PHYSICAL AND FINANCIAL CHARACTERISTICS OF HIGH INPUT AND LOW INPUT DAIRY FARMS IN NEW ZEALAND

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This thesis is dedicated to my parents

Luis Angel Silva Velasquez and Doraliza Villacorta Oblitas

ABSTRACT

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In recent years the use of supplements in New Zealand dairy farms has increased, but there is little information about the way in which this extra feed has influenced the dairy system. This research work aimed at analysing the effect of extra feed input on the physical and financial performance of dairy farms. ProfitWatch data corresponding to 915 owner -operated dairy farms were analysed. The data was classified according to dairy season (1998/99, 1999/00, 2000/01, 2001/02), extra feed offered per cow (low input systems: <50kg DM extra feed/cow; Intermediate input system: between 50-500 kg DM extra feed/cow; High input systems: >500kg DM extra feed/cow) and quartiles according to EFS/ha. The definition of extra feed comprised supplements imported, winter grazing and maize grown in the farm. The statistical analysis comprised analysis of variance (ANOVA) and regression analysis done in SAS. In all 4 dairy seasons, high input systems had higher stocking rates (2.7-2.8 vs 2.4-2.5 cows/ha), lower comparative stocking rate (83-86 vs 92-83 kg LWT/t DM), higher milksolids production per cow (293-341 vs 249-295 kg MS/cow) and per hectare (826-921 vs 616-744 kg MS/ha), and higher use of nitrogen fertiliser per hectare (85-116 vs 53-67 kg N/ha/year) than low input systems. During the period of study, milksolids payout increased from $3.58/kg MS in 1998/99 to $5.30/kg MS in 2001/02. High input systems had higher Gross Farm Income per hectare ($3287/ha vs $2374/ha in 1998/99; and $5377/ha vs $4362/ha in 2001/02) and higher Farm Working Expenses per hectare ($2519/ha vs $1760/ha in 1998/99, and $3259/ha vs $2187/ha in 2001/02) than low input systems. There were not significant differences in EFS/ha, Return on Assets (%) and Return on Equity (%) between farms in the 3 feed input systems. Within each feed input system, farms in the top quartile for EFS/ha had higher stocking rates and higher estimated pasture consumed per hectare than their corresponding farm system in the bottom quartile. Regression analysis of all the farms (915 farms) showed that across all farms, the marginal (average of 4 years) response to the extra feed used was 50g MS/cow/kg DM extra feed per cow. But the marginal response per hectare to extra feed was higher (96g MS/ha/kg DM extra feed per hectare) due to associated increases in stocking rate and other inputs. The operating cash surplus per hectare increased by approximately $0.07 to $0.12/kg DM of extra feed used per hectare, but EFS/ha was not significantly affected by these differences in cash operating surplus.

Keywords: low, intermediate and high input systems; extra feed.

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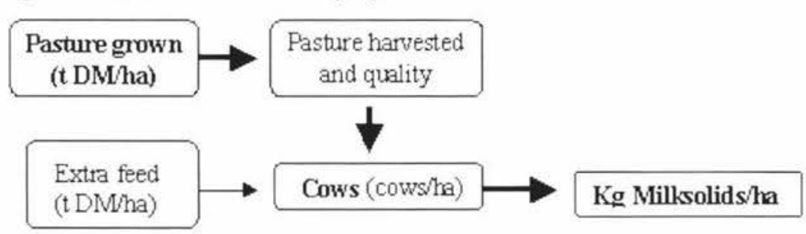
CHAPTER 1

INTRODUCTION

Approximately 10% of the milk produced in the world occurs in pastoral systems (World Animal Review, 1995; In: Holmes, 2000). This is because the optimum weather conditions (rain, temperature) and soil fertility necessary for pasture growth during the whole year occur only in a few countries.

The pastoral dairy system, simple in structure (See figure 1), is a dynamic system in which all parameters are related and influence each other. In this system, pasture growth is greatly influenced by weather conditions, pasture cultivars, the use of fertilisers and grazing management (Holmes et al., 2002). The performance of the dairy cow is influenced by her genetic merit and the environment, especially the feeding environment (Kolver, 2000). Healthy cows, with high feed conversion efficiency and longevity are essential for high milksolids production per cow.

Figure 1.1: The Pastoral Dairy System



Stocking rate influences the level of pasture utilisation, the feed intake of the cow and milksolids production per cow (McGrath, 1997). When pasture production is not enough, supplementary feeds can be used to meet the feed requirements of the herd (See Figure 1.1).

The New Zealand pastoral dairy system is characterised by its low cost of production and the lack of subsidies from the government. Between 90% and 95% of the milk produced in this country is exported (Burton, 2001; NZOY, 2000), at a price that varies from year to year. Maintaining low costs of production is necessary to remain competitive in the global market (Parker, 1998; Holmes, 2000). But keeping low costs of production can also limit farm profitability during periods of high milksolids payouts (McCall et al., 1999).

In New Zealand, the strategic management of grazing, stocking rate, calving and dry-off dates, fertilisers and supplementary feed have resulted in a system with a high degree of synchrony between feed demand and feed supply. However, this system also constrains milksolids production per cow (Penno et al., 1996). This is due to the variability in pasture growth and pasture quality during the year, and to the limits that grazed pasture imposed on dry matter intake (Holmes et al., 2002; Kolver, 2000). While in the USA and Europe the average milk production per cow is 8000 - 9000 kg per lactation (USDA, 2003; Zwald et al., 2001; Perkins, 2002), in New Zealand milk production per cow is on average 3500 – 4000 kg per lactation (Zwald et al., 2001; Perkins, 2002).

Since in New Zealand farm income is related to milksolids production per hectare, strategies oriented to increase milksolids production per hectare can potentially increase farm profitability. The inclusion of extra feed into the pastoral system can increase farm profitability by increasing milksolids production per cow and per hectare. Changes in stocking rate and in calving and dry-off dates are necessary when extra feed is used in order to maximise feed utilisation and the conversion of feed into milksolids (Holmes et al., 2002). However, the effect of feeding supplements on farm profitability can vary depending on the milksolids response to the extra feed, the costs associated with feeding the supplements, and the milk price (Penno, 2003).

In New Zealand, strategies aimed at increasing milksolids production must not be separated from profit. Recently there has been an increase in mi lksolids production per cow and per hectare, due in part to higher inputs of fertilisers and extra feed into the pastoral system (MAF, 2001). However, increases in milksolids production per hectare have not always resulted in higher farm profits per hectare due to the increase in production costs (Van der Poel, 1996).

1.1 AIMS AND GENERAL DESCRIPTION OF THE RESEARCH

In recent years there have been major debates about the profitability of the inclusion of extra feed into the dairy system. However, there is little information about the effect that the inclusion of extra feed has had on commercial dairy farms. The general objective of this work was to analyse the influence that extra feed has had on commercial dairy farms in recent years.

This research work starts with the revision of literature related to the physical and financial characteristics of low input and high input dairy farms in New Zealand (Chapter 2). This chapter shows that the dairy system should be adapted to the amount of extra feed input and that milksolids production, per cow and per hectare, is influenced by the use of extra feed. This chapter also shows that the reports about the profitability of low input or high input dairy farms in previous research works are contradictory.

This thesis comprises the analysis of ProfitWatch data corresponding to 4 dairy seasons (between 1998/99 and 2001/02). To analyse the effect of extra feed on the dairy system, dairy farms in ProfitWatch were classified according to the amount of extra feed offered per cow. The definition of extra feed, for the classification of dairy farms, comprised supplements imported, pasture imported as winter grazing and maize grown in the farm. Three feed input systems (low input: <50 kg DM extra feed/cow; Intermediate input: 50-500 kg DM extra feed/cow; High input: >500 kg DM extra feed/cow) were formed and analysed.

The first part of the results describes the physical characteristics of low, intermediate and high input systems between 1998/99 and 2001/02 (Chapter 3). In this chapter the objective was to describe how the inclusion of extra feed influenced the farm system (farm size, stocking rate, comparative stocking rate), milksolids production, per cow and per hectare; pasture production and the use of nitrogen fertiliser. This information helps to understand the influence that the inclusion of extra feed has had on farm size, stocking rate, milksolids production (per cow and per hectare), some reproductive characteristics of the herds and pasture production per hectare.

The second part of the results describes the financial characteristics of low, intermediate and high input systems between 1998/99 and 2001/02 (Chapter 4). In this chapter the objective was to describe how the use of extra feed influenced Gross Farm Income ($/ha), Farm Working Expenses ($/ha), Economic Farm Surplus ($/ha), Return on Assets (%), Return on Equity (%), and the cost of milksolids production ($/kg MS). This chapter helps to understand how the inclusion of extra feed into the system, and the adaptation of the dairy system to this extra feed, have affected the profitability of dairy farms (EFS/ha, RoA, RoE). The financial analysis of low, intermediate and high input dairy systems also helps to understand the effect of extra feed on Gross Farm Income per hectare and Farm Working Expenses per hectare.

The third part of the results (Chapter 5) analyses the physical and financial characteristics of low, intermediate and high input dairy farms in the top and bottom quartiles for EFS/ha. In this chapter the objective was to determine the physical (stocking rate, comparative stocking rate, milksolids production, pasture production) and financial (Gross Farm Income, Farm Working Expenses, Return on Assets and Return on Equity, cost of milksolids production) characteristics of farms in the top and bottom quartiles for EFS/ha. The classification of the 3 feed input systems into quartiles for EFS/ha helps to identify the characteristics that make low, intermediate and high input farms profitable. The inclusion of extra feed requires the adaptation of the system. For this reason, the characteristics of low, intermediate and high input farms in the top quartile for EFS/ha help to clarify the adaptations that are necessary in the dairy system in order to maximise profitability.

The last part of the results (Chapter 6) comprises simple and multiple regression analysis of the whole data. In this chapter, instead of classifying the dairy farms in 3 feed input systems, all dairy farms were used for the regression analysis. The objective of this chapter was to determine the relationships between milksolids production (per cow and per hectare), Gross Farm Income ($/ha), Farm Working Expenses ($/ha), Economic Farm Surplus ($/ha), Return on Assets (%) and Return on Equity (%) with the amount of extra feed used per cow or per hectare. This chapter helps to clarify the relationships between different farm parameters and the inclusion of extra feed.

This study provides a better understanding of the effect of extra feed input on New Zealand dairy farms in recent years. By knowing the effects of extra feed on the system, it will be possible to advise dairy farmers on the profitable inclusion of extra feed into their farms.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

In New Zealand, the average milksolids production per cow and per hectare increased steadily between the 1998/99 and 2001/02 dairy seasons (See Table 2.1). During this period, the Economic Farm Surplus per hectare (EFS/ha) increased by approximately 231% (See Table 2.1). This increase was mainly due to increases in milksolids payout and in milksolids production per hectare. The increase in milksolids production per hectare was due, in part, to genetic improvement of the cow (LIC, 2003). The increase in the use of supplementary feeding in dairy farms in recent years also contributed to increase milksolids production per hectare (Dexcel, 2003). During this period, the increase in milksolids production per hectare was also associated with increases in farm working expenses (Dexcel, 2003).

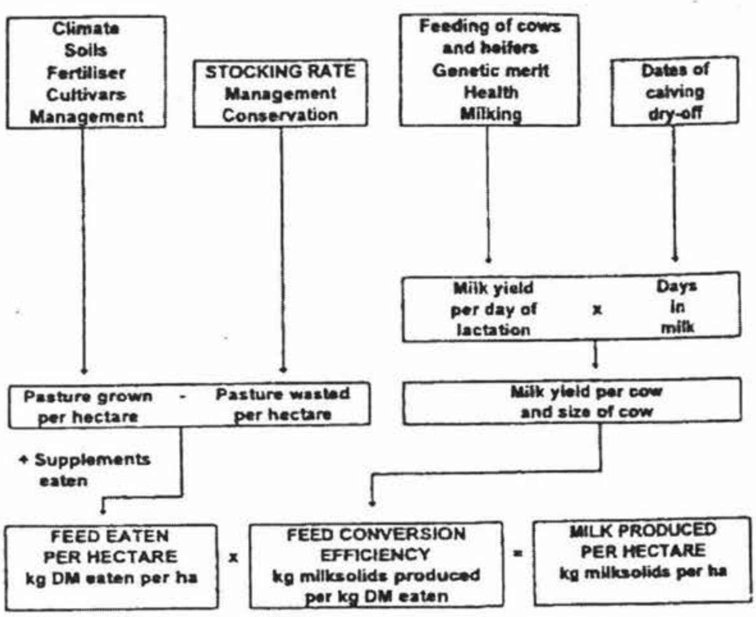
Table 2.1: Changes in milksolids payout, milksolids production per cow and per hectare and Economic Farm Surplus, between 1998/99 and 2001/02 (Source: LIC, 2003; Dexcel, 2003).

Parameter	Annual average		
	1998/99	2001/02	% Increase
Milksolids payout ($/kg MS)	3.75	5.35	+43%
kg MS/cow	256	307	+20%
kg MS/ha	684	824	+20%
$EFS/ha (for owner operators)	600	1985	+231%

In pastoral dairy systems, such as those in New Zealand, milk production per hectare is determined by the quantity and the quality of the feed supply; and by the efficiency with which feed demand is matched with feed supply. Feed demand per hectare is determined by stocking rate and characteristics of the cows (genetic merit, physiological status and liveweight of the cow). Feed supply per hectare is determined by pasture production per hectare and the amount of feed imported per hectare.

In the dairy system, all parameters are interrelated (See Figure 2.1). Pasture production is influenced by climate, soil type, fertilisers, cultivars, and grazing management (Holmes et al., 2002). Stocking rate and grazing management influence the level of pasture utilisation and feed intake of the cow. Several factors including genetics, feeding level of the cow and lactation length influence the efficiency with which the cow converts the feed eaten into milk. During periods of pasture deficit, extra feed can be brought into the system to meet the feed requirements of the herd.

Figure 2.1: Factors that influence milk production (From: Holmes et al, 2002).



2.2 THE NEW ZEALAND DAIRY INDUSTRY

The New Zealand dairy industry has undergone significant changes in recent years (See Table 2.2). Approximately 90% to 95% of the milk produced in this country is exported (NZOY, 2000). There are 3 main co-operatively owned dairy companies in New Zealand: Fonterra, Tatua and Westland (LIC, 2003). In recent years, the total number of cows and the number of cows per herd increased in New Zealand while the total number of herds decreased (See Table 2.2).

Table 2.2: Changes in the dairy industry in New Zealand (Source: LIC, 2003).

Parameter	Annual average		
	1998/99	2001/02	% Increase
Dairy herds	14362	13649	-5%
Total number of cows	3,269,362	3,692,703	+13%
Average farm size (N cows)	229	271	+18%

In New Zealand, dairy farms management is based on 3 main operating structures: owner operators, sharemilkers and contract milkers (LIC, 2003). Approximately 62% of farmers in New Zealand are owner operators, who operate their own farm and receive all the farm income (LIC, 2003). Thirty eight percent of farmers are sharemilkers, most of them (63%) 50/50 sharemilkers (LIC, 2003). In the 50/50 sharemilking structure the farm is managed by the sharemilker, who owns the herd and plant equipment, while the owner of the land shares the expenses related to maintenance of the land (LIC, 2003). In the sharemilkers agreement both parties share the total income. There are also other operating structures which represent a small proportion (0.1%) of dairy farms (LIC, 2003).

There are physical and financial differences between the farms of owner operators and sharemilkers. On average, owner-operators have smaller farms, smaller herds, and lower stocking rates than 50/50 sharemilkers (See Table 2.3). Since owner operators have more capital invested in the farm, their average milksolids payout and EFS/ha are higher than 50/50 sharemilkers. (See Table 2.3).

Table 2.3: Differences between owner operators and sharemilkers in 2001/02 (Source:LIC, 2003; Dexcel, 2003).

Parameter	Operating structure		Owner Operators vs. Sharemilkers)
	Owner Operators	Sharemilkers	
Farm size (ha)	97	113	+16%
Herd size (N cows)	251	306	+22%
Stocking rate (cows/ha)	2.61	2.78	+7%
Milksolids payout ($/kg MS)	5.28	2.48	-53%
$EFS/ha	1985	955	-52%

2.3 PHYSICAL CHARACTERISTICS OF NEW ZEALAND PASTORAL DAIRY SYSTEMS

2.3.1 PASTURE PRODUCTION

In New Zealand pasture-based dairy systems, pasture production per hectare is the main limiting factor for milksoldis production per hectare (Penno et al., 1996). The annual pasture yield per hectare can vary significantly (See Table 2.4), depending on the region, season of the year and the use of fertilisers (N, P) and/or irrigation (Clark et al., 2001; Kolver, 2000; Holmes et al., 2002).

Table 2.4: Pasture production in different regions of New Zealand (From: Holmes et al. 2002).

Region		Total annual production	
		Pastures: (t DM/ha)	Milksolids: (kg MS/ha)
North Island:			
•	Waikato	12 to 17	(850 kg MS/ha)
•	Taranaki	11 to 15	(800 kg MS/ha)
•	Manawatu/Wairarapa	10 to 13	(780 kg MS/ha)
South Island:			
•	Nelson/Golden Bay	12 to 14	(700 kg MS/ha)
•	West Coast	9 to 12	(650 kg MS/ha)
•	Canterbury (irrigated)	14 to 17	(1000 kg MS/ha)

Pasture quality and composition are also influenced by environmental factors. During spring, the content of soluble carbohydrates and protein in pasture, and its digestibility, are higher than during summer (See Table 2.5). During summer, low rainfall and heat increase the content of fibre in pasture (See Table 2.5) and the concentration of dead matter in the sward can reach 35% - 40%, even in well managed farms (Clark and Penno, 1996). During autumn, rainfall boosts pasture growth and accelerates the degradation of the dead matter accumulated during summer.

Table 2.5: Pasture quality during spring and summer (Adapted From: Kolver, 2000).

Season	% DM	MJME/kg DM	% CP	Fibre
Spring	12-18	11.0-12.5	18-35	35-45
Summer	15-20	9.0-10.5	14-22	42-52
Dry summer	20-30	8.0-9.5	9-14	52-65

Pasture yield per hectare can be increased with the use of fertilisers, irrigation, improved cultivars, and good grazing management (optimum rotation lengths, pre and post grazing pasture covers).

2.3.2 COWS

The characteristics of the cow play an important role in milksolids production. Feed intake, feed conversion efficiency and milksolids production per cow have all increased with the genetic improvement of the cow (See Table 2.6).

In New Zealand, high genetic merit cow are highly "specialised" for milksolids production. The selection criteria for milksolids production has also increased the prevalence of reproductive problems in the cow. Reproductive problems in high genetic merit cows are mainly associated with a state of negative energy balance in early lactation (Lucy, 2001). For this reason, in order to express their full genetic potential and minimise reproductive problems, cows must be well fed.

Table 2.6: Effect of genetic merit on animal performance (From Holmes, 1999).

Parameter	% of increase
Yield of milk or solids	+ 18%
Feed intake	+ 6%
Feed intake above maintenance	+ 10% approx
Feed conversion efficiency	+ 10%
Liveweight	0%

The efficiency with which the cow converts the feed into milk determines the efficiency of feed utilisation. Feed conversion efficiency (FCE) can increase with increases in milksolids production per cow and despite the associated increases in feed intake of the cow (Clark and Penno, 1996). The amount of milksolids produced per kilogram of liveweight (kg MS/kg LWT) is a measure of feed conversion efficiency (Glassey, 2001). As FCE increases, kg MS/kg LWT also increases (See Table 2.7). This is because kg MS/kg LWT takes into account differences in animal size and maintenance costs (large animals have higher maintenance costs than small animals). At equal milksolids production per cow, FCE is higher in small animals than in large animals (See Table 2.7). This is because large animals must eat more to meet their higher maintenance requirements (See Table 2.7).

Table 2.7: Influenced of physiological factors (liveweight, pregnancy and milksolids production) on feed demand (t DM/cow/year), feed conversion efficiency (kg MS/t DM), and milksolids production per kilogram of liveweight (kg MS/kg LWT) (Adapted from: Holmes, 2000).

MS yield and tDM/year	Liveweight (kg) and t DM/year required for maintenance and pregnancy		
	350 (1.79 t)	450 (2.13 t)	550 (2.44 t)
300 (1.80 t)	**3.59 t DM** 84 kg MS/t DM 0.86 kg MS/kg LWT	**3.93 t DM** 76 kg MS/t DM 0.67 kg MS/kg LWT	**4.24 t DM** 71 kg MS/t DM 0.55 kg MS/kg LWT
350 (2.10 t)	**3.89 t DM** 90 kg MS/t DM 1.00 kg MS/kg LWT	**4.23 t DM** 83 kg MS/t DM 0.78 kg MS/kg LWT	**4.54 t DM** 77 kg MS/t DM 0.64 kg MS/kg LWT
400 (2.40 t)	**4.19 t DM** 95 kg MS/t DM 1.14 kg MS/kg LWT	**4.53 t DM** 88 kg MS/t DM 0.89 kg MS/kg LWT	**4.84 t DM** 83 kg MS/t DM 0.73 kg MS/kg LWT
450 (2.70 t)	**4.49 t DM** 100 kg MS/t DM 1.29 kg MS/kg LWT	**4.83 t DM** 93 kg MS//t DM 1.00 kg MS/kg LWT	**5.14 t DM** 88 kg MS/t DM 0.82 kg MS/kg LWT

The feed intake of the cow is affected by physiological factors like liveweight, pregnancy and milksolids production (See table 2.7). High genetic merit cows have high feed intakes due to their high milksolids production (See table 2.6).

2.3.3 DAIRY SYSTEMS

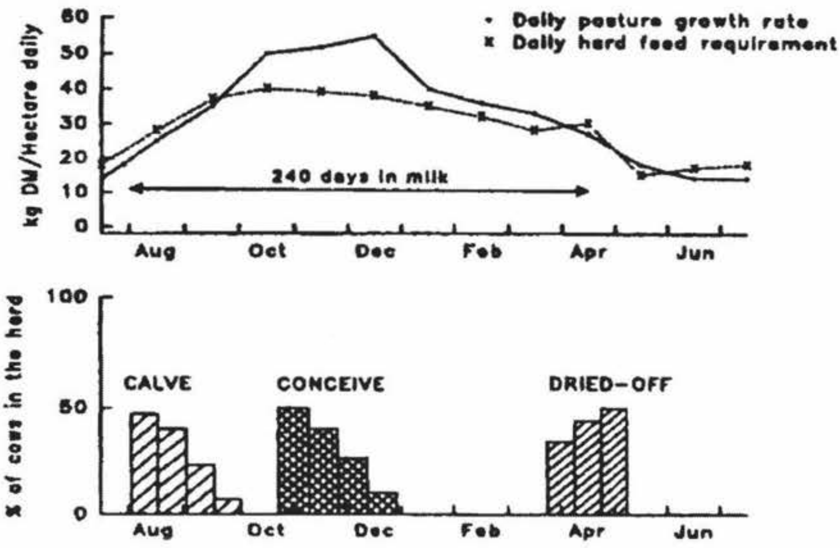
2.3.3.1 LOW INPUT DAIRY SYSTEMS

In New Zealand, dairy production is characterised for its seasonality and its high degree of synchrony between feed demand and pasture supply (Holmes, 2000). All-pasture dairy systems have a seasonal milk production that follows the seasonal pattern of pasture growth (See Figure 2.2). In these systems, the peak of lactation is matched with the peak of pasture growth rate in spring (October) and the dry period is synchronised with the season of low pasture growth rate (winter). Factors like fertility and genetic merit of the cow, stocking rate, grazing management and the use of feed influence the efficacy with which the synchrony between feed demand and feed supply is achieved (Holmes et al., 2002).

An optimum calving date in New Zealand is early spring (late July- August), with the early dates in the northern region and the later dates in the southern regions (See Figure 2.2). Late calving dates can result in low milksolids production per cow, especially during dry summers, due mainly to shorter lactation lengths (Garcia and Holmes, 1999). A compact calving pattern (90% of the herd calved within 6 weeks) is also essential to maximise pasture utilisation in spring (Stevens et al., 2000). This is because with a compact calving, the total feed demand of the herd increases uniformly and within a short period of time. Earlier than optimum calving dates can also cause a temporary pasture deficit in early lactation, due mainly to the low pasture growth rates in late winter.

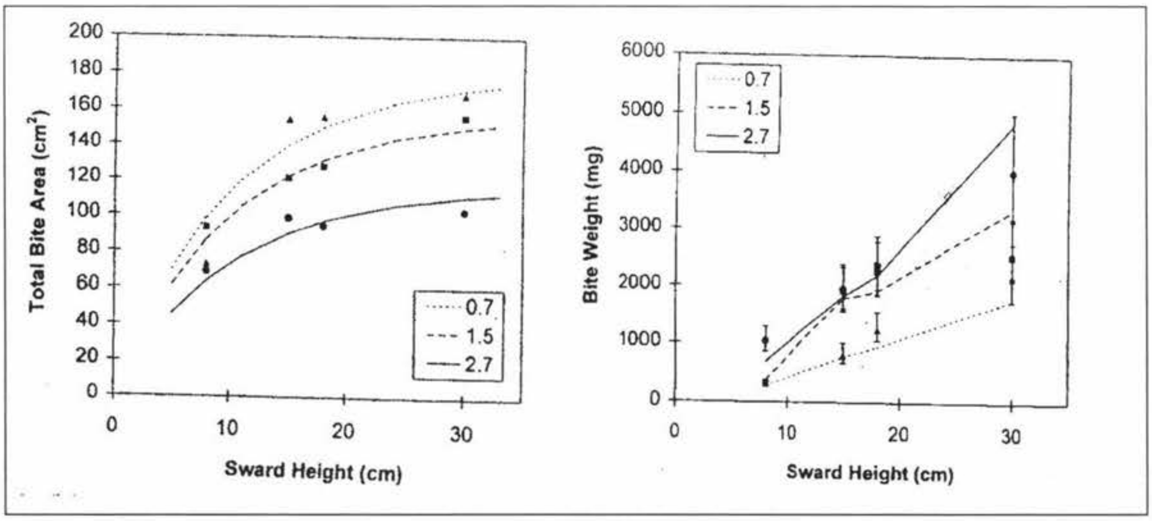
In order to have a compact calving in early spring and an average calving interval of 365 days, conception should occur preferably in October and if possib le 82 days after calving (See Figure 2.2). High conceptions rates (60%-68%) can be achieved with an early resumption of ovarian activity and oestrous; and an 8-week calving-to- first-mating interval (Xu and Burton, 2000). It is recommended that cows calve at condition score 5 to ensure that body condition in early lactation does not decrease to such low levels as to affect fertility (Verkerk et al., 2000).

