The Potential Impact of Water Market Reform and Dairy Deregulation on Dairy Farming for the Lower Murray[1]

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A linear programming model is utilised here to reduce the uncertainty around the impacts of dairy deregulation and water market reform on the future productivity and profitability of irrigated farming in the Lower Murray River Irrigation Area. This information was provided to assist in evaluating the timing and mix of irrigation infrastructure investments under consideration by dairy framers in the Lower Murray Irrigation Area and the South Australian Government.

Possible future milk prices received and water rights (including allocations and trade restrictions), together with possible improvements in on farm productivity are assumed in this regionally based model.

The model results suggest that some dairy farmers will consider withdrawing from dairying and selling water allocation under a range of potential future milk and water prices.

Key words: irrigated dairy farming, linear program

Introduction[2]

The Lower Murray Reclaimed Irrigation Area (LMRIA) is a significant milk producing region in South Australia, with farm gate value of milk production of around $30 million in 1999-2000. These dairy farms are situated on former flood plains along the lower reaches of the River Murray. Water from the River Murray is used to irrigate pastures on these dairy farms, usually by opening gates in the levee bank along the river to flood irrigate swamps or by pumping water up to highland areas. The swamps are flood irrigated due to the nature of the soils and the requirement to apply sufficient water to leach salt from the paddocks. A significant amount of run-off water from the swamps is returned to the River Murray. This excess water carries with it nutrients and bacteria from paddocks (as well as salt that would have eventually been returned to the River irrespective of irrigation).

The irrigation infrastructure for many of the swamps is relatively inefficient. Contributing factors can include poor design or condition of infrastructure, poor management practices and uneven paddocks. Irrigators have also had little incentive in the past to effectively monitor and control these water diversions.

Dairy farmers and the wider local community, the South Australian Government and the Murray Darling Basin Commission (MDBC) have been working to address issues of:

- excess water use;
- water quality;
- the rehabilitation and ownership[3] of irrigation infrastructure; and
- improved management arrangements for addressing these issues.

This paper summarises work undertaken to assist in addressing one component of these issues. In considering funding options for rehabilitation of irrigation infrastructure, policymakers recognised a risk that Government could make a substantial contribution to rehabilitation but then find that many irrigators sold their

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[2] Background information on the LMRIA is summarised from PIRSA (2001).
[3] Around two thirds of the irrigation infrastructure serving irrigators in the Lower Murray Irrigation Area is government owned.

water and exited farming. As such the returns on the government investment would be significantly reduced.

The objective of this part of the study was to gather information to help answer the question

'Is the extent of dairying (both water use and area irrigated) in the region likely to contract significantly as a result of changes to water policy?'

To provide information relevant to this concern a linear programming model, the 'South Australian Dairy and Horticulture Linear Program' model, has been used.

The Victorian Department of Natural Resources and Environment built this model in 1994/95 for the MDBC as part of a wider effort in assessing the likely impact of water market reforms on regional agricultural users of water from the River Murray.

Data relevant to dairy farming and water use in the lower River Murray have been updated for the current application. In addition, data and assumptions have been independently reviewed.

Model Overview and Method

In this model, dairy farmers are assumed to have a single objective of maximising the gross margin for the region through choosing a range of activities such as:

- Which pasture types to sow over how large an area;
- How many cows to stock;
- How much water to apply to chosen pastures; and
- How much of a range of goods and services (including milk and River Murray water) to buy or sell.

Farmers make these choices under a range of constraints including farmland area, irrigation and rainfall water availability and productivity of pastures and animals.

The model used for this analysis explicitly recognises the major possible activities and limiting constraints for dairy farmers in the LMRIA. Rainfall data, pasture growth (by

pasture type), together with pasture required for cow maintenance and milk production (by spring or autumn calving), derive a relationship between monthly-irrigated water use and milk (and pasture crop) output. The water requirement assumptions are consistent with the firm cap on water diversions from the lower Murray approved in March 2001.

Annual constraints are specified for land area, water allocation by swamp and highland, milk, water and other product prices as well as productivity assumptions regarding pasture utilisation, and water use efficiency. Some of the key assumptions used in this model are presented in Table 1 below. Refer to Eigenraam (1999) for full model documentation.

Table 1 Values of key variables in the Water Trade Model

Area swamps (ha)	5,712
Area highlands (ha)	1,581
Number of cows	18,625
Water allocation - private swamps (ML)	32,830
	(7,412 of which environmental flow)
Water allocation – government swamps (ML)	70,677
	(14,788 environmental flow)
Maximum water use (ML)	103,507
	(22,200 environmental flow)
Base water price ($/ML)	50
Drainage charges (private swamps) ($/ML)	4
Drainage charges (government swamps) ($/ML)	15

Exogenous variables include water allocation and transfer possibilities, water and milk prices and the productivity of swamp or highland due to rehabilitated infrastructure.

