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Impacts of changing water price and availability on irrigated dairy farms in northern Victoria

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Abstract

Farming systems throughout the Murray-Darling Basin are under increasing scrutiny from the perspective of ecological sustainability of farm and catchment systems. In northern Victoria, the dairy industry is a major user of water, and contributes to the environmental issues. Changes in irrigation water price, availability and policy will invariably impact on the viability of dairy farming in this region, but the diversity of dairy farm systems suggests that the impact will vary between farms. Two case study farms, a 'water reliant' farm and a 'fodder reliant' farm, were used to examine economic and social impacts of changes in water price, availability and policy.

Key Words: Dairy, Irrigation, Water

1 Introduction

The ecological sustainability of farming systems throughout the Murray-Darling Basin is under increasing scrutiny from customers of the various industries and the community. In the Goulburn-Broken and Murray Catchments the dairy industry produces approximately 25% of Australia's milk and is a major user of water. Approximately 60% of the irrigation water in the region is used by the dairy industry. This industry is therefore, a contributor to the overall environmental issues in these catchments. The major environmental issues are environmental flows in river systems, rising water tables and associated increases in salinity, and nutrient loss from farms and associated effects on water quality.

On the majority of dairy farms in the irrigation region of northern Victoria, more than 60% of the energy consumed is produced on the milking area, predominantly in the form of irrigated pasture. This highlights the importance of irrigated pasture in dairy production systems of the region. The amount of supplements bought onto the farm can vary, however, with some farms not bringing in any feed and others bringing in around three-quarters of the estimated energy required by the milking herd (Armstrong et al. 1998, 2000).

In the last 6 to 8 years, the cost per megalitre of water right delivered has increased by 50% in some water services areas. Marsden and Jacobs (2002) forecast that water prices are expected to increase further in the medium term. However, the impacts of changes in water price and water availability will be different on different farms as each has varying resource inventories, production systems and capabilities to adjust to changing situations.

In the past, many dairy farm businesses have used in excess of 130% of water right, to enable irrigation of expanded areas of sown pasture, despite long term (or original) expectations of only delivering water right plus 30% "sales" allocation (Gyles et al. 1999). There is considerable variation in the water right per hectare (perennial pasture equivalent) for irrigated dairy farms across the northern Victorian irrigation region. Hence, farming systems are affected by the water right intensity categories and the operating conditions for that year.

Research into the adoption of irrigation practices and improved water use efficiency (WUE) in the dairy industry indicates that it is unlikely improvements are currently being made to a level both industry and natural resource managers desire (Linehan et al. 2001, Armstrong et al. 2002). To accelerate improvements in WUE on irrigated dairy farms, or to obtain more water for environmental flows, it is likely that policy instruments will be needed. An assessment of the possible socio-economic impacts of implementing policy settings for irrigated dairy farms in Northern Victoria is required by institutional and natural resource policy makers to support decision making and enable design of policies to achieve the desired, rather than unintended outcomes.

An important part of making an informed decision about the appropriateness of mechanisms is to understand the impact on the dairy farmer's capacity to respond. For example, how would reduced irrigation water availability impact on the ability of a farmer to maintain the viability of the business. Research on case study farms suggests that there are many complex decisions involved in changing farming systems or improving WUE at the farm level. This paper demonstrates the impact of changing irrigation water price and availability on the profitability of two case study dairy farms.

2 Method

The approach comprises several key aspects, namely the steering committee, the use of case studies and spreadsheet modelling. The effects of changes in water price and availability have been examined by imposing different scenarios on the case study farms without changing the current feed production system.

2.1 Steering committee

Considerable inputs were obtained from a steering group comprised of dairy farmers, consultants, a rural counsellor, a water industry representative, an extension officer, economists and scientists. The project steering group met every three months and provided overall direction on the systems to be analysed, the issues that needed to be considered and communication of the outcomes from the analysis. This ensured the analyses carried out were subject to rigorous questioning and a broad range of perspectives were considered.

2.2 Case studies

A case study approach was chosen to examine the impact of changing irrigation water price and availability on current farming systems and on possible developments in the future. Farm management decisions require consideration of the complex combination of human, production, environmental, economic, and financial components of the business (Makeham and Malcolm 1993). To understand the complexity of decision making processes, an in-depth examination of a small number of businesses is more beneficial than surveying a large random sample (Crosthwaite *et al.* 1997, Sterns *et al.* 1998). A case study approach was, therefore a legitimate and appropriate method for analysing the complex farm management issues associated with changing water price and availability.

