Table Grape Irrigation Benchmarking 2002 - 2011

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Table Grape Irrigation Benchmarking

Seasons 2002 - 2011

Prepared for: Department of Sustainability and Environment

Prepared by: Maxine Schache, Richard Ratna and Linda Pollock

Department of Primary Industries

Telephone 03 5051 4500

Email maxine.schache@dpi.vic.gov.au,

linda.pollock@dpi.vic.gov.au

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Executive summary

The DPI Table Grape Irrigation Benchmarking Project was initiated during the season 2001/02. 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 and New South Wales, covering seasons 2002/03 to 2010/11. Examples of the main information gathered for each site were the amount of water used, the variety, the irrigation system and scheduling method used, the pumping and water costs, and the crop yield and gross return.

While the number of growers in the study has remained around 13 to 14 over the years, in season 2010/11 the number of sites (65) and associated area (132.9 ha) have increased by 26 and 72.6 ha respectively when compared to season 2002/03. It should be noted that this is not a representative sample of growers and care must be adopted when attempting to extrapolate the results to the broader irrigation community.

The grape varieties planted at the different sites were Autumn Royal, Calmeria, Cardinal, Crimson Seedless, Flame Seedless, Ohanez, Menindee Seedless, Rally Seedless, Red Emperor, Red Globe, Thompson Seedless and Zante Currant.

The extreme rainfall events experienced by many table grape growers in the 2010-2011 irrigation season led to many sites in this study being water logged or prone to high disease pressure, both of which led to lower quality and yields.

The average yield of all varieties for drip irrigated sites in 2011 (5.7 t/ha) was less than half that of 2010, and 21.8 t/ha lower compared to the average of 2009. In the case of low level irrigated sites, the average yield in 2011(5.4 t/ha) was 8.6 t/ha and 18.5 t/ha lower than the averages of 2010 and 2009 respectively.

For the first time since 2005 there were more participants using capacitance probes (27) than reported experience (18) as their scheduling method. There was virtually no difference in the average water applied for each of the scheduling methods reported in 2011Irrespective of the irrigation scheduling method used, the seasonal averages in 2011 were among the lowest of the nine seasons studied.

The median values for water applied for drip (4.01 Ml/ha) and low level (4.27 Ml/ha) irrigated sites were very similar in the 2011 season. In 2011 75% of the low level sites used 4.57 Ml/ha or less while 4.61 Ml/ha was the median for the drip irrigated sites. The medians for the previous two years for low level irrigated sites were 9.21 Ml/ha in 2010 and 8.31 Ml/Ha in 2009 and 6.59 Ml/ha and 7.39 Ml/ha for drip irrigated sites in the same years.

The season 20010/11 resulted in 13.8% of sites scoring within the target 85-90% application efficiency range with a further 33.8% scoring over 90%. This result indicates that there are still many sites that could improve their timing and amount of irrigation.

The average application efficiencies for sites with drip irrigation were more consistent over the nine years and were also higher than those for low level irrigation. In 2011, the application efficiency for low level irrigation was 21% less than the average for drip irrigation, and 1% below its own nine-year average of 86%. The nine-year averages show that drip irrigated sites had an application efficiency average of 86% while the low level irrigated sites only averaged 74%.

The crop production per megalitre results for both drip (0.55 t/Ml) and low level (0.39t/Ml) irrigated sites were the lowest on record. Despite the drop in water applied for each of the irrigation systems (see Figure 5) the reduced yields (see Figure 4) had a greater influence on these results. The results from previous years ranged from 1.4 t/Ml (2007) to 4.85 t/Ml (2003) for drip irrigated sites and 1.8 t/Ml (2006) to 3.47 t/Ml (2004) for low level irrigated sites. In 2011 the range was greater for drip irrigated sites (0 to 6.9 t/Ml) than for the low level irrigated sites (0 to 4.58 t/Ml).

The results for 2011 shows that both drip (1.4 t/Ml) and low level (1.3t/Ml) irrigated sites average crop production per Megalitre were the lowest on record. Both were well under their long term average with drip 1.1 t/Ml less. The different varieties grown each had an average crop production per Megalitre of water in 2011 lower than in 2010 and all were under their longterm average except for low level irrigated Flame Seedless.

The median value for gross return per megalitre for 2011 ($1107/Ml) was lowest on record, with the previous lowest being $3067/Ml in 2005 compared to the highest of $6753/Ml in 2009. The range of values in 2011 was very large being $0/Ml to $21653/Ml which is the second highest value on record. For only the second time since the start of the project low level irrigated sites ($3976/Ml) showed a higher gross return per megalitre than their drip irrigated counterparts ($3078/Ml). Both the low level (-$560/Ml) and drip (-$1935/Ml) had lower averages in 2011 than their long term averages. Drip irrigated sites have a higher long term average than the low level sites.

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 2001/02 in the table grape industry 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 Centre Pivot Irrigated Potatoes” between the Department of Primary Industries (DPI), Department of Sustainability (DSE) and the Mallee Catchment Management Authority (MCMA). This current annual report contains nine years of data covering seasons 2002/03 to 2010/11.

1.2 Irrigation benchmarking

The DPI Table Grape Irrigation Benchmarking Project aims to identify “best irrigation management practices” in the table grape 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, citrus, potatoes, dried vine fruits and almonds.

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 scheduling methods used
- Irrigation systems used
- Pumping and water costs
- Yields and returns

1.3 Report style

The report style adopted since 2009 ensures a consistent and effective mode of communication and is compliant with the Victorian Government Branding Policy and the 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

Table grape growers from Victoria and New South Wales 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, vine spacing, area of the site, age of vines, irrigation scheduling methods used, soil types and yields. The questions were aimed at developing a better understanding of each grower's level of irrigation performance.

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

While the number of growers has remained relatively stable over the years (Table 1), the number of sites and associated area in 2010/11 has increased by 26 and 72.6 ha respectively when compared to 2002/03. It should be noted this may not be a representative sample of growers 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	13	39	60.3
2003/04	13	39	60.3
2004/05	13	39	70.4
2005/06	14	51	81.3
2006/07	14	45	84.7
2007/08	14	49	99.5
2008/09	14	61	131.7
2009/10	14	64	131.9
2010/11	13	65	132.9

The irrigation systems used included low-level sprinklers, overhead sprinklers, drip and furrow irrigation. The grape varieties planted at the different sites were Autumn Royal, Calmeria, Cardinal, Crimson Seedless, Fantasy, Flame Seedless, Ohanez, Menindee Seedless, Midnight Beauty, Rally Seedless, Red Emperor, Red Globe, Thompson Seedless and Zante Currant.

2.2 Indicators of irrigation performance

The data collected was analysed using the "Irrigation Benchmarking Module", database software 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 from season to season.

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

- Yield
- Irrigation water applied
- Irrigation application efficiency
- Crop production per Megalitre of water applied
- Gross return per Megalitre of water applied
- Cost of water per tonne of fruit
- 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:
  - Yield and 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 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 water 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, 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 Gol Gol, Irymple, Menindee, Merbein, Mildura, Red Cliffs, Robinvale, Sunnycliffs and Yelta as indicated on the map depicted in Figure 1.

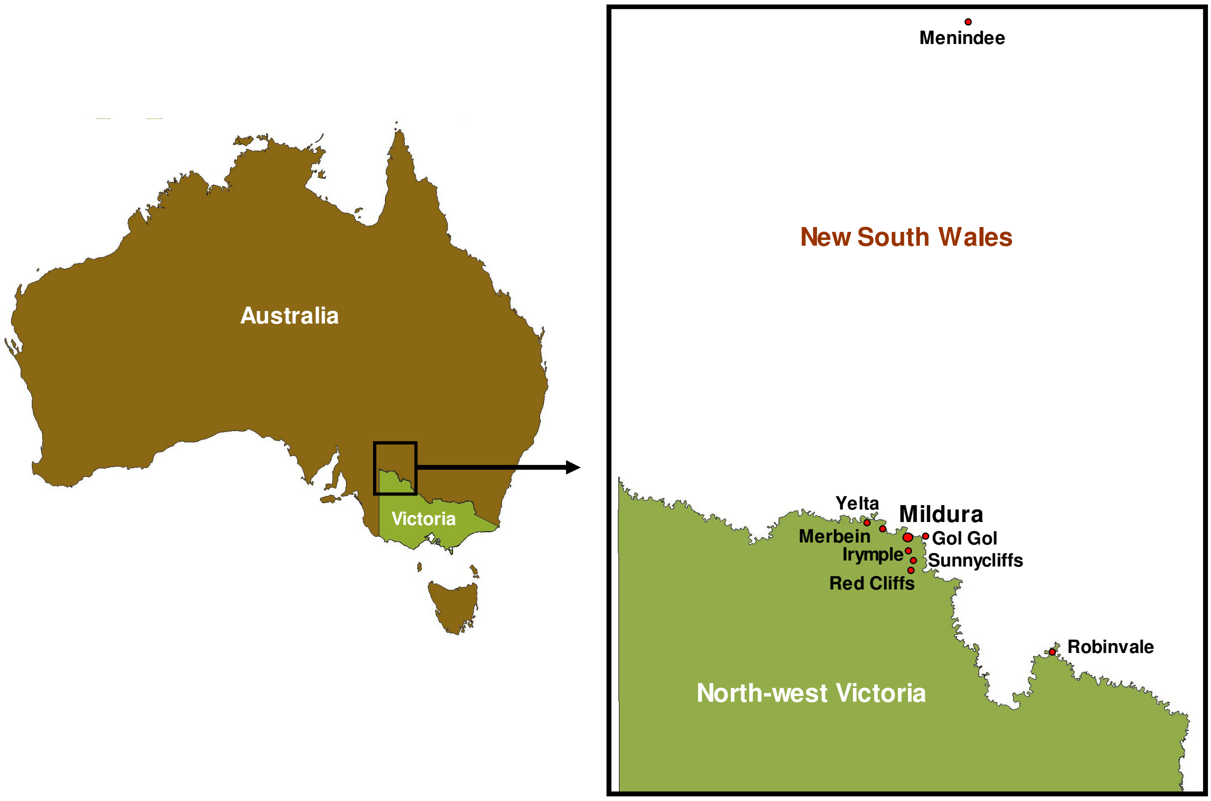


Figure 1: Site locations included in study

3 Results

3.1 Yield and irrigation water applied

The yield and irrigation water applied at all sites for each season are shown as box plots in Figures 2 and 3. The lower and upper ends of the coloured box indicate the 25th and 75th percentiles respectively while the inside band indicates 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 shows the box plot of yields in 2011 was the lowest over the period studied. The yields at many sites were affected by diseases and loss in fruit quality following the extreme rainfall events experienced at many of the sites in this study during summer. Only 25% of sites had yields above 8.6 t/ha in 2011, which is less than half the number of sites that achieved similar or better yields in the year with the second lowest box plot, i.e. 2010. The median yield in 2011 was 1.9 t/ha, while the medians in the other years were 12.6 t/ha (2010), 23.2 t/ha (2009), 15.1 t/ha (2008), 18.8 t/ha (2007), 18.0 t/ha (2006), 22.0 t/ha (2005), 25.0 t/ha (2004) and 24.8 t/ha (2003).

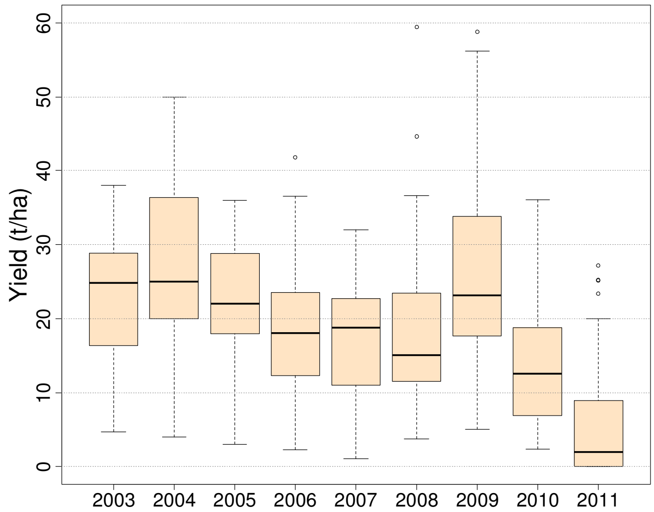


Figure 2: Box plot of yield between 2003 and 2011

In terms of water applied (Figure 3), the results at most sites in 2011 were clearly lower than in the previous years. This was mainly the result of the above normal rainfall events during summer in season 2010/11that satisfied a great part of the peak crop water demand and reduced the need for supplementary irrigation. In 2011, 75% of the sites applied less than 4.6 ML/ha. The median water applied in that year (4.0 ML/ha) was 2.7 ML/ha lower than the median in 2010 (6.7 ML/ha), while the medians in the other years varied between 6.0 ML/ha (2008) and 8.9 ML/ha (2005).

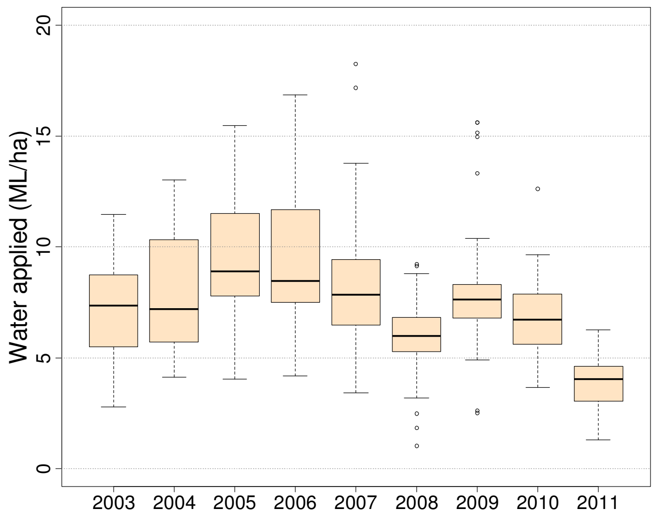


Figure 3: Box plot of water applied between 2003 and 2011

3.1.3 Yield and water applied per irrigation system type

Table 2 shows the number of sites in the study with drip irrigation has considerably increased over the years, i.e. up from 9 in 2002/03 to 57 in 2010/11. Conversely, from 29 sites with low level irrigation in 2002/03, there were only 8 sites left in 2010/11. It should also be noted that there were no longer participants with furrow and overhead irrigation in the study in 2010/11. The changes over the period studied were the results of the adoption of more efficient irrigation systems by many participating sites, and also due to the fact that most newly included sites in the study were drip irrigated, especially in season 2010/11.

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

	Season	Drip	Furrow	Low level	Overhead
	2002/03	9		29	1
	2003/04	9		29	1
Number	2004/05	10		29	
of sites	2005/06	14	7	30	
	2006/07	12		31	2
	2007/08	23		26	
	2008/09	38		23	
	2009/10	53		11	
	2010/11	57		8	
	Total	**225**	**7**	**216**	**4**
	2002/03	6.5		7.6	5.9
Average	2003/04	6.8		8.4	7.6
water	2004/05	7.2		10.0	
applied	2005/06	7.5	8.0	10.8	
(ML/ha)	2006/07	7.0		9.5	3.9
	2007/08	5.2		6.6	
	2008/09	7.0		9.3	
	2009/10	6.5		8.7	
	2010/11	3.8		4.2	
	Average	**5.9**	**8.0**	**8.7**	**5.3**
	2002/03	27.2		23.1	5.0
Average	2003/04	26.0		27.4	16.2
yield	2004/05	19.7		22.3	
(t/ha)	2005/06	13.2	19.7	19.7	
	2006/07	10.9		20.1	13.4
	2007/08	17.3		19.1	
	2008/09	27.5		23.9	
	2009/10	13.5		14.0	
	2010/11	5.7		5.4	
	Average	**15.3**	**19.7**	**21.2**	**12.0**

The seasonal averages of water applied by drip irrigated sites were consistently lower than those of low level irrigated sites over the nine seasons, i.e. 2.8 ML/ha lower on average. In the last season, the high rainfall amount resulted in low average water usage at both drip and low level irrigated sites, i.e. 3.8 ML/ha and 4.2 ML/ha respectively. These values represent only 64% and 48% respectively of their nine-year average.

The average yield for drip (5.7 t/ha) and low level (5.4 t/ha) irrigation systems in 2010/11 were the lowest results so far, i.e. only 37% and 25% respectively of their corresponding nine-year average. The rainy conditions in 2010/11 were conducive to diseases and crop damage, resulting in inferior grape quality and marketable yield for both drip and low level irrigated sites.

The resulting average yield for drip irrigation in 2011(5.7 t/ha) was just over 40% of the previous year's average (13.5 t/ha) and only 37% of the overall average. In the case of low level irrigated sites, the average yield was 5.4t/ha in 2011, 39% of the previous year and only 25% of the overall average. The overall lower nine-year average of drip irrigation was mostly due to its poor results in 2005/06 and 2006/07, when the average yields were respectively 6.4 t/ha and 9.2 t/ha less than the yields of low level irrigation.
The box plots in Figure 4 show the variation of yield at the different sites and irrigation systems in 2009, 2010 and 2011. As can be seen in Figure 4 the medians in 2011 for low level (1.55 t/ha) and drip irrigated sites (1.98t/ha) were the lowest recorded in the nine years of the study. The previous lowest and highest medians recorded for low level irrigated sites were 14.88t/ha in 2010 and 25 t/ha in 2004. The corresponding figures for drip irrigated sites were 9.31t/ha in 2007 and 35.5t/ha in 2003. The yield range for low level irrigated sites in 2011 (0 to 19.91 t/ha) was lower than for the

drip irrigated sites (0 to 27.18 t/ha). The low yields reported were mainly due to high disease pressure brought on by the extreme rainfall events experienced in December 2010 and January and February 2011.

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.

The 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 (ML/ha) in each year.

Drip irrigation used less water than low level irrigation, as shown by the number in the top ranked sites in the last three years.

Figure 5 shows that the median values for water applied for drip (4.01 Ml/ha) and low level (4.27 Ml/ha) irrigated sites were very similar in the 2011 season. In 2011 75% of the low level sites used 4.57 Ml/ha or less while 4.61 Ml/ha was the median for the drip irrigated sites. The medians for the previous two years for low level irrigated sites were 9.21 Ml/ha in 2010 and 8.31 Ml/ha in 2009 and 6.59 Ml/ha and 7.39 Ml/ha for drip irrigated sites in the same years.

The presented results show how the yields at the majority of sites have been affected in 2011. Three of the low level irrigated sites and 11 of the drip irrigated sites reported zero yields in 2011. Eleven of the drip irrigated sites reported increased yields in 2011 compared to 2010, while 25 sites reported decreases. There seems to be no correlation between early and late harvested varieties and yield decreases. There were eight drip irrigated sites in the top ten performing properties in 2011 and only two low level irrigated sites. There seems to be no correlation between variety and rating in the top ten, although both low level sites were Flame Seedless. The range for drip irrigated sites was 0 to 27.2 t/ha and 0 to 19.9 t/ha for low level irrigated sites.

All ten of the top ten ranked sites for water applied were drip irrigated (in fact 16 drip irrigated sites outperformed their low level counterparts).

It is interesting to note that the yield at site 110BC improved from 5.0 t/ha (2009) to 9.2 t/ha (2010) while the water applied changed from 15.6 ML/ha with low level in 2009 to 8.3 ML/ha with drip in 2010. As already pointed out, the absence of an obvious relationship between water applied and yield suggests the influence of confounding factors, e.g. climatic conditions, crop management or water distribution throughout the season.

