HOW BEST TO COMPARE LOW & HIGH INPUT PASTORAL SYSTEMS

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ABSTRACT

New Zealand dairy farm systems are changing. The traditional seasonal all-pasture system reliant on rainfall for success is now but one of a range of systems adopted by farmers, others include various levels of nitrogen fertiliser and introduced feed, both on and off farm, split calving systems and once-a-day milking. Despite these changes pasture is a critical input to almost all systems so pasture growth and utilisation are still key factors in successful dairy farm businesses. The dilemma for the dairy industry is whether or not such changes are threatening New Zealand's coveted position as a low cost producer of milk able to compete in global markets. There is also some confusion of how to define a high input system due to the fact that all the current systems have evolved from a pasture-based system. Recently two students at Massey University, New Zealand, analysed the same dataset of dairy farm data, each for slightly different reasons. The conclusions drawn from their research differed with respect to the impact of intensification on farm performance. The reason their results differed was that they used different approaches to measure the impact of intensification; each approach was soundly based on a logical argument so, in isolation, could not be faulted. This paper has been written to consolidate these results and to attempt to provide some rationale for the differing approaches taken and some direction in their interpretation and comparison for farm decision makers.

INTRODUCTION

New Zealand dairy farm systems are changing. The traditional seasonal all-pasture system reliant on rainfall for success is now but one of a range of systems adopted by farmers, others include various levels of nitrogen fertiliser and introduced feed, both on and off farm (Roche & Reid, 2002). Some have also moved away from seasonality with split calving systems and milking all year round (Crosse, O'Brien & Ryan, 2000) while others are restricting their herd within the season to once-a-day milking as an alternative approach to address a growing number of herd and farm management issues (Dalley & Bateup, 2004). Despite these changes pasture is a critical input to almost all systems so pasture growth and utilisation are still key factors in successful dairy farm businesses (Clearwater & Wright, 2003, Holmes et al, 2002)

Structural changes on farm are reflected in industry statistics such as average herd size (more than doubled in the last twenty years) and the number of herds, farm size (up 50% in the last 10 years) and stocking rate, milksolids production per cow (up 16% in 10 years) and per hectare (up 25% in 10 years) (Table 1). New Zealand milk production has increased at a rate of 5.6% annually since 1973 and total milk production has increased by 270% from 1974 to 2004.

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Table 1: Statistics from NZ dairy farms in 1974/75, 1993/94 and 2003/04 (Source LIC, 2004)

	1974/75	1993/94	2003/04
Stocking rate (Cows/ha)	1.6	2.5	2.75
Effective dairy hectares	74	77	111
Herd size	112	188	302
No. of herds	18,540	14,597	12,751
Milksolids per cow	220	278	322
Milksolids per hectare	360	708	889

Productivity improvements have been the farmer response to falling real milk prices in the 70s and 80s and relatively constant real prices since then, increasing land and dairy co-operative share values and increasing lifestyle demands. Higher than average milk prices in 200/01 and 2001/02 resulted in an increase in on-farm expenditure of 15-20% on many farms (MAF, 2002). Use of supplements increases as milk price increases and farmers target higher milk production by running more cows and increasing the days in milk of the herd.

The traditional methods of measuring and comparing NZ dairying systems are being challenged under the new systems. For example, stocking rate, a useful indicator in comparisons of pastoral systems, is not considered a conclusive enough measure in more intensive systems (Penno, 1999). Similarly, milksolids (MS) production per hectare becomes a poor comparative indicator of performance when purchased feeds (supplements and grazing off) are included in the system. The oft-stated rule that (cash) farm working expenses should be below 50% of gross farm income (McGrath, 1997) is also challenged by changing systems; some farmers achieve it by maintaining absolute costs at a low level, others manage both costs and levels of milk production to achieve target and others ignore it altogether and concentrate instead on marginal cost to marginal return relationships to optimise profits. Leslie (2001) and Roche & Reid (2002) note how costs have increased significantly in recent years but so also have production levels; Roche & Reid (2002) quote the case of one group of farmers who have increased their expenditure by 21% to achieve a 67% increase in operating profit per hectare.

