

# **WATER USE EFFICIENCY AND IRRIGATION PRACTICES IN THE MARY RIVER CATCHMENT, QUEENSLAND**

David Wigginton and Steven Raine

National Centre for Engineering in Agriculture,  
University of Southern Queensland, Toowoomba.

## **ABSTRACT**

The Mary River Catchment lies north of Brisbane and extends from Maleny in the south to Maryborough in the north. The catchment is currently facing increasing demands for water from urban, industrial and rural water users. A substantial proportion of the water in the catchment is currently used for dairy, sugar and horticultural production. While a limited amount of irrigation research has been conducted by these industries in other areas, little is known regarding the relative efficiency of on-farm water use by these industries in the Mary River Catchment. The lack of information regarding the performance of existing on-farm irrigation practices in this area makes it difficult to identify improved practices and effectively target irrigation extension programs. This also creates problems for the accurate assessment of potential gains from improvements in water use efficiency. The objectives of this study were to identify current on-farm agricultural water management practices and the potential for improved on-farm efficiencies within the catchment.

The initial scope of this study was to estimate the volume of water used by irrigation in the Mary River Catchment. This study involved surveying irrigators in the sugar cane, dairy and horticultural sectors. The survey collected data on volumetric water use, irrigation practices, production data, farmer perceptions and drivers and farm demographics. Where possible, survey data was augmented with data obtained from governmental and industry sources. The volume of water used for irrigation in the Mary River Catchment was found to be approximately 62 703 ML with the dairy sector using approximately 64% of the total, sugar accounting for 25% and horticulture 11%. However, the sugar cane sector was found to apply the least amount of water per hectare (2.9 ML/ha) compared to the horticultural (3.55 ML/ha) and dairy (4.2 ML/ha) sectors. It was found that farmers in the horticultural sector had a high rate of adoption of objective scheduling techniques and irrigation systems that were perceived to increase water use efficiency. In comparison, farmers in the dairy and sugar sectors primarily used inefficient application systems and little or no objective scheduling techniques. More than half of the irrigators in the dairy sector recognised that their water use efficiency could be improved through changes to application system or scheduling techniques. By comparison, more than 50% of farmers in the sugar and horticultural sectors recognised improvement through changes to application infrastructure but only 30% could see benefits through changes to scheduling techniques. The implications of these results for research and extension programs to improve water use efficiency in the Mary Catchment will be discussed.

## **INTRODUCTION**

Located North of Brisbane, the Mary River Catchment extends from Maleny in the south, to Maryborough in the north and covers a total area of 940 164 hectares (Pointon, et al. 1999). Fed by multiple tributaries, the Mary River has a mean annual discharge of 2 309 000 ML (Mary River Catchment Coordinating Committee, 1997) with approximately 75% of this discharge occurring between November and April. Within the catchment, eleven dams and weirs provide a total storage capacity of 135 785 ML (Pointon et al. 1999).

Water from within the Mary River provides for a number of uses, both within the catchment and in the surrounding areas. According to the Mary Catchment Coordinating Committee (1997) approximately 30 000 ML per year is used for town water, with more than 25 000 ML per year used for irrigation. As development in the surrounding areas of the Sunshine Coast and Hervey Bay continues, it is likely that increasing demands will be placed on Mary River Catchment water for domestic and industrial use in these areas as well as within the catchment.

While additional water storage infrastructure will be required in the future, it is the demand for water that will determine the timing of the development of such infrastructure. Improvements in the efficiency of current water users will reduce both the current and future demands on the available water resources. Hence,

the identification and implementation of strategies to improve water use efficiency is a tangible way to reduce water demand and delay the costs associated with the construction of future infrastructure.

Little is known regarding the relative efficiency of on-farm water use in the Mary River catchment. The lack of information regarding the performance of existing on-farm irrigation practices in this area makes it difficult to identify improved practices and effectively target irrigation extension programs. It also creates problems for the accurate assessment of potential gains from improvements in water use efficiency. The objectives of this paper are to identify current on-farm agricultural water management practices and the potential for improved on-farm efficiencies within the catchment. The paper involves a desktop analysis of available water use data, including consultation with industry stakeholders and Department of Natural Resources staff, and an on-farm survey of irrigators.

