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Estimating benefits for dairy production systems from sustainable irrigation practices:

Intervention and adjustment in Victorian Land and Water Management Plans ^a

Oliver Gyles ^b

Approaches to valuing regional responses in plant productivity from investment in natural resource management are reviewed. The usefulness of data from surveys for estimating marginal physical product is discussed. Since investment reduces declining trends in productivity, an estimate of value marginal product based on based on milk price has seemed appropriate. But as forage is an increasingly substitutable intermediate product in dairy production systems its value will not exceed that of the least cost substitute. Qualified estimates indicate the extent of overestimation of benefits produced by some previous approaches. Implications for natural resource management policy are considered.

Key words:- Physical response, water use efficiency, pasture productivity, supplementary feeding

1. INTRODUCTION

Management plans addressing sustainable development issues in Victorian irrigation areas have been in the implementation phase for up to ten years.

The planning phase for these investment programs included *ex ante* economic evaluations of management options using conventional benefit:cost analysis generally following the government “Guidelines for Preparation of Salinity Management Plans” (Anon, 1988).

The assessment of primary benefits was based on estimates of future productivity for both the “Without Plan” and “With Plan” scenarios. Continuing trends in the degradation of natural resources in the absence of intervention formed the basis of these comparisons, with works expected to halt or reverse declining trends in productivity.

This paper discusses some aspects of the evaluation of benefits for the dairy industry arising from the joint investment by landholders and government in improved irrigation practices and natural resource protection. The objective is not so much to reiterate previous *ex ante* project evaluations but rather to consider some broader possibilities for monitoring the benefits of regional programs. To some extent this approach is necessary as detailed biophysical monitoring of on-site outcomes is expensive and often impractical. Thus there is a trade off between investment in works to obtain benefits and expenditure for monitoring to confirm the benefits.

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b Agriculture Victoria, Institute of Sustainable Irrigated Agriculture, Department of Natural Resources and Environment, Tatura 3616. Views expressed are those of the author.

2. ESTIMATING PHYSICAL RESPONSE

The consequences of changed hydrologic conditions in irrigation regions have led to increasing losses in regional output. For example, the projected decline in productivity caused by rising watertables and increasing salinity for the Shepparton Irrigation Region is shown in Figure 1 (Anon, 1989).

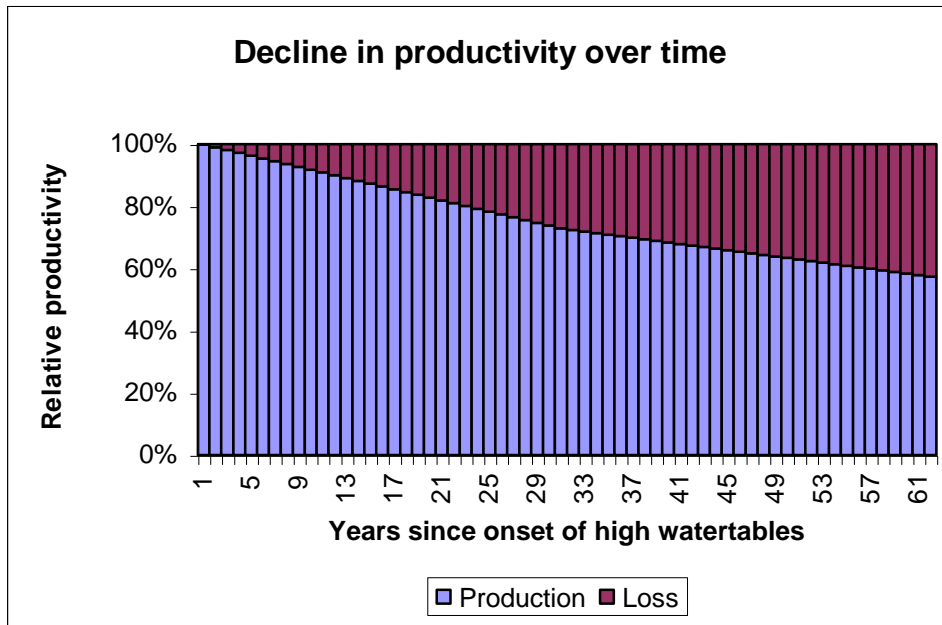


Figure 111: Predicted decline in productivity for the Shepparton Irrigation Region.

Depending on the timing and extent of intervention, the benefits arising from individual projects may be a mix of restoration and prevention. This is shown for a situation where some loss has already occurred in Figure 2.

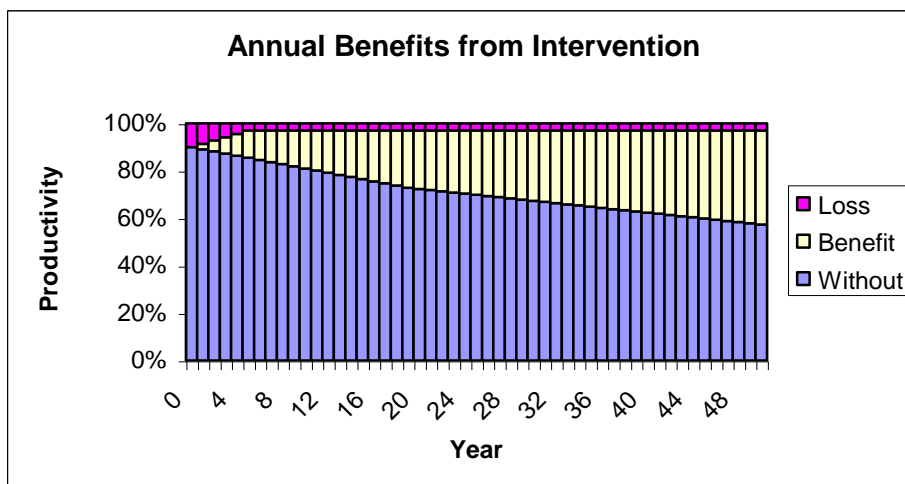


Figure 222: Timing and magnitude of project benefits

2.1 Base Level Regional Productivity and With Plan Monitoring

Water use efficiency (WUE) defined as the milk production from pasture per unit of total water use (Armstrong *et al*, 1998) is a potentially useful indicator of trends in pasture productivity. This indicator is calculated using a production efficiency analysis (PEA) which adjusts total annual milk production to allow for the net contribution of brought in supplements and for any pasture consumption by non-milking stock.

