MODELLING FEEDING SYSTEM EFFICIENCY AND PROFITABILITY OF AN IRRIGATED DAIRY FARM

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SUMMARY

Biophysical and financial analysis of a case study dairy farm in 2000/01 was used to examine performance and opportunities to improve performance by expansion or intensification under the prevailing conditions. Performance of each system was also examined under a range of technical feeding efficiencies. The operating profit of the farm was improved by expansion or intensification that included increasing per cow production. However, the projected operating profit for all scenarios, in particular, those that increased grain use were sensitive to assumptions about technical efficiency of the feeding system, and the success of each option depended on achieving high levels of efficiency. The effects of drought in 2002/03 on farm performance were also modelled. The drought led to an operating loss for each of the development options analysed.

Keywords: feeding efficiency, profitability, dairy farming systems

INTRODUCTION

Over 20 years to 2000/01, milk production in northern Victoria increased from 1,300 to 2,744 million L, accounting for around 25% of Australia's milk. Over the same period, farm numbers declined and herd size and stocking rate increased. Prior to 1980, production systems were predominantly pasture-based with concentrate feeding < 0.2 t/cow, but by the mid 90's concentrate use had increased to between 0.6 and > 2.0 t/cow (Doyle *et al.* 2000). There is now great diversity in irrigated dairy systems with energy supplied to the herd from pasture varying from 25 to 100% (Armstrong *et al.* 2000).

Projected increases in production will be used for commodity products for export and the systems to produce this milk need to be 'low cost' and sustainable as these products are unlikely to command sustained high prices. The price per kg butterfat equivalent for export focused cooperatives has varied 15% either side of the mean over the last 10 years. Feed costs comprise the major component of the variable costs of milk production, and pasture is generally the lowest cost feed. Therefore, optimising consumption of the herbage grown is important, as many costs invested in pasture production have already been incurred. Prices for brought-in feeds also vary markedly depending on supply and demand. In addition, supplementing grazing cows with concentrates presents unique challenges requiring skills in allocating pasture, estimating herbage intake, and calculating the amount of supplements needed to achieve target levels of production while optimising conversion of these feeds into milk.

A universal characteristic of biological responses is that the incremental increase in production from additional inputs eventually diminishes. For example, increasing the amount of grain supplements fed to cows will, at some point, produce smaller and smaller milk production responses. Diminishing responses occur because of increases in the rate of substitution of supplement for pasture (Stockdale *et al.* 1997), greater associative effects on digestion of pasture and the supplement (Mould *et al.* 1983), or the cow is approaching her intake potential for the feeding system. It is not possible to quantify all of these effects (defined as technical feeding efficiency) or the impact of farmers' skills on this efficiency on individual farms.

The importance of technical efficiency of the feeding system to farm profitability on an irrigated dairy farm was examined using a case study and modelling approach.

METHODS

The biophysical and economic performance of an irrigated dairy farm was analysed (termed current system - CS), assuming that the prevailing environment in 2000/01 remained unchanged for 8 years. The farm was family operated, with about 60% of energy requirements of the Friesian x Jersey herd obtained from pasture. There were 243 milking cows all calving in spring, and producing 5,200 L/cow. The farm had 55 hectares of irrigated perennial pasture, a water right of 5.6 ML/ha and access to ground water and drainage diversion (about 150 ML/yr). Each cow was offered 1.34 t DM grain and 0.87 t DM hay per year.

The feeding system was analysed for each season and on an annual basis using the metabolisable energy (ME) requirements of all stock (SCA 1990) and known feed inputs. Requirements for lactating cows included ME for maintenance, lactation, pregnancy, growth of younger cows, walking and grazing. Estimates of ME available from body tissue mobilisation in early lactation were based on cows losing liveweight (LW) at 0.5 kg/day (28 MJ/kg LW loss) for the first 90 days. Metabolisable energy required for LW gain in autumn/winter was based on cows gaining 0.375 kg/day (34 MJ/kg LW gain) in late lactation and when dry. Requirements for maintenance of bulls was 80 MJ/day and for maintenance and growth of 1 to 2 year old stock, 75 MJ/day. Calves were reared on agistment after weaning.

Grain (12.6 MJ ME/kg DM) was fed in the dairy with no wastage. Hay (9.3 MJ ME/kg DM) was fed in hay rings in spring (wastage 20%) and in the paddock in autumn/winter (wastage 40%). Estimated ME of pasture consumed was taken from a database of nutritive characteristics of pastures (Cohen and Doyle 2000), with seasonal values of 11.7, 9.6, 10.6 and 11.8 MJ/kg DM for spring through to winter.