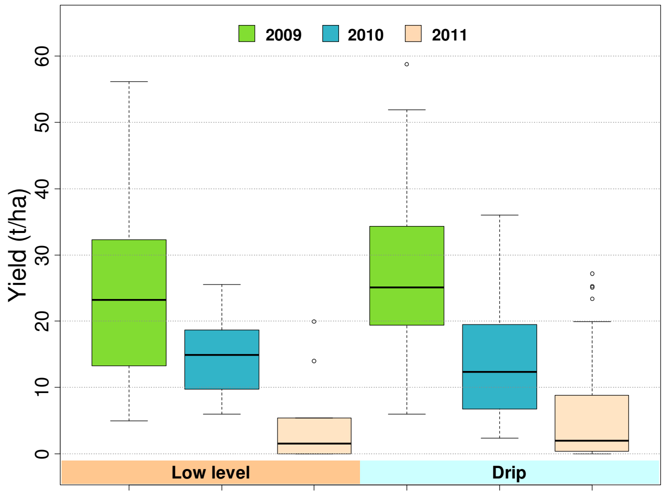


Figure 4: Box plot of yield per irrigation system type for 2009, 2010 and 2011

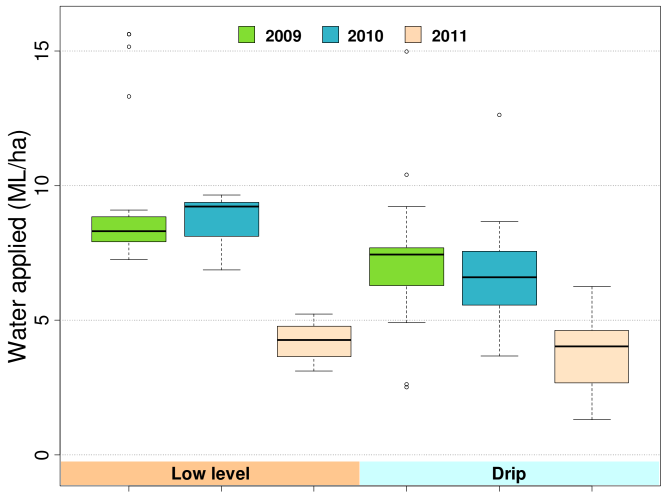
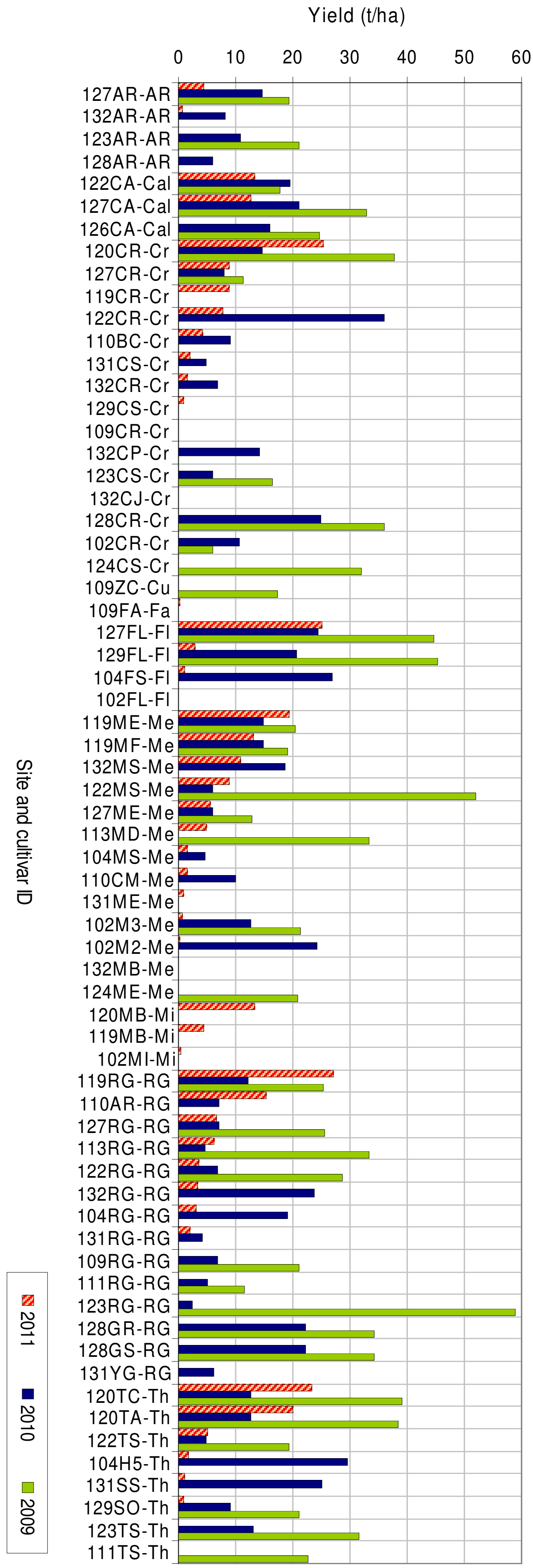


Figure 5: Box plot of water applied per irrigation system type for 2009, 2010 and 2011

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



AR: Autumn Royal, Cal: Calmeria, Cr: Crimson Seedless, Cu: Currant, Fa: Fantasy. Fl: Flame Seedless, Mi: Midnight Beauty, Me: Menindee Seedless, Oh: Ohanez, RG: Red Globe, Th: Thompson Seedless

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

		Yield					
		(t/ha)			Rank*		
	Site	2011	2010	2009	2011	2010	2009
Drip irrigation systems	127AR-AR	4.5	14.6	19.4	26	26	40
	132AR-AR	0.8	8.2		45	41	
	123AR-AR		10.8	21.1	52	34	37
	128AR-AR		6.0			51	
	122CA-Cal	13.4	19.5	17.8	10	14	44
	127CA-Cal	12.6	21.0	32.9	13	12	18
	126CA-Cal		16.1	24.7		20	29
	120CR-Cr	25.3	14.8	37.8	2	25	10
	127CR-Cr	9.0	8.1	11.3	15	42	53
	119CR-Cr	8.9			17		
	122CR-Cr	7.8	36.0		18	1	
	110BC-Cr	4.3	9.2		27	39	
	131CS-Cr	2.0	4.9		33	56	
	132CR-Cr	1.5	6.9		39	45	
	129CS-Cr	0.9			43		
	109CR-Cr	0.0			50		
	132CP-Cr		14.2		52	27	
	123CS-Cr		5.9	16.4	52	54	46
	132CJ-Cr				52		
	128CR-Cr		25.0	35.9		6	13
	102CR-Cr		10.7	6.0		35	58
	124CS-Cr			32.0			21
	109ZC-Cu	0.0		17.4	51		45
	109FA-Fa	0.2			49		
	127FL-Fl	25.1	24.5	44.7	3	7	6
	129FL-Fl	2.9	20.8	45.3	31	13	5
	104FS-Fl	1.0	26.9		41	3	
	102FL-Fl				52		
	119ME-Me	19.4	14.9	20.4	7	23	39
	119MF-Me	13.1	14.9	19.1	12	23	42
	132MS-Me	11.0	18.6		14	18	
	122MS-Me	8.9	6.0	51.9	16	49	4
	127ME-Me	5.5	6.0	13.0	21	49	50
	113MD-Me	5.0		33.4	24		16
	104MS-Me	1.7	4.6		36	59	
	110CM-Me	1.6	10.0		37	36	
	131ME-Me	1.0			42		
	102M3-Me	0.7	12.7	21.4	46	29	33
	102M2-Me	0.3	24.3		48	8	
	132MB-Me				52		
	124ME-Me			21.0			38
	120MB-Mi	13.3			11		
	119MB-Mi	4.6			25		
	102MI-Mi	0.5			47		
	119RG-RG	27.2	12.2	25.4	1	32	28
	110AR-RG	15.3	7.1		8	44	
	127RG-RG	6.7	7.2	25.6	19	43	26
	113RG-RG	6.3	4.7	33.4	20	58	17
	122RG-RG	3.6	6.9	28.7	28	46	24
	132RG-RG	3.4	23.8		29	9	
	104RG-RG	3.1	19.2		30	15	
	131RG-RG	1.9	4.3		34	60	
	109RG-RG		6.8	21.1	52	47	36
	111RG-RG		5.1	11.6	52	55	52
	123RG-RG		2.4	58.8	52	61	1
	128GR-RG		22.2	34.3		10	14
	128GS-RG		22.2	34.3		10	14
	131YG-RG		6.3			48	
	120TC-Th	23.4	12.6	39.2	4	30	8
	120TA-Th	20.0	12.6	38.5	5	30	9
	122TS-Th	5.0	4.8	19.3	23	57	41
	104H5-Th	1.8	29.6		35	2	
	131SS-Th	1.2	25.2		40	5	
	129SO-Th	0.9	9.1	21.1	44	40	35
	123TS-Th		13.2	31.5	52	28	22
	111TS-Th			22.7	52		32

Continued on next page

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

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

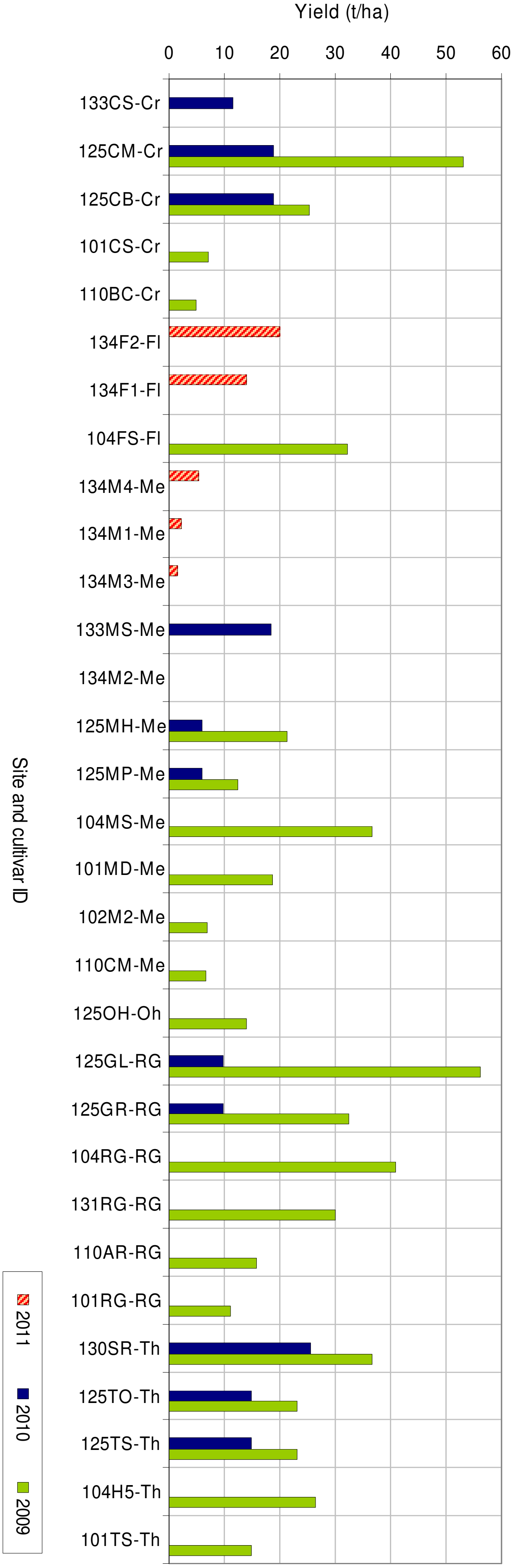


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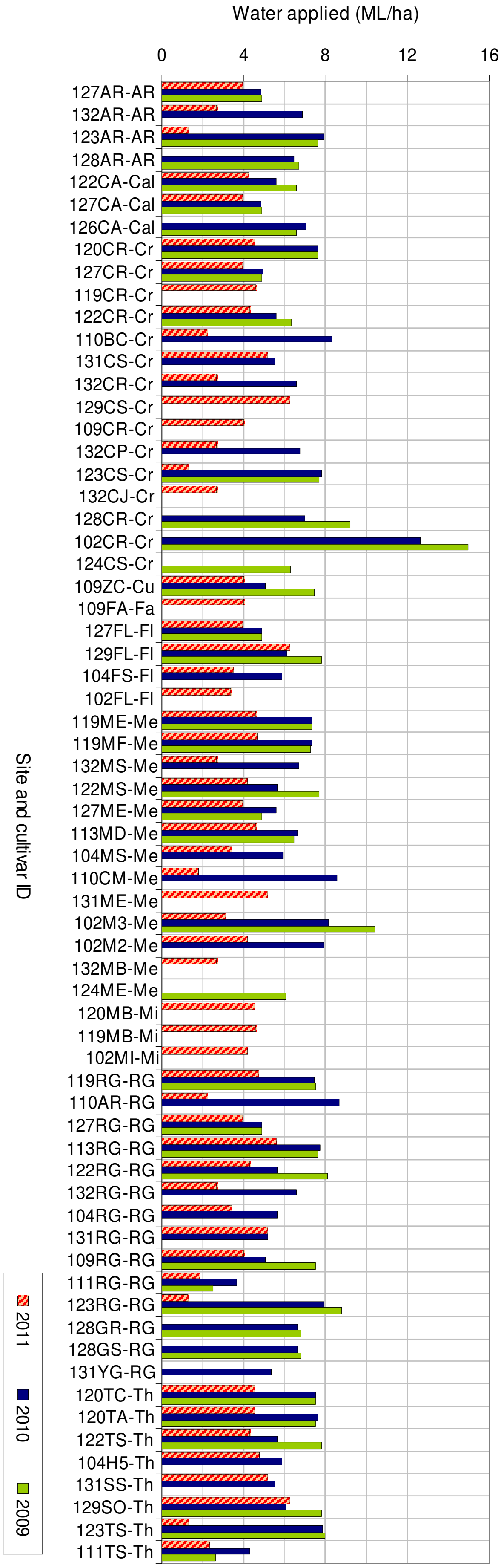
Table 3b: Sites using low level irrigation ranked with respect to the highest yield

Low level irrigation systems

	Yield					
	(t/ha)			Rank**		
Site	2011	2010	2009	2011	2010	2009
133CS-Cr		11.5		52	33	
125CM-Cr		18.8	53.1		16	**3**
125CB-Cr		18.8	25.4		16	27
101CS-Cr			7.1			55
110BC-Cr			5.0			59
134F2-Fl	19.9			**6**		
134F1-Fl	14.0			**9**		
104FS-Fl			32.2			20
134M4-Me	5.4			22		
134M1-Me	2.2			32		
134M3-Me	1.6			38		
133MS-Me		18.5		52	19	
134M2-Me				52		
125MH-Me		5.9	21.4		52	34
125MP-Me		5.9	12.5		52	51
104MS-Me			36.6			12
101MD-Me			18.8			43
102M2-Me			6.9			56
110CM-Me			6.7			57
125OH-Oh			14.0			49
125GL-RG		9.8	56.2		37	**2**
125GR-RG		9.8	32.5		37	19
104RG-RG			40.8			**7**
131RG-RG			30.0			23
110AR-RG			15.8			47
101RG-RG			11.1			54
130SR-Th		25.6	36.7		**4**	11
125TO-Th		14.9	23.2		21	30
125TS-Th		14.9	23.2		21	30
104H5-Th			26.3			25
101TS-Th			15.0			48
Maximum	27.2	36.0	58.8	52	61	59
Median	2.0	12.6	23.2			
Minimum		2.4	5.0			

** Based on all sites, i.e. including sites w ith drip irrigation

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



AR: Autumn Royal, Cal: Calmeria, Cr: Crimson Seedless, Cu: Currant, Fa: Fantasy. Fl: Flame Seedless, Mi: Midnight Beauty, Me: Menindee Seedless, Oh: Ohanez, RG: Red Globe, Th: Thompson Seedless

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	127AR-AR	4.0	4.8	4.9	24	**3**	**3**
	132AR-AR	2.7	6.9		**10**	34	
	123AR-AR	1.3	7.9	7.6	**1**	49	30
	128AR-AR		6.5	6.7		26	15
	122CA-Cal	4.3	5.6	6.6	39	15	13
	127CA-Cal	4.0	4.9	4.9	24	**4**	**3**
	126CA-Cal		7.0	6.6		37	14
	120CR-Cr	4.6	7.6	7.6	45	42	29
	127CR-Cr	4.0	5.0	4.9	24	**7**	**3**
	119CR-Cr	4.6			49		
	122CR-Cr	4.3	5.6	6.3	40	15	11
	110BC-Cr	2.2	8.3		**7**	53	
	131CS-Cr	5.2	5.5		56	13	
	132CR-Cr	2.7	6.6		**10**	27	
	129CS-Cr	6.2			63		
	109CR-Cr	4.0			30		
	132CP-Cr	2.7	6.7		**10**	33	
	123CS-Cr	1.3	7.8	7.7	**1**	47	33
	132CJ-Cr	2.7			**10**		
	128CR-Cr		7.0	9.2		36	55
	102CR-Cr		12.6	15.0		64	58
	124CS-Cr			6.3			**10**
	109ZC-Cu	4.0	5.0	7.4	30	**8**	24
	109FA-Fa	4.0			30		
	127FL-Fl	4.0	4.9	4.9	24	**6**	**3**
	129FL-Fl	6.3	6.1	7.8	64	25	35
	104FS-Fl	3.5	5.9		23	21	
	102FL-Fl	3.4			20		
	119ME-Me	4.6	7.4	7.3	49	39	20
	119MF-Me	4.6	7.3	7.3	53	38	19
	132MS-Me	2.7	6.7		**10**	32	
	122MS-Me	4.2	5.6	7.7	37	17	34
	127ME-Me	4.0	5.6	4.9	24	14	**3**
	113MD-Me	4.6	6.6	6.4	52	29	12
	104MS-Me	3.5	5.9		21	23	
	110CM-Me	1.8	8.6		**5**	56	
	131ME-Me	5.2			56		
	102M3-Me	3.1	8.2	10.4	17	52	56
	102M2-Me	4.2	7.9		37	51	
	132MB-Me	2.7			**10**		
	124ME-Me			6.1			**9**
	120MB-Mi	4.6			45		
	119MB-Mi	4.6			49		
	102MI-Mi	4.2			36		
	119RG-RG	4.7	7.5	7.5	54	40	28
	110AR-RG	2.2	8.7		**8**	57	
	127RG-RG	4.0	4.9	4.9	24	**5**	**3**
	113RG-RG	5.6	7.7	7.6	62	44	31
	122RG-RG	4.3	5.6	8.1	40	17	43
	132RG-RG	2.7	6.6		**10**	27	
	104RG-RG	3.5	5.7		21	20	
	131RG-RG	5.2	5.2		56	**10**	
	109RG-RG	4.0	5.1	7.5	33	**9**	25
	111RG-RG	1.9	3.7	2.5	**6**	**1**	**1**
	123RG-RG	1.3	7.9	8.8	**1**	49	52
	128GR-RG		6.6	6.8		30	16
	128GS-RG		6.6	6.8		30	16
	131YG-RG		5.3			11	
	120TC-Th	4.6	7.5	7.5	45	41	25
	120TA-Th	4.6	7.6	7.5	45	43	25
	122TS-Th	4.3	5.6	7.8	40	17	37
	104H5-Th	4.8	5.9		55	22	
	131SS-Th	5.2	5.5		56	12	
	129SO-Th	6.3	6.0	7.8	64	24	35
	123TS-Th	1.3	7.9	8.0	**1**	48	40
	111TS-Th	2.3	4.3	2.6	**9**	**2**	**2**

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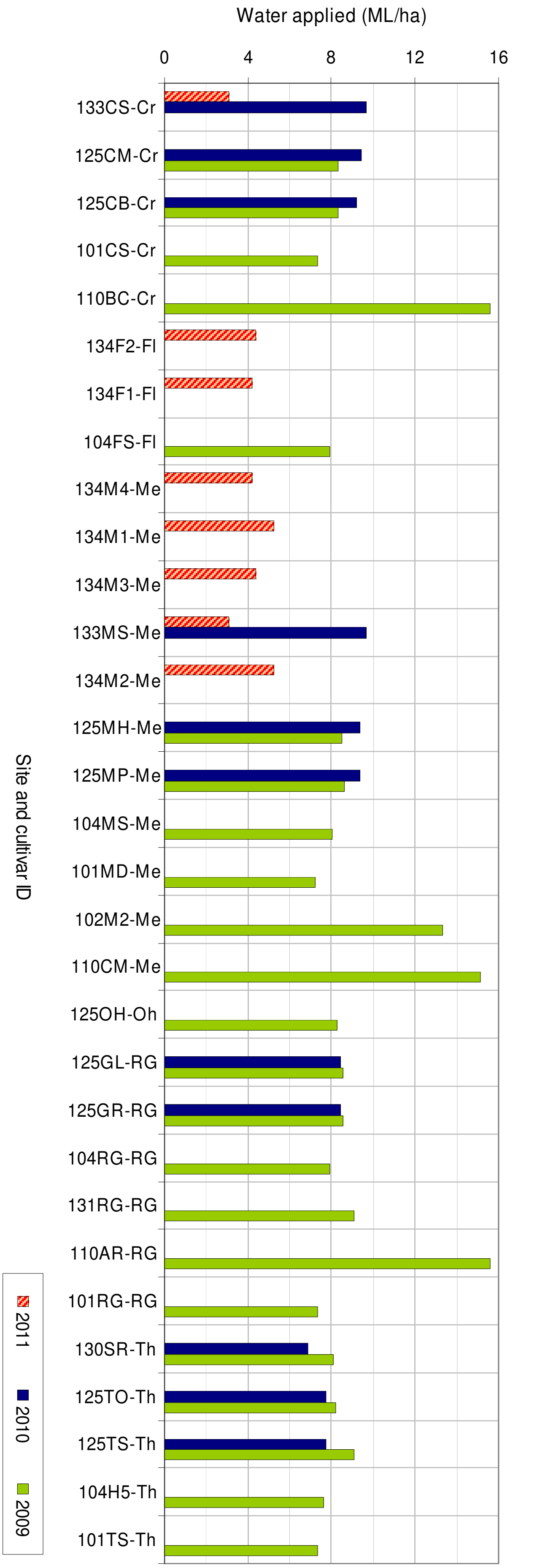
* Based on all sites, i.e. including sites with low level irrigation

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



AR: Autumn Royal, Cal: Calmeria, Cr: Crimson Seedless, Cu: Currant, Fa: Fantasy. Fl: Flame Seedless, Mi: Midnight Beauty, Me: Menindee Seedless, Oh: Ohanez, RG: Red Globe, Th: Thompson Seedless

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	133CS-Cr	3.1	9.7		18	62	
	125CM-Cr		9.4	8.3		61	46
	125CB-Cr		9.2	8.3		58	47
	101CS-Cr			7.3			20
	110BC-Cr			15.6			60
	134F2-Fl	4.4			43		
	134F1-Fl	4.2			34		
	104FS-Fl			7.9			38
	134M4-Me	4.2			34		
	134M1-Me	5.2			60		
	134M3-Me	4.4			43		
	133MS-Me	3.1	9.7		18	62	
	134M2-Me	5.2			60		
	125MH-Me		9.3	8.5		59	48
	125MP-Me		9.3	8.6		59	51
	104MS-Me			8.1			41
	101MD-Me			7.2			18
	102M2-Me			13.3			57
	110CM-Me			15.2			59
	125OH-Oh			8.3			45
	125GL-RG		8.4	8.6		54	49
	125GR-RG		8.4	8.6		54	49
	104RG-RG			7.9			38
	131RG-RG			9.1			53
	110AR-RG			15.6			60
	101RG-RG			7.3			20
	130SR-Th		6.9	8.1		35	42
	125TO-Th		7.8	8.2		45	44
	125TS-Th		7.8	9.1		45	54
	104H5-Th			7.6			31
	101TS-Th			7.3			20
	Maximum	6.3	12.6	15.6	64	64	60
	Median	4.0	6.7	7.6			
	Minimum	1.3	3.7	2.5			

** Based on all sites, i.e. including sites w ith drip irrigation

3.1.4 Yield and water applied per irrigation scheduling method

The method used to schedule irrigation can play an important part in how effectively and efficiently water is applied. Some of the methods used in the present study were tensiometer, capacitance probe, experience and dig or dig-stick.

Table 5 shows that for the first time since 2005 there were more participants using capacitance probes (27) than reported experience (18) as their scheduling method. There was virtually no difference in the average water applied for each of the scheduling methods reported in 2011, with irrigators using capacitance probes averaging 4 Ml/ha, dig stick 3.8 Ml/ha, experience 3.8 Ml/ha and tensiometer 3.6 Ml/ha. These ranged from 2.2 Ml/ha (experience) 0 to 4.7 Ml/ha (dig stick) lower than the previous year and 2.5 Ml/ha (capacitance probes) to 5.2 Ml/ha (dig stick) than the long term averages.