While cost of production is often expressed on a per enterprise, per hectare or per cow basis the most relevant measure is cost per unit of output as this can be readily compared against the returns per unit of output to determine profitability (Shadbolt, 2004). Factors such as stocking rates, milk production per cow, replacement rates, variable and fixed costs, capital invested and net income from livestock all impact on cost calculations so as the system changes so also will the cost. As farm size increases, scale needs to be considered in analyses, as it affects productivity and costs differentially (Leslie, 1998; Parker, 1998; Blackwell, 2000).

As with all financial measures the cost of production should not be viewed in isolation, profitability, wealth creation and liquidity are all, to a greater or lesser extent, critical measures of farm success (Shadbolt, 2004). A farm with a low cost of production is not necessarily more profitable than one with a higher cost of production and vice versa. For example, the obvious benefit for a large farm is economies of scale resulting in a lower cost of production but the profitability measures such as operating profit per hectare, return on assets and return on equity need also to reflect advantages of scale. A highly profitable farm may or may not be creating wealth for its owners (it depends on how wisely the profit is being invested) or meet its commitments to the government, the bank and the family; some very efficient, profitable farms still require off-farm income as the business cannot generate enough cash to meet the family's requirements.

The dilemma for the dairy industry is whether or not such changes are threatening New Zealand's coveted position as a low cost producer of milk (IFCN, 2004) able to compete in global markets. Discussions in the rural press include concerns about higher levels of risk, greater reliance on machinery and higher (average) costs of production with intensification but few comprehensively report on the impact of such systems on wealth creation, liquidity, profit (return on equity) or efficiency. There is also some confusion of how to define a high input system due to the fact that all the current systems have evolved from a pasture-based system. There seems to be more agreement about the definition of low input system as one that is optimally stocked and utilises feed that can only be provided by pasture. Deane (1999) suggests that a high input system is achieved when, after maximizing pasture utilization, supplementary feeds are used to further increase stocking rate. Similarly Roche & Reid (2002) suggest that a high input system would be one that carries more cows to the hectare than if it were optimally stocked for a pasture-only system. There has been considerable debate over the profitability of the use of extra feed; some reports have shown that low feed input farms can be highly profitable (Penno et al., 1996; McGrath, 1997; Armer, 2000; Kuriger, 2002), others have showed that high feed input farms can also be highly profitable (Van der Poel, 1996; Moore, 2000; Roche and Reid, 2002).

Recently two postgraduate students at Massey University, New Zealand, analysed the same dataset of dairy farm data, each for slightly different reasons (Buron de Machado, 2004, Silva-Villacorta, 2004,). The two students analysed 4 years of owner operator data (1998-2002). The conclusions drawn from their research differed with respect to the impact of intensification on farm performance. The reason their results differed was that they used different approaches to measure the impact of intensification; each approach was soundly based on a logical argument so, in isolation, could not be faulted. This paper has been written to consolidate these results and to attempt to provide some rationale for the differing approaches taken and some direction in their interpretation and comparison for farm decision makers.

