Know-how for Horticulture™

Benchmarking Vegetable Industry water use

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VIC Department of Primary Industries

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HAL

Final Report

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Benchmarking Vegetable Industry Water Use

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HAL Project Number: **VG** 04015

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This report details the results of the project "Benchmarking Vegetable Industry Water Use" conducted over 15 months from July 2004 to September 2005.

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Media Summary

Vegetable production is intensive, often requiring large inputs of water and nutrients. The value of crops is high, and water has traditionally been regarded as a small component of the total growing cost. This is changing, as demand increases for this scarce resource, and the industry recognises the need to develop and implement more efficient irrigation practices. Irrigation benchmarking involves the collection of on-farm information about irrigation practices, and allows growers to compare themselves with others in terms of crop performance and water use efficiency (WUE). A pilot study was conducted during the 2004/05 growing season, to benchmark water use in vegetable crops grown in two contrasting areas of Victoria: - peri-urban Melbourne (Cranbourne, Mornington Peninsula and Werribee) and the Mallee (Mildura and Swan Hill). An approach used successfully in other horticultural crops was combined with a set of WUE indicators to collect information from a total of 25 sites. Most participants used fixed sprinkler irrigation. Crops included were lettuce, broccoli and carrots near Melbourne, and carrots, pumpkins, squash and zucchinis in the Mallee. The major focus of the study was to evaluate the benchmarking process, and the results highlighted inconsistencies and inaccuracies in on-farm methods for managing and recording water applications. The limited set of information collected, with variation in crop and irrigation type, region, planting time and climate, made it difficult to make meaningful comparisons. Averaged values for yield in the target crops ranged from 8.1 – 50.8 t/ha, for water use from 1.2 to 3.3 ML/ha, and for WUE from 2.3-28.4 t/ML. Nevertheless, this information provides useful insights into some of the issues facing farmers in the irrigation of vegetable crops across Victoria. Commitment to the benchmarking process varied, with the less experienced farmers showing most interest in participation and learning from the results. Most participants saw value in the information and were willing to take part in future benchmarking activities. Water use efficiency was not seen as a high priority for many of these growers, but most saw it as becoming more important to them. Comparisons between crops and growing districts were also of interest, despite the gaps and inconsistencies in the results. Recommendations were developed for future benchmarking activities, and for related research and extension priorities.

Technical Summary

Vegetable production is intensive, often requiring large inputs of water and nutrients. The value of crops is high, and water has traditionally been regarded as a small component of the total growing cost. This is changing, as demand increases for this scarce resource, and water shortages occur in vegetable growing areas. The vegetable industry currently lags behind other horticultural sectors in the understanding of plant water needs and irrigation best practices. Irrigation benchmarking is a proven tool for increasing water use efficiency (WUE). It allows growers to compare their performance at both local and national levels, as well as providing policy makers with sound information to use in setting realistic efficiency targets. A pilot study was conducted during the 2004/05 growing season, to benchmark water use in vegetable crops grown in two contrasting areas of south-eastern Australia: - peri-urban Melbourne (Cranbourne, Mornington Peninsula and Werribee) and the Mallee (Mildura and Swan Hill). A methodology previously used in other horticultural crops was combined with a set of WUE indicators. Results were collected from a total of 25 sites. Most participants used fixed sprinkler irrigation systems, and crops included were lettuce, broccoli and carrots near Melbourne, and carrots, pumpkins, squash and zucchinis in the Mallee. While the information on water use was a useful starting point, the major focus of the study was to evaluate the value of the benchmarking process. Inconsistencies in on-farm recording of water use cast doubts over the validity of some measurements obtained. Seasonal and market factors also influenced project results. Average marketable yields reported by growers ranged from 13.3 t/ha for broccoli to 50.8 t/ha for carrots around Melbourne, and from 8.1 t/ha for squash to 43.2 t/ha for carrots in the Mallee. The average water use reported for the target crops ranged from 1.2 (in broccoli) to 3.3 ML/ha (in carrots) around Melbourne, and from 1.7 (in squash) to 3.1 ML/ha (in zucchini) in the Mallee. Average crop water use efficiencies (measured as t/ML) varied from 9.2 (for broccoli) to 28.4 (for lettuce) around Melbourne, and from 2.3 (for pumpkin) to 24.5 (for carrots) in the Mallee. Using averaged Melbourne market prices at the times of harvest for each crop, crop values were also estimated in terms of land ($/ha) and water ($/ML). Statistically meaningful comparisons could not be made between the crops and regions due to the limited data set. Growers were provided with reports for their particular crop and region, and were then asked to comment on the value of the process and how it might be improved. Water use efficiency was generally not seen as a high priority at a time of depressed market prices and ample water supply, although most growers agreed that it may become so. The comparative results were of interest, but their accuracy and value were rightly questioned given the limited sample and obvious differences in cropping circumstances. Most growers were unaware of how much water per hectare they were applying. The application of water for environmental control - eg to prevent wind damage - arose as a significant consideration in some areas. The relative experience of farmers was also important in their engagement with the process. Those new to vegetable production were often keen to participate and learn about their water use, whereas some of the larger more established growers agreed to take part but then lacked commitment in collecting the required information. Apart from making the monitoring requirements as easy as possible (with recording tools and direct assistance), a more rigorous selection process for participants is recommended for future benchmarking activities.

Introduction

Vegetable production is intensive, often requiring large inputs of water and nutrients in the production of high value crops. Despite this, the vegetable industry currently lags behind other horticultural sectors in the understanding of plant water needs and irrigation best practices. Benchmarking can be used as a major driver for on farm improvements in natural resource management, particularly in relation to irrigation and nutrient inputs. Irrigation benchmarking is a proven tool for improving water use efficiency. It allows producers to compare their performance at both local and national levels, as well as providing policy makers with sound information to use in setting realistic efficiency targets. Peer support networks often develop from such benchmarking exercises, significantly enhancing the adoption of best management practice. The past two years have seen water shortages in many vegetable-growing areas, and focussed attention on irrigation efficiency. Irrigation benchmarking and adoption of best practices will lead growers to irrigate more efficiently and have a better understanding of crop water requirements. In turn, this will reduce growing costs, and help farmers to demonstrate responsible use of scarce natural resources.

Irrigation benchmarking is well established in Australia, particularly in Viticulture. Benchmarking techniques used in other horticultural industries could also be appropriate for use in vegetable production. This project was initiated to test a benchmarking process in vegetables that had been developed and used successfully in citrus, grapes and potatoes.

Methods

A benchmarking process for water use efficiency (WUE) was piloted with vegetable growers in two significant but contrasting production areas of Victoria with a view to extending the process to other crops and regions nationally. The two focus areas were the Mallee (Mildura and Swan Hill) and the peri-urban fringes of Melbourne – Werribee, Mornington Peninsula and Cranbourne Previous approaches used successfully in horticulture (eg Skewes and Meissner, 1997) were blended with recommended reporting indicators (DSE 2004).

Individual growers were approached to take part in the study based on their involvement in other research and extension activities. Participants were also sought in northern Victoria using advertisements in the local press. Information was collected from a total of 22 growers, monitoring 25 blocks across the two study areas (Table 1). Crops comprised carrots and cucurbits (pumpkins, zucchinis and squash) in the Mallee, and carrots, lettuce and broccoli around Melbourne.

Methods for measuring on-farm water flow rates were also discussed, and a GE Panametrics Transport PT 878 Portable Liquid Flow meter was borrowed and modified (with fittings to suit smaller pipe diameters) for use in the project. The information on output from pumps proved to be of interest to most growers.

Table 1: Vegetable blocks surveyed

Region	CROP	BROCCOLI	LETTUCE	CARROTS
Melbourne	Cranbourne	3	3	
	Werribee	2	4	
	Mornington			4

Region	CROP	ZUCCHINI	PUMPKIN	SQUASH	CARROTS
Mallee	Mildura	1	3	1	1
	Swan Hill	2			1

The farm questionnaire and irrigation recording sheet used in the project are shown in Appendix 1. It should be noted that one zucchini block was omitted from the report because the crop was grown between grapevine rows, making the results inconsistent with the other zucchini blocks monitored.

The following water use efficiency indicators were assessed

- YIELD (t/ha)
- WATER USE EFFICIENCY (t/ML)
- GROSS RETURN PER HECTARE ($/ha)
- GROSS RETURN PER MEGALITRE ($/ML)
- APPLICATION EFFICIENCY (%)

It was intended that the information collected be incorporated within a broader database of irrigation benchmarks for horticultural crops. The project team held various discussions with the developers of the database, and suggested modifications that would allow the vegetable data to be included. Some of these changes will be incorporated into revision of the database software. The version currently available proved too inflexible to accommodate the data set collected under this project.

References

DSE (2004) Farm Water Use Efficiency Technical Reference Booklet. Department of Sustainability and Environment, Victoria.

Skewes M and Meissner T (1997). Irrigation Benchmarks and Best Management Practices for Potatoes. Technical Report No. 265. Primary Industries and Resources, SA.

Results

A combined report, showing results in the format presented to growers, is attached as Appendix 2. Results derived from crop monitoring, farmers estimates and market information are summarised for crops and regions (Table 2) and overall (Table 3) below.
Information was also expected from an additional 4 carrot crops and one zucchini crop in the Mallee but was not supplied despite repeated requests from project staff.

Table 2: Vegetable WUE Summary by Crop and Region/Area

Melbourne Region	Cranbourne		Werribee		Mornington Peninsula
	Lettuce	Broccoli	Lettuce	Broccoli	Carrots
No. of Sites	3	3	4	2	4
Average Yield (t)	37.2	17.4	43.7	13.3	50.8
Average ML/ha	2.1	9.2	1.6	1.2	3.3
Average WUE (t/ML)	19.3	2.8	28.4	10.8	20.0
Average $/ha	26,477	21,718	30,231	16,628	29,282
Average $/ML	13,725	11,514	19,680	13,531	11,513

Mallee Region	Swan Hill		Mildura Area			
	Carrots	Zucchini	Carrots	Pumpkin	Zucchini	Squash
No. of Sites	1	2	1	3	1	1
Average Yield	43.2	20.0	17.0	8.4	36.1	8.1
Average ML/ha	1.8	3.1	2.6	10.5	3.0	1.7
Average WUE (t/ML)	24.5	6.7	6.4	2.3	12.2	4.6
Average $/ha	24,917	30,200	11,050	2,040	32,490	7,078
Average $/ML	14,141	10,414	4,185	833	10,976	7,839

Table 3: WUE Crop Summary (all regions)

	Lettuce	Broccoli	Carrots	Pumpkin	Zucchini	Squash
No. of Sites	7	5	6	3	3	1
Average Yield (t)	41	15.7	43.9	8.4	25.4	8.1
Average ML/ha	1.8	2.2	2.9	10.5	3.0	1.7
Average WUE (t/ML)	24.5	9.8	18.5	2.3	8.54	4.6
Average $/ha	28,622	19,718	25,515	2,040	30,963	7,078
Average $/ML	17,128	12,321	10,729	833	10,420	7,839

Figure 1: Water applied (ML/ha) on a crop basis

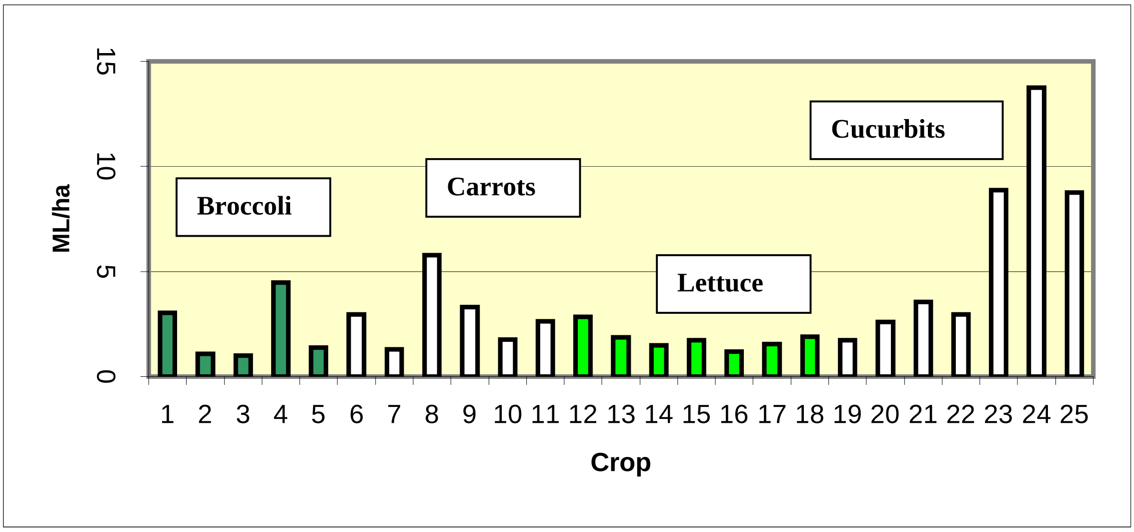
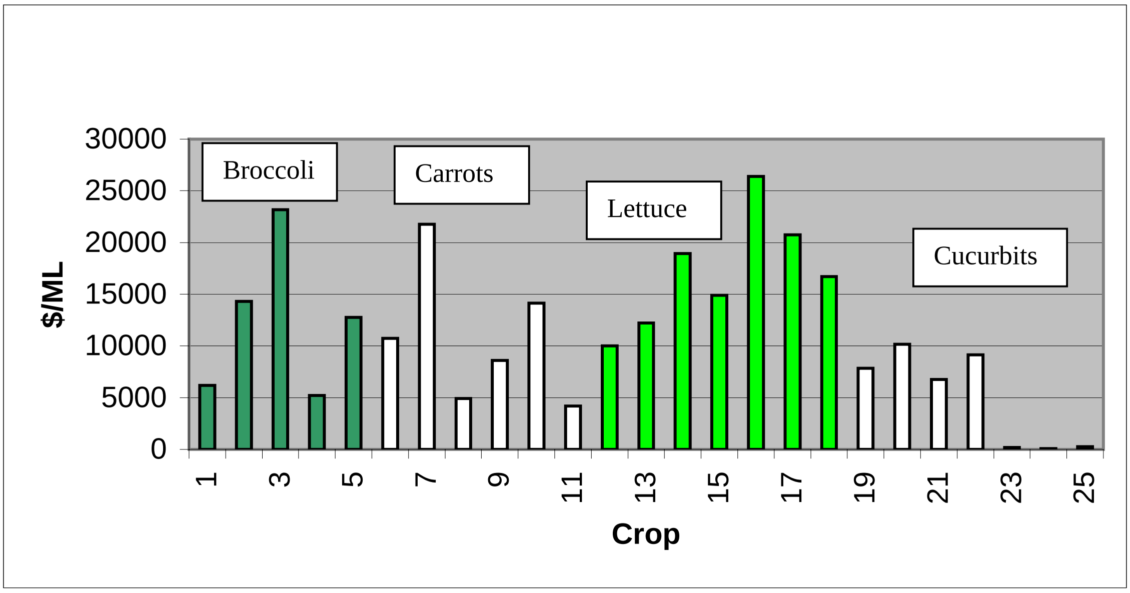


Figure 2: Returns ($/ML) for irrigation applied on a crop basis



Grower comments on the benchmarking process

Reports for each crop were delivered and explained to participating growers. They were then asked their opinions on the process and how it might be improved, with the following questions:

1: - Was the study of value to you?