In 2011sites using dig sticks had a much higher average yield (16.6 t/ha) than those using capacitance probes (5.8 t/ha), experience (2.8 t/ha) or tensiometers (1.1 t/ha).Except for those sites using dig sticks, the averages were very much lower in 2011 than the overall averages (10.6 t/ha for capacitance probes, 16.1 t/ha for experience and 18.3 t/ha for tensiometer scheduled sites).

Table 5: Number of sites, average seasonal amount of water applied and yield - Irrigation scheduling method comparison

	Season	Capacitance	Dig	Experience	Tensiometer
Number of sites	2002/03	10		19	10
	2003/04	10		18	11
	2004/05	14	5	10	10
	2005/06	13	5	22	11
	2006/07	7	4	22	11
	2007/08	11	3	17	17
	2008/09	16	3	22	19
	2009/10	12	3	28	20
	2010/11	27	9	18	11
	Total	**120**	**32**	**176**	**120**
Average water applied (ML/ha)	2002/03	6.6		7.8	7.0
	2003/04	6.6		8.8	8.0
	2004/05	8.4	10.3	10.1	9.3
	2005/06	8.4	9.8	9.8	10.2
	2006/07	6.3	13.8	9.0	7.6
	2007/08	5.2	9.0	6.2	5.7
	2008/09	7.7	15.5	6.9	8.0
	2009/10	7.1	8.5	6.0	7.8
	2010/11	4.0	3.8	3.8	3.6
	Average	**6.5**	**9.0**	**7.5**	**7.4**
Average yield (t/ha)	2002/03	23.6		23.0	24.7
	2003/04	22.8		29.2	26.6
	2004/05	18.6	19.4	25.2	23.5
	2005/06	19.6	16.3	18.2	15.9
	2006/07	13.2	22.4	18.6	16.9
	2007/08	21.7	19.0	15.4	19.3
	2008/09	21.1	9.1	28.0	30.4
	2009/10	14.9	8.8	12.8	13.6
	2010/11	5.8	16.6	2.8	1.1
	Average	**16.4**	**16.3**	**18.9**	**19.4**

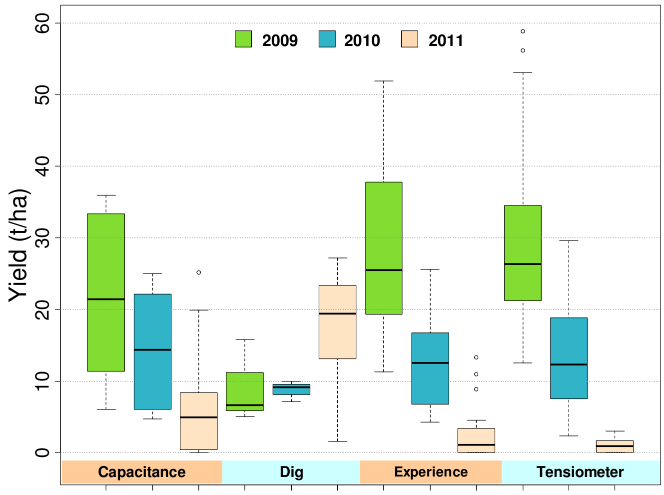


Figure 8: Box plot of yield per irrigation scheduling method for 2009, 2010 and 2011

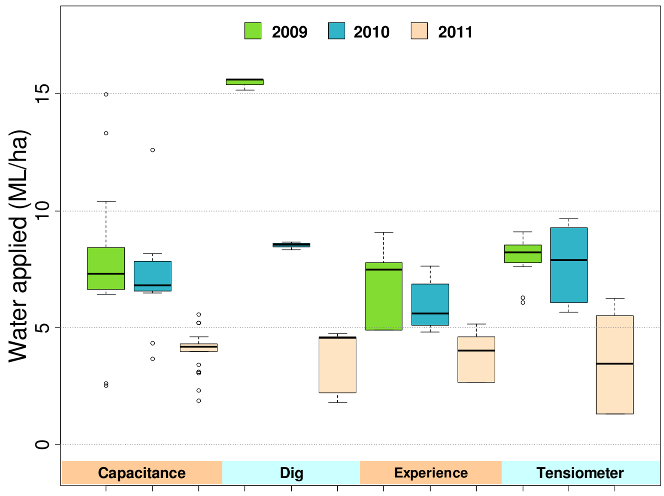


Figure 9: Box plot of water applied per irrigation scheduling method for 2009, 2010 and 2011

Figure 8 shows that in stark contrast to the previous two years, sites using dig sticks had the highest median yield recorded in 2011 (19.43t/ha) and were much higher than the previous two years. All other scheduling methods showed a marked decline in median yields reported. Four of the tensiometer scheduled sites recorded no yield in 2011, with the highest yield recorded being 3t/ha which is approximately one tenth of the maximum yields of previous years. The median yield for irrigations scheduled using experience alone was 1.09t/ha which is an 11.32 t/ha reduction on the next lowest result (recorded in 2010) and 24.39t/ha lower than the highest ever value recorded (2009). 75% of the experience scheduled sites recorded 3t/ha or lower figures in 2011, with the range from 0 to 13.33 t/ha. The median yield in 2011 for capacitance probe scheduled sites was 4.26t/ha.This was the lowest ever recorded figure with 11.7t/ha (2010) being the next lowest and 23.75 t/ha (2003) being the highest. In 2011 75% of the sites recorded a yield of 8.08t/ha or less. The maximum yield in 2011 was 25.13 which was the second lowest recorded.

3.2 Irrigation application efficiency

Application efficiency was 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 standard set of crop coefficients. These figures do not cater for differences between varieties, canopy size, row and vine spacing. The crop coefficients may change as a result of a combination of those variables, and therefore may contribute to differences in the predicted drainage and hence application efficiency calculations.

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, and is therefore a useful guide when comparing sites and properties for the purpose of irrigation benchmarking.

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

From Figure 10 it can be seen that despite the drop in volume of water applied in 2011 (see above), the application efficiency decreased from a median of 89% in 2010 to 83% in 2011. This means that despite more water being applied in 2010 there was more predicted through drainage in 2011. In 2011 75% of the sites had application efficiencies above 75%. For only the second year (with 2006 being the other year) there were sites that recorded 100% application efficiency with 25% of the sites rating 92% or above.

Just over half the application efficiencies in 2011 were below the target range of 85-90% while approximately one in seven sites fell within the target range. 2011 had the third highest number of properties scoring over 90% since the start of the project in 2002. The majority of irrigators draw their water from the Murray which has had extremely good water quality, so the potential build up of salt in the rootzone through lack of leaching will be minimised, the irrigators of these sites should be monitoring soil health to ensure a damaging salt concentration is not reached.

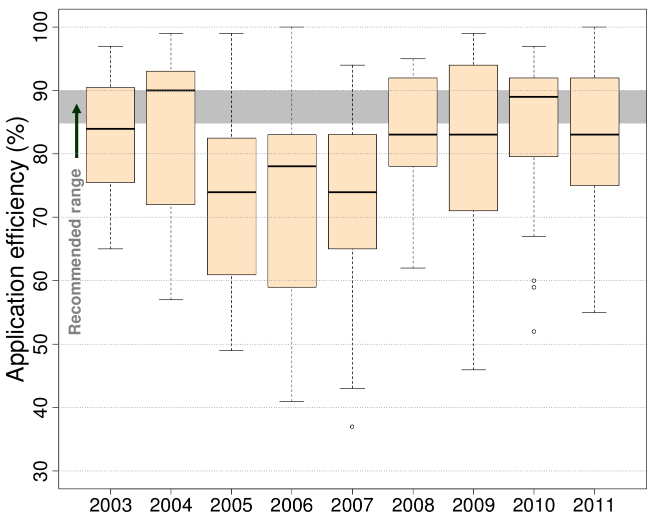


Figure 10: Box plot of irrigation application efficiency between 2003 and 2011

Table 6 shows the percentage of sites that achieved application efficiencies within the recommended 85-90% range and on either side of the 85-90% range over the last nine seasons.

3.2.1 Application efficiency per irrigation system type

Table 7 shows the average application efficiencies for the different irrigation system types. For the third consecutive year drip irrigated sites achieved an average within the recommended 85-90% range. The seasonal averages for drip irrigation were more consistent over the nine years and were also higher than those for low level irrigation each year

In 2011, the application efficiency for low level irrigation was 21% less than the average for drip irrigation, and 1% below its own nine-year average of 86%. The nine-year averages show that drip irrigated sites had an application efficiency average of 86% while the low level irrigated sites only averaged 74%.

The application efficiency per irrigation system type (Figure 11) shows the medians of sites with drip irrigation were higher than the medians of sites with low level irrigation. The box plots also indicate there were many drip irrigated sites that met the target. The highest low level application efficiency value was 71% with half of the properties rating 63.5% or above and 25% rating below 61.5%. Application efficiencies for drip irrigated sites were 81% or better in 75% of the sites.

The box plots show that the range of application efficiencies in 2011 was greater for both low level and drip irrigated sites than in 2010.

Figures 12a and 12b and Tables 8a and 8b compare the last three years' application efficiencies of sites, grouped by irrigation system type and variety. Tables 8a and 8b also present the rank of each site with respect to the highest application efficiency values.

Table 6: 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	15.4	56.4	28.2
2003/04		48.7	51.3
2004/05	10.3	82.1	7.7
2005/06	3.9	90.2	5.9
2006/07	17.8	75.6	6.7
2007/08	18.4	55.1	26.5
2008/09	9.8	54.1	36.1
2009/10	15.6	42.2	42.2
2010/11	13.8	52.3	33.8

Table 7: Average application efficiency - Irrigation system type comparison

Season	Average application efficiency (%)				
	Drip	Furrow	Low level	Overhead	Average
2002/03	86		82	86	**83**
2003/04	88		82	82	**83**
2004/05	83		71		**74**
2005/06	84	74	65		**72**
2006/07	79		68	91	**72**
2007/08	86		81		**83**
2008/09	85		75		**81**
2009/10	87		71		**85**
2010/11	85		64		**83**
Average	**86**	**74**	**74**	**87**	**80**

The application efficiency per irrigation system type (Figure 11) shows the medians of sites with drip irrigation were higher than the medians of sites with low level irrigation.

Figures 12a and 12b and Tables 8a and 8b compare the last three years' application efficiencies of sites, grouped by irrigation system type and variety. Tables 8a and 8b also present the rank of each site with respect to the highest overall application efficiency in each year.

The ranking in Tables 8a and 8b indicate that, irrespective of variety, the sites with the best application efficiencies in 2011 were all using drip irrigation systems. Drip irrigated sites occupied almost all the top rankings in the previous two years, i.e. nine and ten sites in the top ten highest application efficiencies in 2010 and 2009 respectively.

All low level irrigated sites had application efficiencies below the recommended 85-90% range in 2011. The results of most of these sites in 2011 were also lower compared to 2010. This is compounded by a drop in median figures from 2009 to 2010.

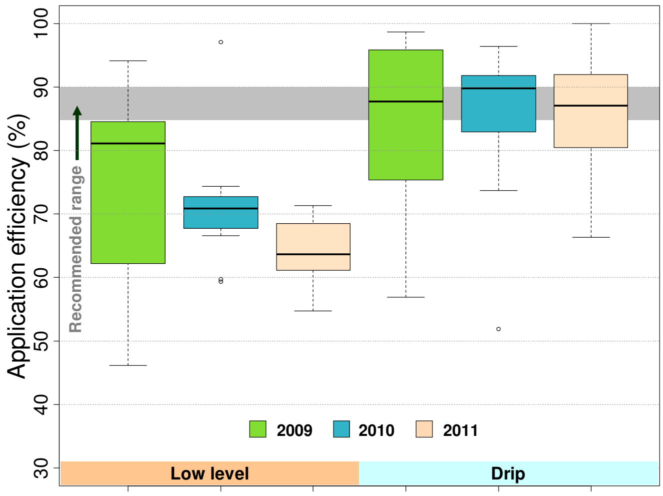


Figure 11: Box plot of irrigation application efficiency per irrigation system type for 2009, 2010 and 2011

Figure 12a: Application efficiency at sites using drip irrigation grouped by variety

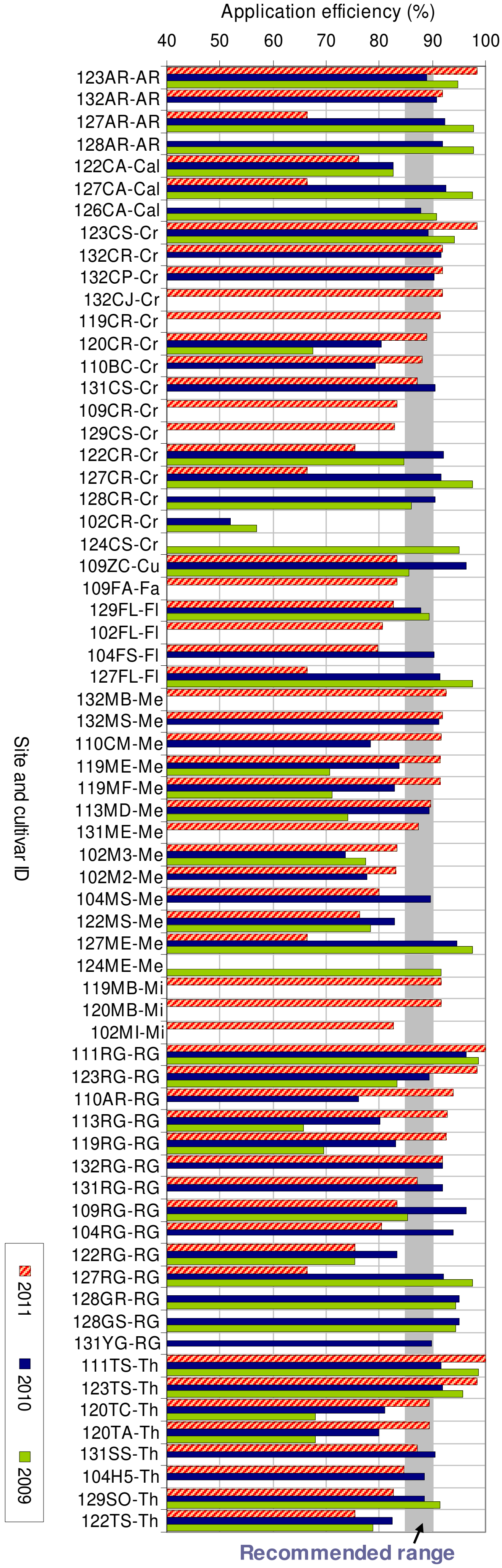


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Table 8a: Sites using drip irrigation ranked with respect to the highest application efficiency

		Application efficiency					
		(%)			Rank*		
	Site	2011	2010	2009	2011	2010	2009
Drip irrigation systems	123AR-AR	98.4	88.9	94.7	3	33	12
	132AR-AR	92.0	90.7		11	22	
	127AR-AR	66.4	92.4	97.7	55	10	3
	128AR-AR		91.8	97.7		15	4
	122CA-Cal	76.0	82.7	82.7	48	43	33
	127CA-Cal	66.4	92.5	97.5	55	9	5
	126CA-Cal		87.8	90.8		36	22
	123CS-Cr	98.4	89.2	94.1	3	32	16
	132CR-Cr	92.0	91.7		11	17	
	132CP-Cr	92.0	90.2		11	27	
	132CJ-Cr	92.0			11		
	119CR-Cr	91.4			20		
	120CR-Cr	88.9	80.3	67.5	26	46	51
	110BC-Cr	88.1	79.3		27	49	
	131CS-Cr	87.1	90.6		31	23	
	109CR-Cr	83.2			35		
	129CS-Cr	83.0			39		
	122CR-Cr	75.4	92.1	84.7	50	11	29
	127CR-Cr	66.4	91.7	97.5	55	18	5
	128CR-Cr		90.4	86.1		25	25
	102CR-Cr		51.9	56.9		64	58
	124CS-Cr			95.0			11
	109ZC-Cu	83.2	96.3	85.5	37	4	26
	109FA-Fa	83.2			35		
	129FL-Fl	82.6	87.8	89.4	42	37	24
	102FL-Fl	80.5			43		
	104FS-Fl	79.8	90.2		46	26	
	127FL-Fl	66.4	91.5	97.5	55	20	5
	132MB-Me	92.5			10		
	132MS-Me	92.0	91.3		11	21	
	110CM-Me	91.7	78.3		17	50	
	119ME-Me	91.4	83.8	70.6	20	38	47
	119MF-Me	91.3	82.9	71.0	22	41	46
	113MD-Me	89.6	89.4	74.2	23	30	45
	131ME-Me	87.3			28		
	102M3-Me	83.3	73.7	77.4	34	55	42
	102M2-Me	83.1	77.6		38	51	
	104MS-Me	79.9	89.7		45	29	
	122MS-Me	76.4	82.8	78.3	47	42	41
	127ME-Me	66.4	94.6	97.5	55	7	5
	124ME-Me			91.7			18
	119MB-Mi	91.7			18		
	120MB-Mi	91.6			19		
	102MI-Mi	82.6			40		
	111RG-RG	100.0	96.4	98.5	1	2	2
	123RG-RG	98.4	89.3	83.3	3	31	32
	110AR-RG	93.9	76.1		7	52	
	113RG-RG	92.8	80.2	65.8	8	47	52
	119RG-RG	92.6	83.1	69.6	9	40	48
	132RG-RG	92.0	91.8		11	16	
	131RG-RG	87.1	91.8		29	14	
	109RG-RG	83.4	96.3	85.4	33	3	28
	104RG-RG	80.5	94.0		44	8	
	122RG-RG	75.4	83.4	75.4	50	39	44
	127RG-RG	66.4	92.0	97.5	55	12	5
	128GR-RG		95.0	94.4		5	13
	128GS-RG		95.0	94.4		5	13
	131YG-RG		89.9			28	
	111TS-Th	100.0	91.7	98.6	1	19	1
	123TS-Th	98.4	91.9	95.8	3	13	10
	120TC-Th	89.4	81.2	68.0	24	45	49
	120TA-Th	89.4	79.9	68.0	24	48	49
	131SS-Th	87.1	90.6		29	24	
	104H5-Th	84.8	88.6		32	34	
	129SO-Th	82.6	88.5	91.4	41	35	20
	122TS-Th	75.5	82.3	78.8	49	44	40

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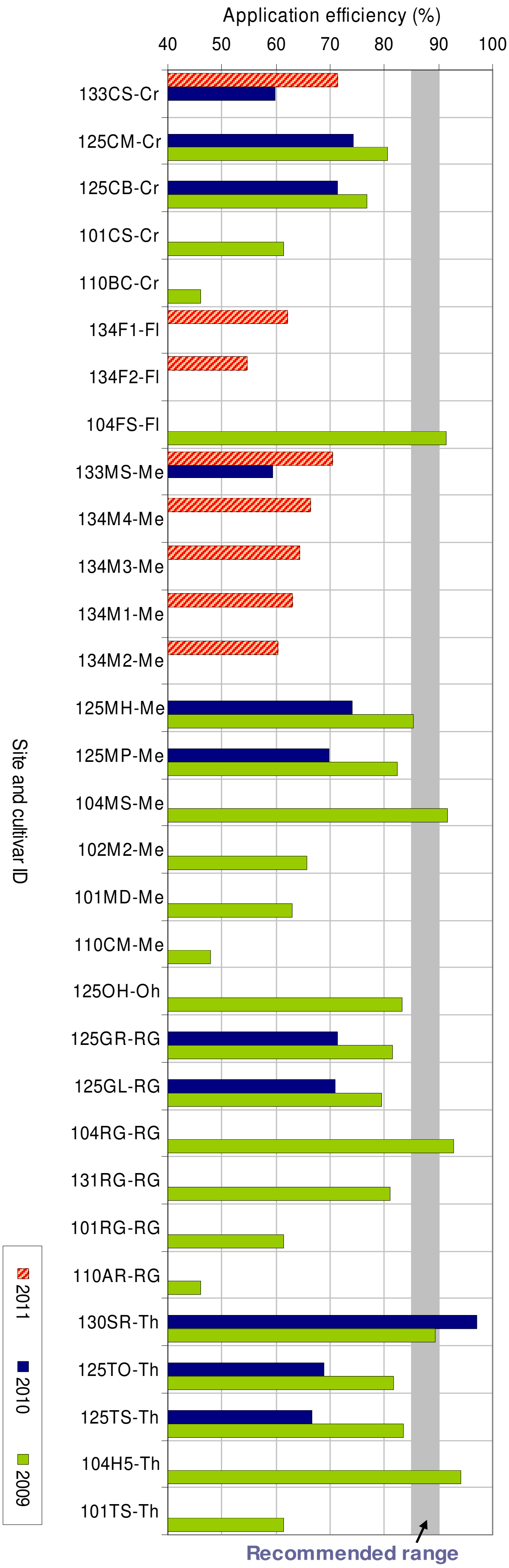
* Based on all sites, i.e. including sites with low level irrigation

Figure 12b: Application efficiency at sites using low level irrigation grouped by variety



AR: Autumn Royal, Cal: Calmeria, Cr: Crimson Seedless, Cu: Currant, Fa: Fantasy. Fl: Flame Seedless, Mi: Midnight Beauty, Me: Menindee Seedless, Oh: Ohanez, RG: Red Globe, Th: Thompson Seedless

Table 8b: Sites using low level irrigation ranked with respect to the highest application efficiency

	Site	Application efficiency (%)			Rank**		
		2011	2010	2009	2011	2010	2009
Low level irrigation systems	133CS-Cr	71.3	59.8		52	62	
	125CM-Cr		74.4	80.6		53	38
	125CB-Cr		71.4	76.7		56	43
	101CS-Cr			61.4			55
	110BC-Cr			46.2			60
	134F1-Fl	62.0			63		
	134F2-Fl	54.7			65		
	104FS-Fl			91.4			21
	133MS-Me	70.6	59.3		53	63	
	134M4-Me	66.4			54		
	134M3-Me	64.4			61		
	134M1-Me	62.9			62		
	134M2-Me	60.3			64		
	125MH-Me		74.1	85.4		54	27
	125MP-Me		69.7	82.5		59	34
	104MS-Me			91.7			19
	102M2-Me			65.8			53
	101MD-Me			63.0			54
	110CM-Me			48.0			59
	125OH-Oh			83.4			31
	125GR-RG		71.4	81.5		57	36
	125GL-RG		70.9	79.5		58	39
	104RG-RG			92.7			17
	131RG-RG			81.1			37
	101RG-RG			61.4			55
	110AR-RG			46.2			60
	130SR-Th		97.0	89.4		1	23
	125TO-Th		68.9	81.7		60	35
	125TS-Th		66.6	83.6		61	30
	104H5-Th			94.1			15
	101TS-Th			61.4			55
	Maximum	100.0	97.0	98.6	65	64	60
	Median	83.4	89.0	83.4			
	Minimum	54.7	51.9	46.2			

** Based on all sites, i.e. including sites w ith drip irrigation

3.2.2 Application efficiency per irrigation scheduling method

The box plots in Figure 13 show the application efficiencies achieved with different irrigation scheduling methods during the last three seasons. Except at sites with capacitance probes, the other sites had generally higher application efficiencies in 2011 than in 2010. In 2011, tensiometer sites where irrigation scheduling was based on dig experience had application efficiencies closer to the recommended range.