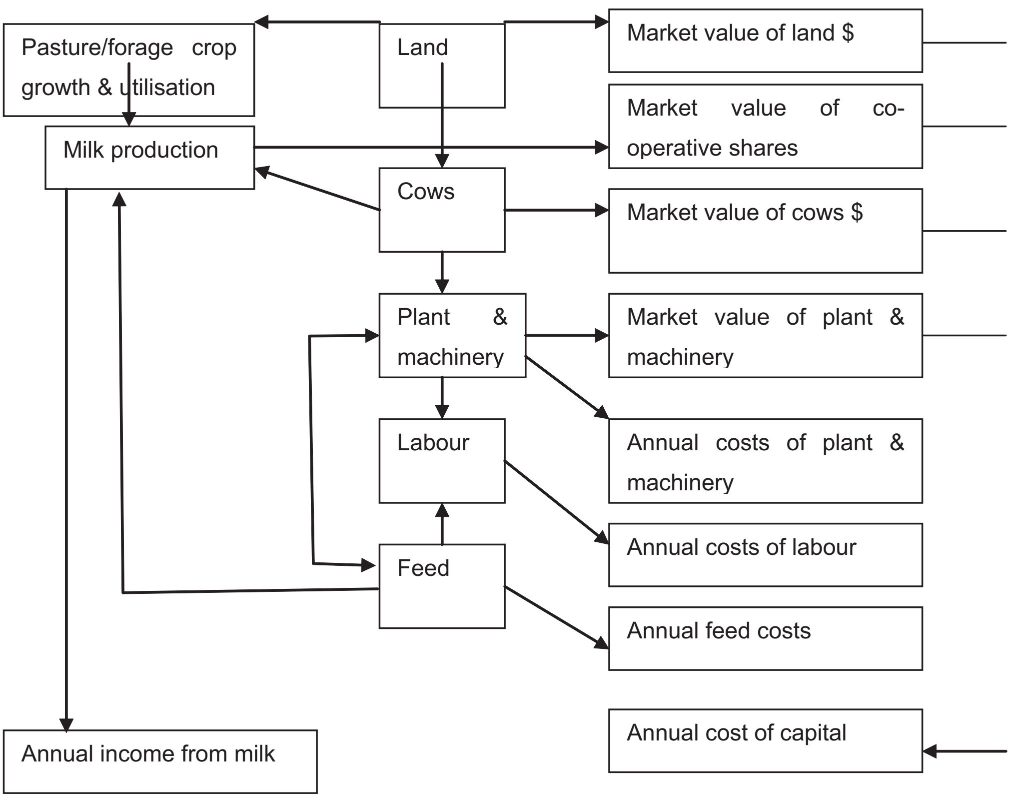
METHODOLOGY

The Buron de Machado (2004) and Silva-Villacorta (2004) analyses were based on four years of data (1998/1999 to 2001/2002) from the ProfitWatch dataset (Dexcel, New Zealand). Their studies were restricted to 626 and 794 datasets respectively of owner operator, seasonal supply businesses in the North Island. The analysis was conducted between farms in each study and within each season for the Silva-Villacorta study and across all seasons for the Buron de Machado study.

Each study used the farm data to calculate production, cost of production and profitability indicators. The primary difference between them was how they grouped the farms to provide comparative data. Silva-Villacorta (2004)'s objective was to study the physical and financial performance of commercial dairy farms that differed in the amount of extra feed used. The data were classified according to each of the four dairy seasons and the extra feed used per cow. Extra feed comprised supplements imported (hay, pasture silage, maize silage, concentrates and other feeds), winter grazing and maize silage grown on the farm. Buron de Machado (2004) also wanted to quantify the productive and economic characteristics of low, intermediate and high input systems; her data was classified according to farm size and stocking rate and she was particularly interested in the inherent variability within each system.

To enable a comparison of the two approaches the following framework (Figure 1) is suggested. The resources utilised by the farms, their inputs, are listed in order of their ability to restrict or limit output. This recognises that the first step in farm analyses is often to recognise what is the most limiting resource and to measure how well that resource is being utilised before examining the next most limiting resource and so on. This focus in this paper is specifically on the land, cows and feed resources utilised by the farm. In terms of productivity or efficiency ratios it is useful to put physical output against physical inputs and financial outputs against financial inputs. If possible it is also useful to measure how the relationship between output and input changes as the level of input changes, the question being asked here is at what level of inputs are diminishing outputs observed? In economists terms we would be trying to find the point at which marginal returns equal marginal costs.