2: - How could it be improved to give you greater benefit - in terms of the process (making it easier to use), or information delivered (format or content)?

3: - What, if anything, did you learn anything from the results?

4: - What issues do you have with irrigation?

5: - How do you rate yourself as an irrigator?

6: - Where do you see chances to improve?
7: - How could we help you? - eg would you like to participate in an   irrigation management course?
8: - Would you be willing to take part in further development of this approach?
9: - Would you recommend it to others?
10: - Apart from watering the crop, when else do you irrigate?
11: - What percentage of your total irrigation is used for environmental control? (ie protecting the crop against damage from frost, dust or heat)

Summarised responses to these questions were as follows:

Was this study of value to you?

This project was perceived to be of value by about half of the grower participants. Growers that produced good results were more favourable in their comments. It gave them confidence and some gratification that they were on the right track. For growers that had multiple blocks this study was of value as it highlighted the differences in irrigation practices between two blocks with different pumps or systems on the same property. As the amount of water needed is mostly judged by visual analysis (experience, digging a hole, calendar), participation in the project provided a different means of measuring water. However, the accuracy of the results (responses) was a major limitation.

The growers that did not find this study of value commented that because climatic conditions were not taken into account, the true amount of water applied and its efficiency is questionable. It was expressed that water is the cheapest asset on the farm and in order to grow lettuce, you need a lot of water. Studies such as this will only be of value when water must be bought. In one case, accurate estimates of water use had already been made, so the grower found this study to be of no additional value. Other growers commented that not knowing the reason for the differences in the numbers meant they were frustrated with the results.

How could it be improved to give you greater benefit - in terms of the process (making it easier to use), or information delivered (format or content)?

Growers commented that the accuracy of the data limited the value they got from this study. When undertaking the evaluation it was stressed to the growers that the accuracy of the results is only as good as the data provided, and that each grower knows how seriously they took this study and therefore has to judge for themselves how accurate their results are. The reporting back sessions picked up errors in the estimated figures at several properties.

Some of the growers had automated sprinklers and they could have set the count to 0 to achieve more accurate irrigation duration times. However, this was not explored initially with the growers. It was also recommended that a waterproof recording sheet be used.

Comments were made regarding the way irrigation times were recorded. Growers that were committed to the process seemed to have no problems with the way the data was collected. They said the recording was easy with the only problem they found was remembering to do it. It was recommended that small flow meters be fitted to sprinklers. This would give an accurate flow rate as well as application efficiency. In order to get greater benefit from this study, many growers commented on including rain and climate data. It was suggested that rain gauges should be on all properties.

Some growers wanted to be involved in the planning phases of future projects in order to help develop a program that would be minimally intrusive to growers.

What, if anything, did you learn from the results?

The responses varied depending on the individual results. Growers that were efficient water users and/or achieved a high yield commented that this study shows they are doing the right thing. Some growers commented that some of the results could not be true, and that other growers had provided inaccurate information about their yields. Some growers were surprised to see such differences between water use and yield, whilst others were more concerned about the ML/ha needed to achieve a good yield. Most growers found it useful to have their flow rate measured. Growers that had recorded irrigation on multiple sites, were generally surprised by the differences.
One grower on the low end of the results questioned his future in the industry when he saw how far behind he was, (something that he knew but the benchmarking process confirmed it).

What issues do you have with irrigation?

Most of the growers commented that they did not have any issues with irrigation. However, it was noted that one of the major problems is that most irrigation systems are set up so that you have to water more than one block (to utilise the output of the pump), even if it's unnecessary.

For some growers in the south, allocations have never been monitored. Most growers commented that water was the cheapest asset on the farm and that they will apply as much as they think is required. For the growers that did have irrigation issues, problems tended to be more mechanical such as blocked sprinklers.

How do you rate yourself as an irrigator?

All growers rated themselves as good irrigators, with most saying that they are conscious about the amount of water they apply and know when they are wasting it. Some growers said that during busy times, the pumps may be on for longer as there is no time to go and turn them off. One grower was looking at automating his system to overcome such problems, but was still weighing up the cost involved.

Where do you see chances to improve?

Most growers noted that their only chance to improve is by using an automated system or new technological improvements, as they are running as efficiently as they can on a manual system. All southern growers commented that drip irrigation is not feasible. In contrast the results in the north showed the drip irrigation was quite effective in gaining increased Water Use Efficiency (WUE) in cucurbit production.

The use of probes (to monitor soil moisture) was suggested by some growers whilst another grower commented that farmers need to reduce the amount that is grown and consequently reduce water requirements.

How could we help you? - eg would you like to participate in an irrigation management course?

Most growers (65%) said that if there was a free irrigation course they would participate in it. Other growers commented that an irrigation course would be pointless and that courses in monitoring and soil moisture management are more important. Most northern growers have completed an irrigation management course already.

Would you be willing to take part in further development of this approach?

All growers said that they would participate in further development of this approach. Comments regarding better accuracy and timing of the study were mentioned. A study in November would be more appropriate than January/February. There also needs to be more emphasis on what data is required. Growers would be able to provide more accurate information now that they know what they are participating in and what was expected of them.

Would you recommend it to others?

Most growers (80%) said they would recommend this study to others. Many could not give a reason why, but one grower commented that it was a very good study for the future of the industry, as every grower will be accountable for what they use. The farmers that did not see value in this study generally said they would not recommend it to others because it won't make a difference to how people irrigate and that farmers don't want to know this type of information.

Apart from watering the crop, when else do you irrigate?

- To prevent sand drift
- To maintain young seedlings
- To maintain a wet base
- To suppress the smell of chook manure to neighbouring housing estates
- To encourage weed germination (for weed control)
- To get the soil into the right condition for working and bed formation.
- To control dust, even if the ground is bare, will still water to protect other young crops
- Fertigation

What percentage of your total irrigation is used for environmental control?
Most growers commented that they watered between 1-10% for environmental control. Most growers estimated that 5% of their total irrigation was for environmental control as there are no other options at present.

Discussion

While the primary objective of this project was to evaluate the benchmarking process, the focus of participating growers was understandably on the information reported, and on their performance relative to that of others. The value of these numbers depends on how accurately figures on yield and water use have been recorded, and in some cases, this information proved highly questionable. The reasons for this varied, with some growers finding the logistics of recording yields and water applications for a single block too difficult to manage in a busy season. For others, commitment to the process fell away as other issues, such as low market prices, came to dominate their thinking. This is also seen in the evaluation responses, where many growers placed a low priority on water management as an issue in their business, and one even responded that water allocations should be cut to limit production and increase market prices. When the cost of water (generally from 0 to $250/ML) and crop returns per ML (Table 2) are taken into account, it can be seen that water is a minor economic consideration for most crops. Another report listing returns for water use by Victorian vegetable crops (ABS Census, 2001) gives much lower estimates than the figures derived from this study, but even then, economics can still be seen as an underlying factor in grower attitudes to WUE.

In other cases, growers may have felt that they were already applying best practices, and were reluctant to part with detailed information about them, despite agreeing to participate. For example, irrigation records were expected from an additional 4 carrot blocks in the Mallee but were not supplied despite repeated requests from project staff. A consultant advising two of the growers about irrigation scheduling, collected much of this information but failed to provide it as agreed when the season concluded.

The problems encountered in collecting information could be addressed by more careful selection of participants – and more attention to detail in explanations of what is required of them. More realistically, irrigation may need to be linked to benchmarking of other farming practices, providing information of greater value and impact to the farmer.

Data collected over a single season and crop when conditions may not be considered "normal" will always be open to debate. Some growers around Melbourne declined to participate in the project because water shortages meant that their current approaches to irrigation were not typical of their normal practices. All the Melbourne sites were planted from December to February, and were harvested by the end of April. Unfortunately, a delayed start to the project meant that spring plantings in the Mallee were missed (except for one carrot crop), and late summer/autumn crops were monitored instead – with some harvests extending into June.

Despite the difficulties in collecting credible information and leaving aside several outlying figures, there were some interesting results to emerge from the study (see Table 2 and Appendix 2). Around Melbourne, lettuce crops used the least water, averaging 1.8 ML/ha, reflecting a short growing season (averaging 46 days). The Cranbourne crops were given more water (possibly due to lighter soils), but produced slightly lower yields (average planting rates were higher at Werribee). Broccoli yields were reasonably consistent, with the root disease "club root" probably responsible for the lowest yielding block. Average water use was much higher on Cranbourne broccoli crops (9.2 cf 1.6 ML/ha) – due to high values for 2 out of 3 monitored blocks. The reasons for this are unclear, as times of planting, rainfall and other information give no obvious clue to a need for higher irrigation rates. It is difficult to draw any meaningful comparisons between carrot crops, as there were too many inconsistencies between them. Average yields from the Mornington Peninsula (MP) were higher than those from the Mallee, and water use was also a little higher around Melbourne, but planting times (November for MP, August and January for the Mallee), climate and crop duration all differed. All the Melbourne carrot crops produced higher yields than those from the Mallee, although the averages are strongly influenced by one site, which performed very poorly in comparison with all the others in the study. Of the cucurbits in the Mallee, zucchinis produced the best yields, but pumpkins used the most water. Only one squash block was monitored, but it's water use was the lowest of all the cucurbit crops. Drip irrigation was used on the squash and two zucchini crops. Average water use under drip (two crops – 3.25 ML/ha) was not markedly different from that under sprinklers (one crop – 2.6 ML/ha) for the Mallee zucchini crops. The Mallee pumpkin crops were all grown under sprinklers, but one performed much better than the other two, where weeds were a problem. In terms of $/ML, none of the pumpkin blocks rated highly compared with the other crops in the study (Figure 2, crops 24-26).

A significant variable to emerge from this study is the amount of water applied to vegetable crops for environmental control. Irrigations were used to germinate weeds (presumably for post-emergent spraying), control wind-blown dust and sand, and to protect and maintain moisture under young seedlings. The extent of these irrigations was regulated by a number of factors including soil-type (with more irrigations on lighter soils) and position in the paddock (exposed blocks requiring more irrigations). One grower reported that if his crop were planted next to a bare patch, he would water that as well, to keep the dust down. Over-watering also occurred when the output of a pump was too great for one block, necessitating the irrigation of other areas, whether they needed it or not. With an abundant supply of water, these issues have not been of concern to growers in the past.

In summary, the information collected in this study provides useful insights into some of the issues facing farmers in the irrigation of vegetable crops across Victoria. Water use efficiency was not seen as a high priority for many of these growers, but most saw it as becoming more important to them. Commitment to the benchmarking process varied, with the less experienced farmers showing most interest in participation and learning from the results. Despite some early negativity towards the project, most growers were interested in the results, and were willing to participate in future benchmarking activities.

Technology Transfer

The project was directly promoted to approximately 50 growers – including industry leaders - in the target regions. A presentation was delivered through the VegCheque program to the Werribee Young Growers Group in May (2005), describing project objectives and activities. The target audience for the project included researchers and policy makers who are keen to develop better estimates of water use in horticultural crops, and to identify and promote the most efficient irrigation systems across the

Australian vegetable industry. To this end, close links were maintained with researchers on Project VG 04010: Australian vegetable crops – Maximising returns from water. This included a joint project planning meeting, held in October 2004.

Direct contact with participating growers was also a major part of the project, with initial interviews, follow-up visits/calls, and final delivery and discussion of results by the project team. Grower workshops were not considered practical, due to the size and geographical spread of the groups involved, as well as confidentiality concerns.

A reference group, initially planned for the project, was also deemed impractical due to the late project start and for the reasons outlined above.

Publications

Water Use Efficiency in the Vegetable Industry. Poster display at the Mildura Show and Werribee Field Day (May 2005).

B. Ashcroft, S. Henderson, S. Vujovic, D. Csaky, A. Boland and J.Vargas, 2005. Benchmarking the irrigation practices of cucurbit growers in Southern Australia. Abstract/presentation at the International Cucurbit Symposium, Townsville Qld, September 2005.

Articles on the project, including a call for grower participants, also appeared in the Summer Fruits and Riverlink newsletters in the Sunraysia.

B. Ashcroft, S. Henderson, S. Vujovic, D. Csaky, J.Vargas and A. Boland. Benchmarking water use in the Australian vegetable industry - a pilot study. Abstract submitted for the forthcoming Australian Vegetable Industry Conference, Brisbane 2006.

An article about the project will also be submitted to “Vegetables Australia”.

Recommendations

The benchmarking process was of value, generating information of interest to most of the participating vegetable growers, although many did not see the topic as a current priority. There is merit in developing this approach further, to better meet industry needs and benefit farmer participants. This could be achieved by linking irrigation into other benchmarking activities that target information sought by the growers.

Future benchmarking activities should also be designed to collect a comprehensive set of information – at least spanning several seasons. Factors such as region, crop-type and management system will also need to be adequately represented if meaningful comparisons are to be made.

The participation and commitment of growers is essential to the success of this process. Apart from measures suggested above, care is needed in 1) providing clear instructions for participants; 2) selecting candidates on the basis of their commitment; and 3) providing them with adequate support to ensure that the information collected is accurate and worthwhile.

Benchmarking activities should be linked with any national program for improving water use efficiency in vegetable crops, so that regions and/or issues of greatest need can be targeted and addressed. The information collected should also be incorporated into a central database, to provide a reference source to the industry, researchers and policy makers on water use in vegetable crops.

Several areas for further study also emerged from the project.

- A market study to analyse and promote the benefits of efficient water use in vegetable production will help to justify such activities to growers, and highlight the industry's efforts to other stakeholders (markets, government and the broader community).

- If accurately reported, the extent of variation in water use for the same crop, between growers and regions, suggests inefficiencies and warrants further investigation. Watering for environmental control, or to utilise excessive pump discharge are likely to be important in such studies.

- The interaction between irrigation and plant disease was identified as a priority issue by one grower, and although further details are needed, optimising irrigation and plant health (yield and quality) could be a future focus for water use studies.

Acknowledgement

The project team would like to thank all participating growers for their interest and contributions to this project.

