Perspectives for Decision Support Systems: Irrigated Dairy Production in the Murray region.

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Consultation with industry identified a range of knowledge and information management tools required for building decision support systems (DSSs) that can help guide sustainable development of irrigated dairy production in the Murray Region. Individual production systems vary in complexity and input intensity and are coupled with the unique business and lifestyle goals of farm families. While single issue focussed decision support tools are limited to promoting understanding of single factor responses, the relevant opportunity costs for resources must be considered. Thus a whole farm perspective for DSSs is required to assist farm business managers optimise the profitability of production and development given the range of technical options, market conditions, environmental constraints, personal aspirations and family goals prevailing on that farm. The research, development and decision support needs elicited from producers using low, medium and high input production systems reflected both the necessity to optimise management of current systems and concerns regarding likely expansion paths for viable businesses.

1 Introduction

Murray Dairy, the regional dairy industry body for northern Victoria and the Riverina, New South Wales has identified increased economics and management support as a priority for the continuing development of prosperous and sustainable irrigated dairy businesses. The regional industry is under increasing pressure to incorporate new technology into production systems and increase efficiency in response to the cost-price squeeze. System changes are also required for sustainable environmental management if the industry is to maintain access to natural resources and international markets. Current factors accentuating the cost-price squeeze are reduced irrigation water availability (Farmanco *et al*, 1997), increasing real costs for water and other inputs, and lower commodity prices expected from deregulation.

2 R&D and DSS Needs of the Murray Region

Producer groups representing production systems categorised on the basis of the level of feeding of imported supplements were consulted to identify the research and development needs of irrigation dairy farmers in Northern Victoria.

2.1 District system analysis

As a means of identifying the types of systems which have been adopted by Murray Dairy Region dairyfarmers, an analysis of data collected by DNRE officers (Armstrong et al, 1998) was undertaken. Production, feed input and water use data from 144 properties across the region for the 1995/96 season were examined. Farms were then ranked in terms of their imported feed inputs on a tonnes/cow basis (Table 1).

Table 1: Characteristics of farms categorised in terms of supplements

Supplements (t/cow)	% Farms	Av. Herd size	% Regional Production	Av. Litres per cow	Cows per Eff Ha*	Irrigation (Ml/cow)
<1	28.2	139	23.2	4072	2.3	3.5
1-2	54.0	155	54.6	4758	2.7	3.2
2-2.5	12.3	160	14.8	5216	2.8	3.0
>2.5	5.4	180	7.4	6217	3.6	2.0

**** Effective Ha is calculated as 1 Ha perennial pasture =1, 1 Ha annual pasture = 0.5 and 1 Ha dry = 0.1Ha***

The data set was divided into four systems:

- **Low Input systems** (<1 tonne supplement /cow) which are lower stocked, rely on water availability (3.5Ml/cow) and result in lower per cow production (now only 28% of farms)
- **Modest Input systems** (1-2 tonnes/cow) this group is introducing supplements (54% of farms) and increasing stocking rate (majority of properties).
- **Medium input systems** (2-2.5 tonnes/cow) these systems have pushed supplements and stocking rate further and achieved a reduction in water use/cow with associated per cow production increases (12.5% of farms).
- **High input systems (semi-feedlot)** being >2.5 tonnes/cow. This management style makes up a small proportion of the district (5.6%) with high per cow production (2000 litres above the low input system)

The relationship between system and herd size is not significant, although average size increases with the level of input.

Low water allocations in recent years, and more interest in supplements are believed (by the study team) to have resulted in increased supplement use and a shift toward categories using a higher level of inputs.

2.2 Focus Groups

A series of focus groups met to identify the complexities of each input system, and the various strengths and weaknesses of each system.

Three focus groups (of 8-10 dairyfarmers) were organised, each explored one input system:-

- Low input (<1 t/cow)
- Modest-Medium inputs (1-2.5 t/cow)
- High inputs (>2.5t/cow)

The facilitated groups considered:-

1. That group's requirement for Research and Development (in what areas would more information/data assist management of the operation)
2. Which system would be most appropriate for the Region in 10 years time.
3. Why the farmers operate their current system, and what would trigger a move to a higher input system.
4. What extra skills would be required to move to a higher input system.
5. The group's candid view of the other systems.

The results from these focus groups are summarised in Appendix 1[1].

3 Current DRDC Research Program.

It is worth noting many of the topics identified by the groups have been, or are currently, the subject of research programs. However, even though producer perceptions may differ from reality, they remain real knowledge gaps for producers until programs can successfully communicate the information. Knowledge may be delivered through various extension channels (Web, Target 10, consultant etc).