The medians for the different scheduling methods in 2011 were 71% (capacitance), 79% (dig), 92% (experience) and 83% (tensiometer). As pointed out previously, the results for the dig method come from a small sample (i.e. six sites) and hence could also be dependent on other factors common to those sites.

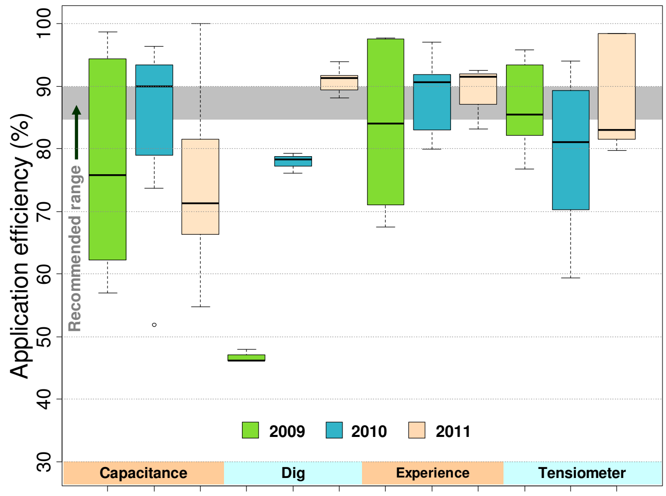


Figure 13: Box plot of irrigation application efficiency per irrigation scheduling method for 2009, 2010 and 2011

Table 9 presents the average application efficiencies obtained with the different scheduling methods over the last nine seasons. In 2011 sites that had their irrigations scheduled using capacitance probes dropped to their lowest ever average application efficiency (74%), well below the overall average of 79%. In most past seasons sites using capacitance probes have generally outperformed their counterparts using other scheduling methods. In 2011 the other three scheduling methods all outscored their ongoing averages (dig stick + 19%, experience + 9% and tensiometer +6%).

Table 9: Average application efficiency - Irrigation scheduling method comparison

Season	Average application efficiency (%)			
	Capacitance	Dig	Experience	Tensiometer
2002/03	84		78	91
2003/04	86		79	88
2004/05	78	68	69	76
2005/06	78	65	71	69
2006/07	81	52	71	76
2007/08	80	83	87	82
2008/09	78	47	84	87
2009/10	85	78	89	79
2010/11	74	91	89	88
Average	**79**	**72**	**80**	**82**

3.3 Crop production per ML of water applied

The crop production per megalitre (see Equation 1 - Appendix B) in Figure 14 shows a similar trend as the box plots of yields in Figure 2. This indicates that the crop production per megalitre was determined to a great extent by the yield results over the years. The influence of the amount of water applied can also be seen when comparing year 2010 to years 2005, 2006 and 2007 in Figures 2, 3 and 14. Although the yield in 2011 was much lower than in the years mentioned, the higher water applied between years 2005 and 2007 resulted in similar crop production per megalitre. The median value for 2011 (0.48t/Ml) was the lowest on record. 75% of the sites had crop production per Megalitre values of 1.94t/Ml or lower with 25% recorded 0.05% K t/Ml or lower. For the other years the results were 5.1 t/ML (2009), 3.9 t/ML (2008), 2.9 t/ML (2007), 2.8 t/ML (2006), 3.3 t/ML (2005), 5.0 t/ML (2004) and 4.8 t/ML (2003).

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

Figure 15 shows the crop production per Megalitre results for both drip (0.55 t/Ml) and low level (0.39t/Ml) irrigated sites were the lowest on record. Despite the drop in water applied for each of the irrigation systems (see Figure 5) the reduced yields (see Figure 4) had a greater influence on these results. The results from previous years ranged from 1.4 t/Ml (2007) to 4.85 t/Ml (2003) for drip irrigated sites and 1.8 t/Ml (2006) to 3.47 t/Ml (2004) for low level irrigated sites in 2011 was greater (0 to 6.9 t/Ml) than for the low level irrigated sites (0 to 4.58 t/Ml).

The results for 2011 (Table 10) shows that both drip (1.4 t/Ml) and low level (1.3t/Ml) irrigated sites average crop production per megalitre were the lowest on record. Both were well under their long term average with drip 1.1 t/Ml lower and lowlevel sites 1.4 t/Ml lower.

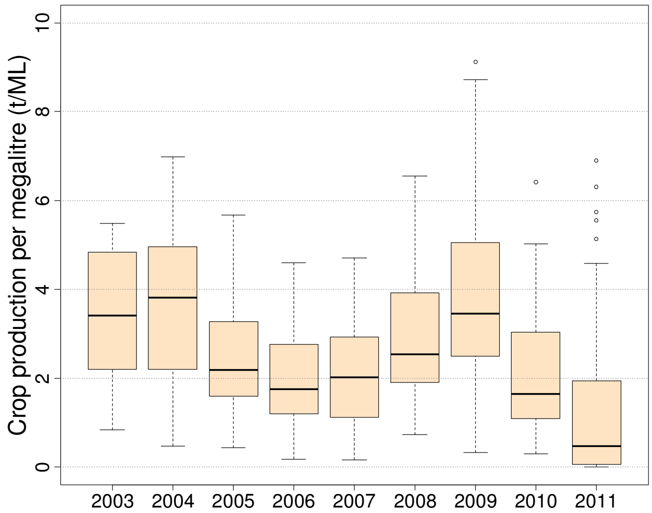


Figure 14: Box plot of crop production per Megalitre of water applied between 2003 and 2011

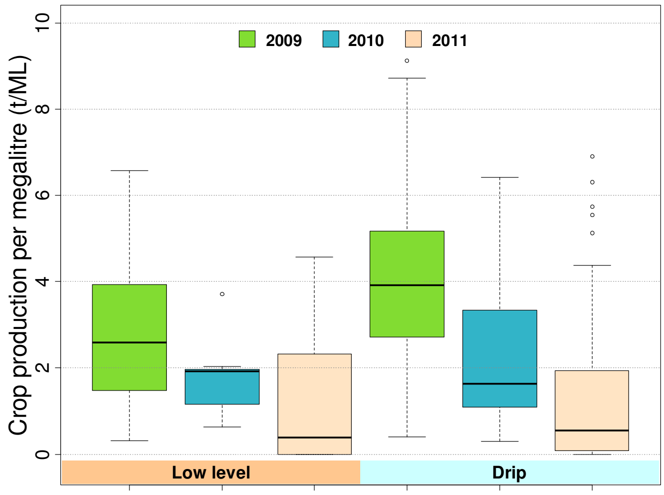


Figure 15: Box plot of crop production per Megalitre of water applied per irrigation system type for 2009, 2010 and 2011

Table 10: Average crop production per megalitre of water applied - Irrigation system type comparison

Season	Average crop production per megalitre (t/ML)				
	Drip	Furrow	Low level	Overhead	Average
2002/03	4.1		3.3	0.8	**3.4**
2003/04	3.8		3.7	2.1	**3.7**
2004/05	2.8		2.3		**2.4**
2005/06	1.8	2.5	2.0		**2.0**
2006/07	1.5		2.3	3.5	**2.1**
2007/08	3.3		3.1		**3.2**
2008/09	4.2		2.8		**3.7**
2009/10	2.1		1.7		**2.1**
2010/11	1.4		1.3		**1.4**
Average	**2.5**	**2.5**	**2.7**	**2.5**	**2.6**

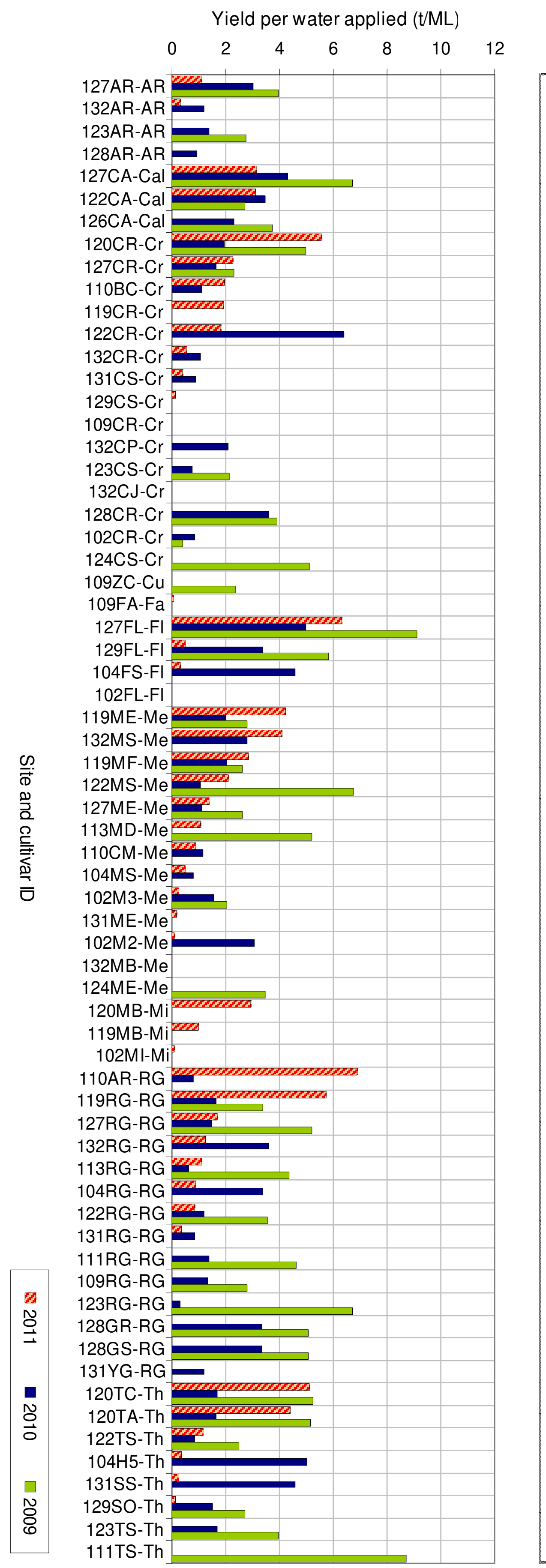


Figure 16a: Crop production per megalitre of water applied at sites using drip irrigation grouped by variety

AR: Autumn Royal, Cal: Calmeria, Cr: Crimson Seedless, Cu: Currant, Fa: Fantasy. Fl: Flame Seedless, Mi: Midnight Beauty, Me: Menindee Seedless, Oh: Ohanez, RG: Red Globe, Th: Thompson Seedless

Table 11a: Sites using drip 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
Drip irrigation systems	127AR-AR	1.1	3.0	4.0	25	16	23
	132AR-AR	0.3	1.2		41	40	
	123AR-AR		1.4	2.8	51	37	37
	128AR-AR		0.9			50	
	127CA-Cal	3.2	4.3	6.7	11	**6**	**4**
	122CA-Cal	3.1	3.5	2.7	12	**10**	38
	126CA-Cal		2.3	3.8		18	27
	120CR-Cr	5.6	1.9	5.0	**4**	24	17
	127CR-Cr	2.3	1.6	2.3	15	32	47
	110BC-Cr	1.9	1.1		17	46	
	119CR-Cr	1.9			18		
	122CR-Cr	1.8	6.4		19	**1**	
	132CR-Cr	0.6	1.1		32	49	
	131CS-Cr	0.4	0.9		36	51	
	129CS-Cr	0.2			45		
	109CR-Cr	0.0			50		
	132CP-Cr		2.1		51	19	
	123CS-Cr		0.8	2.1	51	57	48
	132CJ-Cr				51		
	128CR-Cr		3.6	3.9		**9**	25
	102CR-Cr		0.9	0.4		52	58
	124CS-Cr			5.1			14
	109ZC-Cu			2.3	51		46
	109FA-Fa	0.1			49		
	127FL-Fl	6.3	5.0	9.1	**2**	**3**	**1**
	129FL-Fl	0.5	3.4	5.8	34	11	**8**
	104FS-Fl	0.3	4.6		40	**4**	
	102FL-Fl				51		
	119ME-Me	4.2	2.0	2.8	**8**	22	36
	132MS-Me	4.1	2.8		**9**	17	
	119MF-Me	2.8	2.0	2.6	14	21	41
	122MS-Me	2.1	1.1	6.8	16	48	**3**
	127ME-Me	1.4	1.1	2.6	21	47	40
	113MD-Me	1.1		5.2	27		11
	110CM-Me	0.9	1.2		29	43	
	104MS-Me	0.5	0.8		33	56	
	102M3-Me	0.2	1.6	2.1	43	33	49
	131ME-Me	0.2			44		
	102M2-Me	0.1	3.1		48	15	
	132MB-Me				51		
	124ME-Me			3.5			29
	120MB-Mi	2.9			13		
	119MB-Mi	1.0			28		
	102MI-Mi	0.1			47		
	110AR-RG	6.9	0.8		**1**	55	
	119RG-RG	5.7	1.6	3.4	**3**	31	31
	127RG-RG	1.7	1.5	5.2	20	35	**10**
	132RG-RG	1.3	3.6		23	**8**	
	113RG-RG	1.1	0.6	4.4	26	60	21
	104RG-RG	0.9	3.4		29	12	
	122RG-RG	0.8	1.2	3.5	31	39	28
	131RG-RG	0.4	0.8		37	54	
	111RG-RG		1.4	4.6	51	36	18
	109RG-RG		1.3	2.8	51	38	35
	123RG-RG		0.3	6.7	51	61	**5**
	128GR-RG		3.3	5.1		13	15
	128GS-RG		3.3	5.1		13	15
	131YG-RG		1.2			42	
	120TC-Th	5.1	1.7	5.2	**5**	28	**9**
	120TA-Th	4.4	1.7	5.1	**7**	30	13
	122TS-Th	1.2	0.9	2.5	24	52	45
	104H5-Th	0.4	5.0		37	**2**	
	131SS-Th	0.2	4.6		42	**4**	
	129SO-Th	0.2	1.5	2.7	45	34	38
	123TS-Th		1.7	3.9	51	29	24
	111TS-Th			8.7	51		**2**

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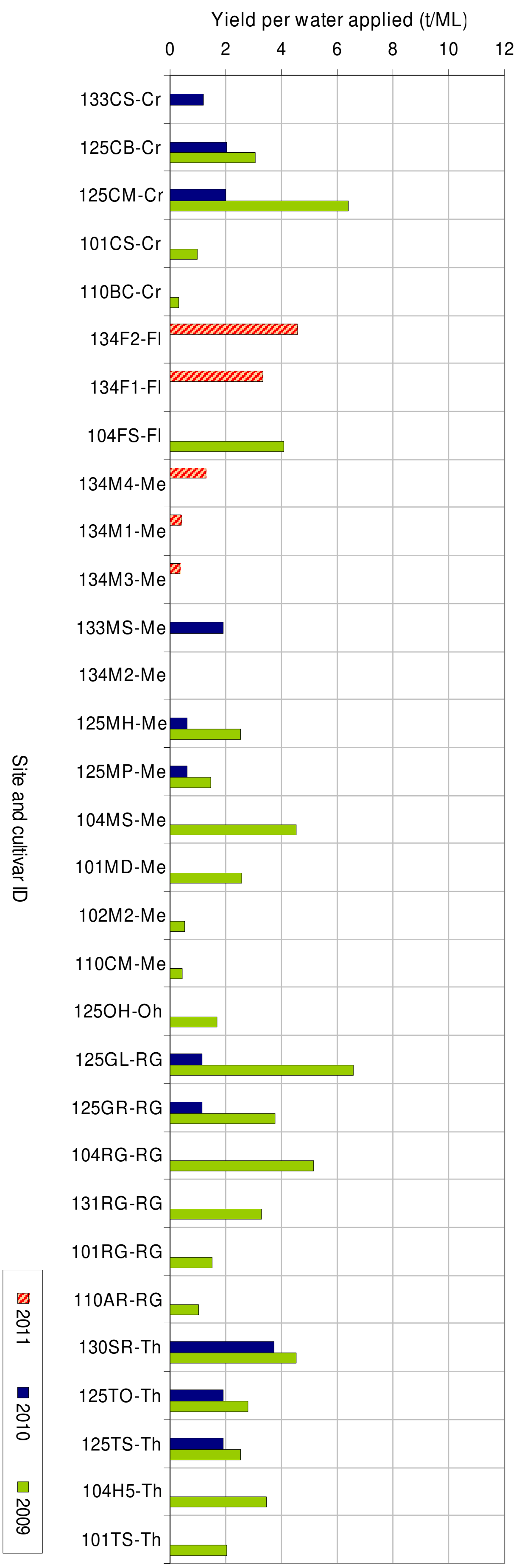
* Based on all sites, i.e. including sites with low level irrigation

Figure 16b: Crop production per megalitre of water applied at sites using low level irrigation grouped by variety



AR: Autumn Royal, Cal: Calmeria, Cr: Crimson Seedless, Cu: Currant, Fa: Fantasy. Fl: Flame Seedless, Mi: Midnight Beauty, Me: Menindee Seedless, Oh: Ohanez, RG: Red Globe, Th: Thompson Seedless

Table 11b: 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	133CS-Cr		1.2		51	40	
	125CB-Cr		2.0	3.1		20	33
	125CM-Cr		2.0	6.4		23	**7**
	101CS-Cr			1.0			55
	110BC-Cr			0.3			59
	134F2-Fl	4.6			**6**		
	134F1-Fl	3.4			**10**		
	104FS-Fl			4.1			22
	134M4-Me	1.3			22		
	134M1-Me	0.4			35		
	134M3-Me	0.4			39		
	133MS-Me		1.9		51	25	
	134M2-Me				51		
	125MH-Me		0.6	2.5		58	44
	125MP-Me		0.6	1.5		58	53
	104MS-Me			4.6			19
	101MD-Me			2.6			42
	102M2-Me			0.5			56
	110CM-Me			0.4			57
	125OH-Oh			1.7			51
	125GL-RG		1.2	6.6		44	**6**
	125GR-RG		1.2	3.8		44	26
	104RG-RG			5.2			12
	131RG-RG			3.3			32
	101RG-RG			1.5			52
	110AR-RG			1.0			54
	130SR-Th		3.7	4.6		**7**	19
	125TO-Th		1.9	2.8		25	34
	125TS-Th		1.9	2.6		25	43
	104H5-Th			3.5			30
	101TS-Th			2.0			50
	Maximum	6.9	6.4	9.1	51	61	59
	Median	0.5	1.6	3.5			
	Minimum		0.3	0.3			

** Based on all sites, i.e. including sites with drip irrigation

Figures 16a and 16b and Tables 11a and 11b show the performances of different sites grouped by irrigation system and variety and ordered according to the crop production per megalitre of water applied. In 2011, eight out of the top 10 ranked sites were irrigated by drip. In 2011, the top ranks were more or less evenly distributed among several varieties, e.g. Crimson Seedless, Flame Seedless, Thompson Seedless and Red Globe.

As already observed in the previous years, there were big variations between sites within the same irrigation system and variety group, e.g. from 6.9 t/ML to 0.0 t/ML for drip irrigated sites growing Red Globe. This tends to indicate that any cause and effect relationship cannot be generalised due to site specific conditions, specially in regard to how the different crops were affected by the heat waves of November 2010 and extreme rainfall events in January and February 2011. This can be seen from the results of sites growing the same variety, with similar water usage and applications efficiencies but different yields, hence different crop production per megalitre.

Table 12 shows the average crop production was lower in 2010/11 compared to 2009/10 and 2008/09, irrespective of variety and irrigation system. Only varieties Calmeria under drip irrigation and Flame Seedless under low level irrigation had an average crop production close to their respective nine-year average. The highest crop production per megalitre in 2011 were obtained with Flame Seedless (1.8 t/ML) and Calmeria (3.1 t/ML) under drip irrigation and with Flame Seedless (4 t/ML) under low level irrigation.

Table 12: 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	Autumn Royal							3.4	1.6	0.5	**1.6**
	Calmeria	5.2	5.0	2.9	0.6	1.8	4.1	4.4	3.4	3.1	**3.4**
	Crimson			0.7	1.5	1.3	3.1	3.1	2.0	1.2	**2.0**
	Currant							2.3		0.0	**1.2**
	Fantasy									0.1	**0.1**
	Flame	5.0	3.9				3.8	7.5	4.3	1.8	**4.0**
	Menindee	2.6	3.0	2.4	1.6	2.0	3.1	3.6	1.7	1.5	**2.2**
	Midnight Beauty									1.3	**1.3**
	Red Globe	5.1	4.0	3.3	2.2	1.6	3.6	4.5	1.7	1.7	**2.7**
	Thompson	3.2	3.7	3.4	2.7	1.1	1.8	4.7	2.4	1.4	**2.6**
Low level	Calmeria	3.3	4.3								**3.8**
	Cardinal	1.7	1.8	1.5	1.8						**1.7**
	Crimson	5.1	6.5	2.4	1.5	1.6	2.9	2.7	1.7	0.0	**2.3**
	Flame	3.5	2.4	2.3	2.3	2.6	4.9	4.1		4.0	**3.0**
	Menindee	2.8	3.5	1.8	1.5	2.8	2.3	2.0	1.1	0.4	**2.2**
	Ohanez						3.0	1.7			**2.3**
	Red Emperor	3.7	3.5	2.8	2.5	2.3					**2.9**
	Red Globe	3.5	4.3	3.0	2.3	2.4	5.7	3.6	1.2		**3.4**
	Thompson	3.5	3.6	1.9	2.3	2.2	2.0	3.1	2.5		**2.6**
Overhead	Crimson	0.8	2.1			3.6					**2.2**
	Menindee					3.3					**3.3**
Furrow	Calmeria				3.7						**3.7**
	Crimson				1.5						**1.5**
	Flame				1.6						**1.6**
	Menindee				1.6						**1.6**
	Rally				1.2						**1.2**
	Red Globe				3.3						**3.3**
	Thompson				4.5						**4.5**

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). A number of factors contribute to the differences in gross return between sites and between seasons. Such factors include age of the vines, maintenance and management of irrigation systems, volume of water applied, crop damage, and the market value of the crop. Gross return per megalitre of water applied does not consider input costs and therefore does not give an indication of growers' profits.