Appendix 1: Initial Questionnaire for Participants

VEGETABLE IRRIGATION BENCHMARKING SURVEY

CROP ___________________________

Office use only
PROPERTY CODE:____________________
SITE CODE(S):_________________________
DATE :_______________________________
INTERVIEWER:______________________

1. PROPERTY DETAILS:

Manager's name: ______________________________________

Postal Address: ______________________________________

Town: ______________________________________

Postcode: ______________________________________

Street address: ______________________________________

Phone Number: ______________________________________

Irrigation district/or private diverter: ______________________________________

Latitude: ______________________________________

Longitude: ______________________________________

SITE DETAILS

Total area of farm (irrigated land) (ha/acres):______________________________________

Total farm water use per annum: ______________________________________

Name of site being assessed: ______________________________________

Area of site being assessed (ha/acres): ______________________________________

IRRIGATION SYSTEM

System type: (circle number)

1) centre pivot

2) drip

3) furrow

4) overhead sprinkler

5) other : ______________________________________

Salinity of irrigation water : ____________________(circle units)_ppm ,or mg/L, or ECμS/cm, or ECdS/m

Do you grow under plastic mulch? YES _______ NO _______

Is a drainage reuse system –installed? YES________ NO _______

-used? YES________ NO _______

IRRIGATION PRACTICES

Do you schedule irrigation ? YES________ NO _______

If yes, method used to schedule irrigation (circle number)

1. calendar
2. evaporation data
3. dig a hole
4. tensiometer
5. gypsum block
6. C probe
7. enviroscan/ diviner
8. neutron probe
9. experience
10. other ____________________________________

Do you use irrigation for environmental control or in soil preparation (frost, sand drift, weed germination etc) ?

YES________ NO _______

SOIL DESCRIPTION FOR MAJORITY OF AREA

NAME OF SOIL/ from soil map:

____

Topsoil Depth (cm)

____

Topsoil texture:

____

Rootzone depth (cm)

____

Texture and depth of subsoil layers within or below rootzone (eg. hard pan layer)

____

____

____

RAW for rootzone (mm):

____

Have you attended an Irrigation Management Course? YES________ NO ________

Any
Comments:____

____

PUMP MEASUREMENTS

SPECIFICATIONS	PUMP 1
Pump output pressure (kPa, or PSI)	
Suction head (m)	

CROP DETAILS

Variety being assessed: ____

Approximate harvest time: ____

Crop row spacing :

between beds __________ number of rows per bed ___________ between plants down the bed ___________

RETURNS

YEAR	THIS SEASON	COMMENTS
Yield (tonnes/ ha)		
Assigned value ($/t)		

How are yields measured? Tonne bins / boxes / total yeild divided by area / other ___________________

Were there any adverse conditions which significantly influenced yield eg. frost, disease

____

____

Below is a sample record of the irrigation sheet you will need to fill in.

IRRIGATION DIARY

Grower Name: ____

Site Name: ____

System application rate: __________________ mm/hr

DATE	HOURS APPLIED	RAINFALL	COMMENTS (please indicate where water application is not for crop irrigation, eg.bed formation, frost control, weed germination, etc.)

Example only
Please record your data on the full size sheet titled **IRRIGATION SCHEDULE RECORDING SHEET** provided at the end of this questionnaire.

Privacy statement:

The Department of Primary Industries (DPI) is committed to protecting personal information provided by you in accordance with the principles of the Information Privacy Act 2000. The information you provide will be used by DPI to help develop a better understanding of the current level of irrigation performance in horticultural enterprises. Your personal information will not be disclosed to any other organisation, unless authorised by law. The results of the water use efficiency benchmarking study will be reported to participants in the study, the Department of Primary Industries and Horticulture Australia. Reasonable efforts will be made to de-identify any personal information about participants in the benchmarking study. If you wish to access information held about you or have any other enquires about this project please contact: Bill Ashcroft, DPI Tatura (03) 5833 5253.

DEPARTMENT OF
PRIMARY INDUSTRIES

Benchmarking Vegetable Industry Water Use

Consolidated Grower Reports

Appendix 2: Consolidated Report for Growers

Victoria
The Place To Be

AUSVEG

HAL
Know-how for Horticulture™

Benchmarking Vegetable Industry Water Use: Consolidated report

Written by Daniella Csaky
Primary Industries Research Victoria (PIRVic)
Knoxfield Centre
Private Bag 15
Knoxfield Delivery Centre
Knoxfield, Victoria 3156, Australia

For more information about this study contact Daniella Csaky on (03) 92109464 or Bill Ashcroft on (03) 5833 5253
For further information, visit the DPI Website at http://www.dpi.vic.gov.au
or contact the DPI Customer Service Centre on 136 186

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INTRODUCTION

Water is being recognised as an important and limited resource and it's availability for vegetable production has decreased. In recent years, studies have been undertaken to benchmark water use in the dairy, wine-grape, citrus and potato industries.

This project pilots an approach to benchmarking water use in the vegetable industry. The following report is crop specific. It outlines the pilot project and provides a summary of the results so that growers can compare their Water Use Efficiency (WUE) with that of others. The following report is based on results obtained in the southern and northern regions of Victoria.

WHAT IS BENCHMARKING?

Benchmarking is a measure of operational performance allowing comparison between farms, and can be used as a major driver for improvements in natural resource management. Irrigation benchmarking collects sound information on water use efficiency, allowing farmers to learn from others and if necessary, improve their practices to reduce costs and demonstrate responsible use of water. This particularly relates to irrigation and nutrient inputs.

Over the past two years, attention has shifted towards irrigation efficiency due to water shortages in vegetable growing areas. Irrigation benchmarking is a proven tool for increasing water use efficiency. It allows producers to compare their performance at both local and national levels, as well as providing policy makers with sound information to use in setting realistic efficiency targets.

Irrigation benchmarking and the adoption of best practices will lead growers to irrigate more efficiently and have a better understanding of crop water requirements. In turn this will reduce growing costs, and help them to demonstrate responsible use of scarce natural resources.

AIMS / OBJECTIVES

This project pilots an approach to the collection of water use data for vegetable crops. The aim of this project is to test an irrigation benchmarking process for the vegetable industry in a one-year pilot study conducted in contrasting production areas in the southern and Sunraysia regions of Victoria. The work provides growers, industry and policy makers with important information about water use and irrigation efficiency. The process will be based on new recommendations developed for Victorian farmers, as well as on previous work done in other horticultural industries.

The process is being tested in two different regions with a view to developing it for application to vegetable crops nation-wide. Recommendations for future development of the package, along with associated research and development priorities, will also be prepared.

METHODOLOGY

Two contrasting production areas were targeted:

1. Southern Region – Werribee, Cranbourne and Mornington Peninsula (Figure 1).
2. Northern Region – Mildura (Irymple, Red Cliffs, Nangiloc) and Swan Hill (Figure 2)

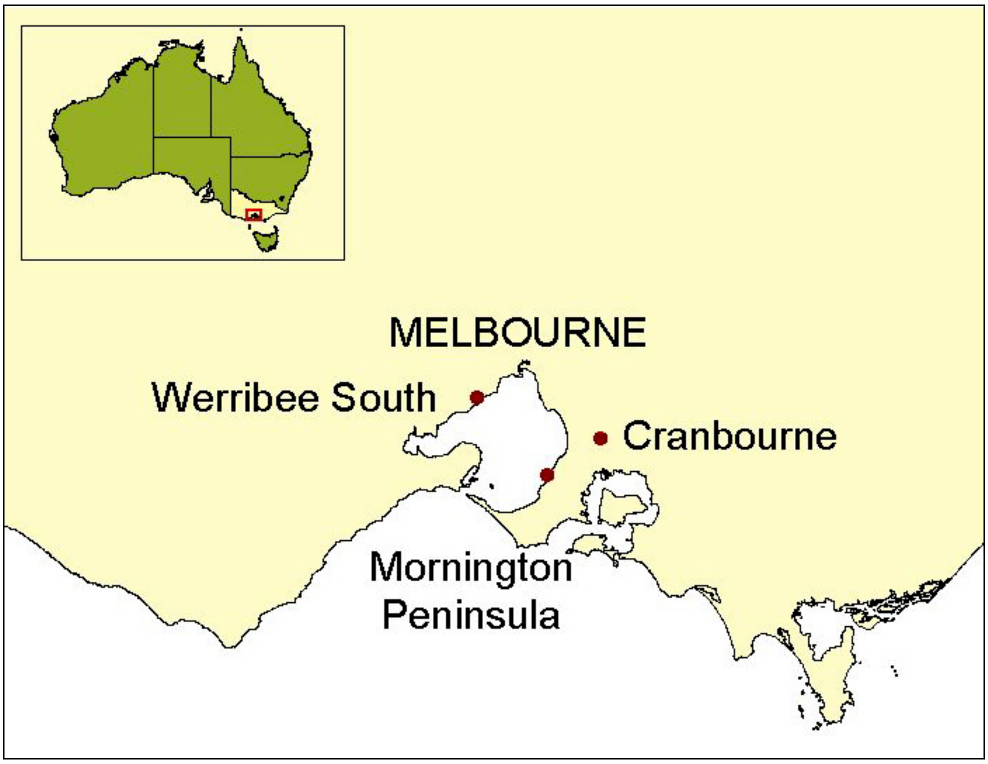

Figure 1 Site Locations in the Southern Region

Figure 2 Site Locations in the Northern Region

In the Southern Region, Irrigators who had previously worked with the Department of Primary Industries were approached to participate in this study. Three crop types were selected: lettuce, carrots and broccoli. By contrast, project staff in the Northern Region included growers they had previously not worked with. The crop types selected were carrots and the cucurbits zucchini, squash and pumpkins.

Letters were sent out inviting these growers to participate in the study. Sites were chosen in consultation with the grower on the basis of the availability of the required data. In the Southern Region, data from crops planted from December 2004 to February 2005 were included and all crops were harvested by the end of April 2005. Due to the difference in crop types, the Northern Region planting-harvest time was considerably longer than in the Southern Region and included crops planted in January and harvested in June 2005.

The three regions within the southern production area focused on different crops with various varieties being represented within the sample areas. Broccoli and lettuce growers were located in Werribee and Cranbourne whilst carrot growers were situated on the Mornington Peninsula. This type of distribution did not occur in the Northern Region.

The data collection and analysis included visits to grower's properties to measure flow rates from the pump used in the test blocks. This was done using a GE Parametric Transport PT378 Portable Liquid Flowmeter. Pipe specifications and measurements were noted and the pump pressure and power were recorded.

Most growers kept an irrigation diary and noted irrigation times and the duration. However, some growers could only give best estimates.

Growers completed a questionnaire about their irrigation practices for the 2004-2005 summer season (Attachment 1). This was mainly conducted by phone after the collection of the irrigation diaries. The information gathered in the survey gives a broad understanding of the irrigation practices occurring on that farm.

All produce was for fresh market. However, detailed information about the quality of the produce (and its impact on returns) was not recorded.

INDICATORS OF IRRIGATION PERFORMANCE

Measures of irrigation performance used in this study are presented below. They are accompanied by information on how they were derived from the data provided by the farmers in both field measurements and interviews.

The rationale used was to establish the best performing sites over the suite of indicators. These indicators do not give an accurate assessment of the total financial situation of the site, but include gross return figures.

Yield (t/ha)

Yield and quality information were collected over the summer irrigation season. Most of the growers estimated their yield. Broccoli is usually measured by the carton weighing an average of 8kg. For this study, it was assumed the one carton contained 24 heads of broccoli. Lettuce are also sold by the box (10kg), and there are usually 10 lettuce heads per box (ie 1kg/head).

Total Water Applied (ML/ha)

The total water applied was calculated from the flow rate, the total duration of irrigation from planting to harvest for the crop and the area that was monitored.

Water Use Efficiency (t/ML)

Water Use Efficiency is a measure of the yield achieved (tonnes) for the total volume of irrigation water per hectare applied over the growing season of the crop.

An efficient irrigator is one who applies the correct amount of water at the right time to meet the crop's requirements and leach harmful salts from the rootzone.

Other aspects such as soil water holding capacity, crop loads, canopy size, irrigation system, crop and emitter spacings, and variations in environmental conditions (eg. rainfall) affect the amount of irrigation applied and the overall performance of a site, and therefore contribute to the differences observed between sites.

Gross Return per Hectare ($/ha)

Gross returns per hectare ($/ha) were calculated on the basis of average yield figures obtained from the growers and average market prices. All vegetables were sold on the fresh market, and the quality of the crop was not determined. Average prices were taken from Melbourne Market for the month the crop was harvested.

Gross Return per Megalitre ($/ML)

The gross return per hectare ($/ha) was divided by the volume of water applied per hectare over the season (ML/ha) to derive the gross return per megalitre of irrigation ($/ML).

It should be noted that these figures were used for comparison between sites only and were not meant to reflect the actual returns received.

