied for each system was lower than for the previous two seasons. The drip irrigation results were 12.8 ML/ha, 13.9 ML/ha and 9.7 ML/ha for the 2009, 2010 and 2011 seasons respectively, compared to the low level results of 14.1 ML/ha, 13.2 ML/ha and 8.9 ML/ha respectively.

Figures 6a and 6b and Tables 3a and 3b present the performance of each site, in terms of yield and ranking, for the years 2011, 2010 and 2009. To improve the quality of the graphs and tables for the number of sites involved, the results were grouped by irrigation system type and split into two pages. The sites were further regrouped by variety and ranked according to the highest overall yield in each year.

Tables 3a and 3b show that individual sites had more or less consistent performances over the last three years. The grouping by variety also indicates Carmel and Nonpareil were often among the best performing varieties. The last year again showed big differences in yield between some sites within the same variety group and irrigation system, e.g. Carmel yields ranging from 0.4 t/ha to 4.6 t/ha under drip irrigation and from 1.1 t/ha to 4.4 t/ha under low level irrigation. With eight sites among the top ten rankings in 2011, some individual drip irrigated sites continued to achieve higher yields than low level irrigated sites.

The volume of water applied at different sites is presented in Figures 7a and 7b and Tables 4a and 4b. The sites were grouped and listed in the same order as the yields, presented in Figures 6a and 6b and Tables 3a and 3b, to facilitate comparison of yield and water applied. However, the ranks in Tables 4a and 4b were based on the lowest water applied in each year.

In 2011, there was a decrease in the amount of water applied in all but two drip irrigated sites. All low level irrigated sites had a reduction in water applied in the same year.

There were only three drip irrigated sites among the ten sites with the lowest volumes of water applied in 2011 compared to six in 2010 and 2009.

The sites with the lowest yields for mature trees also had the lowest water application rates. It may be that these sites experienced some water logging due to the extreme rain events, resulting in both a reduced irrigation need and reduced harvest. There were reports of crops being harder to remove from the trees during harvest in 2011, resulting in not all nuts being harvested that also resulted in lower yields.

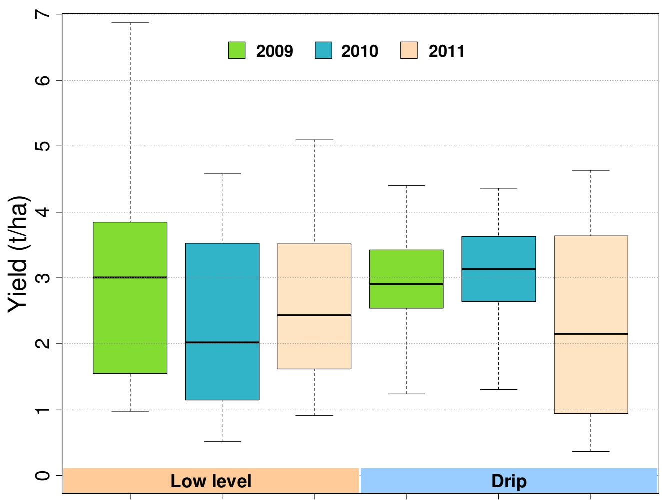


Figure 4: Box plot of yield per irrigation system type for 2009, 2010 and 2011

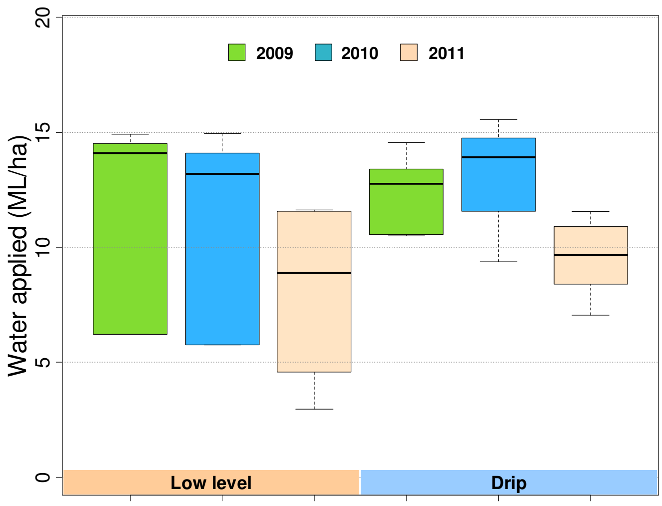
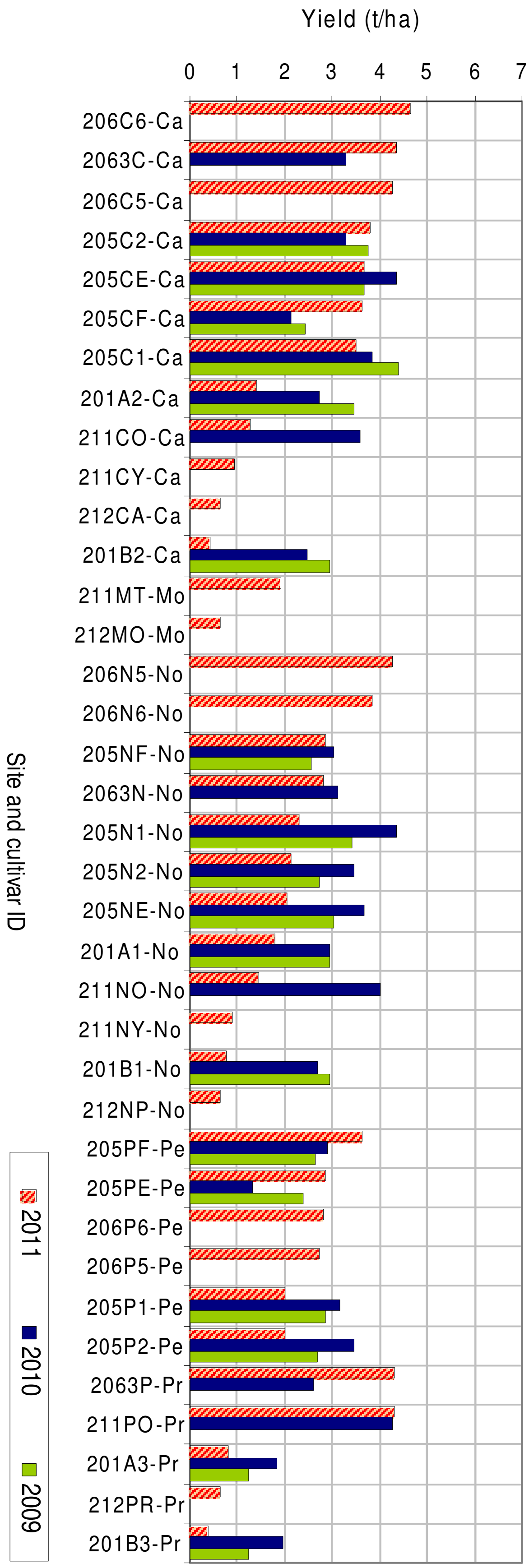


Figure 5: Box plot of water applied per irrigation system type for 2009, 2010 and 2011

Figure 6a: Yield at sites using drip irrigation grouped by variety and ranked with respect to yield



Ca: Carmel, Fr: Fritz, Mo: Monterey, Ne: Ne Plus, No: Nonpareil, Pe: Peerless, Pr: Price

Table 3a: Sites using drip irrigation ranked with respect to the highest yield

	Site	Yield (t/ha)			Yield Rank*		
		2011	2010	2009	2011	2010	2009
Drip irrigation systems	206C6-Ca	4.6			2		
	2063C-Ca	4.4	3.3		3	13	
	206C5-Ca	4.3			7		
	205C2-Ca	3.8	3.3	3.8	10	14	5
	205CE-Ca	3.7	4.4	3.7	11	2	7
	205CF-Ca	3.6	2.1	2.4	12	26	22
	205C1-Ca	3.5	3.9	4.4	16	8	3
	201A2-Ca	1.4	2.7	3.5	39	22	8
	211CO-Ca	1.3	3.6		41	10	
	211CY-Ca	1.0			43		
	212CA-Ca	0.6			48		
	201B2-Ca	0.4	2.5	3.0	52	25	13
	211MT-Mo	1.9			33		
	212MO-Mo	0.6			48		
	206N5-No	4.3			7		
	206N6-No	3.8			9		
	205NF-No	2.9	3.1	2.5	19	19	21
	2063N-No	2.8	3.1		22	18	
	205N1-No	2.3	4.4	3.4	27	3	9
	205N2-No	2.2	3.5	2.8	29	12	17
	205NE-No	2.1	3.7	3.0	30	9	11
	201A1-No	1.8	3.0	3.0	35	20	13
	211NO-No	1.5	4.0		38	6	
	211NY-No	0.9			44		
	201B1-No	0.8	2.7	3.0	47	23	13
	212NP-No	0.6			48		
	205PF-Pe	3.6	2.9	2.6	12	21	20
	205PE-Pe	2.9	1.3	2.4	19	31	23
	206P6-Pe	2.8			21		
	206P5-Pe	2.7			23		
	205P1-Pe	2.0	3.2	2.9	31	15	16
	205P2-Pe	2.0	3.5	2.7	32	11	18
	2063P-Pr	4.3	2.6		5	24	
	211PO-Pr	4.3	4.3		6	4	
	201A3-Pr	0.8	1.9	1.3	46	29	26
	212PR-Pr	0.6			48		
	201B3-Pr	0.4	2.0	1.3	53	28	26

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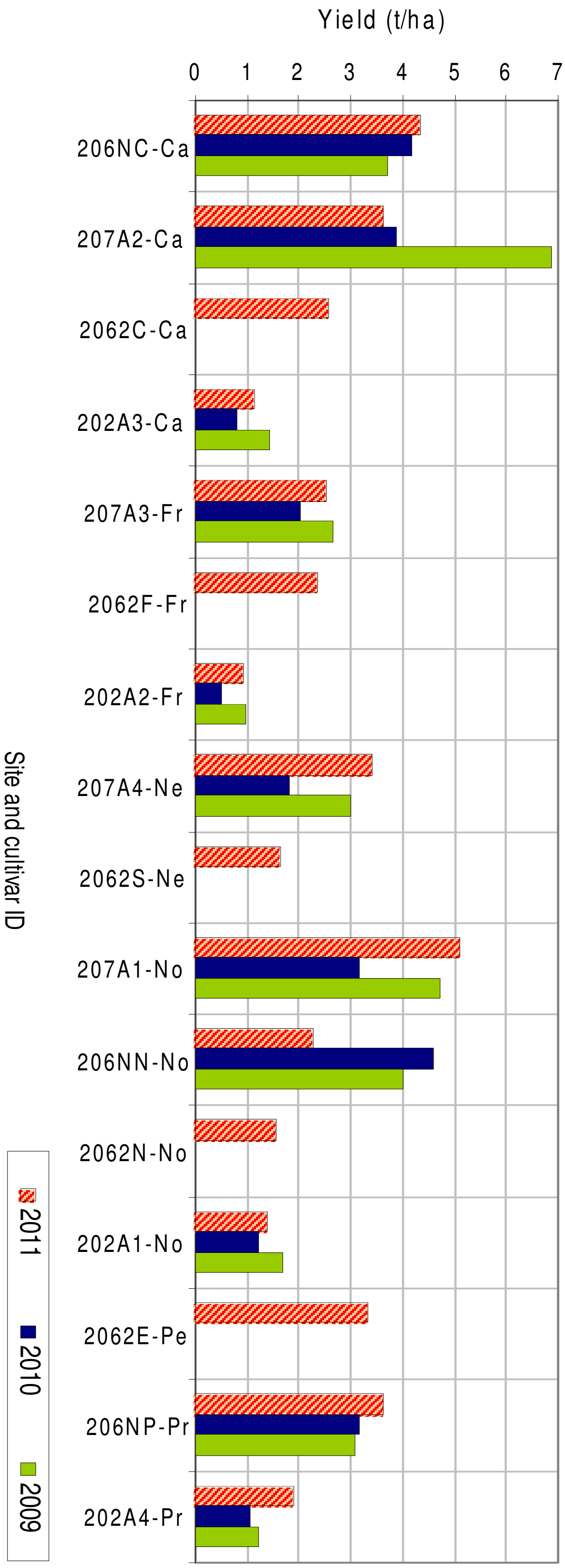
* Based on all sites, i.e. with drip and low level irrigation

Figure 6b: Yield at sites using low level irrigation grouped by variety and ranked with respect to yield



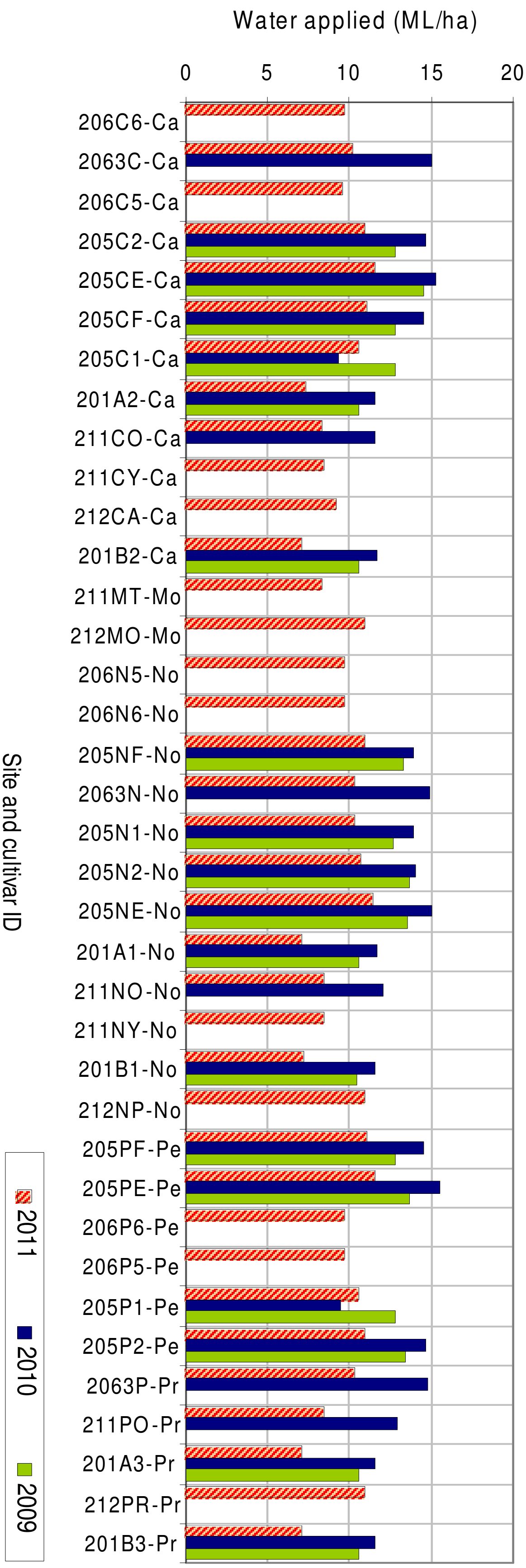
Ca: Carmel, Fr: Fritz, Mo: Monterey, Ne: Ne Plus, No: Nonpareil, Pe: Peerless, Pr: Price

Table 3b: Sites using low level irrigation ranked with respect to the highest yield