Figure 17 shows the median value for gross return per megalitre for 2011 (($1107/Ml) was lowest on record, with the previous lowest being $3067/Ml in 2005 compared to the highest of $6753/Ml in 2009. The range of values in 2011 was very large being $0/Ml to $21653/Ml which is the second highest value on record. For only the second time since the start of the project low level irrigated sites ($3976/Ml) showed a higher gross return per megalitre than their drip irrigated counterparts ($3078/Ml). Both the low level (-$560/Ml) and drip (-$1935/Ml) had lower averages in 2011 than their long term averages. Drip irrigated sites have a higher long term average than the low level sites.

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

Drip irrigated sites had an average gross return per megalitre of $816/ML higher than low level irrigated sites in 2010 (Table 13). In fact, the seasonal results for drip irrigation were higher than those of low level irrigation seven years out of eight. The results for drip and low level irrigated sites in the last season were $4412/ML and $1863/ML respectively below their results in 2008/09 and $1191/ML and $862/ML respectively below their eight-year averages.

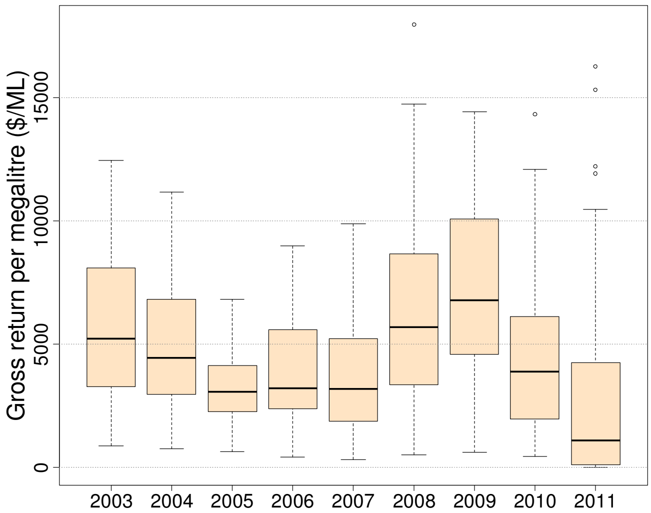


Figure 17: Box plot of gross return per Megalitre of water applied between 2003 and 2011

Table 13: Average gross return per megalitre of water applied ($/ML) - Irrigation system type comparison

Season	Average gross return per megalitre ($/ML)				
	Drip	Furrow	Low level	Overhead	Average
2002/03	6908		5298	1180	**5564**
2003/04	5540		5340	3002	**5326**
2004/05	3706		3167		**3305**
2005/06	3589	4539	3471		**3650**
2006/07	2664		3812	7760	**3678**
2007/08	6713		6164		**6402**
2008/09	8924		5379		**7542**
2009/10	4512		3696		**4365**
2010/11	3078		3976		**3188**
Average	**5013**	**4539**	**4536**	**4926**	**4773**

Table 14: Average gross return per megalitre of water applied ($/ML) - 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**
Autumn Royal							9633	4732	1244	**4659**
Calmeria	7119	6406	3690	2504	2362	5875	6963	4429	5941	**5215**
Cardinal	2697	2925	1173	2211						**2252**
Crimson	4632	6711	2602	2980	3668	8232	6960	5190	2453	**4816**
Currant							2107		5	**1056**
Fantasy									103	**103**
Flame	6756	5199	3625	3658	5128	10610	16940	9053	8585	**7482**
Menindee	4558	5167	2793	2848	4828	5444	6072	3765	2390	**4180**
Midnight Beauty									2892	**2892**
Ohanez						5907	3373			**4640**
Rally				2576						**2576**
Red Emperor	5847	5546	4036	2959	2608					**4199**
Red Globe	6223	5678	4031	4462	3202	8346	8320	2936	3331	**5134**
Thompson	5280	4700	3112	4447	2960	3310	6838	4724	2772	**4264**
Average	**5564**	**5326**	**3305**	**3650**	**3678**	**6402**	**7542**	**4365**	**3188**	**4773**

3.4.2 Gross return per Megalitre of water applied - variety comparison

The seasonal average gross return achieved by each variety is presented in Table 14. The results are calculated from the market value of a particular variety and the volume of water applied per hectare. If the price for the sale of fruit has not changed substantially then the difference in gross return per megalitre between seasons depends largely on the irrigation applied and the yield.

With an average return of $8585/Ml Flame out performed all of the other varieties in this study in 2011. Flame has consistently had the greatest returns since 2001. Autumn Royal (-$3415/Ml), Crimson (-$2363/Ml), Menindee (-$1790), Red Globe (-1803) and Thompson (-1492) were all well below their long term averages.

However all varieties had lower results in 2010/11 compared to 2009/10 except for Calmeria and Red Globe. It should again be noted some of these best results should be interpreted with caution as they were obtained from a small sample of sites.

3.5 Cost of water per tonne of fruit

Cost of water per tonne of fruit is calculated using Equation 3 (Appendix B) and is influenced by many factors within irrigation systems and seasons. Inputs comprise 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.

In 2010, 50% of the sites had a cost of water per tonne of fruit between $63/t and $206/t. As a comparison, the results for 50% of the sites were between $43/t and $120/t in 2009 and between $56/t and $223/t in 2008.The majority of values in the last eight seasons were below $100/t but a few sites had extremely high values, e.g. above $300/t. The outliers in most cases were due to a combination of an extremely low yield combined with a high cost of water.

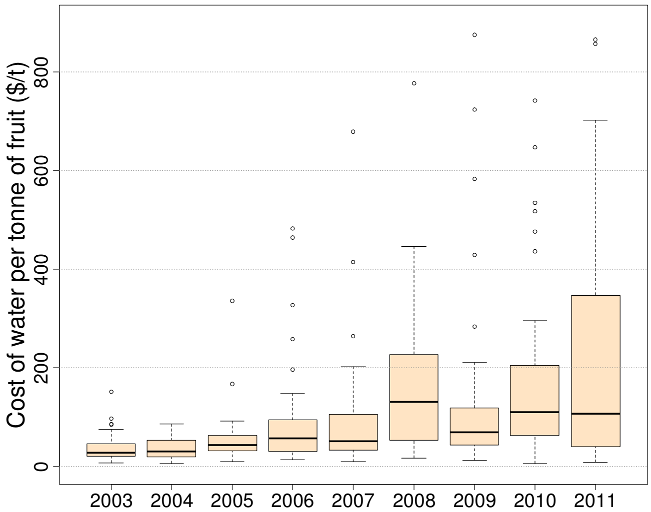


Figure 18: Box plot of cost of water per tonne of fruit between 2003 and 2011

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

Table 15 shows the result for drip irrigation in 2010 ($267/t) was the highest average cost of water per tonne of fruit over the nine seasons. This result was also more than twice the seasonal average ($118/t) and five times the 2011 average of low level irrigated sites ($53/t). The main reason is the reduced yields experienced by many irrigators due to the extreme rainfall events experienced in 20011. There were more drip irrigated sites participating in 2011 that were impacted by the rainfall reflecting the greater impact on the average of the drip sites.

Figure 18 shows that in 2011 the median value of the cost of water per tonne of fruit was the third highest in the nine years of the project at $107/t in 2011 behind $131/t in 2008 and $110/t in 2010. The main reason for this high value was not the cost of water as experienced in 2008 but the low yields due to the extreme rainfall events during the growing season. In 2011 the mid range 50% of sites had a cost of water per tonne of fruit between $40/t and $347/t. As a comparison, the results for 2010 were between $63/t to $206/t and $43/t to $120/t for 2009.

Table 15: Average cost of water per tonne of fruit - Irrigation system type comparison

Season	Average cost of water per tonne of fruit ($/t)				
	Drip	Furrow	Low level	Overhead	Average
2002/03	26		39	152	**39**
2003/04	32		39	62	**38**
2004/05	46		61		**57**
2005/06	106	41	89		**87**
2006/07	122		82	24	**90**
2007/08	138		187		**165**
2008/09	99		150		**119**
2009/10	227		98		**204**
2010/11	267*		53		**160***
Average	**118**	**41**	**89**	**66**	**107**

* two sites that produced negligible volumes of fruit in 2011 (eg 15 Kg/Ha) were discounted in determining these averages

3.6 Gross return per dollar water input

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

Figure 19 shows there were large variations between the different sites within each year.

Table 16 shows a different perspective from the results presented in Figure 19. The gross returns per dollar water input in 2011 showed the median value was the lowest of all years recorded at $9.50. The results of the previous years ranged from $13.40 in 2008 to $52.30 in 2003. This is chiefly due to the low yields experienced in 2011. The range of values for 2011 was the second highest recorded at 0 to $401.20. In 2011 the drip irrigated sites recorded their lowest value at $24 which is $19 less than the overall average. Conversely the low level irrigated sites had their highest ever average at $98 which is $58 greater than the overall average. The number of low level sites was only eight, three of which recorded no yield, so any comparison between the drip and low level irrigated sites may be misleading. This demonstrates how different statistics can provide different level of information. In the present case, the high results at some sites compensated for the low results at other sites and therefore influenced the averages.

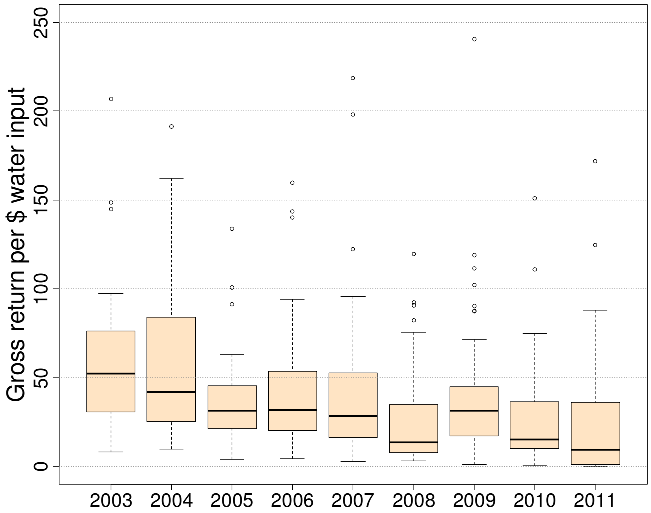


Figure 19: Box plot of gross return per dollar water input between 2003 and 2011

Table 16: Average gross return per dollar water input ($/$) - Irrigation system type comparison

Season	Average gross return per dollar water input ($/$)			
	Drip	Furrow	Low level	Overhead
2002/03	101		58	9
2003/04	65		55	23
2004/05	47		34	
2005/06	46	56	39	
2006/07	41		41	93
2007/08	40		16	
2008/09	52		20	
2009/10	45		28	
2010/11	24		98	
Average	**43**	**56**	**40**	**54**

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.
- After the good yield results for season 2008/09, the heatwave conditions in November 2009 and extreme rainfall events in 2011 showed how severely the yield at many sites could be affected by unfavourable climatic conditions.
- The extreme rainfall events experienced by many table grape growers in the 2010-2011 season led to many sites in this study being water logged or prone to high disease pressure, both of which led to lower quality and yields.
- The average yield of all varieties for drip irrigated sites in 2011 (5.7 t/ha) was less than half that of 2010, and 21.8 t/ha lower compared to the average of 2009. In the case of low level irrigated sites, the average yield in 2011(5.4 t/ha) was 8.6 t/ha and 18.5 t/ha lower than the averages of 2010 and 2009 respectively.
- Season 2010/11 resulted in 13.8% of sites scoring within the target 85-90% application efficiency range with a further 33.8% scoring over 90%. This result indicates that there are still many sites that could improve their timing and amount of irrigation.
- Drip irrigated sites generally achieved application The average application efficiencies for sites with drip irrigation were more consistent over the nine years and were also higher than those for low level irrigation. In 2011, the application efficiency for low level irrigation was 21% less than the average for drip irrigation, and 1% below its own nine-year average of 86%. The nine-year averages show that drip irrigated sites had an application efficiency average of 86% while the low level irrigated sites only averaged 74%.
- The crop production per megalitre results for both drip (0.55 t/Ml) and low level (0.39t/Ml) irrigated sites were the lowest on record. Despite the drop in water applied for each of the irrigation systems (see Figure 5) the reduced yields (see Figure 4) had a greater influence on these results. The results from previous years ranged from 1.4 t/Ml (2007) to 4.85 t/Ml (2003) for drip irrigated sites and 1.8 t/Ml (2006) to 3.47 t/Ml (2004) for low level irrigated sites. In 2011 the range was greater for drip irrigated sites (0 to 6.9 t/Ml) than for the low level irrigated sites (0 to 4.58 t/Ml).
- The results for 2011 shows that both drip (1.4 t/Ml) and low level (1.3t/Ml) irrigated sites average crop production per Megalitre were the lowest on record. Both were well under their long term average with drip 1.1 t/Ml less. The different varieties grown each had an average crop production per Megalitre of water in 2011 lower than in 2010 and all were under their longterm average except for low level irrigated Flame Seedless.
- The median value for gross return per megalitre for 2011 ($1107/Ml) was lowest on record, with the previous lowest being $3067/Ml in 2005 compared to the highest of $6753/Ml in 2009. The range of values in 2011 was very large being $0/Ml to $21653/Ml which is the second highest value on record. For only the second time since the start of the project low level irrigated sites ($3976/Ml) showed a higher gross return per megalitre than their drip irrigated counterparts ($3078/Ml). Both the low level (-$560/Ml) and drip (-$1935/Ml) had lower averages in 2011 than their long term averages. Drip irrigated sites have a higher long term average than the low level sites.
- In terms of irrigation scheduling method, sites that used capacitance probes or tensiometers achieved higher application efficiencies than sites using the dig method or experience only.
- More important than using a particular irrigation system or scheduling method alone is the effective combination of different irrigation and management practices used by growers in achieving good production quality and quantity.

Appendix

A. Further reading

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

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 2011	Scheduling Method	System Type	Variety	Assigned value ($/t)								
					2003	2004	2005	2006	2007	2008	2009	2010	2011
101CS	6	Capacitance	Low level	Crimson Seedless							3000		
101MD	18	Capacitance	Low level	Menindee Seedless	1000	1000	1400	2000	2100	2100	1800		
101RG	60	Capacitance	Low level	Red Globe	1000	1000	1400	1700	1400	1750	1800		
101TS	60	Capacitance	Low level	Thompson Seedless	1000	200	1200	1600	1800	1800	1600		
102CR	8	Capacitance	Drip	Crimson Seedless						3400	3200	3000	
102FL	1	Capacitance	Drip	Flame Seedless									0
102M2	34	Capacitance	Low level	Menindee Seedless						3400	3500		
102M2	36	Capacitance	Drip	Menindee Seedless								3500	3500
102M3	23	Capacitance	Drip	Menindee Seedless						3400	3500	3250	3500
102MI	5	Capacitance	Drip	Midnight Beauty									4000
103CM	12	Tensiometer	Drip	Calmeria	1750	1190	1289	1666					
103CN	5	Capacitance	Drip	Crimson Seedless			1266	1546					
103FS	9	Tensiometer	Drip	Flame Seedless	2000	2190							
103MD	13	Tensiometer	Drip	Menindee Seedless	2060	1690	1427	2190					
103RG	13	Other	Drip	Red Globe	1820	1000	1263	2341					
103TS	13	Tensiometer	Drip	Thompson Seedless	1600	1390	1543	1810					
104FS	32	Tensiometer	Low level	Flame Seedless						2200	2400		
104FS	34	Tensiometer	Drip	Flame Seedless								2200	2200
104H5	5	Tensiometer	Low level	Thompson Seedless						1900	2200		
104H5	7	Tensiometer	Drip	Thompson Seedless								2400	3000
104MS	5	Tensiometer	Low level	Menindee Seedless						1700	2000		
104MS	7	Tensiometer	Drip	Menindee Seedless								3000	2200
104RG	15	Tensiometer	Low level	Red Globe							1300		
104RG	17	Tensiometer	Drip	Red Globe								1800	1300
105FL	18	Other	Low level	Flame Seedless	1600	1600	1500	1700	1600				
105MD	12	Other	Low level	Menindee Seedless	1600	1600	1500	1500	1200				
105RG	9	Other	Low level	Red Globe	1600	1600	1500	1600	1800				
105TS	44	Other	Low level	Thompson Seedless	1600	1600	1500	1600	1600				
106CM	11	Other	Low level	Calmeria	1600	1600							
106CR	11	Other	Low level	Crimson Seedless	1600	1600							
106MD	11	Other	Low level	Menindee Seedless	1600	1600							
106RG	11	Other	Low level	Red Globe	1600	1600							
106TS	52	Other	Low level	Thompson Seedless	1600	1600							
107CR	10	Other	Low level	Crimson Seedless			1400	1550	1400				
107FL	11	Other	Low level	Flame Seedless	1600	1600	1500	1500	1600				
107MD	14	Other	Low level	Menindee Seedless	1600	1600	1400	1500	1600				
107RE	17	Other	Low level	Red Emperor	1600	1600	1450	1200	1150				
107RG	15	Other	Low level	Red Globe	1600	1600	1200	1100	1375				
107TS	12	Other	Low level	Thompson Seedless			1200	1550	1450				
108MD	50	Dig	Low level	Menindee Seedless	1600	1600	1400	1400					
109CR	2	Other	Drip	Crimson Seedless									2000
109FA	3	Other	Drip	Fantasy									2000
109RG	13	Other	Drip	Red Globe							2000	500	0
109ZC	27	Other	Drip	Currant							900		1225
110AR	18	Dig	Low level	Red Globe	1600	1600	1200	1789	1300	1385	1700		
110AR	20	Dig	Drip	Red Globe								1400	2216
110BC	4	Other	Overhead	Crimson Seedless	1400	1400							
110BC	9	Dig	Low level	Crimson Seedless			1200	1684	1750	4500	2050		
110BC	10	Dig	Drip	Crimson Seedless								2100	1865
110CM	12	Dig	Low level	Menindee Seedless	1600	1600	1000	1305	1400	1400	1400		
110CM	14	Dig	Drip	Menindee Seedless								1400	1400
110DC	21	Dig	Low level	Cardinal	1600	1600	800	1200					
111RG	15	Capacitance	Drip	Red Globe	444	1146	1200	1800	1250		1700	1000	0
111TS	13	Capacitance	Drip	Thompson Seedless	560	1794	1200	1600	1500		1100		0
112CR		Capacitance	Low level	Crimson Seedless			1400	2777					
112RG		Capacitance	Low level	Red Globe			1200	2333					
112TS		Capacitance	Low level	Thompson Seedless			1200	1667					
113MD	17	Capacitance	Drip	Menindee Seedless	2200	1600	1400	2200	2200	2700	2777		2000
113RG	17	Capacitance	Drip	Red Globe	2400	1400	1260	2200	2000	2500	2777	2600	2000
114MS	15	Capacitance	Low level	Thompson Seedless	2000	1600	1200	1800					
114RG	15	Capacitance	Low level	Red Globe	2400	1400	1400	2000					
115RG	6	Capacitance	Low level	Red Globe	1700	600							
115RG	7	Capacitance	Drip	Red Globe			1500						
116FS	19	Tensiometer	Low level	Flame Seedless	1700	2000	1850	2667	2600				
116MS	11	Tensiometer	Low level	Menindee Seedless	2000	1400	1800	2000	1900				
116NC	4	Tensiometer	Low level	Crimson Seedless				2444	2200				
116RG	10	Tensiometer	Low level	Red Globe	1850	1300	1700	2667	1900				
116TS	8	Tensiometer	Low level	Thompson Seedless	1800	1200	2100	2667	2200				
117RG	12	Tensiometer	Low level	Red Globe	1600	1600	1200	2000					
117TS	64	Tensiometer	Low level	Thompson Seedless	1600	1600	1400	1500					
118CA	15	Other	Furrow	Calmeria				1495					
118CR	4	Other	Furrow	Crimson Seedless				1750					
118FS	15	Other	Furrow	Flame Seedless				1660					
118MS	15	Other	Furrow	Menindee Seedless				2100					
118RG	10	Other	Furrow	Red Globe				2300					