## **WATER USE IN THE CATCHMENT**

### **Analysis of Available Data**

Irrigation water in the catchment is provided by a regulated system in the northern (downstream) reaches of the catchment whilst irrigators in the remainder of the catchment draw unregulated water directly from the river and its tributaries. Reasonable data relating to water use in the regulated system is available, however data for unregulated water use has not been collected. It is estimated that three sectors within the catchment comprise the majority of water used for irrigation, these being the sugar cane, dairy and horticultural industries.

Available data in the regulated sections of the catchment includes water allocated to each property as well as water used by individual properties. Data on water allocations is divided between sectors, with 34% of the water in the regulated section of the catchment allocated to the sugar sector while dairy obtains 25% and horticulture approximately 6%. Although 13% of the water is allocated to the beef sector, it is unlikely that this water is used for beef cattle and therefore remains unused or is traded to farmers in another sector. However, this data is of water allocation only and may not give an accurate reflection of the proportion of water actually used in each sector.

Water use data in the regulated section is available, however this data has no breakdown to indicate what sector the water is used in. Obtaining truly accurate water use data broken down into usage by each sector would require consultation with each license holder to confirm what enterprise the water is used for. However, useful data that is readily available includes the total amount of water delivered for irrigation. In 1996, a total of 25 296 ML of water was delivered to regulated water users and was used to irrigate a total area of 19 110 ha (State Water Projects, 1999). Water use in the unregulated sections of the catchment is not collected and therefore the best figures available for water use in these sections are estimates provided by local extension staff.

Sugar cane production in the catchment is undertaken in the northern end of the catchment around Maryborough with approximately 11 000 ha of cane grown on about 190 farms (P Downs and F Sestak, pers comm.). Approximately half of this area is irrigated, with a further 50% of this irrigated area using water sourced from the regulated irrigation scheme. Irrigation on sugar cane is undertaken primarily using high pressure travelling irrigator with benchmark application rates of 3 to 3 ½ ML/ha (F Sestak, pers comm.).

The dairy industry in the Mary River Catchment comprises 223 farms occupying a total of 28 667 ha (Pointon, et al. 1999) with approximately 7000 ha of this area devoted to fodder or forage crops. Spatially, the dairy sector occupies the central and southern portions of the catchment with the proportion of water used from the regulated and unregulated systems unknown. Similarly, horticultural production is also undertaken in the central and southern portions of the catchment. However, an accurate estimate of the area under production is difficult to obtain. The total area devoted to horticulture is likely to be between 1800 ha (Greer et al. pers comm.) and 7 717 ha (Pointon et al. 1999) with the total area divided evenly between row and tree crops. With the exception of pineapples, of which only a small proportion is irrigated, most other horticultural crops rely on irrigation. Due to the large proportion of farms in the unregulated sections of the catchment, total water use is unable to be obtained from currently available data.

This analysis of data has shown that specific industry related irrigation information is not currently available, particularly for the dairy and horticultural sectors. While some data on regulated water use in each sector is available, it is impossible to ascertain the volumes of water used from unregulated sources. Therefore, estimates of water use, particularly in the dairy and horticultural sectors, are likely to be inaccurate due to the uncertainty regarding the proportion of water used from these unregulated sources. There is also no accurate data relating to current on-farm irrigation efficiencies, application systems, management practices or the factors influencing water use in each sector. Conducting on-farm surveys of a representative sample of irrigators in the catchment is a valid method of collecting sufficient data to more accurately represent the characteristics of irrigation in the catchment.

### **Analysis of Survey Data**

The process of surveying farmers in the catchment was undertaken during June and July of 1999, to obtain, as randomly as possible, a sample of approximately 10% of farmers in each sector. The survey involved collecting data for each farm on the;

- General farm attributes (e.g. size, topography, water sources);
- Demographics of irrigator (e.g. age, level of education, computer literacy);
- Production/output (e.g. yields, returns);
- Water use (e.g. area irrigated, amount of irrigation, volume applied); and
- Irrigation drivers and farmer perceptions.