WUE has been reported by Heuperman *et al* (1986) for a farm at Tongala, Gyles and Young (1991) for the Girgarre area, and by Armstrong *et al* (1998) and Linehan *et al* (2001) for the Northern Irrigation Region. All these estimates are based on farm surveys. Those by Armstrong *et al* and Linehan *et al* are for representative regional samples. Armstrong has also prepared estimates using regional data from the Victorian Dairy Industry Authority Survey and Goulburn-Murray Water (*pers. comm.* Armstrong, 2001). Standardised¹ estimates are shown in Figure 3.

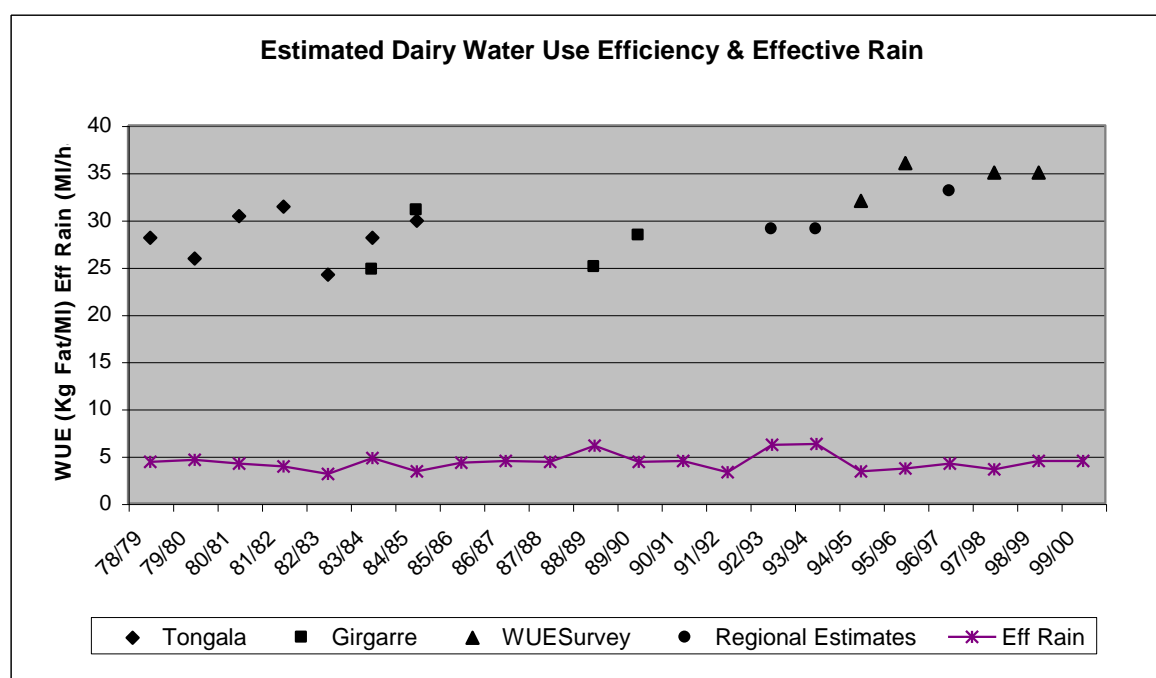


Figure 333: Dairy water use efficiency estimates for seasons in the Northern Irrigation Region.

Figure 3 shows an increasing trend in WUE estimates from slightly below 30 kg Fat/ML when plan implementation commenced in the early 1990s to approximately 35 kg Fat/ML in recent seasons².

There is a wide range in WUE as defined on dairy farms within irrigation regions. The spread in performance is shown in Figure 4.

¹ Mainly standardised with respect to estimation of effective rainfall.

² More credence might be given to the later WUE data shown in Figure 3 on this account as these are derived from “more random” and larger samples (approximately 5% of population). All surveys found variability between seasons on individual farms.