To investigate the impact of water market reform on dairying in the LMRIA, the model was calibrated to reflect current conditions in the region, except for two areas:

- On farm water use efficiency; and
- Water use and transfer conditions.

On farm productivity

Irrigators in the LMRIA may be assumed to take actions to improve the on farm productivity of their operations in the face of added pressures such as dairy deregulation and water market reform on their profitability. It was observed that one of the more obvious ways in which many dairy farmers could improve their on farm productivity was through the laser levelling of bays to increase irrigation efficiency and pasture productivity[4]. To reflect such rational behaviour by farmers, water use efficiencies were calibrated consistent with laser levelling across the LMRIA, but with no rehabilitation of off-farm infrastructure. More specifically, water use efficiency on the highlands of 85 per cent was assumed, and 60 per cent for the swamps. (The equivalent water use efficiency for swamp areas excluding the environmental allowance is 80%.)

Water use and transfer conditions

In the past, irrigation water for the swamps has been allocated on the basis of area of fodder or rateable area of pasture, with some amendments made over time to incorporate conveyancing allowances which were returned to the River Murray and to authorise diversions from back channels or main drains to highland areas. In 1993/94 an interim cap on water diversion from the River Murray of 83.4 GL per annum was set. However, the absence of secure meters to measure volumes of water diverted across the LMRIA limited the ability to ascertain the extent of compliance with this cap.

In March 2001, a firm cap of 103.5 GL was approved by the MDBC. This allowance was based on irrigation water requirements, developed in consultation with irrigators, assuming best practice and recognising different rainfall/evaporation zones (PIRSA 2001). These allocations are summarised in Table 1 above, and include a non-

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[4] See for example, Tonkin Consulting (2000) and PIRSA (2001)

transferable 22.2 GL a year environmental management allowance for the swamps. The 9.3 GL allocated for highland areas is transferable. These water allocations are assumed to be in place and adhered to in the linear programming experiments.

The linear program was then run under alternative prices of water and milk to gain an understanding of the likely impact of water market reform on the LMRIA. Of particular interest were likely:

- net sales or purchases of irrigation water by irrigators in the region;
- areas of swamp irrigated; and
- changes in regional gross margin.

The farm gate price (net of freight) of milk was varied between $0.18, $0.23 and $0.28 per litre. The alternative modelled values for the price for short-term sales (leases) of irrigation water were $30, $50 and $70 per ML. For each experiment, the lowest price of water at which irrigators might sell water in some areas rather than use it for irrigation was also estimated.

Results

The model results appear broadly in line with expectations. Gross margins range from a low of around $500 per hectare to almost $1700 per hectare of owned land depending on the milk and water price scenarios used. Land is increasingly utilised for irrigated dairying as water prices fall and milk prices rise. Although land is less likely to be used for dairying as water prices increase, the potential gross margin from the region increases because of the value of the water sold and the associated costs of production avoided. The major point to note throughout these model results is that water market reform (including increased transferability, clearer definition and enforcement of property rights and changes to water prices) is expected to lead to less irrigated dairying on the swamps under all scenarios used.

Some of the key results from the modelling with respect to impact of water market reform are summarised in Table 2 below. Note firstly, that even at a relatively high milk price (28c/l) and low water price ($30/ML), only 67% of the swamps are

irrigated for dairying. Under the model assumptions, greater returns can be made from some swampland by selling water, and avoiding gross margin costs associated with running cows on this land. The highland areas nearly always utilise irrigated water in the model. This is driven by the higher assumed water use efficiency for the highland areas compared to the swamps.

The modelled swamp land area irrigated for dairying collapses if milk prices fall below 20-21c/l at the lower scenario water price. The environmental allocation of 22.2 ML would be the only water applied to swamps in this instance.

Table 2 Impact of various milk and water prices on area irrigated

(excluding environmental flows)

Milk Price (c/l)		Water Price ($/ML) 30	50	70
18	Swamp	0%	0%	0%
	High Land	100%	4%	0%
23	Swamp	67%	33%	0%
	High Land	100%	100%	100%
28	Swamp	67%	55%	45%
	High Land	100%	100%	100%

From Table 2 it can be seen that under the assumptions of the model, a milk price of $0.28 per litre and a water price of $50 per mega litre, that only around 55 per cent of the swamp area in the LMRIA would be irrigated to gain the highest gross margin for the region (excluding water applied under the environmental allocation). Further, the area of swamp irrigated would collapse if the farm gate milk price fell to $0.18 per litre.