2.3 Model

Excel spreadsheets, developed in a previous phase of the project (see Doyle *et al.* 2002) were used for both the economic and biophysical modelling. The effects of changes in water price and availability on each current farm system were assessed using discounted net cash flow budgets over a 10-year period. The methods used for farm management economic assessments are described in Makeham and Malcolm (1993). Both cash and profit analyses were conducted, but only the profit analyses are reported in this paper.

2.4 Details of case study farms

Two case study farms were selected: a 'water reliant farm' and a 'fodder reliant farm'. Accurate records of physical and financial data were an important criteria when selecting the case study farms. Both of the farms chosen were also well managed and above average in system and financial performance. Physical details for the case study farms are given in Table 1.

Table 1. Physical details for 'water reliant' and 'fodder reliant' case study farms

			Water reliant farm	Fodder reliant farm
Land area				
	Home area	title (ha)	46.5	123
		irrigated perennial pasture (ha)	40	66.5
		irrigated annual pasture (ha)	-	32
	Outblock	title (ha)	152	187
		irrigated perennial pasture (ha)	16	-
		irrigated annual pasture (ha)	16	35.3
		maize (ha)	-	22
Water				
	Home	ML water right	177	454
	Outblock	ML water right	165	400
Herd		cows	165	496
Feed supply				
	Estimated pasture consumption	t DM/ha	12.5	15
	Hay/silage fed	t DM (conserved on outblock)	136	1,000
	Grain fed	t	300	920
		t/cow	1.8	1.85
Milk production		kg butterfat	43,000	137,000

2.5 Assumptions

Physical and financial data for the 2001/02 season were collected from the case study farms through a personal interview. As 2001/02 was not a typical year, it was necessary to adjust some of the figures collected to long-term averages. Assumptions regarding long-term averages were:

- Milk price: $6.50/kg butterfat
- Grain price: $180/t

- Hay price: $120/t
- Operators allowance: $60,000 (value decided on by steering committee)
- Irrigation water allocation: 160% of water right (As the allocation in 2001/02 for these farms was 100%, it was necessary to do a water and feed budget to estimate the reduction in temporary irrigation water (TWE) and hay purchases.

A Goulburn-Murray Water (G-MW) base water price of $35/ML was used (approximate average across districts at the present time). The TWE price was estimated assuming an opportunity earning rate on the capital value of the water right of 8% plus the base G-MW price of $35/ML. Assuming $1,200 for the capital value of a megalitre of water right, the opportunity cost would be $96/ML. Hence, for an allocation of 100% water right the TWE price would be estimated as follows:

$96 (opportunity cost) / 1 (allocation) + $35 (base G-MW price) = $131 / ML

For a 200% water right allocation the TWE price would be:

$96 (opportunity cost) / 2 (allocation) + $35 (base G-MW price) = $83 / ML.

The economic analysis combined the milking area and outblocks as a single business.

2.6 Scenarios tested

2.6.1 Water price

The base G-MW price of $35/ML was increased by 50%, 100%, 200% ($52.5, $70, $105).

2.6.2 Water availability

The irrigation water allocation was decreased from 160% of water right to 145%, 130% and 100%.

In low allocation years, it was assumed that temporary irrigation water (TWE) was purchased to maintain milk production and the same area irrigated. It was also assumed that grain and hay/silage prices were constant across all the allocation scenarios analysed. It is reasonable to assume grain price will be independent of the long-term allocation, but hay/silage price may vary with allocation as well as TWE.

All these scenarios were analysed in steady state over a 10-year period, assuming no change in capital value of land, herd or water right. It was also assumed there were no changes to the feed production system.

2.6.3 Reliability

Reductions in maximum irrigation water allocation may increase the reliability of irrigation water availability, which could be expected to have some benefits for dairy farmers. Three scenarios (based on information for the Goulburn System provided by GM-W) of different maximum allocation and reliability were tested on the water reliant farm using a 10-year development budget.

1. Maximum water allocation of 160% of water right: 2 years of 100%, 1 year of 110%, 1 year of 130%, 1 year of 140%, 1 year of 150% and 4 years of 160%.
2. 145% maximum: 2 years of 100%, 1 year of 120%, 1 year of 140% and 6 years of 145%.
3. 130% maximum: 1 year of 100%, 1 year of 115% and 8 years of 130%.