Figure 2.2: Seasonal Pastoral System (From Holmes, 2002).



The physical characteristics of the sward (pasture composition, pasture height and pasture mass) also influence the feed intake of the cow (See Figure 2.3). High pre-grazing pasture yields are associated with high feed intakes up to a point. Higher than optimum pre-grazing pasture yields are associated with low pasture quality and pasture wastage.

Figure 2.3: Effect of 4 pasture heights (8, 15, 18, 30 cm) and 3 pasture mass (0.7, 1.5, 2.7 mg/cm^3) on intake of cattle grazing paspalum swards (From Woodward, 1998).



A good grazing management maximises the feed intake of the cow and maintain the optimum pre and post grazing pasture covers in the farm. Maintaining optimum pre and post grazing pasture covers also preserves pasture quality and ensures pasture supply for the future. The establishment of pre and post grazing pasture yields maintains pasture in a vegetative state and prevents pasture overgrazing or pasture undergrazing.

In New Zealand all-pasture systems, suggested pre and post grazing pasture yields in early spring, when calving starts, are 2500-2700 and 1300-1400kg DM/ha, respectively (Phillips and Matthews, 1994). Maintaining an average pasture cover (average of all paddocks) greater than 2000 kg DM/ha at calving is important to avoid feed deficits in early lactation (McCall and Clark, 1999). However, in all-pasture systems it is often not possible to achieve these targets unless extra feed is imported into the farm. As pasture growth rate increases from early spring, rotation length should decrease steadily to maintain optimum pasture covers in the farm. In late spring, an optimum post-grazing pasture yield is 1500-1600kg DM/ha (Phillips and Matthews, 1994).

Rotation length is influenced by pasture growth rate. Short rotation lengths are necessary in spring when pasture growth rate is high. Since pasture growth rate is low during winter, long rotation lengths are necessary during this season.

There is a positive relationship between stocking rate (cows/ha) and pasture utilisation (Holmes et al., 2002; Penno, 1999). This is because stocking rate determines feed demand per hectare, grazing intensity, and pasture utilisation. Stocking rate is an important tool to manage the feed demand in the farm. Low stocking rates can lead to pasture under utilisation and can affect farm profitability (Holmes et al., 2002). This is because at high pasture utilisation most of the capital invested on pasture is eaten and converted into income from the sale of milk.

There are also positive relationships between stocking rate and milksolids production per hectare, and between stocking rate and gross farm income (Holmes et al., 2002; Penno, 1999; Macdonald et al., 2001). In pasture-only systems there is a negative relationship between stocking rate and milksolids production per cow

(Macdonald et al., 2001). Low stocking rates are associated with high milksolids production per cow, but low milksolids production and income per hectare (Holmes et al., 2002). At very high stocking rates, milksolids production per hectare decreased due to a significant decrease in milksolids production per cow (Wright and Pringle, 1983).

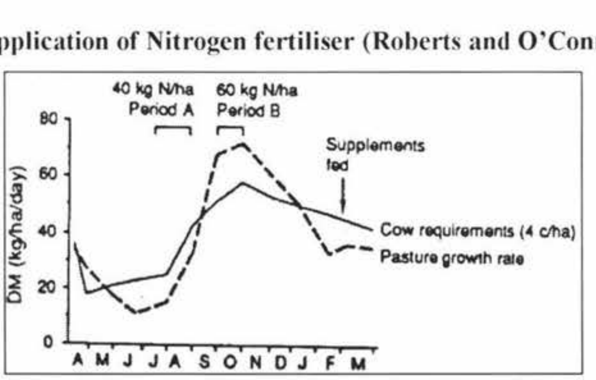
During spring, pasture wastage can occur at low stocking rates if pasture conservation as hay or silage is not practised. Pasture conservation is an option to transfer pasture surplus from spring to periods of pasture deficit (summer, autumn, winter, or early spring). However, the conservation of pasture as hay or silage usually decreases the quality of the pasture conserved and increases farm expenses (Thompson, 1997). Removing paddocks from grazing, to make pasture hay or silage, also leads to a temporary increase in stocking rate in the remaining paddocks. This temporary increase in stocking rate increases the feed demand per hectare, grazing intensity and pasture utilisation in the remaining paddocks (Holmes et al., 2002). However, the feed intake of the cow and milksolids production per cow can be affected. The increase in grazing intensity can also affect pasture re-growth if optimum post-grazing pasture yields are not established and pasture overgrazing occurs.

Although high stocking rates can minimise pasture surpluses and increase milksolids production per hectare (Reid, 1997), they can be risky in all-pasture systems. Stocking rate should be high enough to keep the cows well fed, maintain pasture utilisation and avoid problems of under-nutrition. In a study done by Penno (1999), in all-pasture systems, the optimum stocking rates to maximise milksolids production per hectare were 4.4 cows/ha (102 kg LWT/tDM) for Jersey cows, and 3.2 cows/ha (94 kg LWT/t DM) for Holstein-Friesian cows. However, the optimum stocking rate for maximum EFS/ha at $3.50/kg MS (85 kg LWT/tDM) was lower than the optimum stocking rate for maximum milksolids production (Penno, 1999). This is because high stocking rates are also associated with high farm expenses and high risks if weather condition varies (dry seasons).

High stocking rates and early calving in spring (late July/August) are associated with pasture deficits in early lactation (See Figure 2.2). The strategic use of fertilisers, especially nitrogen fertiliser, helps to maintain soil fertility and can help to overcome periods of pasture deficit by increasing pasture production (Roberts and O'Connor, 1992). The application of nitrogen fertiliser during winter (July/Aug) and spring (October) can increase pasture production in early and late spring (See Figure 2.4). Pasture surplus that can result from the application of nitrogen fertiliser can be conserved as hay or silage and be used during periods of pasture deficit (Roberts and O'Connor, 1992; McGrath et. al., 1998).

The application of other fertilisers (phosphorus, sulphur, potash) can also increase pasture production if the availability of these nutrients is limiting pasture production. In 1997, it was estimated that the P levels on 38% of New Zealand dairy farms were below optimum levels (Butler and Johnston, 1997). The use of fertilisers can also decrease the cost of pasture production by increasing pasture production (Armer, 2000).

Figure 2.4: Strategic application of Nitrogen fertiliser (Roberts and O'Connor, 1992)



During summer and autumn pasture growth rate decreases due to low rainfall. It is difficult to maintain the optimum pre and post grazing pasture yield during summer due to the increase in the content of dead matter in the sward and to the low pasture growth rates during this season (Phillips and Matthews, 1994). Pasture deficits can occur during summer, especially during dry summers and/or at high stocking rates. During summer, optimum sward condition can be maintained with 20-30 day rotation lengths (Holmes et al., 2002).

During autumn, optimum pre and post grazing pasture covers are 2400-2700 and 1200-1400kg DM/ha, respectively (Phillips and Matthews, 1994). Rotation length can be extended to 40-70 days during late summer and autumn to maintain optimum post grazing pasture covers with slower pasture growth rates (McCall and Clark, 1999).

Irrigation can increase pasture production during summer (18% - 58%), when water supply is a limiting factor (Thomson, 1996). Maintaining an intensive grazing is also important during summer to maintain pasture quality. The milksolids response to irrigation depends on the amount of extra pasture grown and the efficiency with which this extra pasture is utilised and converted into milk.

Since farm income per hectare is related to milksolids production per hectare, the objective of a dairy farm should be to maintain cows lactating for as long as possible, whenever sufficient feed can be provided and it is still profitable to do so. In all-pasture systems, milk production can be extended to the end of April/May if weather conditions are favourable (See Figure 2.2). However, dry summers can force farmers to dry-off their herds earlier. Milksolids production in late lactation can occur at the expense of body reserves if pasture supply is not enough, especially in high genetic merit cows (Garcia and Holmes, 1999). An early dry-off can result in short lactation lengths and low milksolids production per cow and per hectare, but it also prevents an excessive decrease in body condition score and in average pasture cover (Garcia and Holmes, 1999). The use of extra feed in late lactation can make it possible for the dry-off date to be delayed, but the viability of this will depend on the costs of the extra feed and the value of milk.

During winter, grazing management should be oriented to maximise pasture growth and avoid pasture and soil damage by treading. Grazing-off during winter can help to build pasture cover in the farm and prevent pasture damage (Moore, 2000). Optimum pre and post grazing pasture covers during winter are2500-2700 and 800-1000 kg DM/ha, respectively (Phillips and Matthews, 1994). Long rotation lengths (40-120 days) are necessary during this season to maintain the optimum pasture covers (Holmes et al., 2002).

Milksolids production per cow is influenced by feed intake (especially energy intake), feed conversion efficiency and lactation length (Holmes, 2002). For this reason, in all-pasture systems (low input systems) milksolids production per cow is limited, even with ad-libitum access to pasture (McCall and Clark, 1999). Seasonal and regional variations in pasture production (See Table 2.4), also limits the amount of feed that can be fed to the herd, the stocking rate and the lactation length. As consequence, milksolids production per hectare is also limited (825 kg MS/ha on average; LIC, 2003). Profitable farms are characterised by maximising pasture production and pasture utilisation. All-pasture systems can be highly profitable when pasture utilisation is maximised (Howse and Leslie, 1997; Armer, 2000; Moore, 2000). Therefore, the stocking rate should be determined aiming at least 75% pasture utilisation (Macdonald et al., 2001).

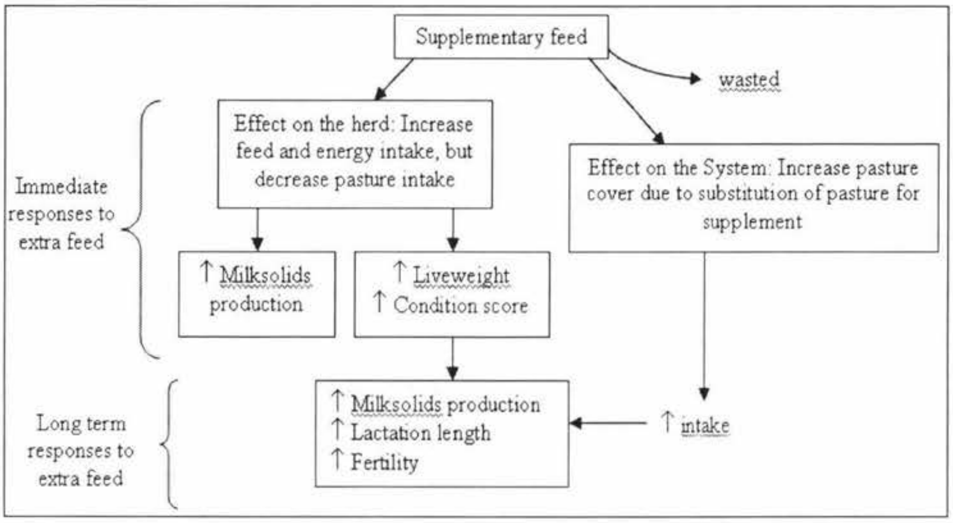
2.3.3.2 HIGH INPUT DAIRY SYSTEMS

2.3.3.2.1 Effects of supplements on the system

Since pasture production is a limiting factor for milksolids production per cow and per hectare in New Zealand dairy farms, the inclusion of extra feed into the farm can remove the limits imposed by pasture production. Most of New Zealand dairy farms import variable amounts of supplements nowadays (Holmes, 1998). Extra feed can be supplied as feed imported (silage, etc) or as pasture grazed off for non-lactating stock (dry cows, heifers).

The inclusion of extra feed can have immediate and long-term effects on the dairy system (See Figure 2.5). Immediate responses comprise increases in feed intake, milksolids production, body liveweight, condition score and fertility of the cow. Another immediate response to the use of extra feed is the increase in pasture cover in the farm (Holmes et al., 2002). This build-up of pasture cover in the farm is due to the substitution of pasture intake for supplement intake. The rate of substitution varies between 0.3 and 0.7 kg of pasture/kg DM of supplement (Holmes and Matthews, 2001). This decrease in pasture intake can lead to pasture underutilisation if substitution is not managed appropriately (Holmes and and Matthews, 2001). Pasture wastage due to substitution can be prevented or minimised by increasing the stocking rate and/or the amount of pasture conserved in the farm (Holmes et al., 2002).

Figure 2.5: Immediate and long term effects of the use of supplements. (Adapted from Holmes et al., 2002).



The long-term responses to supplementary feeding are related to the efficiency with which the extra pasture and the extra condition score, accumulated during the feeding of supplements, is converted into milk. Long-term responses comprise increases in milksolids production per cow and fertility of the cow (See figure 2.5). The increase in milksolids production per cow can be due to longer lactation lengths and/or higher daily milksolids production per cow in late lactation (Garcia and Holmes, 1999). A good reproductive performance of the herd is vital to maintain the synchrony between feed demand and pasture supply in the following season. It also decreases the rate of culling due to empty cows (Xu and Burton, 2000).

2.3.3.2.2 Response to supplementary feeding

Supplements should be use strategically in order to maximise the milksolids response to extra feed and/or avoid pasture or supplement wastages. Several factors like pasture quality, the quality of supplement, the genetic merit of the cow, the stage of lactation, the rate of pasture substitution, and the size of feed deficit influence the response to extra feed (Thomson et al.,1998; Macdonald, 1999; Penno et al., 1999; Holmes et al., 2002).

The milksolids response to extra feed introduced into intensive systems can vary widely (70 or lower, to 130gMS/kgDM) depending on the need of the system for extra feed (Holmes et al., 2002; Macdonald, 1999; Thomson et al, 1998; Penno et al., 1999). High milksolids responses to supplementary feeding are observed when feed supply is the main limiting factor for milksolids production (Penno and Kolver, 2000), as it can occur at high stocking rates, with high genetic merit cows in early lactation..

2.3.3.2.3 Inclusion of supplements into the system

There are a wide variety of feeds (pasture hay, pasture silage, maize silage, turnips crops, meals, grains, concentrates; by-products) that can be used as supplements (Van der Poel, 1996, Reid, 1997; Jamieson, 1996).

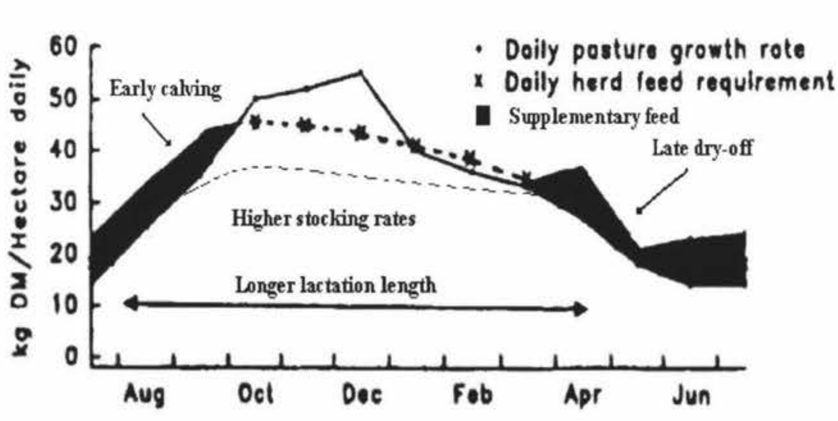
The cost, quality and availability of supplements should be considered before deciding the supplements to use. The high cost of supplements can make their use unprofitable, even when milksolids production per cow and per hectare increases (Van der Poel, 1996). In New Zealand, after nitrogen fertiliser, the supplement of choice is maize silage in the North Island (Roche and Reid, 2002). In the South Island, the use of cereal silage and cereal grains can be profitable due to the lower cost of these supplements in this region (Roche and Reid, 2002).

The use of supplementary feeds enables farmers to overcome the limits established by pasture production and gives greater physical flexibility to the system. This is because supplements enable more control of the pastoral system, facilitate the achievement of pre grazing pasture yields and decreases the production risks associated with farming (Holmes, 2000; Moore, 2000). To be successful, the pastoral dairy system should be modified when high amounts of extra feed are imported into the farm. The aim should be to maintain the synchrony between the feed demand of the herd and feed supply (Holmes et al., 2002). For this reason, planning the development of a high feed input systems is a necessary step to determine the type and amount of supplements to be use, labour requirement and the costs involved (Roche and Reid, 2002).

The increase in feed demand of the herd can be achieved by early calving dates, late dry-off dates and/or by increasing the stocking rate (See Figure 2.6). Increasing the stocking rate is the fastest way to increase the feed demand of the herd, maintain grazing intensity and maximise feed utilisation (McCall and Clark, 1999; Reid, 1997). If low stocking rates are maintained in high input systems, pasture wastage can occur unless pasture conservation is practised. There are several reports of high stocking rates in high input New Zealand dairy farms (Jamieson, 1996; Leslie, 1996; Van der Poel, 1997). However, relatively low stocking rates in high input farms are also reported (Roche and Reid, 2002). However, high level of skills are needed in these circumstances to avoid pasture wastage.

An early calving date (July 20; In: Jamieson, 1999) creates a feed deficit in early lactation (See figure 2.6). This is because pasture growth is still low in late winter or early spring (Holmes et al., 2002).

Figure 2.6: Inclusion of extra feed into the pastoral system (Adapted From: Holmes et al., 2002).



The use of supplementary feeds can also allow an extension of the lactation length (See Figure 2.6). Thomson et al. (1998), reported increases in lactation length of 30-36 days when maize silage was used in early or late lactation. In another report, the lactation length was extended 54 days (until the end of May), with the use of maize silage in late lactation (Pinares and Holmes, 1996). In the 1.75t MS/ha trial, lactation lengths of 277 – 291 days, with the use of supplements, were reported; compared with 220-230 days in the unsupplemented herds with the same high stocking rates (Macdonald, 1999).

Management of high feed input dairy systems requires skill and knowledge to determine the optimum time for their use and the optimum amount of supplementary feeds to use (Van der Poel, 1997). As feed input affects other farm parameters, the whole system should be adapted and oriented to maintain the synchrony between feed demand and feed supply.

2.3.3.2.4 Milksolids production in high input systems

Increases in milksolids production per cow and per hectare, from the use of supplementary feeds, have been reported. In the case of Reid (1997), the use of supplementary feeds (silage, vegetable waste, grazing-off), which constituted up to 45% of the total diet of the cow, increased milksolids production per cow and allowed an increase of the stocking rate. This resulted in significant increases in milksolids production per hectare (See Table 2.8).

Table 2.8: Effect of feed input on milksolids production per cow and per hectare (Reid, 1997).

Years	kg MS/Cow.	Cows/ha	MS/ha
89-93	301	3.8	1136
94	384	3.1	1186
95	419	3.6	1494
96	410	4.1	1675
97	425	4.5	1920

Table 2.9: Ration for dairy cows in some high input systems in New Zealand (From: Holmes, 2000).

Feed	New Zealand	
	Van der Poel	Edgecombe
Grazed pasture	3.8 t DM/cow	3.3 t DM/cow
Maize silage	1.2 t DM/cow	
Horticultural by-products		3.3 t DM/cow
Total intake	5.0 t DM/cow	6.6 t DM/cow
Milk yield/cow	430 kg MS	550 kg MS

Table 2.9 shows two examples of high input dairy systems in New Zealand. In these farms, maize silage and horticultural by-products formed 24% and 50% of the total diet of the cow, respectively. The average milksolids production per cow in these high feed input farms was higher than the national average (288 kg MS/cow) in 1999/00 (LIC, 2003). Leslie (2001), also reported increases in milksolids production per cow and per hectare with the use of supplementary feeds.

Experimental trials have also found that the inclusion of extra feed into the system can increase milksolids production per hectare significantly. In the 1.75t MS/ha trial (Macdonald, 1999), high stocking rates and high milksolids production per cow and per hectare were achieved with the use of nitrogen fertiliser and supplementary feeds (See Table 2.10). In this trial, the average milksolids production per cow and per hectare were significantly higher than the national average corresponding to that year (LIC, 2003).

Table 2.10: Average stocking rate and milksolids production in the high input farmlets of the 1.75t MS/ha trial (Macdonald, 1999).

Farm Parameters	Control (200 kg N/ha + silage)	200kg N/ha + Maize grain	200 kg N/ha + Maize silage	200 kg N/ha + Balanced ration
kg DM extra feed/cow	68	1395	1279	1458
Stocking rate	4.42	4.42	4.42	4.42
Kg MS/cow	269	400	364	407
Lactation length (days)	217	283	277	291
Kg MS/ha	1190	1768	1606	1800

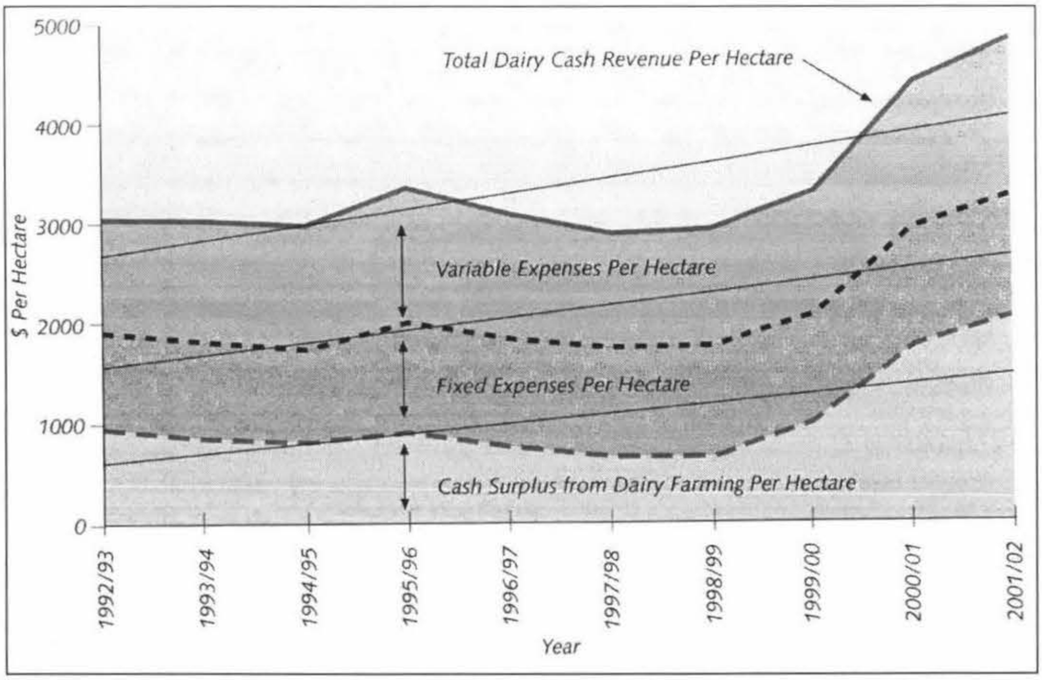
2.3.4 BREED AND GENETIC MERIT IN DAIRY FARMS

In New Zealand, Holstein-Friesian is the prevalent breed (54%) followed by Jersey (15%) (LIC, 2003). There is a large number of Holstein-Friesian/Jersey crossbred cows (23%), and a large number of herds have mixed breeds (LIC, 2003). The genetic evaluation system in New Zealand has designed a method, called Breeding Worth, for the comparison of the genetic value of the cows irrespective of breed (LIC, 2003). The calculation of Breeding Worth has varied over the years and in recent years it includes the traits of milkfat, milkprotein, volume, liveweight, fertility and longevity (LIC, 2003). The average Breeding Worth for cows in New Zealand has increased steadily since 1987 (LIC, 2003). Between 1987 and 2001, Jersey cows had on average higher Breeding Worth than Holstein-Friesian/Jersey crossbreed. During this period, Jersey cows and Holstein-Friesian/Jersey crossbreed had higher Breeding Worth than Holstein-Friesian cows (LIC, 2003).

2.4 FINANCIAL CHARACTERISTICS OF NEW ZEALAND DAIRY FARMS (Key financial performance indicators)

Initially, farm profitability was measure by the operating cash surplus from dairy farming. The operating cash surplus per hectare resulted from the subtraction of the variable and fixed costs per hectare from the total gross farm income per hectare (See Figure 2.7). The measurement of farm profitability in this way does not consider non-cash expenses. For this reason, other indicators of financial performance were developed. Financial performance indicators provide information about the financial progress and development of the dairy business. The "key" performance indicators are those that relate directly to the objective of the business (Shadbolt, 1997). Economic farm surplus per hectare (EFS/ha), the percentages of return on assets and return on equity, and the total productivity factor are some key indicators of a farm's financial performance (Bodeker and Anderson, 2001; Leslie and Miller, 1999; Shadbolt, 1997; Falloon, 1996).

Figure 2.7 Cash changes in income and expenditure in owner-operated dairy farms between 1992/93 and 2001/02 (From: Dexcel, 2003).



2.4.1 Economic Farm Surplus ($EFS/ha)

Economic Farm Surplus per hectare (EFS/ha) is a simple measure of farm profit in New Zealand (Leslie and Miller, 1999). EFS/ha is calculated from the cash surplus that is left after Farm Working Expenses per hectare (FWE/ha) are subtracted from Gross Farm Income per hectare (GFI/ha). This cash surplus is adjusted to reflect non-cash costs relevant to the business, and to bring all farms to a common operating base (See table 2.11). This economic costing method produces the operating profit which in New Zealand is called EFS. EFS/ha is used to compared the profitability of dairy farms in a more or less equal structural basis, and to compare the profitability of one farm in different years over a period of time (ProfitWatch, 1999; Leslie and Miller, 1999; Shadbolt, 1997)

Table 2.11: Calculation of Economic Farm Surplus (From Dexcel, 2003b).