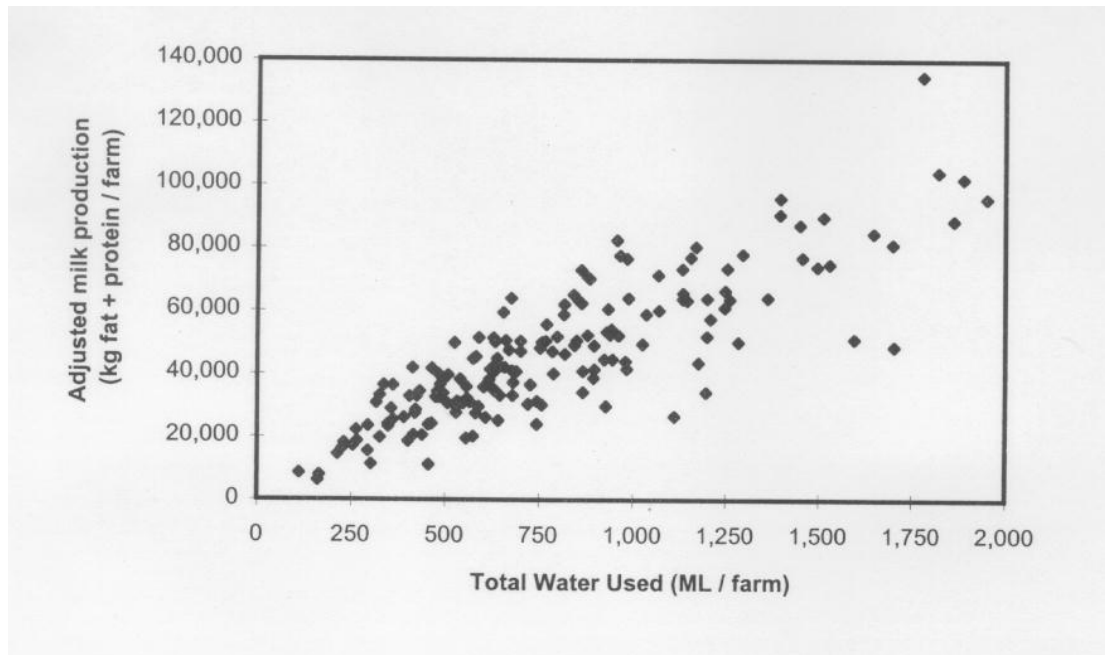


Figure 444: Milk solids from pasture based production and water use on dairy farms in northern Victoria and southern New South Wales (After Armstrong *et al* 1998)

Ferris and Malcolm (1999) point out that, given a market for water, individual farm WUE is “the economically efficient technical efficiency ratio for that farm operation”. What constitutes the characteristics of “that farm operation ” will depend on previous sunk capital, seasonal conditions, prices and operating policy. If these characteristics are unchanged then only other exogenous factors should alter production functions and/or best operating conditions and changes in land and water quality should thus be reflected as changes in WUE.

2.2 Factors Affecting Dairy Water Use Efficiency

Land and water quality attributes such as inherent fertility and salinity affect WUE. Production practices and technology also influence efficiency. Investments affecting irrigation efficiency such as landforming and tail water recycling systems and those practices influencing pasture dry matter production such as pasture establishment following landforming, irrigation frequency and fertiliser rates alter plant efficiency, and so contribute to potential WUE. Similarly management of pasture quality and utilisation through stocking rates, grazing rotations, pasture topping and supplementary feeding regimes influence WUE.

Seasonal factors leading to an abundance of pasture tend to reduce WUE since stocking rate cannot be instantaneously increased on a regional basis. Prolonged wet conditions can affect animal performance and reduce pasture quality and dry matter production.

2.2.1 Plan investments affecting WUE

Management plans aim to increase irrigation efficiency through the encouragement of whole farm planning with emphasis on land forming and tail water recycling. Improved irrigation layout is also estimated to reduce groundwater accessions by 10%. Landforming necessitates pasture establishment and the reduced operating labour requirement fosters more frequent irrigation and the intensification of other

inputs including livestock and fertiliser. Investment by landholders in improved irrigation layout is part of the agreed cost sharing for irrigation salinity management plans.

Surface and sub-surface drainage projects reduce the impact of waterlogging and salinity.

2.2.2 Non plan changes affecting WUE

2.2.2.1 Technical Support

Other programs and activities, notably technical support from dairy processing companies, farm management consultants, other service providers and the dairy extension program “Target 10” are aimed at increasing technical efficiency in the dairy industry. What impact have these activities had on WUE?

Boomsma *et al*, (1999) report estimates of substantial financial benefits for participants in the grazing management program in Target 10. DNRE Evaluation Report No 2 (Anon, 2000) refers to survey results indicating an average increase in pasture consumption of 21% for 36 participant farms in Gippsland. It is not indicated whether this increase was estimated from field measurements or calculated from production data. No comparison with non-participant farms is given although the estimated increase was tempered by allowance for historical trends in pasture consumption made by Target 10 staff. Modelling using VDIA 1994/95 survey data for West and South Gippsland as the basis for a “base farm” estimated a productivity improvement of 5.95% valued at \$8,804 per participating farm per annum (Anon, 2000).

Estimates of regional pasture based milk production³ using the same VDIA survey data (Figure 5 and Figure 6) do not indicate significant increases in pasture consumption, if 1994/95 is taken as the base year.

Further, because potential pasture growth is strongly influenced by available soil moisture (Figure 7), in non-irrigated regions potential pasture consumption will vary with rainfall. The impact of drought in South Gippsland in the 1996/97 season is clearly shown in Figure 5. Similarly a dry season and the increased supplementary feeding in West Gippsland in the 1997/98 is indicated in Figure 6. Inferences regarding the efficacy of extension programs aimed at increased pasture consumption are meaningless unless individual farm and regional time series data are viewed in a seasonal context. Some agronomic appraisal including an assessment of water use should be carried out before analysis of response is attempted.

Estimated pasture based production is more constant in irrigation regions since effective rainfall can be supplemented with irrigation water to fully meet crop water requirement (Figure 8 and Figure 9). This is particularly so since the introduction of transferable water entitlement (TWE). This institutional reform has broken the nexus between land and water and allows the market to move water to higher value uses. This has enabled the dairy industry to buy water as the cheapest option for maintaining production in low allocation years (Gyles *et al* 1999) except for the Gippsland Irrigation region (Figure 9) when severe supply restrictions in 1997/98 limited production (*pers. comm.* Bates, 2002)

³ The calculations assume farms are net importers of feed and carry only milking stock.