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Site	Age 2011	Scheduling Method	System Type	Variety	Assigned value ($/t)								
					2003	2004	2005	2006	2007	2008	2009	2010	2011
118RS	7	Other	Furrow	Rally Seedless				2100					
118TS	45	Other	Furrow	Thompson Seedless				1660					
119CR	5	Other	Drip	Crimson Seedless									2200
119MB	3	Other	Drip	Midnight beauty									2100
119ME	18	Other	Low level	Menindee Seedless					1500	2000			
119ME	21	Dig	Drip	Menindee Seedless							1800	2500	2200
119MF	11	Other	Low level	Menindee Seedless					1500	2000			
119MF	14	Dig	Drip	Menindee Seedless							1800	2500	2200
119RG	6	Other	Low level	Red Globe					1200	1620			
119RG	9	Dig	Drip	Red Globe							2000	1600	1785
119TS	43	Other	Low level	Thompson Seedless					1200	1800			
120CR	7	Other	Low level	Crimson Seedless					2000	2200			
120CR	10	Dig	Drip	Crimson Seedless							1950	2000	2200
120MB	5	Other	Drip	Midnight Beauty									2100
120TA	7	Other	Low level	Thompson Seedless					2000	1800			
120TA	8	Dig	Drip	Thompson Seedless							1800	1700	1700
120TC	5	Other	Low level	Thompson Seedless					2000	1800			
120TC	8	Dig	Drip	Thompson Seedless							1800	1700	2040
121TS	10	Other	Low level	Thompson Seedless					1145				
122CA	14	Capacitance	Drip	Calmeria				1667	1333	1450	1550	1160	1888
122CR	12	Capacitance	Drip	Crimson Seedless				2778	2944	2850		2230	2350
122MS	12	Capacitance	Drip	Menindee Seedless				2222	1789	1218	1950	500	2144
122RG	14	Capacitance	Drip	Red Globe				2111	1367	1682	2250	1600	1961
122TS	12	Capacitance	Drip	Thompson Seedless				2166	1988	280	1800	800	2102
123AR	14	Tensiometer	Drip	Autumn Royal							3100	2900	0
123CS	12	Tensiometer	Drip	Crimson Seedless					2200	2000	2880	2245	0
123RG	14	Tensiometer	Drip	Red Globe					1400	1550	1880	1445	0
123TS	31	Tensiometer	Drip	Thompson Seedless					1100	1900	2000	1600	0
124CS	9	Tensiometer	Overhead	Crimson Seedless					2200				
124CS	11	Tensiometer	Drip	Crimson Seedless						1800	2350		
124ME	3	Tensiometer	Overhead	Menindee Seedless					2300				
124ME	5	Tensiometer	Drip	Menindee Seedless						2500	1700		
125CB	6	Tensiometer	Low level	Crimson Seedless						3000	2100	3000	
125CM	9	Tensiometer	Low level	Crimson Seedless						3000	2200	3000	
125GL	21	Tensiometer	Low level	Red Globe						1600	1800	1700	
125GR	19	Tensiometer	Low level	Red Globe						1600	1800	1700	0
125MH	15	Tensiometer	Low level	Menindee Seedless						1700	1800	2250	
125MP	15	Tensiometer	Low level	Menindee Seedless						1700	1800	2250	
125OH	17	Tensiometer	Low level	Ohanez						2000	2000		
125TO	17	Tensiometer	Low level	Thompson Seedless						2000	1800	2100	
125TS	5	Tensiometer	Low level	Thompson Seedless					1900	1900	1850	2100	
126CA	27	Capacitance	Drip	Calmeria						1430	1678	1850	
127AR	6	Capacitance	Drip	Autumn Royal							2700	2667	2666
127CA	18	Capacitance	Drip	Calmeria						1450	1550	1160	1888
127CR	8	Capacitance	Drip	Crimson Seedless						2850	2400	2667	2350
127FL	23	Capacitance	Drip	Flame Seedless						2700	3100	1790	3431
127ME	13	Capacitance	Drip	Menindee Seedless						1218	1950	500	2144
127RG	13	Capacitance	Drip	Red Globe						1682	2700	1600	1961
128AR	4	Capacitance	Drip	Autumn Royal								3069	
128CR	12	Capacitance	Drip	Crimson Seedless							2800	3358	
128GR	12	Capacitance	Drip	Red Globe							2410	2173	
128GS	12	Capacitance	Drip	Red Globe							2410	2173	
129CS	2	Tensiometer	Drip	Crimson Seedless									2000
129FL	30	Other	Drip	Flame Seedless							2200	2400	2200
129SO	52	Other	Drip	Thompson Seedless							1800	1600	2000
130SR	6	Other	Low level	Thompson Seedless							2000	2000	
131CS	4	Other	Drip	Crimson Seedless								2800	2000
131ME	2	Other	Drip	Menindee Seedless									1500
131RG	27	Other	Low level	Red Globe							1100		
131RG	29	Other	Drip	Red Globe								1800	1300
131SS	4	Other	Drip	Thompson Seedless								1800	1700
131YG	3	Other	Drip	Red Globe								1800	
132AR	4	Other	Drip	Autumn Royal								3380	2500
132CJ	2	Other	Drip	Crimson Seedless									0
132CP	11	Other	Drip	Crimson Seedless								3000	0
132CR	8	Other	Drip	Crimson Seedless								3150	2185
132MB	2	Other	Drip	Menindee Seedless									0
132MS	12	Other	Drip	Menindee Seedless								2600	2009
132RG	9	Other	Drip	Red Globe								1850	1838
133CS	11	Capacitance	Low level	Crimson Seedless								1800	0
133MS	11	Capacitance	Low level	Menindee Seedless								2150	0
134F1	29	Capacitance	Low level	Flame Seedless									3553
134F2	9	Capacitance	Low level	Flame Seedless									3553
134M1	20	Capacitance	Low level	Menindee Seedless									1755
134M2	2	Capacitance	Low level	Menindee Seedless									0
134M3	5	Capacitance	Low level	Menindee Seedless									1755
134M4	7	Capacitance	Low level	Menindee Seedless									1755

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
101CS							7.34									2.84		
101MD	5.51	4.14	6.76	6.32	6.19	4.85	7.24			0.41	0.25	0.93	1.51	1.83	1.04	2.68		
101RG	5.51	4.51	6.76	6.32	6.45	5.59	7.34			0.34	0.35	0.93	1.51	1.51	1.34	2.84		
101TS	5.51	4.46	6.76	6.32	6.24	5.27	7.34			0.37	0.18	0.90	1.41	1.44	1.10	2.84		
102CR						3.98	14.97	12.61							0.72	6.45	6.06	
102FL									3.40									0.66
102M2						8.78	13.31								3.31	4.56		
102M2								7.93	4.21								1.78	0.71
102M3						3.75	10.39	8.16	3.06						0.91	2.35	2.15	0.51
102MI									4.19									0.73
103CM	7.37	6.67	8.35	8.46						0.73	0.11	1.50	1.39					
103CN			8.35	8.46								1.50	1.39					
103FS	7.37	6.52								0.78	0.10							
103MD	7.37	7.15	8.35	8.46						0.78	0.33	1.50	1.39					
103RG	7.37	7.15	8.35	8.46						0.78	0.51	1.50	1.39					
103TS	7.37	7.15	8.35	8.46						0.78	0.33	1.50	1.39					
104FS						6.52	7.90								1.92	0.68		
104FS								5.88	3.48								0.58	0.70
104H5						6.52	7.63								1.92	0.45		
104H5								5.89	4.77								0.67	0.73
104MS						6.52	8.05								1.94	0.67		
104MS								5.92	3.45								0.61	0.69
104RG							7.90									0.57		
104RG								5.66	3.45								0.34	0.67
105FL	10.98	13.01	11.87	16.86	11.88					3.27	4.61	4.71	9.63	6.07				
105MD	10.98	13.01	11.87	16.86	13.15					3.30	4.64	4.77	9.91	7.52				
105RG	10.98	13.01	11.57	16.86	18.24					3.30	4.70	4.73	9.89	11.52				
105TS	10.98	12.70	11.87	16.86	17.18					3.27	4.68	4.71	9.73	9.78				
106CM	11.45	8.73								4.07	1.77							
106CR	4.91	5.73								0.78	0.37							
106MD	4.91	5.73								0.78	0.37							
106RG	5.18	6.00								0.78	0.37							
106TS	4.91	5.73								0.78	0.37							
107CR			8.91	9.08	7.85							2.16	1.99	1.02				
107FL	6.84	7.21	9.07	9.08	7.85					1.24	0.50	2.32	1.93	0.83				
107MD	6.84	7.21	9.02	9.08	7.85					1.26	0.53	2.32	1.93	0.83				
107RE	6.84	7.21	8.80	9.08	7.85					1.26	0.53	2.32	1.93	0.83				
107RG	6.84	7.21	9.07	9.08	7.85					1.24	0.50	2.32	1.93	0.83				
107TS			8.88	9.08	7.85							2.29	1.99	0.81				
108MD	5.38	5.38	9.78	9.78						1.30	2.29	3.95	4.27					
109CR									4.01									0.67
109FA									4.01									0.67
109RG							7.49	5.06	4.04							1.10	0.19	0.67
109ZC							7.43	5.04	4.01							1.08	0.19	0.67
110AR	8.90	10.94	11.62	13.35	13.77	8.62	15.62			2.19	3.62	4.16	6.51	6.64	1.14	8.40		
110AR								8.66	2.21								2.07	0.14
110BC	5.93	7.55								0.83	1.36							
110BC			10.38	12.50	13.77	9.23	15.62					3.23	5.68	6.60	1.63	8.40		
110BC								8.32	2.20								1.73	0.26
110CM	8.90	10.94	9.46	6.73	13.77	9.15	15.15			2.29	3.66	2.40	1.16	6.69	1.78	7.88		
110CM								8.56	1.79								1.86	0.15
110DC	8.90	10.94	10.23	6.73	13.77					2.06	3.40	2.89	1.39	6.57				
111RG	2.78	5.01	4.05	4.19	4.44	2.49	2.51	3.66	1.87	0.08	0.85	0.05	0.00	0.26	0.15	0.04	0.13	0.00
111TS	3.04	5.16	6.58	4.88	6.22	3.19	2.61	4.33	2.31	0.15	1.42	1.09	0.57	1.47	0.24	0.04	0.36	0.00
112CR			11.35	10.91								3.89	3.48					
112RG			8.52	8.06								1.38	0.74					
112TS			8.69	7.90								1.37	0.59					
113MD	8.90	8.43	5.77	7.86	6.55	6.30	6.43	6.63	4.62	2.83	1.76	0.85	1.52	0.65	1.44	1.66	0.70	0.48
113RG	7.23	8.13	7.24	8.93	7.68	7.57	7.63	7.72	5.56	2.19	1.88	1.65	1.93	1.48	2.59	2.61	1.53	0.40
114MS	8.48	8.02	15.47	15.32						1.76	0.55	7.88	8.19					
114RG	8.55	8.48	14.50	14.36						1.76	0.83	6.94	7.25					
115RG	10.64	9.83								2.75	1.82							
115RG			6.98									1.66						
116FS	7.04	8.49	11.68	12.69	7.05					0.38	1.70	4.62	5.15	2.45				
116MS	7.62	10.83	11.57	12.69	7.05					0.37	2.71	4.59	5.30	2.45				
116NC				12.45	10.77								5.98	3.86				
116RG	7.66	12.93	11.43	12.60	9.82					0.46	4.55	4.29	5.03	3.13				
116TS	7.69	11.27	11.75	12.69	9.45					1.05	3.31	4.66	5.15	2.85				
117RG	5.39	5.13	6.53	7.62						0.42	0.15	0.28	1.09					
117TS	5.37	5.08	6.53	7.50						0.47	0.21	0.28	3.87					
118CA				7.90									1.33					
118CR				8.30									2.15					
118FS				8.50									2.58					
118MS				8.50									2.56					
118RG				8.00									1.40					

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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
118RS				7.50									2.10					
118TS				7.40									2.21					
119CR									4.61									0.40
119MB									4.61									0.38
119ME					7.07	6.82								2.34	0.49			
119ME							7.34	7.36	4.61							2.16	1.19	0.40
119MF					7.07	6.82								2.34	0.49			
119MF							7.25	7.33	4.64							2.10	1.25	0.40
119RG					8.79	7.32								1.87	0.49			
119RG							7.51	7.46	4.73							2.28	1.26	0.35
119TS					7.11	6.82								1.84	0.49			
120CR					10.35	8.20								3.39	1.26			
120CR							7.60	7.60	4.55							2.47	1.50	0.51
120MB									4.55									0.38
120TA					8.77	6.58								3.25	0.76			
120TA							7.49	7.63	4.55							2.40	1.53	0.48
120TC					8.84	6.58								3.61	0.76			
120TC							7.49	7.51	4.55							2.40	1.41	0.48
121TS					6.47									1.10				
122CA				7.04	5.43	5.51	6.57	5.61	4.27				1.24	1.40	0.95	1.13	0.97	1.03
122CR				7.04	5.43	4.83	6.34	5.61	4.31				1.24	1.40	0.73	0.97	0.44	1.06
122MS				7.04	6.05	6.16	7.68	5.62	4.21				1.24	1.57	1.38	1.67	0.97	0.99
122RG				8.64	8.44	5.51	8.11	5.62	4.31				2.15	2.59	0.95	2.00	0.93	1.06
122TS				7.41	7.20	6.11	7.80	5.62	4.31				1.17	1.50	1.34	1.65	0.99	1.06
123AR							7.61	7.90	1.30							0.40	0.88	0.02
123CS					8.82	7.72	7.67	7.81	1.30					2.09	0.56	0.45	0.84	0.02
123RG					8.82	7.72	8.79	7.90	1.30					2.04	0.56	1.47	0.84	0.02
123TS					8.82	7.72	7.99	7.87	1.30					1.75	0.40	0.33	0.64	0.02
124CS					4.30									0.26				
124CS						1.85	6.28								0.08	0.32		
124ME					3.44									0.41				
124ME						1.03	6.06								0.08	0.50		
125CB						6.00	8.34	9.21							1.31	1.94	2.64	
125CM						5.29	8.31	9.43							1.04	1.62	2.42	
125GL						5.29	8.55	8.44							1.04	1.75	2.46	
125GR						5.29	8.55	8.44							0.99	1.58	2.42	
125MH						5.29	8.51	9.34							1.04	1.24	2.42	
125MP						5.29	8.61	9.34							1.04	1.51	2.83	
125OH						6.00	8.27								1.31	1.37		
125TO						6.00	8.23	7.76							1.31	1.51	2.42	
125TS					4.93	6.00	9.09	7.76						0.69	1.31	1.49	2.59	
126CA						5.27	6.59	7.03							0.30	0.61	0.86	
127AR						5.39	4.90	4.82	3.98						0.75	0.11	0.37	1.34
127CA						5.39	4.90	4.85	3.98						0.75	0.12	0.37	1.34
127CR						5.39	4.90	4.96	3.98						0.75	0.12	0.41	1.34
127FL						6.52	4.90	4.91	3.98						0.43	0.12	0.42	1.34
127ME						5.39	4.90	5.56	3.98						0.74	0.12	0.30	1.34
127RG						5.39	4.90	4.86	3.98						0.75	0.12	0.39	1.34
128AR							6.67	6.47								0.16	0.53	
128CR							9.21	6.98								1.28	0.67	
128GR							6.79	6.64								0.38	0.33	
128GS							6.79	6.64								0.38	0.33	
129CS									6.22									1.06
129FL							7.79	6.10	6.25							0.82	0.75	1.09
129SO							7.79	6.03	6.25							0.67	0.70	1.09
130SR							8.06	6.87								0.85	0.20	
131CS								5.53	5.15								0.52	0.67
131ME									5.15									0.65
131RG							9.07									1.71		
131RG								5.16	5.15								0.42	0.66
131SS								5.51	5.15								0.52	0.66
131YG								5.34									0.54	
132AR								6.85	2.67								0.64	0.22
132CJ									2.67									0.22
132CP								6.74	2.67								0.66	0.22
132CR								6.59	2.67								0.55	0.22
132MB									2.67									0.20
132MS								6.68	2.67								0.58	0.22
132RG								6.59	2.67								0.54	0.22
133CS								9.65	3.11								3.88	0.89
133MS								9.65	3.11								3.93	0.92
134F1									4.18									1.59
134F2									4.35									1.97
134M1									5.21									1.93
134M2									5.21									2.07
134M3									4.35									1.55
134M4									4.18									1.41

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
101CS							789									7.1		
101MD	73	45	171	284	344	1480	1190			16.0	18.0	9.7	18.9	29.1	19.0	18.8		
101RG	40	49	861	176	176	1065	789			25.0	20.0	18.5	12.6	12.9	36.6	11.1		
101TS	297	153	746	1192	1216	6543	5622			25.0	25.0	18.5	25.3	1.1	12.2	15.0		
102CR						239	1713	1620							6.5	6.0	10.7	
102FL									315									0.0
102M2						1278	1812								8.5	6.9		
102M2								730	327								24.3	0.3
102M3						239	639	587	156						9.1	21.4	12.7	0.7
102MI									197									0.5
103CM	36	6	79	77						38.0	33.5	23.9	3.8					
103CN			119	115								5.5	18.8					
103FS	58	7								37.0	25.2							
103MD	79	35	165	159						19.0	39.3	29.3	10.0					
103RG	95	64	198	191						35.5	34.6	23.4	21.0					
103TS	158	73	331	319						35.7	35.0	28.6	29.0					
104FS						442	155								32.2	32.2		
104FS								81	78								26.9	1.0
104H5						3041	724								11.5	26.3		
104H5								660	563								29.6	1.8
104MS						1120	349								22.3	36.6		
104MS								199	179								4.6	1.7
104RG							36									40.8		
104RG								13	21								19.2	3.1
105FL	230	332	328	686	432					22.4	22.4	23.6	18.0	19.5				
105MD	464	668	665	1412	1071					17.4	20.5	18.0	13.7	14.4				
105RG	309	452	439	940	1094					15.0	33.0	22.9	24.9	21.2				
105TS	1830	2684	2627	5545	5577					15.0	23.6	19.3	16.8	15.8				
106CM	264	118								37.3	37.3							
106CR	34	17								24.8	37.3							
106MD	102	50								24.8	37.3							
106RG	102	50								24.8	37.3							
106TS	373	182								24.8	37.0							
107CR			332	313	161							32.1	17.6	14.1				
107FL	53	22	102	87	37					37.5	24.8	30.0	41.8	25.5				
107MD	237	101	445	379	164					18.6	37.5	29.3	17.2	20.0				
107RE	81	35	152	130	54					25.0	25.0	24.5	22.4	17.8				
107RG	266	110	508	434	179					37.5	50.0	33.5	36.6	32.0				
107TS			1103	982	398							18.5	28.4	22.0				
108MD	77	146	254	279						20.5	20.5	20.5	20.5					
109CR									143									0.0
109FA									29									0.2
109RG							893	149	28							21.1	6.8	0.0
109ZC							887	150	28							17.4		0.0
110AR	533	911	1069	1714	1499	712	2981			25.0	25.0	26.3	20.0	22.1	26.1	15.8		
110AR								628	32								7.1	15.3
110BC	85	144								5.0	16.2							
110BC			349	629	627	411	1255					20.0	21.4	25.0	22.5	5.0		
110BC								462	162								9.2	4.3
110CM	175	291	195	96	476	338	892			11.7	21.7	15.0	7.3	20.0	8.3	6.7		
110CM								179	11								10.0	1.6
110DC	53	90	78	39	156					15.0	20.0	15.0	12.4					
111RG	4	46	3	0	14	8	2	7	0	15.0	12.4	23.0	13.4	3.4		11.6	5.1	0.0
111TS	8	77	59	31	80	13	2	20	0	4.7	12.8	22.0	17.2	1.6		22.7		0.0
112CR			818	740								18.0	24.0					
112RG			133	72								30.1	11.1					
112TS			277	120								9.5	16.6					
113MD	477	316	154	278	119	8077	3843	902	314	22.5	4.0	7.7	23.2	14.8	29.6	33.4		5.0
113RG	393	360	317	376	277	13145	5692	1941	221	37.5	37.5	30.8	23.2	29.7	44.6	33.4	4.7	6.3
114MS	124	39	572	607						37.8	31.5	29.0	27.0					
114RG	124	60	504	538						31.5	25.2	35.3	24.0					
115RG	38	27								20.7	41.4							
115RG			25									3.0						
116FS	11	50	135	150	71					20.5	17.3	18.5	15.6	20.5				
116MS	39	290	490	567	261					15.5	12.2	13.6	2.7	17.3				
116NC				160	166								2.3	20.7				
116RG	71	707	667	781	487					26.3	29.4	25.5	19.1	28.7				
116TS	81	258	362	400	221					26.3	18.1	21.6	18.8	23.1				
117RG	23	9	16	61						16.6	35.8	36.0	34.2					
117TS	172	77	102	1453						12.6	11.8	14.3	19.1					
118CA				32									29.2					
118CR				70									12.2					
118FS				42									13.5					
118MS				41									13.5					
118RG				45									26.4					

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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
118RS				274									9.2					
118TS				71									33.6					
119CR									138									8.9
119MB									19									4.6
119ME					169	185								22.4	13.8			
119ME							315	176	37							20.4	14.9	19.4
119MF					262	279								27.8	8.5			
119MF							464	277	56							19.1	14.9	13.1
119RG					540	701								22.0	18.5			
119RG							1320	742	130							25.4	12.2	27.2
119TS					258	359								31.0	13.0			
120CR					959	1659								8.1	21.8			
120CR							1434	857	190							37.8	14.8	25.3
120MB									44									13.3
120TA					1160	1206								17.6	15.4			
120TA							1719	1070	185							38.5	12.6	20.0
120TC					749	836								25.9	13.3			
120TC							999	586	130							39.2	12.6	23.4
121TS					170									23.0				
122CA				69	77	53	67	387	52				5.3	9.6	4.0	17.8	19.5	13.4
122CR				103	116	60	86	191	536				6.1	3.2	17.4		36.0	7.8
122MS				69	87	77	99	387	151				4.0	10.8	15.7	51.9	6.0	8.9
122RG				477	574	210	474	541	268				2.9	4.6	5.1	28.7	6.9	3.6
122TS				260	333	298	390	238	402				7.8	5.2	11.0	19.3	4.8	5.0
123AR							150	378	3							21.1	10.8	0.0
123CS					465	512	314	662	5					18.0	10.4	16.4	5.9	0.0
123RG					905	1022	1872	1310	10					9.0	28.8	58.8	2.4	0.0
123TS					780	738	452	1001	10					20.3	13.4	31.5	13.2	0.0
124CS					35									15.6				
124CS						110	125								11.6	32.0		
124ME					28									11.3				
124ME						195	39								3.8	21.0		
125CB						416	493	269							12.8	25.4	18.8	
125CM						362	412	246							23.5	53.1	18.8	
125GL						226	274	159							59.4	56.2	9.8	
125GR						347	395	250							28.3	32.5	9.8	0.0
125MH						272	234	185							16.5	21.4	5.9	
125MP						272	282	216							13.4	12.5	5.9	
125OH						208	175								17.7	14.0		
125TO						725	675	442							7.8	23.2	14.9	
125TS					295	2080	1793	1358						2.0	14.5	23.2	14.9	
126CA						172	377	520							29.2	24.7	16.1	
127AR						86	13	291	171							19.4	14.6	4.5
127CA						43	7	142	77						32.2	32.9	21.0	12.6
127CR						43	7	160	85						14.8	11.3	8.1	9.0
127FL						20	6	131	68						25.0	44.7	24.5	25.1
127ME						128	22	319	256						13.0	13.0	6.0	5.5
127RG						174	30	619	345						21.8	25.6	7.2	6.7
128AR							100	24									6.0	
128CR							1147	53								35.9	25.0	
128GR							760	44								34.3	22.2	
128GS							504	29								34.3	22.2	
129CS									109									0.9
129FL							109	63	73							45.3	20.8	2.9
129SO							1110	523	110							21.1	9.1	0.9
130SR							1299	187								36.7	25.6	
131CS								77	77								4.9	2.0
131ME									46									1.0
131RG							1140									30.0		
131RG								336	379								4.3	1.9
131SS								182	180								25.2	1.2
131YG								190									6.3	
132AR								383	56								8.2	0.8
132CJ									40									0.0
132CP								115	16								14.2	0.0
132CR								255	42								6.9	1.5
132MB									75									0.0
132MS								154	25								18.6	11.0
132RG								272	46								23.8	3.4
133CS								177	44								11.5	0.0
133MS								191	45								18.5	0.0
134F1									70									14.0
134F2									63									19.9
134M1									326									2.15
134M2									158									0
134M3									167									1.55
134M4									414									5.44