The model also indicates that at $0.28 per litre and $50 per mega litre about 40 per cent of the allocation (exclusive of the environmental allocation) would be sold out of

the region (See Table 3 below). This increases to 78 per cent if milk prices fall to $0.18 per litre.

Table 3 Impact of various milk prices on swamp area irrigated and water sold

With a $50/Ml water price, percentage of water allocation sold excludes environmental allowance

	$0.18/l	$0.23/l	$0.28/l
Reduction in area of swamp irrigated (%)	100	66	45
Proportion of allocation sold (%)	78	50	40

The model also indicated that at a milk sale price of $0.28 per litre, the minimum price at which irrigators would choose to sell some of their water rather than irrigate all swamps is $22 per megalitre.

Model Interpretation

Note that this model optimises the inputs and outputs that maximise regional gross margin under some assumed constraints. It does not predict how irrigators will behave. It does however, provide a broad indication of how irrigators might respond if they chose to maximise their profits under the same set of constraints. As such, the model indicates that water tradability could result in significant changes to both the extent of swamp area irrigated and the sale of water from the region. If water market reform results in higher water prices, the model suggests that irrigators are likely to sell more water and reduce irrigation, even at high milk prices. If however, future water prices are at the lower end of current expectations, farmers in the region will have lower gross margins, but are likely to irrigate more land for dairying than in a higher water price environment. At low milk prices, the model suggests that regional gross margin is greatest with a minimum amount of swamp irrigated, which utilises the environmental water flow requirements for this land.

Interpreting results from the model should be made with caveats on both the structure of the model chosen to represent this farming system, and the appropriateness of the assumed objective function, associated activities and constraints. Eigenraam (1999)

discusses limitations such as linearity, perfect divisibility and the validity of the assumed objective function in the context of using this and similar linear programming models to estimate derived demand for irrigated water. He concluded that it was unlikely that these limitations would significantly affect the validity of analyses they conducted or the conclusions drawn from their analyses. The study conducted here is certainly a subset of that analysis. However, some of the limitations relevant to this analysis do warrant explanation.

Firstly, the model covers the LMRIA as a single operating entity. That is a single decision-maker is maximising gross margin across the region in the model. While individual farmers may pursue profits, they are less likely to act collectively and fully utilise opportunities to maximise profit across the entire LMRIA. To that extent, the model may overstate both the profit opportunities truly facing farmers and the movement out of dairying.

There are two further aspects associated with the desirability of choosing gross margin as the objective. Eigenraam (1990) points out that alternative objectives such as minimising risk, and accumulating wealth may be equally valid. A gross margin objective does lead to model results with useful information regarding the impact on variable returns from rehabilitation and water market reform. New fixed capital such as irrigation infrastructure can also be imposed in the model, and that infrastructure and any associated productivity changes are recognised in the model. However, the model cannot optimise options regarding fixed capital such as preferred farm size and irrigation infrastructure.

This information is useful but should be used with care. For example the model suggests that the region could get a greater return from selling water rather than using it for irrigation in some instances. This is the extent to which the model results should be used.

It should be remembered that the sale of water has implications for the use of other fixed as well as variable inputs. As such, farmers are unlikely to make all the changes associated with the sale of water as a result of lower gross margins in one year. They would take a longer view of the net returns from farming versus the sale of water. The

model does not take account of the costs associated with such activities as increasing scale or scope, or selling farm capital.

It is advisable to note that the constraints and activities assumed in the model are not exhaustive. In addition to issues associated with fixed capital, there are some constraints to farmers that are not accommodated for in the model. As a result the model could either understate or overstate movements out of dairying. For example, the implicit model assumption that infrastructure already exists to transfer water to the highlands may result in an understatement of the movement out of dairying. On the other hand, assumptions relating to minimal transaction costs associated with buying and selling water and cows could lead to an overstatement of the movement out of dairying, particularly in the short run.

While land is separated into swamp and highland, the variation in productivity and profitability between swamps and properties within swamps in the LMRIA is not accounted for in the model. Average regional water use requirements, farm management expertise and land and capital productivity are assumed. Whether the use of averages overstates or understates movement out of dairying is difficult to determine.

Hence model results about changes in water and land use should be interpreted in terms of likely directions and broad magnitudes for the region, rather than specific changes by landholders.

Concluding Comments

It can be concluded from the model results tabled (under the range of milk and water prices considered) that water market reform will result in serious consideration by some dairy farmers in the LMRIA of withdrawing from dairying and selling water allocation.

The extent of any under utilisation of irrigation infrastructure is uncertain and will depend on the opportunities for greater dairy productivity and profitability (eg through increased economies of scale or pasture utilisation) not considered in the

model, as well as future market prices and structures. The model results infer a risk, however, that the swamp area in the LMRIA could be lost from irrigated dairying as a result of market pressures from water market reform.

References

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