"An efficient irrigator is one who applies the correct amount of water at the right time to meet the crops requirements"

SITE INFORMATION

Table 1 Summary of Broccoli Information

PROPERTY DETAILS		Broccoli 01	Broccoli 02	Broccoli 03	Broccoli 04	Broccoli 05
LOCATION		Cranbourne	Werribee	Cranbourne	Cranbourne	Werribee
MANAGEMENT DETAILS	Scheduling	Observation	Observation	Observation	Observation	Observation
	$/ML	6,180	14,310	23,174	5,190	12,752
IRRIGATION SYSTEMS DETAILS	Type	Overhead	Overhead	Overhead	Overhead	Overhead
	Flow Rate (L/sec)	47.5	52.2	17.06	85	43
	Hours Irrigated	43.5	17.5	45.75	41	22.25
CROP DETAILS	Variety	Mix of 5	Legacy, Viper, Golliath	Ironman, Greenbelt	Ironman, Greenbelt	Viper

Table 2 Summary of Carrot Information

PROPERTY DETAILS		Carrot 01	Carrot 02	Carrot 03	Carrot 04	Carrot 05	Carrot 06
LOCATION		Mornington	Mornington	Mornington	Mornington	Swan Hill	Nangiloc
MANAGEMENT DETAILS	Scheduling	Observation	Observation	Observation	Observation	Observation	Observation
	$/ML	10,736	21,766	4,930	8,619	14,141	4,185
IRRIGATION SYSTEMS DETAILS	Type	Overhead	Overhead	Overhead	Overhead	Overhead	Overhead
	Flow Rate (L/sec)	12	22	34	16.5	N/A	N/A
	Hours Irrigated	82	Unknown	75.5	89	75	50.25
	Total Water Applied (ML/ha)	2.952	1.308	5.770	3.304	1.762	2.640
CROP DETAILS	Variety	Western Red	Stefano	Not reported	Not reported	Kendo	Red Hot

Table 3 Summary of Lettuce Information

Property Details		Lettuce 01	Lettuce 02	Lettuce 03	Lettuce 04	Lettuce 05	Lettuce 06	Lettuce 07
Location		Cranbourne	Cranbourne	Cranbourne	Werribee	Werribee	Werribee	Werribee
Management Details	Scheduling	Observation	Observation	Observation	Observation	Observation	Observation	Observation
	$/ML	10,006	12,213	15,687	14,885	26,637	20,761	16,700
Irrigation Systems Details	Type	Overhead	Overhead	Overhead	Overhead	Overhead	Overhead	Overhead
	Flow Rate (L/sec)	72.5	72	47.5	36	47.6	32	87.6
	Hours Irrigated	48.5	70	25.16	16.00	14.00	13.50	18.00
Crop Details	Variety	Iceberg	Iceberg	Iceberg	Iceberg	Iceberg	Iceberg	Not Reported

Table 4 Summary of Cucurbit Information

Property Details		Squash 01	Zucchini 01	Zucchini 02	Zucchini 03	Pumpkin 01	Pumpkin 02	Pumpkin 03
Location		Mildura	Swan Hill	Swan Hill	Irymple	Mildura	Red Cliffs	Red Cliffs
Management Details	Scheduling	Observation	Observation	Observation	Observation	Observation	Observation	Observation
	$/ML	7,839	12,182	8,101	10,976	2,166	76	256
Irrigation Systems Details	Type	Drip	Overhead	Drip	Drip	Overhead	Overhead	Overhead
	WUE (t/ML)	0.27	8.07	5.37	12.20	5.78	0.76	0.43
Crop Details	Variety	Not Reported	Not Reported	Not Reported	Not Reported	Jap	Butternut	Jap

BROCCOLI - PERFORMANCE COMPARISONS

Yield (t/ha)

Figure 3 represents the yield of broccoli from participating farms in tonnes per hectare. Broccoli 03 and 04 (same grower) had the largest yield of approximately 18.5 t/ha. The yield achieved by the other growers ranged from 12.5 t/ha to 18.5 t/ha.

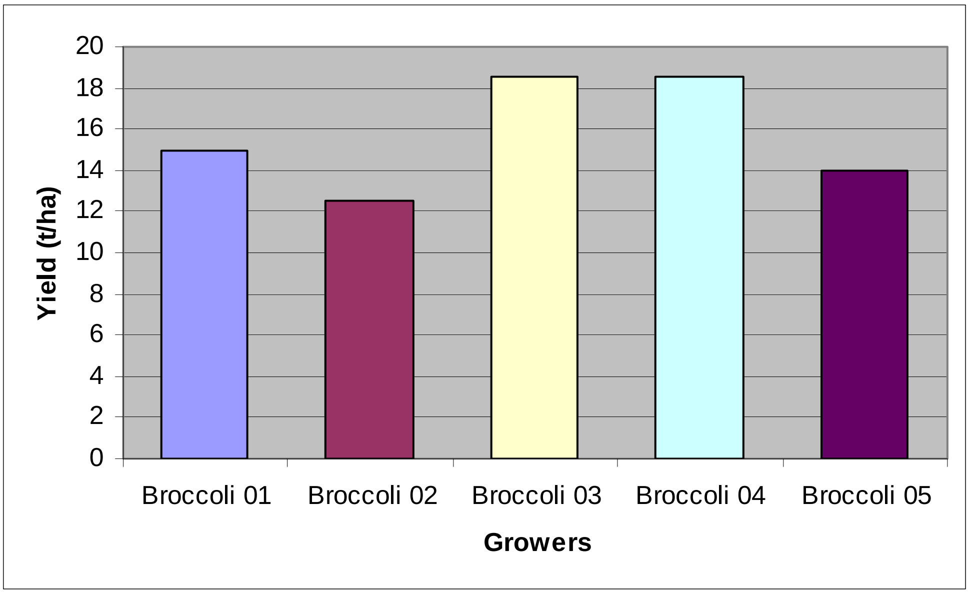

Figure 3 Broccoli - Yield (t/ha)

Variations in yield were not solely due to differences in irrigation management. There were other factors in the growing system that impacted on yield such as variety, nutrition and disease. Broccoli 02 experienced club root, which also affected the yields of other growers, although they did not specify any adverse factors.

Total Water Applied (ML/ha)

The total amount of water (ML) applied to the farm (per hectare) through irrigation is represented in Figure 4. Broccoli 04 applied the greatest amount of water, almost four times that applied by Broccoli sites 02, 03 and 05. However, Broccoli 04 and 03 achieved the same yield. Broccoli 01 applied the second largest amount of water per hectare and achieved the third largest yield (Figure 3).

The amount of rainfall received during the planting-harvest periods was quite uniform.

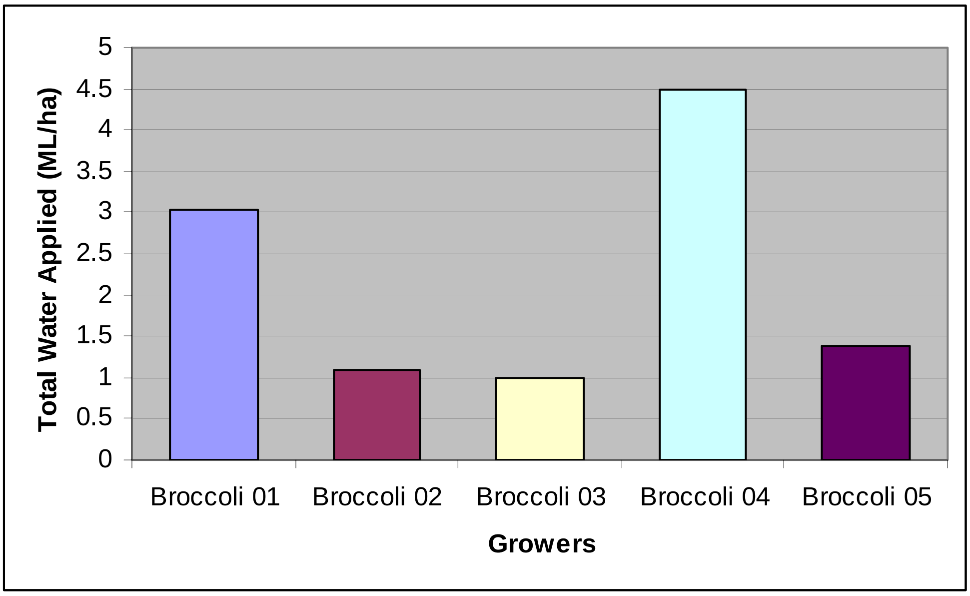

Figure 4 Total Water Applied for Broccoli (ML/ha)

Water Use Efficiency (t/ML)

Water Use Efficiency (Figure 5) introduces irrigation management into the equation, as achieving a high yield with an excessive amount of water is not ideal or efficient. As the availability of water decreases, the importance of Water Use Efficiency or Yield per Megalitre of Irrigation is increasing.

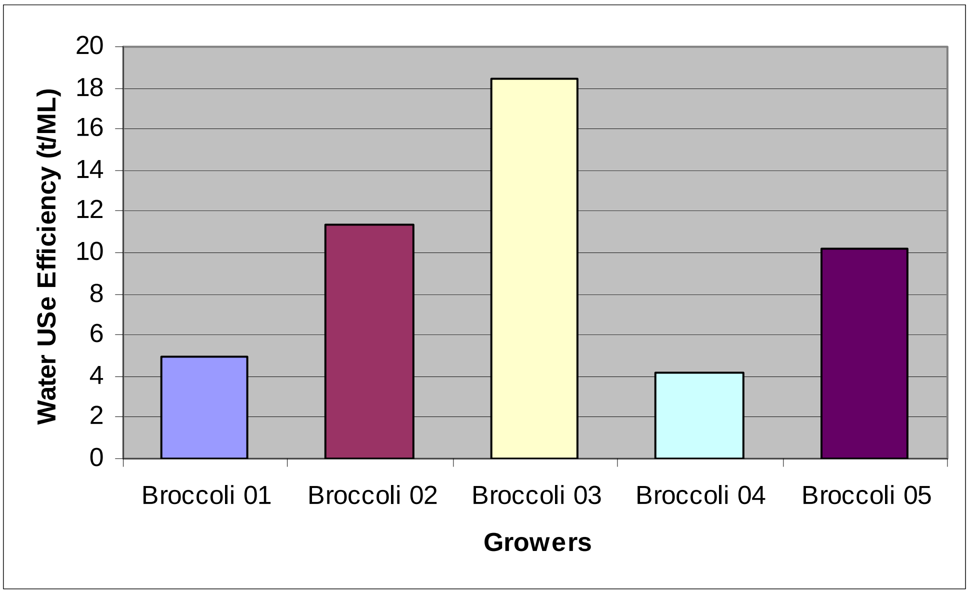

Figure 5 Broccoli - Water Use Efficiency (t/ML)

Broccoli 03 had the highest ranking in Water Use Efficiency with Broccoli 04 achieving the lowest. Broccoli 03 and 04 were the same grower, but different blocks and irrigation pumps were used on the same farm. The duration of irrigation was approximately the same as was the yield. However, the flow rate from the two pumps varied. The pump used for Broccoli 03 produced a quarter of the flow rate of that used for Broccoli 04.

Broccoli 02 and Broccoli 03 achieved a Water Use Efficiency of approximately 11 and 10 t/ML respectively. Although they had the two lowest yields, their water use was low so they achieved a reasonable water use efficiency rating. Broccoli 01 and 04 used the most water for the yield they produced.

There are other factors that affect Water Use Efficiency. All growers noted that irrigation occurs for a variety of reasons including weed seed germination, and to minimise crop damage from sand drift, dust and wind. The percentage of time irrigation occurred for these reasons was not quantified.

Gross Return per Hectare ($/ha)

The gross return per hectare for the five broccoli sites is shown in Figure 6. Markets prices were obtained from the Melbourne Market Authority and are to be used as a guide only. It was assumed that all marketable broccoli was first quality and sold in cartons. It is also assumed that cartons contained 24 broccoli heads and weighed 8kg.

The average prices obtained for the broccoli relate to February 2005 as all the broccoli growers harvested during this month. The gross return per hectare was highly dependant on the yield.

Broccoli 03 and 04 achieved the same yield and consequently, achieved the same gross return per hectare. Broccoli 02 achieved approximately $5,000/ha less than Broccoli 03 and 04.

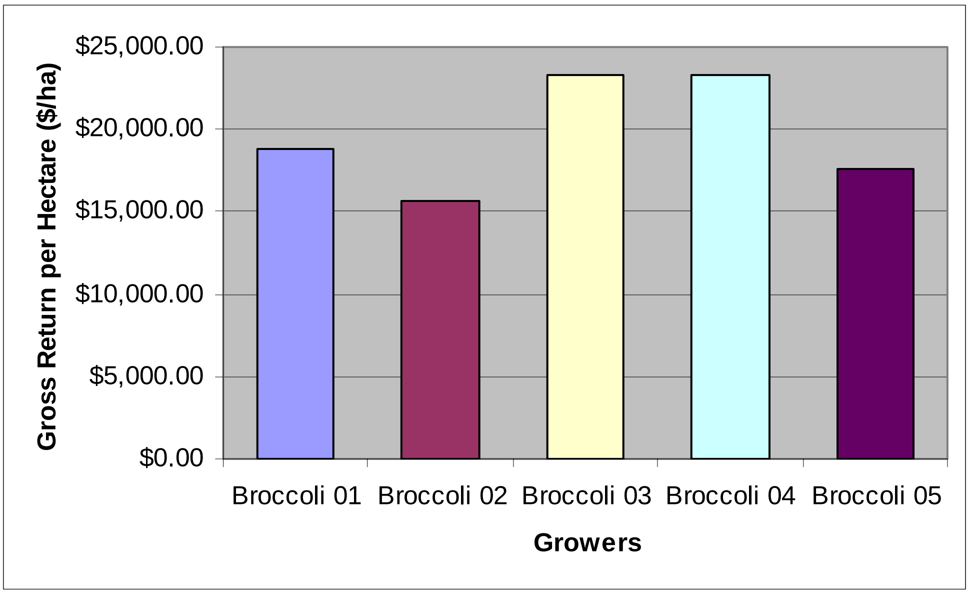

Figure 6 Broccoli - Gross Return per Hectare ($/ha)

Gross Return per Megalitre ($/ML)

Figure 7 represents the gross return per megalitre. Figure 4 shows that both Broccoli 03 and Broccoli 04 achieved the same yield yet their water use differed significantly. Broccoli 04 achieved a quarter of the gross return per megalitre of water than of Broccoli 03. This figure is closely linked to the Water Use Efficiency graph with the same patterns evident.

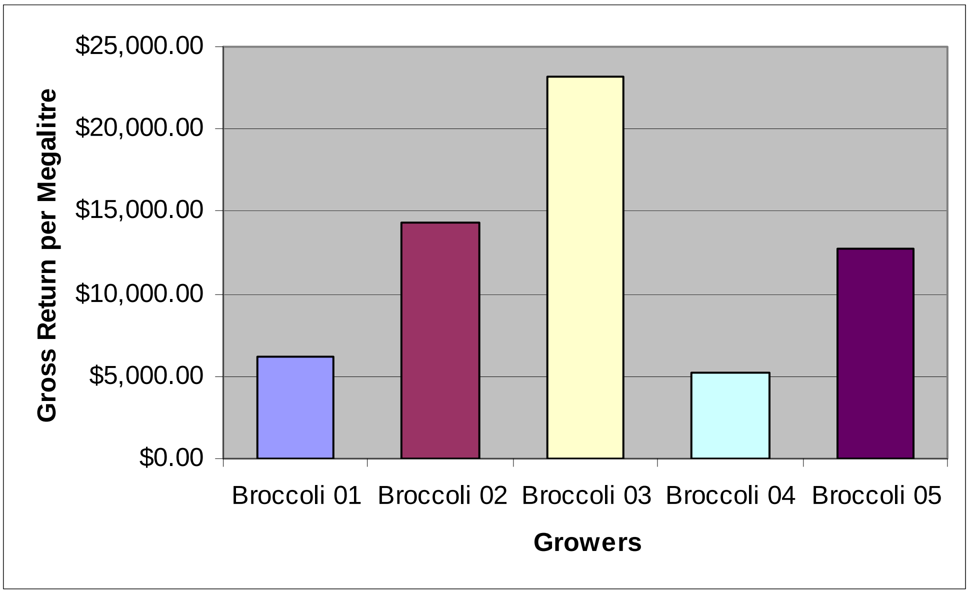

Figure 7 Broccoli - Gross return per Megalitre ($/ML)

Market Prices

Table 5 is a matrix showing the effects of yield and market price on gross margins. These monthly average prices have been obtained from the Melbourne Market Authority. It shows how the gross return of Broccoli will vary when the market price changes. It also shows how a variation in yield will affect the gross return. This year was a particularly poor one for market prices. The boxes highlighted represent yields and returns achieved by the growers that participated in this study.