Parameter	Reason
Farm Income	
- **Farm Working Expenses (including run-off lease payments)**	
= Cash Surplus	
Adjustments:	
- Depreciation	
- Runoff Adjustment	(If runoff is owned and not leased)
+/- Stock Adjustment	(For changes in opening and closing stock numbers)
- Labour Adjustment	(Managers wage, additional unpaid staff/family labour)
= **EFS**	

Between 1993/94 and 1998/99, there were small changes in EFS/ha (Dexcel, 2003). Between 1998/99 and 2001/02, EFS/ha increased significantly, due mainly to increases in milksolids payout (Dexcel, 2003). Leslie (1998) found that EFS/ha was strongly related to milksolids production per hectare (kg MS/ha). However, there was a wide variation in EFS/ha between farms at the same production level. EFS/ha varied from -$500 to $2000/ha in farms that produced 900 kg MS/ha (Leslie 1998).

2.4.1.1 Economic Farm Surplus per hectare (EFS/ha) and the dairy system

Farms with high EFS/ha are characterised by achieving high pasture harvesting efficiency, high feed conversion efficiency, long lactations lengths and high milksolids production per cow and per hectare (Holmes, 2000; Prewer, 2002; McGrath, 1997). A high cash surplus per hectare and the control of farm working expenses per hectare are essential for high profits per hectare (Armer, 2000). In a study of Waikato and Bay of Plenty dairy farms (See Table 2.12), it was found that farms with high EFS/ha had high gross farm income per hectare and maintained low cash expenses per hectare (Holmes, 2000). Farms with high EFS/ha had also higher feed and land costs per hectare, lower overhead costs per hectare, and more cows per labour unit than farms with low EFS/ha (Prewer, 2002; Leslie, 1998).

Table 2.12: Financial characteristics of Waikato and Bay of Plenty dairy farms (135 dairy farms) classified according to their EFS/ha (From Holmes, 2000).

Parameter	Units	Top 25%	Average	Bottom 25%
GROSS INCOME	$/ha	3410	3160	2915
	$/kg MS	3.65	3.76	3.88
CASH EXPENSES (excludes depresiation)	$/ha	1535	1690	1835
	$/kg MS	1.64	2.01	2.44
Paid Wages	$/ha	167	216	210
	$/kg MS	0.18	0.26	0.28
Feeds; Grazing; Fertilisers	$/ha	616	608	666
	$/kg MS	0.65	0.72	0.89
Vehicles; Administration; Standing Charges, Repair and Maintenance	$/ha	416	496	583
	$/kg MS	0.44	0.59	0.78
CASH SURPLUS	$/ha	1880	1470	1080
	$/kg MS	2.01	1.75	1.44
EFS	$/ha	1295	749	177
At a commodity price of $3.00/kg MS				
EFS	$/ha	730	345	-265

There is a relationship between milksolids production per hectare (kg MS/ha), GFI/ha, FWE/ha and EFS/ha (Leslie, 2001). Strategies to increase milksolids production will only be profitable if the rate of increase in farm income is higher than the rate of increase in farm expenses. In a study done by Leslie (1998), it was found that GFI/ha and FWE/ha increased as milksolids production per hectare increased. But the rate of increase in GFI/ha, with increases in milksolids production per hectare, was faster than the rate of increase in FWE/ha (Leslie, 1998).

The profitability of a dairy farm is associated with the synchrony between feed demand and feed supply (Leslie, 1998), and the level of pasture utilisation (Howse and Leslie, 1997). Holmes (2000) and Leslie (1998) stated that one of the characteristics of farms with high EFS/ha was their high estimated pasture harvesting efficiency per hectare. In the study done by Howse and Leslie (1997), if farms in the quartile with the lowest EFS/ha had achieved the same pasture utilisation as that achieved by farms in the quartile with the highest EFS/ha, their milksolids production per hectare and GFI/ha would have increased by 235kg MS/ha and \$790/ha, respectively.

The inclusion of supplements into the dairy system can have variable effects on farm profitability. Feed costs per hectare (\$/ha) and FWE/ha increase when supplements or grazing-off are utilised (See Table 2.13). Table 2.13 shows that farms with the highest profit spent more on supplements and/or off-farm grazing, but were also more profitable. These farms associated the use of high amounts of extra feed (supplements purchased and grazing off) with high stocking rates (3.3 cows/ha) and pasture conservation in the farm. Although total feed costs per hectare (\$/ha) in farms with high EFS/ha were higher than in the average farms, the efficient use of the extra feed resulted in higher milksolids production and income, per cow and per hectare (See Table 2.13).

Table 2.13: EFS/ha of 64 owner-operated commercial dairy farms in Taranaki (From: Howse and Leslie, 1997)

	Highest Profit			Lowest Profit
Profit (\$/hectare)	\$2,280	\$1,800	\$1,570	\$1,120
Cows/hectare	3.3	3.1	2.9	2.8
Milksolids/cow (kg)	334	307	298	267
Milksolids/hectare (kg)	1100	938	870	742
Purchased supplements				
(t DM):	1.1	0.5	0.3	0.3
(\$/ha):	315	142	108	90
Grazing (\$/ha)	215	147	103	111
Level of skills required?	"Highest"			"Lowest"

In the study done by Howse and Leslie (1997), farms with low EFS/ha also utilised supplements and grazing -off, presumably to prevent periods of pasture deficit. These farms also had low estimated pasture harvesting efficiency and low amounts of pasture conserved per hectare (Howse and Leslie, 1997). This suggests that in farms with low EFS/ha the total feed available per hectare was not efficiently utilised and converted into milksolids.

To be profitable, the use of extra feed should take place during periods of pasture deficit, when the system needs it (Holmes, 2000). The effect of extra feed on EFS/ha will depend on the milksolids response to the extra feed (kg MS/kg DM), the cost of the extra feed ($/kg DM) and the milksolids payout ($/kg MS) (Penno, 2003). In the pastoral systems, the inclusion of extra feed will give a response of about 7g MS/MJME (Penno, 2002), but this response is influenced by other factors such as feeding level of the cow (Penno and Kolver, 2000). Holmes (2000) estimated that to be profitable the extra feed brought into the farm should cost less than $0.05 per dollar payout/kg MS (15c at a milk price of $3/kgMS).

2.4.1.2 Economic Farm Surplus per hectare ($EFS/ha) and feed input

Maintaining low costs of production per kg MS does not necessarily result in high profit. In Taranaki, farms with the highest EFS/ha had at the same time the highest costs of production per kg MS (Howse and Leslie, 1997). Since gross farm income per hectare is related to the amount of milksolids produced per hectare, the use of supplementary feed can potentially increase farm profitability by increasing milksolids production per hectare (Reid, 1997). In recent years, dairy farmers have tried to increase milksolids production per hectare by purchasing and feeding significant amounts of extra feed (MAF, 2001).

The inclusion of extra feed into the dairy system (intensification) should be accompanied by modifications of the system in order to be profitable. These modifications comprise high genetic merit cows, high management skills, the use of high-yielding crops and well-proven techniques (Parker, 1998). For small farms, the inclusion of extra feed into their system (intensification) can be appropriate to increase milksolids production per hectare and farm profitability (Parker, 1998). But, the intensification of the system will be profitable whenever the revenue from the extra milksolids produced per hectare exceeds the costs associated with the inclusion of extra feed (Parker, 1998).

Dairy farms that import high amounts of supplements per hectare (high input systems) are better at taking advantage of high milksolids payouts than all-pasture systems (McCall and Clark, 1999). With increasing milksolids payouts, the ability to increase gross farm income per hectare is greater in high input systems than in all-pasture systems. But this requires high milksolids production per hectare in high input systems.

Apart from the feed cost, the cost of achieving the synchronisation between feed demand and feed supply should also be considered before increasing the input of extra feed into the system. High input systems have higher costs of production due also to the use extra labour and extra cows (Penno et al., 1999). In the study done by Penno et al. (1996), a high input farms (3.24 cows/ha + 400 kg N/ha + 105 kg DM maize silage/cow) produced 20% more milksolids per hectare than an all -pasture farm (3.24 cows/ha, no nitrogen and no supplements fed). Although the high input farm had higher milksolids production per hectare, at the milksolids payouts of 1993/94 ($3.86/kg MS) and 1994/95 ($3.91/kg MS), its average EFS/ha ($2484/ha) was not significantly different from the all-pasture farm ($2487/ha). This is because farm working expenses in the high input farm were 49% higher than in the all-pasture farm (Penno et al., 1996). Other high input farms in the same study (4.48 cows/ha + 0-400 kg N/ha/year + 782-1661 kg DM maize silage/cow) had even higher milksolids production per hectare than the all-pasture farm, but had lower EFS/ha than the all-pasture farm at the milksolids payouts of those years (Macdonald et al., 1999).

For this reason, decisions to intensify a dairy system should take into account climate, milksolids payout and the cost of supplements (Moore, 2000). Some regions can be more suitable for high input dairy farms. In the South Island for example, it is possible to purchase high quality supplements (grain, by-products) at a relatively low price (Roche and Reid, 2002).

The intensification of the dairy system is not profitable unless all the inputs are utilised effectively (Van der Poel, 1996). High input of fertilisers per hectare is only profitable if the extra pasture produced per hectare is efficiently converted into milk (Attrill and Miller, 1996). The lack of synchronisation between feed demand and feed supply leads to feed wastage. Holmes (2000) found that farms with low EFS/ha offered more feed per hectare than that required by the herd. In these farms, the feed demand of the herd was not enough to convert all the feed available into milk.

High input systems should be flexible to respond to falls in milksolids payout (Parker, 1998). The system should suit milksolids payout and farmers goals. At a milk price of $3.00/kg MS, it is unlikely that extra feed purchased at 20 c/kg DM is profitable (Holmes, 2000). But at a milk price of $4.00/kg MS feed purchased at 20c/kg DM can be profitable in farms that have increased their stocking rate to maximise pasture utilisation and the utilisation of extra feed (Holmes, 2000). In the study done by Penno et al. (1996), at a milksolids payout of $3.50/kg MS, the price of supplements in the farms that used extra feed had to be less than $0.30/kg DM in order to generate an EFS/ha higher than the all-pasture farm.

2.4.1.3 Changes in farm income and expenditure over time

2.4.1.3.1 Gross Farm Income per hectare (GFI/ha)

Gross Farm Income per hectare (GFI/ha) comes from the sale of milksolids, the sale of stock (stock sold - stock purchase) and other farm incomes such as sale of silage made on farm (Attrill and Miller, 1996; Bodeker and Anderson, 2001). A high GFI/ha is essential for a high cash surplus and a high EFS per hectares (Howse and Leslie, 1997; Leslie, 2001). In New Zealand, GFI/ha increased significantly between 1992/93 and 2001/02. In owner-operated dairy farms (See Figure 2.7), GFI/ha increased from around $3100/ha to $4797/ha (Dexcel, 2003). This increase was due to increases in milksolids production per cow and per hectare, and between 1998/99 and 2001/02 to increases in milksolids payout (Dexcel, 2003).

2.4.1.3.1.1 Income from sale of milksolids($/ha)

Milksolids production per hectare and milksolids payout are the main factors that affect the GFI/ha of all dairy farms (Leslie, 1998). This is because 85% to 95% of GFI/ha comes from the sale of milksolids (Attrill and Miller, 1996). In New Zealand, milksolids payout (inflation adjusted) has decreased by 1.9% per year over the past 25 years, (Penno and Kolver, 2000). In the last 20 years, the lowest milksolids payout (inflation adjusted) was $2.96/kg MS, in 1990/91, and the highest was $5.35/ha, in 2001/02 (LIC, 2003).

Dairy systems are often influenced by milksolids payout (Penno and Kolver, 2000). High milksolids payouts can stimulate the inclusion of more inputs into the system with the aim of increasing milksolids production per hectare (MAF, 2001; Holmes, 2000; McCall and Clark, 1999).

2.4.1.3.2 Farm Working Expenses per hectare (FWE/ha)

Farm working expenses per hectare is divided into variable and fixed costs (Attrill and Miller, 1996) and it does not include interest payments. Fixed costs (overheads) are affected by size of the system, but are relatively unaffected by the systems' productivity (Attrill and Miller, 1996). Variable costs vary according to the amount of milksolids produced per hectare and comprise expenditure on wages, cows, fertilisers, feed and land (Attrill and Miller, 1996). In New Zealand, the variable, fixed and total farm working expenses per hectare increased steadily over the last 10 years (See Figure 2.7). Control of farm working expense per hectare is necessary to increase profitability. McGrath (1997), reported that FWE/ha represents less than 50% of GFI/ha in farms with high EFS/ha.

2.4.1.3.2.1 Cow costs ($/cow)

The main expenses related to the number of cows farmed are wages, animal health, herd improvement, farm dairy and electricity. From 1992/93 to 2001/02, the expenditure on all of these items increased by 31% - 44% (Dexcel, 2003). This can be due to increases in labour cost, veterinary fees, in the price and frequency of use of antibiotics, the use of CIDR's, the use of somatic cell count control tests, teat sprays for mastitis prevention and cleaning detergents (Familton, 1996; Howse and Leslie, 1997).

2.4.1.3.2.2 Feed costs: Pasture production ($/ha), Supplements made on farm ($/ha) and supplements brought-in ($/cow)

Between 1992/93 and 2001/02, the expenditure on feed (pasture and supplements) increased by 83% in owner-operated farms (Dexcel, 2003). During the 2000/01 season, high demand for extra feed increased the price of supplements (MAF, 2001). This is because the cost of supplements is also influenced by its demand. In 1999/2000, dairy farms with high milksolids production per cow (more than 400 kg MS/cow) spent approximately $200/cow more on feed than average farms (Glassey, 2001). Feed costs depend on the cost of growing feed on the farm (e.g. brassica crops, maize for silage), the cost of pasture regrassing/renovation/conservation and the cost of feed purchased (grazing-off, hay, pasture silage, maize silage, meal and other feeds).

Between 1986/87 and 1995/96, the expenditure on supplementary feed in New Zealand dairy farms increased by nearly 350% (Howse and Leslie, 1997). Due to their generally high costs, the use of supplementary feed can have a variable effect on the profitability of dairy farms (See Table 2.14).

Table 2.14: Cost of supplements for dairy cows (From Brookes, 2002).

Feed	Cents/kg DM	Feed	Cents/kg DM
Mixed pasture	8-10	Barley	32
Grass silage	12	Peas	40
Barley straw	15	Lupins	50
Turnips	15	Molasses	60
Apple pomace	15	Soyabean meal	78
Maize silage	18	Urea (46% N) as protein supplement	90
Pasture hay	25		

2.4.1.3.2.3 Cost of land ($/ha)

In New Zealand, one of the largest investments of a dairy farm is on the land (Penno et al., 1996). The price of dairy land, which is also expressed according to the kg MS/ha that can be produced on that land ($/kg MS), has fluctuated considerably in the last 20 years (LIC, 2003). The price of dairy land, excluding shares, increased from $10759/ha in 1999 to $14554/ha in 2002 (New Zealand Rural Property Sales Statistics, In: LIC, 2003).

The cost of pasture production ($/kg DM) can be divided in cost of land and variable costs (fertilisers, pasture renovation, crop and regrassing, freight, repairs and maintenance of paddocks, and the control of weeds and pests). The cost of capital of the land is also included to account for potential earnings that can be obtained if the land is used for other purposes. Land value and pasture yield are the main determinants of the cost of pasture production (See Table 2.15).

Table 2.15: Influence of land value and pasture production on cost of pasture production (From Penno et al., 1996).

Land value ($/ha)	**10000**	**15000**	**20000**	**25000**
Capital cost ($/ha @ 8.5%)	850	1275	1700	2125
Fertiliser ($/ha)	250	250	250	250
Other ($/ha)	50	50	50	50
Annual cost of pasture ($/ha)	1150	1575	2000	2425
Cost of 12t DM/ha ($/Kg DM)	**$0.10**	**$0.13**	**$0.17**	**$0.20**
Cost of 16t DM/ha ($/kg DM)	**$0.07**	**$0.10**	**$0.13**	**$0.15**

The cost of pasture production is positively related to the cost of land, and negatively related to pasture production. As pasture is one of the cheapest sources of feed for dairy cattle (Clark and Penno, 1996), the cost of pasture production can significantly influence farm profitability.

Between 1992/93 and 2001/02, the expenditure on fertilisers increased by 53% in owner-operated dairy farms (Dexcel, 2003). Since fertilisers can increase pasture production per hectare, their use can potentially decrease the cost of pasture production ($/kg DM). The profitability of the use of fertilisers will depend on the pasture response to fertilisers (kg DM/kg fertiliser), the conversion of the extra pasture grown into milksolids (kg MS/kg DM extra pasture) and the marginal costs (extra costs associated with the use of fertilisers). In a study done by Roberts and O'Connor (1992), it was estimated that to be cost effective, the response to nitrogen should be around 8-10 kg DM/kg N applied. This assumption is taking into account the income from the milksolids response to the use of nitrogen and the marginal costs associated with its use.

2.4.1.3.2.4 Overheads costs ($/ha)

The expenditure on overheads is relatively fixed, but it can vary widely between farms (Dexcel, 2003). It includes expenses on repairs and maintenance, administration, vehicles and standing charges. Between 1992/93 and 2001/02, overhead expenses, including interest payments, increased by 60% in New Zealand dairy farms (Dexcel, 2003).

2.4.2 Cost of Milksolids Production ($/kg MS)

The term cost of production refers to the average cost of producing one unit of output (Kay and Edwards, 1999). Farm profitability is influenced by cost of milksolids production and milksolids payout. Any time a product is sold for more than its cost of production, there is a profit (Kay and Edwards, 1999). For the calculation of the cost of milk production, the sum of the total cash and non cash expenses involved in milk production and the opportunity cost of capital is divided by total milk production (IFCN, 2003). Opportunity costs of capital should be included in the calculation of costs of production (IFCN, 2003). This is because, in the future, potential successors of the farmer, or the farmer himself, can decide on alternative uses of the capital invested in the farm.

In the dairy business it is important to maximise the margin between the cost of milksolids production and farm income (Bird, 2003). Cash surplus from milksolids production ($/ha) increases as farm working expenses per kilogram of milksolids (FWE/kg MS) decreases (See Figure 2.8). As FWE/kg MS increases, milksolids production per hectare should also increase to maintain the same cash surplus per hectare as the previous production levels (See Figure 2.8).

Figure 2.8: Influence of milksolids production per hectare and farm working expenses per kilogram of milksolids on cash surplus per hectare at $3.60/kg MS payout (From: Hedley and Bird, 2003).

In the world, New Zealand has one of the lowest costs per unit of milk produced (McCall and Clark, 1999; IFCN, 2003). This is because grazed pasture is usually the cheapest source of feed, and its feeding in New Zealand constitutes the main proportion of the diet for dairy cattle (Holmes et al., 2002). The use of supplementary feed increases the cost of milksolids production directly and indirectly (See Table 2.16). But although high feed input systems have higher costs of production per kg of MS, they can be profitable if the milksolids output per hectare is significantly high (Bird, 2003).

Table 2.16 Effect of the proportion of pasture in the diet on the cost of milksolids production (From: Hurley (1995): In Holmes, 2000).

	Percentage of grazed pasture in the diet (%)		
	30 (eg Denmark)	50 (eg Ireland)	90 (eg New Zealand)
Cost of Feed ($/kg MS)	2.9	2	1.1
Cost of feeding machinery & facilities ($/kg MS)	5.1	2.9	0.6

In New Zealand, between 1992/93 and 2001/02, there was an increase in farm working expenses per cow, per hectare and per kg MS (See Table 2.17). If milksolids payout had remained constant at $3.51/kg MS (as in 1992/93), the cash surplus from dairy farming in 2001/02 would have been lower than in 1992/93. This is because of the high FWE/kg MS ($3.37/kg MS) in 2001/02 (See Table 2.17). For New Zealand pastoral dairy systems, the cost of milksolids production in owner operators should be close to $2.00/kg MS, and $1.10/kg MS for sharemilkers (Bird, 2003). Holmes (2000) found that farms with high EFS/ha had lower costs of production per kg MS than farms with low EFS/ha. Farms with high EFS/ha diluted FWE/kg MS by achieving high milksolids production per hectare.

Table 2.17: Change in average farm working expenses (excluding interest payments) per cow, per hectare and per kg MS, between 1992/93 and 2001/02, in owner operators (From Dexcel, 2003).

Farm working expenses	Dairy Season		
	1992/93	1998/99	2001/02
$ FWE/ cow	639	623	886
$ FWE/ hectare	1461	1597	2258
$ FWE/ kg MS	2.32	2.25	2.74
Milksolids payout	3.51	3.51	5.28

The expenditure on feed (pasture production, supplements and fertilisers) constitutes the main proportion of farm expenses per kg MS (Dexcel, 2003). However, maintaining off-farm inputs at low levels, to maintain low production costs, do not necessarily maximise profit (Howse and Leslie, 1997). In 2001/02, a year of high milksolids payout, FWE/kg MS and the profit per kg MS were the highest in the last 10 years (Dexcel, 2003). Managed efficiently, during years of high milksolids payouts, high input systems can be more profitable per kg MS than low input systems (McCall and Clark, 1999).

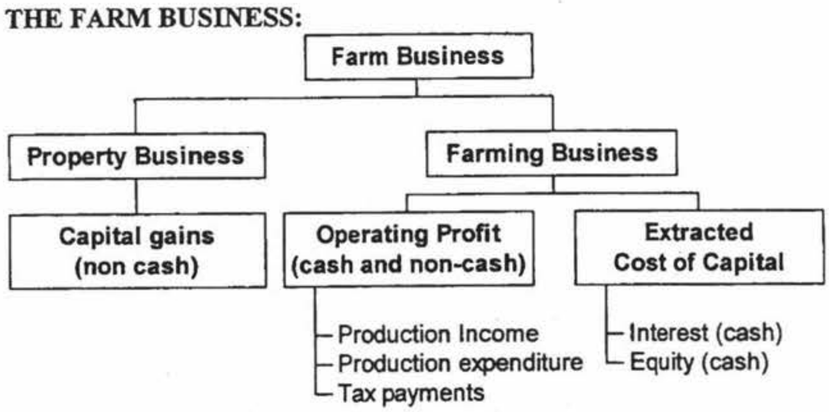
2.4.3 Return on Assets (RoA) and Return on Equity (RoE)

The dairy farm is for some dairy farmers a business. This business (See Figure 2.9) has 2 components the property business and the farming business (Shadbolt, 2001). This is because farmer's capital is not only formed by the profit from milksolids production, but also from the capital attached to the physical components of the farm.

The property business, which constitutes the farmer's assets, is a non-cash component formed by farm buildings, land, machinery, farm dairy, livestock, and other physical components that have value (See Figure 2.9). The property business can be converted into cash when parts of these assets are sold and capital gains or losses occur (Rawlings and Shadbolt, 2000).

The farming business is formed by the operating profit from milksolids production and the extracted cost of capital (See Figure 2.9). The operating profit is formed by the cash left after cash (e.g. feed costs) and non-cash expenses (e.g. depreciation) involved in milksolids production are subtracted from the gross farm income (Rawlings and Shadbolt, 2000).

Figure 2.9: Structure of the dairy business (From: Rawlings and Shadbolt, 2000).



The extracted cost of capital, also known as cost of funding, is the cash extracted from the business to meet the expectations of the providers of funds (Shadbolt, 2001). In the farm business, assets come from a mixture of debt (liabilities) and equity (owner's own capital) (Kay and Edwards, 1999). The interest payments (less tax credits) paid to financing institutions on money loans (debts) constitutes the cost of debt. Cash withdrawals from equity capital's earnings, for debt repayments or to meet family commitments, constitute the cost of equity (See Figure 2.9). For the success of the dairy business in the long term, it is necessary that its operating profits exceed its costs of funding (Shadbolt, 2001).

The rate of return on assets (RoA) measures, in percentage, the profit generated by the capital invested in the farm (Kay and Edwards, 1999; Dexcel, 2003c). It can be calculated from EFS, by excluding the run-off adjustment and by dividing this value by the total assets owned in the farm (Dexcel, 2003c). RoA can be used to compare returns between dairy farms and between dairy farms and other type of businesses (Falloon, 1996).

RoA should be higher as the risk of the business increases and the value of the assets decreases (Falloon, 1996). In New Zealand, the value of cows and machinery, the only assets owned by sharemilkers, vary from year to year. In 2001/02, capital appreciation of sharemilkers was much lower than in previous year (Dexcel, 2003). As consequence, RoA for sharemilkers (including capital appreciation) was significantly lower in 2001/02 (23.1%) compared to 2000/01 (71.5%) (Dexcel, 2003). In recognition of these risks, sharemilkers should expect higher returns on capital than owner operators (Falloon, 1996).

Equity, also known as Net Worth, is the portion of the assets that belong to the owner (Bird, 2003; Ryan, 2002). The rate of return on equity (RoE) measures the profit generated by the owner's own capital (Dexcel, 2003c; Kay and Edwards, 1999). For the calculation of RoE, interest payments and non-run-off leases are subtracted from EFS (in which the run-off adjustment has been excluded), and this value is divided by the owner's equity (Dexcel, 2003c).

Owner's equity increases when part of the operating profit is used to increase farm assets or decrease liabilities (Dexcel, 2003c; Kay and Edwards, 1999). The growth in equity, which is a measure of the success of the farm, gives dairy farmers financial solvency and enables them to make use of opportunities in the future (Bird, 2003; Billington, 2001; Ryan, 2002). But, equity growth depends on how farmers spend and invest their profits (Bird, 2003).

The success of the dairy business cannot only be measured by production (Rawlings and Shadbolt, 2000). While EFS describes the ability of the dairy farm to generate an operating profit during a particular time, return on capital and return on equity provides more information about the growth of the business and its long-term viability (Shadbolt, 2001; Rawlings and Shadbolt, 2000; Kay and Edwards, 1999).

Results of case studies showed that farms with high milksolids production per hectare, high EFS/ha and high RoA can have lower RoE than farms with lower milksolids production per hectare, EFS/ha and RoA (See Table 2.18).