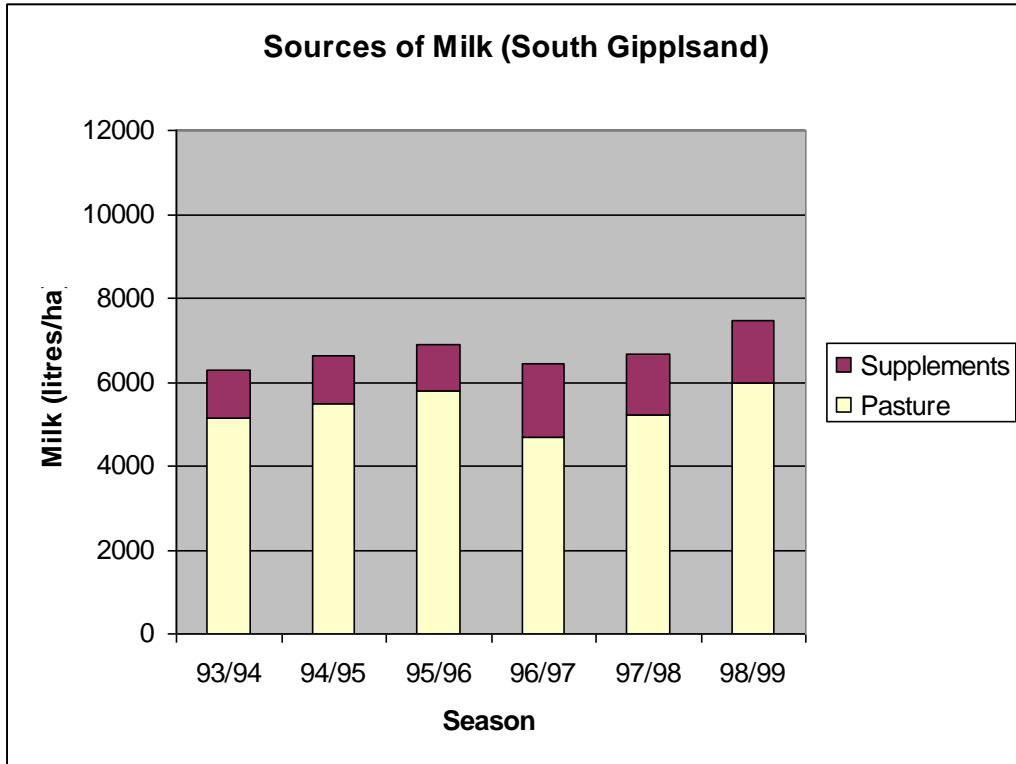


Figure 555: Sources of milk for VDIA survey farms in South Gippsland

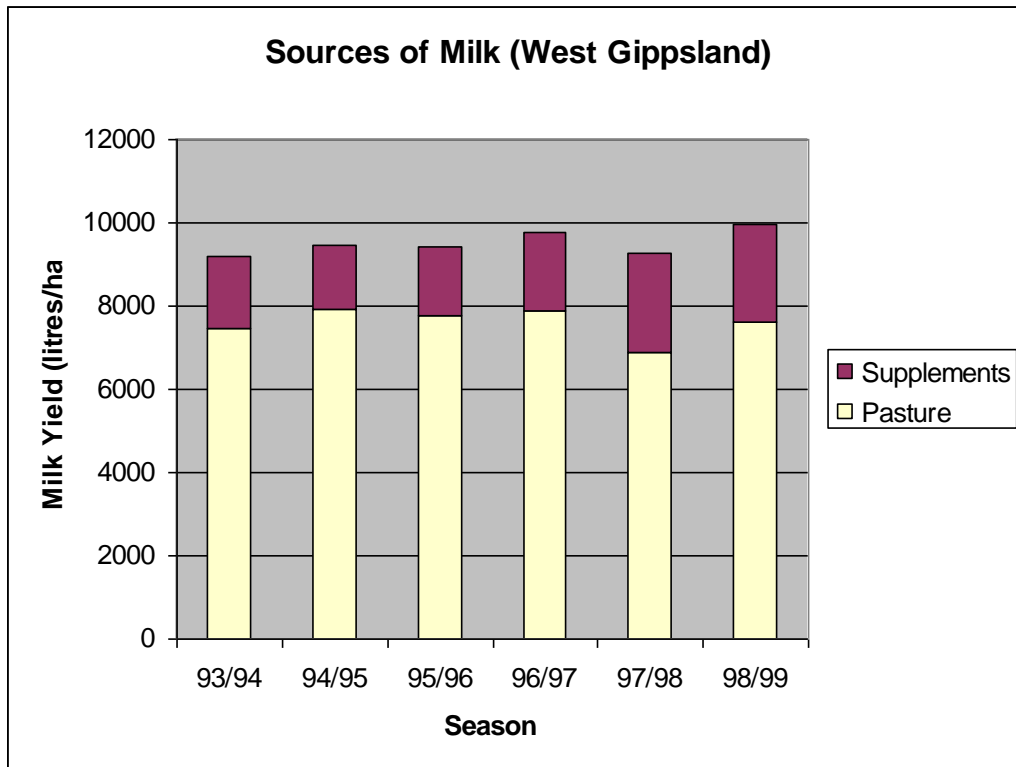


Figure 666: Sources of milk for VDIA survey farms in West Gippsland

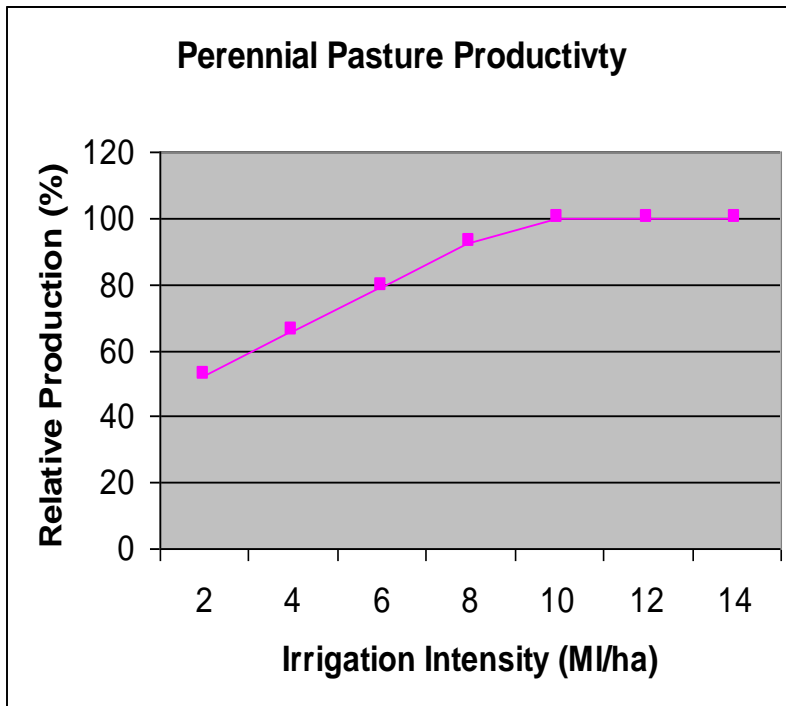


Figure 7: Pasture response to irrigation intensity. (after Bethune, 2001)