Table 5 Effect of market price and yield on broccoli gross margin per hectare.

Market Price \ t/ha	10	12	14	16	18
$8.00	$10,000	$12,000	$14,000	$16,000	$18,000
$10.00	$12,500	$15,000	$17,500	$20,000	$22,500
$12.00	$15,000	$18,000	$21,000	$24,000	$27,500
$14.00	$17,500	$21,000	$24,500	$28,000	$31,500
$16.00	$20,000	$24,000	$28,000	$32,000	$36,000

The last 5 year average broccoli prices for February with the Melbourne Market Authority are shown in Figure 8. Last year was particularly good for broccoli growers that harvested in February with an average price of approximately $20.00 a carton, almost double the price for this year. Over the five year period, prices have risen after a low so according to this trend, the price for broccoli should rise next year.

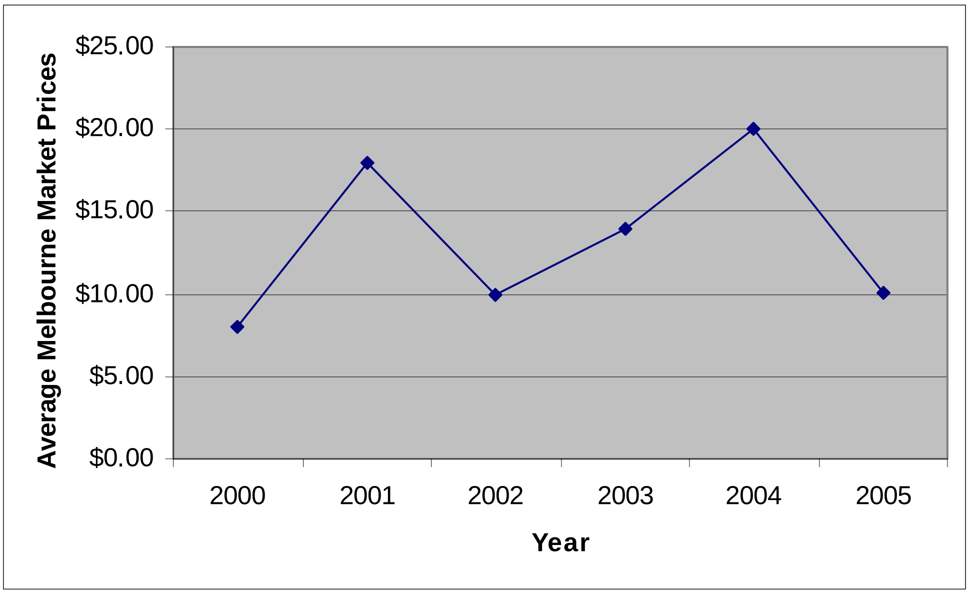

Figure 8 Average Five Year Trend for Broccoli Market Prices during February.

CARROTS - PERFORMANCE COMPARISONS

Yield (t/ha)

Figure 9 represents the yield of carrots in tonnes per hectare. Carrot 01 stood out with an approximate yield of 55 t/ha. The other three sites in the Southern Region (Carrot 02-04) recorded a yield of approximately 49 t/ha. Carrot 05 recorded a slightly lower yield that most growers whereas Carrot 06 only recorded approximately one quarter of the yield recorded by all other growers.

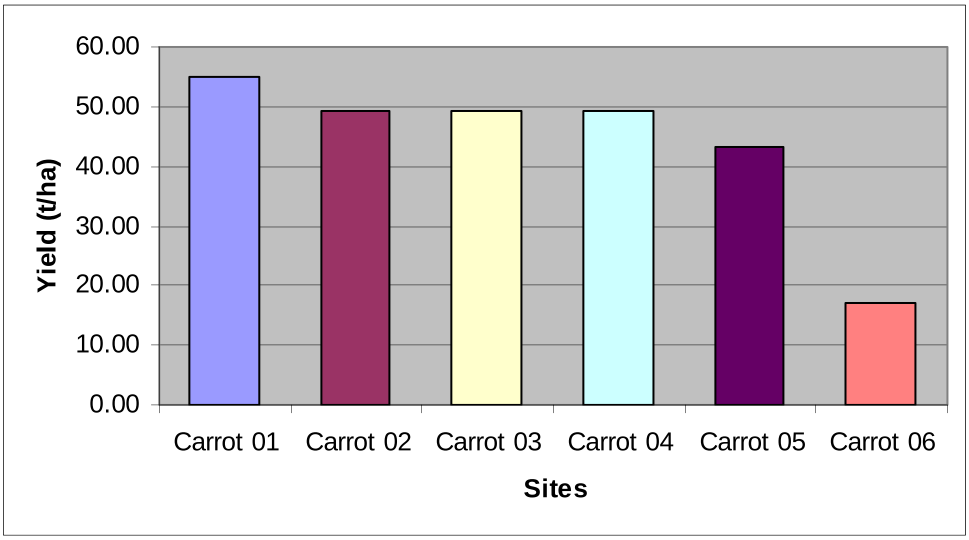

Figure 9 Carrots - Yield (t/ha)

Variations in yield are not solely due to differences in irrigation management. There are other factors in the growing system that impact on yield such as variety, nutrition and disease. Carrot 01 experienced nutritional problems. The other growers did not specify any adverse conditions.

Total Water Applied (ML/ha)

The total amount of water applied to the farm (per hectare) through irrigation is represented in Figure 10. Carrot 03 applied the greatest amount of water (ML) with almost double the amount applied per hectare than the other growers. Carrot sites 02, 03 and 04 achieved the same yield yet their water usage varied greatly. Carrot 01 had the highest yield and only applied an average 3 ML/ha. The amount of rainfall received during the planting-harvest periods was quite uniform in the Southern Region and only varied by 1-5mm between sites. Carrot 06 used applied more water than Carrot 02 and Carrot 05 but achieved the lowest yield.

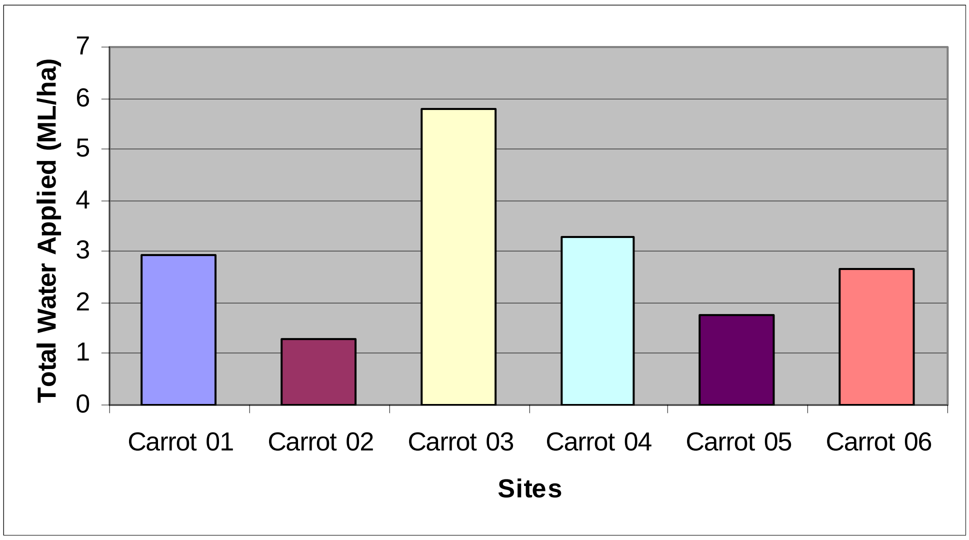

Figure 10 Total Water Applied for Carrots (ML/ha)

Water Use Efficiency (t/ML)

Water Use Efficiency (Figure 11) introduces irrigation management into the equation, as achieving a high yield with an excessive amount of water is not ideal or efficient. As the availability of water decreases, the importance of Water Use Efficiency or Yield per Megalitre of Irrigation is increasing.

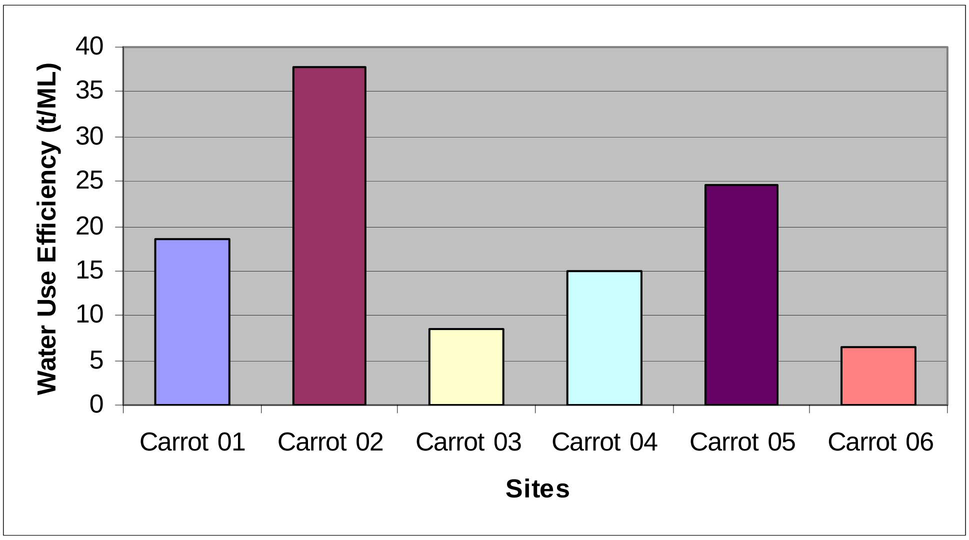

Figure 11 Carrots - Water Use Efficiency (t/ML)

Carrot 02 ranked the highest in Water Use Efficiency achieving 38 t/ML of water. However, this figure may be exaggerated as the total water irrigated was measured differently for this grower. Carrot 05 achieved the second highest Water Use Efficiency as their yield was slightly lower than other sites but their water use was the second lowest. Carrot 01 showed a two fold variation in water use efficiency from Carrot 03.

Although Carrot sites 02, 03 and 04 achieved the same yield, the amount of water used for irrigation varied. Carrot 03 used the most water for the yield achieved. Moreover, the crop growth (planting-harvest) period for Carrot 03 was 108 days, with the other growers harvesting their carrots after a minimum of 130 days. Carrot 05 scored the lowest ranking in Water Use Efficiency as they used they recorded the lowest yield and used more water than other growers.

There are other factors that affect Water Use Efficiency. All growers noted that irrigation occurs for a variety of reasons including weed seed germination, and to minimise crop damage from sand drift, dust and wind. The percentage of time irrigation occurred for these reasons was not quantified.

Gross Return per Hectare ($/ha)

The gross return per hectare for the four carrot sites is shown in Figure 12. Markets prices were obtained from the Melbourne Market Authority and are to be used as a guide only. It is assumed that all carrots were first quality and sold in 20kg bags. The average prices obtained for the carrots relate to the month the carrots were harvested and are highly dependant on the quality.

All carrots in the Southern Region were harvested in March and April, 2005. Carrot 05, in the Northern Region harvested in February. The average market price was the same for the three months. Carrot 06 harvested in June 2005 with the average market price being approximately $1.50 a bag higher than what was achieved in the previous months..

Carrot sites 02, 03 and 04 achieved the same yield and consequently, achieved the same gross return per hectare. Carrot 01 achieved approximately $5,000/ha more than the other growers due to a greater yield. Although the market price for carrots during June 2005 was higher, Carrot 06 achieved the lowest yield and therefore, had the lowest gross return per hectare.

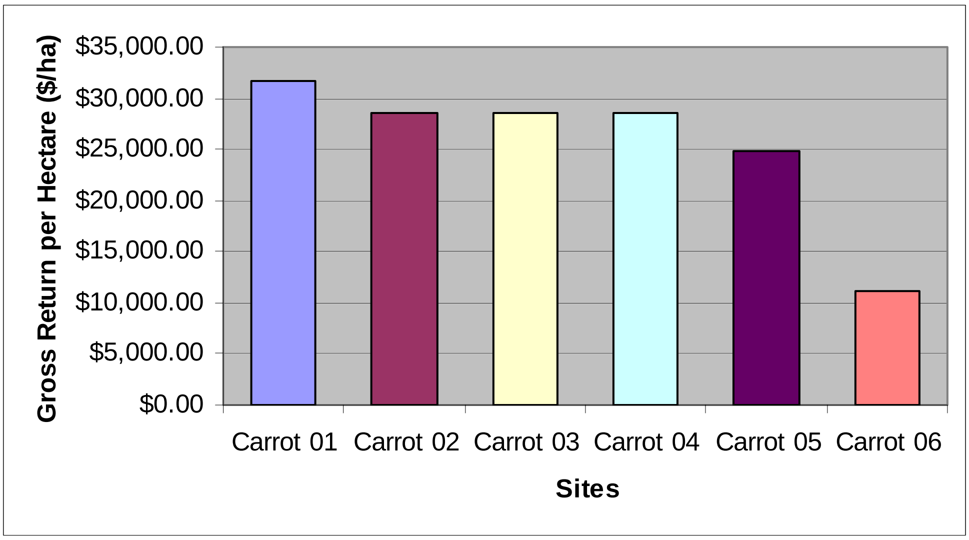

Figure 12 Carrots - Gross Return per Hectare ($/Ha)

Gross Return per Megalitre ($/ML)

Figure 13 represents the gross return per megalitre. Figure 9 showed that Carrot 02, Carrot 03 and Carrot 04 achieved the same yield yet their water use differed significantly. Carrot 02 seemed to get almost twice the return per megalitre of water than Carrot 01 and almost four times that of Carrot 03 and 5 times that of Carrot 06.