Table 2.18: Physical and financial performance of case study farms in the lower North Island (From: Rawlings and Shadbolt, 2000)

	Farm A	Farm B	Farm C
Kg MS/cow	384	326	325
Kg MS/ha	1417	933	730
FWE%GFI(%)	56.5%	48%	52%
RoA	10.2	6.70%	10%
EFS/ha($/ha)	$2,850	$1,415	$845
Average Equity Growth per year (%)	-3.3%	-1.9%	7.73%
Average Equity (%)	74%	56%	50%
Average Value Creation per year ($)	-$10,850	-$16,600	$7,220

In Table 2.18, farms A and B had higher operating profits (EFS/ha) than farm C. But the negative RoE, which is a measure of equity growth, in farms A and B indicates that this profit was not used to increase equity and that owner's capitals were actually decreasing (See Table 2.18). Although farm C had lower EFS/ha, this profit was used to increase owner's equity (See Table 2.18).

This is because RoE is also influenced by the relation between RoA and cost of funding, and by the size of the cost of funding (Kay and Edwards, 1999). If RoA is greater than the cost of funding (interest paid on borrowed capital) then the extra return accrues to equity and RoE is greater than RoA (See Table 2.19). However, if RoA is lower than the cost of funding, part of the equity capital's earnings has to be used to pay for the cost of funding and, as consequence, RoE is lower than RoA (See Table 2.19). When the cost of funding is large compared to equity, the effect on RoE of the relationship between RoA and cost of funding is greater (Kay and Edwards, 1999).

Table 2.19: Effect of return on assets (RoA) and cost of funding (i) on return on equity (RoE) (From: Kay and Edwards, 1999).

If RoA > i , then RoE > RoA
If RoA < i , then RoE < RoA

The ability of the dairy business to pay for its cost of funding is essential for its sustainability and determines its success in the long-term (Shadbolt, 2001). Dairy farmers should aim at obtaining RoE higher than the interest rates (Dexcel, 2003c).

In New Zealand, the average RoA for owner operators increased from 1.8% in 1998/99 to 7.50% in 2001/02 (See Table 2.20). There was also a significant increase in RoA for sharemilkers (See Table 2.20). The significant increase in RoA during this period was associated with the increase in milksolids payout (See Table 2.20). However, the lower RoE in 2000/01 and 2001/02 compared to RoA suggests that during these years the cost of funding was greater than RoA. Between 1992/93 and 2001/02, the average equity for owner operators decreased from 73% to 67% of total assets (Dexcel, 2001).

Table 2.20: Return on capital (excluding capital appreciation) and return on equity in owner operators and sharemilkers (From Dexcel, 2003).

	Dairy Season		
Operating Strucutre	1998/99 ($3.58/kg MS)	2000/01 ($5.00/kg MS)	2001/02 ($5.28/kg MS)
Owner Operators			
Return on Assets (%)	1.80%	7.60 %	7.50 %
Return on equity (%)		4.60 %	2.70 %
Sharemilkers			
Return on Assets (%)	-2.50%	13.00%	11.90%
Return on equity (%)			

The dairy business is also a means through which dairy farmers save money to achieve personal goals and plan their retirement. Expansion of the dairy business, off-farm investment, debt reduction, education, improved livestyle and planning for their retirement are some of the goals dairy farmers aspire (Billington, 2001; Ryan, 2002). Equity growth gives farmers financial freedom and can help them to achieve their goals (Billington, 2001; Ryan, 2002). Since RoA and RoE measure the level of return to capital invested in the farm, their assessment should be part of the financial analysis of dairy farms. This will enable dairy farmers to monitor t heir equity and make long - term decisions towards their goals.

CHAPTER 3

PHYSICAL CHARACTERISTICS OF LOW INPUT AND HIGH INPUT PASTURE-BASED DAIRY SYSTEMS IN NEW ZEALAND

ABSTRACT

Dairy production in New Zealand is characterised for its low-cost, low-input, seasonal pastoral systems. Milksolids production per cow and per hectare in all-pasture systems is limited by restrictions in feed intake of the cow, feed supply per hectare and pasture quality. Supplementary feeds can be used to overcome the limits. The use of supplementary feeding has increased in New Zealand dairy farms in recent years, but there is little information about the physical characteristics of these farms. This research aimed at studying the physical characteristics of dairy farms in New Zealand, according to their level of feed imported per cow. ProfitWatch data corresponding to 915 owner-operated dairy farms, between 1998/99 and 2001/02, were analysed. The data was classified according to the dairy season (1998/99, 1999/00, 2000/01, 2001/02) and extra feed used per cow (low input systems <50kg DM/cow, intermediate input system 50-500 kg DM/cow, and high input systems >500kg DM/cow). For the present study, the definition of extra feed comprised supplements imported, winter grazing and maize silage grown in the farm. Analysis of variance (ANOVA) using SAS were carried out to identify significant differences between feed input systems. High input farms had higher stocking rates (2.7-2.8 vs 2.4-2.5 cows/ha), lower comparative stocking rate (83-86 vs 92-83 kg LWT/t DM), and higher milksolids production per cow (293-341 vs 249-295 kg MS/cow) and per hectare (826 -921 vs 616-744 kg MS/ha) than low input farms. The use of nitrogen fertiliser was also higher in high input farms than in low input farms (85-116 vs 53-67 kg N/ha/year). There were not significant differences in farm size, herd breeding worth, reproductive management and estimated pasture consumed per hectare between high and low input systems. These results show that it is important to adapt the dairy system (stocking rate) to the amount of extra feed used, in order to maintain a synchrony between feed demand and feed supply.

3.1 INTRODUCTION

In New Zealand, the majority of dairy farms are characterised by their low feed input, low-production costs and seasonal milk production. However, these low feed input systems also limit milksolids production per cow and per hectare (Roche and Reid, 2002). As milksolids production per cow is influenced by feed intake (Kolver, 2000), the input of extra feed into the dairy system can potentially increase milksolids production per cow and per hectare (Van der Poel, 1997).

In all-pasture systems (low input systems), milksolids production per cow is determined by feed intake and the quality of the pasture eaten (Clark and Penno, 1996; McGrath, 1997). In these systems, pasture production per hectare and the efficiency with which pasture is harvested and converted into milksolids determine milksolids production per hectare (Clark and Penno, 1996). In recent years, dairy farmers have increased the amount of feed supplied to their herds, through the use of supplementary feeding, with the aim of increasing milksolids production per cow and per hectare (MAF, 2001). This is because high milksolids productions per cow and per hectare have been reported in farms that use supplementary feeding (Van der Poel, 1997; Jamieson, 1996; Macdonald, 1999). However, the inclusion of extra feed requires the adaptation of the system in order to maximise milksolids production per cow and per hectare, and farm profitability.

In the last 10 years, the average milksolids production per cow and per hectare has increased in New Zealand (LIC, 2003). Similarly, the use of extra feed also increased in recent years (MAF, 2001). But there is little information about the physical characteristics of low input farms and high input farms in New Zealand. For this reason, it is important to know how the use of extra feed has affected milksolids production and the whole dairy system. This knowledge can help to identify the principles that influence milksolids production, and the characteristics that a low or high input system should have to be profitable and sustainable. The objective of this paper is to describe and compare the physical characteristics of low, intermediate and high input dairy systems on commercial farms in New Zealand.

3.2 MATERIALS AND METHODS

3.2.1 MATERIALS

This study comprises the analysis of data from Profitwatch, for the dairy seasons between 1998/99 and 2001/02. Profitwatch is a database with physical and financial data about New Zealand dairy farms.

Data for Profitwatch is collected through annual surveys conducted by Dexcel, an institution in charge of research and extension programs for the dairy industry in New Zealand. The data is based on actual farm accounts, obtained with previous consent of dairy farmers (Dexcel, 2003).

The selection of farms to be involved in the survey starts in April each year. Initially a stratified sample of 800 dairy farmers is randomly selected (Dexcel, 2003). This survey aims at collecting data from equal numbers of owner operators and 50/50 sharemilkers, from the six dairy regions in which New Zealand has been divided by Livestock Improvement (Dexcel, 2003). This sample comprises approximately 6% of the total population of owner operators and sharemilkers (Dexcel, 2003).

From May to September, Dexcel's Consulting Officers contact the farmers that were randomly selected and invite them to participate in the survey (Dexcel, 2003). After this period, data are collected from farmers who agreed to participate in the survey. The number of surveys taken for the analysis can be smaller than the sample selected because some farmers decline to participate in the survey, cannot be contacted or do not meet the survey criteria (Dexcel, 2003). The results of the survey are published in February of the following year in the Economic Survey of New Zealand Dairy Farmers. The database is updated each year, as new data becomes available. ProfitWatch also includes data from dairy farms, collected by consulting officers during the year, which are not included in the Economic Survey of dairy farms (Prewer, 2003).

The data provided by Dexcel corresponded to 1,970 surveys of dairy farms, from different operating structures, taken over 4 years. Since there are physical and financial differences between owner operators and other operating structures (LIC,2003; Dexcel, 2003), only data from owner-operated dairy farms (981) were considered for the analysis. The distribution of the data according to dairy season and region is shown in appendix 1.1.

The data from the 981 surveys selected corresponded to 626 owner-operated dairy farms. This is because 398 (64%) dairy farms were surveyed only once between 1998/99 and 2001/02; while 228 dairy farms (36%) were surveyed more than once (See Appendix 1.2).

3.2.2 METHODOLOGY

3.2.2.1 DATA MANAGEMENT

3.2.2.1.1 Classification of the data by season

The data corresponded to 4 dairy seasons (1998/99, 1999/00, 2000/01 and 2001/02). Since there were differences in milksolids payout in each season, the data was analysed separately for each season

3.2.2.1.2 Classification of the data according to operating structure

Since there are differences between farm operating structures, after the classification by season the data was split according to the operating structure of the farm. Only data corresponding to owner-operated farms were analysed in this study.

3.2.2.1.3 Classification of the data according to extra feed input (kg DM extra feed/cow)

After the data was classified according to dairy season and operating structure, the data from owner operators was further classified according to the amount of extra feed used per cow (kg DM extra feed/cow). For this classification, the definition of "extra feed" comprised supplements imported on to the dairy farm (pasture hay, pasture silage, maize silage, meals, grains, other feeds), pasture imported as winter grazing and maize grown on farm.

Maize silage made on the farm and pasture imported as grazing-off during winter were included into the definition of extra feed because dairy systems in New Zealand are based on pasture grown on the farm. Other feeds, different from pasture grown on the farm, are considered supplemen tary feeds. Hay and pasture silage made on farm were not included into the definition of extra feed because they come from pasture grown on the farm and pasture is the basic diet of dairy cattle in New Zealand.

Three feed input systems were considered in this study:

- **System 1: Low input system:** This group comprises almost self-contained all-pasture farms. Farms in this group used less than 50 kg DM of extra feed per cow.

- **System 2: Intermediate input systems:** This group comprises farms that used between 50 and 500 kg DM of extra feed per cow.

- **System 3: High input systems**: This group comprises farms that used more than 500 kg DM of extra feed per cow.

3.2.2.1.4 Physical parameters studied

3.2.1.4.A General farm data

3.2.1.4.A.1 Farm size (Eff. Ha): It refers to the number of effective dairy hectares in the farm used for milksolids production. Maize for silage can be grown temporarily in this area. This area includes races and farm buildings, but excludes fenced off waste areas, and land used for other purposes (horticulture, beef, sheep, etc) (ProfitWatch, 1999).

3.2.1.4.A.2 Herd size (N cows): It refers to the maximum number of cows milked in any month of the season (ProfitWatch, 1999).

3.2.1.4.A.3 Herd breeding worth (BW): It indicates the average genetic merit of the herd. The value of BW in ProfitWatch is an average of the herd for the corresponding season, it does not refer to the BW at the time of the survey (ProfitWatch, 1999). In the dataset provided some herds had values of BW equal to 0. After enquires about the meaning of these values, they were no considered in the analysis of the data since they represented missing values (Prewer, 2003).

3.2.1.4.A.4 Liveweight of Cows (kg LWT): It refers to the average liveweight of cows in the herd on December 1st. This date is chosen to measure liveweight due to the low effects of drought or pregnancy, in seasonal herds, at this time of the year (ProfitWatch, 1999). If cows in the herd were not weighted around this date, liveweight was estimated (See Appendix 2.1).

3.2.1.4.A.5 Stocking rate (SR): It refers to the maximum number of cows milked per effective hectare. This value is the result of dividing herd size by farm size (See Appendix 2.2).

2.2.1.4.A.5 Comparative stocking rate (CSR): It refers to the kilograms of liveweight of cows in the farm expressed per tonne of total dry matter of feed supplied for cows (kg LWT/t DM). The formula used to estimate CSR is shown in Appendix 2.3.

3.2.2.1.4.B Milksolids production

3.2.2.1.4.B.1 Milksolids production per cow (kg MS/cow): This value represents the average milksolids production per cow in the herd (See Appendix 2.4).

3.2.2.1.4.B.2 Milksolids production per hectare (kg MS/ha): It refers to the average milksolids production per hectare in the farm (See Appendix 2.5).

3.2.2.1.4.B.3 Lactation length (days): It refers to the average days in milk of the herd, measure between the mean calving date and the mean drying-off date of the herd (ProfitWatch, 1999). There were no data available from the 1998/99 dairy season.

3.2.2.1.4.B.4 Milksolids production per kg of liveweight (kg MS/kg LWT) (See Appendix 2.6).

3.2.2.1.4.B.5 Estimated milksolids production per tonne of dry matter offered (kg MS/t DM) (See Appendix 2.7).

3.2.2.1.4.C Reproductive characteristics of the herd

3.2.2.1.4.C.1 Replacement rate (%): It refers to the percentage of 2-year-old heifers that enter the herd each year.

3.2.2.1.4.C.2 Spring planned start of calving: It is the date when calving starts in spring. The planned start of calving is calculated taking into account the start of mating in the previous year and the duration of pregnancy in the cow (282 days). There were no data available from the 2000/01 dairy season.

3.2.2.1.4.C.3 Days from start of calving to mean calving date: It is an estimation of the compactness of calving. Only data from the season 2001/02 was available.

3.2.2.1.4.C.4 Percentage of cows induced, percentage of use of CIDR's and percentage of cows culled (empty or late calvers): No data were available for the season 1998/99.

3.2.2.1.4.D Pasture production

3.2.2.1.4.D.1 Estimated pasture consumed (t DM/ha): This value is an estimation of the average pasture consumed per hectare, based on the energy requirements of the herd (See Appendix 2.8).

3.2.2.1.4.D.2 Use of nitrogen fertiliser per hectare (kg N/ha): It refers to the amount of elemental nitrogen applied during the year to the effective dairy hectares in the farm (ProfitWatch, 1999). As nitrogen applied can be from different sources (Urea, DAP, etc), the calculation of kg N/ha applied takes into account the type of fertiliser, the percentage of nitrogen in this fertiliser and the rate of fertiliser application (kg/ha of fertiliser).

3.2.2.1.4.E Supplements made on farm (kg DM/ha)

3.2.2.1.4.E.1 Hay and pasture silage made on farm (kg DM/ha): It is an estimation of pasture dry matter conserved as hay or silage in the farm (See Appendix 2.9).

3.2.2.1.4.E.2 Maize silage made on farm (kg DM/ha): This value refers to the amount of maize for silage grown in the farm, for the farms that grew maize (See Appendix 2.10).

3.2.2.1.4.E.3 Supplements made on farm (kg DM/ha): It refers to the amount of hay, pasture silage and maize silage made on farm (See Appendix 2.11).

3.2.2.1.4.F Feed imported per hectare (kg DM/ha)

3.2.2.1.4.F.1 Supplements imported per hectare (kg DM/ha): It refers to the amount of feed, different from grazed pasture, imported, from outside the effective dairy area (See Appendix 2.12).

3.2.2.1.4.F.2 Pasture imported as winter grazing-off (kg DM/ha): It refers to the amount of pasture consumed by cows grazing off during winter. It does not include pasture imported as heifers grazing-off (See Appendix 2.13).

3.2.2.1.4.F.3 Total feed imported per hectare (kg DM/ha): It comprises the amount of supplements imported per hectare and the amount of pasture imported per hectare as winter grazing.

3.2.2.2 STATISTICAL ANALYSIS

Initially, a test of distribution of the data for EFS/ha was carried out. This test showed a normal distribution of the data, but with some extreme values (See Appendix 3.1). In order for the results to be more representative of the population and reduce the effect of extreme values, which might be due to error in the data or to especial cases, only data comprised within 2 standard deviations of EFS/ha was considered for the analysis. Appendix 3.1 shows that some observations were very extreme and their inclusion in the analysis may have had an influence in the results. This procedure is a fair manner of discarding data that are in the extremes without affecting significantly the mean (Watt, 1993). The reason why data within 2 standard deviations was chosen is because 95% of the data is comprised within these intervals and in statistics is a standard practise to work with a 95% confidence interval (Gould and Gould, 2002).

The 95% confidence intervals for the ProfitWatch data provided (Owner operators and sharemilkers) were found for each year, according to the EFS/ha (See Appendix 3.2). After data outside the 2 standard deviations confidence interval (66 surveys) was discarded, data corresponding to 915 owner-operated dairy farms were left (See Appendix 3.3).

Sixty-six observations from owner-operated dairy farms were excluded from the analysis. Some of these observations excluded corresponded to farms that had an EFS/ha extremely negative EFS/ha (See Appendix 3.1). The other part of observations excluded corresponded to farms that had an extremely positive EFS/ha (See Appendix 3.1). In both groups there was a significant margin between these extreme observations and the rest of the data (See Appendix 3.1). The mean values did not change significantly with the exclusion of these values due to the large amount of data. But due to the smaller data in the analysis of dairy farms according to quartiles for EFS/ha, and as consequence greater influence of extreme values, this procedure decreased the influenced of extreme values in the quartile assessment (according to EFS/ha) of the 3 feed input systems studied.

3.2.2.2.1 Analysis of variance

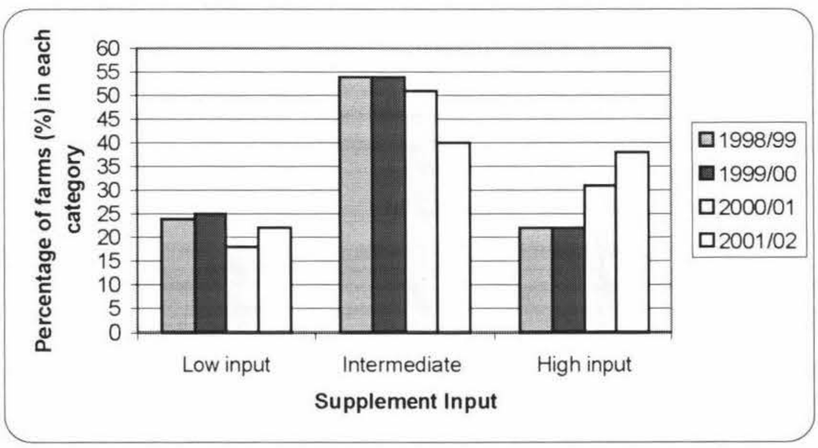
The statistical analysis of the data comprised analysis of variance (ANOVA). The analysis of variance, developed by R.A. Fisher in 1923, is a method that looks for differences between means of samples with normal distribution (Watt, 1993). The data analysed in this work had a normal distribution (parametric data). In this paper, one-way and two-way analyses of variance were carried out. This is because dairy season and feed input are variables that can be related to the physical characteristics of each observation.

The SAS statistical software was used in the analysis of the data. The statistical analysis comprised the Means procedure and the General Linear Model (GLM) procedure of SAS. This is because GLM allows analysis of variance between groups with different number of observations (SAS, 2003).

3.3.- RESULTS

Analysis of ProfitWatch data showed that the majority of owner operators dairy farms in New Zealand (40-54%) used between 50 and 500 kg DM of extra feed per cow (See Figure 3.1). Between 1998/99 and 1999/00, years in which milksolids payouts were \$3.58 and \$3.78/kg MS, respectively, there were no significant variations in the proportions of low, intermediate and high input farms. In 2000/01 and 2001/02, years in which milksolids payout increased to \$5.00 and \$5.30/kg MS, respectively, the proportion of low and intermediate input farms decreased while the proportion of high input farms increased (See Figure 3.1).

Figure 3.1: Distribution of owner-operated dairy farms in New Zealand according to the amount of extra feed input per cow (Low input <50kg DM/cow; Intermediate input 50-500 kg DM/cow; High input >500kg DM/cow).



***Extra feed: supplements imported + pasture imported as winter grazing + maize silage made on farm.**

PHYSICAL DESCRIPTION OF THE SYSTEMS:

The description of the systems was mainly based on data corresponding to the 1998/99 and 2001/02 dairy seasons. This is because these years represented the extremes of the dairy seasons in study in terms of time and milksolids payout. Milksolids payouts in 1998/99 and 2001/02 were the lowest (\$3.58/kg MS) and the highest (\$5.30/kg MS) of the dairy seasons in study, respectively.

3.3.1 GENERAL FARM DATA

The general characteristics and milksolids production of farms in the low, intermediate and high input systems are shown in Table 3.1.

Table 3.1: Physical Characteristics of dairy farms, in 1998/99 and 2001/02, according the amount of extra feed input per cow [1]

Farm Parameters	1998/99 [2]			2001/02 [2]		
	Low input	Int. input	High input	Low input	Int. input	High input
Number of farms	58	128	51	43	76	73
Farm General Data						
Farm size (Eff. Ha)	74 [a]	88 [a]	88 [a]	85 [a]	90 [a]	89 [a]
Herd size (N. cows)	181 [a]	220 [ab]	241 [b]	209 [a]	229 [a]	242 [a]
Herd breeding worth	38 [a]	38 [a]	36 [a]	77 [a]	79 [a]	74 [a]
Cow Liveweight (kg)	419 [a]	436 [b]	443 [b]	429 [a]	436 [a]	462 [b]
Stocking Rate (cows/ha)	2.47 [a]	2.64 [ab]	2.83 [b]	2.53 [a]	2.60 [a]	2.71 [a]
Comparative SR (kg LWT/t DM)	92 [a]	88 [ab]	86 [b]	83 [a]	83 [a]	83 [a]
Milksolids Production						
Kg MS/cow	249 [a]	274 [b]	293 [c]	295 [a]	310 [a]	341 [b]
Lactation length (days)	---	---	---	257 [a]	261 [ab]	267 [b]
Kg MS/ha	616 [a]	720 [a]	826 [c]	744 [a]	808 [a]	921 [b]
Kg MS/kg LWT	0.60 [a]	0.63 [ab]	0.66 [b]	0.69 [a]	0.72 [ab]	0.74 [b]
Estimated kg MS/ t DM offered	54 [a]	55 [a]	56 [a]	57 [a]	59 [ab]	61 [b]
Estimated kg DM offered /kg MS	18.5	**18.1**	17.9	17.5	16.9	16.4

[1] Feed input: supplements imported + winter grazing + maize grown on farm
[2] Values with different superscript letter are statistically different (it refers to statistical difference within each year only)

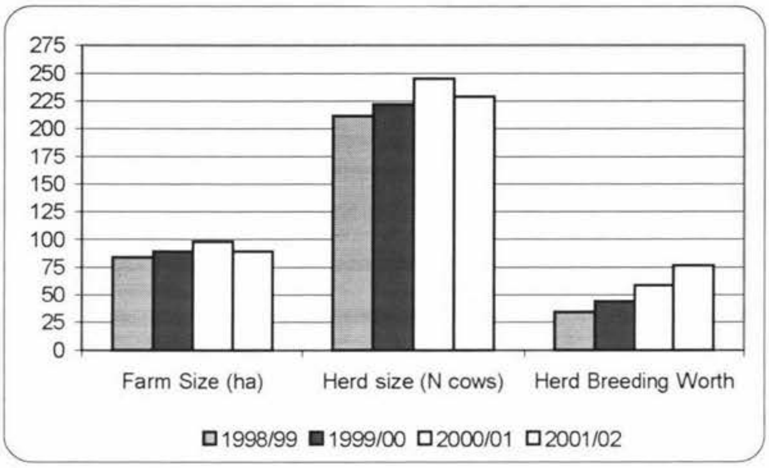
3.3.1.1-Farm size, herd size, herd breeding worth and cow's liveweight

Between 1998/99 and 2001/02 there were increases in the average farm size (from 84 to 89 ha), herd size (from 212 to 229), and herd breeding worth (from 34 to 76) in owner-operated dairy farms (See Figure 3.2).

High input systems tended to have larger farms than low input systems (See Figure 3.3), but with an exception in 2000/01, these differences were not significant (See Table 3.1 for data from the seasons 1998/99 and 2001/02). In the 4 dairy seasons analysed, high input systems had larger herds than intermediate and low input systems

(See Figure 3.4). Within each year there were not significant differences in herd breeding worth between high, intermediate and low input systems (See Table 3.1 for data from the seasons 1998/99 and 2001/02).

Figure 3.2: Average farm size (Eff. Ha), herd size and herd breeding worth between 1998/99 and 2001/02.



In all 4 dairy seasons high input systems had heavier cows than intermediate and low input systems (See Table 3.1 for data from the seasons 1998/99 and 2001/02). But the difference in cow's liveweight between high input and low input systems was not significant in 1999/00.

Figure 3.3 Farm size (Eff. Ha) in low, intermediate and high input farms.