Figure 1: A resource framework for analysis of dairy farm systems



RESULTS AND DISCUSSION

Land: Land as a resource can be easily measured physically but its market value has traditionally been a combination of the underlying value of the land and the production level achieved on that land plus the value of the co-operative shares required to be held for that level of production. An increase in milk production results therefore not only in an increase in income but also an increase in land value and a requirement to purchase more co-operative shares. Co-operative shares have generated good returns in recent years as shares have increased in value from $2/share in 2001 when the Fonterra Co-operative Group was established to $5.18/share in 2005 (Fonterra, 2005). Wealth creation from an improvement in land value and share value is not captured in cost of production and most return on equity measures or comparisons of farm system efficiency yet it has often been the main reason for increases in production. The wider implications of such farmer decisions should always be understood when comparing farm results, it is worth noting that there is usually a rational reason for investment decisions made by farmers the benefits of which are not immediately captured in current performance measures.

Previous studies have noted that as farm size increases so productivity and costs differ (Leslie, 1998; Parker, 1998; Blackwell, 2000). Pinochet-Chateau (2005), working on a similar dataset to the two students found that effective area did not have a consistent correlation with return on equity (risk). Although there were positive correlations 4 years out of five in only one of those years was the correlation significant. In his analysis the efficiency of converting (all) resources to profit did not vary according to farm size.

From the Buron de Machado (2004) results (Figure 3) it can be seen that productivity differed according to farm size in some situations, notably smaller farms produced more milksolids per hectare under low and medium inputs (stocking rates) than medium and larger size farms. Farm size had less impact than stocking rate on operating profit per hectare (Figure 4) with higher results from the higher stocking rate systems. However, although farm working expenses per hectare were significantly higher as stocking rate increased, there was no difference in either farm working expenses as a percentage of gross farm income or return on equity across the groups. The efficiency of converting (all) resources to profit did not vary according to farm size or stocking rate. When analysing the impact of scale on average cost of production Buron de Machado (2004) reported that the cost of milk production did differ by farm size in some instances; the small size, low stocking rate farm group had significantly higher costs of production ($/kgMS) than all of the other groups and the small size, high stocking rate and intermediate size, low stocking rate farms had higher costs than the large size, high stocking rate farm but the cost of production of all the other groups did not differ significantly. Silva-Villacorta (2004) split his farm data by feed input so did not identify or analyse farm size specifically although he did note there were no significant differences in farm size between his low, medium and high feed input groups.

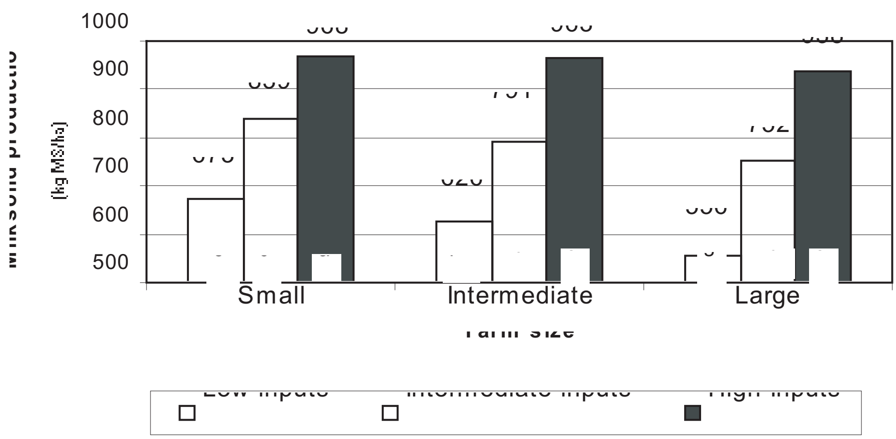
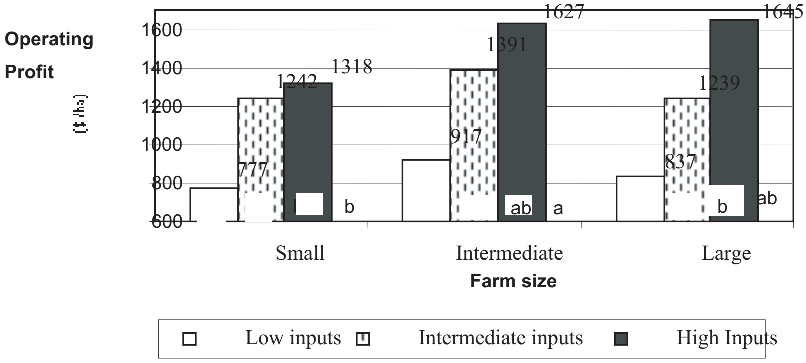