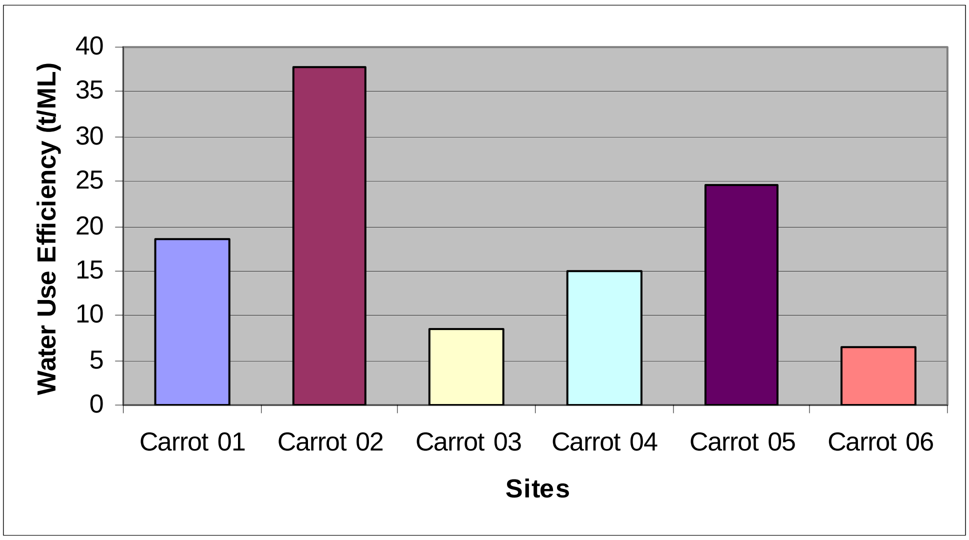

Figure 13 Carrots - Gross return per Megalitre ($/ML)

Table 6 is a matrix showing the effects of yield and market price on gross margins. These monthly average prices have been obtained from the Melbourne Market Authority, and show how the gross return of carrots will vary when the market price changes. Table 2 also illustrates how variation in yield will affect the gross return. This year (summer 2004) was particularly poor in relation to market prices. The boxes highlighted represent yields and returns achieved by the growers that participated in this study.

Table 6 Effect of market price and yield on carrot gross margin per hectare.

t/ha / Market Price	45	50	55	60	65
$8.00	$18,000	$20,000	$22,000	$24,000	$26,000
$10.00	$22,500	$25,000	$27,500	$29,000	$31,500
$11.525	$23931	$28,812	$31,693	$34,575	$37,456
$12.00	$27,000	$30,000	$33,000	$36,000	$39,000
$14.00	$31,500	$35,000	$38,500	$42,000	$45,500
$16.00	$36,000	$40,000	$44,000	$48,000	$52,000

A five year comparison (Figure 14) shows that the price of carrots has remained quite steady ranging from a low of $12 per bag in 2000 to as high as $14.5 per bag in 2003. However, this year, the lowest price for carrots sold in 20 kg bags was $11.53.

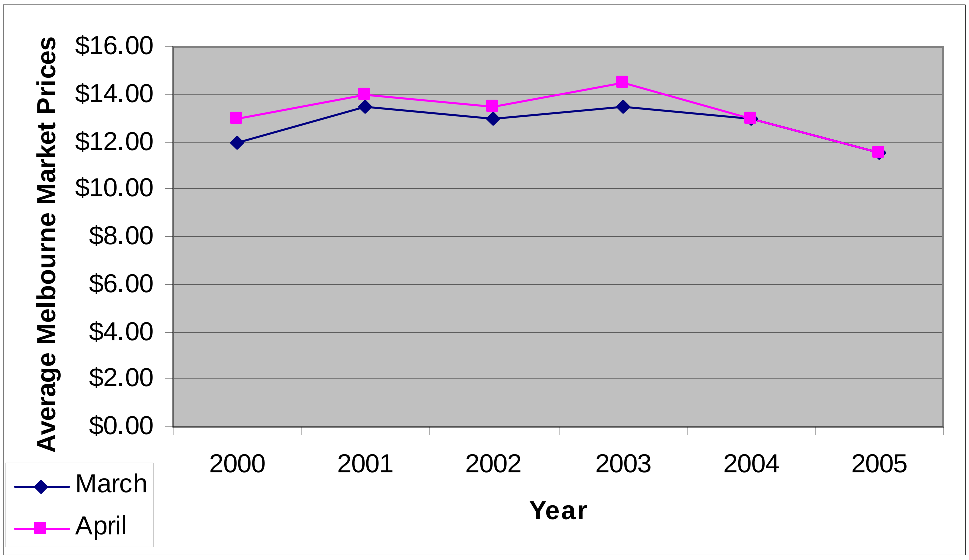

Figure 14 Average Five Year Trend for Carrot Market Prices during March and April

LETTUCE - PERFORMANCE COMPARISONS

In the following graphs, it is estimated that the average weight of a box of lettuce containing 10 heads of lettuce is 10kg.

Yield (t/ha)

Figure 15 represents the yield of lettuce in tonnes per hectare. Lettuce sites 06, 05 and 07 recorded the highest yields. These growers and Lettuce 04 were situated in Werribee. In contrast, the Cranbourne growers, Lettuce 01, 02 and 03 recorded lower yields than the Werribee sites.

The reason for this difference could be that the Cranbourne growers planted less lettuce per hectare than the Werribee growers. In both regions, the average marketable yield reported by the growers was 70-90% of the planted crop.

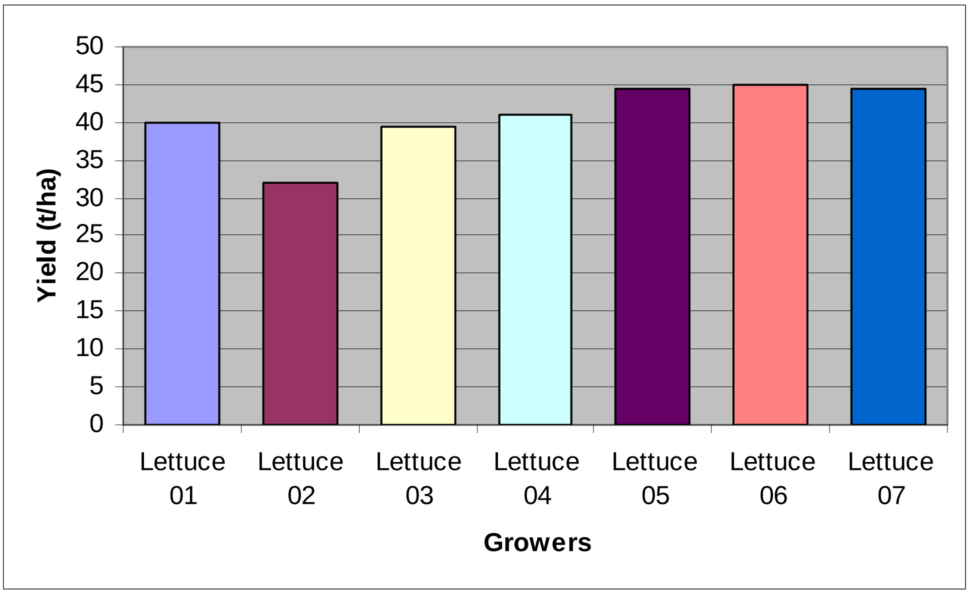

Figure 15 Lettuce - Yield (t/ha)

Variations in yield were not solely due to differences in irrigation management. There were other factors in the growing system that impact on yield such as variety, nutrition and disease. However, Lettuce 01 and 05 experienced adverse conditions over the summer period due to excessive rain, which produced general damage to the lettuce as well as increased bacteria and mildew infections.

Total Water Applied (ML/ha)

The total amount of water (ML) applied to the farm (per hectare) through irrigation is represented in Figure 16. Lettuce 01 applied the largest amount of water per hectare, twice as much as Lettuce 03 and 06. Lettuce 05 applied the least amount of water Although Lettuce 05 produced the same yield as Lettuce 06 and 07, the water applied to produce this yield was considerably lower. All growers produced reasonable yields and all growers applied under 3 ML/ha of water. The amount of rainfall received during the planting-harvest periods was quite uniform and only varied by 1-2mm between sites.

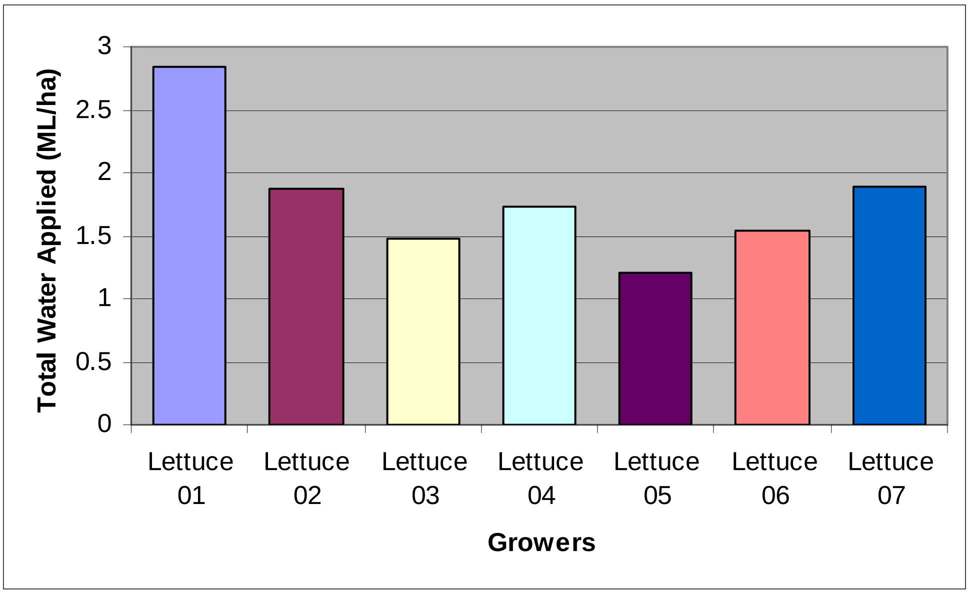

Figure 16 Total Water Applied for Lettuce (ML/ha)

Water Use Efficiency (t/ML)

Water Use Efficiency introduces irrigation into the equation. Achieving a high yield with an excessive amount of water is not ideal or efficient. As the availability of water decreases, the importance of Water Use Efficiency or Yield per Megalitre of Irrigation is increasing.

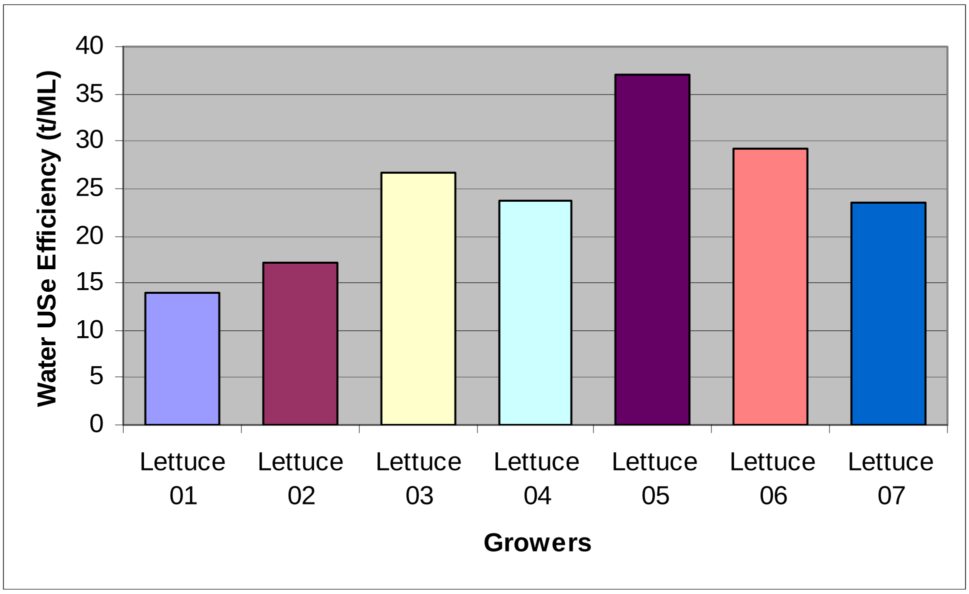

Figure 17 Lettuce - Water Use Efficiency (t/ML)

Lettuce 05 achieved the greatest water use efficiency (Figure 17) due to recording the second highest yield and applying the lowest amount of water per hectare. Although Lettuce 06 achieved the greatest yield, the amount of water applied per hectare was slightly higher than Lettuce 05. Therefore, Lettuce 06 scored second in water use efficiency.

Although Lettuce 03 did not produce the highest yield, this site was more efficient in water use than Lettuce 07, which had the second highest yield.

Lettuce 01 achieved a reasonable yield but ranked quite low at being an efficient water user as did Lettuce 02.

The Cranbourne growers scored significantly lower in water use efficiency than the Werribee growers. The lowest ranking was Lettuce 05 which produced only 14 t/ML of water. This is almost half of what Lettuce 05 achieved. The specific reason for such differences was not within the scope of this study. Possible reasons include the fact that Lettuce 01 planted the least number of lettuce plants per hectare, or that Cranbourne crops were mainly on sandy soils whereas in Werribee, they were predominantly on loam/clays, which retain water for longer periods.

Gross Return per Hectare ($/ha)

Figure 18 represents the approximate gross return per hectare for the various growers. These figures are based on average monthly prices obtained from the Melbourne Market Authority and are to be used as a guide only. They are average prices and do not represent the exact price growers would have received per carton, which would depend on daily price and quality considerations.

All growers harvested their lettuce in February except Lettuce 04 who harvested in March. The average Melbourne Market Price for Lettuce in February was $8.54 per carton whereas in March it was $1.00 a carton lower, at $7.53.

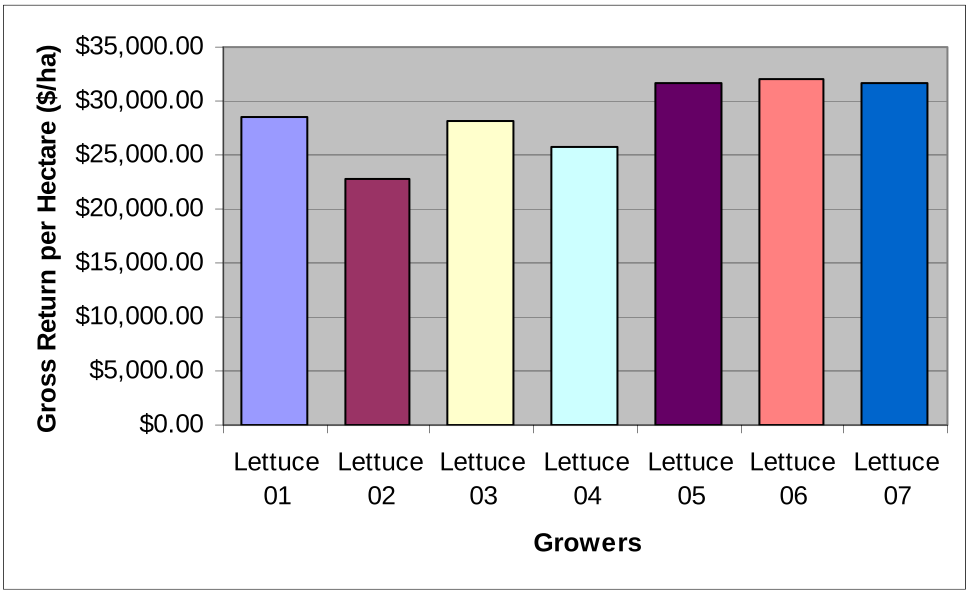

Figure 18 Lettuce - Gross Return per Hectare ($/ha)

The gross return per hectare is directly related to the yield produced and the month the lettuce was harvested.