Water use for each of the industries was obtained by measuring the number of irrigations in a season and the amount applied per irrigation and averaging this volume over the total area irrigated. The resulting figures indicated that sugar cane production had the lowest application rate of 2.90 ML/ha compared to 3.55 ML/ha for horticulture and 4.20 ML/ha for the dairy industry. Variability in application volumes was smallest between sugar irrigators with the largest variances observed in dairy and tree crop production. Water use figures provided by irrigators were for a "typical" dry year and hence should be regarded as maximum amounts likely to be applied and not averages.

From the data obtained, it was also possible to determine the value of production per ML of irrigation water applied. However, it should be noted that this represents the economic value of production to which irrigation has contributed and not the marginal economic return directly attributable to irrigation. Horticultural row crops were found to produce the greatest value of irrigated output (\$12425/ML), followed by tree crops (\$4095/ML) with irrigation in the sugarcane and dairy industries contributing to approximately \$1000 of production per megalitre applied. However, variances in the economic value are extremely large in the horticultural industry and much smaller in both the dairy and sugar industries.

Significant differences in the type of on-farm irrigation application technique used were found between the industry sectors. While high pressure travelling irrigators (water winches) were the dominant methods in the sugar and dairy sectors, these systems were only used by 8% of horticultural farmers. Horticultural producers were found to use a high proportion of micro-spray (35%) and trickle (25%) techniques which is consistent with the requirements for more precise application and management of irrigation on these crops. Furrow irrigation is almost non-existent in the catchment with only minor occurrences in the dairy and sugar industries. High pressure hand-shift and solid set spray systems are used by 38% of the dairy sector and 32% of the horticultural sector.

Irrigation scheduling is not widely practiced within any of the agricultural sectors in the Mary River catchment. While 22% of horticultural producers used an objective soil-moisture measurement technique to schedule irrigations, only 5% of dairy farmers and no surveyed sugarcane farmer used any objective measure.

When asked if changes to on-farm irrigation infrastructure would increase water use efficiency, precisely half of the irrigators in both the dairy and horticultural sectors indicated that such changes would increase efficiency, compared to 80% of irrigators in the sugar sector. By contrast, 65% of irrigators in the dairy sector thought that efficiency could be improved through changes in scheduling or management practices while only approximately 30% of horticultural and sugar farmers agreed.

## Estimating Catchment Irrigation

The total volume of irrigation water used within the catchment and the proportion applied to each sector are important factors in identifying the potential for reducing pressure on the catchment water resources by improved irrigation efficiency. However, the analysis of existing data indicated that the volume of unregulated water used within the catchment is not currently known and hence, the total volume of irrigation water used within the catchment is also unknown.

The combination of farm level data collected as part of the on-farm survey process and the pre-existing catchment level land use data provides an opportunity to estimate the volume of irrigation water used by each sector. By combining these two data sources, the total volume of irrigation water used within the catchment was estimated at approximately 63 000 ML (Table 1). Of this volume, approximately 64% (40 000 ML) was attributed to the dairy sector, 25% (15 950 ML) to the sugar sector, and 11% (6745 ML) to the horticultural sector.

**Table 1. Total irrigation water use in the catchment**

	Water Use (ML/ha)	Average Irrigated Area (ha/farm)	Number of Farms	Total Area (ha)	Total Water Used (ML)
<b>Sugar Cane</b> <i>Total</i>	2.9			5500	<b>15950</b>
<b>Dairy</b>	<i>Winter Pasture</i>	4.4	37	156	25619
	<i>Summer Pasture</i>	3.9	23	156	14063
	<i>Fodder Crops</i>	1.1	2	156	326
	<i>Total</i>			9725	<b>40008</b>
<b>Horticulture</b> <i>Total</i>	3.6			1900	<b>6745</b>
<b>Total</b>					<b>62703</b>

## POTENTIAL FOR IMPROVED EFFICIENCIES

The available catchment level data and survey data together provide a detailed view of current irrigation practices within the Mary River catchment. While a substantial amount of industry and catchment wide land use data was obtained through a desktop analysis, this data did not provide any level of knowledge regarding on-farm irrigation management practices, actual water use, nor barriers to improving on-farm water use efficiencies. Similarly, no data was available relating to the demographics of irrigators, their production data or the factors influencing their decision making process. The surveys were conducted with a view to providing more detailed information relating to these issues at the farm scale and to better identify the sector within the catchment where improvements in irrigation efficiency would most readily be achieved. Full results of this data are available (Wigginton and Raine, 1999).