Figure 3: Milksolid production per ha (Kg MS/ha) in three farm sizes and Low, Intermediate and High input (stocking rate) dairy systems (different letters indicate significant differences between the groups at the 5% level)

Cows: When Buron de Machado (2004) ignored farm size and concentrated just on inputs (stocking rate) she noted significant increases in production per cow and per hectare as stocking rate increased as well as significant increases in quantity of imported feed and the Dexcel estimate of pasture eaten. Farm working expenses also significantly increased (specifically

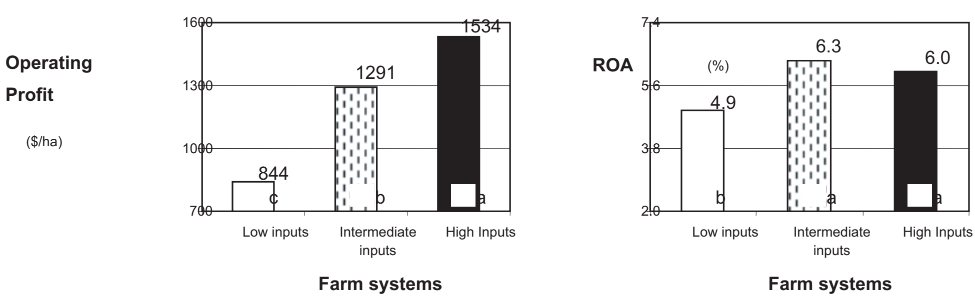
Figure 4: Operating profit ($/ha) in three farm sizes and Low, Intermediate and High input (stocking rate) dairy systems (different letters indicate significant differences between the groups at the 5% level)



fertiliser, supplements and grazing costs) but, again, there was no difference in farm working expenses as a percentage of gross farm income. Gross Farm Income and operating profit per hectare increased significantly with stocking rate but there was no difference in return on equity or cost of milk production between the medium and the high stocking rate groups. The low stocking rate group however had significantly lower returns on assets and return on equity and had higher costs of production so was less efficient at converting resources to profit and more vulnerable to milk price variability than both of the higher stocking rate groups. If we accept the Dexcel estimate of pasture eaten as a proxy for pasture growth and utilisation it could be concluded that the low stocking rate farms are sub-optimal with respect to this critical input (Clearwater & Wright, 2003, Holmes et al, 2002); this is further reflected by their poor economic performance.

The definition of a high input system as one that carries more cows to the hectare than if it were optimally stocked for a pasture-only system (Roche & Reid, 2002) fits with Buron de Machado's grouping of the farms by stocking rate but a low stocking rate is not as consistent with the definition of low input systems as those that are optimally stocked and utilise feed that

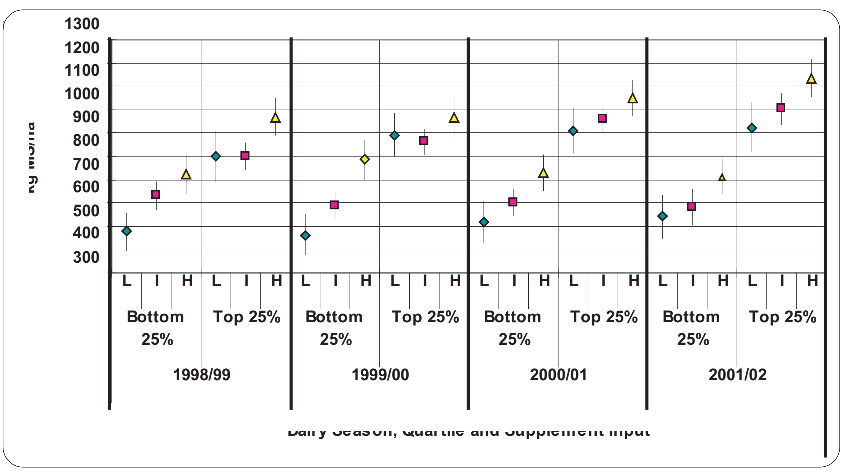
Figure 5 & 6: Operating profit ($/ha) and Return on Assets (%) respectively in Low, Intermediate and High input (stocking rate) dairy systems (different letters indicate significant differences between the groups at the 5% level)