The approach to testing efficiency of the feeding system was to vary the ME of grain as a surrogate for a range of effects including diminishing returns to extra grain, associative effects between feeds, including digestive disorders, and variable management skills. In the initial analysis of all systems, grain ME was assumed to be 10% lower than the value above. This arbitrary change in ME was applied to the grain for convenience and could equally have been applied to the pasture and hay. To examine the likely implications of changes in efficiency of the feeding system, the assumption of a 10% decline in grain ME was varied to 0% (no associative effects between feeds, perfect management), 5 or 20%.

In the analysis reported, milk price was $7.00/kg butterfat, with grain and hay purchased as fed at $180/t and $120/t, respectively. The financial performance of this and other systems was estimated using established farm management methods for economic and risk assessments (Makeham and Malcolm 1993). Data reported are for operating profit (gross income - variable costs- overhead costs).

The farmer and a stakeholder steering group identified development options for the farm in 2001/02. The group, comprised of farmers, farm management consultants, a rural counsellor, an extension officer, water authority and funding body representatives, and scientists, also ensured assumptions made in the analysis were sensible. The development options tested that are reported here were:

- Intensification (ISR) by increasing stocking rate to 6 cows/ha and maintaining production at 5,200 L/cow. The feed needed for the extra 87 cows (and replacements) was imported (increased to 1.83 t DM grain and 1.09 t DM hay/cow) as there was little potential to increase pasture production or utilisation.
- Intensification (ICP) by increasing per cow production to 6,500 L while maintaining stocking rate. The supplementary feed increased to 1.80 t DM grain and 1.07 t DM hay per cow.
- Expansion (E) of the CS by purchasing land to increase the effective production area to 73 ha, while maintaining stocking rate and per cow production (80 extra cows and more replacements).

The biophysical aspects of the development options were modelled and the results tested with the steering group. The various development options were subjected to variations in technical efficiency, and economic performance assessed. Included in the development budgets was an allowance for continued deterioration in the farmer's terms of trade (ratio of prices received to prices paid) as a real decline in profitability of around 1.6% per annum. In all development options, labour was increased in proportion to increases in stock numbers, and the dairy and effluent systems were upgraded. Existing feeding facilities were considered adequate for all of the development options considered. In the case of the expansion option, developments were carried out on the new land.

For ICP, where grain was a prime driver of increased milk production, the sensitivity to additional grain was further tested by assuming marginal milk production responses to extra grain of 1.8, 1.4, 1.0

or 0.6 L milk/kg DM extra grain. If all the additional energy in the grain, after allowing for a 10% decline in grain ME, was converted to milk, a response of about 1.8 kg 4% fat corrected milk would be expected (SCA 1990). As such responses have seldom been measured, we tested possible effects of diminishing returns from the grain used to increase per cow production.

The effects of the 2002/03 drought were analysed for the base farm and the 3 development options using the 10% decline in ME of grain. In this analysis, milk price was $6.00/kg butterfat, grain and hay prices were $320/t and $230/t as fed, respectively, and temporary water transfer was priced at $350/ML to reflect the prevailing conditions. There were no changes in stock numbers.

RESULTS

The operating profit of the farm increased when intensification occurred by increasing per cow production (ICP) or by expansion (E) (Figure 1). The performance of all systems was affected by reducing the technical efficiency of the feeding system (0 to 20% decline in grain ME), with intensification systems impacted more by changes in technical efficiency than the current system. If the analysis had been based on return on assets, similar impacts would have been observed.

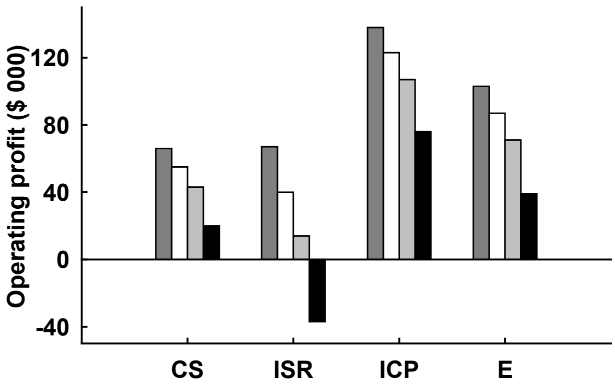

Figure 1. Effects of technical efficiency of the feeding system (decline, in order, of 0, 5, 10 or 20% in grain ME) on operating profit for an irrigated dairy farm (CS = current system, ISR = intensified by increasing stocking rate, ICP = intensified by increasing per cow production, E = expansion).