The analysis has been carried out beginning with the lowest allocation in year 1 and progressively increasing to the highest allocation in year 10. As no initial debt was assumed, the order of events occurring within the 10 year timeframe was not critical. However, if a high level of initial debt was assumed, the order of events may become important. Given that water storages are currently low, the lowest allocation was applied to year 1.

Again it was assumed that TWE was purchased to maintain the irrigated area in low allocation years.

2.7 Sensitivity testing – pasture consumption

The effect of pasture consumption on operating profit was tested in a sensitivity analysis for both case study farms. Only the results from the water reliant farm are presented here.

Pasture consumption was varied by 20% above and below (15 t DM/ha and 10 t DM/ha) the estimated pasture consumption for the farm (12.5 t DM/ha). Milk production was assumed to remain unchanged, but the amount of brought in feed varied depending on the amount of pasture consumed. Costs were assumed to remain the same at a pasture consumption of 10 t DM/ha. However, at an increased pasture consumption of 15 t DM/ha, it was assumed there would be an additional cost of $10,000 per year for the extra labour required to improve the grazing management (Fulkerson 2003).

3 Results and Discussion

3.1 Water price

Annual operating profit declined as the base irrigation water price, of $35/ML, was increased by 50%, 100% and 200%, on both farms (Table 2). When water price was increased by 100% ($70/ML), the annual operating profit on the water reliant farm was reduced by $21,000 compared to a $52,000 decrease on the fodder reliant farm. However, the impact of doubling water price was greater on the water reliant farm in terms of percentage change in annual operating profit (-40%) compared to the fodder reliant farm (–18%).

Operating profit was more sensitive to increases in water price than may have been expected. Including the outblocks in the analysis caused profit to be more sensitive to irrigation water price than if the farms had purchased all their fodder and agistment.

Table 2. Impact of irrigation water price on annual operating profit of a water reliant farm and a fodder reliant farm.

Water Price ($/ML)	Operating profit ($ '000) and % reduction in operating profit	
	Water reliant farm	Fodder reliant farm
35	52	285
53	41 (-21%)	259 (-9%)
70	31 (-40%)	233 (-18%)
105	10 (-80%)	182 (-36%)

The impact of increasing water price on the percentage reduction in annual operating profit varied depending on the amount of pasture consumed (Figure 1). If pasture consumption was 10 t DM/ha (district average) on the water reliant farm, the impact would be greater, with the operating profit becoming negative at $105/ML. However, if pasture consumption could be increased to 15 t DM/ha without significant investment, the impact of increasing water price would be reduced. This indicates many farmers have the option to buffer the impacts of water price increases by improving/fine tuning pasture and feeding management.

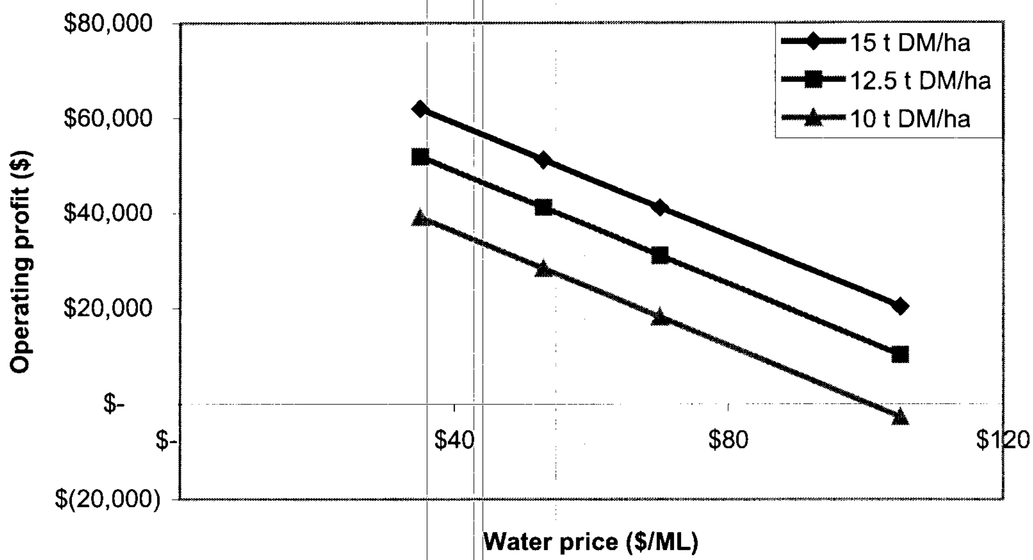

Figure 1: Impact of irrigation water price on annual operating profit of a water reliant farm with various levels of pasture consumption.