can only be provided by pasture. Even though the low stocking rate did use less feed, they also grew less feed so perhaps were not optimally stocked. Her low input group, the low stocking rate group of farmers, under perform in all indicators.

Feed: When Buron de Machado (2004) split the farms by stocking rate she noted the low stocking rate farms had low levels of imported feed and pasture eaten, lower profitability and higher costs of production. However, when Silva-Villacorta (2004) grouped the farms by extra feed used per cow (as supplements imported (hay, pasture silage, maize silage, concentrates and other feeds), winter grazing and maize silage grown on the farm) the low input farms only had lower stocking rates than the high input farms not the intermediate input farms, and lower production per hectare (Figure 7), gross farm income and farm working expenses than the high input farms but they did not have lower profitability. There were no significant differences between operating profit $/ha, the return on assets or return on equity between the three input systems. Farms in the Silva-Villacorta (2004) low input group cannot therefore be described, on average, as suboptimal; unlike the Buron de Machado low input (stocking rate) group they include farms with a range of stocking rates all using minimal levels of extra feed. They are managing costs to achieve similar returns per hectare to the high input systems that have higher stocking rates and are using more extra feed.

Figure 7: Milk Solid production kgMS/ha in low (L), intermediate (I) and high (H) feed-input farms in the top or bottom quartiles for operating profit/ha between 1998/99 and 2001/02. (Silva-Villacorta, 2004)

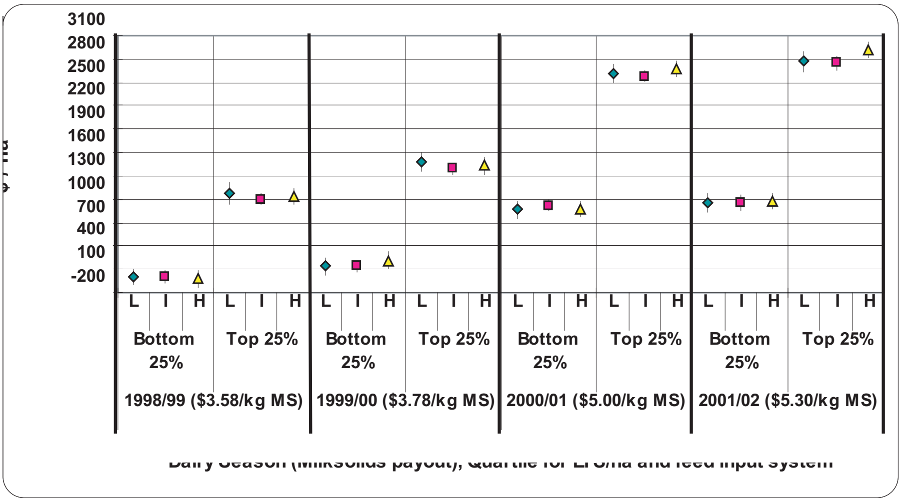


Silva-Villacorta (2004) noted a wide difference in operating profit between farms from feeding extra feed. Individual farms had higher or lower costs per kilogramme of extra feed and higher or lower milk production responses due to the management ability of each farmer and other farm specific circumstances. Because management ability has such an influence on results he further separated the data into those farmers in the bottom 25% and those in the top 25% by operateing profit in each year to more clearly identify the impact of management.

