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

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Contents

Introduction
Method and approach
Model
Details of farms
Assumptions
Scenarios tested
Sensitivity testing – pasture composition
Results and discussion
Water price
Water availability
Reliability
Conclusions and future directions
Acknowledgements
References
Appendix

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.

Keywords: water price policy; irrigated dairy farming

Introduction

The ecological sustainability of farming systems throughout the Murray-Darling Basin is under increasing scrutiny from urban consumers, overseas customers and the community. In the Goulburn-Broken and Murray Catchments the dairy industry produces approximately 25% of Australia's milk and uses approximately 60% of the irrigation water (Douglass and Abuzar 1998). The industry impacts on the environmental flows in river systems, water tables and associated salinity, and nutrient loss to waterways and associated effects on water quality.

On the majority of irrigated dairy farms, more than 60% of the energy consumed is produced on the milking area as pasture. The amount of supplements bought onto the farm varies widely, with some farms not bringing in any feed and others bringing in around 75% of the energy required by the milking herd (Armstrong et al. 2000).

In the last six to eight years, the cost per megalitre of water right has increased by 50% in some water services areas. Marsden and Jacobs (2002) forecast that water prices would increase further in the medium term. 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 capacities to adjust to changing situations.

There is considerable variation in the water right per hectare for irrigated dairy farms across the region (Gyles et al. 1999). Hence, farming systems are affected by the water right intensity of the farm and the allocation for that year.

Research into the adoption of 'best management practices' for improved water use efficiency (WUE) in the dairy industry indicates that voluntary adoption will only lead to slow change (Linehan et al. 2001, Armstrong et al. 2002). To accelerate improvements in WUE, or to obtain more water for environmental flows, it is likely that policy instruments will be needed. However, an important part of making an informed decision about the appropriateness of policy instruments is to understand the impact on the dairy farmer's capacity to respond. Research on case study farms suggests that there are many complex decisions involved in changing farming systems or improving WUE at the farm level (Armstrong 2004).

The work presented in this paper examines the impact of changing irrigation water price and availability on the profitability of two case study dairy farms.

Method and approach

The approach comprised the use of a steering committee, the use of case studies and spreadsheet modelling. Further details relating to the steering committee and the use of case studies can be found in Armstrong et al. (2004). The effects of changes in water price and availability were examined by imposing different scenarios on the two farms without changing the current feed production system.

Model

Excel spreadsheets, modified from those developed in a previous phase of the project (see Doyle et al. 2002, Ho et al. 2004) were used for both the economic and biophysical modelling. The effects of changes in water price and availability on the two farms were assessed using discounted net cash flow budgets over a ten-year period. The methods used for farm management economic assessments are described in Makeham and Malcolm (1993). Both cash flow and profit analyses were conducted, but only the profit analyses are reported in this paper.

Details of farms

The farms selected were a ‘‘water-reliant’ farm’ and a ‘‘fodder-reliant’ farm’. Accurate records of physical and financial data were important criteria when selecting the case study farms with summary details given in Table 1 - Appendix. Both were well managed and above average in system and financial performance.

Assumptions

Physical and financial data for the 2001/02 season were collected through a personal interview. As 2001/02 was not a typical year in terms of water allocation or milk price, some of the data collected were adjusted 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
- 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.
- Base water price of $35/ML (approximate average across districts at the time). The TWE price was estimated assuming an opportunity earning rate on the capital value of the water right of 8%, plus the base Goulburn Murray Water (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 allocations of 100 or 200% water right the TWE price would be estimated as follows:
    - $96 (opportunity cost) ÷ 1 (allocation) + $35 (base G-MW price) = $131/ML, and
    - $96/2 (allocation) + $35 = $83/ML.

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

Scenarios tested

__Water price__ The base G-MW price of $35/ML was increased by 50%, 100% and 200%.

__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 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 ten-year period, assuming no change in capital value of land, herd or water right.

__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 of different maximum allocation and reliability were tested on the 'water-reliant' farm using a ten-year development budget (Figure 1 - Appendix).

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.

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

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

Sensitivity testing – pasture consumption

The effect of pasture consumption on operating profit was tested in a sensitivity analysis for both case study farms.

Pasture consumption on the milking area was varied by 20% above and below (15 t DM/ha and 10 t DM/ha) the estimated pasture consumption for the 'water-reliant' 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. For the 'fodder-reliant' farm, pasture consumption was decreased by 40% (10 t DM/ha) below the estimated pasture consumption for the farm. Milk production was maintained, but the amount of bought-in feed was adjusted.