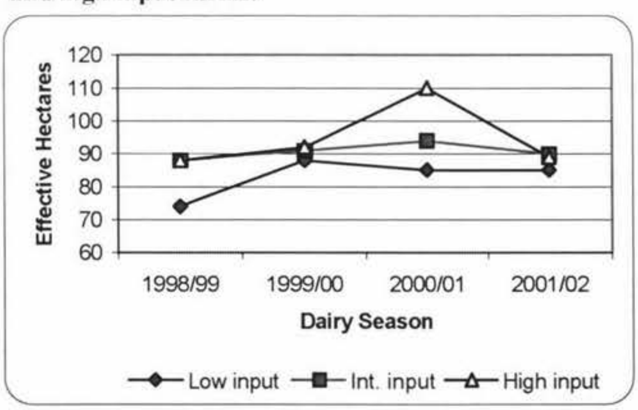
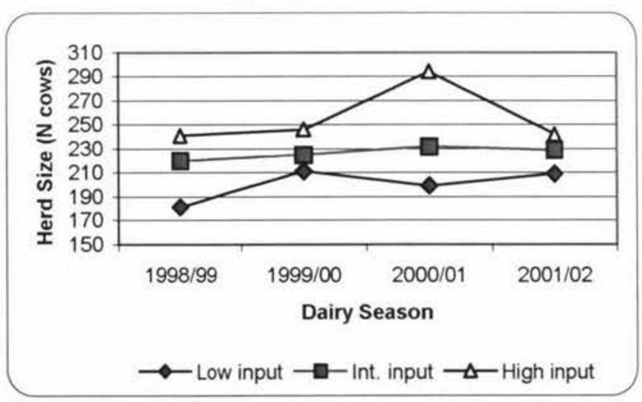


Figure 3.4: Average herd size (N cows) in low, intermediate and high input farms.



3.3.1.2.- Stocking Rate (cows/ha) and Comparative Stocking Rate (kg LWT/t DM)

Between 1998/99 and 2001/02, the average stocking rate in owner-operated dairy farms in New Zealand remained constant (See Figure 3.5). During this period, the average comparative stocking rate decreased significantly (See Figure 3.6).

Figure 3.5: Average stocking rate, between 1998/99 and 2001/02

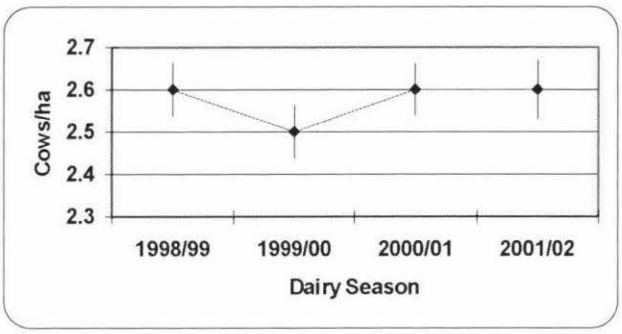
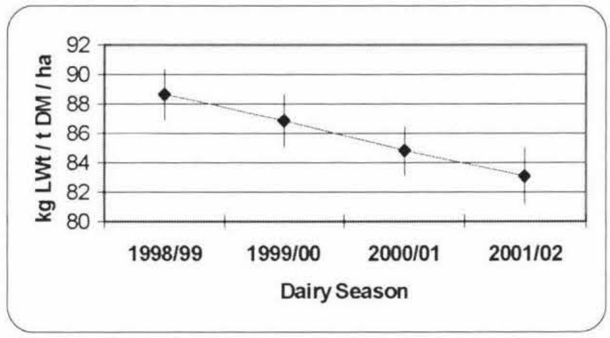
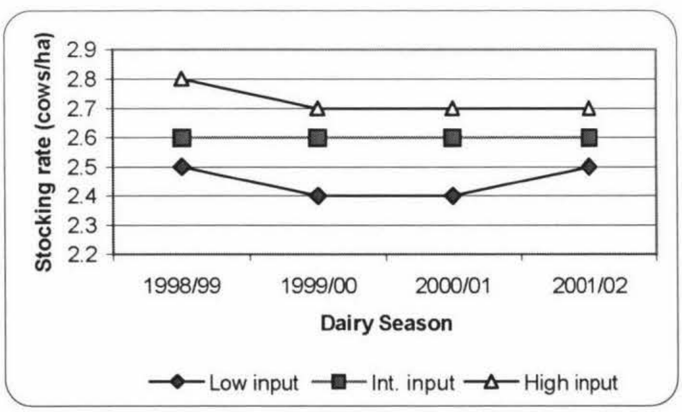


Figure 3.6: Average comparative stocking rate, between 1998/99 and 2001/02.



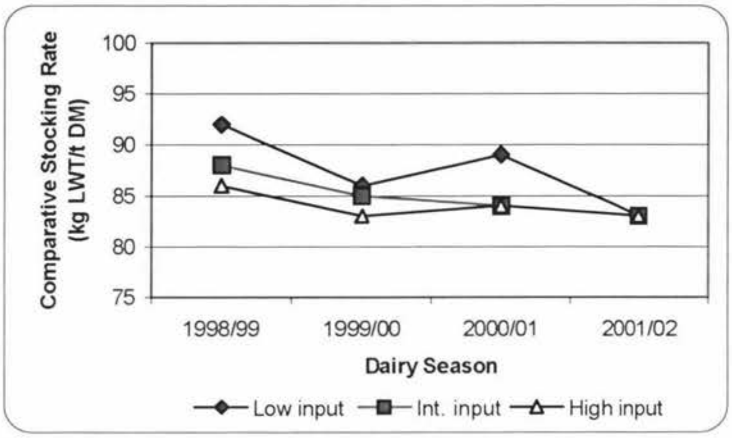
In all 4 dairy seasons, high input systems had higher stocking rates than intermediate and low input systems (See Figure 3.7). However, the difference in stocking rate between systems was not significant in 2001/02 (See Table 3.1).

Figure 3.7: Stocking rate (cows/ha) in low, intermediate and high input farms.



There were no significant differences in comparative stocking rate between systems in 1999/00 and 2001/02 (See Figure 3.8). But in 1998/99 and 2000/01, high input systems had significantly lower comparative stocking rates than low input systems (See Table 3.1 for data from the seasons 1998/99 and 2001/02).

Figure 3.8: Comparative stocking rate in low, intermediate and high input farms.



3.3.2.- MILKSOLIDS PRODUCTION

Between 1998/99 and 2001/02, there were significant increases in milksolids production per cow (See Figure 3.9), milksolids production per hectare (See Figure 3.10), and milksolids production per kg of liveweight.

Figure 3.9: Average milksolids production per cow between 1998/99 and 2001/02.

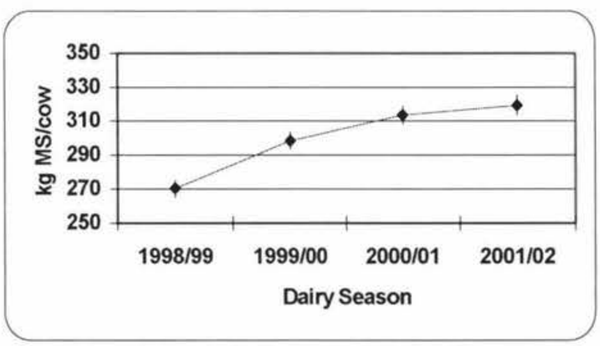
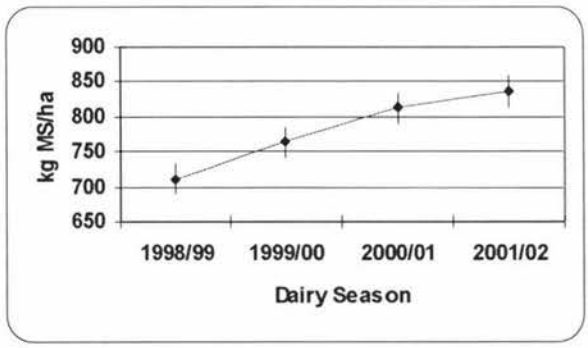
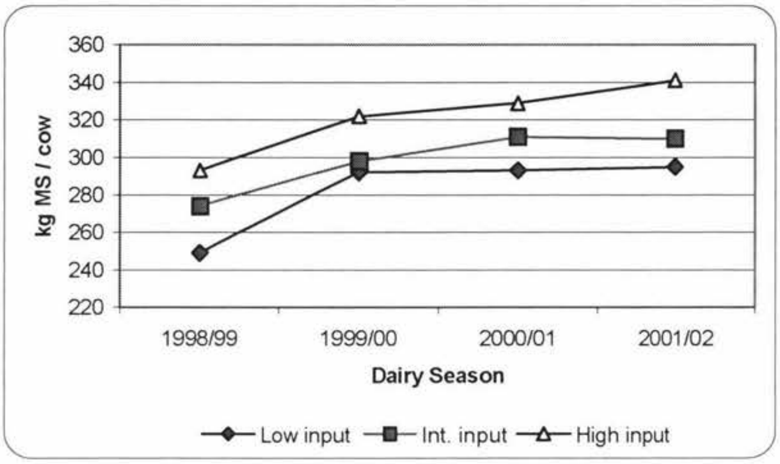


Figure 3.10: Average milksolids production per hectare between 1998/99 and 2001/02.



High input systems had significantly higher (+13% - +18%) milksolids production per cow than intermediate and low input systems (See Table 3.1). Milksolids production per cow in high input systems was 44 to 46 kg MS higher than in low input systems (See Figure 3.11).

Figure 3.11: Milksolids production per cow in low, intermediate and high input farms.

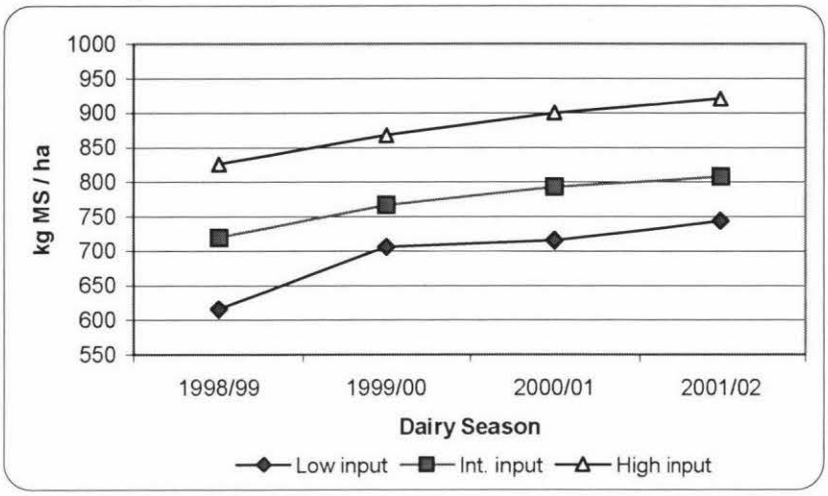


Between 1999/00 and 2001/02, high input systems tended to have longer lactation lengths (+10 days in milk) than intermediate and low input systems. But the difference in lactation length was only significant in 2001/02 (See Table 3.1).

In all 4 dairy seasons, high input systems had higher milksolids production per kg of liveweight than intermediate and low input systems (See Table 3.1 for data from the seasons 1998/99 and 2001/02). In intermediate input systems, milksolids production per kg of liveweight was intermediate between those of high and low input systems.

High input systems had higher milksolids production per hectare than intermediate and low input systems (See Table 3.1). The difference in milksolids production per hectare between high input and low input systems decreased from 210 kg MS/ha in 1998/99 to 177 kg MS/ha in 2001/02 (See Figure 3.12). Milksolids production per hectare in intermediate input systems was intermediate between those of high and low input systems (See Figure 3.12).

Figure 3.12: Milksolids production per hectare in low, intermediate and high farms.



With an exception in 2001/02, in which the difference was significant, there were not significant differences between systems in the estimated milksolids production per tonne of dry matter of feed offered in the farm (See Table 3.1).

3.3.3.- REPRODUCTIVE CHARACTERISTICS OF THE HERD

In all 4 dairy seasons, high input systems had higher replacement rates than intermediate and low input systems (See Table 3.2 for data from the seasons 1999/00 and 2001/02), but the difference was only significant in 1998/99. Between 1998/99 and 2001/02, the average start of calving in high, intermediate and low input systems varied between 24th July and 1st August. There were not significant differences betweens systems in the average number of days from the start of calving to mean calving date (See Table 3.2).

Between 1999/00 and 2001/02, high input systems tended to have higher number of cows induced than intermediate and low input systems, but the differences were not significant (See Table 3.2 for data from the seasons 1999/00 and 2001/02). Although the differences were not significant, between 1999/00 and 2001/02, the percentages of use of CIDR's were higher in high input systems than in intermediate and low input systems (See table 3.2). There were not significant differences in the percentages of cows culled (late calvers or cows empty) among systems (See Table 3.2 for data from the seasons 1999/00 and 2001/02).

Table 3.2: Reproductive characteristics of dairy farms, in 1999/00 and 2001/02, according to their level of extra feed input per cow [1]

Farm Parameters	1999/00 [2]			2001/02 [2]		
	Low input	Int. input	High input	Low input	Int. input	High input
Number of farms	58	128	51	43	76	73
Replacement rate (%)	22% [a]	22% [ab]	23% [b]	22% [a]	23% [a]	25% [a]
Spring planned start of calving date	24-Jul-98	26-Jul-98	30-Jul-98	24-Jul-01	26-Jul-01	26-Jul-01
Days from start of calving to mean calving date	----	----	----	22 [a]	23 [a]	22 [a]
Cows induced (%)	6% [a]	8% [a]	8% [a]	5% [a]	4% [a]	5% [a]
Use of CIDR's (%)	6% [a]	9% [a]	9% [a]	4% [a]	9% [a]	9% [a]
Cows culled (late calvers or empty)	8% [a]	7% [a]	8% [a]	6% [a]	8% [a]	8% [a]

[1] Feed input: supplements imported + winter grazing + maize grown on farm
[2] Values with different superscript letters are statistically different (it refers to statistical difference within each year only)

3.3.4.- ESTIMATED PASTURE CONSUMED (t DM/ha) AND USE OF NITROGEN FERTILISER (kg N/ha)

Between 1998/99 and 2001/02, the average estimated pasture consumed in dairy farms varied between 9.9 and 10.7 t DM/ha. In all 4 dairy seasons, there were no significant differences in estimated pasture consumed per hectare between low, intermediate and high input systems (See Table 3.3).

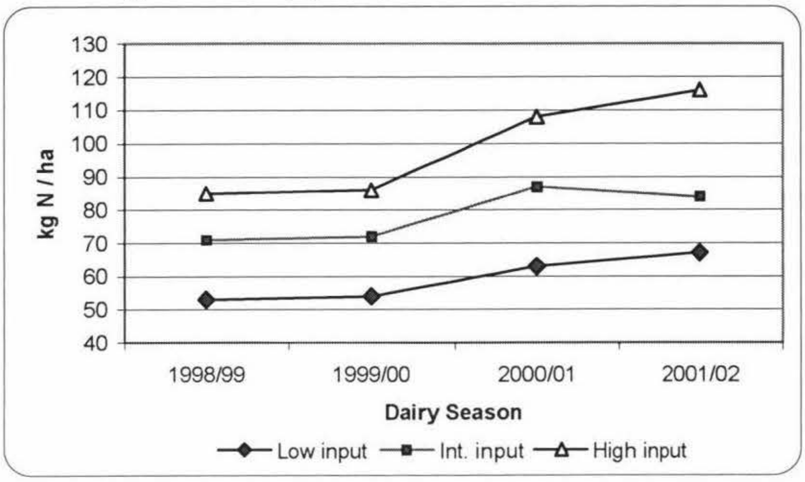
Table 3.3: Estimated pasture consumed per hectare (t DM/ha) and use of nitrogen fertiliser (kg N/ha) in dairy farms, in 1998/99 and 2001/02, according to their level of extra feed input per cow [1]

Farm Parameters	1998/99 [2]			2001/02 [2]		
	Low input	Int. input	High input	Low input	Int. input	High input
Number of farms	58	128	51	43	76	73
Estimated pasture consumed (t DM/ha)	9.7 [a]	10.0 [a]	10.0 [a]	11.0 [a]	11.0 [a]	10.2 [a]
kg N applied /ha/year	53 [a]	71 [ab]	85 [b]	67 [a]	84 [a]	116 [b]

[1] Feed input: supplements imported + winter grazing + maize grown on farm
[2] Values with different superscript letters are statistically different (it refers to statistical difference within each year only).

The average amount of nitrogen applied per hectare in owner-operated dairy farms increased from 66 to 92 kg/ha between 1998/99 and 2001/02. During this period, high input systems used significantly more nitrogen fertiliser per hectare than intermediate and low input systems (See Table 3.3). The average amount of nitrogen fertiliser applied per hectare in intermediate input systems was intermediate between those of high and low input systems (See Figure 3.13).

Figure 3.13: Use of nitrogen fertiliser (kg N/ha) in low, intermediate and high input farms.



3.3.5.- SUPPLEMENTS MADE ON THE FARM: hay, pasture silage, maize silage, crops (t DM/ha).

Between 1998/99 and 2001/02, 73% to 87% of dairy farms made supplement on-farm. During this period, the average amount of supplements made on farm increased from 469 kg DM/ha in 1998/99 to 767 kg DM/ha in 2001/02. Of the farms that made supplements on farm, 97% to 100% made hay or pasture silage, and between 11% and 20% of dairy farm also grew maize for silage on the farm (8% to 15% of all owner-operated dairy farms). High input systems made more supplements on farm than intermediate and low input systems (See Table 3.4).

The average amount of hay and pasture silage made on farm increased from 374 to 634 kg DM/ha between 1998/99 and 2001/02, but there were no significant differences among systems in the amount of hay and pasture silage made on farm (See Table 3.4).

Table 3.4: Supplements made on farm (kg DM/ha) and feed imported per hectare (kg DM/ha) in dairy farms, in 1998/99 and 2001/02, according the their level of extra feed input per cow [1]

Farm Parameters	1998/99 [2]			2001/02 [2]		
	Low input	Int. input	High input	Low input	Int. input	High input
Number of farms	58	128	51	43	76	73
Supplements made on farm						
Hay and silage made on farm (kgDM/ha)	399 [a]	357 [a]	490 [a]	728 [a]	568 [a]	669 [a]
Farms that made maize silage (%)	2% [5]	5%	20%	0%	12%	26%
Maize silage made on farm (kg DM/ha)	---	671	1078	0	604	944
Supp. made on farm (kg DM/ha)	376 [a]	411 [a]	860 [b]	728 [a]	635 [a]	955 [b]
Feed imported						
Farms that imported supplements (%)	52%	93%	100%	53%	87%	95%
Supplements imported (kg DM/ha) [3]	53 [a]	402 [b]	1115 [c]	50 [a]	514 [b]	1715 [c]
Farms that use winter grazing (%)	2% [5]	43%	69%	0%	28%	74%
Winter grazing (kg DM/ha)	---	455	1120	0	513	880
Total feed imported (kg DM/ha) [4]	53 [a]	574 [b]	1884 [c]	50 [a]	630 [b]	2336 [c]
Total feed imported per cow (kg DM/cow)	22 [a]	217 [b]	667 [c]	20 [a]	242 [b]	863 [c]
Total extra feed input per cow (kg DM/cow)	22 [a]	229 [b]	737 [c]	20 [a]	250 [b]	943 [c]

[1] Extra feed input: supplements imported + winter grazing + maize grown on farm
[2] Values with different superscript letter are statistically different (it refers to statistical difference within each year only).
[3] Supplements imported: hay and pasture silage, maize silage, grains, meals, other feeds.
[4] Total feed imported = supplements imported + winter grazing.
[5] 1 farm

3.3.6.- Total Feed imported (Supplements and winter grazing)

Between 1998/99 and 2001/02, 90% to 95% of farms imported some extra feed as supplements or winter grazing.

Between 1998/99 and 2001/02, approximately 50% of low input farms imported 44 to 54 kg DM/ha of feed (See Table 3.4). Since only one low-input farm used winter grazing (in 1998/99), the use of grazing-off during winter cannot be considered as a practised in most low input systems.

Between 1998/99 and 2001/02, intermediate input systems imported from 574 to 630 kg DM/ha of feed; and high input systems from 1884 to 2336 kg DM/ha (See table 3.4).

3.4.- DISCUSSION

3.4.1 PHYSICAL CHANGES IN NEW ZEALAND DAIRY FARMS BETWEEN 1998/99 AND 2001/02

Since dairy farms in ProfitWatch were not the same in all 4 dairy seasons, it is difficult to make conclusions about trends over time, since they cannot be completely accurate. The increases in average farm size and herd size between 1998/99 and 2001/02 are trends that have been observed since the early 1970s and 1980s, respectively (LIC, 2003). The increase in average herd breeding worth between 1998/99 and 2001/02 is also a trend that has been observed from around 1987 (LIC, 2003). Table 3.5 shows a comparison of the data found in this study with the data published in Dairy Statistics. However, these comparisons should be analysed with caution since data published in Dairy Statistics are averages of different farm operating structures (owner operators and sharemilkers).

Table 3.5: Comparison of farm size, herd size, stocking rate, kg MS/cow and kg MS/ha found in this study with data from dairy Statistics (LIC, 2003).

Farm Parameters	1998/99		2001/02	
	In this study	Dairy Statistics	In this study	Dairy Statistics
Farm size (Eff. Ha.)	84	91	89	103
Herd size (N cows)	212	229	229	271
Stocking rate	2.64	2.67	2.62	2.67
kg MS/cow	270	256	319	307
kg MS/ha	711	684	837	824
Lactation length (days)	---	266	263	268

The increase in average farm size between 1998/99 and 2001/02 was probably the reason why the average stocking rate remained relatively constant during this period of time despite increases in average herd size. Although there was a small increase in the average liveweight of the cows between 1998/99 and 2001/02, it is difficult hypothesise about changes in liveweight of the cows over these years. This is because liveweight of the cows is an estimated measure (See section 3.2.1.4.A.4).

The decrease in average comparative stocking rate between 1998/99 and 2001/02 suggests that dairy farmers increased the feeding level of their herds in recent years. But the accuracy of this conclusion is influenced by the reliance on estimated body liveweight and dry matter.

The increase in milksolids production per cow and per hectare between 1998/99 and 2001/02 is a trend that has been reported since 1992/93 (LIC, 2003).

Between 1998/99 and 2001/02, there were no significant differences in the average planned start of calving in spring. This is because in New Zealand, dairy farmers try to synchronise the peak of lactation with the peak of pasture growth rate in October (Holmes et al., 2002).

The increase in the use of nitrogen fertiliser over these years can be associated with the increase in milksolids payout. This is because the use of nitrogen fertiliser is one of the cheapest options to increase feed supply in the dairy farm (McGrath et al., 1998). Although in all 4 dairy seasons there were no significant increases in the average amount of pasture consumed per hectare, it is difficult to make a conclusion since the amount of pasture consumed per hectare is an estimated value. The increase in the amount of pasture conserved on farm (kg DM/ha) over these years can be associated with the increased use of nitrogen fertiliser. But the lower amount of pasture conserved on farm in 1998/99 can also be the result of adverse weather conditions in that year (drought).

The increases in the average amounts of maize silage made on farm and supplements imported (conserved pasture, maize silage, meals, grains, other feeds) during the period of study can be associated with the increases in milksolids payout during these years.

3.4.2 COMPARISON OF PHYSICAL FARM PARAMETERS OF HIGH AND LOW INPUT DAIRY SYSTEMS

The increase in the proportion of high input farms between 1998/99 and 2001/02 was probably associated with the increase in milksolids payout from \$3.58/kg MS (1998/99) to \$5.30/kg MS (2001/02).

3.4.2.1 GENERAL FARM DATA

3.4.2.1.1 Herd breeding worth (BW)

The reason why there was no significant difference on average herd BW between low, intermediate and high input systems can be associated with the high use of artificial breeding (80%-85%) in all dairy farms in New Zealand (LIC, 2003). The increase in BW over time, in all 3 systems, suggests that dairy farmers are trying to increase the genetic merit of their herds.

3.4.2.1.2 Liveweight of the cows (kg)

The difference in cow liveweight between low and high input systems can be due to the higher level of feeding of the cows in high input farms. However, this is just an assumption since the average liveweight of the cows in each feed input system can also have been influenced by breed (e.g. more Jerseys cows in low input farms) (See section 3.2.1.4.A.4). Since there were no significant differences in the estimated pasture consumed per hectare between low and high input systems, it is probable that the extra feed offered to the cows in high input systems may have also contributed to increase body liveweight. This is because during the partition of nutrients in the body a proportion of the energy is utilised for maintenance, body weight gain and pregnancy (Holmes et al., 2002).

3.4.2.1.3 Stocking rate (cows/ha)

In low input systems, pasture production per hectare determines the number of cows that can be fed per hectare. Since high input systems had higher feed supply per hectare (pasture + extra feed) than intermediate and low input systems, their stocking rates were also higher in order to maximise feed utilisation. This is because milksolids production and farm profitability are influenced by the synchrony between feed demand and feed supply (Howse and Leslie, 1997; Holmes, 2000)

The average stocking rates in the 3 systems described in this study were lower than the stocking rates in the 8 farmlets of the 1.75 tMS/ha trial at Dexcel (Macdonald, 1999).

3.4.2.1.4 Comparative stocking rate (kg LWT/t DM)

In the present study the actual feed intake per cow was not measured, but it is likely that it was higher for cows in high input farms as assessed by their higher milksolids production per cow. This is because high input farms had lower comparative stocking rates than low input farms. Penno (1999) found that the optimum comparative stocking rate for maximum EFS/ha varied between 81 and 85 kg LWT/t DM. With the exception of 1998/99, high input systems had a comparative stocking rate within the range suggested by Penno (1999). In three dairy seasons (1998/99, 1999/00, 2000/01), low input systems had a comparative stocking rate higher than the optimum suggested by Penno (1999) for maximum EFS/ha.

3.4.2.2 MILKSOLIDS PRODUCTION

Since there were not significant differences in herd breeding worth between systems, differences in milksolids production per cow between high and low input systems are mainly due to the level of feeding of the cows in these systems. This statement is further supported by the higher kg MS/kg LWT observed in high input systems. This expression is used because it reduces variations due to differences in liveweight between different breeds (Glassey, 2001).

The increase in lactation length is one of the ways in which the use of extra feed can increase milksolids production per cow (Holmes et al., 2002). In this study, the difference in lactation length between high and low input systems was small (0 to 11 days) compared to other works in which the use of extra feed increased lactation length by 54, 60 and 74 days (Pinares and Holmes, 1996; Penno et al., 1999). The short difference in lactation length between low and high input systems in this study can be because the values in this study are averages of a group of farms with different systems and efficiency of management.

The combination of high stocking rates, high milksolids production per cow and slightly longer lactation lengths determined higher milksolids production per hectare in high input farms (See Table 3.1). Other studies have also reported higher milksolids production per hectare in high input systems than in low input systems (Macdonald, 1999; Van de Poel, 1997).