From Silva-Villacorta (2004)'s presentation of operating profit per hectare for the top and bottom quartiles of farmers (Figure 8) it can be concluded that the greatest impact on EFS/ha is management not the production system. A good manager will deliver a good operating profit regardless of whether the farm is a low, medium or high input system. Similarly poorer management results in a lower operating profit regardless of the level of extra feed in the system.

It is important that these facts are remembered when comparing between farm systems, a top performing low input system will outperform a poorer performing high input system and vice versa; the relevant measure of performance of course is not milk production per hectare but operating profit per hectare.

Figure 8: Average Operating Profit $/ha in low (L), intermediate (I) and high (H) feed-input farms in the top or bottom quartiles for operating profit/ha between 1998/99 and 2001/02. (Silva-Villacorta, 2004)

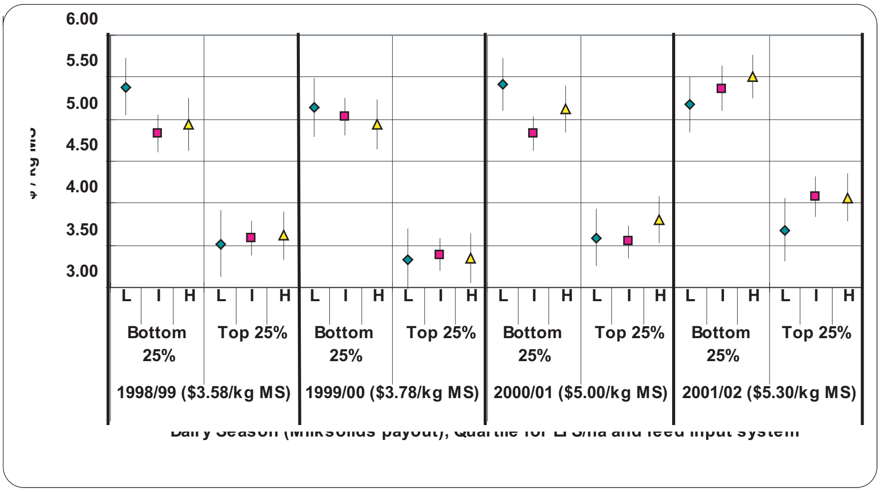


As with Buron de Machado's study the low input system did have significantly higher costs of production in some years. The expected decrease in costs ($/kg MS) as production levels increase from low to medium input systems can be observed in some years (showing an economies of scale response) as can the increase in costs from medium to high input systems (diseconomies of scale) but this is not consistent across all years. What is consistent is that cost of production is much higher in the bottom 25% of farms than the top 25% of farms. This is because one of the factors that most impacts on cost of production is level of production. This means the bottom quartile are less able to handle fluctuations in milk payout than the top quartile.

CONCLUSION

Care must be taken when comparing farm systems. The criteria by which farms are split into groups for comparison can have a significant impact on the results achieved. Further debate is required to improve industry understanding of 'low' and 'high' input systems and on-going research is needed to define optimal stocking rates in a range of environmental conditions. When interpreting differences in return on assets and return on equity the methods used to value farm assets should be taken into account. As milk production increases so also does the value of the farm and the number of shares required by the dairy co-operatives. While the wealth of the farm increases the return on assets does not change. For the farm owner wealth, liquidity and profit are all critical parameters of success, the weight put on any one will reflect the goals of that farm; wealth creation is a common goal on farms. While cost of production is a useful measure

Figure 9: Cost of milk production $/kgMS in low (L), intermediate (I) and high (H) feed-input farms in the top or bottom quartiles for operating profit/ha between 1998/99 and 2001/02. (Silva-Villacorta, 2004)



when determining the impact of scale and the vulnerability of a system to price variation it is not a proxy for profitability. Within each group of farmers there was great variability so while the 'extra feed' or 'stocking rate' criteria provided some points of difference the differences within the groups were sometimes greater than the differences between them. A further split by operating profit improved the interpretation of the data as it helped to recognise the role of the manager in both revenue generation and cost control and led to the conclusion that it is not the system that determines the best result but the manager.

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