In ICP, individual cow production was increased by feeding additional grain and declining responses to additional supplement were more likely. For development options of this type, operating profits were very sensitive to the assumed milk production response to extra grain (Figure 2). Reduced milk price and increased prices for purchased feed and water associated with the drought led to an operating loss for all systems (Figure 3), with the impacts demonstrating the risks involved in dairy production including the timing of developments.

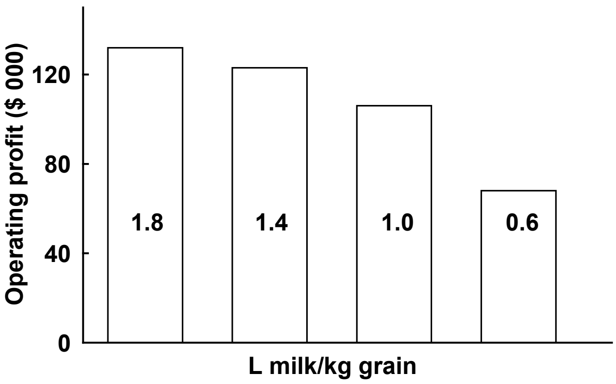

Figure 2. Effects of variable responses in milk production to extra grain (1.8, 1.4, 1.0, 0.6 L/kg) on operating profit for an irrigated dairy farm intensified by increasing per cow production.

DISCUSSION

Maintaining high pasture utilisation to contain production costs has been a key strategy on irrigated dairy farms for many years. In recent years, grain usage has increased markedly (Doyle *et al.* 2000) in some instances leading to inefficiencies through reduced pasture utilisation. As would be expected under 'normal' conditions, most methods of increasing the scale of this enterprise through expansion or intensification improved profit. The exception was increasing herd size, while maintaining per cow production, which decreased profit. The reason was the system was already close to optimum ('best practice') and the costs of importing all feed needed for the additional cows decreased productivity.

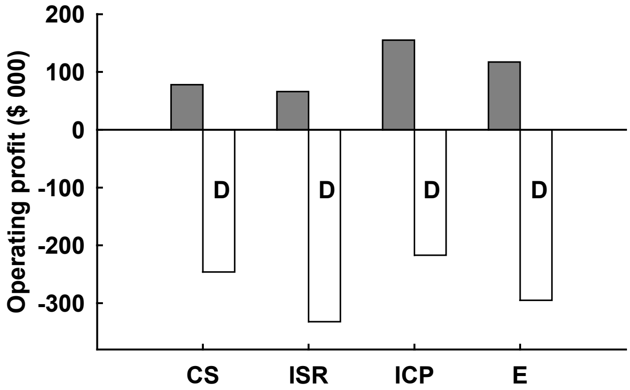

Figure 3. Effects of drought (D) on operating profit for a dairy farm (CS = current system, ISR = intensified by increasing stocking rate, ICP = intensified by increasing per cow production, E = expansion) at a constant technical efficiency of the feeding system (grain ME reduced by 10%).

The modelling conducted indicated potential for significant impacts on the financial viability of dairy farm businesses when intensified using brought in feeds. Marginal milk production responses to supplements can be low (< 0.5 kg/kg concentrate) in cows grazing high quality pastures (Stockdale *et al.* 1997; Penno 2001), and high (>1.0 kg/kg) when cows graze pastures of medium digestibility or at low allowances (Stockdale *et al.* 1997). In spring calving systems, there is a negative correlation between the response to extra feeding and the ME concentration of the pasture consumed (Stockdale *et al.* 1997). Feeding concentrate-based supplements over an entire lactation was associated with an average increase in 4% fat corrected milk yield of 0.7 kg milk/kg DM concentrate across 24 farms in northern Victoria (G. Walker *pers. com.*). This suggests associative effects between pasture and concentrates in grazing cows and/or declining marginal responses as amount of supplement increases are important on farms.

Intensification of farms usually increases the risk of losses under adverse conditions. In reality, very few farmers would have experienced the operating losses predicted during the drought by the model (Figure 3), regardless of their system, as the model took the 'unrealistic' option of assuming no change in the farming system. However, the analysis demonstrates the need to thoroughly evaluate risk before undertaking developments.

Continued productivity gains on dairy farms will only be achieved where feeding systems are better understood and the financial risks of intensifying can be better evaluated.

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