Gross Return per Megalitre ($/ML)

Figure 19 represents the gross return per megalitre. This was calculated from the gross return per hectare and the total amount of irrigation water applied to the crop.

The gross return per megalitre is directly related to water use efficiency. As the market price for March was lower than February, Lettuce 04 achieved a lower ranking. The Werribee Growers (Lettuce 04-07) generally achieved a greater gross return per megalitre than the Cranbourne growers and in some cases, the difference between the results at the two locations doubled.

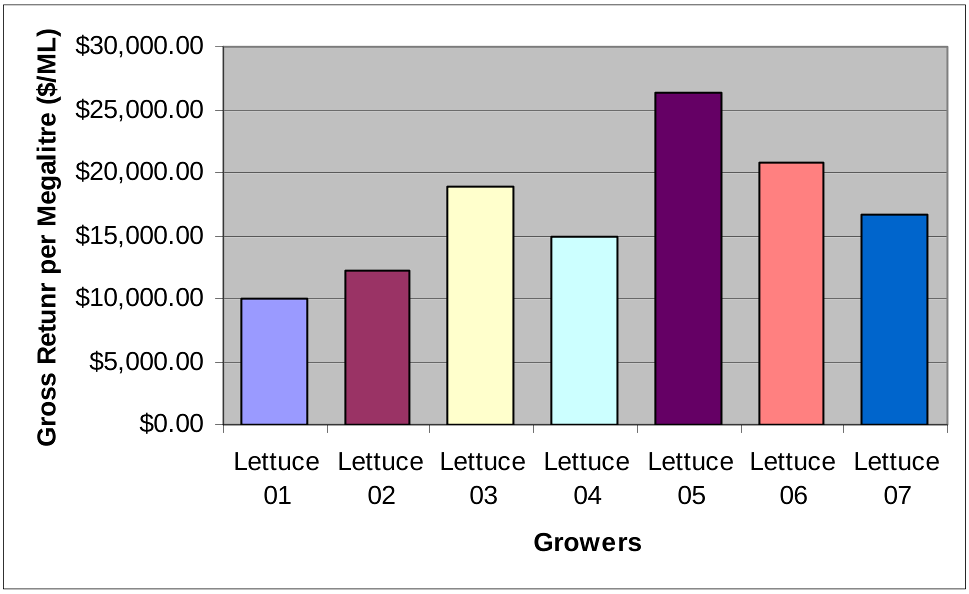

Figure 19 Lettuce - Gross return per Megalitre ($/ML)

Market Prices

Table 7 is a matrix showing the effects of yield and market price on gross margins. These monthly average prices have been obtained from the Melbourne Market Authority, and show how the gross return for lettuce will vary when the market price changes. Table 2 also illustrates how variation in yield will affect the gross return. This year was a particularly poor one in relation to market prices. The boxes highlighted represent yields and returns achieved by the growers that participated in this study.

Table 7 Effect of market price and yield on lettuce gross margin per hectare.

Market Price \ t/ha	38	40	42	44	46
$5.00	$19,000	$20,000	$21,000	$22,000	$23,000
$7.525 (March Harvest)	$28,595	$30,100	$31,605	$33,110	$34,615
$8.525 (February Harvest)	$32,395	$34,100	$35,805	$37,510	$39,215
$10.00	$38,000	$40,000	$42,000	$44,000	$46,000
$12.00	$45,600	$48,000	$50,400	$52,800	$55,200
$14.00	$53,200	$56,000	$58,800	$61,600	$64,400
$16.00	$60,800	$64,000	$67,200	$70,400	$73,600

A five year, market price comparison for lettuce in February and March is shown in Figure 20. 2004 was a particularly good year for lettuce growers that harvested in February reaching an average price of $17.05, almost double the price for this year. March 2004 and 2003 were both good seasons, with market prices reaching $12 a carton compared to $7.525 that was paid this year. Over the five year period, prices this year are the second lowest and according to trend, they should rise next year.

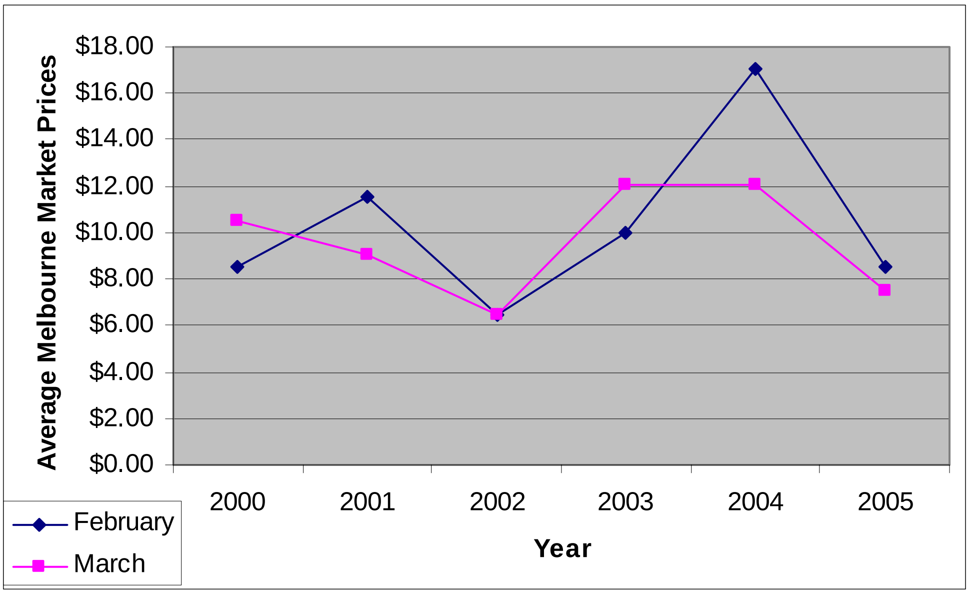

Figure 20 Average Five Year Trend for Lettuce Market Prices during February and March

CUCURBITS - PERFORMANCE COMPARISONS

Yield (t/ha)

Figure 21 represents the yield of squash, zucchini and pumpkins in tonnes per hectare. Zucchini 03 recorded nearly twice the yield of the other two zucchini sites. Pumpkin 01 recorded a yield almost three times that of the other pumpkin growers.

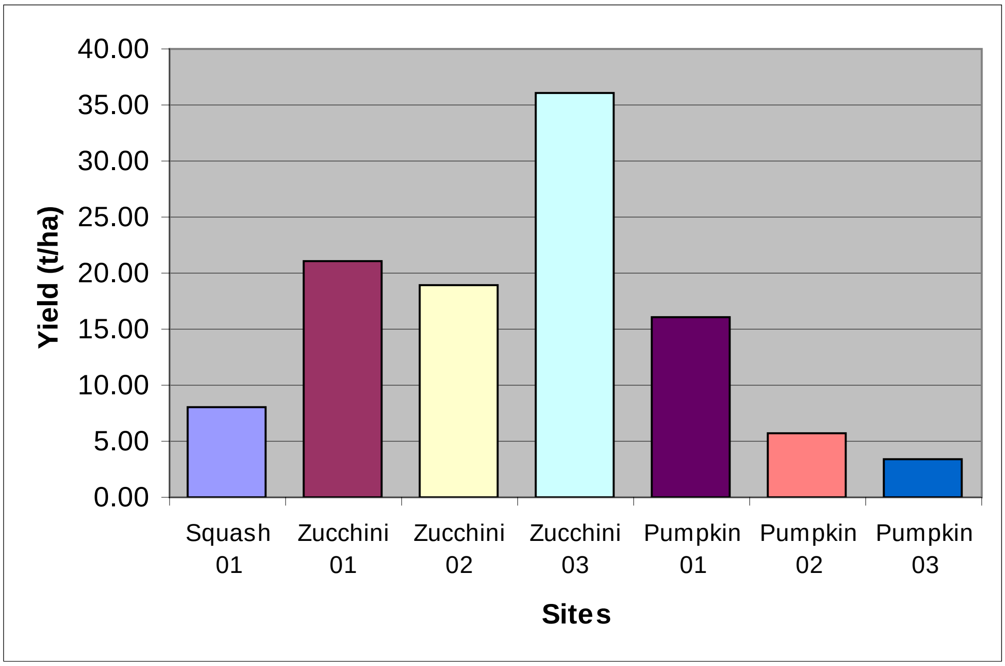

Figure 21 Cucurbits - Yield (t/ha)

Variations in yield were not solely due to differences in irrigation management. There were other factors in the growing system that impact on yield such as variety, nutrition and disease. However, Lettuce 01 and 05 experienced adverse conditions over the summer period due to excessive rain, which produced general damage to the lettuce as well as increased bacteria and mildew infections.

Total Water Applied (ML/ha)

The total amount of water (ML) applied (per hectare) to the cucurbit farms through irrigation is represented in Figure 22. Pumpkin 02 applied the largest amount of water per hectare; one third more than the other pumpkin growers and approximately seven times that of other cucurbit growers. All Squash and Zucchini growers used drip irrigation except Zucchini 01, whereas the pumpkins were all irrigated with overhead sprinklers.

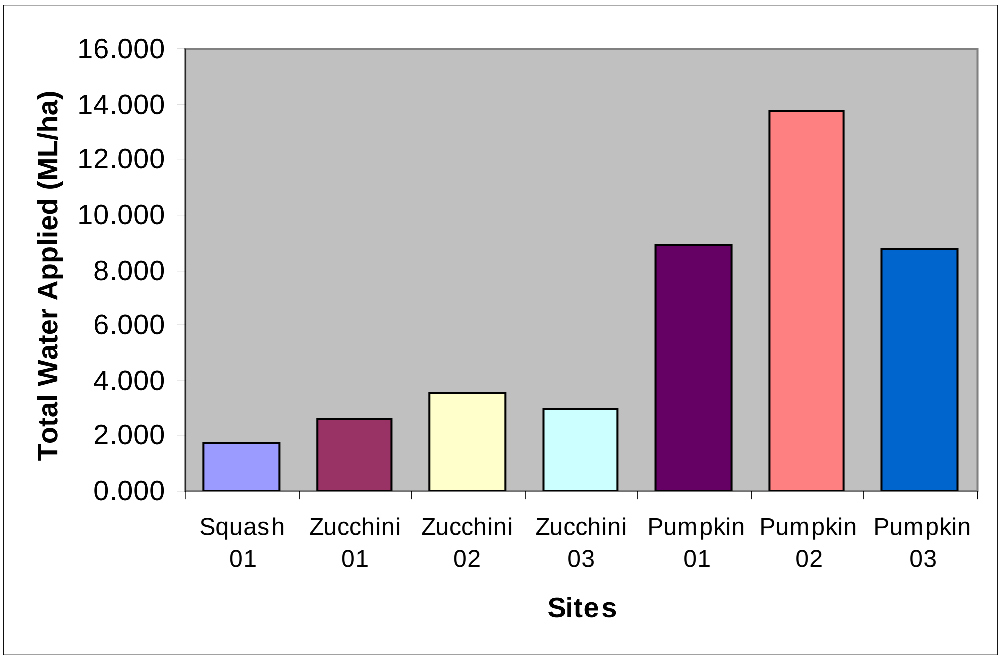

Figure 22 Total Water Applied for Cucurbits (ML/ha)

Water Use Efficiency (t/ML)

Water Use Efficiency introduces irrigation management into the equation. Achieving a high yield with an excessive amount of water is not ideal or efficient. As the availability of water decreases, the importance of Water Use Efficiency or Yield per Megalitre of Irrigation is increasing.

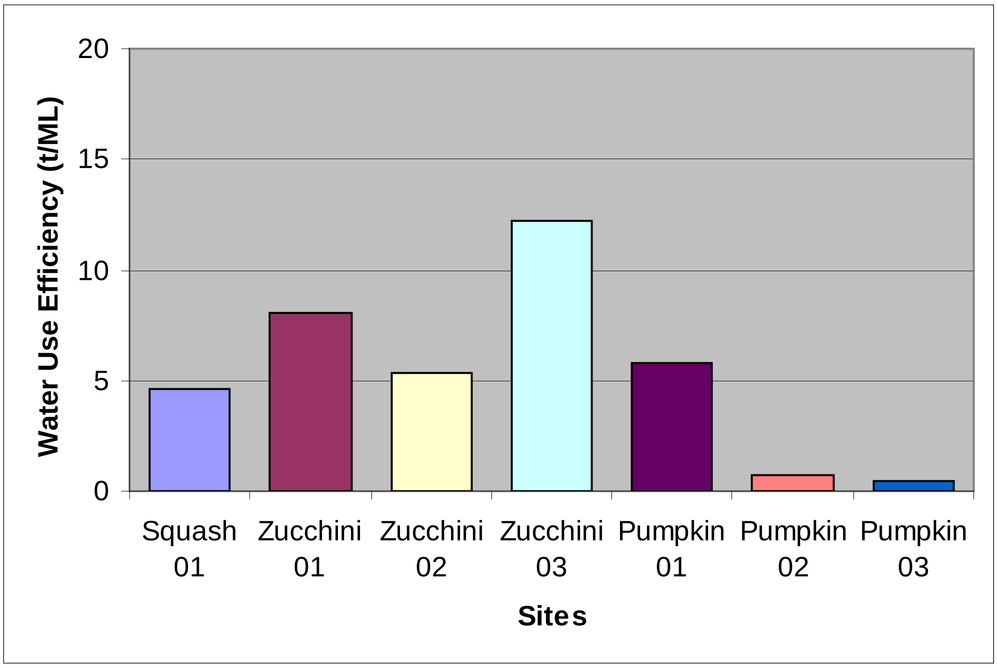

Figure 23 Cucurbits - Water Use Efficiency (t/ML)

Zucchini 03 achieved the greatest Water Use Efficiency (Figure 23). Pumpkins 02 and 03 achieved a low ranking. Different crops and irrigation systems were used in this group, and as few crops were monitored, caution should be used in drawing any meaningful comparisons between them.

Gross Return per Hectare ($/ha)

Figure 24 represents the approximate gross return per hectare for the various growers. These figures are based on average monthly prices obtained from the Melbourne Market Authority and are to be used as a guide only. They are average prices and do not represent the exact price growers would have received per carton, which would depend on daily price and quality considerations.