### Horticulture

The horticultural sector in the Mary River catchment occupies less than 9% of the total irrigated area, uses <5% of the allocated water and approximately 11% of the total irrigation water in the catchment. The average gross value of production per ML of irrigation water applied is high (~\$12500/ML applied for row crops and ~\$4100/ML for tree crops).

The sector uses a relatively high proportion (87%) of micro-spray, solid-set spray and trickle irrigations systems reflecting greater investment in irrigation technology and better management of irrigation water. Accordingly, the proportion of farmers (22%) using an objective scheduling technique is higher than in the other sectors. A significant proportion (59%) of horticultural irrigators also use computers as part of their farm management suggesting that they are willing to invest in new technology. This may be related to the average age of horticultural irrigators which is ~50 years old and the large proportion of the irrigators that are post-secondary educated (32%). A large proportion (86%) of horticultural irrigators do not believe that they are water limited and a substantial proportion (51%) would not make any changes to their management practices if water availability increased. A larger proportion (54%) of horticultural irrigators believe that they are either well informed or fully informed on irrigation issues than in the other irrigation sectors. However, 50% suggested that irrigation efficiencies could be improved through changes to their on-farm

infrastructure while 62% suggested improvements could be achieved through better scheduling and management.

The potential for significantly influencing irrigation efficiencies within the horticultural sector is likely to be low and the influence of improved water use efficiencies in this sector on overall catchment water availability would be minimal. Key indicators to the difficulties faced with making significant efficiency gains in this sector include:

- the relatively large proportion of irrigators who believe that their current water supply volume is adequate and who would not alter their practices if additional water became available; and
- the relatively high proportion of irrigators already using micro-irrigation application systems and the perception that they are less likely to be currently operating with substantial in-field volumetric losses.

## **Sugar Cane**

The irrigated sugar cane industry in the Mary River catchment occupies approximately 26% of the total irrigated area and uses approximately 25% of the total irrigation water in the catchment. Irrigation water in the industry is obtained almost equally from regulated and unregulated sources. However, only 50% of all sugar cane farms in the catchment are irrigated and on average <80% of the total cropped area on these farms is irrigated. The average gross value of production per ML of irrigation water applied (average = \$1058/ML) is substantially less than that observed in the horticultural sector but comparable with the dairying values.

Irrigation in the sugar cane industry is characterised by a large proportion (79%) of irrigators using high pressure water winches and an almost complete lack of objective irrigation scheduling techniques. The large proportion of high pressure travelling irrigators in this sector is a legacy of past irrigation practices and while some farmers have installed centre-pivots or trickle systems, many have not been able to justify the capital expense of such systems.

The average age of sugar cane farmers surveyed (~60 years) was higher than for any other sector and is presumably a major factor in the very low levels of post-secondary education and computer adoption observed for this sector. A substantial proportion (42%) of sugar cane irrigators believe that they are water limited and a large number (47%) would opt to apply more water to existing crops if additional water was made available. The majority of irrigators in this sector (80%) indicated that changes in their on-farm infrastructure would produce an increase in efficiency while only 30% believed that changes to irrigation management could improve efficiency. This sector was the most responsive of the sectors to changes in product price with 36% of irrigators considering the expected return when deciding irrigation strategy.

The heavy reliance on high pressure travelling irrigators and the lack of objective scheduling techniques within the sugar cane industry suggest that improvements in irrigation water use efficiency are possible within this sector. However, as the volumes of irrigation water applied per unit area are comparatively low and the variation between farmers in the volume applied is also low, it could be expected that the total volumes saved by the adoption of improved practices would be correspondingly small. Any improvements in efficiencies in this sector are also likely to result in increased productivity rather than water savings *per se*. This is because a large number of irrigators believe that they are water limited and are likely to use any water savings associated with improved application efficiencies to increase the frequency of irrigations. Key indicators to the difficulties faced with making significant efficiency gains in this sector include:

- the relatively low volumes of water currently used on a per area basis;
- the strong perception that on-farm infrastructure changes are required to improve irrigation efficiency; and
- the aging population and corresponding low levels of interest in adopting new technologies.