3.4.2.3 REPRODUCTIVE CHARACTERISTICS OF THE HERDS

Although earlier calving dates can be possible with the use of supplementary feed (Holmes et al., 2002), the results found in this study suggests that high input farms were no utilising the extra feed to achieve early calving dates. The planned start of calving in low intermediate and high input systems was in late winter early spring (24^{th} Jul – 1^{st} Aug). This is within the range of planned start of calving published in Dairy Statistics (LIC, 2003). The average days from start of calving to mean calving date (22-23 days in 2001/02) suggest that on average most of the herd calves within 6-

7 weeks, in all 3 feed input systems. This data agrees with the average days from start of calving to mean calving date published in Dairy Statistics (LIC, 2003).

3.4.2.4 ESTIMATED PASTURE CONSUMED AND USE OF NITROGEN FERTILISER

Although there were no significant differences in estimated pasture consumed per hectare between systems, it is difficult to reach a conclusion from this data since the actual pasture consumed was not measured. Pasture consumed in this study is an estimate based on the total energy requirements of the cow and the energy supplied by the feed imported (See Appendix 2.8). The difference between the energy requirements of the cow and the energy supplied by the extra feed is attributed to pasture consumed. Howse and Leslie (1997), reported an average estimated pasture consumed of 13.7t DM/ha in Taranaki dairy farms, which is higher than the average pasture consumed per hectare in low, intermediate and high input systems in this study (9-11t DM/ha). This difference can be due to the fact that the data in this study is the average of all the regions in New Zealand.

High input systems used more nitrogen fertiliser than low input systems (+32 to +49 kg N/ha). This can be due to the fact that nitrogen fertiliser is usually a cheap source of extra feed (Holmes et al., 2002). Van der Poel (1996) and Jamieson (1996) also reported increases in the use of nitrogen fertiliser with the intensification of their systems.

3.4.2.5 SUPPLEMENTS MADE ON FARM AND FEED IMPORTED

In this study, there were no significant differences in the amount of hay and pasture silage made on farm between high and low input systems (See Table 3.4). Although high input systems used more nitrogen per hectare than low input systems, their higher stocking rates probably also limited the amount of pasture that can be conserved on farm.

Since maize grown on farm and feed imported was the basis for the criteria of classification of the systems, it is not appropriate to make comparisons between systems in relation to the amount of feed made on farm or feed imported.

3.5.- CONCLUSIONS

3.5.1 High input systems had higher stocking rates, lower comparative stocking rates, higher milksolids production (per cow and per hectare) and higher use of nitrogen fertiliser per hectare than intermediate and low input systems.

3.5.2 There were no significant differences in replacement rate, calving date, and the percentages of cows induced, use of CIDR's and cows culled (late calvers or empty) between low, intermediate and high input systems.

3.5.3 There were no significant differences in the estimated pasture consumed per hectare between the 3 feed input systems.

3.5.4 The importation of extra feed into the dairy system requires the physical adaptation of the system. In all dairy systems, management should be oriented to maintain a synchrony between feed demand of the herd and feed supply.

3.5.5 Stocking rate should be high enough to maximise the utilisation of pasture grown in the farm and extra feed.

3.5.6 The inclusion of extra feed into the dairy system can result in higher feeding levels of the cow (lower comparative stocking rates) and heavier cows.

3.5.7 The inclusion of extra feed into the dairy system results in higher milksolids production per hectare. This is associated to the increases in milksolids production per cow and stocking rate.

CHAPTER 4

FINANCIAL CHARACTERISTICS OF LOW INPUT AND HIGH INPUT PASTURE-BASED DAIRY SYSTEMS

ABSTRACT

In the last few years there has been major debate about the profitability of dairy farms with low input and high input of extra feed in New Zealand. Since high input farms have higher milksolids production per hectare it is possible that their financial performance is also higher than in low input systems. This study aimed at describing the financial characteristics of New Zealand dairy farms with low and high input of feed. Data from ProfitWatch (915 owner-operated dairy farms) corresponding to the dairy seasons 1998/99, 1999/00, 2000/01, 2001/02 were analysed. The data was classified according to the dairy season and feed imported per cow (low input systems <50kg DM/cow, intermediate input system 50-500 kg DM/cow, and high input systems >500kg DM/cow). In this study, the definition of extra feed comprised supplements imported, winter grazing and maize silage made in the farm. During the period of study milksolids payout increased from $3.58/kg MS in 1998/99 to $5.30/kg MS in 2001/02. High input systems had significantly higher gross farm income per hectare than low input systems ($3287/ha vs $2374/ha in 1998/99, and $5377/ha vs $4362/ha in 2001/02). This is because high input systems had higher incomes per hectare from the sale of milksolids and stock than low input systems. Farm working expenses per hectare were also significantly higher in high input systems ($2519/ha vs $1760/ha in 1998/99, and $3259/ha vs $2187/ha in 2001/02). High input farms had higher cost of labour, feed, fertilisers and overheads than low input farms. As consequence, the EFS/ha of high input and low input systems were not significantly different ($550/ha vs $474/ha in 1998/99 and $1902/ha vs $1849/ha in 2001/02). In all 4 dairy seasons, there were not significant differences in the percentages of return on assets and return on equity between low, intermediate and high input systems. These results show that between 1998/99 and 2001/02, although differences in farm income and expenditure between low, intermediate and high input systems, they all 3 were equally profitable.

4.1 INTRODUCTION

New Zealand, the majority of dairy systems are characterised by their low feed input, low-costs of production and seasonal milk production. These low-cost systems are necessary due to the relatively low and variable milk price. However these systems also limit milksolids production per cow and per hectare (Kolver, 2000) and, consequently, farm profitability.

In the last FWE years there has been considerable debate over the profitability of low input and high input dairy farms in New Zealand. Studies have shown that low feed input farms (all-pasture farms) can be highly profitable (Penno et al., 1996; McGrath, 1997; Armer, 2000; Kuriger, 2002). Similarly, some studies have also showed that high input farms can also be highly profitable if managed properly, physically and financially (Van der Poel, 1996; Moore, 2000; Roche and Reid, 2002).

Generating a high farm income per hectare is the first step to achieve high farm profit (Leslie, 2001). Since gross farm income per hectare is mainly determined by milksolids production per hectare (Howse and Leslie, 1997), increases in milksolids production per hectare can potentially increase farm profitability. The input of extra feed into pasture-based dairy systems can potentially increase farm profitability through increases in milksolids production per cow and per hectare.

In recent years, dairy farmers have increased the amount of feed offered to their herds (kg DM/cow), and the amount of money spent on feed purchased, with the aim of increasing milksolids production per cow and per hectare (Attrill and Miller, 1996, MAF, 2001). In 1989/90, the expenditure on pastures and supplements was 23% of the total variable costs; but in 1999/00, it was 30% of the total variable costs (Leslie, 2001). The use of supplementary feeds increases the cost of milksolids production directly and indirectly (Hurley, 1995: In Holmes, 2000). High feed input systems can be profitable if the income from the marginal milksolids response to the extra feed is higher than the increase in farm expenses associated with the use of extra feed (Van der Poel, 1996). The financial success of high input systems will be influenced by factors like labour efficiency, high milksolids production per hectare and pasture utilization (Leslie, 2001).

The objective of this paper is to describe the financial characteristics of low, intermediate and high feed input dairy farms in New Zealand. This information will contribute to understand the way in which the use of extra feed is affecting the profitability of dairy farms in New Zealand.

4.2 MATERIALS AND METHODS

4.2.1 MATERIALS

See section 3.2.1 in chapter 3 (Page 43).

4.2.2 METHODOLOGY

4.2.2.1 DATA MANAGEMENT

4.2.2.1.1 Classification of the data by season

See section 3.2.2.1.1 in chapter 3 (Page 44)

4.2.2.1.2 Classification of the data according to operating structure

See section 3.2.2.1.2 in chapter 3 (Page 44)

4.2.2.1.3 Classification of the data according to extra feed input (kg DM extra feed/cow)

See section 3.2.2.1.3 in chapter 3 (Page 44)

4.2.2.1.4 Financial parameters studied

4.2.2.1.4.A Gross farm income per hectare (GFI/ha):

4.2.2.1.4.A.1 Income from the sale of milksolids ($/ha): It represents the income from the sale of milk for processing (It does not include winter milk premium). This value is obtained directly from the accounts of the farm (ProfitWatch, 1999) and then is adjusted to the average milksolids payout of the season (See Appendices 4.1 and 4.2). This procedure is necessary to decrease differences due to milksolids payout between dairy companies.

4.2.2.1.4.A.2 Net stock income ($/ha): It represents the income from the sale and purchase of stock. Stock income comes from the sale of females stock (cows or heifers), bobby calves, dairy beef and bulls used for mating (ProfitWatch, 1999). Stock purchases include the purchase of bulls for mating (ProfitWatch, 1999).

Net stock income does not include change in stock numbers (ProfitWatch Database, 2003). To minimise the effect of change in stock numbers on stock income, the stock adjustment used for the estimation of EFS/ha (See Appendix 4.14) will be included in the calculation of stock income (See Appendix 4.3). This procedure will reflect more accurately the stock income in dairy farms.

4.2.2.1.4.A.3 Gross farm income ($GFI/ha): It refers to the total income from the dairy business only (See Appendix 4.4). GFI also includes other dairy income such as sale of surplus supplements (ProfitWatch, 1999). It does not include stock adjustment, dividends, shares, interest, house rent and other incomes received from leased land or cow (ProfitWatch, 1999).

4.2.2.1.4.B Farm Working Expenses per hectare (FWE/ha):

For the calculation of Farm Working Expenses per hectare, the sum of total animal costs, feed costs, fertiliser costs, and overhead costs in the farm is divided by farm size. Farm working expenses does not include labour adjustment nor interest payments.

For the calculation of FWE/kg MS, labour costs (including labour adjustment)/kg MS and FWE excluding labour/kg MS, the total values of each group were divided by the total milksolids production of the farm.

4.2.2.1.4.B.1 Animal costs

4.2.2.1.4.B.1.1 Labour costs ($/cow): It refers to the expenditure on labour. The estimation of labour costs (See Appendix 4.5) include wages paid to employed staff (including insurance and allowances), and the labour adjustment used for the estimation of EFS/ha (See Appendix 4.11 and Appendix 4.12) to account for all unpaid labour in the farm.

Wages costs are taken directly from the accounts (ProfitWatch, 1999). Cases of unpaid labour can occur when the farmer is the manager of the farm or when there are family members who work in the farm but their wages do not appear in the accounts.

The number of labour units in the farm is found by dividing the number of hours staff work on the farm by 2400. This is because 2400 hours per year is the expected number of hours a labour unit should work in the dairy farm (ProfitWatch, 1999). The number of cows per labour unit is found by dividing herd size by the number of labour units in the farm (ProfitWatch, 1999).

4.2.2.1.4.B.1.2 Other animal costs ($/cow): It refers to the costs of animal health, herd improvement, farm dairy and electricity (See Appendix 4.6). These values can be obtained directly from the accounts or can be calculated by adding the costs of items associated with each category.

Animal health costs include the health costs of the entire dairy herd. It also includes health costs of youngstock grazing off if the farmer pays for it (ProfitWatch, 1999). Costs of herd improvement are associated with breeding and herd testing (ProfitWatch, 1999).

Dairy shed costs comprise the costs of rubberware, detergents and teat spray when teat spray costs are not separated in the accounts (ProfitWatch, 1999). Electricity costs refer to the electricity costs of the dairy business: farm dairy and stock water supply (ProfitWatch, 1999).

4.2.2.1.4.B.2 Fertilisers and Feed costs

4.2.2.1.4.B.2.1 Fertiliser costs ($/ha): It comprises the costs of all fertilisers used in the dairy unit (See Appendix 4.7). It also includes fertiliser costs of the run-off, if the farmer owns one (ProfitWatch, 1999).

4.2.2.1.4.B.2.2 Feed costs ($/ha): It refers to all the costs associated with feed supplied to the herd (See Appendix 4.8).

The costs of supplements made on farm comprise the expenses associated with harvesting supplements on the dairy unit (ProfitWatch, 1999). It also includes the costs of supplements made on the run-off if the farmer owns one (ProfitWatch, 1999). The cost of supplements purchased includes the cost of all bought-in feed, including dog food (ProfitWatch, 1999). The costs of grazing off comprise winter grazing and youngstock grazing off farm (ProfitWatch, 1999). The costs of crop and regrassing refer to all cropping and regrassing done on the dairy unit and in the runoff, if the far mer owns one (ProfitWatch, 1999).

4.2.2.1.4.B.3 Overhead costs ($/ha): It comprises fixed costs associated with the dairy business (See Appendix 4.9). It also includes overhead costs of the run-off, if the farmer owns one (ProfitWatch, 1999). To eliminate differences due to run-off lease, the run-off adjustment will be included in the calculation of overhead costs.

Vehicle costs refer to the expenses associated with vehicles used in the dairy business only (ProfitWatch, 1999). Repair and maintenance costs include the costs of shelter trees (ProfitWatch, 1999). Freight costs for stock and food excludes costs from outside the dairy business such as transport of the herd from the North to the South Island (ProfitWatch, 1999).

Administration costs also include farm consultant fees, phone expenses, subscription to farming publications, accountancy fees and other administrative work associated with the dairy business (ProfitWatch, 1999). Standing charges refer to the costs of rates, farm insurance, ACC (ProfitWatch, 1999). Other costs refer to expenses made on other items that relates to the dairy operation (Protective clothing for example) (ProfitWatch, 1999).

4.2.2.1.4.C Indicators of financial performance

4.2.2.1.4.C.1 Economic Farm Surplus per hectare ($EFS/ha): It is the operating profit left after farm working expenses are subtracted from gross farm income and adjustments for depreciation, labour, run-off and stock numbers are made (See Appendix 4.10).

The adjustment for depreciation is taken from the accounts of the farm (ProfitWatch, 1999). Costs associated with personal use are not considered (ProfitWatch, 1999). It comprises depreciation of assets related to the dairy business only.

The adjustments for labour are made taking into account the position of the person in the farm (ProfitWatch, 1999). The manager's wage is determined by the number of cows in the farm (See Appendix 2.11). For farms with 200 cows or less, or 440 cows or more, a minimum or maximum wage is determined, respectively, according to the employment market.

The value of other unpaid labour is determined by the estimated hours worked by that staff and the average annual staff wage (See Appendix 4.12).

The adjustments for run-off are applied to all farmers who own run-offs. This adjustment is based on lease prices of run-offs in the region (ProfitWatch, 1999). When lease prices of are not known, the run-off adjustment is 5% of the market value of the runoff, according to the class of land in the region (See Appendix 4.13).

The stock adjustment is made based on the opening and closing stock numbers, and the market value of the stock (See Appendix 4.14).

4.2.2.1.4.C.2 Percentage of Return on Assets (%RoA) (Excluding capital appreciation): It measures the return of the dairy business on the capital invested on the farm (See Appendix 4.15).

4.2.2.1.4.C.3 Percentage of Return on Equity (%RoE): It measures the return of the dairy business on the owner's capital invested on the farm (See Appendix 4.16).

4.2.2.1.4.D Cost of production

4.2.2.1.4.D.1 Variable costs per hectare ($/ha) and per kg of milksolids ($/kg MS): They refer to the variable costs (animal costs excluding labour adjustment, fertiliser costs and feed costs) made per hectare or per kg MS (See Appendix 4.17).

4.2.2.1.4.D.2 Fixed costs per hectare ($/ha) and per kg of milksolids ($/kg MS): They refer to the overhead costs made per hectare or per kg MS(See Appendix 4.18).

4.2.2.1.4.D.3 Total cost of milksolids production ($/kg MS): It refers to the cost of producing 1 kg of milksolids. In the calculation of milksolids production costs the opportunity cost of capital has also been included (See Appendix 4.19).

4.2.2.2 STATISTICAL ANALYSIS

See section 3.2.2.2 in chapter 3 (Page 50).

4.3.- RESULTS

The physical characteristics of low, intermediate and high input systems were shown in Table 3.1, Table 3.2, Table 3.3 and Table 3.4. Table 4.1 shows the financial characteristics of the 3 feed input systems in 1998/99 and 2001/02.

Table 4.1: Financial characteristics of dairy farms, in 1998/99 and 2001/02, according to their level of extra feed input [1].

Farm Parameters	1998/99 [2]			2001/02 [2]		
	Low input	Int. input	High input	Low input	Int. input	High input
Number of farms	58	128	51	43	76	73
Gross Farm Income						
Milksolids payout ($/kg MS)	3.58	3.58	3.58	5.30	5.30	5.30
Income from the sale of milksolids ($/ha)	2183 [a]	2585 [b]	3004 [c]	3941 [a]	4251 [a]	4888 [b]
Stock income ($/ha) [3]	201 [a]	235 [ab]	280 [b]	471 [a]	540 [ab]	594 [b]
Gross Farm Income per hectare ($/ha)	2374 [a]	2821 [b]	3287 [c]	4362 [a]	4679 [a]	5377 [b]
Farm Working Expenses						
Animal costs						
Labour units per year	1.7 [a]	2.0 [b]	2.0 [b]	1.9 [a]	2.0 [a]	2.2 [a]
Average number of cows per labour unit	111 [a]	114 [a]	119 [a]	113 [a]	114 [a]	111 [a]
Labour cost ($/cow) [4]	227 [a]	230 [a]	244 [a]	307 [a]	314 [a]	316 [a]
Animal health ($/cow)	42 [a]	44 [ab]	50 [b]	51 [a]	58 [a]	69 [b]
Herd improvement ($/cow)	25 [a]	26 [a]	27 [a]	26 [a]	27 [a]	30 [b]
Farm dairy and electricity ($/cow)	59 [a]	60 [a]	65 [a]	62 [a]	61 [a]	72 [b]
Total animal costs excluding labour ($/cow) [5]	126 [a]	130 [a]	142 [b]	139 [a]	146 [a]	171 [b]
Fertilisers and feed costs						
Fertilisers ($/ha)	240 [a]	280 [b]	322 [c]	330 [a]	378 [b]	428 [c]
Supplements purchased ($/cow)	24 [a]	54 [b]	94 [c]	62 [a]	105 [b]	185 [c]
Winter cow grazing off ($/cow)	0 [a]	33 [b]	43 [c]	0	29 [b]	42 [c]
Crop and regrassing ($/cow)	5 [a]	8 [a]	15 [b]	6 [a]	8 [a]	15 [b]
Total feed costs per cow ($/cow) [6]	57 [a]	117 [b]	156 [c]	105 [a]	153 [b]	265 [c]
Total feed costs per hectare ($/ha) [6]	143	304	437	263	398	716
Overhead costs						
Repair and Maintenance costs ($/ha)	127 [a]	137 [ab]	163 [b]	226 [a]	243 [a]	289 [b]
Vehicles costs ($/ha)	93 [a]	106 [ab]	117 [b]	112 [a]	144 [b]	156 [b]
Other overhead costs [7]	469 [a]	529 [a]	675 [b]	555 [a]	602 [b]	757 [c]
Total overhead costs ($/ha)	689 [a]	772 [a]	955 [b]	893 [a]	989 [b]	1202 [c]
Farm Working Expenses per hectare ($/ha)	**1265 [a]**	**1601 [b]**	**1945 [c]**	**1735 [a]**	**2063 [b]**	**2675 [c]**
FWE per cow ($/cow)	526 [a]	608 [b]	691 [c]	683 [a]	797 [b]	993 [c]
FWE per kg MS ($/kg MS)	2.15 [a]	2.22 [ab]	2.38 [b]	2.32 [a]	2.59 [b]	2.93 [c]
FWE excluding wages per kg MS ($/kgMS)	1.92 [a]	1.96 [a]	2.10 [b]	2.02 [a]	2.28 [b]	2.60 [c]
Labour costs per kg MS ($/kg MS) [4]	0.94 [a]	0.85 [a]	0.86 [a]	1.07 [a]	1.02 [ab]	0.94 [b]
Exp. On feed /total farm exp. (%) [6]	11%	19%	22%	15%	19%	27%
Cash Surplus ($/ha)	1088 [a]	1191 [ab]	1321 [b]	2627 [a]	2616 [a]	2707 [a]
EFS per hectare at actual payout ($/ha)	**474 [a]**	**534 [a]**	**550 [a]**	**1849 [a]**	**1926 [a]**	**1902 [a]**
EFS ($/ha) at $5.30/kg MS	1489 [a]	1740 [b]	1952 [c]			
EFS ($/ha) at $3.58/kg MS				585 [a]	553 [a]	330 [b]

[1] Feed input: supplements imported + winter grazing + maize grown on farm

[2] Values with different superscript letter are statistically different (it refers to statistical difference between systems within each year only).

[3] Stock income = net stock income + stock adjustment

[4] Labour costs = wages + labour adjustment. (family unpaid labour)

[5] Total animal costs excluding labour ($/cow) = Animal health, herd improvement, farm dairy and electricity

[6] It comprises the costs of supplements made on farm (crop and regrassing), supplements purchased, winter grazing-off and young stock grazing. Total feed costs per hectare are estimations based on feed costs per cow and the average stocking rate for each system and year.

[7] Freight, weed and pest control, administration, standing charges, run-off lease and other expenses.

Since 1998/99 and 2001/02 were the extremes of the dairy seasons in study, in terms of period and milksolids payouts, the descriptions of the systems were mainly based on these dairy seasons. But differences between the other dairy seasons will be stated in the description of the results.

4.3.1.- Gross Farm Income per hectare ($GFI/ha)

Between 1998/99 and 2001/02, the average GFI/ha in owner-operated dairy farms increased by 57%, from $2787/ha in 1998/99 to $4876/ha in 2001/02 (See Figure 4.1).

Figure 4.1: Average gross farm income per hectare, between 1998/99 and 2001/02.

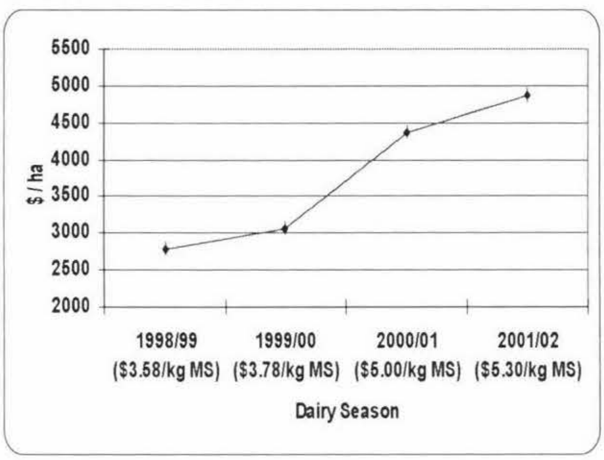
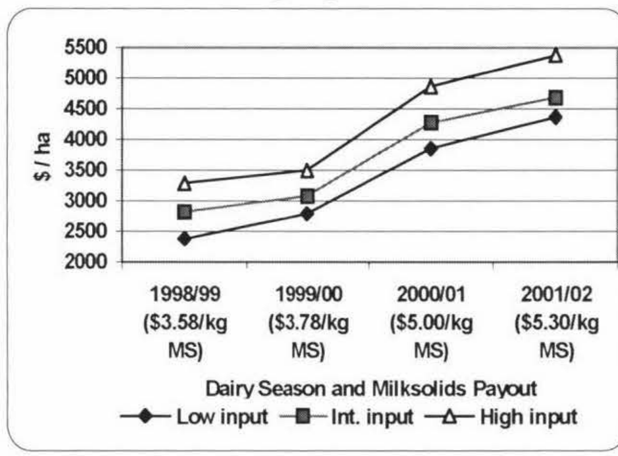


Figure 4.2: Gross farm income per hectare in low, intermediate and high input.



In all 4 dairy seasons, high input systems had significantly higher GFI/ha than intermediate and low input systems (See Figure 4.2). GFI/ha of intermediate input systems was intermediate between those of high and low input systems (See Figure 4.2).

During the 4 dairy seasons, high input systems had significantly higher stock income than low input systems (See Table 4.1). Stock income in intermediate input systems was intermediate to those of low input and high input systems (See Table 4.1).

4.3.1.1 Income from the sale of milksolids ($/ha)

Between 1998/99 and 2001/02, the average milksolids payout increased by 40%, from $3.58 to $5.30/kg MS. This increase in milksolids payout caused a significant increase in the average income from the sale of milksolids in all 3 feed input systems (See Table 4.1). In all 3 systems, 90% to 92% of GFI/ha came from the sale of milksolids.

In all 4 dairy seasons, high input systems had significantly higher income from the sale of milksolids than intermediate and low input systems (See Table 4.1).

4.3.2 Farm Working Expenses per hectare ($FWE/ha)

Between 1998/99 and 2001/02, the average FWE/ha in owner-operated dairy farms increased by 34%, from $1614/ha in 1998/99 to $2162/ha in 2001/02 (See Figure 4.3).

Figure 4.3: Average farm working expenses per hectare between 1998/99 and 2001/02.