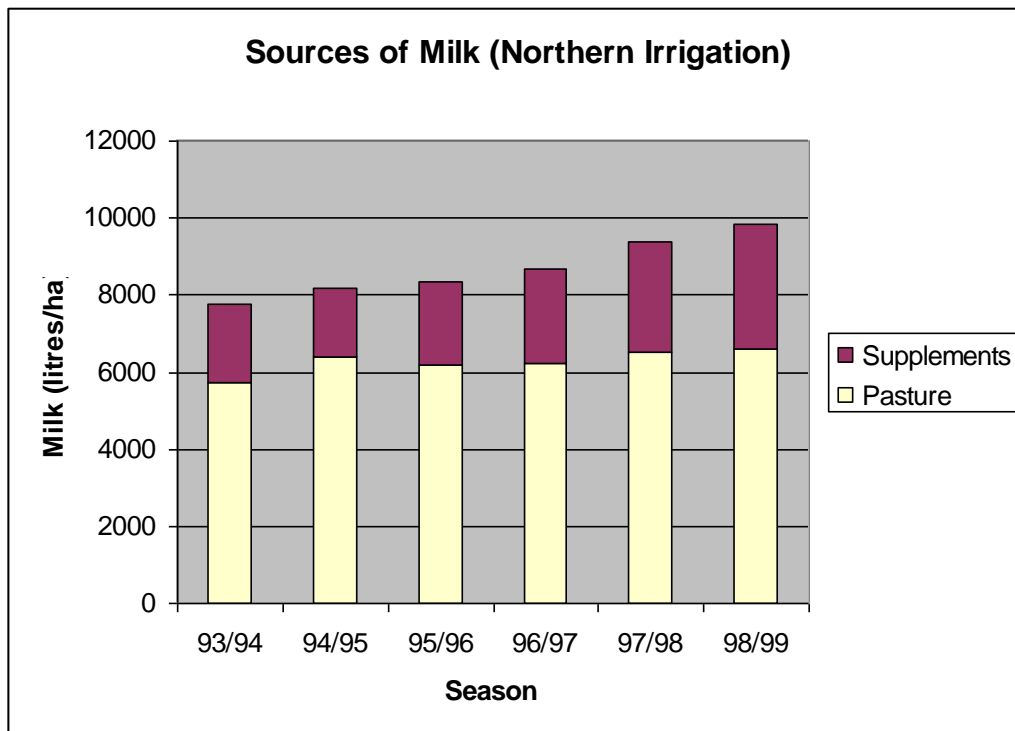


Figure 8: Sources of milk for VDIA survey farms in Northern Irrigation Region

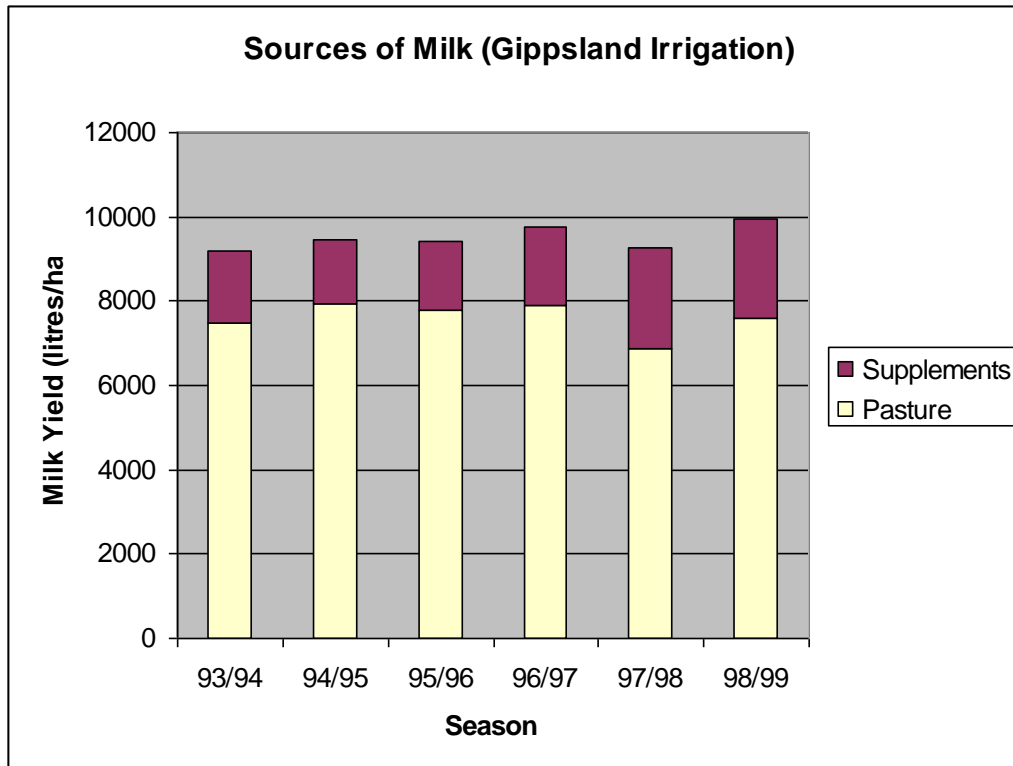


Figure9: Sources of milk for VDIA survey farms in Gippsland Irrigation Region

2.2.2.2 Stocking rate

The adjusted stocking rate in the regions and seasons discussed above is shown in Figure 10. Stocking rate is adjusted downward to allow for the proportion of recorded stocking rate fed by brought in feed. Adjusted stocking rate ranges from 1.2 to 1.4 cows/ha except for that in the Gippsland Irrigation region which is between 1.7 to 1.9 cows/ha. The higher stocking rate for Gippsland Irrigation may be due to a higher proportion of farm area being under perennial pasture and used for milking stock. The adjusted stocking rate⁴ found in the Northern Irrigation region water use efficiency surveys was close to 2.5 cows/ha.

There is an upward trend in all regions of approximately 0.1 cows/ha over the period, an increase of approximately 7% in the non-irrigated regions. The responses found by King and Stockdale (1980) would produce a small increase in animal productivity.

⁴ Adjusted for brought in feed and non-milking stock carried.

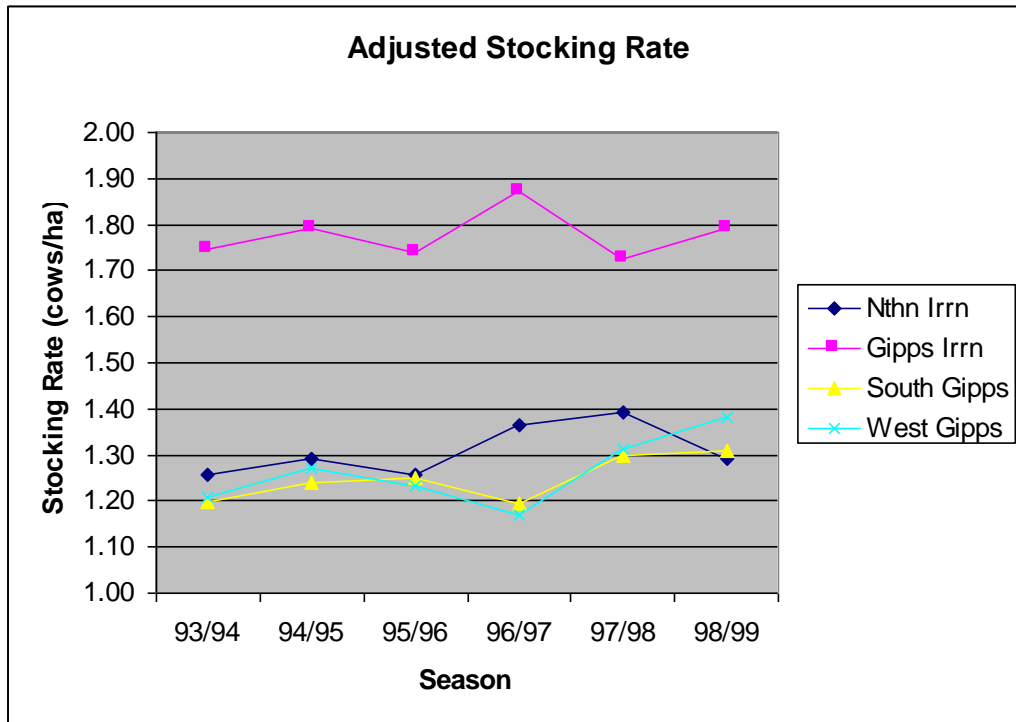


Figure 10: Adjusted stocking rate of milking cows in dairying regions

2.2.2.3 Milk Prices and Supplementary Feed and Water Costs

Farm gate prices (cents/litre) estimated for a farm supplying Murray-Goulburn with an average production pattern, milk composition and scale of operation (*pers. comm.* I. Gibb, Farmanco, 2002) and grain feeding costs calculated using ABARE indexes are shown in Figure 11.

Comparison of price and cost movements and sources of milk production indicates the level of supplementary feeding is responsive to the margin between feed costs and milk price. To the extent that increased levels of supplementary feeding requires investment in livestock, feeding system and milking capacity this is a strategic adjustment to perceived trends in commodity prices, rather than simply a tactical response to seasonal factors, although seasonal conditions may trigger a strategic investment.

Conversely, after allowance for seasonal conditions, pasture productivity is virtually unresponsive underscoring Ferris and Malcolm's contention that farms are functioning near best operating conditions for the characteristics of that farm. Lineham *et al* (2001) found regional water use efficiency did not alter despite large short-term changes in the market price for water. This concurs with the finding of Murray-Prior and Wright (2001) that while producers may make rapid tactical adjustments, strategic investment (or disinvestment) under uncertainty is much slower and less extensive than most technical and economic modelling would predict.