		Yield					
		(t/ha)			Rank*		
	Site	2011	2010	2009	2011	2010	2009
Low level irrigation systems	206NC-Ca	4.4	4.2	3.7	3	5	6
	207A2-Ca	3.6	3.9	6.9	15	7	1
	2062C-Ca	2.6			24		
	202A3-Ca	1.1	0.8	1.4	42	34	25
	207A3-Fr	2.5	2.0	2.6	25	27	19
	2062F-Fr	2.4			26		
	202A2-Fr	0.9	0.5	1.0	44	35	29
	207A4-Ne	3.4	1.8	3.0	17	30	12
	2062S-Ne	1.7			36		
	207A1-No	5.1	3.2	4.7	1	15	2
	206NN-No	2.3	4.6	4.0	28	1	4
	2062N-No	1.6			37		
	202A1-No	1.4	1.2	1.7	40	32	24
	2062E-Pe	3.3			18		
	206NP-Pr	3.6	3.2	3.1	12	15	10
	202A4-Pr	1.9	1.1	1.2	34	33	28
	Maximum	5.1	4.6	6.9	53	35	29
	Median	2.3	3.1	3.0			
	Minimum	0.4	0.5	1.0			

* Based on all sites, i.e. with drip and low level irrigation

Figure 7a: Water applied at sites using drip irrigation grouped by variety and ranked with respect to yield



Ca: Carmel, Fr: Fritz, Mo: Monterey, Ne: Ne Plus, No: Nonpareil, Pe: Peerless, Pr: Price

Table 4a: Sites using drip irrigation ranked with respect to the lowest water applied

		Water applied					
		(ML/ha)			Rank*		
	Site	2011	2010	2009	2011	2010	2009
Drip irrigation systems	206C6-Ca	9.7			25		
	2063C-Ca	10.2	15.0		28	32	
	206C5-Ca	9.6			22		
	205C2-Ca	10.9	14.6	12.8	36	25	15
	205CE-Ca	11.6	15.3	14.6	45	34	26
	205CF-Ca	11.1	14.5	12.8	42	23	14
	205C1-Ca	10.6	9.4	12.7	33	**5**	12
	201A2-Ca	7.3	11.5	10.5	14	**7**	**6**
	211CO-Ca	8.4	11.6		15	**10**	
	211CY-Ca	8.4			18		
	212CA-Ca	9.2			21		
	201B2-Ca	7.1	11.7	10.6	**9**	12	**8**
	211MT-Mo	8.4			15		
	212MO-Mo	10.9			36		
	206N5-No	9.6			23		
	206N6-No	9.7			25		
	205NF-No	10.9	14.0	13.3	38	21	17
	2063N-No	10.4	14.9		30	28	
	205N1-No	10.3	13.9	12.7	29	20	11
	205N2-No	10.7	14.0	13.6	34	22	21
	205NE-No	11.4	15.0	13.6	43	32	19
	201A1-No	7.1	11.7	10.5	**9**	13	**6**
	211NO-No	8.4	12.1		18	14	
	211NY-No	8.4			18		
	201B1-No	7.2	11.6	10.5	13	**9**	**5**
	212NP-No	10.9			38		
	205PF-Pe	11.0	14.5	12.8	41	23	16
	205PE-Pe	11.5	15.6	13.6	44	35	20
	206P6-Pe	9.7			25		
	206P5-Pe	9.6			23		
	205P1-Pe	10.6	9.4	12.7	32	**6**	12
	205P2-Pe	11.0	14.7	13.4	40	26	18
	2063P-Pr	10.4	14.8		30	27	
	211PO-Pr	8.4	13.0		17	15	
	201A3-Pr	7.1	11.5	10.6	**9**	**8**	**8**
	212PR-Pr	10.9			35		
	201B3-Pr	7.1	11.6	10.6	12	11	**8**

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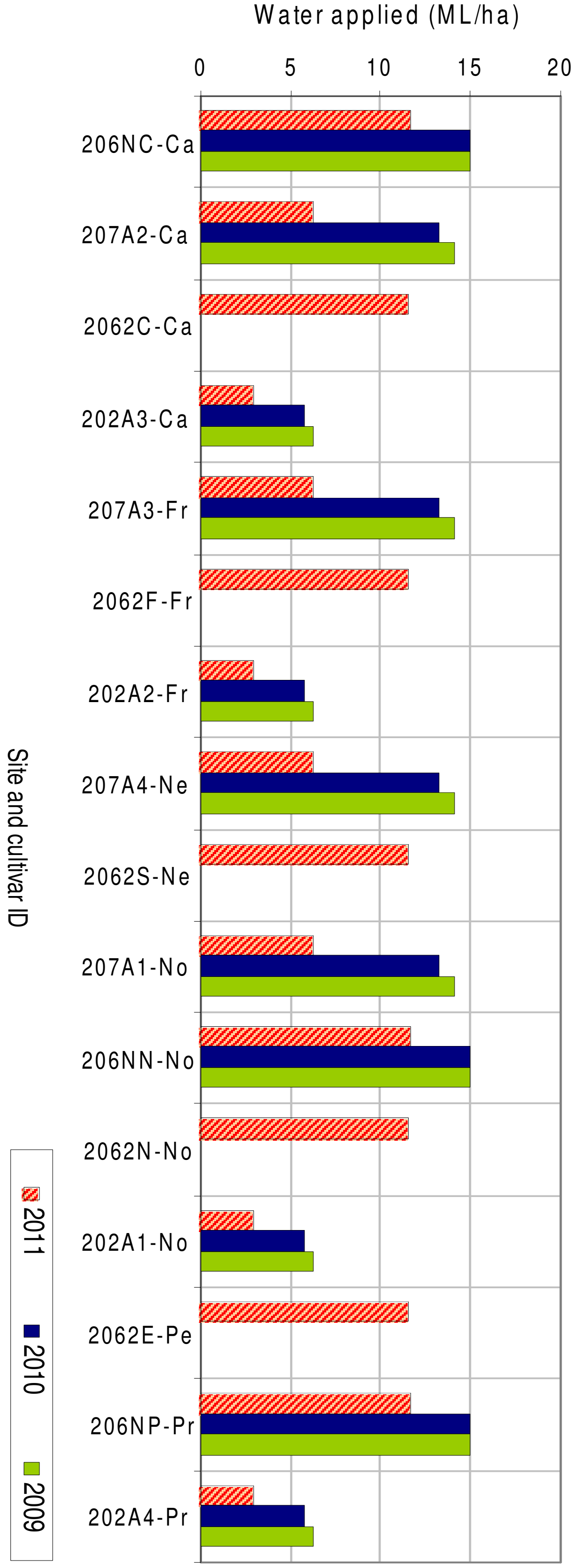
* Based on all sites, i.e. with drip and low level irrigation

Figure 7b: Water applied at sites using low level irrigation grouped by variety and ranked with respect to yield



Ca: Carmel, Fr: Fritz, Mo: Monterey, Ne: Ne Plus, No: Nonpareil, Pe: Peerless, Pr: Price

Table 4b: Sites using low level irrigation ranked with respect to the lowest water applied

		Water applied					
		(ML/ha)			Rank*		
	Site	2011	2010	2009	2011	2010	2009
Low level irrigation systems	206NC-Ca	11.6	14.9	14.9	51	29	27
	207A2-Ca	6.2	13.2	14.1	5	16	22
	2062C-Ca	11.6			46		
	202A3-Ca	3.0	5.8	6.2	1	1	1
	207A3-Fr	6.2	13.3	14.1	5	19	22
	2062F-Fr	11.6			46		
	202A2-Fr	3.0	5.8	6.2	1	1	1
	207A4-Ne	6.2	13.2	14.1	5	16	22
	2062S-Ne	11.6			46		
	207A1-No	6.2	13.2	14.1	5	16	22
	206NN-No	11.6	14.9	14.9	51	29	27
	2062N-No	11.6			46		
	202A1-No	3.0	5.8	6.2	1	1	1
	2062E-Pe	11.6			46		
	206NP-Pr	11.6	14.9	14.9	51	29	27
	202A4-Pr	3.0	5.8	6.2	1	1	1
	Maximum	11.6	15.6	14.9	51	35	27
	Median	9.7	13.2	12.8			
	Minimum	3.0	5.8	6.2			

* Based on all sites, i.e. with drip and low level irrigation

3.2 Irrigation application efficiency

Application efficiency is calculated (see Equation 6 in Appendix B) for each site using the grower's irrigation records and weather data collected for the region where each property is located. In PIRSA's benchmarking module, the drainage calculation is based on the irrigation water applied in excess of the combined soil moisture deficit and predicted daily crop water use. Daily crop water use is based on site specific weather data and a set of generic crop coefficients. These figures do not cater for differences between varieties, age, canopy size, row and tree spacing. The actual crop coefficients may change as a result of a combination of those variables, and therefore may contribute to differences in the predicted drainage and application efficiency.

The results for application efficiency should not be interpreted as being definitive due to the large number of variables that influence its calculation. However, application efficiency remains a valuable indicator of over or under irrigation, particularly at sites where crop coefficients are close to matching the generic standards.

An application efficiency of 85-90%, as represented by the horizontal strip in Figure 8, would result in a leaching fraction of 10 - 15% of the total irrigation water applied. This is considered optimal to prevent a build-up of salts in the root zone. Conversely, an application efficiency below 85% indicates a potential over-irrigation, i.e. an excessive amount of irrigation water passing through the root zone. If the application efficiency is greater than 90% then under-irrigation may be occurring and harmful salts may not be leached from the root zone.

Figure 8 shows that the median values for application efficiency were 76%, 78% and 76% for the years 2011, 2010 and 2009 respectively. In 2011 there were no sites with application efficiencies above 90% and 75% of sites had application efficiencies below 84%. Table 5 shows that only 17% of the sites (nine sites) had application efficiencies in the 85-90% target range.

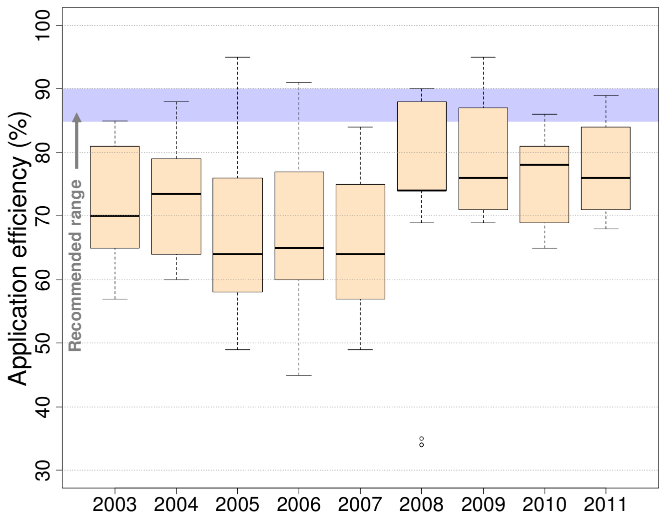


Figure 8: Box plot of irrigation application efficiency between 2003 and 2011

Table 5: Percentage of sites within, over and under the recommended 85-90% range of application efficiency

Season	Percentage of sites with application efficiency		
	within 85-90%	under 85-90%	over 85-90%
2002/03	16.0	84.0	
2003/04	12.5	87.5	
2004/05		85.4	14.6
2005/06	12.2	85.4	2.4
2006/07		100.0	
2007/08	18.2	69.7	12.1
2008/09	13.8	65.5	20.7
2009/10	14.3	85.7	
2010/11	17.0	83.0	

Table 6: Average application efficiency - Irrigation system type comparison

Season	Average application efficiency (%)		
	Drip	Low level	Average
2002/03		71	**71**
2003/04		73	**73**
2004/05	82	65	**69**
2005/06	81	64	**68**
2006/07		66	**66**
2007/08	73	76	**75**
2008/09	81	76	**79**
2009/10	75	77	**75**
2010/11	80	71	**77**
Average	**78**	**70**	**73**

3.2.1 Application efficiency per irrigation system type

Table 6 shows the nine-year average application efficiency for drip irrigation systems was 8% higher than that of low level irrigation systems. The 2011 seasonal average for both the drip (80%) and low level (71%) irrigated sites were slightly above the long term averages (78% and 70% respectively).

Figure 9 shows that the median application efficiency for the drip irrigated sites was higher in 2011 than the previous two years but that of the low level sites was lower. The application efficiencies of the drip irrigated sites were higher than the low level sites, with the range of values for the low level sites being much smaller than in the previous two years.

Figures 10a and 10b compare the last three years' application efficiencies of sites, grouped by irrigation system type and variety. Tables 7a and 7b present the rank of each site with respect to the highest overall application efficiency in each year.

Figure 10a shows nine drip irrigated sites had application efficiencies in the target 85 to 90% range in 2011. Figure 10b shows that the highest application efficiency recorded for the low level sites for the same year was 78%, well below the 85-90% target.

Tables 7a and 7b show that the top ten ranked sites in 2011 were all drip irrigated. Of the drip irrigated sites only two reduced their application efficiencies (by 3.1%) in 2011 compared to 2010. The other 22 all improved their application efficiencies by up to 11.4%, although only two improved when compared to 2009. In contrast eight of the low level irrigated sites had lower application efficiencies in 2011 (by up to – 11%) compared to their 2010 results, with only three showing an improvement (up to 3.5%).

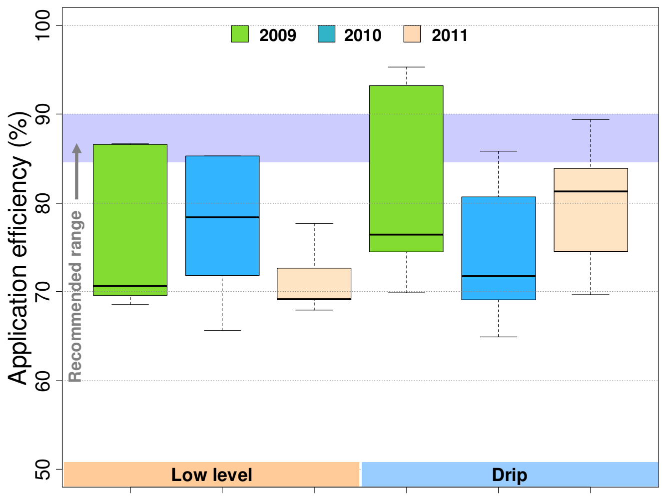
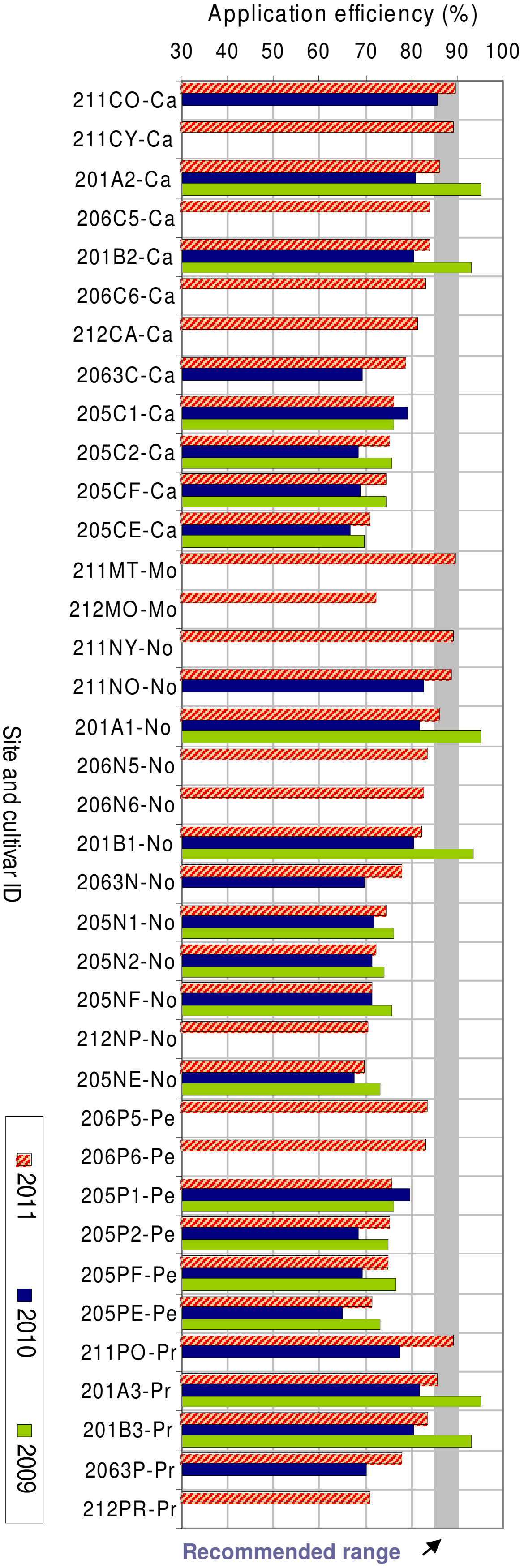