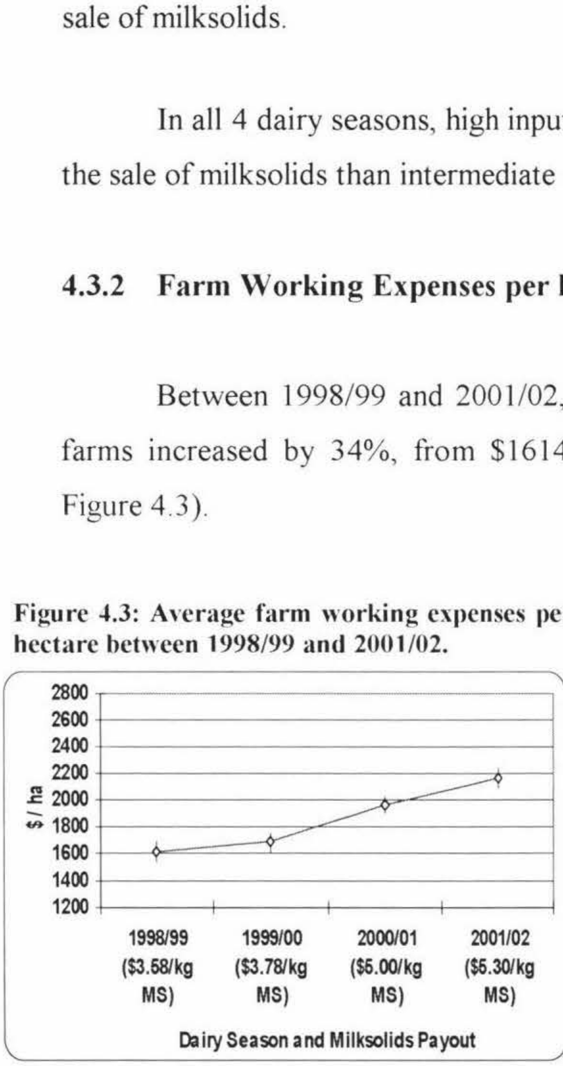
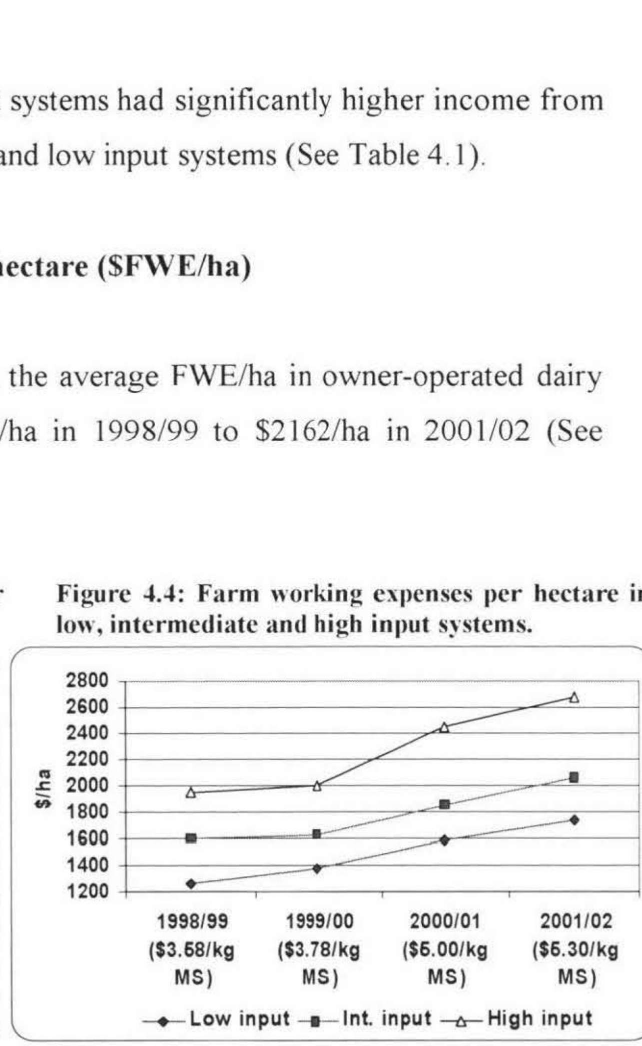


Figure 4.4: Farm working expenses per hectare in low, intermediate and high input systems.



In all 4 dairy seasons, high input systems had significantly higher FWE/ha than intermediate and low input systems (See Figure 4.4). During this period, FWE/ha in intermediate input systems were intermediate between those of high and low input systems (See Figure 4.4). FWE/ha increased to a greater extent on the high input systems, so that the difference in FWE/ha between low and high input systems increased from $680/ha in 1998/99 to $940/ha in 2001/02 (See Table 4.1).

In all 4 dairy seasons, high input systems had significantly higher FWE/cow, FWE/kg MS and FWE/kg MS (excluding labour) than low input systems (See Table 4.1, Figure 4.5 and Figure 4.6). FWE/cow, FWE/kg MS and FWE/kg MS (excluding labour) in intermediate input systems were intermediate to those of low and high input systems (See Table 4.1, Figure 4.5 and Figure 4.6).

Figure 4.5: FWE/kg MS in low, intermediate and high input systems.

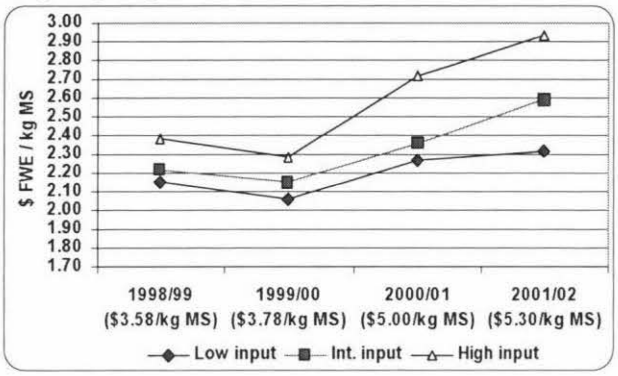
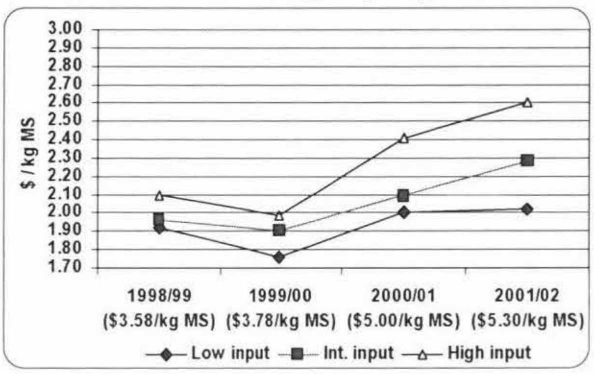


Figure 4.6: FWE/kg MS (excluding labour) in low, intermediate and high input systems.



4.3.2.1 Animal costs ($/cow): labour (wages + labour adjustment), animal health, herd improvement, farm dairy and electricity expenses

Between 1998/99 and 2001/02, the average labour costs in owner-operated dairy farms increased from $233/cow to $314/cow. During the same period, the average animal costs excluding labour (animal health, herd improvement, farm dairy and electricity) increased from $131/cow to $155/cow.

Although the differences were not significant in 1998/99 and 2000/01, high input systems had higher labour units per year than intermediate and low input systems in all 4 dairy seasons (See Table 4.1). There were not significant differences between systems in the number of cows per labour unit (See Table 4.1).

There were no significant differences in labour costs per cow between systems, in all 4 dairy seasons (See Table 4.1). But when labour costs were expressed per kg MS, high input systems had lower labour costs than low input systems (See Figure 4.7), but the differences were significant only in 2000/01 and 2001/02 (See Table 4.1).

Although in all 4 dairy seasons the average animal costs (excluding labour) were higher in high input systems than in low input systems (See Figure 4.8), the differences were significant only in 1998/99 and 2001/02 (See Table 4.1).

Figure 4.7: Labour costs per kg MS in low, intermediate and high input systems.

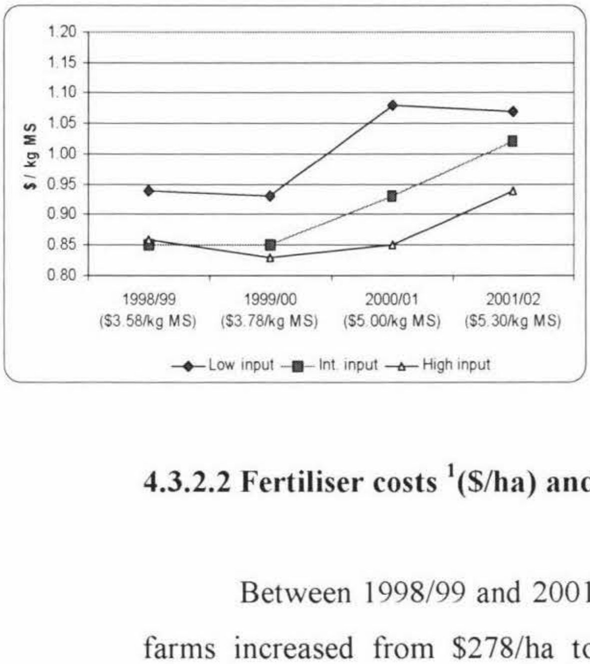
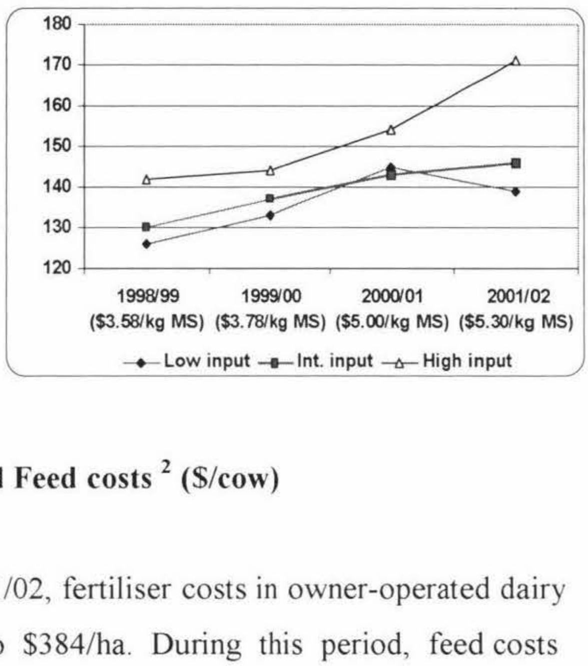


Figure 4.8: Animal costs excluding labour (animal health, herd improvement, farm dairy and electricity) in low, intermediate and high input systems.



4.3.2.2 Fertiliser costs [1]($/ha) and Feed costs [2] ($/cow)

Between 1998/99 and 2001/02, fertiliser costs in owner-operated dairy farms increased from $278/ha to $384/ha. During this period, feed costs increased from $120/cow to $184/cow.

With the exception of 1999/00, high input systems had significantly higher fertiliser costs than low input systems (See Figure 4.9). Fertiliser costs in intermediate input systems were intermediate to those of low input and high input systems (See Figure 4.9).

[1] Fertiliser costs: N, P, K, S, and other fertilisers.
[2] Feed costs: supplements made on farm, supplements imported, winter grazing-off, youngstock grazing-off, crop and regressing.

In all 4 dairy seasons, high input systems had significantly higher feed costs than intermediate and low input systems (See Figure 4.10).

Figure 4.9: Fertiliser costs (\$/ha) in low, intermediate and high input systems.

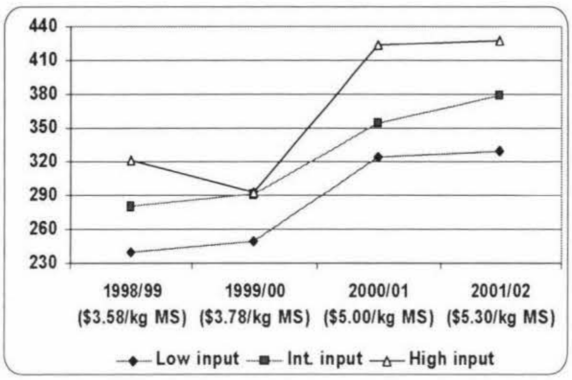
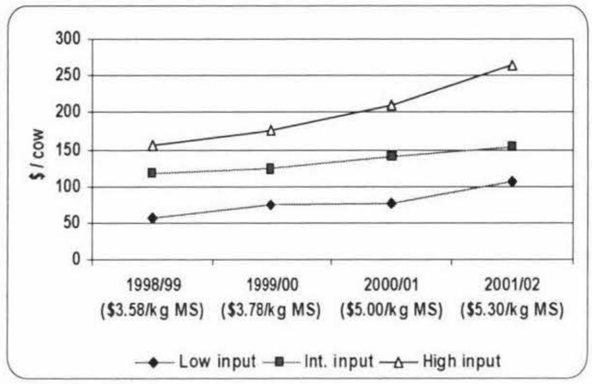


Figure 4.10: Feed costs in low, intermediate and high input systems.

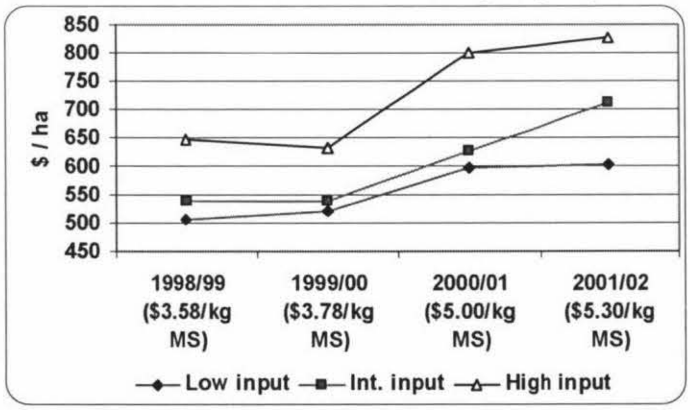


4.3.2.3 Overheads costs per hectare (\$/ha)

Between 1998/99 and 2001/02, the average overheads costs increased from \$805/ha to \$1028/ha.

In all 4 dairy seasons, high input systems had significantly higher overhead costs than low input systems (See Figure 4.11). Overheads costs in intermediate input systems were intermediate to those of low and high input systems (See Figure 4.11).

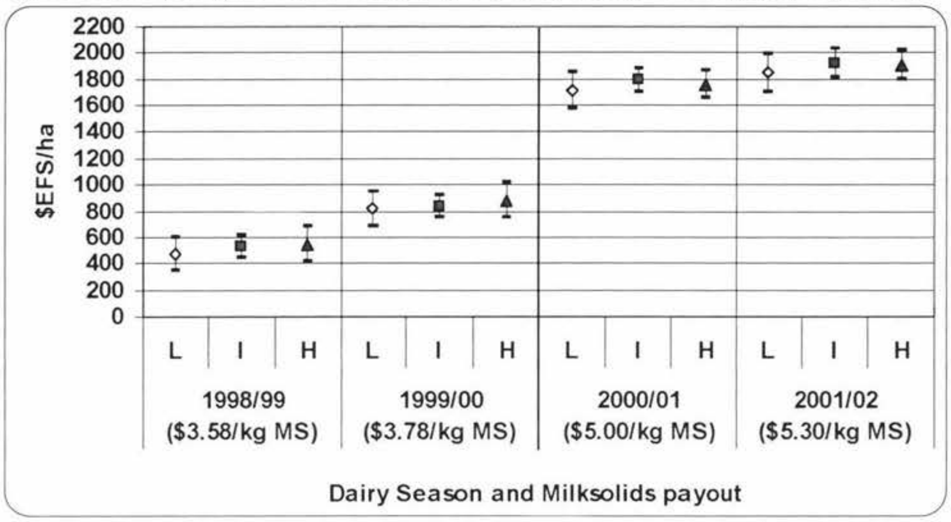
Figure 4.11: Overhead costs in low, intermediate and high input systems.



4.3.3 Economic Farm Surplus per hectare ($EFS/ha)

Between 1998/99 and 2001/02, the average EFS/ha increased from $523 to $1900/ha. Despite the increase in average EFS/ha from year to year, in all 4 dairy seasons there were no significant differences in EFS/ha between low, intermediate and high input systems (See Figure 4.12).

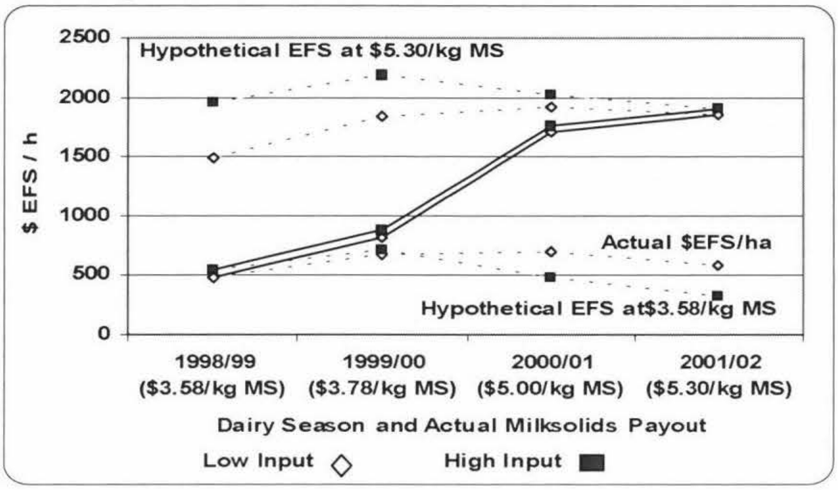
Figure 4.12: Average EFS/ha in low (L), intermediate (I) and high (H) input systems.



Hypothetical calculations showed that, if, during the 4 dairy seasons in study, milksolids payout had remained at $3.58/kg MS while all the other prices, costs and change in inputs varied as actually happened; EFS/ha in high input farms would have been significantly lower than in low input systems in 2000/01 and 2001/02 (See Figure 4.13).

If a hypothetical milksolids payout of $5.30/kg MS was considered over the 4 dairy season in study, high input farms would have had significantly higher EFS/ha than low input farms in 1998/99 and 1999/2000 (See Figure 4.13)

Figure 4.13: Actual changes in EFS/ha (solid lines) in low and high input systems between 1998/99 and 2001/02, and hypothetical EFS/ha (broken lines) if milksolids payouts would have remained constant at $3.58/kg MS and $5.30/kg MS.



4.3.4 Return on Assets excluding capital appreciation (% RoA) and Return on Equity (% RoE)

Between 1998/99 and 2001/02, the average return on assets in owner -operated dairy farms increased from 3.5% to 9%. In all 4 dairy seasons, there were no significant differences on the percentage of RoA between low, intermediate and high input systems (See Table 4.2).

Table 4.2: Return on Assets (excluding capital appreciation) and Return on Equity of low, intermediate and high input dairy farms in 1998/99 and 2001/02.

Farm Parameters	1998/99 [1]			2001/02 [1]		
	Low input	Int. input	High input	Low input	Int. input	High input
Number of farms	58	128	51	43	76	73
Return on Assets (%) [3]	3.7% [a]	3.6% [a]	3.4% [a]	10.5% [a]	9.4% [a]	8.4% [a]
Return on Equity (%)	2.4% [a]	1.5% [a]	1.1% [a]	13.0% [a]	10.7% [a]	9.4% [a]
Net operating assets ($)	1 170 889 [a]	1 390 581 [b]	1 555 783 [b]	1 611 341 [a]	1 730 219 [a]	2 010 668 [b]
Owner's equity ($)	762 365 [a]	873 661 [ab]	1 009 577 [b]	1 072 688 [a]	1 166 180 [a]	1 352 939 [b]
Equity as % of Assets	64 % [a]	60 % [a]	64 % [a]	67 % [a]	68 % [a]	67 % [a]

[1] Values with different superscript letter are statistically different (it refers to statistical difference between systems within each year only).

The percentage of return on equity in owner-operated dairy farms increased from 16% to 38% between 1998/99 and 2001/02. In all 4 dairy seasons, there were no significant differences in the percentage of RoE between low, intermediate and high input systems (See Table 4.2)

Figures 4.14 and 4.15 show the percentages of RoA and RoE in low, intermediate and high input systems.

Figure 4.14: Percentage of Return on Assets (Excluding capital appreciation) in low (L), intermediate (I) and high (H) input systems.

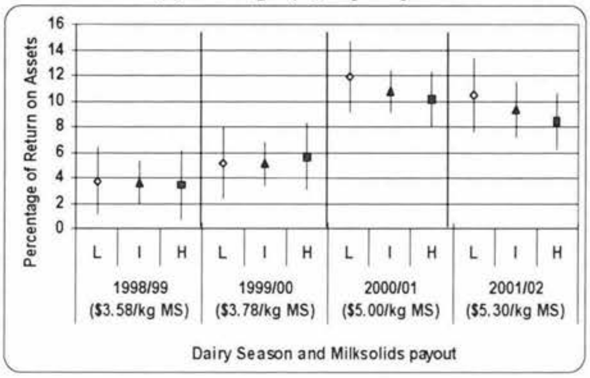
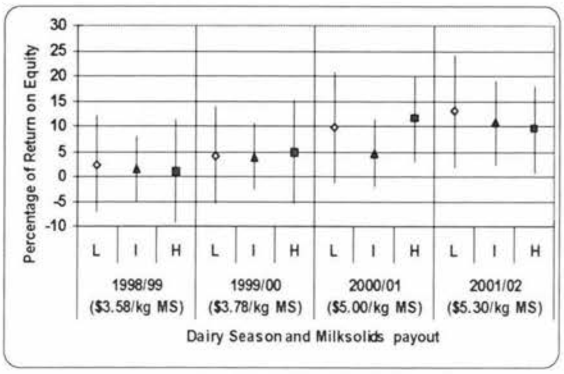


Figure 4.15: Percentage of Return on Equity in low (L), intermediate (I) and high (H) input systems, between 1998/99 and 2001/02.



4.3.5 Costs of production per hectare ($/ha) and per kilogram of milksolids ($/kg MS)

In all 4 dairy seasons, high input systems had significantly higher variable and fixed costs per hectare than intermediate and low input systems (See Table 4.3). Intermediate input systems had variable and fixed costs per hectare intermediate to those of low and high input systems (See Table 4.3).

Table 4.3: Costs of production per hectare and per kg of MS in low, intermediate and high input systems, in 1998/99 and 2001/02, classified according to their level of extra feed input [1].

Farm Parameters	1998/99 [2]			2001/02 [2]		
	Low input	Int. input	High input	Low input	Int. input	High input
Number of farms	58	128	51	43	76	73
Costs per hectare						
Variable costs per hectare ($/ha)	784 [a]	1077 [b]	1317 [c]	1141 [a]	1371 [b]	1874 [c]
Fixed costs per hectare ($/ha)	689 [a]	772 [a]	955 [b]	893 [a]	989 [b]	1202 [c]
Cost of production per kg MS						
Variable costs per kg MS ($/kg MS)	1.27 [a]	1.46 [b]	1.57 [c]	1.50 [a]	1.68 [a]	2.00 [b]
Fixed costs per kg MS ($/kg MS)	1.16 [a]	1.09 [a]	1.18 [a]	1.21 [a]	1.25 [ab]	1.34 [b]
Total cost of production ($/kg MS) [3]	4.29 [a]	4.08 [a]	4.19 [a]	4.34 [a]	4.57 [ab]	4.75 [b]

[1] Feed input: supplements imported + winter grazing + maize grown on farm
[2] Values with different superscript letter are statistically different (it refers to statistical difference between systems within each year only).
[3] Cost per kg MS includes the opportunity cost of capital (See Appendix 4.19).

In all 4 dairy seasons, high input systems had significantly higher variable costs per kg MS than intermediate and low input systems (See Figure 4.16). Although the average fixed costs per kg MS were also higher in high input systems in all 4 dairy seasons (See Figure 4.17), the differences were significant only in 2000/01 and 2001/02 (See Table 4.3).

Figure 4.16: Variable costs per kg MS in low, intermediate and high input systems.

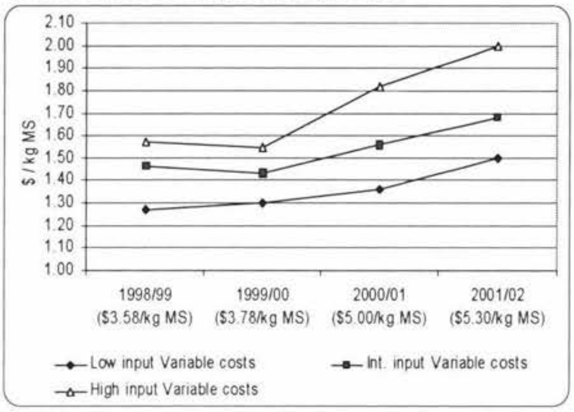
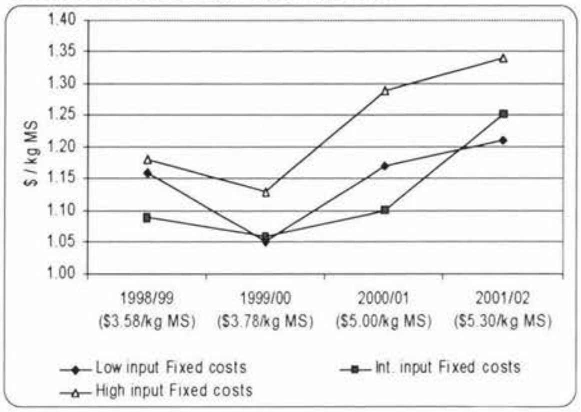
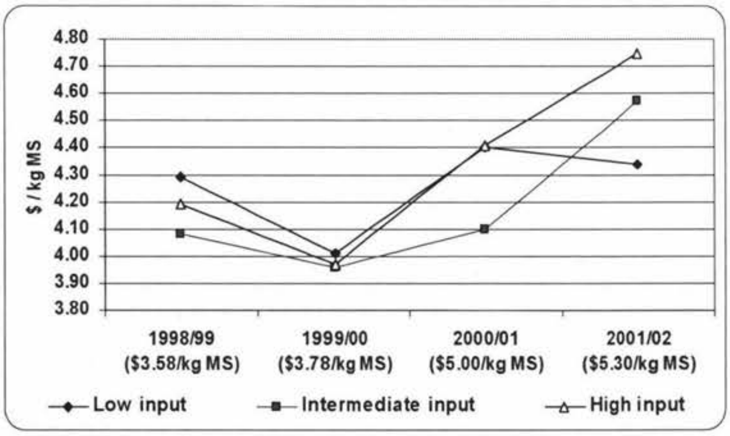


Figure 4.17: Fixed costs per kg MS in low, intermediate and high input systems.



In 1998/99 and 2001/02, there were no significant differences in total costs of milksolids production (it includes the opportunity cost of capital, See Appendix 4.19) between systems (See Table 4.3). In 2000/01, intermediate input systems had significantly lower costs of milksolids production than low and high input systems, but there was no significant difference in milksolids production costs between low and high input systems (See Figure 4.18). In 2001/02, high input systems had higher milksolids production costs than low input systems (See Table 4.3).

Figure 4.18: Cost of milksolids production (including the opportunity cost of capital) in low, intermediate and high input systems.