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
101CS							29									227		
101MD	19	12	24	22	20	22	28			220	228	230	233	160	228	227		
101RG	19	13	24	22	21	25	29			220	230	230	233	160	220	224		
101TS	19	13	24	22	21	24	29			221	229	230	233	162	223	227		
102CR						51	135	100							238	129	163	
102FL									58									241
102M2						41	85								242	163		
102M2								106	65								181	233
102M3						58	138	112	54						237	181	174	241
102MI									67									235
103CM	48	44	52	51						240	211	208	171					
103CN			52	51								208	171					
103FS	48	43								240	212							
103MD	48	47	52	51						240	205	208	171					
103RG	48	47	52	51						240	204	208	171					
103TS	48	47	52	51						240	205	208	171					
104FS						42	52								232	231		
104FS								73	64								231	246
104H5						42	49								229	236		
104H5								69	103								227	244
104MS						42	50								231	229		
104MS								70	64								229	246
104RG							48									231		
104RG								78	64								221	246
105FL	31	28	30	24	20					195	206	207	208	199				
105MD	31	28	29	24	20					195	206	208	208	197				
105RG	31	28	28	24	24					195	207	209	208	191				
105TS	31	27	30	24	24					195	177	207	208	192				
106CM	21	16								194	163							
106CR	18	21								166	167							
106MD	18	21								166	167							
106RG	19	22								207	215							
106TS	18	21								166	167							
107CR			34	29	25							214	220	197				
107FL	25	24	34	29	25					256	200	214	221	199				
107MD	25	24	34	29	25					256	199	214	220	199				
107RE	25	24	33	29	25					256	199	214	221	198				
107RG	25	24	34	29	25					256	200	214	221	198				
107TS			35	29	25							215	220	196				
108MD	11	11	14	14						113	110	212	207					
109CR									87									222
109FA									87									222
109RG							89	89	87							210	228	222
109ZC							88	88	87							206	228	222
110AR	19	27	21	24	24	21	34			256	232	204	164	190	249	222		
110AR								73	18								195	225
110BC	19	27								262	238							
110BC			17	23	24	22	34					206	166	190	248	222		
110BC								69	19								202	249
110CM	19	27	18	14	24	24	33			254	232	208	179	190	251	224		
110CM								72	15								199	239
110DC	19	27	18	14	24					256	233	206	178	190				
111RG	39	51	75	55	55	43	37	47	29	202	171	236	247	204	273	248	232	221
111TS	41	51	77	54	57	43	41	46	29	193	165	218	228	193	272	243	227	220
112CR			49	46								188	188					
112RG			43	44								223	212					
112TS			42	44								226	214					
113MD	44	44	73	122	102	99	100	98	70	228	225	211	165	207	203	192	215	207
113RG	100	42	74	150	125	125	125	128	84	226	223	210	123	174	182	152	182	208
114MS	53	46	49	48						236	238	196	196					
114RG	52	44	48	48						235	236	197	197					
115RG	36	30								213	225							
115RG			33									210						
116FS	39	37	39	34	33					259	214	222	220	133				
116MS	42	55	39	34	33					257	203	222	216	132				
116NC				31	35								218	216				
116RG	42	60	39	34	45					260	194	224	222	218				
116TS	42	54	39	34	43					254	202	234	220	199				
117RG	26	30	23	33						205	220	193	251					
117TS	26	30	23	33						203	220	196	248					
118CA				14									175					
118CR				15									173					
118FS				15									175					
118MS				15									175					
118RG				14									175					

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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
118RS				13									176					
118TS				13									174					
119CR									44									211
119MB									44									212
119ME					25	30								210	238			
119ME							71	69	44							191	206	211
119MF					25	30								210	238			
119MF							70	69	44							193	207	211
119RG					32	32								213	238			
119RG							73	70	45							191	205	211
119TS					26	30								211	238			
120CR					33	35								204	222			
120CR							73	70	43							179	199	207
120MB									43									213
120TA					29	28								204	232			
120TA							72	69	43							186	199	209
120TC					29	28								209	232			
120TC							72	69	43							186	200	209
121TS					24									201				
122CA				35	30	42	45	72	34				190	134	240	221	223	212
122CR				35	30	35	45	70	34				190	134	247	223	221	211
122MS				35	32	45	52	72	34				190	166	237	214	223	212
122RG				44	43	42	54	72	34				183	153	240	214	222	211
122TS				44	43	44	54	72	34				197	163	238	216	222	211
123AR							86	91	41							217	196	224
123CS					76	96	89	90	41					163	227	218	197	224
123RG					76	96	90	90	41					166	227	193	194	224
123TS					76	96	88	89	41					211	231	214	206	241
124CS					15									186				
124CS						19	64								273	230		
124ME					12									101				
124ME						11	66								273	231		
125CB						27	53	45							228	229	238	
125CM						21	53	44							236	230	219	
125GL						21	52	41							236	225	245	
125GR						21	53	43							235	233	242	
125MH						21	49	46							236	221	220	
125MP						21	52	46							236	223	217	
125OH						27	52								228	232		
125TO						27	53	41							228	231	250	
125TS					31	27	49	43						196	228	223	249	
126CA						84	59	61							266	212	213	
127AR						43	61	56	25						252	237	223	212
127CA						43	61	56	25						252	237	223	212
127CR						43	61	56	25						252	237	223	212
127FL						64	61	56	25						237	237	222	212
127ME						43	61	57	25						253	237	220	212
127RG						43	61	55	25						252	237	222	212
128AR							100	63								232	229	
128CR							116	64								189	218	
128GR							67	62								227	232	
128GS							67	63								227	232	
129CS									104									213
129FL							107	86	104							222	225	213
129SO							102	85	104							213	227	213
130SR							41	35								237	258	
131CS								66	96								229	213
131ME									96									211
131RG							37									229		
131RG								70	96								231	213
131SS								67	96								230	213
131YG								64									228	
132AR								78	39								221	219
132CJ									39									219
132CP								79	39								210	219
132CR								78	39								210	219
132MB									39									219
132MS								77	39								214	219
132RG								77	39								215	219
133CS								33	10								216	244
133MS								33	10								214	244
134F1									14									247
134F2									13									248
134M1									14									248
134M2									14									248
134M3									13									250
134M4									14									248

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
101CS							261									0.97		
101MD	99	102	102	104	104	877	263			2.90	4.34	1.43	3.00	4.70	3.92	2.59		
101RG	102	124	102	102	102	775	261			4.54	4.43	2.74	2.00	2.00	6.55	1.52		
101TS	99	102	102	104	104	816	261			4.54	5.61	2.74	4.00	0.17	2.32	2.04		
102CR						61	44	44							1.63	0.40	0.85	
102FL									50									0.00
102M2						42	44								0.97	0.52		
102M2								44	50								3.06	0.08
102M3						42	44	44	50						2.42	2.06	1.56	0.21
102MI									50									0.11
103CM	92	95	97	102						5.16	5.02	2.86	0.44					
103CN			97	102								0.66	2.22					
103FS	92	95								5.02	3.87							
103MD	92	95	97	102						2.58	5.49	3.51	1.18					
103RG	92	95	97	102						4.82	4.84	2.80	2.48					
103TS	92	95	97	102						4.85	4.89	3.43	3.43					
104FS						253	249								4.94	4.07		
104FS								150	115								4.57	0.30
104H5						249	254								1.77	3.45		
104H5								150	115								5.03	0.37
104MS						274	247								3.42	4.55		
104MS								150	115								0.78	0.48
104RG							250									5.17		
104RG								152	115								3.38	0.89
105FL	99	102	102	104	104					2.04	1.72	1.99	1.07	1.64				
105MD	99	102	102	104	104					1.58	1.58	1.52	0.81	1.09				
105RG	99	102	102	104	104					1.37	2.54	1.98	1.48	1.16				
105TS	99	102	102	104	104					1.37	1.86	1.63	1.00	0.92				
106CM	99	102								3.26	4.27							
106CR	99	102								5.05	6.51							
106MD	99	102								5.05	6.51							
106RG	99	102								4.79	6.22							
106TS	99	102								5.05	6.46							
107CR			102	104	104							3.60	1.94	1.80				
107FL	99	102	102	104	104					5.48	3.44	3.31	4.60	3.25				
107MD	99	102	102	104	104					2.72	5.20	3.25	1.89	2.55				
107RE	99	102	102	104	99					3.65	3.47	2.78	2.47	2.27				
107RG	99	102	102	104	99					5.48	6.93	3.69	4.03	4.08				
107TS			102	104	104							2.08	3.12	2.80				
108MD	10	12	13	13						3.81	3.81	2.10	2.10					
109CR									90									0.01
109FA									90									0.05
109RG							2024	1987	89							2.81	1.34	0.00
109ZC							2038	1997	90							2.34		0.00
110AR	111	115	118	122	102	312	172			2.81	2.29	2.26	1.50	1.61	3.02	1.01		
110AR								147	109								0.82	6.90
110BC	111	116								0.84	2.14							
110BC			118	122	102	298	172					1.93	1.71	1.82	2.44	0.32		
110BC								106	109								1.10	1.94
110CM	111	116	118	122	102	300	174			1.31	1.98	1.59	1.09	1.45	0.91	0.44		
110CM								148	109								1.17	0.89
110DC	111	116	118	122	102					1.69	1.83	1.47	1.84					
111RG	80	81	81	81	81	81	84	84	90	5.38	2.49	5.68	3.19	0.76		4.62	1.38	0.00
111TS	80	81	81	81	81	81	84	84	90	1.55	2.47	3.34	3.53	0.26		8.72		0.00
112CR			13	13								1.59	2.20					
112RG			13	13								3.53	1.37					
112TS			13	13								1.10	2.10					
113MD	10	12	13	13	13	1218	485	257	115	2.53	0.47	1.33	2.95	2.26	4.69	5.19		1.07
113RG	10	12	13	13	12	1031	426	236	115	5.18	4.61	4.26	2.59	3.87	5.89	4.37	0.61	1.12
114MS	99	102	102	104						4.46	3.93	1.87	1.76					
114RG	99	102	102	104						3.69	2.97	2.43	1.67					
115RG	10	12								1.94	4.21							
115RG			13									0.43						
116FS	80	81	81	81	81					2.91	2.04	1.58	1.23	2.91				
116MS	80	81	81	81	81					2.03	1.13	1.18	0.21	2.45				
116NC				11	11								0.18	1.92				
116RG	80	81	81	81	81					3.43	2.27	2.23	1.51	2.92				
116TS	80	81	81	81	81					3.41	1.61	1.84	1.48	2.44				
117RG	99	102	102	100						3.08	6.98	5.51	4.49					
117TS	99	102	102	104						2.35	2.32	2.19	2.54					
118CA				81									3.69					
118CR				81									1.47					
118FS				81									1.59					
118MS				81									1.59					
118RG				81									3.3					

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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
118RS				81									1.23					
118TS				81									4.54					
119CR									115									1.92
119MB									115									0.99
119ME					81	531								3.17	2.02			
119ME							191	198	115							2.78	2.02	4.21
119MF					84	531								3.93	1.25			
119MF							192	197	115							2.63	2.03	2.83
119RG					81	502								2.50	2.52			
119RG							189	197	115							3.38	1.64	5.74
119TS					81	531								4.36	1.90			
120CR					78	459								0.78	2.66			
120CR							188	190	115							4.98	1.94	5.55
120MB									115									2.93
120TA					81	454								2.01	2.34			
120TA							189	188	115							5.14	1.65	4.38
120TC					81	547								2.93	2.02			
120TC							189	193	115							5.23	1.68	5.13
121TS					104									3.56				
122CA				102	102	102	109	789	115				0.75	1.77	0.73	2.71	3.48	3.13
122CR				102	102	102	109	563	115				0.86	0.58	3.60		6.42	1.81
122MS				102	102	102	109	788	115				0.56	1.79	2.54	6.76	1.07	2.11
122RG				102	102	102	109	280	115				0.34	0.55	0.93	3.54	1.22	0.83
122TS				102	102	102	109	110	115				1.05	0.73	1.80	2.48	0.85	1.17
123AR							339	379	115							2.77	1.37	0.00
123CS					102	450	337	381	115					2.04	1.35	2.14	0.76	0.00
123RG					102	450	308	377	115					1.02	3.74	6.69	0.30	0.00
123TS					102	450	328	379	115					2.29	1.74	3.94	1.67	0.00
124CS					79									3.63				
124CS						794	235								6.25	5.10		
124ME					79									3.27				
124ME						2824	84								3.65	3.46		
125CB						392	313	125							2.13	3.05	2.04	
125CM						430	313	124							4.44	6.39	2.00	
125GL						430	307	126							11.22	6.57	1.16	
125GR						430	307	126							5.34	3.80	1.16	
125MH						430	308	124							3.11	2.52	0.63	
125MP						430	306	124							2.53	1.45	0.63	
125OH						392	314								2.95	1.69		
125TO						392	315	128							1.29	2.82	1.92	
125TS					104	392	296	128						0.40	2.42	2.55	1.92	
126CA						79	87	84							5.54	3.75	2.29	
127AR						101	106	775	114							3.96	3.03	1.13
127CA						102	107	777	115						5.97	6.70	4.33	3.16
127CR						102	107	763	115						2.74	2.30	1.63	2.26
127FL						101	106	763	114						3.84	9.12	4.99	6.31
127ME						102	107	692	115						2.41	2.64	1.09	1.37
127RG						102	107	777	115						4.03	5.21	1.47	1.68
128AR							349	17									0.93	
128CR							257	15								3.90	3.58	
128GR							343	15								5.05	3.34	
128GS							343	15								5.05	3.34	
129CS									115									0.15
129FL							251	148	115							5.81	3.40	0.47
129SO							251	148	115							2.71	1.52	0.15
130SR							246	143								4.55	3.72	
131CS								152	115								0.88	0.38
131ME									115									0.19
131RG							230									3.30		
131RG								165	115								0.83	0.37
131SS								152	114								4.57	0.23
131YG								154									1.18	
132AR								290	115								1.19	0.29
132CJ									115									0.00
132CP								293	115								2.11	0.00
132CR								297	115								1.05	0.55
132MB									115									0.00
132MS								294	115								2.78	4.11
132RG								297	115								3.60	1.25
133CS								107	115								1.19	0.00
133MS								107	115								1.92	0.00
134F1									50									3.35
134F2									50									4.58
134M1									50									0.41
134M2									50									0
134M3									50									0.36
134M4									50									1.3

Site	Gross return per megalitre ($/ML)									Cost of water per tonne of fruit ($/t)								
	2003	2004	2005	2006	2007	2008	2009	2010	2011	2003	2004	2005	2006	2007	2008	2009	2010	2011
101CS							2911									284		
101MD	2905	4343	2008	5995	9865	8222	4662			39	27	80	39	25	227	107		
101RG	4538	4433	3830	3398	2805	11464	2728			25	31	336	58	57	120	182		
101TS	4538	1121	3283	6393	311	4175	3268			25	21	42	29	679	357	135		
102CR						5546	1282	2546							53	174	82	
102FL									0									
102M2						3308	1825								69	132		
102M2								10721	272								23	1021
102M3						8222	7216	5061	749						28	34	46	370
102MI									452									702
103CM	9027	5973	3690	739						20	21	38	259					
103CN			834	3427								167	52					
103FS	10045	8465								21	28							
103MD	5313	9286	5007	2589						39	19	31	97					
103RG	8770	4838	3541	5813						21	22	39	46					
103TS	7753	6802	5285	6206						21	22	32	34					
104FS						10860	9779								54	64		
104FS								10058	654								35	429
104H5						3361	7593								147	77		
104H5								12071	1107								32	345
104MS						5806	9098								84	57		
104MS								2354	1054								206	266
104RG							6720									51		
104RG								6089	1154								48	143
105FL	3258	2752	2983	1819	2632					58	70	58	111	72				
105MD	2534	2522	2275	1217	1309					74	76	77	146	109				
105RG	2185	4060	2970	2361	2089					86	47	59	81	102				
105TS	2185	2973	2439	1593	1472					85	64	71	119	129				
106CM	5210	6838								33	26							
106CR	8083	10420								21	17							
106MD	8083	10420								21	17							
106RG	7658	9947								23	18							
106TS	8083	10337								21	17							
107CR			5044	3007	2515							31	58	63				
107FL	8771	5502	4962	6905	5198					20	32	33	24	35				
107MD	4350	8319	4550	2835	4077					39	21	34	59	44				
107RE	5847	5546	4036	2959	2608					29	32	39	46	47				
107RG	8771	11092	4433	4431	5606					20	16	30	28	26				
107TS			2499	4842	4064							53	36	40				
108MD	6099	6099	2935	2935						8	8	15	16					
109CR									20									10311
109FA									103									2040
109RG							5626	671	0							724	1491	
109ZC							2107		5							876		28129
110AR	4494	3657	2712	2681	2087	4188	1719			46	58	60	93	74	109	185		
110AR								1147	15301								195	18
110BC	1180	3002								152	62							
110BC			2311	2880	3177	10969	656					70	81	65	129	583		
110BC								2311	3614								108	63
110CM	2103	3174	1585	1421	2034	1269	615			97	67	85	127	82	349	429		
110CM								1635	1249								137	137
110DC	2697	2925	1173	2211						76	73	92	75					
111RG	2388	2848	6816	5751	954		7847	1381	0	20	44	19	34	142		24	80	
111TS	870	4438	4013	5642	391		9592		0	70	44	32	31	415		13		
112CR			2220	6114								27	19					
112RG			4239	3203								12	31					
112TS			1316	3504								38	20					
113MD	5562	759	1869	6480	4964	12661	14399		2144	15	84	30	14	18	266	99		136
113RG	12442	6455	5364	5700	7744	14730	12144	1578	2247	7	9	9	16	10	180	104	437	102
114MS	8910	6288	2248	3172						26	31	65	70					
114RG	8847	4158	3406	3342						32	40	50	74					
115RG	3306	2527								12	6							
115RG			645									59						
116FS	4949	4077	2930	3272	7555					33	48	61	79	33				
116MS	4069	1577	2115	418	4651					47	86	83	465	40				
116NC				451	4228								483	10				
116RG	6343	2956	3793	4031	5552					28	43	44	64	33				
116TS	6143	1930	3862	3949	5375					28	60	53	66	40				
117RG	4933	11160	6618	8982						36	16	20	25					
117TS	3756	3714	3067	3812						48	49	51	45					
118CA				5522									22					
118CR				2577									54.9					
118FS				2636									50.9					
118MS				3335									50.9					
118RG				7596									24.5					

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Site	Gross return per megalitre ($/ML)									Cost of water per tonne of fruit ($/t)								
	2003	2004	2005	2006	2007	2008	2009	2010	2011	2003	2004	2005	2006	2007	2008	2009	2010	2011
118RS				2576									66					
118TS				7533									18					
119CR									4233									72
119MB									2074									141
119ME					4751	4038								34	276			
119ME							5008	5049	9270							78	109	33
119MF					5896	2498								28	447			
119MF							4730	5069	6232							83	108	49
119RG					3004	4084								43	210			
119RG							6764	2622	10254							64	134	24
119TS					5229	3417								25	294			
120CR					1565	5860								134	182			
120CR							9702	3888	12205							43	109	25
120MB									6149									39
120TA					4013	4211								54	206			
120TA							9249	2804	7452							42	127	26
120TC					5858	3634								37	284			
120TC							9408	2849	10468							41	128	27
121TS					4073									33				
122CA				1252	2362	1056	4207	4039	5907				148	63	152	44	230	40
122CR				2402	1715	10248		14324	4254				128	190	31		89	69
122MS				1255	3206	3098	13187	537	4533				196	62	44	18	743	59
122RG				715	749	1562	7964	1949	1620				328	202	119	33	238	152
122TS				2269	1446	504	4461	683	2461				106	153	62	48	140	107
123AR							8573	3977	0							123	284	
123CS					4488	2699	6167	1703	0					55	341	162	518	
123RG					1428	5790	12579	435	0					109	123	48	1292	
123TS					2524	3300	7887	2677	0					49	265	86	234	
124CS					7990									23				
124CS						11249	11977								129	49		
124ME					7530									26				
124ME						9124	5891								778	28		
125CB						6390	6407	6124							185	103	62	
125CM						13309	14048	5985							97	49	63	
125GL						17958	11823	1969							39	47	110	
125GR						8552	6838	1969							81	81	110	
125MH						5291	4530	1428							139	123	198	
125MP						4297	2616	1428							171	212	198	
125OH						5907	3373								133	187		
125TO						2587	5068	4028							304	113	68	
125TS					759	4599	4718	4028						265	163	117	68	
126CA						7917	6299	4230							17	28	44	
127AR							10693	8070	3013							30	262	112
127CA						8653	10382	5019	5974						19	18	180	36
127CR						7819	5530	4337	5311						42	46	477	56
127FL						10359	28262	8937	21653						30	13	155	20
127ME						2938	5157	543	2945						48	45	648	93
127RG						6785	14078	2356	3290						29	23	536	76
128AR								2847									28	
128CR							10918	12024								68	7	
128GR							12167	7265								70	7	
128GS							12167	7265								70	7	
129CS									295									857
129FL							12780	8165	1026							43	47	271
129SO							4881	2427	291							93	105	866
130SR							9097	7444								56	41	
131CS								2471	769								187	333
131ME									285									674
131RG							3633									76		
131RG								1492	477								203	349
131SS								8224	396								36	548
131YG								2115									142	
132AR								4034	720								254	457
132CJ									0									
132CP								6325	0								145	
132CR								3302	1193								296	241
132MB									0									
132MS								7237	8264								106	32
132RG								6669	2303								86	105
133CS								2135	0								96	
133MS								4121	0								63	
134F1									11914									12
134F2									16262									9
134M1									725									98
134M2									0									
134M3									625									114
134M4									2282									31.1