<u>Incorporation of new knowledge into existing or future farming systems will be facilitated by successfully developed, delivered and supported decision support systems that identify and evaluate advantages for individual farms.</u>

Priorities varied between and within groups indicating the diverse range of farm systems

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[1] Fully reported in Mahoney et al (1999), *Identifying the research, development and decision support needs for irrigated dairy production in the Murray region: Results of focus groups*, Murray Dairy, Kyabram.

existing in the region. This presents an opportunity rather than a problem since a robust whole farm decision support system (WFDSS) can apply relevant knowledge to the whole gamut of possible systems and individual circumstances.

4 Factors Conditioning Attitudes to Change

The Dairy Women's focus group noted that farm systems range from simple to complex and that low input systems can still involve complex interrelationships. This group also highlighted the family and personal stress aspects of changing to more complex systems. Some considered high input systems increased record keeping requirements and the need to manage increased exposure to financial risk.

4.1 Thoughts on the Future

There was speculation by all groups regarding future marketing and economic conditions and their combined effects on system complexity.

Concerns about the need to manage risk by development of flexible systems geared to market conditions indicated potential for DSSs in strategic planning.

There was general agreement on the need to maintain a competitive advantage both within the region and on international markets. Economy of size or scale and technological advances leading to increased water use efficiency were seen as continuing requirements for business development.

4.2 Personal and Family Goals

To a large extent, participants indicated an alignment with personal values and comfort within their existing system.

There is a wide range in perceptions concerning changes in business and family environments necessary to trigger a change to another system. e.g. The middle level input group require a major shift in perceived industry returns/input costs before they would consider shifting to high level input systems (which they perceive have lower margins and a need for more highly skilled labour).

Thus it is important that individual farm managers and their advisers contemplate the relevance of the technical and economic output from a WFDSS in the context of the human environment.

5 Some Whole Farm Perspectives for Dairy Farm Decision Support Systems

5.1 The Relevant Perspective for Comparative Analysis.

A useful, farm specific, Knowledge Based Decision Support System (KBDSS) will enable evaluation of the likely benefits and costs of all sorts of different options for incremental change on an individual farm. The evaluation of each option needs to be made within a framework that recognises the biological and economic integration of the various components of the farm production system.

Thus the relevant comparative analysis is that between different states of the one farm business, rather than between the farm and some industry average or benchmark. Ferris and Malcolm (1999) review the nonsense of using industry comparative analysis as the basis for farm management decisions. They advocate the use of decision support tools based on “economics as a theoretical and applied discipline”.

5.2 The Scope of Analysis

5.2.1 Operational

In some cases the analysis will concern the merits of relatively small daily operational adjustments.

5.2.2 Tactical

Or a range of tactical responses to seasonal changes may be considered.

5.2.3 Strategic

Yet again, for strategic planning, the cash flow and viability implications of major changes in the farm production system or business structure could be examined.

5.3 Black Box or Open Framework?

For a KBDSS to be readily and continuously adapted to the unique characteristics of individual farms there are three aspects which are better separated. Kelly and Malcolm (1999) discuss the distinct nature and function of biological simulation models and economic evaluation. They recommend that outputs from the biological model should be used as the physical inputs (or parts of response functions) for the appropriate economic and financial analysis. They argue that good farm management decisions can be made on the basis of simple estimates of response. And, because the most suitable economic decision support tools will vary depending on the analytical perspective demanded by the question, decision making is less complicated if the economics are detached from the biological model.

5.3.1 Estimation of the physical production response

Estimates of the physical production response to a change in the mix and/or timing of inputs will depend on the manager's knowledge of past performance for the farm, and application of suitable empirical data, simulation model output and/or expert opinion.

5.3.2 Estimation of the economics of the response

The ranking of options will depend on the value of the incremental change in output and the opportunity cost of the resources required to produce the change. The term "opportunity cost" recognises that optimal allocation of resources on individual farms is a juggling act which balances the benefits and costs for different levels of technical efficiency over the range of production activities.

A simulation model may assist those seeking technical efficiency for particular components of the production system (some mistakenly consider this identical with maximum output). But the economic 'Trade Offs" between various options which increase the efficiency of different aspects of the farm business should be explicit in a whole farm KBDSS. This will assist the farm manager think about the mix of inputs defining the <u>Better</u> Management Practices for their individual integrated system. They can then aim to equate value marginal product for each input given relevant commodity prices and factor costs, where relevance is determined by the analytical perspective.

Once best operating conditions are determined, rules based expert systems (Best Management Practices for appropriate levels of technical efficiency?) may assist performance management. However as tools for optimisation they are just rudderless ships in the sea of possibilities.