Figure 9: Box plot of irrigation application efficiency per irrigation system type for 2009, 2010 and 2011

Figure 10a: Application efficiency at sites using drip irrigation grouped by variety



Ca: Carmel, Fr: Fritz, Mo: Monterey, Ne: Ne Plus, No: Nonpareil, Pe: Peerless, Pr: Price

Table 7a: Sites using drip irrigation ranked with respect to the highest application efficiency

		Application efficiency (%)			Application efficiency Rank*		
	Site	2011	2010	2009	2011	2010	2009
Drip irrigation systems	211CO-Ca	89.4	85.8		1	1	
	211CY-Ca	89.1			3		
	201A2-Ca	86.0	81.0	95.3	8	9	1
	206C5-Ca	83.9			10		
	201B2-Ca	83.9	80.4	93.3	11	12	5
	206C6-Ca	83.2			15		
	212CA-Ca	81.3			19		
	2063C-Ca	78.7	69.4		20	26	
	205C1-Ca	76.0	79.1	76.4	24	14	13
	205C2-Ca	75.2	68.6	75.9	28	28	16
	205CF-Ca	74.4	69.0	74.5	32	27	18
	205CE-Ca	70.9	66.7	69.9	40	31	26
	211MT-Mo	89.4			1		
	212MO-Mo	72.5			34		
	211NY-No	89.1			4		
	211NO-No	88.8	82.9		6	6	
	201A1-No	86.3	82.0	95.3	7	8	1
	206N5-No	83.7			13		
	206N6-No	82.9			17		
	201B1-No	82.1	80.7	93.5	18	11	4
	2063N-No	78.0	69.8		21	24	
	205N1-No	74.5	71.9	76.4	31	20	14
	205N2-No	72.3	71.3	74.2	35	22	19
	205NF-No	71.7	71.7	75.9	36	21	15
	212NP-No	70.5			43		
	205NE-No	69.7	67.5	73.4	44	30	20
	206P5-Pe	83.7			13		
	206P6-Pe	83.1			16		
	205P1-Pe	76.0	79.7	76.5	25	13	12
	205P2-Pe	75.2	68.3	75.1	29	29	17
	205PF-Pe	74.7	69.5	76.7	30	25	11
	205PE-Pe	71.3	64.9	73.3	37	35	21
	211PO-Pr	89.1	77.7		5	19	
	201A3-Pr	85.8	82.0	95.2	9	7	3
	201B3-Pr	83.7	80.7	93.3	12	10	5
	2063P-Pr	78.0	70.1		22	23	
	212PR-Pr	70.9			41		

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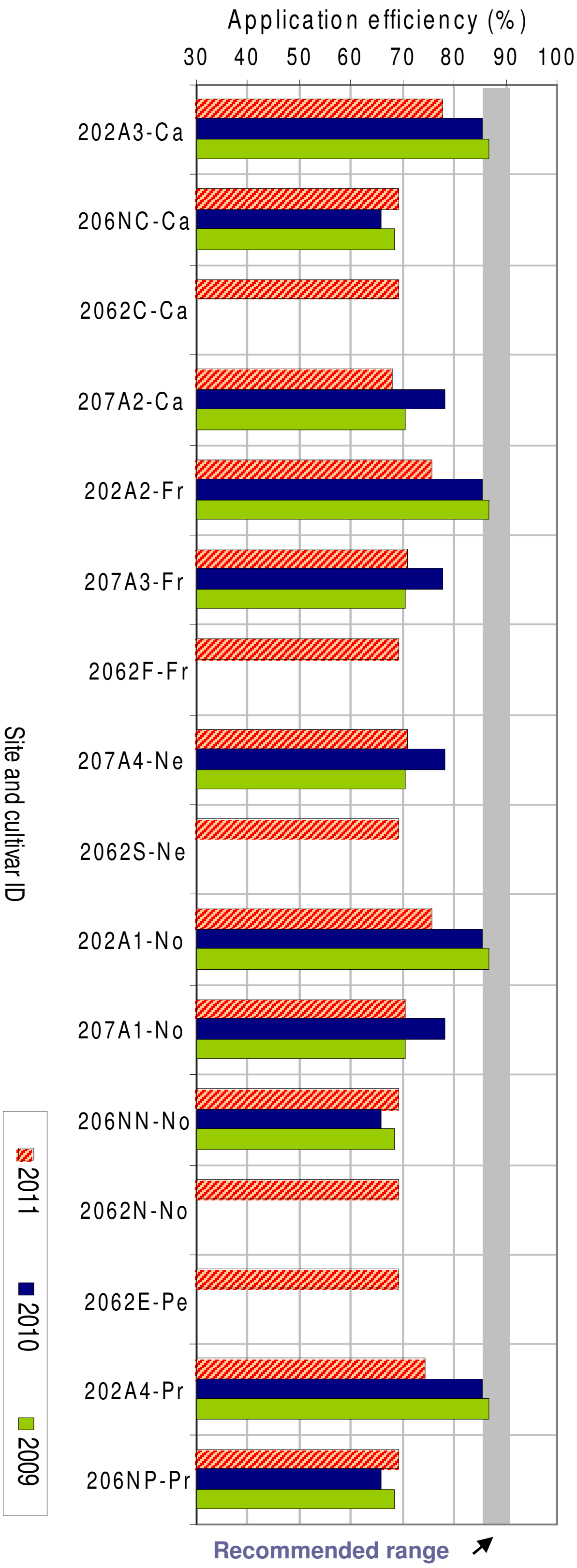
* Based on all sites, i.e. with drip and low level irrigation

Figure 10b: Application efficiency at sites using low level irrigation grouped by variety



Ca: Carmel, Fr: Fritz, Mo: Monterey, Ne: Ne Plus, No: Nonpareil, Pe: Peerless, Pr: Price

Table 7b: Sites using low level irrigation ranked with respect to the highest application efficiency

	Site	Application efficiency (%) 2011	2010	2009	Rank* 2011	2010	2009
Low level irrigation systems	202A3-Ca	77.7	85.3	86.7	23	**2**	**8**
	206NC-Ca	69.2	65.7	68.6	45	33	27
	2062C-Ca	69.1			48		
	207A2-Ca	67.9	78.4	70.6	53	15	22
	202A2-Fr	75.7	85.3	86.6	26	**2**	**10**
	207A3-Fr	71.0	77.9	70.6	39	18	22
	2062F-Fr	69.1			48		
	207A4-Ne	71.0	78.4	70.6	38	15	22
	2062S-Ne	69.1			48		
	202A1-No	75.6	85.3	86.7	27	**2**	**7**
	207A1-No	70.6	78.4	70.6	42	15	22
	206NN-No	69.2	65.7	68.6	45	34	27
	2062N-No	69.1			48		
	2062E-Pe	69.1			48		
	202A4-Pr	74.3	85.3	86.7	33	**2**	**8**
	206NP-Pr	69.2	65.8	68.6	45	32	27
	Maximum	89.4	85.8	95.3	53	35	27
	Median	75.6	77.9	75.9			
	Minimum	67.9	64.9	68.6			

* Based on all sites, i.e. with drip and low level irrigation

3.3 Crop production per ML of water applied

Crop production per megalitre of water applied (t/ML) is another good performance indicator to compare how efficiently growers are using irrigation water. Also referred to as the water use index, it is calculated based on the yield and water applied (see Equation 1 - Appendix B).

Figure 11 shows, except for the year 2008, there has been an increasing trend in crop production per water applied in the recent years. The 2011 median was 0.26 t/ML, which was higher than the previous highest median recorded in 2010, i.e. 0.22 t/ML. There was also a wider range in 2011, with 50% of sites achieving a crop production between 0.38 t/ML and 0.18 t/ML, compared to a range of 0.29 t/ML and 0.18 t/ML in 2010.

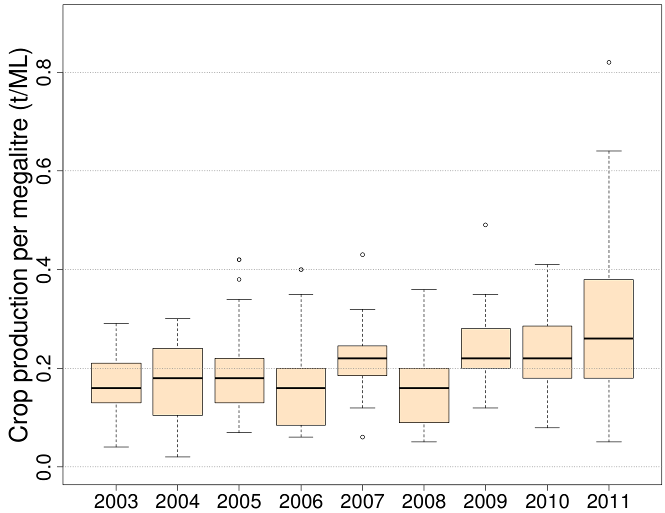


Figure 11: Box plot of crop production per megalitre of water applied between 2003 and 2011

3.3.1 Crop production per megalitre of water applied - Irrigation system type comparison

Figure 12 shows the median value for tonnes harvested per Megalitre applied for low level irrigated sites in 2011 (0.34 t/ML) was the highest ever recorded for any irrigation system. The range was also much greater (0.14 t/ML to 0.82 t/ML) than in the previous two years (0.09 t/ML to 0.31 t/ML in 2010 and 0.16 t/ML to 0.49 t/ML in 2009). The drip irrigated site median was similar to the previous two seasons although the range was larger (0.05 t/ML to 0.51 t/ML in 2011, compared to 0.08 t/ML to 0.41 t/ML in 2010 and 0.12 t/ML to 0.35 t/ML in 2009).

Table 8 shows that in 2011 for only the second time the low level irrigated sites had a higher average tonnes per megalitre value compared to drip irrigated sites. The overall average of the drip irrigated sites is still higher at 0.23 t/ML than that of the low level sites at 0.19 t/Ml. The seasonal averages of both irrigation systems in the last three years were also higher than their respective nine-year average.

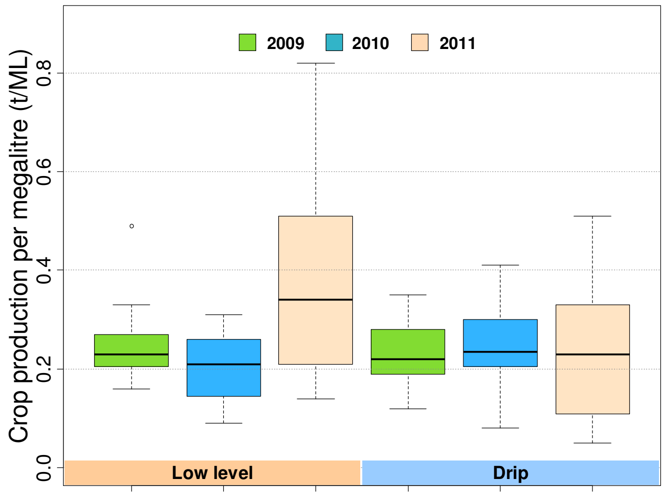


Figure 12: Box plot of crop production per megalitre of water applied per irrigation system type for 2009, 2010 and 2011

Table 8: Average crop production per megalitre of water applied - Irrigation system type comparison

Season	Average crop production per megalitre (t/ML)		
	Drip	Low level	Average
2002/03		0.17	**0.17**
2003/04		0.16	**0.16**
2004/05	0.27	0.18	**0.19**
2005/06	0.23	0.14	**0.16**
2006/07		0.22	**0.22**
2007/08	0.19	0.14	**0.16**
2008/09	0.23	0.26	**0.24**
2009/10	0.24	0.20	**0.23**
2010/11	0.24	0.38	**0.28**
Average	**0.23**	**0.19**	**0.21**

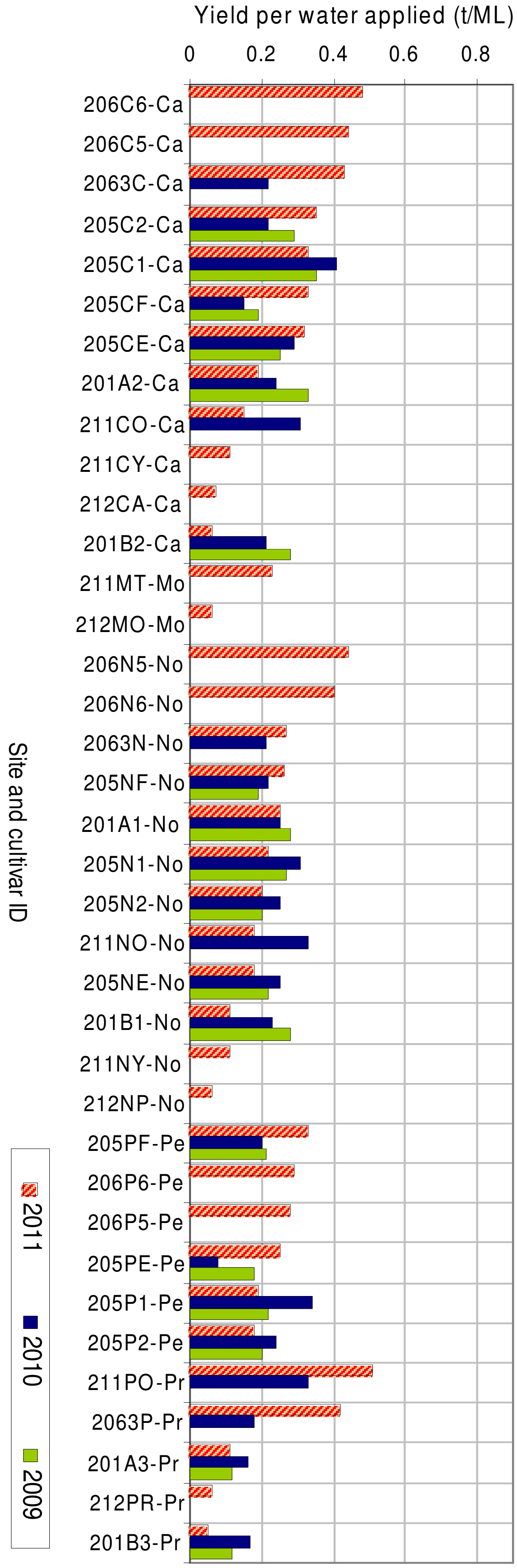
Table 9 compares the crop production per megalitre with respect to irrigation system type and crop variety. The season 2011 was generally a good year in terms of crop production per megalitre when most varieties had results above their respective nine-year average.