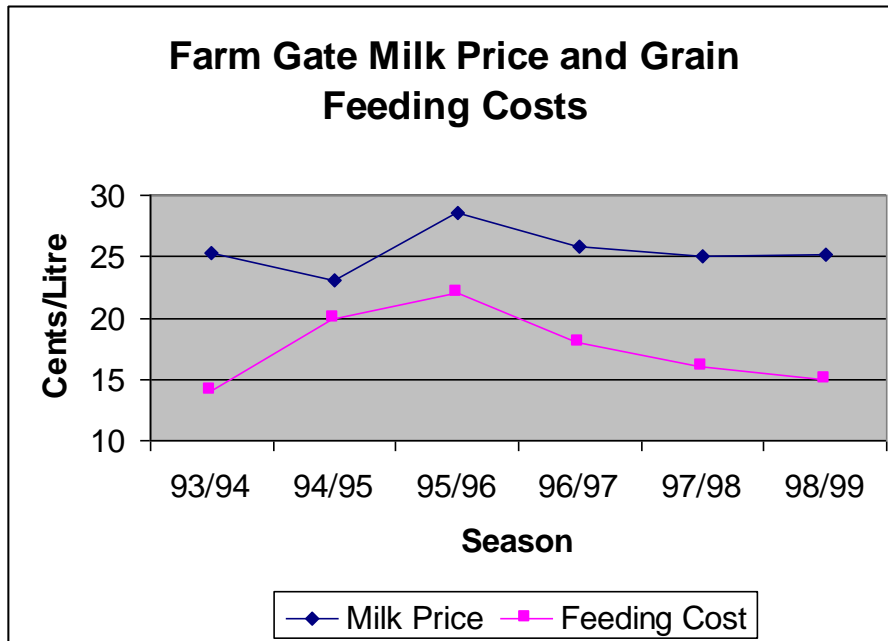


Figure 11: Milk price and estimated grain feeding costs

2.3 Magnitude of Physical Response

The foregoing treatment of physical production in dairy regions suggests that, after allowance for the influence of other programs, regional pasture productivity in irrigation regions has remained steady or risen slightly despite expectations of a decline of 0.9% per year due to increasing salinity. This maintenance of productivity is in contrast to other areas. For example, Vere *et al* (2001) found a long-term decline in economic productivity in tableland regions of NSW.

Increases in the area protected by sub-surface drainage to approximately 10% of the Shepparton Region (Kularatne *et al*, 2001) and downward trends in August watertable heights (Anon, undated) also support this estimate.

3. VALUATION OF PRODUCTIVITY BENEFITS

3.1.1 Marginal or average productivity?

WUE as reported above is an estimate of average, not marginal, productivity. Figure 7 shows diminishing returns by pasture to irrigation intensity in northern Victoria. Marginal response is almost constant until irrigation intensity exceeds 8 ML/ha. Irrigation requirement (and response) is influenced by seasonal conditions as effective rainfall and evaporative demand will vary from year to year. For example, Armstrong *et al* estimated irrigation requirements for perennial pasture of 11.5 ML/ha and 9 ML/ha for seasons 1994/5 and 1995/6 respectively and calculated average irrigation intensities of 9.2 ML/ha and 7.8 ML/ha from their survey data for the same years. Thus it seems likely that most irrigators are operating in the region of constant response in Figure 7 and marginal WUE would be close to average WUE. This is more likely to be so since the introduction of TWE as surplus water right can be traded rather than wasted on excess irrigation⁵.

⁵ Gyles (1999) has estimated the annual cost of irrigation water under TWE at \$64/ML.

3.2 Value of increased forage production

As the predicted trend in pasture productivity for the non-intervention scenario is downward, it is assumed that no capital investment is required to utilise additional forage production. That is the grazing and milking capacity already exists and there is no regional adjustment in stocking rate to relatively small annual reductions in pasture production.

3.2.1 Substitution of Intermediate products

Because supplements and forage are substitutable in milk production, they are classed as intermediate products or outputs in the dairy system (Doll and Orazem, 1984). Therefore the highest value for any component of the ration is that of the amount of least cost substitute feedstuff that would produce the same response.

The significance of milk price is in setting an economic maximum level for feeding cows for milk production. The economic maximum level for feeding is determined by the response curve to fodder and the ratio of milk price to the cost of fodder. Makeham (1974) defines the economically optimum level of input as that indicated by the point where the slope of the response curve and that of the “price line” relating the cost of the input to the price of the output is identical. At this point marginal revenue equals marginal cost. This optimum level of input is the only point where the value of additional milk output produced by the additional fodder and its cost are equal. Below this level of input, additional units of fodder return more value in milk than the cost of the extra feed. But, notwithstanding the surplus generated by the response to the level of feeding, because fodder is a substitutable intermediate output in the dairy production system, its value will not exceed the price of the least cost substitute.

3.2.2 Cost of Supplementary Feeding

At 2001 prices in the Northern Irrigation region the average cost of production of additional milk using supplements is approximately 17 cents per litre using grain or maize silage and around 20 cents per litre for hay (Gyles and Kelly, 2001). Again the distinction between average and marginal productivity arises as profit maximising managers would be expected to adjust inputs until marginal cost equals marginal revenue. However most dairy farmers appear to avoid the possibility of supplements becoming substitutes for pasture and use scale rather than intensity to drive profit.

4. INTERVENTION OR ADJUSTMENT

Irrigation water is a limiting resource and the potential irrigation demand by the capable and suitable land in the northern irrigation region far exceeds the supply. In some situations, adjustment to salinity by shifting water and other mobile resources from high to low salinity land is a lower cost option for managing salinity than attempting to protect or reclaim affected land. The possibility of the relocation of water resources means there is an opportunity cost for irrigation water used on project sites. The market price for permanent transfer of water right provides an indication of this cost from a regional perspective. However the potential benefits from the continuing use of sunk costs of previous investment in land layout and milking infrastructure usually favour remediation and protection.

The potential for adjustment to changing circumstances internally or through market mechanisms means no project stands in isolation and the evaluation and monitoring of all programs is interrelated. The realistic value of benefits lies somewhere between the full price effect of lost production and the net benefits of adjustment after information, and transaction costs (Marshall *et al.*, 1994). However the equity implicit in community management plans will mitigate against the achievement of the full extent and rate of efficiency gains offered by potential adjustment.