3.2 Water availability

Annual operating profit declined as the irrigation water allocation was decreased from 160% to 145%, 130%, and 100% on both farms (Table 3). When allocation was reduced from 160 to 100% of water right the annual operating profit on the water reliant farm fell by $22,000 compared to $35,000 for the fodder reliant farm. Again the impact of reducing irrigation allocation to 100% was greater on the water reliant farm, in terms of percentage reduction in operating profit (-41% compared with –12%) than for the fodder reliant farm.

Table 3. Impact of irrigation water availability on annual operating profit of a water reliant farm and a fodder reliant farm.

Water allocation (%)	Operating profit ($ '000) and % reduction in operating profit	
	Water reliant farm	Fodder reliant farm
160	52	285
145	48 (-7%)	284 (-0.5%)
130	43 (-16%)	279 (-2%)
100	30 (-41%)	250 (-12%)

In terms of percentage reduction in annual operating profit, the impact of reducing irrigation water allocation varied depending on the amount of pasture consumed (Figure 2).

While increasing water price resulted in a linear rate of decrease in operating profit, reducing the irrigation water allocation resulted in a more rapid rate of decline in operating profit. This is due to more TWE being purchased, as the allocation decreased and at a higher price. It is also likely that at low water allocations, the cost of purchased fodder would increase and this would lead to a greater increase in the rate of decline, if included.

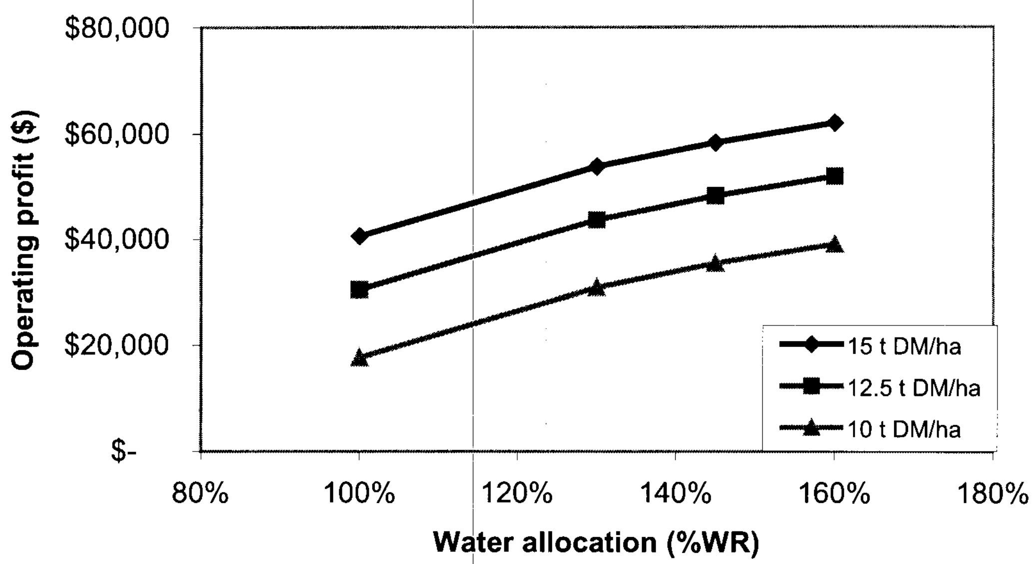

Figure 2: Impact of irrigation water availability on annual operating profit of a water reliant farm with various levels of pasture consumption.

Reducing irrigation allocation from 160% to 100% of water right (37.5% reduction) resulted in a 41% reduction in annual operating profit, which is similar to the reduction in annual operating profit resulting from a 100% increase in irrigation water price (Table 2). Hence, operating profit is more sensitive to a change in water availability than to a change of the same proportion in water price.

3.3 Reliability

Reductions in maximum irrigation water allocation could increase the reliability of irrigation water availability. Three scenarios of different maximum allocation and reliability were tested on the water reliant farm (see methods).

The impact of reducing the maximum allocation from 160 to 145% of water right resulted in a 2% reduction in 10-year cumulative operating profit (Table 4). The impact of reducing the maximum allocation from 160 to 130% of water right was more significant, resulting in a reduction of 7% ($420,000 to $391,000) in 10-year cumulative operating profit. The Internal Rate of Return decreased from 1.96% to 1.65%.