Figures 13a and 13b and Tables 10a and 10b show the performances of different sites grouped by irrigation system and variety and ordered according to the crop production per megalitre of water applied. Most of the top ranked sites in the previous three years were using drip irrigation and were growing Carmel or Nonpareil. In 2011 the top four performing sites were all low level irrigated with no one variety standing out. The highest figure ever recorded (0.82 t/ML) occurred in 2011 and was a low level irrigated Nonpareil site. This high figure reflected both a high yield and low water application rate (less than half that applied in either of the previous two years) at this site. However, the big difference between the results of sites within the same group, e.g. crop production per megalitre between 0.48 t/ML and 0.06 t/ML for drip irrigated sites growing Carmel, and between 0.82 t/ML and 0.14 t/ML for low level irrigated sites growing Nonpareil suggest that a specific combination of irrigation system type and variety alone does not guarantee good results.

Table 9: Average crop production per megalitre of water applied - Variety and irrigation system type comparison

System type	**Variety**	**Average crop production per megalitre (t/ML)**									
		2002/03	**2003/04**	**2004/05**	**2005/06**	**2006/07**	**2007/08**	**2008/09**	**2009/10**	**2010/11**	**Average**
Drip	Carmel			0.29	0.24		0.20	0.28	0.26	0.27	**0.26**
	Monterey									0.15	**0.15**
	Nonpareil			0.29	0.24		0.21	0.24	0.26	0.22	**0.24**
	Peerless						0.15	0.20	0.22	0.25	**0.21**
	Price			0.25	0.21			0.12	0.21	0.23	**0.21**
Low level	Carmel	0.17	0.16	0.17	0.15	0.27	0.15	0.32	0.24	0.39	**0.21**
	Fritz	0.15	0.17	0.16	0.15	0.14	0.12	0.18	0.12	0.31	**0.17**
	Mission		0.19	0.19	0.08	0.24					**0.18**
	NePlus	0.20	0.16	0.18	0.16	0.19	0.15	0.21	0.14	0.35	**0.19**
	Nonpareil	0.19	0.17	0.21	0.14	0.25	0.17	0.29	0.26	0.41	**0.21**
	Peerless	0.15	0.17	0.14	0.13	0.13				0.29	**0.16**
	Price	0.13	0.14	0.15	0.10	0.19	0.10	0.21	0.20	0.48	**0.17**

Figure 13a: Crop production per megalitre of water applied at sites using drip irrigation grouped by variety



Ca: Carmel, Fr: Fritz, Mo: Monterey, Ne: Ne Plus, No: Nonpareil, Pe: Peerless, Pr: Price

Table 10a: Sites using drip irrigation ranked with respect to the highest crop production per megalitre of water applied

Drip irrigation systems

	Crop production per megalitre (t/ML)			Rank*		
Site	2011	2010	2009	2011	2010	2009
206C6-Ca	0.48			6		
206C5-Ca	0.44			8		
2063C-Ca	0.43	0.22		10	18	
205C2-Ca	0.35	0.22	0.29	16	18	5
205C1-Ca	0.33	0.41	0.35	17	1	2
205CF-Ca	0.33	0.15	0.19	17	30	23
205CE-Ca	0.32	0.29	0.25	20	8	12
201A2-Ca	0.19	0.24	0.33	36	14	3
211CO-Ca	0.15	0.31		41	5	
211CY-Ca	0.11			44		
212CA-Ca	0.07			48		
201B2-Ca	0.06	0.21	0.28	49	22	6
211MT-Mo	0.23			30		
212MO-Mo	0.06			49		
206N5-No	0.44			8		
206N6-No	0.40			13		
2063N-No	0.27	0.21		26	22	
205NF-No	0.26	0.22	0.19	27	18	23
201A1-No	0.25	0.25	0.28	28	11	6
205N1-No	0.22	0.31	0.27	31	5	9
205N2-No	0.20	0.25	0.20	33	11	20
211NO-No	0.18	0.33		38	3	
205NE-No	0.18	0.25	0.22	38	11	15
201B1-No	0.11	0.23	0.28	44	17	6
211NY-No	0.11			44		
212NP-No	0.06			49		
205PF-Pe	0.33	0.20	0.21	17	25	17
206P6-Pe	0.29			23		
206P5-Pe	0.28			25		
205PE-Pe	0.25	0.08	0.18	28	35	26
205P1-Pe	0.19	0.34	0.22	36	2	15
205P2-Pe	0.18	0.24	0.20	38	14	20
211PO-Pr	0.51	0.33		5	3	
2063P-Pr	0.42	0.18		11	26	
201A3-Pr	0.11	0.16	0.12	44	29	28
212PR-Pr	0.06			49		
201B3-Pr	0.05	0.17	0.12	53	28	28

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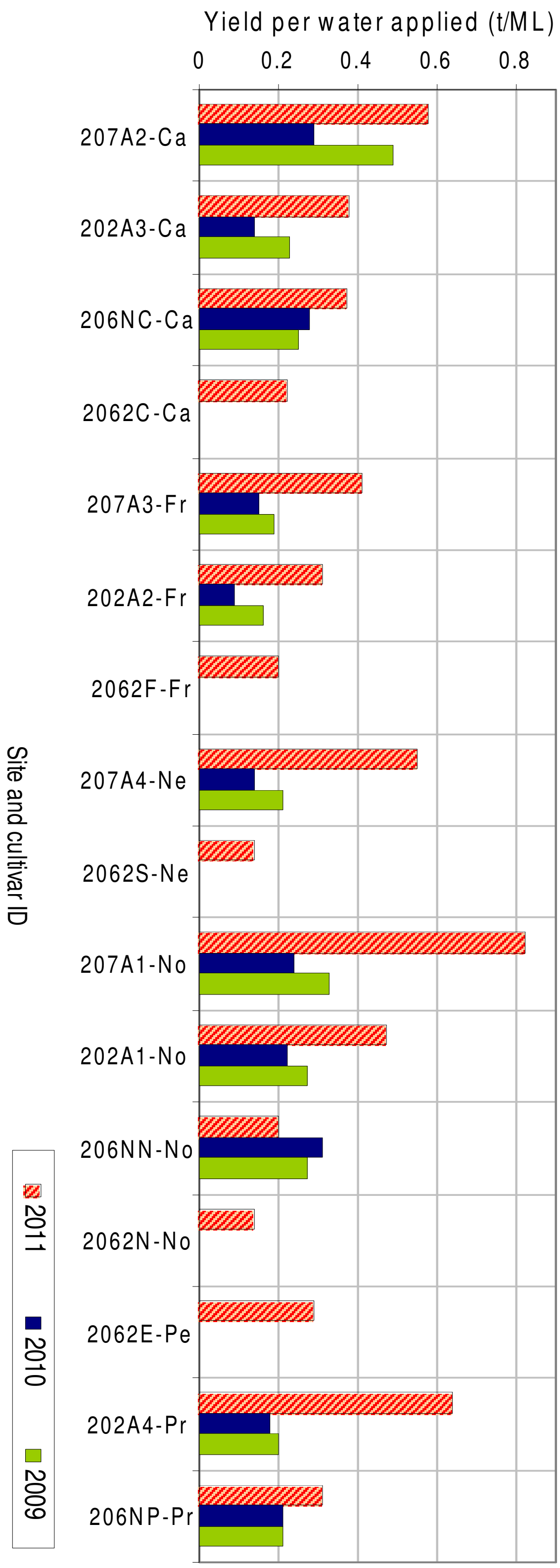
* Based on all sites, i.e. with drip and low level irrigation

Figure 13b: Crop production per megalitre of water applied at sites using low level irrigation grouped by variety



Ca: Carmel, Fr: Fritz, Mo: Monterey, Ne: Ne Plus, No: Nonpareil, Pe: Peerless, Pr: Price

Table 10b: Sites using low level irrigation ranked with respect to the highest crop production per megalitre of water applied

		Crop production per megalitre					
		(t/ML)			Rank*		
	Site	2011	2010	2009	2011	2010	2009
Low level irrigation systems	207A2-Ca	0.58	0.29	0.49	3	8	1
	202A3-Ca	0.38	0.14	0.23	14	32	14
	206NC-Ca	0.37	0.28	0.25	15	10	12
	2062C-Ca	0.22			31		
	207A3-Fr	0.41	0.15	0.19	12	30	23
	202A2-Fr	0.31	0.09	0.16	21	34	27
	2062F-Fr	0.20			33		
	207A4-Ne	0.55	0.14	0.21	4	32	17
	2062S-Ne	0.14			42		
	207A1-No	0.82	0.24	0.33	1	14	3
	202A1-No	0.47	0.22	0.27	7	18	9
	206NN-No	0.20	0.31	0.27	33	5	9
	2062N-No	0.14			42		
	2062E-Pe	0.29			23		
	202A4-Pr	0.64	0.18	0.20	2	26	20
	206NP-Pr	0.31	0.21	0.21	21	22	17
	Maximum	0.8	0.4	0.5	53	35	28
	Median	0.3	0.2	0.2			
	Minimum	0.1	0.1	0.1			

* Based on all sites, i.e. with drip and low level irrigation

3.4 Gross return per ML of water applied

Gross return per megalitre of water applied is the ratio between the price per hectare ($/ha) received by the growers for the sale of their produce and the volume of irrigation water applied (ML/ha) over the season (see Equation 2 - Appendix B). It can also be calculated by multiplying the crop production per megalitre of water applied by the price per tonne of almond. Differences in gross return between sites and between seasons occur as a result of differences in yields, irrigation applications and almond prices. The price of almonds is determined by factors such as supply, demand, quality (variety and grade) and currency exchange rates for the export market. Gross return per megalitre of water applied does not consider input costs and therefore does not give an indication of growers' profits.

Figure 14 shows the gross return per megalitre of water applied for the last nine years. The box plot in 2011 was the fourth highest recorded. The medians of the recent years, i.e. $1049/ML in 2011, $1118/ML in 2010, $1006/ML in 2009 and $854/ML in 2008, were well below the median in 2007 ($1584/ML). In 2011, 75% of sites received less than $1533/ML compared to $1393/ML in 2010, $1262/ML in 2009, $1142/ML in 2008 and $1762/ML in 2007. The results reflect a general reduction in the amount of water applied rather than increases in yield despite a reduction in returns per tonne ($500 to $1000 drop in the price per tonne from 2010 to 2011). As a comparison, the median prices obtained by participating growers were $4000/t in 2011, $5000/t in 2010, $4500/t in 2009, $5200/t in 2008, $7250/t in 2007, $7000/t in 2006, $8500/t in 2005, $6000/t in 2004 and $6000/t in 2003.

3.4.1 Gross return per megalitre of water applied - irrigation system type comparison

Table 11 shows the average gross return per megalitre of water applied for low level irrigated sites ($1507/ML) was much higher than for drip irrigated sites ($962/ML) in 2011. The average result of drip irrigated sites in 2011 was very much lower than the overall average ($1169/ML) while that of low level irrigated sites was very much higher than the overall average ($1168/ML). The overall averages for drip irrigated sites and low level irrigated sites have converged ($1169/ML and $1168/ML respectively).

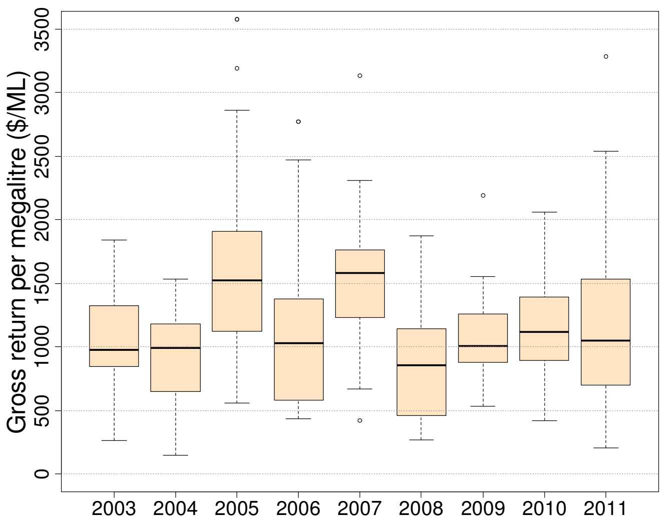


Figure 14: Box plot of gross return per megalitre of water applied between 2003 and 2011

Table 11: Average gross return per megalitre of water applied - Irrigation system type comparison

Season	Average gross return per megalitre ($/ML)		
	Drip	Low level	Average
2002/03		1054	**1054**
2003/04		904	**904**
2004/05	2322	1524	**1650**
2005/06	1613	938	**1090**
2006/07		1536	**1536**
2007/08	1052	757	**864**
2008/09	1046	1144	**1083**
2009/10	1186	1021	**1134**
2010/11	962	1507	**1126**
Average	**1169**	**1168**	**1168**

Table 12: Average gross return per megalitre of water applied - Variety comparison

Variety	Average gross return per megalitre ($/ML)									
	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	Average
Carmel	1045	845	1663	1170	1888	948	1328	1239	1204	**1258**
Fritz	940	878	1373	976	1063	639	774	605	1223	**976**
Mission		1114	1609	512	1760					**1249**
Monterey									574	**574**
NePlus	1226	806	1510	1132	1334	748	959	686	1388	**1149**
Nonpareil	1190	992	1926	1131	1759	1006	1161	1264	1074	**1272**
Peerless	887	1026	1240	821	683	822	905	1072	1038	**958**
Price	754	830	1544	1094	1376	569	719	996	1199	**1062**
Average	**1054**	**904**	**1650**	**1090**	**1536**	**864**	**1083**	**1134**	**1126**	**1168**

3.4.2 Gross return per megalitre of water applied - variety comparison

The average gross return per megalitre of water applied for each variety and season is presented in Table 12. The varieties that achieved the highest results in 2010/11 were NePlus ($1388/ML), Fritz ($1223/ML) and Carmel ($1201/ML). Since the price per tonne of almond obtained by the participants for the different varieties was all around $4000/t, the gross return per megalitre of water applied was therefore directly related to the crop production per water applied.

Compared to 2009/10, the results in 2010/11 were higher for all varieties except Carmel and Nonpareil. In 2006/07 and 2004/05, almost all varieties had a higher seasonal average than in the last three seasons. As mentioned previously, the higher price of almond in 2004/05 and 2006/07 was one of the main reasons for the higher gross return per water applied in those years.

The average results of the nine seasons in the last column of Table 12 show Nonpareil had the highest average ($1272/ML), followed by Carmel ($1258/ML) and Mission ($1249/ML). However, the fact there were no sites growing variety Mission in 2007/08 and 2008/09, when the results would have been definitely lower, contributed in maintaining its overall average relatively high compared to the other varieties. There were only two sites of young Monterey trees (3 to 5 years old) resulting in low average production while still having high water needs. Peerless ($958/ML) and Fritz ($976/ML) were the other varieties with the lowest nine year averages.

3.5 Cost of water per tonne of almond

Cost of water per tonne of almond is calculated using Equation 3 (Appendix B) and is influenced by many factors within irrigation systems and seasons. Inputs include the cost of irrigation water, the cost of on/off-peak electricity for pumping, the total number of irrigation hours and the yield produced. It should not be interpreted as being definitive due to the number of variables involved in the calculation.

Figure 15 shows the cost of water per tonne of almond in 2011 returned to similar figures experienced before the severe reductions in water allocation caused by drought experienced in the 2007 season. The median for 2011 was \$212/t compared to \$537/t in 2010, \$1267/t in 2009, \$1088/t in 2008 and \$242/t in 2007. The smaller range was also reminiscent of this same time.

The high costs associated with the purchase of permanent water by one irrigator lead to the high outliers seen in 2011.The main cause for the high values between 2008 and 2010 is the high cost for the water applied, particularly where participants purchased additional water. As an indication, the medians for the cost of water were \$18/ML in 2011, \$77/ML in 2010, \$260/ML in 2009, \$144/ML in 2008, and between \$13/ML (2007) and \$46/ML (2003) for the other years.