5. DISCUSSION AND CONCLUSION

Good data describing changes in physical production with and without intervention is required if monitoring of project outcomes is to go beyond reiteration of the *ex ante* evaluation process where outcomes equal outputs by assumptions. Water use efficiency surveys can provide part of this information and are useful at a regional scale. However “regional usefulness” does not imply that average data has any use for making farm management decisions, where the unique circumstances require thoughtful and thorough assessment of the unique options and opportunity costs. A simple fact which seems to have been forgotten, or perhaps never understood by those who think higher water use efficiency in isolation a noble aim in itself.

Although the previous costs of implementation are sunk, effective monitoring and *ex post* evaluation adds meaning to the “management cycle” and new information and insights to the next round of *ex ante* appraisals. Data collection, analysis, planning, monitoring and evaluation increase the cost of implementation and a certain scale of expected benefits is required before planning, let alone implementation should proceed. This fact seems to be sometimes overlooked by enthusiastic promoters of the latest issues in vogue. The approach to monitoring of some agricultural and natural resource management programs appears to be in its infancy in terms of the collection of meaningful data for the analysis of response. Despite the existence of an extensive literature on agronomy and the economics of response to guide the monitoring and evaluation process, resources are being diverted to the invention of new (should we say naïve?) approaches where the collection of impressions and stories form the basis for evidence of change. This may well be the sign of different things to come but from a socioeconomic viewpoint there is no point in “making a difference” unless it provides a net benefit.

“But who shall say that Romance is dead, and that the world has become flat, stale and unprofitable when these things can happen?” (Paterson, 2000).

6. REFERENCES

- Anon (1988) *Guidelines for the preparation of Salinity Management Plans*, Government of Victoria, Melbourne
- Anon (1989) *The Shepparton Region in the “Do Nothing” case*, Paper SE 9, Background papers, Shepparton Irrigation Region Land and Water Salinity Management Plan, Volume III, Rural Water Commission, Tatura
- Anon (2000) *The value of prospective improvements from research and development in the Victorian dairy industry*, Report 2, Evaluation report series, Department of Natural Resources and Environment, Melbourne

- Anon (Undated) *The underground flood 1999*, Shepparton Irrigation Region Implementation Committee, Goulburn-Broken Catchment Authority, Shepparton
- Armstrong D, Knee J, Pritchard K, Doyle P and O Gyles (1998) *A survey of Water-use efficiency on irrigated dairy farms in Northern Victoria and southern New South Wales* Department of Natural Resources and Environment, Institute of Sustainable Irrigated Agriculture, Kyabram/Tatura
- Bethune M (2000) *Salinity control with sustainable farm salt balance through integrated management*, Final Report NRMS Project I 6053. Murray-Darling Basin Commission, Canberra.
- Boomsma J, Walton M and G Drysdale (1999) Target 10 final report (1996-1999), Department of Natural Resources and Environment, Melbourne
- Ferris, A, and Malcolm, LR (1999) *Sense and Nonsense in Dairy Farm Management Economic Analysis*, Contributed paper, 43rd Annual Conference, Aust Agric and Resource Econ. Soc, Christchurch, New Zealand
- Gyles O and K Kelly (2001) *A preliminary assessment of the economics of soil modification and drainage for irrigated dairy forage production*, Milestone report for research project 438, Dairy Research and Development Corporation.
- Gyles O (1999) *Economic Aspects of Harvesting High Drain Flows in Irrigation Regions*, Proc. Ann. Econ. Conf., Rutherglen, Department of Natural Resources and Environment, Melbourne
- Gyles OA, Baird C and S Brown (1999) *Economics of Reduced Water Allocations: Estimating Impacts on the Northern Victorian Dairy Industry*, 43rd Ann. Conf. Aust. Agric. and Resource Econ. Soc., Christchurch, NZ.
- Gyles O A and MES Young (1991) *Economic aspects of groundwater pumping for salinity management in the Shepparton region*. Report on pre-project and early with-project production and productivity in parts of the Girgarre salinity control project., Institute of Sustainable Irrigated Agriculture, Department of Natural Resources and Environment, Tatura
- King K R and Stockdale C R (1980) The effects of stocking rate and nitrogen fertilizer on the productivity of irrigated perennial pasture grazed by dairy cows: 2. Animal production. *Aust. J. Exp. Agric. Anim. Husb.* **20**: 537-542.
- Kularatne D, Gyles O and M Morris (2001) *Irrigation land and water management plan implementation targets and achievements*, Internal report prepared for Catchment and Water Division, Department of Natural Resources and Environment, Melbourne
- Lineham C, Armstrong C, Knee J, Doyle P, Johnson F, Bowman K and O Gyles (2001) *A survey investigating changes in water use efficiency on irrigated dairy farms in northern Victoria*, Agriculture Victoria, Department of Natural Resources and Environment, Tatura and Kyabram
- Marshall G, Jones R and S McGrath (1994) *Significance of farmer response for estimating agricultural costs of land salinisation*, Contributed paper 38th Ann. Conf. Aust. Agric. and Resource Econ. Soc., Wellington, NZ.

Murray-Prior R B and V E Wright (2001) *Influence of strategies and heuristics on farmers' response to change under uncertainty*, Aust J Agric and Resource Econ **45 573-598**

Paterson A B (2000) An English view, Wireless and other talks in, *Song of the Pen* , Complete works 1901-1941, Landsdowne, Sydney , p 494

Vere D T, Jones R E and MH Campbell (2001) *Long-term changes in the economic productivity of four major pasture categories in the south-eastern tablelands of NSW* Rangeland Journal, 23(2), p.148-158.