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
101CS							11									61		
101MD	26	38	18	51	84	9	17			93	94	86	76	70	79	63		
101RG	39	32	4	30	24	15	10			94	92	86	76	77	76	61		
101TS	40	10	29	54	3	5	12			93	96	87	78	77	79	61		
102CR						64	18	36							82	57	52	
102FL									0									81
102M2						50	27								62	66		
102M2								151	3								78	83
102M3						120	102	71	10						76	77	74	83
102MI									6									83
103CM	88	56	34	6						90	98	82	84					
103CN			8	30								82	84					
103FS	97	80								89	99							
103MD	52	89	46	23						89	95	82	84					
103RG	86	46	32	51						89	93	82	84					
103TS	76	63	48	54						89	95	82	84					
104FS						41	37								71	91		
104FS								62	5								90	80
104H5						13	29								71	94		
104H5								75	9								89	85
104MS						20	35								70	92		
104MS								15	8								90	80
104RG							26									93		
104RG								37	9								94	80
105FL	28	23	26	15	22					70	65	60	43	49				
105MD	22	21	20	10	11					70	64	60	41	43				
105RG	19	34	26	20	18					70	64	59	41	37				
105TS	19	25	21	13	12					70	63	60	42	43				
106CM	48	62								65	80							
106CR	75	94								84	93							
106MD	75	94								84	93							
106RG	71	90								85	94							
106TS	75	93								84	93							
107CR			46	27	22							76	78	87				
107FL	82	50	45	62	46					82	93	74	79	89				
107MD	41	76	42	25	36					82	93	74	79	89				
107RE	55	50	37	26	24					82	93	74	79	89				
107RG	82	101	40	40	52					82	93	74	79	89				
107TS			23	43	36							74	78	90				
108MD	207	191	91	90						76	57	60	56					
109CR									0									83
109FA									1									83
109RG							3	0	0							85	96	83
109ZC							1		0							85	96	83
110AR	35	28	20	19	18	13	9			75	67	64	51	52	87	46		
110AR								7	125								76	94
110BC	9	23								86	82							
110BC			17	21	27	35	4					69	55	52	82	46		
110BC								20	30								79	88
110CM	17	24	12	10	17	4	3			74	66	75	83	51	81	48		
110CM								10	10								78	92
110DC	21	22	9	16						77	69	72	79	52				
111RG	22	26	63	53	9		72	13	0	97	83	99	100	94	94	99	96	100
111TS	8	41	37	52	4		87		0	95	73	83	88	76	92	99	92	100
112CR			53	144								66	68					
112RG			101	75								84	91					
112TS			31	82								84	93					
113MD	149	19	47	160	122	10	28		15	68	79	85	81	90	77	74	89	90
113RG	332	162	134	140	198	14	27	6	20	70	77	77	78	81	66	66	80	93
114MS	76	52	19	26						79	93	49	47					
114RG	76	35	28	27						79	90	52	49					
115RG	145	100								74	82							
115RG			25									76						
116FS	52	42	30	34	78					95	80	60	59	65				
116MS	42	16	22	4	48					95	75	60	58	65				
116NC				5	219								52	64				
116RG	66	30	39	42	57					94	65	62	60	68				
116TS	64	20	40	41	55					86	71	60	59	70				
117RG	44	97	59	81						92	97	96	86					
117TS	34	32	27	33						91	96	96	48					
118CA				68									83					
118CR				31.9									74					
118FS				32.6									70					
118MS				41.3									70					
118RG				94									83					

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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
118RS				32									72					
118TS				93									70					
119CR									31									91
119MB									15									92
119ME					44	7								67	93			
119ME							23	23	67							71	84	91
119MF					53	5								67	93			
119MF							22	23	45							71	83	91
119RG					28	8								79	93			
119RG							31	12	74							70	83	93
119TS					49	6								74	93			
120CR					15	12								67	85			
120CR							45	18	88							67	80	89
120MB									53									92
120TA					37	9								63	89			
120TA							43	13	65							68	80	89
120TC					54	6								59	89			
120TC							44	13	75							68	81	89
121TS					34									83				
122CA				11	21	10	36	5	47				82	74	83	83	83	76
122CR				22	16	92		25	34				82	74	85	85	92	75
122MS				11	29	28	112	1	36				82	74	78	78	83	76
122RG				6	7	14	67	7	13				75	69	83	75	83	75
122TS				21	13	5	38	6	20				84	79	78	79	82	75
123AR							25	10	0							95	89	98
123CS					40	6	18	4	0					76	93	94	89	98
123RG					13	13	40	1	0					77	93	83	89	98
123TS					23	7	23	7	0					80	95	96	92	98
124CS					96									94				
124CS						14	48								95	95		
124ME					90									88				
124ME						3	61								92	92		
125CB						16	20	49							78	77	71	
125CM						31	45	48							80	81	74	
125GL						42	38	15							80	79	71	
125GR						20	22	15							81	81	71	
125MH						12	15	11							80	85	74	
125MP						10	9	11							80	82	70	
125OH						15	11								78	83		
125TO						7	16	31							78	82	69	
125TS					7	12	16	31						86	78	84	67	
126CA						82	61	42							94	91	88	
127AR							90	10	24						86	98	92	66
127CA						75	88	7	52						86	97	92	66
127CR						68	52	6	42						86	97	92	66
127FL						91	241	12	172						93	97	91	66
127ME						26	44	1	23						86	97	95	66
127RG						59	119	3	26						86	97	92	66
128AR								111								98	92	
128CR							41	508								86	90	
128GR							35	307								94	95	
128GS							35	307								94	95	
129CS									2									83
129FL							51	51	8							89	88	83
129SO							20	15	2							91	88	83
130SR							36	49								89	97	
131CS								15	6								91	87
131ME									2									87
131RG							15									81		
131RG								9	4								92	87
131SS								50	3								91	87
131YG								13									90	
132AR								13	6								91	92
132CJ									0									92
132CP								21	0								90	92
132CR								10.6	9.1								92	92
132MB									0									92
132MS								24.6	62.8								91	92
132RG								21.5	17.5								92	92
133CS								18.7	0								60	71
133MS								33.9	0								59	71
134F1									294									62
134F2									401									55
134M1									17.9									63
134M2									0									60
134M3									15.4									64
134M4									56.4									66

Site	Yield per volume of drainage (t/ML)									Cost of drainage per tonne of fruit ($/t)								
	2003	2004	2005	2006	2007	2008	2009	2010	2011	2003	2004	2005	2006	2007	2008	2009	2010	2011
101CS							2.5									109.6		
101MD	39.3	73.2	10.5	12.5	15.9	18.3	7.0			2.9	1.6	11.0	9.4	7.4	48.7	39.7		
101RG	73.4	56.5	19.9	8.3	8.5	27.4	3.9			1.6	2.4	46.1	13.8	13.5	28.8	70.2		
101TS	68.1	135.8	20.5	17.9	0.8	11.2	5.3			1.7	0.8	5.6	6.6	156.4	74.3	52.1		
102CR						9.0	0.9	1.8							9.6	74.7	39.6	
102FL									0.0									
102M2						2.6	1.5								25.9	45.2		
102M2								13.7	0.5								5.2	173.1
102M3						10.0	9.1	5.9	1.3						6.8	7.8	12.0	61.9
102MI									0.7									122.3
103CM	51.9	294.8	15.9	2.7						2.0	0.4	6.9	42.5					
103CN			3.7	13.5								30.1	8.5					
103FS	47.6	262.2								2.2	0.4							
103MD	24.5	117.3	19.5	7.2						4.2	0.9	5.6	15.9					
103RG	45.7	68.4	15.6	15.1						2.2	1.5	7.1	7.6					
103TS	45.9	104.5	19.0	20.9						2.2	1.0	5.8	5.5					
104FS						16.8	47.1								15.8	5.5		
104FS								46.7	1.5								3.5	86.8
104H5						6.0	58.7								43.5	4.5		
104H5								44.0	2.4								3.7	52.6
104MS						11.5	54.7								24.9	4.7		
104MS								7.6	2.4								21.2	53.6
104RG							71.2									3.7		
104RG								56.3	4.5								2.9	28.0
105FL	6.9	4.9	5.0	1.9	3.2					17.1	24.7	23.2	63.4	36.8				
105MD	5.3	4.4	3.8	1.4	1.9					22.2	27.2	30.8	86.0	62.2				
105RG	4.6	7.0	4.9	2.5	1.8					25.8	17.1	24.0	47.2	64.6				
105TS	4.6	5.0	4.1	1.7	1.6					25.4	23.7	28.4	68.8	73.5				
106CM	9.2	21.1								11.8	5.3							
106CR	31.6	100.1								3.4	1.1							
106MD	31.6	100.1								3.4	1.1							
106RG	31.6	100.1								3.4	1.1							
106TS	31.6	99.3								3.4	1.1							
107CR			14.9	8.9	13.8							7.4	12.7	8.1				
107FL	30.2	49.4	12.9	21.6	30.6					3.5	2.2	8.5	5.2	3.7				
107MD	14.7	71.3	12.6	8.9	24.0					7.3	1.5	8.7	12.6	4.7				
107RE	19.8	47.5	10.6	11.6	21.3					5.4	2.3	10.4	9.7	5.0				
107RG	30.2	99.7	14.5	18.9	38.4					3.5	1.1	7.6	5.9	2.8				
107TS			8.1	14.3	27.2							13.5	7.9	4.1				
108MD	15.8	9.0	5.2	4.8						1.9	3.6	6.2	6.8					
109CR									0.1									1728
109FA									0.3									341.9
109RG							19.2	36.5	0.0							106.0	54.8	
109ZC							16.1		0.0							127.4		4724
110AR	11.4	6.9	6.3	3.1	3.3	22.9	1.9			11.2	19.2	21.4	45.1	35.7	14.4	99.4		
110AR								3.4	112.6								46.6	1.1
110BC	6.0	11.9								21.3	11.1							
110BC			6.2	3.8	3.8	13.8	0.6					21.8	36.8	31.3	22.9	313.7		
110BC								5.3	16.3								22.3	7.5
110CM	5.1	5.9	6.2	6.3	3.0	4.7	0.8			25.0	22.4	21.6	21.9	39.7	67.9	223.2		
110CM								5.4	10.8								29.8	11.4
110DC	7.3	5.9	5.2	8.9						17.6	22.5	26.0	15.6					
111RG	181.8	14.6	426.6		12.8		316.0	38.0		0.6	7.5	0.3	0.0	8.4		0.3	2.9	
111TS	32.5	9.0	20.2	30.0	1.1		643.4			3.3	12.1	5.4	3.6	98.2		0.2		
112CR			4.6	6.9								9.1	6.2					
112RG			21.8	15.0								1.9	2.8					
112TS			6.9	28.4								6.1	1.5					
113MD	8.0	2.3	9.0	15.2	22.8	20.5	20.1		10.3	4.7	17.6	4.4	2.7	1.8	60.7	25.6		14.1
113RG	17.1	19.9	18.7	12.0	20.1	17.2	12.8	3.1	15.6	2.2	2.0	2.1	3.4	1.9	61.4	35.6	86.3	7.4
114MS	21.4	57.4	3.7	3.3						5.5	2.1	32.9	37.5					
114RG	17.9	30.3	5.1	3.3						6.5	4.0	23.8	37.3					
115RG	7.5	22.8								3.0	1.1							
115RG			1.8									14.2						
116FS	54.3	10.2	4.0	3.0	8.4					1.8	9.5	24.3	32.2	11.6				
116MS	42.3	4.5	3.0	0.5	7.1					2.3	21.6	32.8	194.4	13.8				
116NC				0.4	5.4								31.3	3.6				
116RG	57.1	6.5	5.9	3.8	9.2					1.7	15.0	16.3	25.6	10.6				
116TS	25.0	5.5	4.6	3.7	8.1					3.8	17.8	21.0	26.6	12.0				
117RG	39.9	239.0	130.0	31.2						2.8	0.5	0.9	3.5					
117TS	26.7	57.1	51.6	4.9						4.2	2.0	2.2	23.3					
118CA				22.0									3.7					
118CR				5.67									14.2					
118FS				5.23									15.4					
118MS				5.27									15.3					
118RG				18.9									4.3					

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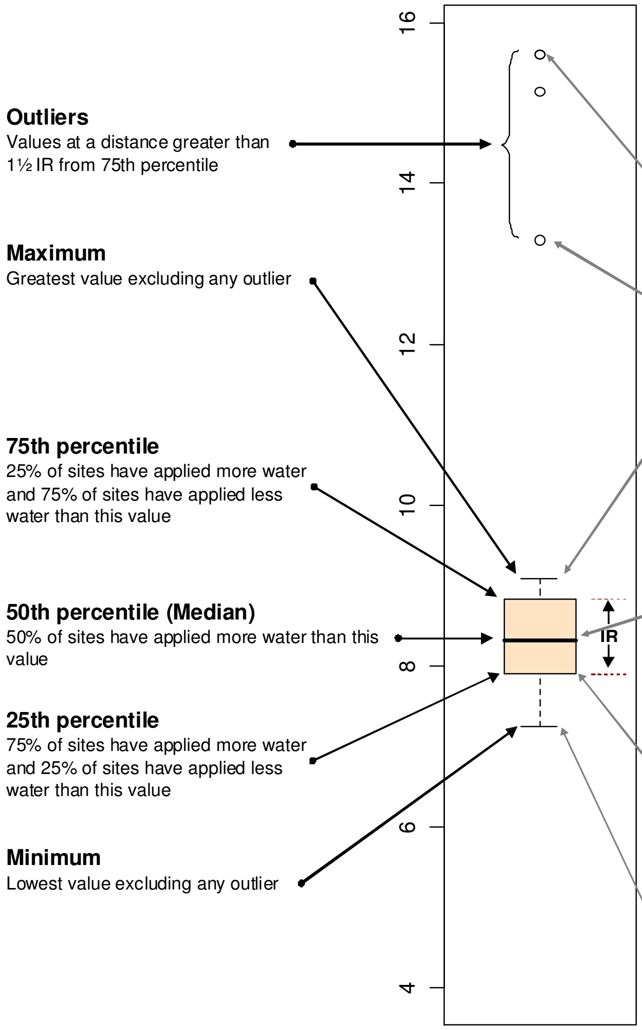
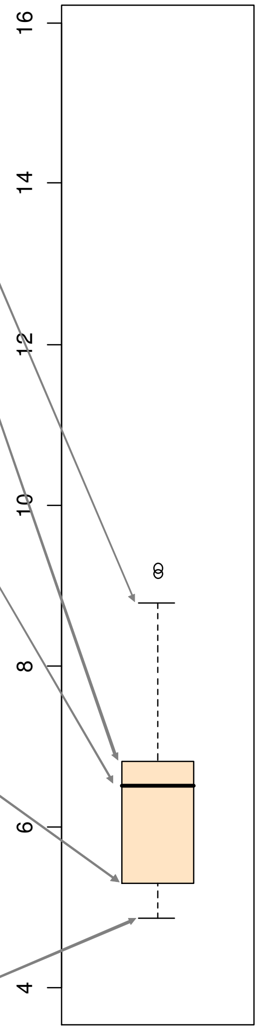
Site	Yield per volume of drainage (t/ML)									Cost of drainage per tonne of fruit ($/t)								
	2003	2004	2005	2006	2007	2008	2009	2010	2011	2003	2004	2005	2006	2007	2008	2009	2010	2011
118RS				4.4									18.4					
118TS				15.2									5.3					
119CR									22.4									6.2
119MB									11.8									11.7
119ME					9.6	27.8								11.2	20.1			
119ME							9.5	12.5	49.1							23.0	17.7	2.8
119MF					11.9	17.2								9.3	32.4			
119MF							9.1	11.9	32.7							24.1	18.4	4.3
119RG					11.8	37.3								9.2	14.2			
119RG							11.1	9.7	77.8							19.4	22.6	1.8
119TS					16.8	26.2								6.4	21.3			
120CR					2.4	17.3								43.9	28.1			
120CR							15.3	9.9	49.8							14.0	21.5	2.8
120MB									34.6									3.3
120TA					5.4	20.4								19.9	23.6			
120TA							16.1	8.2	41.3							13.4	25.6	2.8
120TC					7.2	17.6								15.0	32.6			
120TC							16.3	8.9	48.3							13.2	24.1	2.9
121TS					20.8									5.7				
122CA				4	6.9	4.2	15.7	20.2	13.0				26.1	16.1	26.2	7.5	39.6	9.6
122CR				4.9	2.3	23.9		81.1	7.4				22.6	48.9	4.6		7.1	17.0
122MS				3.2	6.9	11.3	31.1	6.2	9.0				34.7	16.1	9.8	3.8	128.0	14.0
122RG				1.4	1.8	5.4	14.4	7.3	3.4				81.6	62.0	20.5	8.2	39.5	37.3
122TS				6.6	3.5	8.2	11.7	4.8	4.8				16.7	31.8	13.5	10.1	24.8	26.3
123AR							52.4	12.3	0.0							6.5	31.7	
123CS					8.6	18.7	36.4	7.0	0.0					12.9	24.6	9.5	55.9	
123RG					4.4	51.8	40.0	2.8	0.0					25.1	8.9	8.0	137.9	
123TS					11.6	33.4	94.1	20.6	0.0					9.6	13.8	3.6	19.0	
124CS					59.8									1.4				
124CS						136.6	101.4								5.9	2.4		
124ME					27.1									3.1				
124ME						44.3	41.9								64.0	2.3		
125CB						9.8	13.1	7.1							40.2	23.9	17.7	
125CM						22.6	32.8	7.8							19.1	9.6	16.2	
125GL						57.3	32.0	4.0							7.5	9.7	32.1	
125GR						28.5	20.5	4.1							15.2	15.0	31.6	
125MH						15.9	17.3	2.5							27.2	18.0	51.3	
125MP						12.9	8.3	2.1							33.5	37.1	60.1	
125OH						13.6	10.2								29.0	31.1		
125TO						5.9	15.3	6.2							66.2	20.7	21.0	
125TS					2.9	11.1	15.6	5.8						36.9	35.4	19.1	22.5	
126CA						98.1	40.8	18.8							1.0	2.5	5.4	
127AR							172.2	39.8	3.4							0.7	19.8	37.6
127CA						43.1	265.9	57.3	9.4						2.7	0.4	13.6	12.2
127CR						19.8	91.5	19.6	6.7						5.8	1.2	39.6	19.0
127FL						58.7	361.8	58.6	18.8						1.9	0.3	13.2	6.7
127ME						17.6	105.0	20.0	4.1						6.5	1.1	35.2	31.2
127RG						29.1	206.9	18.4	5.0						4.0	0.6	42.8	25.5
128AR								11.3									2.3	
128CR							28.0	37.4								9.5	0.6	
128GR							89.6	67.1								3.9	0.4	
128GS							89.6	67.1								3.9	0.4	
129CS									0.9									146.0
129FL							54.9	27.8	2.7							4.6	5.7	47.3
129SO							31.6	13.1	0.8							7.9	12.2	151.0
130SR							43.0	125.6								5.9	1.2	
131CS								9.4	3.0								17.5	43.0
131ME									1.5									85.3
131RG							17.5									14.3		
131RG								10.1	2.9								17.6	45.0
131SS								48.6	1.8								3.4	70.6
131YG								11.6									14.4	
132AR								12.8	3.6								23.7	36.8
132CJ									0.0									
132CP								21.5	0.0								14.2	
132CR								12.7	6.8								24.6	19.4
132MB									0.0									
132MS								32.0	51.1								9.2	2.6
132RG								44.0	15.6								7.1	8.4
133CS								3.0	0.0								38.7	
133MS								4.7	0.0								25.8	
134F1									8.8									4.6
134F2									10.1									4.0
134M1									1.11									36.3
134M2									0									
134M3									1									40.5
134M4									3.87									10.5

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.



Low level irrigation (2009) Water applied (Ml/ha)	Low level irrigation (2009) Site	Index	Low level irrigation (2008) Site	Low level irrigation (2008) Water applied (Ml/ha)
-	-	26	110BC-Cr	9.2
-	-	25	110CM-Me	9.2
-	-	24	102M2-Me	8.8
15.6	110AR-RG	23	110AR-RG	8.6
15.6	110BC-Cr	22	120CR-Cr	8.2
15.2	110CM-Me	21	119RG-RG	7.3
13.3	102M2-Me	20	119ME-Me	6.8
9.1	125TS-Th	19	119TS-Th	6.8
9.1	131RG-RG	18	119MF-Me	6.8
8.6	125MP-Me	17	120TA-Th	6.6
8.6	125GL-RG	16	120TC-Th	6.6
8.6	125GR-RG	15	104MS-Me	6.5
8.5	125MH-Me	14	104FS-Fl	6.5
8.3	125CB-Cr	13	104H5-Su	6.5
8.3	125CM-Cr	12	125CB-Cr	6.0
8.3	125OH-Oh	11	125TS-Th	6.0
8.2	125TO-Th	10	125TO-Th	6.0
8.1	130SR-Su	9	125OH-Oh	6.0
8.1	104MS-Me	8	101RG-RG	5.6
7.9	104RG-RG	7	125GL-RG	5.3
7.9	104FS-Fl	6	125CM-Cr	5.3
7.6	104H5-Su	5	125GR-RG	5.3
7.3	101TS-Th	4	125MH-Me	5.3
7.3	101RG-RG	3	125MP-Me	5.3
7.3	101CS-Cr	2	101TS-Th	5.3
7.2	101MD-Me	1	101MD-Me	4.9



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

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