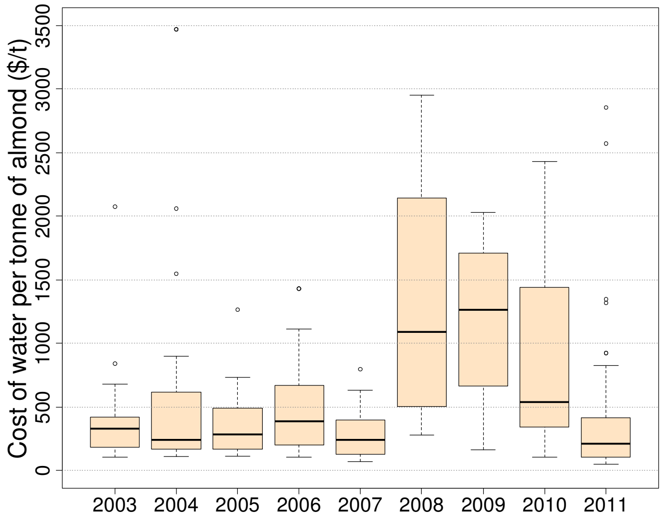


Figure 15: Box plot of cost of water per tonne of almond between 2003 and 2011

3.5.1 Cost of water per tonne of almond - irrigation system type comparison

Table 13 shows the average cost of water per tonne of almond for each irrigation system type and season. The costs in 2011 seem to have returned to the pre-drought figures, i.e. prior to the 2008 season. The average of all nine seasons was \$744/t for drip irrigation and \$704/t for low level irrigation. The high cost of water per tonne of almond for low level irrigated sites in 2007/08 (\$2798/t) and 2008/09 (\$880/t), and for drip irrigated sites in 2008/09 (\$1423/t) and 2009/10 (\$1052/t), greatly contributed in increasing the overall average cost for each irrigation system.

The averages since 2007/08 were greatly influenced by the substantial increase in the cost of additional water purchased by growers. The cost of additional water also varied greatly depending on the timing of the purchase, with temporary water reaching a high of \$1200/ML in December 2007.

Table 13: Average cost of water per tonne of almond - Irrigation system type comparison

Season	Average cost of water per tonne of almond ($/t)		
	Drip	Low level	Average
2002/03		408	**408**
2003/04		688	**688**
2004/05	226	372	**349**
2005/06	314	545	**493**
2006/07		285	**285**
2007/08	537	2798	**1976**
2008/09	1423	880	**1217**
2009/10	1052	492	**876**
2010/11	470	225	**396**
Average	**744**	**704**	**717**

3.6 Gross return per dollar water input

This indicator compares dollar returns from the sale of almond with the expenditure on water used ($/$). It is strongly influenced by water costs and the gross return from crop production. Water costs often differ between growers according to the supply source and its associated cost structure.

Figure 16 shows that the median value for gross return per dollar water input for 2011 had risen to 18.90, similar to the pre-drought results. This reflects the drop in water costs as the price received for the almonds dropped by $500 to $1000 per tonne. The box plots from 2008 to 2010 were well below those in the other years. The lower gross return per dollar water input for most participants between 2008 and 2010 can be attributed to the combined effect of the reduced price of almond and the increased cost of additional water purchased in recent years.

Table 14 displays the average gross returns for every dollar of water input. As already mentioned, the higher cost of water in the recent seasons had a major impact on the average gross return per dollar water input from 2008 to 2010. Over the nine seasons, low level irrigated sites achieved on average $4.9 more per dollar of water applied than drip irrigated sites. In 2011, low level irrigated sites averaged $1.90 higher gross returns per dollar water input than drip irrigated sites. In 2011, both drip and low level irrigated sites outperformed the nine-year averages.

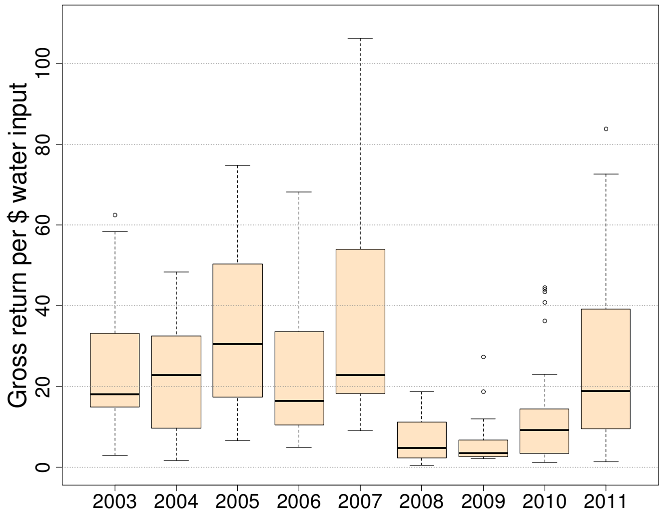


Figure 16: Box plot of gross return per dollar water input between 2003 and 2011

Table 14: Average gross return per dollar water input - Irrigation system type comparison

Season	**Average gross return per dollar water input ($/$)**	
	Drip	**Low level**
2002/03		25.1
2003/04		22.1
2004/05	48.9	33.3
2005/06	33.7	21.4
2006/07		36.7
2007/08	11.0	4.3
2008/09	3.8	8.7
2009/10	11.5	17.3
2010/11	25.4	27.3
Average	**19.0**	**23.9**

4. Conclusions

- Irrigation Benchmarking continues to be a useful tool to assess and compare growers' performances from season to season, as well as to identify best irrigation management practices.
- Although site-specific conditions and the presence of confounding factors often make comparisons difficult, the results nevertheless provide important information about the diversity that exists within the industry and the potential returns associated with different irrigation management strategies.
- The above normal rainfall in the last season had a high impact on the variation of yield and amount of water applied between sites.
- Over the period under study, drip irrigated sites had a lower average volume of water applied and a higher average yield than low level irrigated sites. This resulted in a higher crop production per megalitre of water applied with drip compared to low level irrigation.
- Although it is recommended to have a leaching fraction no more than 10-15% (i.e. application efficiency of 85-90% to minimise drainage while controlling soil salinity), results have shown the majority of sites had application efficiencies below 85% in 2010/11.
- Within the nine seasons, Nonpareil and Carmel were consistently among the varieties with the highest gross return per megalitre of water applied.
- The reduced price of almonds and the increased cost of water used in the recent years also had a major impact on the gross return per dollar water input of most participants.
- The water allocation restrictions in the last few years strongly increased the cost of irrigation water where a grower decided to buy additional water beyond the allocation received.

Appendix

A. Further reading

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- Sommer, K. J. & Pollock, L. (2008b). Dried vine fruit irrigation benchmarking 2002-2008. Technical report, Department of Primary Industries, Vic.
- Sommer, K. J. & Pollock, L. (2008c). Table grape irrigation benchmarking 2002-2008. Technical report, Department of Primary Industries, Vic.
- Toll, Z. & Burrows, D. (2006a). Almond irrigation benchmarking 2002-2006. Technical report, Department of Primary Industries, Vic.
- Toll, Z. & Burrows, D. (2006b). Dried vine fruit irrigation benchmarking 2002-2006. Technical report, Department of Primary Industries, Vic.
- Toll, Z. (2006c). Open hydroponics irrigation benchmarking 2002-2005. Technical report, Department of Primary Industries, Vic.
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- Toll, Z. & Burrows, D. (2006e). Potato centre pivot irrigation benchmarking 2002-2005. Technical report, Department of Primary Industries, Vic.
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- Vargas, J. (2005a). Almond irrigation benchmarking 2002-2005. Technical report, Dept. of Primary Industries, Vic.
- Vargas, J. (2005b). Dried fruit irrigation benchmarking 2002-2005. Technical report, Department of Primary Industries, Victoria.
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B. Performance indicator formulas

1. $$\textbf{Crop production per ML (t/ML)} = \frac{\text{Yield (t/ha)}}{\text{Water applied (ML/ha)}}$$

2. $$\textbf{Gross return per ML (\$/ML)} = \frac{\text{Yield (t/ha)} \times \text{Assigned value (\$/t)}}{\text{Water applied (ML/ha)}}$$

3. $$\textbf{Cost of water per tonne of almond (\$/t)} = \frac{\text{Cost of water applied per ha (\$/ha)}}{\text{Yield (t/ha)}}$$

4. $$\textbf{Cost of water applied per ha (\$/ha)} =$$
$$\left(\text{Cost of water (\$/ML)} + \text{pumping cost (\$/ML)}\right) \times \text{water applied (ML/ha)}$$

5. $$\textbf{Gross return per dollar water input} = \frac{\text{Yield (t/ha)} \times \text{Assigned value (\$/t)}}{\text{Cost of water applied per ha (\$/ha)}}$$

6. $$\textbf{Application efficiency (\%)} = \frac{\left(\text{Water applied (ML/ha) - drainage (ML/ha)}\right) \times 100}{\text{Water applied (ML/ha)}}$$

7. $$\textbf{Yield per volume of drainage (t/ML)} = \frac{\text{Yield (t/ha)}}{\text{Estimated drainage (ML/ha)}}$$

8. $$\textbf{Cost of drainage per tonne (\$/t)} = \frac{\text{Cost of drainage per ha (\$/ha)}}{\text{Yield (t/ha)}}$$

9. $$\textbf{Cost of drainage per ha (\$/ha)} =$$
$$\left(\text{Cost of water (\$/ML)} + \text{pumping cost (\$/ML)}\right) \times \text{estimated drainage (ML/ha)}$$

C. Performance indicator tables

Site	Age	Scheduling Method	System Type	Variety	Assigned value ($/t)								
					2003	2004	2005	2006	2007	2008	2009	2010	2011
201A1	16	Capacitance - Logging	Low level	Nonpareil	6390	6000	8500	7000	7000	5200			
201A1	19	Capacitance - Logging	Drip	Nonpareil							4500	5000	4000
201A2	16	Capacitance - Logging	Low level	Carmel	6000	6000	8500	7000	7000	5200			
201A2	19	Capacitance - Logging	Drip	Carmel							4500	5000	4000
201A3	16	Capacitance - Logging	Low level	Price	6000	6000	8500	7000	7000	5200			
201A3	19	Capacitance - Logging	Drip	Price							4500	5000	4000
201B1	8	Capacitance - Logging	Low level	Nonpareil		6000	8500	7000	7000	5200			
201B1	11	Capacitance - Logging	Drip	Nonpareil							4500	5000	4000
201B2	8	Capacitance - Logging	Low level	Carmel		6000	8500	7000	7000	5200			
201B2	11	Capacitance - Logging	Drip	Carmel							4500	5000	4000
201B3	8	Capacitance - Logging	Low level	Price		6000	8500	7000	7000	5200			
201B3	11	Capacitance - Logging	Drip	Price							4500	5000	4000
202A1	28	Capacitance - Logging	Low level	Nonpareil	6000	6000	8500	6500	7500	5200	4500	5000	4000
202A2	28	Capacitance - Logging	Low level	Fritz	6000	6000	8500	6500	7500	5200	4500	5000	4000
202A3	28	Capacitance - Logging	Low level	Carmel	6000	6000	8500	6500	7500	5200	4500	5000	4000
202A4	28	Capacitance - Logging	Low level	Price	6000	6000	8500	6500	7500	5200	4500	5000	4000
203A1	21	Capacitance - Manual	Low level	Carmel	6530	5930	8400	7200	7250	5200			
203A2	21	Capacitance - Manual	Low level	Fritz	5970	5970	8400	7000	7250	5200			
203A3	19	Capacitance - Manual	Low level	NePlus	6300	5900	8400	7200	7250	5200			
203A4	22	Capacitance - Manual	Low level	Nonpareil	6390	6050	8400	7504	7250	5200			
205A1	29	Capacitance - Logging	Low level	Nonpareil	6000	6000	9000	6400	6810				
205A2	11	Capacitance - Logging	Low level	Carmel	6000	6000	9000	6400	5670				
205A3	11	Capacitance - Logging	Low level	Peerless	6000	6000	9000	6400	5540				
205A4	11	Capacitance - Logging	Low level	NePlus	6000	6000	9000	6400	5570				
205B1	27	Capacitance - Logging	Low level	Nonpareil	6000	6000	9000	6400	6810				
205B2	27	Capacitance - Logging	Low level	Carmel	6000	6000	9000	6400	5670				
205B3	27	Capacitance - Logging	Low level	Peerless	6000	6000	9000	6400	5540				
205C1	15	Capacitance - Logging	Drip	Carmel						5700	4500	5000	4000
205C2	15	Capacitance - Logging	Drip	Carmel						5700	4500	5000	4000
205CE	22	Capacitance - Logging	Drip	Carmel						5700	4500	5000	4000
205CF	10	Capacitance - Logging	Drip	Carmel						5700	4500	5000	4000
205N1	15	Capacitance - Logging	Drip	Nonpareil						5700	4500	5000	4000
205N2	14	Capacitance - Logging	Drip	Nonpareil						5700	4500	5000	4000
205NE	22	Capacitance - Logging	Drip	Nonpareil						5700	4500	5000	4000
205NF	10	Capacitance - Logging	Drip	Nonpareil						5700	4500	5000	4000
205P1	15	Capacitance - Logging	Drip	Peerless						5700	4500	5000	4000
205P2	14	Capacitance - Logging	Drip	Peerless						5700	4500	5000	4000
205PE	22	Capacitance - Logging	Drip	Peerless						5700	4500	5000	4000
205PF	10	Capacitance - Logging	Drip	Peerless						5700	4500	5000	4000

Continued on next page

Site	Age	Scheduling Method	System Type	Variety	Assigned value ($/t)								
					2003	2004	2005	2006	2007	2008	2009	2010	2011
2062C	38	Capacitance - Logging	Low level	Carmel									4000
2062E	38	Capacitance - Logging	Low level	Peerless									4000
2062F	38	Capacitance - Logging	Low level	Fritz									4000
2062N	38	Capacitance - Logging	Low level	Nonpareil									4000
2062S	38	Capacitance - Logging	Low level	Neplus									4000
2063C	14	Capacitance - Logging	Drip	Carmel								5000	4000
2063N	14	Capacitance - Logging	Drip	Nonpareil								5000	4000
2063P	14	Capacitance - Logging	Drip	Price								5000	4000
206A1	15	Capacitance - Logging	Low level	Nonpareil		6000	8500	6500	7250	5700			
206A9	35	Capacitance - Logging	Low level	Nonpareil		6000	8500	6500	7250				
206B1	15	Capacitance - Logging	Low level	Price		6000	8500	6500	7500	5700			
206B9	35	Capacitance - Logging	Low level	NePlus		6000	8500	6500	7250				
206C1	15	Capacitance - Logging	Low level	Carmel		6000	8500	6500	7250	5700			
206C5	7	Capacitance - Logging	Drip	Carmel									4000
206C6	9	Capacitance - Logging	Drip	Carmel									4000
206C9	35	Capacitance - Logging	Low level	Fritz		6000	8500	6500	7500				
206D9	35	Capacitance - Logging	Low level	Mission		6000	8500	6500	7250				
206N5	7	Capacitance - Logging	Drip	Nonpareil									4000
206N6	9	Capacitance - Logging	Drip	Nonpareil									4000
206NC	18	Capacitance - Logging	Low level	Carmel							4500	5000	4000
206NN	18	Capacitance - Logging	Low level	Nonpareil							4500	5000	4000
206NP	18	Capacitance - Logging	Low level	Price							4500	5000	4000
206P5	7	Capacitance - Logging	Drip	Peerless									4000
206P6	9	Capacitance - Logging	Drip	Peerless									4000
207A1	28	Capacitance - Logging	Low level	Nonpareil	6400	3550	8500	7000	7250	5200	4500	5000	4000
207A2	28	Capacitance - Logging	Low level	Carmel	6400	3550	8500	7000	7250	5200	4500	5000	4000
207A3	28	Capacitance - Logging	Low level	Fritz	6400	3550	8500	7000	7500	5200	4500	5000	4000
207A4	28	Capacitance - Logging	Low level	NePlus	6400	3550	8500	7000	7250	5200	4500	5000	4000
208CA	4	Capacitance - Logging	Drip	Carmel				7000					
208NP	4	Capacitance - Logging	Drip	Nonpareil				7000					
208PR	4	Capacitance - Logging	Drip	Price				7000					
209CA	21	Capacitance - Logging	Drip	Carmel			8500	7000					
209NP	21	Capacitance - Logging	Drip	Nonpareil			8500	7000					
209PR	21	Capacitance - Logging	Drip	Price			8500	7000					
210CA	6	Capacitance - Logging	Drip	Carmel			8500	7000					
210NP	6	Capacitance - Logging	Drip	Nonpareil			8500	7000					
210PR	6	Capacitance - Logging	Drip	Price			8500	7000					
211CO	11	Evaporation data	Drip	Carmel								4500	4000
211CY	5	Evaporation data	Drip	Carmel									4000
211MT	5	Evaporation data	Drip	Monterey									4000
211NO	11	Evaporation data	Drip	Nonpareil								4500	4000
211NY	5	Evaporation data	Drip	Nonpareil									4000
211PO	11	Evaporation data	Drip	Price								4500	4000
212CA	3	Capacitance - Logging	Drip	Carmel									4000
212MO	3	Capacitance - Logging	Drip	Monterey									4000
212NP	3	Capacitance - Logging	Drip	Nonpareil									4000
212PR	3	Capacitance - Logging	Drip	Price									4000