5.3.3 Assessment of Environmental Consequences and Natural Resource Impacts

The biophysical processes associated with changes in the production system should be considered in terms of the long term impacts on the natural resource base of the farm and the wider environment. Some adjustment of costs may be necessary to bring these effects into the farm financial and regional economic accounts. The long term sustainability benefits of some lower intensity production systems may offset their lower gross income when natural resource impacts and environmental costs are fully accounted.

5.3.4 Sensitivity Testing and Paths for Business Expansion

Explicit partition of these three aspects in the KBDSS will allow construction of a range of scenarios under different assumptions for technical and allocative efficiency and various policy settings. Farm managers, plant and animal productivity researchers and natural resource managers could then examine the opportunities and implications of different options for appropriate scenarios.

6 Evaluation of Research Benefits

A further benefit of a whole farm perspective, is that when integrated with regional data bases, an adaptable a WFDSS can identify and value the cost to the industry of gaps in knowledge about the technology and management of dairy production. This is because knowledge of the response function for individual inputs or activities makes it possible to evaluate the incorporation of those options into the farming system, thus enabling a benefit:cost analysis of changing the system. This would help set priorities for allocation of scarce research funds which best meet the needs of producers.

7 Acknowledgements

This paper is drawn from the consultants' report on a Dairy Research and Development Corporation funded project initiated and managed by Murray Dairy[2].

The informative discussions held with research, development and extension workers during a study tour in New Zealand[3] contributed to our perspectives for the development and use of DSSs.

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8 References

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[2] Economics of irrigated dairy feedbase production systems - identifying R&D needs of the Murray Region
[3] Cowan *et al* (1999) Report on study tour of decision support activities in New Zealand.

Appendix 1: Needs identified for the system currently operated by the focus group participants.

a. Irrigation	L	M	H
• Strategic management of irrigation to optimise water use efficiency (WUE) under different water availability scenarios (seasonal allocations and water right intensity per hectare)	X	X	X
• Evaluation of options for managing different water allocations (trade offs between water/pasture management/ supplementary feeding)	X	X	
• Benefits and costs of different irrigation frequencies	X		
• Water use efficiency of different pasture species, systems (annual/perennial) and crops in terms of all inputs and metabolisable energy and protein output			X
• Technical and economic evaluation of different irrigation technologies			X

b. Economics	L	M	H
• Better understanding and unbiased advice on nutritional requirements and the merits and shortcomings of the full range of supplements and additives		X	
• Nutritional and financial optimisation of feed rations		X	
• Evaluation of benefits and costs of changing systems	X	X	X
• Budgeting forecasting /monitoring	X		
• Estimation of residual value of farm infrastructure needed to change systems		X	
• Full lactation assessment of seasonal supplementary feeding		X	
• Perspectives for assessing the cost of pasture			X
• Financial options for purchasing fodder			X

c. Nutrition	L	M	H
• Animal response to the range of supplements under different planes of pasture nutrition	X	X	X
• Feed quality			X
• Interactions between traditional supplements and By-products (antagonistic/complimentary)			X
• The nature of the response function to concentrates			X
• Ration formulation			X
• Side effects of supplements/by-products		X	X
• Benefits of vitamins and minerals			X
• Access to a greater number of nutritionists		X	
d. Pasture Management	**L**	**M**	**H**
• Achieving increased pasture utilisation	X		
• Optimising rate and timing of nitrogen application	X		
• Setting rotation lengths	X		
• Estimating seasonal growth rates (preferably not using a plate meter)	X		
• Effects of rotation length on species composition	X		
• Optimising fertiliser use	X		
• Integrating cultivars and water availability for optimum growth and quality		X	
• Production of consistent perennial pasture			X
• Interaction of supplements and pasture fertiliser requirement			X
• Increasing winter growth rates of pastures			X

	L	M	H
e. Plant Breeding	L	M	H
• **Improved forage species including high protein alternatives**			X
• **Do fodder crops provide opportunities for summer water use efficiency**			X
f. Soils	L	M	H
• **Soil management for improved pasture yields**			X
• **Impacts of high stocking rates on soil structure and pasture growth**			X
g. Herd Health	L	M	H
• **Managing mastitis**		X	
• **Improving cow fertility**	X		
• **Improved cow genetics**			X
• **On farm diagnosis of reproductive failure**			X
h. Human Resources	L	M	H
• **Improving availability and management of skilled labour**	X	X	X
• **Building trust with labour**	X	X	
• **Instilling long term goals for labour through incentives compatible with strategic plans**	X	X	
• **Improving people skills**			X
i. Technology	L	M	H
• **Dairy automation**		X	
• **Milking machine technology, operation and maintenance**		X	