Pumpkin 02 experienced markings on the skins of pumpkins, so the price achieved for this crop was below average.

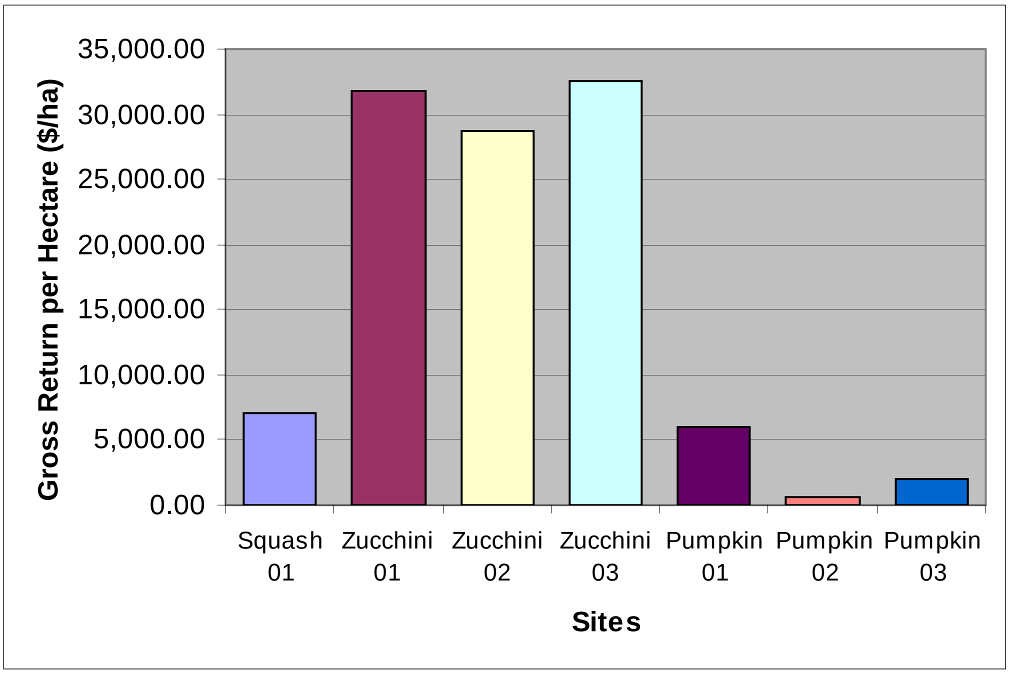

Figure 24 Cucurbits - Gross Return per Hectare ($/ha)

The gross return per hectare is directly related to the yield produced. It should be noted that pumpkins can also be stored for a limited period, and sold onto the market at a time when prices are high.

Gross Return per Megalitre ($/ML)

Figure 25 represents the gross return per megalitre. This was calculated from the gross return per hectare and the total amount of irrigation water applied to the crop.

The gross return per megalitre is directly related to water use efficiency. Pumpkin crops achieved the lowest returns, with crops 02 and 03 barely registering on the graph.

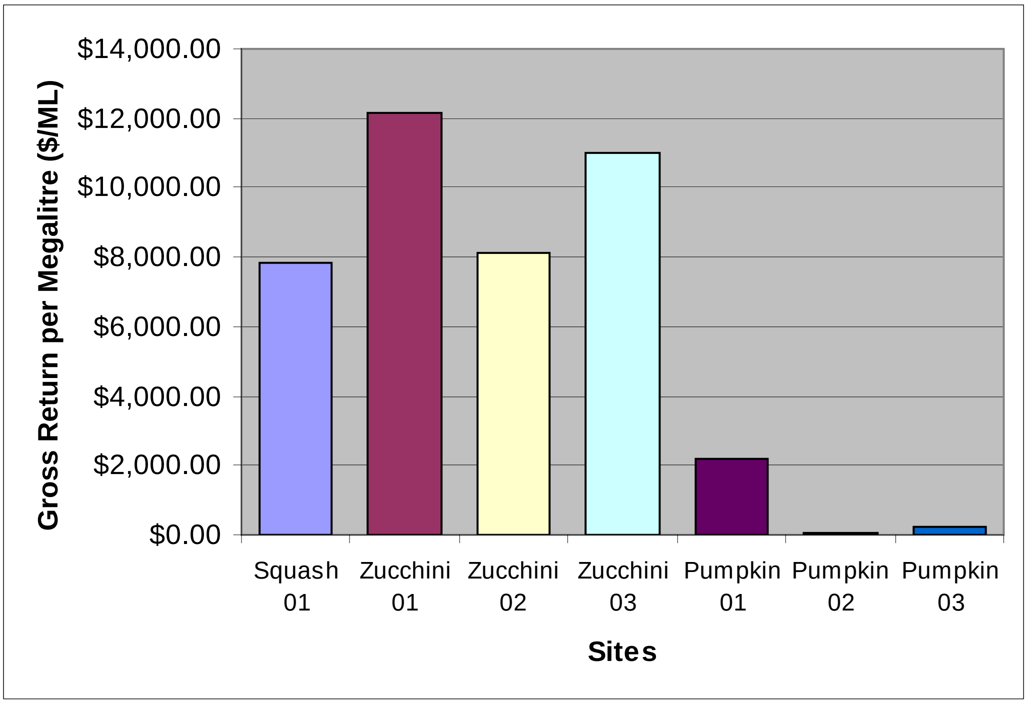

Figure 25 Cucurbits - Gross return per Megalitre ($/ML)

A five year comparison (Figure 26) shows that the price of pumpkins has dropped over the past five years. Prices for Butternut, Grey Bulk and Jap pumpkins are represented in the graph below. Unfortunately, historical market prices for Zucchini and Squash were not available.

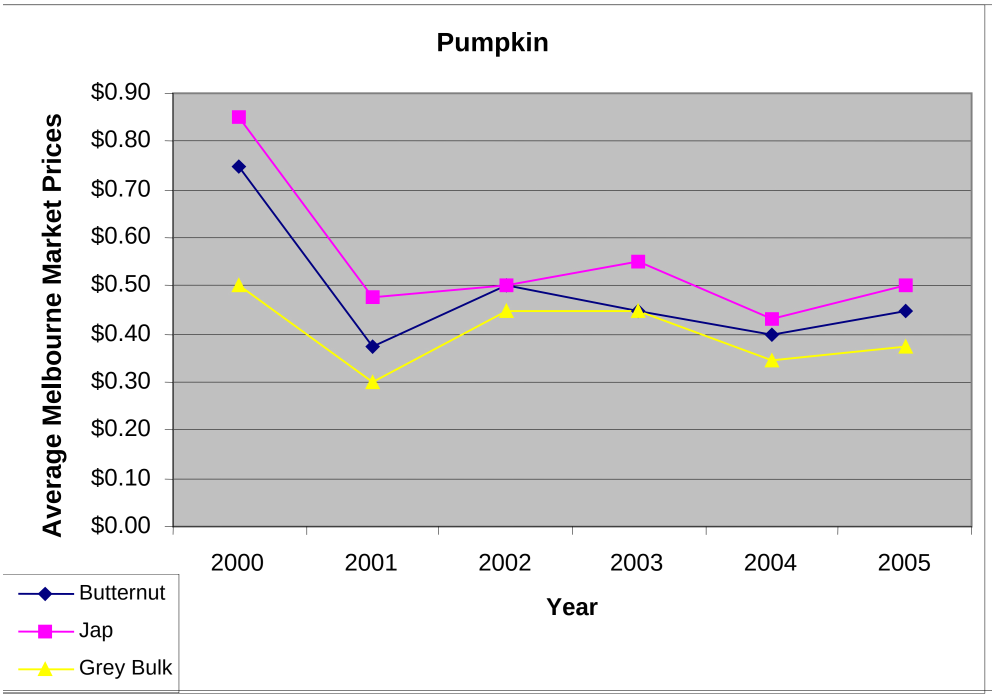

Figure 26 Average Five Year Trend for Pumpkin Market Prices during April

Appendix 3: Evaluation Responses from Growers

QUESTION 1

i. You have been part of a benchmarking study: Was it of any value to you?

Yes

- Pump was measured and since then, the pump has been increased as it was not running what it should have.
- A bit early to say but I think so.
- Yes it has been very positive to get confirmation of our performance as farmers.
- It is of some value but the lack of accuracy limits the value.
- If the data was accurate, the difference between the two farms needs to be closely looked at. The soil types also need to be investigated.
- It shows that I'm on the right track.
- Yes I was pleased to have my flow rates measured.
- It was a different way of looking at water as the amount of water we put on is not usually measured – it's more visual.

No

- Each year, water use changes and until we get accurate figures, we can't compare or budget for water. As an approach, it was not of any use.
- Currently water is not a cost factor but it will become one soon. More interested in this type of study when water will have to be bought and then growers will have to learn not to waste water.
- No but I will do it to help you out, I know I irrigate well.
- Because accurate benchmarking is already being done on farm.
- Because you can't grow lettuce without water.

ii. How could it be improved to give you greater benefit - in terms of the process (making it easier to use), or information delivered (format or content)?

- Too lazy to take note of irrigation times. It's too hard when there are many people that turn pumps on and off. Information about reliability of water would be beneficial.
- Was easy but I am not sure if my data is all that accurate.
- Waterproof recording sheet.
- Accuracy is the key and without accurate data what's the point of the study. This study was conducted in the busiest time in summer and there was no time and there were management problems on the farm.
- Didn't see the point of this study, and would have preferred a study about improving water quality at farm scale and how will crop cope with saline conditions.
- Can I get away with using less water. As the results show, I was quite efficient with water use but how can I further improve?
- Application efficiency would have been useful and communication during the planning stage of the project should have occurred. There are many ways to more accurately measure flow rates and application. Small flow meters can be bought and fitted to sprinklers. Rain gauges are needed on properties too. If

people have electronic systems they should be set to 0 and an accurate record can be used. The problem with this study is that is doesn't take into account weather conditions, evaporation, wind, temperature etc. If DPI did it properly it's a very good commercial business that could be sold.
- Not worried about $/ML. Yield is more important and growing techniques.

(b) What, if anything, did you learn anything from the results?
- There are big discrepancies across water use and yield.
- I am not doing very well compared to the industry norm. That the results calculated for me were different to the other growers. Once growing, carrots only need to be watered twice a week. Other growers used a lot more water than that.
    - It is so hard to put your figures in context when you don't know the other farming systems.
    - Flow Rate from pump (9 responses)
    - Surprised to see that water was being used efficiently on the farm. The flow meter was only partially valuable.
    - It was useful to get a more accurate idea of what I am putting on rather than my usual guess at the end of a season.
    - That the block we neglect was quite efficient and it was surprising to see the difference between the two blocks and pumps.
    - More aware of what you are doing and how many ML/ha is needed to achieve a result. Only relevant to compare with other growers in same area, although soil changes and other conditions will change too. As the figures show I don't over-water, and it will indicate how much water will be needed to be bought.

QUESTION 2

(a) What issues do you have with irrigation?
- No problems with irrigation. Water quality good and bore water not being used. Water use is not metered and water allocations are not checked.
- No problems with irrigation – water is the cheapest asset on the farm.
- No mechanical problems. Water quality is an issue.
- Issues are more mechanical such as blocked sprinklers.
- No problems (one southern lettuce grower and all Northern Vic irrigators)
- The main issue with irrigation is that you have to irrigate more than one block at a time, even when a block may not need water you still have to put it on as you need to water the other block.

(b) How do you rate yourself as an irrigator?
- Fairly good. Responsible with water. However, at times water is wasted.
- Conscientious irrigator. However, water is wasted if it's busy and there isn't enough time to turn off the pump.
- Pretty good, fairly good, quite good etc.
- As an irrigator, my father is rated highly due to the yield and crops we produce on the farm. We are the best broccoli grower in Australia. We had SAP testing and it indicated that we were doing the right thing.
- Try to be as efficient as possible but according to our calculations one lettuce crop needs 1ML of water.

- Quite good, conscious of when wasting water.
- Not too conscious of efficiency. Sometimes waste water, sometimes underwater.
- Pretty conservative with water.
- Changes every year depending on weather conditions.

(c) Where do you see chances to improve?

- There is not a lot that can be done. Probes are already used to monitor irrigation. Most rely on experience and another irrigation system (i.e. drip) is not economical.
- I’m running as efficiently as I can. It’s a manual system. I tried drip but didn’t like it as it produced too many wet spots so I changed back to sprinklers.
- There are not many ways to improve current irrigation practices as the manual system is running as efficiently as it can.
- Putting in Solenoids would reduce water wastage. However, it will cost $250K. Bore water is currently used for washing carrots.
- Trickle is not feasible and the only other chance for improvement is an automated system.
- Automated system.
- Drip irrigation is too costly and I wouldn’t change to automatic as I like the culture of turning on and off the sprinklers. Our sprinklers have a timer as well.
- Better monitoring.
- Reduce the amount that is grown. Estimate properly what can be grown and cut back 20% but then profit margin will be reduced.

(d) How could we help you? - eg would you like to participate in an irrigation management course?

- How to increase profits.
- Not interested in a course as you have to be on a farm to know the farm. There are different weather elements and you have to read the conditions.
- Not interested in irrigation management course. More interested in how to monitor and the options to consider in moisture management.
- How do overhead sprinklers relate to disease pressure and how is disease related to irrigation.

QUESTION 3

(a) Would you be willing to take part in further development of this approach?

  - Yes (4 Melbourne and all Mallee irrigators)
  - Yes, but not in the middle of summer. November is a better time
  - Yes, but would like a fee for participating, as its taking up a bit of time.
  - Yes but it needs to be minimally intrusive to growers and end up with better results. This project wasn’t explained satisfactory in the initial stage.

(b) Would you recommend it to others?

Yes (11 participants)

Why?
This study is very good for the future of the industry, as every grower will be accountable for what they use.

No

Why?
- For irrigation purposes it's not going to make a difference. This study may be of value for crops that are in the ground for longer periods of time.
- Don't see the point of this study.
- Farmers don't really want to know much so there is no point recommending it.

OTHER QUESTIONS

Apart from watering the crop, when else do you irrigate?
- Sand drift
- Young seedlings
- Maintain a wet base
- To suppress the smell of chook manure to neighbouring housing estates
- Control dust, even if ground is bare will still water to protect other young crops
- Bed formation
- Weed germination
- Fertigation

What percentage of your total irrigation is used for environmental control?
- 10%
- 1-2 %
- 5%
- <5 %
- Percentage varied with soil type and position of crop – lighter soils and more exposed block led to higher rates of "environmental control" irrigation

Suggestions from growers
- Cut water allocations by 25%, a cut in productions with drive market prices up.
- The channel system in Werribee loses up to 40% water. Southern Rural Water needs to take action and reduce the amount of wastage from evaporation.