Site	Water applied (ML/ha)									Estimated drainage (ML/ha)								
	2003	2004	2005	2006	2007	2008	2009	2010	2011	2003	2004	2005	2006	2007	2008	2009	2010	2011
201A1	14.95	13.50	13.96	13.02	11.21	11.53				3.99	2.83	3.92	3.25	1.78	1.26			
201A1							10.50	11.67	7.06							0.49	2.11	0.97
201A2	14.95	13.50	13.96	13.02	11.21	11.53				3.99	2.83	3.92	3.25	1.91	1.26			
201A2							10.50	11.50	7.28							0.49	2.18	1.02
201A3	14.95	13.50	13.96	13.02	11.21	11.53				3.99	2.83	3.92	3.25	1.78	1.26			
201A3							10.55	11.52	7.06							0.51	2.07	1.00
201B1	14.95	12.86	11.75	12.01	12.19	11.25				5.13	3.05	2.52	2.67	3.02	1.40			
201B1							10.49	11.55	7.20							0.68	2.23	1.29
201B2	14.95	12.86	11.75	12.01	12.19	11.25				5.13	3.05	2.52	2.67	3.02	1.40			
201B2							10.55	11.65	7.06							0.71	2.29	1.14
201B3	14.95	12.86	11.75	12.01	12.19	11.25				5.13	3.04	2.52	2.67	3.22	1.40			
201B3							10.55	11.60	7.14							0.71	2.24	1.16
202A1	12.26	9.09	11.39	10.90	10.67	6.27	6.23	5.76	2.97	4.26	2.33	3.19	3.55	3.80	1.56	0.83	0.85	0.73
202A2	12.26	9.09	11.39	10.90	10.67	6.27	6.23	5.76	2.97	4.26	2.33	3.19	3.55	3.81	1.55	0.84	0.85	0.72
202A3	12.26	9.09	11.39	10.90	10.35	6.27	6.23	5.76	2.97	4.26	2.41	3.19	3.55	3.69	1.55	0.83	0.85	0.66
202A4	12.26	9.09	11.39	10.90	10.67	6.27	6.23	5.76	2.97	4.26	2.52	3.19	3.55	3.80	1.55	0.83	0.85	0.76
203A1	10.50	10.09	11.36	9.87	8.00	6.75				2.04	1.16	2.74	2.29	1.46	0.67			
203A2	10.50	10.09	11.36	9.87	8.27	6.75				2.04	1.16	2.74	2.29	1.56	0.67			
203A3	10.50	10.09	11.36	9.87	8.27	6.75				2.04	1.16	2.74	2.29	1.82	0.67			
203A4	10.50	10.09	11.36	9.87	8.27	6.75				2.04	1.16	2.74	2.29	1.82	0.67			
205A1	18.85	17.26	19.05	20.33	19.05					8.15	6.83	9.65	11.16	9.80				
205A2	18.85	17.26	19.05	19.45	19.05					8.15	6.48	9.37	10.19	9.77				
205A3	18.85	17.26	19.05	19.45	19.05					7.74	6.48	9.37	10.19	9.77				
205A4	18.85	17.26	19.05	19.45	19.05					7.74	6.48	9.37	10.25	9.77				
205B1	15.45	14.38	16.46	14.78	18.30					4.57	4.45	7.56	5.98	8.60				
205B2	15.45	14.38	16.46	14.78	18.30					4.57	4.45	7.35	5.98	8.82				
205B3	15.45	14.38	16.46	14.78	18.30					4.57	4.45	7.35	5.98	8.60				
205C1						13.06	12.74	9.37	10.60						3.31	3.00	1.96	2.54
205C2						13.20	12.80	14.63	10.90						3.42	3.09	4.59	2.70
205CE						14.02	14.56	15.30	11.55						4.29	4.38	5.09	3.36
205CF						12.96	12.76	14.54	11.05						3.37	3.26	4.52	2.83
205N1						13.07	12.70	13.88	10.30						3.32	3.00	3.91	2.62
205N2						13.16	13.62	14.02	10.74						3.42	3.52	4.02	2.98
205NE						14.02	13.56	14.99	11.42						4.29	3.61	4.87	3.46
205NF						12.96	13.29	13.96	10.94						3.37	3.20	3.96	3.10
205P1						13.10	12.74	9.38	10.57						3.36	3.00	1.91	2.54
205P2						13.16	13.42	14.72	10.97						3.42	3.35	4.66	2.72
205PE						14.02	13.61	15.56	11.54						4.29	3.63	5.46	3.31
205PF						12.91	12.82	14.54	11.00						3.37	2.99	4.43	2.78

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Site	Water applied (ML/ha)									Estimated drainage (ML/ha)								
	2003	2004	2005	2006	2007	2008	2009	2010	2011	2003	2004	2005	2006	2007	2008	2009	2010	2011
2062C									11.57									3.57
2062E									11.57									3.57
2062F									11.57									3.57
2062N									11.57									3.57
2062S									11.57									3.57
2063C								14.99	10.23								4.59	2.19
2063N								14.85	10.36								4.48	2.28
2063P								14.79	10.36								4.42	2.28
206A1		16.18	15.86	15.45	16.64	16.69					5.64	6.30	6.23	6.85	10.96			
206A9		16.21	15.90	15.48	16.26						5.94	6.68	6.36	6.77				
206B1		16.18	15.86	15.45	16.64	16.69					5.91	6.65	6.33	7.15	10.96			
206B9		16.21	15.90	15.48	16.26						5.67	6.34	6.26	6.47				
206C1		16.18	15.86	15.45	16.64	16.69					5.91	6.65	6.33	7.15	10.90			
206C5									9.60									1.54
206C6									9.66									1.63
206C9		16.21	15.90	15.48	16.26						5.67	6.34	6.26	6.47				
206D9		16.21	15.90	15.48	16.26						5.94	6.68	6.36	6.77				
206N5									9.63									1.57
206N6									9.66									1.66
206NC							14.92	14.93	11.62							4.69	5.12	3.58
206NN							14.92	14.93	11.62							4.69	5.13	3.58
206NP							14.92	14.93	11.62							4.69	5.11	3.58
206P5									9.63									1.57
206P6									9.66									1.63
207A1	12.52	12.70	14.85	14.60	13.65	13.65	14.11	13.20	6.20	1.83	2.64	5.33	5.89	3.97	3.57	4.14	2.85	1.82
207A2	12.52	12.70	14.85	14.60	13.65	13.65	14.11	13.20	6.20	1.83	2.64	5.33	5.89	3.97	3.49	4.14	2.85	1.99
207A3	12.52	12.70	14.85	14.60	13.65	13.65	14.11	13.28	6.20	1.83	2.64	5.33	5.89	3.97	3.49	4.14	2.94	1.80
207A4	12.52	12.70	14.85	14.60	13.65	13.65	14.11	13.20	6.20	1.83	2.64	5.33	5.89	3.97	3.49	4.14	2.85	1.80
208CA			6.00	6.81								0.30	0.63					
208NP			6.00	6.81								0.36	0.89					
208PR			6.00	6.81								0.36	0.89					
209CA			14.63	14.34								6.05	5.06					
209NP			14.63	14.34								6.05	5.09					
209PR			14.63	14.34								6.10	5.09					
210CA			5.27	5.61								0.32	0.56					
210NP			5.27	5.61								0.32	0.56					
210PR			5.27	5.61								0.32	0.61					
211CO								11.57	8.38								1.64	0.89
211CY									8.41									0.91
211MT									8.38									0.89
211NO								12.11	8.41								2.07	0.95
211NY									8.41									0.92
211PO								12.98	8.40								2.90	0.92
212CA									9.23									1.72
212MO									10.90									3.00
212NP									10.94									3.22
212PR									10.88									3.17

Site	Cost of excess ($)									Yield (t/ha)								
	2003	2004	2005	2006	2007	2008	2009	2010	2011	2003	2004	2005	2006	2007	2008	2009	2010	2011
201A1	185	137	194	168	92	112				3.10	3.20	3.70	1.04	2.83	0.90			
201A1							53	110	84							2.96	2.96	1.80
201A2	93	69	97	84	49	52				3.10	3.20	3.70	1.10	3.10	0.90			
201A2							27	58	43							3.46	2.72	1.40
201A3	93	69	97	84	41	56				3.10	3.20	3.70	1.10	2.41	0.60			
201A3							27	55	43							1.25	1.85	0.80
201B1	543	337	284	315	317	288					0.31	1.37	0.75	2.72	1.00			
201B1							169	268	248							2.96	2.70	0.78
201B2	271	168	142	158	178	144					0.31	1.37	0.75	2.72	0.90			
201B2							88	137	112							2.96	2.47	0.41
201B3	271	168	142	158	190	144					0.31	1.37	0.75	1.73	0.60			
201B3							88	135	113							1.25	1.97	0.37
202A1	4673	2669	3546	3399	4210	4150	2700	1220	1172	3.41	2.15	3.83	1.40	2.50	1.28	1.69	1.24	1.38
202A2	1869	1035	1414	1357	1689	1650	1088	534	521	2.00	1.70	2.30	1.81	2.50	0.63	0.98	0.52	0.91
202A3	1869	1078	1401	1576	1634	1650	1081	488	429	1.65	1.10	1.80	1.28	2.70	0.48	1.42	0.80	1.14
202A4	935	577	685	680	842	825	540	244	252	0.54	0.42	1.70		2.00	0.65	1.22	1.05	1.89
203A1	211	125	427	318	277	760				1.57	0.40	1.50	1.01	1.93	0.42			
203A2	211	125	427	417	289	760				0.74	0.69	0.80	0.97	1.09	0.56			
203A3	362	214	732	716	554	1244				1.47	0.97	1.85	2.00	1.88	0.85			
203A4	723	429	1463	1431	1150	2604				1.39	1.05	1.95	1.54	2.12	0.63			
205A1	201	181	258	296	228					3.30	2.55	3.60	1.75	4.08				
205A2	52	44	64	71	58					1.80	2.35	2.20	1.75	4.20				
205A3	49	44	64	71	58					3.50	2.90	2.70	1.75	2.30				
205A4	49	44	64	71	58					3.00	3.15	3.60	1.75	2.54				
205B1	112	117	200	160	198					2.30	2.35	2.70	2.46	4.22				
205B2	55	49	96	79	100					2.45	2.55	1.70	2.46	3.90				
205B3	55	58	96	79	98					1.70	2.50	2.20	2.46	2.30				
205C1						2036	7257	6630	757						2.91	4.40	3.86	3.48
205C2						2099	7450	10343	818						2.39	3.75	3.27	3.80
205CE						2063	7698	9015	819						2.81	3.69	4.36	3.65
205CF						769	2906	3776	312						2.57	2.42	2.14	3.64
205N1						4197	14959	18944	1605						2.84	3.42	4.35	2.29
205N2						4544	17418	20448	1925						2.58	2.75	3.45	2.15
205NE						4736	15481	20128	1938						2.57	3.03	3.68	2.07
205NF						3124	11188	13950	1387						3.10	2.54	3.05	2.87
205P1						2023	7129	6330	743						1.96	2.85	3.16	2.02
205P2						2148	7934	10719	833						1.83	2.67	3.47	2.01
205PE						1745	5724	8041	683						1.80	2.41	1.31	2.87
205PF						771	2661	3707	119						2.06	2.63	2.91	3.64

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Site	Cost of excess ($)									Yield (t/ha)								
	2003	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
2062C									44									2.56
2062E									23									3.32
2062F									381									2.35
2062N									1715									1.57
2062S									410									1.66
2063C								921	173								3.29	4.35
2063N								1852	368								3.10	2.80
2063P								896	180								2.59	4.31
206A1		1001	1128	1295	1041	25489					4.13	3.56	3.10	4.87	4.12			
206A9		1270	1440	1392	1254						3.36	3.56	2.44	3.58				
206B1		524	595	658	550	12746					3.98	1.04	2.64	3.55	3.48			
206B9		304	342	344	300						1.86	2.10	2.05	2.96				
206C1		524	595	658	549	12686					3.50	3.70	3.10	5.30	4.36			
206C5									108									4.26
206C6									170									4.64
206C9		151	170	171	149						3.01	3.01	2.46	0.91				
206D9		158	179	173	156						3.01	3.01	1.22	3.95				
206N5									166									4.26
206N6									266									3.84
206NC							2628	1153	472							3.71	4.16	4.35
206NN							5224	2261	911							3.99	4.58	2.27
206NP							2628	1150	472							3.09	3.16	3.65
206P5									55									2.72
206P6									85									2.83
207A1	431	672	1442	1627	936	2863	2649	754	572	2.65	2.41	3.13	3.30	4.03	3.86	4.71	3.16	5.10
207A2	215	336	725	813	468	1399	1325	377	312	3.36	3.77	3.70	4.90	5.90	4.92	6.88	3.88	3.63
207A3	121	188	406	456	262	784	742	217	158	2.78	3.10	2.75	2.30	2.03	2.54	2.64	2.02	2.53
207A4	95	148	319	358	206	616	583	166	124	3.60	3.13	3.23	3.40	3.07	2.21	3.01	1.81	3.41
208CA			1757	3738									0.57					
208NP			3215	7987									0.57					
208PR			1085	2695									0.49					
209CA			15912	13457								2.22	3.46					
209NP			23874	20325								2.22	3.46					
209PR			7945	6709								1.73	2.97					
210CA			151	267								2.22	2.22					
210NP			227	401								2.22	2.22					
210PR			74	142								1.98	1.98					
211CO								334	249								3.58	1.27
211CY									469									0.95
211MT									456									1.93
211NO								846	530								4.03	1.47
211NY									942									0.91
211PO								592	257								4.26	4.29
212CA									7316									0.63
212MO									3172									0.63
212NP									15664									0.63
212PR									5359									0.63