## **Dairying**

The dairy industry in the Mary River catchment occupies approximately 65% of the total irrigated area and is estimated to use approximately 64% of the total irrigation water in the catchment. Slightly more irrigation water (4.4 ML/ha) is applied to winter pastures than summer pastures (3.9 ML/ha) and a comparatively smaller amount (1.1 ML/ha) applied to fodder crops, although the average water applied across all pastures

and crops is 4.2 ML/ha. The gross value of pasture production (average summer pasture = \$910/ML, average winter pasture = \$1463/ML) is comparable to the sugar industry returns but were substantially less than that achieved for the irrigated fodder crops (average = \$2692/ML) and the returns in the horticultural sector.

Irrigation in the dairy industry almost exclusively involves high pressure systems with the largest proportion (59%) of irrigators using travelling irrigators and the majority of the remainder (36%) using either hand shift or solid set systems. The principal reason for the common usage of travelling irrigators in the dairy sector is due to the physical limitation of farm topography. A large number of the dairy irrigators surveyed indicated that they would change to solid set, or even centre pivots, if it wasn't for their topography or location in a flood prone area. Farmers who irrigate areas that are prone to flooding, must have an irrigation system which can be removed from the fields during flood events.

The average age of dairy farmers surveyed (~45 years) was lower than for the other sectors and is presumably closely correlated with the high proportion of post-secondary educated irrigators (55%) and high level of computer adoption (85%). Whilst no farmer in the dairy sector believed that they were fully informed about irrigation, only 5% thought that they were not well informed compared to 37% in the sugar sector and 23% in the horticultural sector. Only 20% of dairy irrigators indicated that they are water limited but 75% indicated that they would change their irrigation practice in some way if more water became available to them. Half of the irrigators in this sector indicated that changes in their on-farm infrastructure would produce an increase in efficiency, whilst the majority of irrigators (65%) believe that changes to scheduling practices and irrigation management could improve efficiency. Currently there is an almost complete lack of objective irrigation scheduling techniques used in the industry. Despite this, the high proportion of irrigators believing that changed management practices could improve efficiencies suggests that this sector is more likely to be responsive to input in this area than the other sectors.

As with the sugar industry, the heavy reliance on high pressure application systems and the lack of objective scheduling techniques within the dairy industry suggest that improvements in irrigation water use efficiency are possible within this sector. However, the larger volumes of water applied per unit area to pastures compared with sugar cane, and the larger total volume of water used in the dairy industry, suggest that the potential for volumetric gains will be greater in the dairy sector than in the sugar industry. Similarly, the opportunities to increase productivity through water savings made are likely to be greater in this sector with 45% (more than any other sector) of dairy irrigators indicating that they would increase irrigated area if more water was available. The substantial differences in economic return between the pastures and fodder crops also suggest that additional gains in economic return may be achieved by directing a greater proportion of irrigation water within this sector to fodder crops.

## **RECOMMENDATIONS**

It is proposed that future irrigation work in the Mary River catchment should focus on developing and implementing techniques to improve water use efficiencies within the dairy industry. This sector uses the largest proportion of irrigation water in the catchment and appears to have some of the highest rates of water application (ML/ha) of any sector. The high variability in irrigation volumes applied also suggests that there is a wide divergence of irrigation management practices being used within this sector. These factors suggest that the greatest volumetric gains in the catchment may be achieved by working in this sector.

The majority of dairy irrigators believed that their current water availability was either insufficient or just adequate. However, more than half of the irrigators in this sector recognised that their water use efficiency could be improved, either through the use of better scheduling techniques, application systems or management practices. While the farmers in this sector are generally younger, better educated and appeared more likely to adopt new technology than in the other sectors, these characteristics are not apparent in their irrigation management. The level of farmer knowledge regarding application technology and management practices is generally low, and irrigation scheduling is not widely used. The accuracy of the current industry benchmarks for pasture and milk production from irrigation is questionable and the industry lacks credible benchmarks for application efficiencies using the various application techniques. These factors suggest that substantial benefits could be realised by directing research and extension efforts towards the improvement of irrigation management in this sector. While there are a number of issues that could sensibly be addressed as part of any future work to improve water use efficiencies, the specific objectives of the second stage of this project will be to:

- benchmark the efficiency of in-field application systems;
- confirm the relationship between irrigation and pasture production; and
- identify the benefits of irrigation scheduling and alternative management practices.

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