Results and discussion

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 - Appendix). When water price was increased to $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 this doubling of 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.

The impact of increasing water price on the percentage reduction in annual operating profit varied depending on the amount of pasture consumed (Figures 2 and 3). If pasture consumption was only 10 t DM/ha on the ''water-reliant'' farm, the operating profit became negative at a water price of $105/ML. However, if pasture consumption could be increased to 15 t DM/ha without significant investment, the impact of increasing water price from $35 to $70/ML could be negated. This indicates many farmers have the option to buffer the impacts of water price increases by improving/fine tuning pasture and feeding management as the average pasture consumption in the region is less than 10 t DM/ha.

If pasture consumption was 10 t DM/ha on the 'fodder-reliant' farm, the impact of increasing water price from $35 to $105/ML was to halve operating profit (Figure 2 and Figure 3 - Appendix).

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 - Appendix). 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.

The impact of reducing allocation on operating profit was again more severe if pasture consumption on the farm was lower (Figure 4 - Appendix).

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. At low water allocations, it is also likely that the cost of purchased fodder would increase and this would lead to a greater increase in the rate of decline, if included. For example for the 'fodder-reliant' farm, the operating profit at 100% allocation was $155,000, using a fodder price of $120/t. When this was increased to $150/t, operating profit decreased to $142,000.

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.

The impact of reducing the maximum allocation from 160% to 145% of water right resulted in a $8,000 (2%) reduction in 10-year cumulative operating profit (Table 4 - Appendix). The impact of reducing the maximum allocation from 160% to 130% of water right was more significant with the 10-year cumulative operating profit decreasing by $29,000 (7%) and the Internal Rate of Return decreased from 2.0% to 1.7%.

A flat reduction in irrigation water allocation, from 160 to 130% of water right over the entire 10-year analysis period, resulted in a 16% decrease in annual operating profit on the 'water-reliant' case study farm (see Table 3 - Appendix). 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.

For the 'fodder-reliant' farm, changing the maximum allocation had minimal effect on the 10-year cumulative operating profit (Table 5 - Appendix).

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 one year in ten.

Conclusions 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 'water-reliant' farms and less efficient farms. The two case study farms analysed were efficient relative to most farms.

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 through improved pasture and feeding management, which may combat the impact of changing irrigation water price and availability. 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.

Acknowledgments

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References

Armstrong D, Ho C, Doyle P, Malcolm B, Gibb I and Brown S 2004, 'Analysing drought impacts and recovery options by adapting a dairy farming systems modelling approach', *AFBM Journal, 2(1):11-16*.

Armstrong D 2004, 'Water use efficiency and profitability on an irrigated dairy farm in northern Victoria: a case study', *Australian Journal of Experimental Agriculture*, no. 44, 137-144.

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

Armstrong DP, Knee JE, Doyle PT, Pritchard KE and Gyles OA 2000, 'Water use efficiency on irrigated dairy farms in northern Victoria and southern New South Wales', *Australian Journal of Experimental Agriculture,* no. 40, pp. 643-653.

Douglass W and Abuzar M 1998, 'Results of the irrigated farm census 1997', Technical Bulletin, Goulburn-Murray Water, Tatura, Victoria.

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

Gyles O, Baird C and Brown S 1999, 'Economics of reduced water allocations: estimating impacts on the northern Victorian dairy industry' in *Proceedings of the forty-third annual conference of the Australian Agricultural and Resource Economics Society*, New Zealand.

Ho C, Nesseler R, Doyle P and Malcolm B 2004, 'Future dairy farming systems in irrigation regions', *AFBM Journal, 2(1):65-74.*

Linehan C, Armstrong D, Knee J, Doyle P, Johnson F, Bowman K and 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 JP and Malcolm LR 1993, 'The Farming Game Now', Cambridge University Press, Cambridge, UK.