Site	Number of irrigations									Days below refill								
	2003	2004	2005	2006	2007	2008	2009	2010	2011	2003	2004	2005	2006	2007	2008	2009	2010	2011
201A1	42	44	54	53	40	42				250	252	212	253	284	290			
201A1							213	211	152							256	206	235
201A2	42	44	54	53	40	42				250	252	212	253	284	290			
201A2							213	210	153							256	203	235
201A3	42	44	54	53	40	42				250	252	212	253	284	290			
201A3							213	210	153							255	205	233
201B1	42	42	47	51	41	42				241	246	219	258	266	256			
201B1							212	210	153							238	192	216
201B2	42	42	47	51	41	42				241	246	219	258	266	256			
201B2							213	211	152							237	189	217
201B3	42	42	47	51	41	42				241	246	219	258	266	256			
201B3							213	211	153							237	195	217
202A1	43	34	48	56	39	24	26	23	13	241	252	239	232	245	259	257	248	267
202A2	43	34	48	56	39	24	26	23	13	241	252	239	232	245	260	257	248	266
202A3	43	34	48	56	38	24	26	23	13	241	252	239	232	246	260	257	248	266
202A4	43	34	48	56	39	24	26	23	13	241	252	239	232	245	260	257	248	267
203A1	30	27	39	35	34	29				279	236	276	248	206	241			
203A2	30	27	39	35	34	29				279	236	276	248	206	241			
203A3	30	27	39	35	34	29				279	236	276	248	206	241			
203A4	30	27	39	35	34	29				279	236	276	248	206	241			
205A1	31	33	35	45	44					266	244	236	212	198				
205A2	31	33	35	41	44					269	246	236	213	196				
205A3	31	33	35	41	44					267	246	236	213	196				
205A4	31	33	35	41	44					267	246	236	212	196				
205B1	42	41	55	43	55					270	265	226	216	199				
205B2	42	41	55	43	55					270	265	226	216	199				
205B3	42	41	55	43	55					270	265	226	216	199				
205C1						191	189	201	169						128	170	207	195
205C2						192	191	200	178						127	170	123	184
205CE						193	197	200	174						119	123	118	176
205CF						192	181	216	177						126	160	121	180
205N1						191	189	194	166						127	171	143	183
205N2						191	196	196	174						127	147	137	176
205NE						193	192	206	175						119	164	131	170
205NF						192	196	214	177						126	158	125	166
205P1						192	190	203	168						126	171	209	196
205P2						191	196	202	178						127	157	119	183
205PE						193	193	200	173						119	161	120	177
205PF						192	194	216	178						126	167	116	189

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Site	Number of irrigations									Days below refill								
	2003	2004	2005	2006	2007	2008	2009	2010	2011	2003	2004	2005	2006	2007	2008	2009	2010	2011
2062C									30									234
2062E									30									234
2062F									30									234
2062N									30									234
2062S									30									234
2063C								184	172								149	180
2063N								184	173								150	179
2063P								184	173								151	178
206A1		29	31	34	35	36					230	239	266	264	223			
206A9		29	31	34	34						230	239	256	264				
206B1		29	31	34	35	36					230	239	256	263	223			
206B9		29	31	34	34						230	239	266	264				
206C1		29	31	34	35	36					230	239	256	263	223			
206C5									173									196
206C6									173									194
206C9		29	31	34	34						230	239	266	264				
206D9		29	31	34	34						230	239	256	264				
206N5									173									195
206N6									173									194
206NC							32	32	30							258	239	233
206NN							32	32	30							258	239	233
206NP							32	32	30							258	239	233
206P5									173									195
206P6									173									194
207A1	31	27	31	28	30	30	31	44	10	252	231	223	229	265	276	255	238	279
207A2	31	27	31	28	30	30	31	44	10	252	231	223	229	265	275	255	238	281
207A3	31	27	31	28	30	30	31	44	10	252	231	223	229	265	276	255	238	279
207A4	31	27	31	28	30	30	31	44	10	252	231	223	229	265	276	255	238	279
208CA			265	277								263	273					
208NP			265	277								258	261					
208PR			265	277								258	261					
209CA			239	272								109	129					
209NP			239	272								109	120					
209PR			239	272								108	120					
210CA			218	235								245	264					
210NP			218	235								245	264					
210PR			218	235								245	254					
211CO								218	176								196	212
211CY									176									209
211MT									176									211
211NO								222	176								185	208
211NY									176									209
211PO								231	176								170	209
212CA									148									206
212MO									148									182
212NP									148									177
212PR									148									181

Site	Cost of water ($/ML)									Crop production per megalitre (t/ML)								
	2003	2004	2005	2006	2007	2008	2009	2010	2011	2003	2004	2005	2006	2007	2008	2009	2010	2011
201A1	70	74	76	79	79	144				0.21	0.24	0.27	0.08	0.25	0.08			
201A1							175	76	134							0.28	0.25	0.25
201A2	70	74	76	79	79	144				0.21	0.24	0.27	0.08	0.28	0.08			
201A2							175	77	130							0.33	0.24	0.19
201A3	70	74	76	79	79	144				0.21	0.24	0.27	0.08	0.22	0.05			
201A3							174	77	134							0.12	0.16	0.11
201B1	70	74	76	79	79	146					0.02	0.12	0.06	0.22	0.09			
201B1							175	76	131							0.28	0.23	0.11
201B2	70	74	76	79	79	146					0.02	0.12	0.06	0.22	0.08			
201B2							174	76	135							0.28	0.21	0.06
201B3	70	74	76	79	79	146					0.02	0.12	0.06	0.14	0.05			
201B3							174	76	133							0.12	0.17	0.05
202A1	80	84	81	68	81	210	260	107	92	0.28	0.24	0.34	0.13	0.23	0.20	0.27	0.22	0.47
202A2	80	81	81	68	81	210	260	107	98	0.16	0.19	0.20	0.17	0.23	0.10	0.16	0.09	0.31
202A3	80	82	80	81	81	210	260	107	91	0.13	0.12	0.16	0.12	0.26	0.08	0.23	0.14	0.38
202A4	80	81	78	68	81	210	260	107	80	0.04	0.05	0.15		0.19	0.10	0.20	0.18	0.64
203A1	46	48	76	79	79	617				0.15	0.04	0.13	0.10	0.24	0.06			
203A2	46	48	76	79	77	617				0.07	0.07	0.07	0.10	0.13	0.08			
203A3	46	48	76	79	77	617				0.14	0.10	0.16	0.20	0.23	0.13			
203A4	46	48	76	79	76	617				0.13	0.10	0.17	0.16	0.26	0.09			
205A1	15	17	18	17	13					0.18	0.15	0.19	0.09	0.21				
205A2	15	17	18	18	13					0.10	0.14	0.12	0.09	0.22				
205A3	15	17	18	18	13					0.19	0.17	0.14	0.09	0.12				
205A4	15	17	18	18	13					0.16	0.18	0.19	0.09	0.13				
205B1	15	17	18	18	13					0.15	0.16	0.16	0.17	0.23				
205B2	15	17	18	18	13					0.16	0.18	0.10	0.17	0.21				
205B3	15	17	18	18	13					0.11	0.17	0.13	0.17	0.13				
205C1						77	359	511	18						0.22	0.35	0.41	0.33
205C2						74	348	324	18						0.18	0.29	0.22	0.35
205CE						72	316	318	18						0.20	0.25	0.29	0.32
205CF						77	358	334	18						0.20	0.19	0.15	0.33
205N1						77	360	349	18						0.22	0.27	0.31	0.22
205N2						76	336	346	18						0.20	0.20	0.25	0.20
205NE						72	338	325	18						0.18	0.22	0.25	0.18
205NF						77	345	347	18						0.24	0.19	0.22	0.26
205P1						76	359	510	18						0.15	0.22	0.34	0.19
205P2						76	341	330	18						0.14	0.20	0.24	0.18
205PE						72	337	313	18						0.13	0.18	0.08	0.25
205PF						77	357	334	18						0.16	0.21	0.20	0.33

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Site	Cost of water ($/ML)									Crop production per megalitre (t/ML)								
	2003	2004	2005	2006	2007	2008	2009	2010	2011	2003	2004	2005	2006	2007	2008	2009	2010	2011
2062C									18									0.22
2062E									18									0.29
2062F									18									0.20
2062N									18									0.14
2062S									18									0.14
2063C								64	18								0.22	0.43
2063N								64	18								0.21	0.27
2063P								65	18								0.18	0.42
206A1		17	18	23	13	401					0.26	0.22	0.20	0.29	0.25			
206A9		17	18	18	13						0.21	0.22	0.16	0.22				
206B1		17	18	23	13	401					0.25	0.07	0.17	0.21	0.21			
206B9		17	18	18	13						0.11	0.13	0.13	0.18				
206C1		17	18	23	13	401					0.22	0.23	0.20	0.32	0.26			
206C5									18									0.44
206C6									18									0.48
206C9		17	18	18	13						0.19	0.19	0.16	0.06				
206D9		17	18	18	13						0.19	0.19	0.08	0.24				
206N5									18									0.44
206N6									18									0.40
206NC							221	64	18							0.25	0.28	0.37
206NN							228	64	18							0.27	0.31	0.20
206NP							221	64	18							0.21	0.21	0.31
206P5									18									0.28
206P6									18									0.29
207A1	15	17	18	18	13	84	64	13	18	0.21	0.19	0.21	0.23	0.30	0.28	0.33	0.24	0.82
207A2	15	17	18	18	13	84	64	13	18	0.27	0.30	0.25	0.34	0.43	0.36	0.49	0.29	0.58
207A3	15	17	18	18	13	84	64	13	18	0.22	0.24	0.19	0.16	0.15	0.19	0.19	0.15	0.41
207A4	15	17	18	18	13	84	64	13	18	0.29	0.25	0.22	0.23	0.22	0.16	0.21	0.14	0.55
208CA			18	18									0.08					
208NP			18	18									0.08					
208PR			18	18									0.07					
209CA			18	18								0.15	0.24					
209NP			18	18								0.15	0.24					
209PR			18	18								0.12	0.21					
210CA			18	18								0.42	0.40					
210NP			18	18								0.42	0.40					
210PR			18	18								0.38	0.35					
211CO								14	25								0.31	0.15
211CY									25									0.11
211MT									25									0.23
211NO								14	25								0.33	0.18
211NY									25									0.11
211PO								14	25								0.33	0.51
212CA									20									0.07
212MO									17									0.06
212NP									2									0.06
212PR									17									0.06

Site	Gross return per megalitre ($/ML)									Cost of water per tonne of almond ($/t)								
	2003	2004	2005	2006	2007	2008	2009	2010	2011	2003	2004	2005	2006	2007	2008	2009	2010	2011
201A1	1325	1422	2253	561	1768	406				387	353	323	1114	353	1971			
201A1							1269	1268	1019							664	356	583
201A2	1244	1422	2253	591	1938	406				387	353	323	1056	322	1843			
201A2							1483	1183	769							568	387	752
201A3	1244	1422	2253	591	1507	271				387	353	323	1056	369	2953			
201A3							532	803	453							1578	571	1316
201B1		145	991	437	1559	462					3473	734	1430	357	1748			
201B1							1270	1168	433							663	390	1347
201B2		145	991	437	1560	416					3473	734	1430	400	1943			
201B2							1262	1061	232							666	429	2572
201B3		145	991	437	992	277					3473	734	1430	630	2914			
201B3							532	849	207							1580	537	2854
202A1	1668	1420	2859	835	1757	1061	1220	1075	1860	329	403	276	621	394	1088	1001	557	232
202A2	979	1123	1717	1080	1757	522	706	449	1223	560	494	457	479	394	2210	1730	1461	416
202A3	807	726	1344	763	1957	398	1025	695	1533	679	770	579	787	354	2900	1191	863	278
202A4	264	277	1269		1405	539	881	912	2541	2075	2061	600		493	2141	1387	657	151
203A1	976	235	1109	737	1751	325				396	1549	675	776	448	10336			
203A2	421	408	591	688	959	428				839	898	1265	1060	798	7845			
203A3	882	567	1368	1459	1644	653				422	639	547	514	447	4920			
203A4	846	630	1442	1171	1854	488				447	590	519	667	412	6886			
205A1	1051	886	1701	551	1459					181	231	182	396	139				
205A2	573	817	1039	576	1250					332	250	297	387	135				
205A3	1114	1008	1276	576	669					171	203	242	387	247				
205A4	955	1095	1701	576	743					199	187	182	387	224				
205B1	893	980	1476	1065	1571					213	209	209	209	129				
205B2	952	1064	929	1065	1209					200	164	332	209	140				
205B3	660	1043	1203	1065	696					288	196	257	209	237				
205C1						1271	1554	2060	1313						436	1106	1297	143
205C2						1032	1318	1118	1394						522	1267	1552	134
205CE						1142	1141	1425	1264						463	1337	1199	149
205CF						1128	853	736	1317						493	2011	2429	143
205N1						1237	1212	1567	890						447	1423	1189	212
205N2						1118	908	1231	801						493	1782	1501	235
205NE						1046	1005	1227	725						505	1616	1417	260
205NF						1362	860	1092	1049						408	1924	1697	179
205P1						854	1006	1685	765						647	1708	1584	246
205P2						793	895	1179	733						695	1832	1500	257
205PE						731	797	421	995						723	2033	3997	189
205PF						909	923	1001	1324						614	1852	1787	55

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Site	Gross return per megalitre ($/ML)									Cost of water per tonne of almond ($/t)								
	2003	2004	2005	2006	2007	2008	2009	2010	2011	2003	2004	2005	2006	2007	2008	2009	2010	2011
2062C									886									265
2062E									1146									205
2062F									812									288
2062N									543									431
2062S									573									409
2063C								1098	1701								335	68
2063N								1045	1081								354	107
2063P								877	1663								423	69
206A1		1532	1907	1304	2123	1407					124	143	185	93	1683			
206A9		1244	1903	1024	1596						153	143	206	125				
206B1		1476	557	1111	1599	1190					129	488	217	129	1991			
206B9		688	1123	861	1319						276	242	245	151				
206C1		1298	1982	1304	2309	1489					147	137	185	86	1590			
206C5									1774									65
206C6									1921									60
206C9		1114	1609	1033	419						171	169	204	492				
206D9		1114	1609	512	1760						171	169	412	113				
206N5									1769									65
206N6									1589									73
206NC							1119	1393	1498							1002	359	156
206NN							1203	1534	780							959	331	300
206NP							932	1060	1255							1203	472	187
206P5									1129									102
206P6									1172									98
207A1	1355	673	1792	1582	2140	1470	1503	1197	3286	139	168	160	153	100	355	239	138	48
207A2	1718	1054	2118	2349	3133	1874	2194	1470	2338	110	107	136	103	68	278	164	112	67
207A3	1421	866	1574	1103	1115	967	841	760	1633	133	131	184	219	198	539	428	217	96
207A4	1840	875	1849	1630	1630	842	959	686	2203	102	129	156	148	131	619	375	241	71
208CA				586									579					
208NP				586									579					
208PR				504									673					
209CA			1290	1689								305	194					
209NP			1290	1689								305	194					
209PR			1005	1450								392	226					
210CA			3577	2772								114	122					
210NP			3577	2772								114	122					
210PR			3191	2472								128	137					
211CO								1392	607								110	308
211CY									450									415
211MT									919									204
211NO								1496	700								102	267
211NY									435									430
211PO								1477	2041								104	92
212CA									271									825
212MO									229									922
212NP									229									664
212PR									230									921