Table 4. Economic impact of changing maximum irrigation water allocation and reliability on the water reliant farm.

Max Water allocation (%)	10-year cumulative operating profit ($ '000)	% decrease in 10-year cumulative operating profit	Internal Rate of Return (IRR) (%)
160	420	0	1.96
145	412	2	1.87
130	391	7	1.65

A flat reduction in irrigation water allocation, from 160 to 130% of water right, resulted in a 16% decrease in annual operating profit on this case study farm (see Table 3). A reduction in maximum allocation from 160 to 130% of water right, with increased reliability, resulted in a

7% reduction in cumulative operating profit. This suggests that the increased reliability has reduced the severity of the impact. However, the increased reliability, at lower maximum allocation, does not outweigh the effects of a reduction in allocation.

The impact of these scenarios would be less on an efficient fodder reliant farm, but would be greater on a less efficient water reliant farm.

The effect of changing the maximum allocation on the probability of having a year below 100% of water right may also need to be considered. This issue was not considered in the analysis as it is expected to occur less frequently than 1 year in 10.

4 Conclusion and future directions

Small increases in irrigation water price and small reductions in the long-term irrigation water allocation will not have a substantial impact on the viability of efficient, well managed dairy farms. However, large increases in irrigation water price and/or reductions in long-term allocation will have a substantial impact on the profitability of dairy farms, in particular on the water reliant farm and on less efficient farms. Some farms may have the potential to improve pasture and feeding management, which could counteract the impact of increasing water price or decreasing water availability.

While studies have indicated that improvements in WUE are often expensive, complicated and difficult to adopt (Linehan et al. 2001; Armstrong et al. 2002), some farms have the potential to make efficiency gains to combat the impact of changing irrigation water price and availability, on profit. The challenge in the future will be to identify changes to the farming system that will enable farms to maintain viability under increases in water price and changes in water availability.

5 Acknowledgements

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6 References

Armstrong D, Byrne S, Johnson F, Doyle P, Gyles O, Warner K (2002) Best management practices for irrigated dairying. Project I-10003 Final report. September 2002. Department of Natural Resources and Environment, Kyabram, Victoria.

Armstrong D, Knee J, Pritchard K, Gyles O, Doyle P (1998) 'A survey of water-use efficiency on irrigated dairy farms in northern Victoria and southern New South Wales'. 76 pp. Technical Publication of Natural Resources and Environment, Institute of Sustainable Irrigated Agriculture, Kyabram Dairy Centre, Kyabram.

Armstrong DA, Knee JE, Doyle PT, Pritchard KE, Gyles OA (2000) Water use efficiency on irrigated dairy farms in northern Victoria and southern New South Wales. *Australian Journal of Experimental Agriculture* **40**, 643-653.

Crosthwaite J, MacLeod N, Malcolm B (1997) Case studies: Theory and practice in agricultural economics. In 'Proceedings of the 41st Conference of the Australian Agriculture and Resource Management Society'. (Gold Coast, Australia)

Doyle P, Malcolm B, Ho C, Nesseler R (2002) Future dairy farming systems in irrigation regions. DAV 10769 Final report. September 2002. (Department of Natural Resources and Environment, Kyabram, Victoria.)

Fulkerson B (2003) 'Accurate feeding is on the money for dairy returns'. Article in: The DairyAustralian. September-October 2003. Pg 3.

Gyles O, Baird C, Brown S (1999) Economic of reduced water allocations: estimating impacts on the northern Victorian dairy industry. Paper presented at Australian Agricultural and Resource Economics Society 43rd Annual Conference, New Zealand, January 1999.

Linehan C, Armstrong D, Knee J, Doyle P, Johnson F, Bowman K, Gyles O (2001) A survey investigating changes in water use efficiency on irrigated dairy farms in northern Victoria. Technical Publication, Institute of Sustainable Agriculture, Agriculture Victoria, Natural Resources and Environment Kyabram and Tatura.

Makeham J, Malcolm L (1993) 'The Farming Game Now.' (Cambridge University Press: Melbourne, Australia)

Marsden and Jacobs (2002) 'Financial Review of Shepparton and Central Goulburn Irrigation Areas: G-MW'. November 2001.

Sterns J, Schweikhardt D, Peterson H (1998) Using case studies as an approach for conducting agribusiness research. *International Food and Agribusiness Management Review* **1**, 311-327.