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

Appendix

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

	'water-reliant' farm	'fodder-reliant' farm
Land area (ha)		
Home area – irrigated perennial pasture	40	66.5
– irrigated annual pasture	-	32
Outblock – irrigated perennial pasture	16	-
– irrigated annual pasture	16	35.3
– maize	-	22
Water right (ML)		
Home	177	454
Outblock	165	400
Herd (cows)	165	496
Feed supply		
Estimated pasture consumption on the milking area (t DM/ha)	12.5	15
Hay/silage fed (t DM) (conserved on outblock)	136	729
Grain fed (t DM) (purchased)	271	828
Milk production (kg butterfat)	43,000	137,000

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 and % reduction in operating profit			
	'water-reliant' farm		'fodder-reliant' farm	
	$'000	%	$'000	%
35	52		285	
53	41	-21	259	-9
70	31	-40	233	-18
105	10	-80	182	-36

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 and % reduction in operating profit			
	'water-reliant' farm		'fodder-reliant' farm	
	$'000	%	$'000	%
160	52		285	
145	48	-7	284	-0.5
130	43	-16	279	-2
100	30	-41	250	-12

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	2.0
145	412	2	1.9
130	391	7	1.7

Table 5. Economic impact of changing maximum irrigation water allocation and reliability on the 'fodder-reliant' farm.

Max Water allocation (%)	10-year cumulative operating profit ($ '000)	% decrease in 10-year cumulative operating profit	Internal Rate of Return (IRR) (%)
160	$2,690	0	7.7
145	$2,699	0.4	7.8
130	$2,682	-0.3	7.7

Figure 1: Water reliability under different water allocations

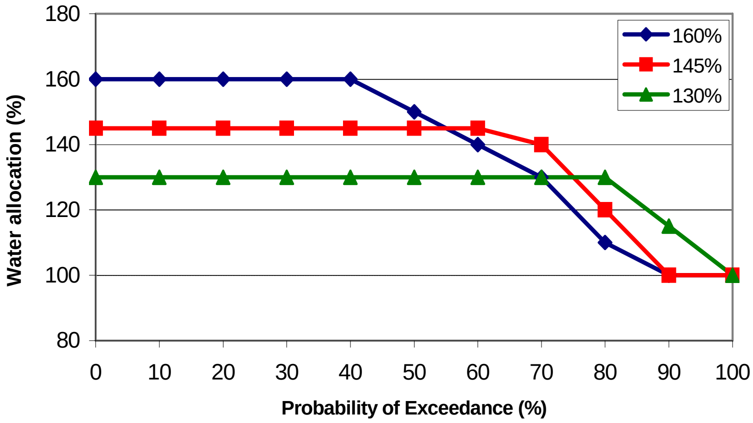

Figure 2. Impact of irrigation water price and pasture consumption on annual operating profit for the 'water-reliant' farm.

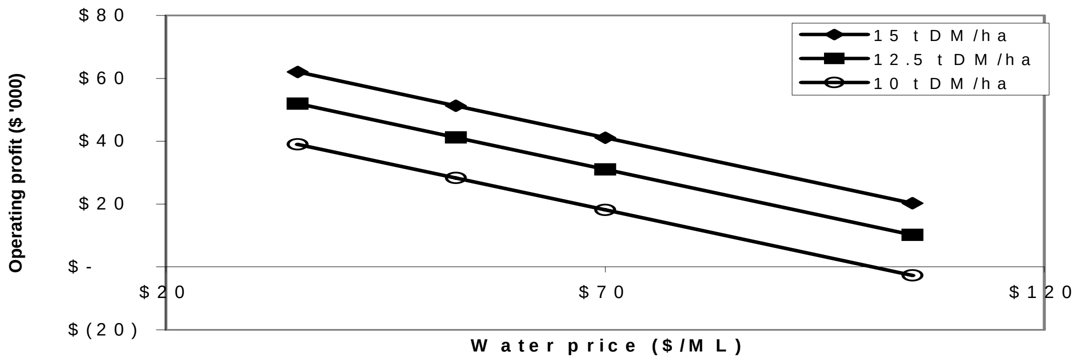

Figure 3: Impact of irrigation water price and pasture consumption on annual operating profit for the 'fodder-reliant' farm.

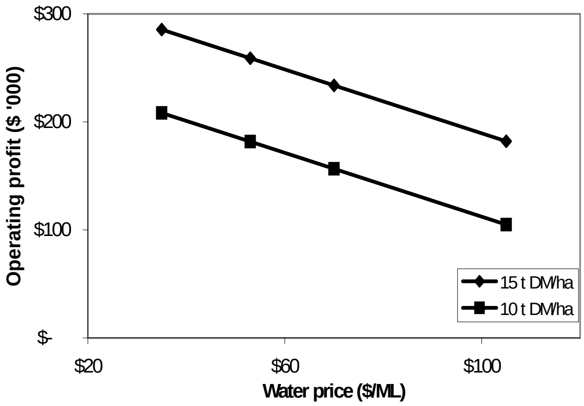

Figure 4. Impact of irrigation water availability and pasture consumption on annual operating profit.