Site	Gross return per $ water input									Application efficiency (%)								
	2003	2004	2005	2006	2007	2008	2009	2010	2011	2003	2004	2005	2006	2007	2008	2009	2010	2011
201A1	17	17	26	6	20	3				73	79	72	75	84	89			
201A1							7	14	7							95	82	86
201A2	16	17	26	7	22	3				73	79	72	75	83	89			
201A2							8	13	5							95	81	86
201A3	16	17	26	7	19	2				73	79	72	75	84	89			
201A3							3	9	3							95	82	86
201B1		2	12	5	20	3				66	76	79	78	75	88			
201B1							7	13	3							93	81	82
201B2		2	12	5	18	3				66	76	79	78	75	88			
201B2							7	12	2							93	80	84
201B3		2	12	5	11	2				66	76	79	78	74	88			
201B3							3	9	1							93	81	84
202A1	18	15	31	11	19	5	5	9	17	65	74	72	67	64	75	87	85	76
202A2	11	12	19	14	19	2	3	3	10	65	74	72	67	64	75	87	85	76
202A3	9	8	15	8	21	2	4	6	14	65	73	72	67	64	75	87	85	78
202A4	3	3	14		15	2	3	8	27	65	72	72	67	64	75	87	85	74
203A1	17	4	13	9	16	1				81	88	76	77	82	90			
203A2	7	7	7	7	9	1				81	88	76	77	81	90			
203A3	15	9	15	14	16	1				81	88	76	77	78	90			
203A4	14	10	16	11	18	1				81	88	76	77	78	90			
205A1	33	26	50	16	49					57	60	49	45	49				
205A2	18	24	30	17	42					57	62	51	48	49				
205A3	35	30	37	17	22					59	62	51	48	49				
205A4	30	32	50	17	25					59	62	51	47	49				
205B1	28	29	43	31	53					70	69	54	60	53				
205B2	30	37	27	31	41					70	69	55	60	52				
205B3	21	31	35	31	23					70	69	55	60	53				
205C1						13	4	4	28						75	76	79	76
205C2						11	4	3	30						74	76	69	75
205CE						12	3	4	27						69	70	67	71
205CF						12	2	2	28						74	74	69	74
205N1						13	3	4	19						75	76	72	75
205N2						12	3	3	17						74	74	71	72
205NE						11	3	4	15						69	73	68	70
205NF						14	2	3	22						74	76	72	72
205P1						9	3	3	16						74	76	80	76
205P2						8	3	3	16						74	75	68	75
205PE						8	2	1	21						69	73	65	71
205PF						9	2	3	73						74	77	70	75

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Site	Gross return per $ water input									Application efficiency (%)								
	2003	2004	2005	2006	2007	2008	2009	2010	2011	2003	2004	2005	2006	2007	2008	2009	2010	2011
2062C									15									69
2062E									20									69
2062F									14									69
2062N									9									69
2062S									10									69
2063C								15	59								69	79
2063N								14	38								70	78
2063P								12	58								70	78
206A1		48	60	35	78	3					65	60	60	59	34			
206A9		39	60	32	58						63	58	59	58				
206B1		47	17	30	58	3					63	58	59	57	34			
206B9		22	35	27	48						65	60	60	60				
206C1		41	62	35	84	4					63	58	59	57	35			
206C5									61									84
206C6									67									83
206C9		35	50	32	15						65	60	60	60				
206D9		35	50	16	64						63	58	59	58				
206N5									61									84
206N6									55									83
206NC							5	14	26							69	66	69
206NN							5	15	13							69	66	69
206NP							4	11	21							69	66	69
206P5									39									84
206P6									41									83
207A1	46	21	53	46	73	15	19	36	84	85	79	64	60	71	74	71	78	71
207A2	58	33	62	68	106	19	27	45	60	85	79	64	60	71	74	71	78	68
207A3	48	27	46	32	38	10	11	23	42	85	79	64	60	71	74	71	78	71
207A4	63	28	54	47	55	8	12	21	56	85	79	64	60	71	74	71	78	71
208CA				12								95	91					
208NP				12								94	87					
208PR				10								94	87					
209CA			28	36								59	65					
209NP			28	36								59	64					
209PR			22	31								58	64					
210CA			75	57								94	90					
210NP			75	57								94	90					
210PR			67	51								94	89					
211CO								41	13								86	89
211CY									10									89
211MT									20									89
211NO								44	15								83	89
211NY									9									89
211PO								43	44								78	89
212CA									5									81
212MO									4									72
212NP									6									71
212PR									4									71

Site	Yield per volume of drainage (t/ML)									Cost of drainage per tonne of almond ($/t)								
	2003	2004	2005	2006	2007	2008	2009	2010	2011	2003	2004	2005	2006	2007	2008	2009	2010	2011
201A1	0.8	1.1	0.9	0.3	1.6	0.7				103.1	74.0	90.6	278.2	56.2	214.5			
201A1							6.1	1.4	1.9							30.9	64.2	80.1
201A2	0.8	1.1	0.9	0.3	1.6	0.7				103.1	74.0	90.6	263.7	54.8	200.6			
201A2							7.1	1.3	1.4							26.5	73.5	105.0
201A3	0.8	1.1	0.9	0.3	1.4	0.5				103.1	74.0	90.6	263.7	58.7	321.4			
201A3							2.5	0.9	0.8							75.9	102.7	186.9
201B1		0.1	0.5	0.3	0.9	0.7					822.5	157.2	318.3	88.3	217.9			
201B1							4.3	1.2	0.6							43.3	75.2	241.2
201B2		0.1	0.5	0.3	0.9	0.6					822.5	157.3	318.3	99.2	242.1			
201B2							4.2	1.1	0.4							44.8	84.2	415.4
201B3		0.1	0.5	0.3	0.5	0.4					820.9	157.2	318.3	166.4	363.2			
201B3							1.8	0.9	0.3							106.3	103.6	464.8
202A1	0.8	0.9	1.2	0.4	0.7	0.8	2.0	1.5	1.9	114.2	103.4	77.1	202.3	140.3	270.2	133.1	82.0	56.5
202A2	0.5	0.7	0.7	0.5	0.7	0.4	1.2	0.6	1.3	194.7	126.8	128.1	156.2	140.7	545.7	231.8	214.8	101.2
202A3	0.4	0.5	0.6	0.4	0.7	0.3	1.7	0.9	1.7	236.0	204.2	162.1	256.5	126.1	716.2	158.5	126.9	62.0
202A4	0.1	0.2	0.5		0.5	0.4	1.5	1.2	2.5	721.2	572.1	167.8		175.4	528.8	184.5	96.7	38.8
203A1	0.8	0.3	0.6	0.4	1.3	0.6				76.8	178.6	162.6	180.1	81.9	1029			
203A2	0.4	0.6	0.3	0.4	0.7	0.8				162.9	103.6	304.8	245.9	150.9	780.6			
203A3	0.7	0.8	0.7	0.9	1.0	1.3				82.0	73.7	131.8	119.3	98.4	489.6			
203A4	0.7	0.9	0.7	0.7	1.2	0.9				86.7	68.1	125.1	154.9	90.6	685.1			
205A1	0.4	0.4	0.4	0.2	0.4					78.2	91.2	92.0	217.2	71.7				
205A2	0.2	0.4	0.2	0.2	0.4					143.4	93.9	146.1	202.9	69.4				
205A3	0.5	0.5	0.3	0.2	0.2					70.0	76.1	119.1	202.9	126.7				
205A4	0.4	0.5	0.4	0.2	0.3					81.7	70.1	89.3	204.0	114.7				
205B1	0.5	0.5	0.4	0.4	0.5					63.0	64.5	96.1	84.7	60.8				
205B2	0.5	0.6	0.2	0.4	0.4					59.1	50.7	148.5	84.7	67.4				
205B3	0.4	0.6	0.3	0.4	0.3					85.2	60.6	114.7	84.7	111.6				
205C1						0.9	1.5	2.0	1.4						110.5	260.5	271.3	34.4
205C2						0.7	1.2	0.7	1.4						135.2	305.7	486.6	33.1
205CE						0.7	0.8	0.9	1.1						141.7	402.8	399.2	43.3
205CF						0.8	0.7	0.5	1.3						128.0	513.1	754.1	36.6
205N1						0.9	1.1	1.1	0.9						113.7	336.2	334.7	53.9
205N2						0.8	0.8	0.9	0.7						128.1	460.6	431.0	65.1
205NE						0.6	0.8	0.8	0.6						154.7	429.7	460.0	78.8
205NF						0.9	0.8	0.8	0.9						106.0	463.2	480.9	50.8
205P1						0.6	1.0	1.7	0.8						165.7	402.2	322.0	59.1
205P2						0.5	0.8	0.7	0.7						180.6	457.1	475.2	63.7
205PE						0.4	0.7	0.2	0.9						221.4	542.2	1401	54.3
205PF						0.6	0.9	0.7	1.3						160.1	432.4	544.4	13.9

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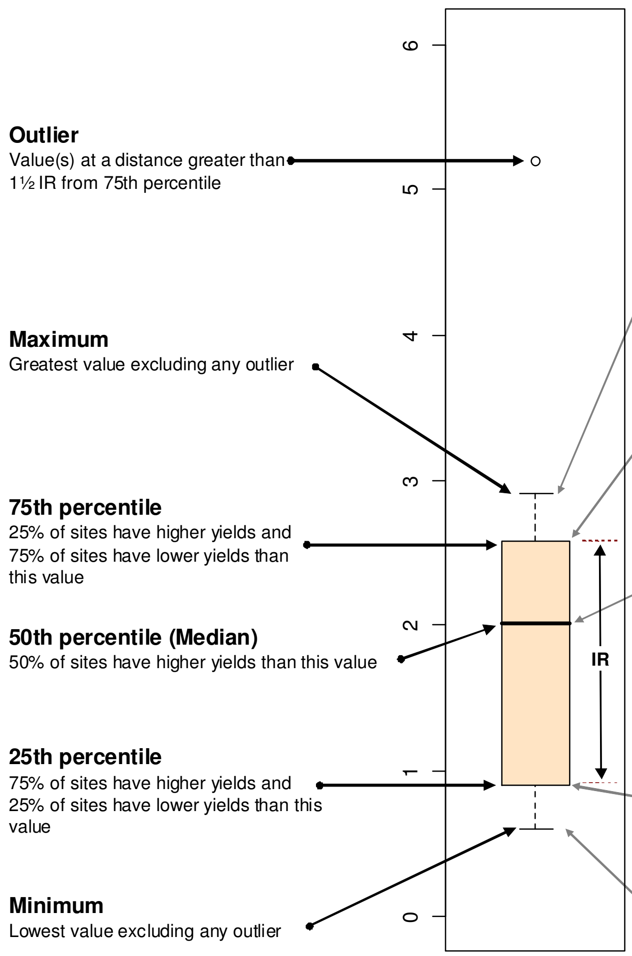
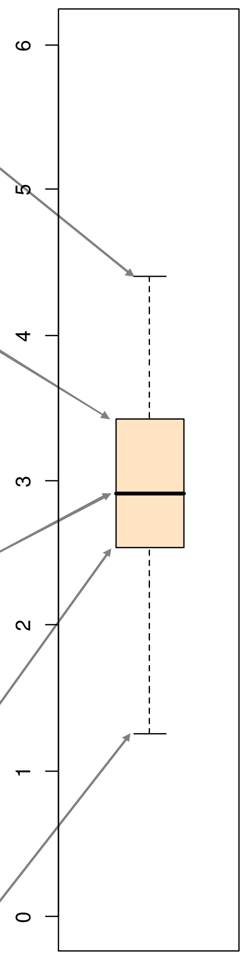
Site	Yield per volume of drainage (t/ML)									Cost of drainage per tonne of almond ($/t)								
	2003	2004	2005	2006	2007	2008	2009	2010	2011	2003	2004	2005	2006	2007	2008	2009	2010	2011
2062C									0.7									81.7
2062E									0.9									63
2062F									0.7									89.0
2062N									0.4									133.0
2062S									0.5									126
2063C								0.7	2.0								102.6	14.6
2063N								0.7	1.2								106.8	23.5
2063P								0.6	1.9								126.5	15.3
206A1		0.7	0.6	0.5	0.7	0.4					43.3	56.6	74.6	38.2	1105			
206A9		0.6	0.5	0.4	0.5						56.1	60.0	84.6	51.9				
206B1		0.7	0.2	0.4	0.5	0.3					47.1	204.4	88.9	55.4	1307			
206B9		0.3	0.3	0.3	0.5						96.7	96.4	99.2	60.0				
206C1		0.6	0.6	0.5	0.7	0.4					53.5	57.4	75.8	37.0	1039			
206C5									2.8									10.5
206C6									2.9									10.1
206C9		0.5	0.5	0.4	0.1						59.7	67.3	82.7	195.5				
206D9		0.5	0.5	0.2	0.6						62.6	71.0	169.2	47.1				
206N5									2.7									10.7
206N6									2.3									12.5
206NC							0.8	0.8	1.2							314.7	123.2	48.2
206NN							0.9	0.9	0.6							301.2	113.5	92.4
206NP							0.7	0.6	1.0							377.8	161.5	57.6
206P5									1.7									16.7
206P6									1.7									16.6
207A1	1.5	0.9	0.6	0.6	1.0	1.1	1.1	1.1	2.8	20.3	34.9	57.6	61.6	29.0	92.7	70.3	29.8	14.0
207A2	1.8	1.4	0.7	0.8	1.5	1.4	1.7	1.4	1.8	16.0	22.3	49.0	41.5	19.8	71.1	48.2	24.3	21.5
207A3	1.5	1.2	0.5	0.4	0.5	0.7	0.6	0.7	1.4	19.4	27.1	65.9	88.4	57.6	137.7	125.6	48.0	27.9
207A4	2.0	1.2	0.6	0.6	0.8	0.6	0.7	0.6	1.9	15.0	26.8	56.1	59.8	38.1	158.2	110.1	52.1	20.6
208CA				0.9									53.5					
208NP				0.6									75.4					
208PR				0.6									87.7					
209CA			0.4	0.7								126.3	68.5					
209NP			0.4	0.7								126.3	69.0					
209PR			0.3	0.6								163.4	80.4					
210CA			6.9	3.9								7.0	12.3					
210NP			6.9	3.9								7.0	12.3					
210PR			6.1	3.3								7.8	14.9					
211CO								2.2	1.4								15.6	32.6
211CY									1.0									45.1
211MT									2.2									21.5
211NO								1.9	1.6								17.5	30.0
211NY									1.0									46.8
211PO								1.5	4.7								23.2	10.0
212CA									0.4									154.0
212MO									0.2									253.7
212NP									0.2									195.8
212PR									0.2									268.0

D. Interpretation of box plots

A box plot is an excellent tool for illustrating the distribution and location of performance indicators for the sites under study. It is very efficient and useful for identifying outliers and for comparing distributions. The figure below describes the different components of a box plot regularly used throughout this report.



Drip irrigation (2008)			Drip irrigation (2009)	
Yield (t/ha)	Site	Index	Site	Yield (t/ha)
5.2	209D1-No	18	205C1-Ca	4.4
2.9	205C1-Ca	17	205C2-Ca	3.8
2.8	205N1-No	16	205CE-Ca	3.7
2.8	205CE-Ca	15	201A2-Ca	3.5
2.6	205N2-No	14	205N1-No	3.4
2.6	205CF-Ca	13	205NE-No	3.0
2.6	205NE-No	12	201B2-Ca	3.0
2.4	205C2-Ca	11	201B1-No	3.0
2.1	205PF-Pe	10	201A1-No	3.0
2.0	205P1-Pe	9	205P1-Pe	2.9
1.8	205P2-Pe	8	205N2-No	2.8
1.8	205PE-Pe	7	205P2-Pe	2.7
1.0	201B1-No	6	205PF-Pe	2.6
0.9	201A2-Ca	5	205NF-No	2.5
0.9	201B2-Ca	4	205CF-Ca	2.4
0.9	201A1-No	3	205PE-Pe	2.4
0.6	201A3-Pr	2	201A3-Pr	1.3
0.6	201B3-Pr	1	201B3-Pr	1.3



IR: Inter-quartile range, i.e. 75th percentile - 25th percentile.

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