4.4.- DISCUSSION

4.4.1 FINANCIAL CHANGES IN NEW ZEALAND DAIRY FARMS BETWEEN 1998/99 AND 2001/02

Between 1998/99 and 2001/02, the increase in milksolids payout, from \$3.58/kg MS in 1998/99 to \$5.30/kg MS in 2001/02, had a significant influence on GFI/ha and FWE/ha. This conclusion is based on observations of previous years (See Table 4.4). Between 1992/93 and 1998/99, the average milksolids payout varied between \$3.39/kg MS and \$3.51/kg MS (Dexcel, 2003). During these dairy seasons, GFI/ha and FWE/ha increased by \$82/ha and \$99/ha, respectively (See Table 4.4). Since there were only small variations in the average milksolids payouts between 1992/93 and 1998/99, the increase in GFI/ha during this period was more related to increases in milksolids production per hectare over these dairy seasons (See Table 4.4).

Table 4.4: Changes in milksolids payout, gross farm income per hectare, farm working expenses per hectare and cash surplus in owner-operated dairy farms in New Zealand, between 1992/93 and 2001/02 (From Dexcel, 2003)

Dairy Season	1992/93	1997/98	1992/93 – 1997/98	1998/99	2001/02	1998/99 – 2001/02
Milksolids payout	\$3.51	\$3.39		\$3.58	\$5.30	
kg MS/ha	628	738	+110	710	823	+113
GFI/ha (\$/ha)	2638	2720	+82	2741	4808	+2067
FWE/ha (\$/ha) [1]	1461	1560	+99	1597	2258	+661
Wages (\$/ha)	197	195	-2	233	314	+81
Pasture and supplements	230	282	+52	280	460	+180
Fertilisers (\$/ha)	257	259	+2	278	384	+106
Overheads (\$/ha) [1]	480	504	+24	497	677	+180
EFS (\$/ha)	618	518	-100	523	1900	+1377
Return on Assets (%)	3.2	1.6	-1.6	3.5	9.0	+5.5

[1] FWE/ha and Overhead costs per hectare does not include interest payments.

The increase in milksolids production per hectare between 1992/93 and 1997/98 was close to that between 1998/99 and 2001/02 (See Table 4.4). The difference in GFI/ha between 1998/99 and 2001/02, would have been close to that between 1992/93 and 1997/98 (+$82/ha), if milksolids payout would have varied slightly (See Table 4.4). For this reason, the sharp increase in the average GFI/ha between 1998/99 and 2001/02 (+$2067/ha) is more associated with the increase in milksolids payout than the increase in milksolids production per hectare (See Table 4.4).

The increase in FWE/ha is a trend that has been observed since 1986/87 (Howse and Leslie, 1997). But the increases in FWE/ha between 1998/99 and 2001/02 were faster than in previous years (See Table 4.4). Wages, feed, fertilisers and overhead costs were the areas with the highest increases (See Table 4.4). These changes in farm expenditure were also described in other reports (MAF, 2001). It seems that dairy farmers tried to increase milksolids production per cow and per hectare, through the use of supplements, with the aim of taking advantage of the high milksolids payouts observed in 2000/01 and 2001/02. However, more studies are necessary to analyse the effect of changes in milksolids payout on farm expenses.

The significant increase in the average EFS/ha between 1998/99 and 2001/02 was also related to the increase in milksolids payout during this period. This is supported by the fact that small variations in EFS/ha were observed in years in which milksolids payout varied slightly (See Table 4.4). Similar changes were observed in the percentage of return on capital between 1998/99 and 2001/02.

4.4.2 COMPARISON OF THE FINANCIAL PERFORMANCE OF HIGH INTERMEDIATE AND LOW FEED INPUT DAIRY SYSTEMS

4.4.2.1 Gross farm income per hectare (GFI/ha)

Since about 90% of GFI/ha depends on milksolids production per hectare, it is sensible that high input systems, due to their higher milksolids production per hectare, have higher GFI/ha than intermediate and low input systems. Other studies have also reported higher gross farm income per hectare in high input systems than in low input systems (Van der Poel, 1997; Macdonald, 1999).

The difference in milksolids production per hectare between high and low input systems decreased from 210kg MS/ha in 1998/99 to 177kg MS/ha in 2001/02. Despite this, the difference in GFI/ha between high and low input systems increased from $913/ha in 1998/99 to $1015/ha in 2001/02. Since approximately 90% of GFI/ha comes from the sale of milksolids, high milksolids payouts causes greater variations in GFI/ha than low milksolids payouts.

The higher stock incomes per hectare in high input systems, compared to intermediate and low input systems, can be associated with their replacement rate, and possibly by the higher weight of cows culled in high input systems or higher prices of cows culled at some months of the year (Prewer, 2003). Although in the last 3 dairy seasons in study the percentages of replacement rate were not significantly different between systems, these percentages comprise a greater number of cows per hectare in high input systems.

4.4.2.2 Farm working expenses per hectare (FWE/ha)

The higher FWE/ha in high input systems, compared to intermediate and low input systems, were mainly associated with their higher stocking rate and higher feed, fertiliser and overhead costs. Increases in farm working expenses per hectare, associated to the use of extra feed, have also been reported in other studies (Van der Poel, 1997; Macdonald, 1999).

The difference in FWE/ha between low and high input systems increased from $759/ha in 1998/99 to $1072/ha in 2001/02. This can be associated with the increase in milksolids payout during this period. The announcement made by Fonterra in 2001/02, of higher prices for shares in the dairy company the following dairy season, can also have influenced the increase in FWE/ha in 2001/02. These factors possibly stimulated dairy farmers to spend more during these dairy seasons, with the aim of taking advantage of the high milksolids payouts and with the aim of owning more shares in the dairy company before the price of shares increases. However, this conclusion must be interpreted with caution since the farms analysed in each year were not the same.

4.4.2.2.1 Animal costs ($/cow)

Since there were not significant differences between high and low input systems in the number of cows per labour unit, high input systems needed more labour units due to their larger herds. Although there were not significant differences in labour costs per cow between systems, labour costs per hectare were higher in high input systems due to their higher stocking rates. There were not significant differences in the number of cows per labour unit between feed input systems. As a consequence, high input systems had lower labour costs per kilogram of milksolids than intermediate and low input systems due to their higher milksolids production per cow.

It is difficult to speculate about the reason for the higher animal health costs per cow in high input systems in 1998/99 and 2001/02. This can be due to more animal health problems in high input systems during these years, but it can also be due to higher expenses on preventive medicine. The higher herd improvement, farm dairy and electricity costs per cow in high input systems in 2001/02 indicate that high input farms spent more on these areas in 2001/02. But it is difficult to speculate about the reasons for the increase in these costs in 2001/02 since differences between systems in these areas were not significant in previous years.

4.4.2.2.2 Feed ($/cow) and fertiliser ($/ha) costs

Although fertiliser costs refer to the cost of all fertilisers used on the dairy farm, the higher fertiliser costs in high input systems can be associated with their higher use of nitrogen fertiliser per hectare.

High input systems had higher feed costs per cow than intermediate and low input systems due to their higher use of extra feed per cow. Therefore, high input systems would have had higher feed costs per hectare than intermediate and low input systems, due to their higher use of extra feed per cow and higher stocking rates.

Feed costs per hectare in high input systems were 22% to 27% of their total FWE/ha. In low input systems, feed costs per hectare was 11% to 15% of their total FWE/ha. In the 1.75t MS/ha trial (Macdonald, 1999), feed costs per hectare in the high input farmlets represented 26% to 46% of their FWE/ha, approximately. In the all-pasture farmlets of the 1.75t MS/ha trial (Macdonald, 1999), feed costs per hectare was 11% of their total FWE/ha, which is similar to the values found in low input systems in this study.

4.4.2.2.3 Overhead costs ($/ha)

The higher overhead costs in high input systems, compared to intermediate and low input systems, are indirectly associated with the use of extra feed. Part of the higher overhead costs per hectare in high input systems is probably due to their higher use of vehicles and machinery to feed the extra feed the herd or grow maize for silage on farm. Similar observations have been reported in other studies (Hurley, 1995: In Holmes 2000; Macdonald, 1999). The higher repair and maintenance costs in high input systems, in all 4 dairy seasons, suggest that repair and maintenance activities in the farm are more necessary as feed input and herd size increases.

4.4.2.3 Economic Farm Surplus ($/ha)

The results of this study suggest that the input of extra feed (plus other associated inputs such as extra cows and nitrogen fertiliser), although it did increase milksolids production per cow and per hectare, did not result in higher EFS/ha. Although high input systems had higher GFI/ha than intermediate and low input systems, their higher FWE/ha, associated with the use of extra feed and higher stocking rates, offset the increase in farm income. This is because a high input system not only comprises a high input of extra feed, but also more cows per hectare, more nitrogen fertiliser per hectare and more skills. The cost of maintaining the synchrony between feed demand and feed supply per hectare, in high input systems, off-set the extra gross farm income per hectare achieved with the use of extra feed.

Van der Poel (1997), also found that intensifying the dairy system, although it did increase milksolids production, did not always increase EFS/ha due to the higher costs of production. The results found in thi s study disagrees with the results of the 1.75t MS/ha trial in which the all-pasture systems were more profitable than the high input systems (Macdonald, 1999). The reason can be that, in the 1.75t MS/ha trial, the input of extra feed per cow, and the cost associated with the use of extra feed, increased significantly. As a consequence, the increase in FWE/ha due to the use of extra feed was greater than the increase in GFI/ha.

4.4.2.4 Return on Assets (%RoA) and Return on Equity (%RoE)

RoA is calculated from EFS (excluding run-off adjustment) and net operating assets (See Appendix 4.15). The lack of difference in EFS/ha between low, intermediate and high input systems (See Figure 4.12), and the higher net operating assets in high input systems (See Table 4.2), would have suggested a lower RoA in high input systems. However, the analysis of the data showed that there were no significant differences in RoA between the 3 feed input systems. This can be because RoA is calculated from the total operating profit (EFS excluding run-off adjustment) of the farm. Small differences in operating profit per hectare could have influenced the total operating profit of the farm. Furthermore, although there were no significant differences in farm size between systems in 3 y ears, the average farm size was higher in high input systems than in intermediate and low input systems (See section 3.3.1.1).

The higher net operating assets in the farm, in intermediate and high input systems, compared to low input systems, shows that the capital invested in the farm increases as the amount of extra feed utilised per cow increases.

The percentages of RoA were higher than the percentages of RoE in 1998/99, 1999/00 and 2000/01 (See Table 4.2). This suggests that the costs of funding (interest rates, extracted cost of equity) during these years were higher than RoA (Kay and Edwards, 1999). As a consequence, part of the equity capital's gains was used to pay for the cost of funding. In 2001/02, the percentage of RoE was higher than the percentage of RoA. This suggests that the cost of funding in this year was lower than RoA (Kay and Edwards, 1999). This can be related with the high milksolids payout observed in this year. As a consequence, the high operating profits obtained in 2001/02 were enough to pay for the costs of funding.

Although in all 4 dairy seasons there were no significant differences on the percentage of RoE between systems, owner's equity was higher in high input systems (See Table 4.2). For this reason, the percentage of RoE refers to a greater amount of capital in high input systems than in than intermediate and low input systems. Since equity is an indicator of financial solvency, equity capital and equity growth offers dairy farmers more options in the future. Due to their higher equity capital, it is possible that high input systems have more options in the future (expansion, early retirement) than intermediate and low input systems. However, the larger amount of operating assets observed in high input systems, and the lack of significant differences in equity as percentage of assets between systems (See Table 4.2), indicate that the amount of capital borrowed in high input systems is larger than in intermediate and low input systems. As a consequence, high input systems can be more risky due to their higher amounts of borrowed capital.

4.4.2.5 Cost of production per kilogram of milksolids ($/kg MS)

The higher milksolids production per hectare observed in high input systems were not enough to dilute their variable and fixed costs per kilogram of milksolids to those of intermediate and low input systems. This observation suggests that farm working expenses in high input systems increase faster than their milksolids production per hectare.

In 2001/02, milksolids production per hectare in high input systems should have been around 1153 kg MS/ha, instead of 921 kg MS/ha as actually was, in order to have variable and fixed costs kg MS similar to that of low input systems. Intermediate input systems should have had a milksolids production per hectare of 889kg MS/ha, instead of 808 kg MS/ha as actually was, to have variable and fixed costs per kg MS similar to that of low input systems. However, this assumption does not consider further increases in variable and fixed costs associated with further increases in milksolids production per hectare.

In 1998/99 and 1999/00, there were not significant differences between the 3 feed input systems in the costs of milksolids production. This can be because the cost of milksolids production also includes non-cash expenses and the opportunity cost of capital. In 1998/99, the average cost of milksolids production in low input systems was higher than in intermediate and high input systems. This can be associated with the adverse weather conditions in 1998/99 (drought). Since low input systems do not use extra feed, droughts can force farmers to dry-off their herds early. As a consequence, milksolids production per hectare was restricted in low input systems and the costs per hectare could not be distributed over many units of output. The increase in the cost of milksolids production in 2001/02 can be associated with the increase in milksolids payout.

4.5.- CONCLUSIONS

4.5.1 Milksolids payout influenced gross farm income per hectare, EFS/ha, return on assets, return on equity and farm working expenses between 1998/99 and 2001/02.

4.5.2 Between 1998/99 and 2001/02, high input systems had significantly higher Gross Farm Incomes per hectare (GFI/ha) than intermediate and low input systems. The higher GFI/ha in high input systems were mainly due to their higher incomes per hectare from the sale of milksolids, which were associated to their higher milksolids production per hectare.

4.5.3 High input systems had significantly higher Farm Working Expenses per hectare (FWE/ha) than intermediate and low input systems. The higher FWE/ha in high input systems was determined by their higher animal costs per cow (health, herd improvement, etc), their higher feed costs per cow, and their higher fertiliser and overhead costs per hectare.

4.5.4 There were not significant differences in Economic Farm Surplus per hectare (EFS/ha), and the percentages of Return on Assets (RoA) and Return on Equity (RoE) between low, intermediate and high input systems. This is because the high FWE/ha in high input systems offset the extra GFI/ha achieved with the use of extra feed.

4.5.5 High input systems had higher variable and fixed costs per hectare and per kilogram of milksolids than intermediate and low input systems. The higher milksolids productions per hectare in high input systems were not enough to dilute their variable and fixed costs per kilogram of milksolids to those of low input systems.

4.5.6 The total cost of milksolids production (including the opportunity cost of capital) can be similar between systems.

CHAPTER 5

PHYSICAL AND FINANCIAL PERFORMANCE OF LOW INPUT AND HIGH INPUT PASTURE-BASED DAIRY SYSTEMS IN NEW ZEALAND IN THE TOP AND BOTTOM QUARTILES FOR EFS/Ha

ABSTRACT

The physical and financial characteristics of dairy farms with the highest EFS/ha can vary depending on the amount of extra feed used per cow. The objective of this study was to analyse the physical and financial characteristics of low, intermediate and high feed input dairy farms with the highest and lowest operating profi t (EFS/ha). ProfitWatch data from 915 owner operated dairy farms were classified according to dairy season (1998/99, 1999/00, 2000/01, 2001/02), feed imported per cow (low input systems (LI) <50 kg DM extra feed/cow, intermediate input system (II) 50-500 kg DM extra feed/cow, and high input systems (HI) >500kg DM extra feed/cow) and quartiles for EFS/ha. For the classification of the data, the definition of extra feed comprised supplements imported, winter grazing and maize silage grown on farm. LI, II and HI farms in the top quartile for EFS/ha had higher stocking rates and lower comparative stocking rates than their corresponding farm systems in the bottom quartile (2.9 vs 2.1 cows/ha in LI and 3.1 vs 2.3 cows/ha in HI farms, in 2001/02). In all 3 systems, farms in the top quartile had higher milksolids production per cow (325 vs 225 kg MS/cow in LI and 369 vs 308 kg MS/cow in HI farms, in 2001/02) and per hectare (924 vs 523 kg MS/ha in LI and 1136 vs 710 kg MS/ha in HI farms, in 2001/02) than farms in the bottom quartile. In all 3 feed input systems, farms in the top quartile also had higher estimated pasture consumed per hectare and, in the last 2 years of the study, higher herd breeding worth than farms in the bottom quartile. In all 3 systems, farms in the top quartile had significantly higher gross farm income per hectare ($5210 vs $3276/ha in LI and $6520 vs $4083/ha in HI farms, in 2001/02) and similar or higher farm working expenses per hectare ($2572 vs $1583/ha in LI and $3598 vs $2572/ha in HI fams, in 2001/02), than their corresponding farm systems in the bottom quartile. LI, II and HI in the top quartile had lower farm working expenses per kg of milksolids and lower labour costs than their corresponding farm systems in

the bottom quartile. These results show that maximising pasture utilisation per hectare and the use of extra feed, through optimum stocking rates; and achieving high milksolids productions per hectare, are essential for high EFS/ha in low, intermediate and high input systems.

5.1. INTRODUCTION

Several authors have studied the physical and financial characteristics of dairy farms with the highest or lowest EFS/ha in New Zealand (Howse and Leslie, 1997; Holmes, 2000; MAF, 2001; Leslie, 2001). However, there is little information about the physical and financial characteristics of high and low feed input dairy farms with the highest or lowest EFS/ha.

Since farms in the quartile with the highest profitability are managed efficiently, their characteristics can help to identify factors that determine their high physical and financial performance. The synchrony between feed demand and feed supply has been stated as an important characteristic of farms with the highest EFS/ha (Holmes, 2000; Leslie, 2001). This synchrony is achieved through optimum stocking rates, in accordance with the amount of feed available (Holmes, 2000; Howse and Leslie, 1997; MAF, 2001). Reports have shown that farms with the highest EFS/ha had significantly higher milksolids production, per cow and per hectare, than farms with lower EFS/ha (Howse and Leslie, 1997; Holmes, 2000; Leslie, 2001; MAF, 2001). This is because high gross farm incomes per hectare, essential for high EFS/ha, are only achieved through high milksolids production per hectare (Leslie, 2001).

Farms with the highest EFS/ha also had higher estimated pasture consumed per hectare than farms with the lowest EFS/ha (Holmes, 2000; Howse and Leslie, 1997). In all-pasture systems (low input systems), the amount of feed offered to the herd depends basically on pasture production. The level of pasture utilisation in these farms will significantly influence their milksolids production and profitability. Managers of all-pasture farms should have high grazing management skills in order to maximise pasture harvesting by lactating cows and to conserve pasture surplus as hay or silage. Well-managed all-pasture farms can be highly profitable (Macdonald, 1999).

Several studies have reported high milksolids productions, per cow and per hectare, in high feed input systems (Leslie, 2001; Macdonald, 1999; Roche and Reid, 2002; Van der Poel, 1996). But there were contradictory reports about the profitability of high input systems. Howse and Leslie (1997) and Leslie (2001), found that farms with the highest EFS/ha use more supplements per cow and per hectare than farms with the lowest EFS/ha. But there are also reports that high feed input systems can be less profitable than low feed input systems (Macdonald, 1999; Van der Poel, 1996). The inclusion of supplementary feed requires high levels of skills to adapt the system to the increased amount of feed available in the farm.

The objective of this paper is to describe the physical and financial characteristics of low, intermediate and high feed input dairy farms in the top or bottom quartiles for EFS/ha. The comparison of low, intermediate and high feed input farms in the quartiles with the highest and lowest EFS/ha can be helpful to understand the characteristics that make these systems profitable.

5.2. MATERIALS AND METHODS

5.2.1 MATERIALS

See section 3.2.1 in chapter 3 (Page 44).

5.2.2 METHODOLOGY

5.2.2.1 DATA MANAGEMENT

5.2.2.1.1 Classification of the data by season

See section 3.2.2.1.1 in chapter 3 (Page 45).

5.2.2.1.2 Classification of the data according to operating structure

See section 3.2.2.1.2 in chapter 3 (Page 45).

5.2.2.1.3 Classification of the data according to feed input (kg DM imported/cow)

See section 3.2.2.1.3 in chapter 3 (Page 45).

5.2.2.1.4 Classification of the data according to EFS/ha

After the classification by season and feed input, the data from owner-operated dairy farms were classified into quartiles according to their Economic Farm Surplus per hectare (EFS/ha). Two quartiles (Top and Bottom quartiles) were then analysed in detailed to determine the physical and financial characteristics of low, intermediate and high feed input systems within each of the two quartiles. This classification enables the analysis of the characteristics of dairy farms with the highest and lowest profitability according to the amount of extra feed used per cow.

5.2.2.1.5 Physical parameters studied

See section 3.2.2.1.4 in chapter 3 (Page 45).

5.2.2.1.6 Financial parameters studied

See section 4.2.2.1.4 in chapter 4 (Page 72).

5.2.2.2 STATISTICAL ANALYSIS

See section 3.2.2.2 in chapter 3 (Page 50).

5.3.- RESULTS

5.3.1 PHYSICAL CHARACTERISTICS

Between 1998/99 and 2001/02, low, intermediate and high feed input farms in the top quartile for EFS/ha had significantly higher stocking rates, lower comparative stocking rate, higher milksolids production (per cow, per hectare, per kilogram of liveweight) and higher estimated pasture consumed per hectare than their corresponding farm systems in the bottom quartile (See Table 5.1). During this period, milksolids payout increased from \$3.58/kg MS in 1998/99 to \$5.30/kg MS in 2001/02.

Table 5.1: Physical characteristics of low and high feed input dairy farms in the top and bottom quartiles for EFS/ha, in 1998/99 and 2001/02 [1]

Parameters	1998/99 [2]				2001/02 [2]			
	Low input		High input		Low input		High input	
Quartile for EFS/ha	**Bottom**	**Top**	**Bottom**	**Top**	**Bottom**	**Top**	**Bottom**	**Top**
Number of farms	16	9	14	17	12	9	19	16
Farm General Data								
Farm size (Eff. Ha)	76 [a]	70 [a]	66 [a]	86 [a]	72 [a]	84 [a]	97 [a]	82 [a]
Herd size (N. cows)	159 [a]	213 [a]	169 [a]	245 [a]	140 [a]	238 [a]	232 [a]	252 [a]
Herd breeding worth	39 [a]	39 [a]	33 [a]	36 [a]	65 [a]	93 [b]	63 [a]	81 [b]
Cow Liveweight (kg)	395 [a]	433 [b]	439 [a]	440 [a]	442 [a]	429 [a]	456 [a]	464 [a]
Stocking Rate (cows/ha)	2.2 [a]	2.9 [b]	2.7 [a]	3.0 [b]	2.1 [a]	2.9 [b]	2.3 [a]	3.1 [b]
Comparative SR (kg LWT/t DM)	95 [a]	85 [b]	92 [a]	82 [b]	97 [a]	78 [b]	89 [a]	79 [b]
Milksolids Production								
kg MS/cow	223 [a]	277 [b]	268 [a]	327 [b]	265 [a]	325 [b]	308 [a]	369 [b]
Lactation length (days)	---	---	---	---	241 [a]	266 [b]	263 [a]	267 [a]
kg MS/ha	478 [a]	804 [b]	723 [a]	977 [b]	543 [a]	924 [b]	710 [a]	1136 [b]
kg MS/kg LWT	0.57 [a]	0.65 [a]	0.61 [a]	0.74 [b]	0.61 [a]	0.76 [b]	0.68 [a]	0.80 [b]
Pasture Consumed								
Estimated pasture consumed (t DM/ha)	8.2 [a]	12.0 [b]	8.9 [a]	11.0 [b]	9.1 [a]	12.4 [b]	8.4 [a]	12.0 [b]
kg N applied /ha/year	53 [a]	75 [a]	75 [a]	103 [a]	48 [a]	100 [b]	100 [a]	160 [b]
Supplements made on farm								
Hay and silage made on farm (kgDM/ha)	413 [a]	558 [a]	399 [a]	720 [a]	625 [a]	815 [a]	369 [a]	932 [b]
Farms that made maize silage (%)	0%	0%	14%	18%	0%	0%	37%	19%
Maize silage made on farm (kg DM/ha)	0	0	630 [a]	1330 [a]	0	0	911 [a]	660 [a]
Supp. made on farm (kg DM/ha)	413 [a]	558 [a]	506 [a]	1163 [a]	625 [a]	815 [a]	824 [a]	1074 [a]
Feed imported								
Farms that imported supplements (%)	50%	78%	100%	100%	42%	100%	89%	100%
Supplements imported (kg DM/ha) [3]	50 [a]	54 [a]	1127 [a]	1407 [a]	19 [a]	47 [a]	1329 [a]	1736 [a]
Farms that use winter grazing (%)	0%	0%	64%	82%	0%	0%	63%	88%
Winter grazing (kg DM/ha)	0	0	896 [a]	1437 [a]	0	0	716 [a]	1160 [a]
Total feed imported (kg DM/ha) [4]	50 [a]	63 [a]	1703 [a]	2472 [b]	19 [a]	47 [b]	1733 [a]	2751 [b]

[1] Feed input: supplements imported + winter grazing + maize grown on farm

[2] Values with different superscript letter are statistically different (it refers to statistical difference within each system and year only).

[3] Supplements imported: hay and pasture silage, maize silage, grains, meals, other feeds.

[4] Total feed imported = supplements imported + winter grazing.

5.3.1.1 Farm Size (Eff. Ha.), Herd Size (N cows), Herd Breeding Worth (BW) and Liveweight of the cows (kg LWT)

Within each feed input system there were not significant differences in farm size between farms in the top or bottom quartile for EFS/ha (See Figure 5.1). This result was found in all 4 dairy seasons in study.

In all 4 dairy seasons, within each feed input systems, farms in the top quartile had larger herds than farms in the bottom quartile (See Table 5.1). But the difference in herd size between quartiles was only significant in intermediate input systems in 1999/00. Within each quartile, the average farm size was higher in high input systems than in intermediate and low input systems in all 4 dairy seasons (See Figure 5.2). But the difference in farm size between systems was significant only in the bottom quartile in 2000/01.

Figure 5.1: Average farm size of low, intermediate and high input farms in the top or bottom quartiles for EFS/ha, between 1998/99 and 2001/02.

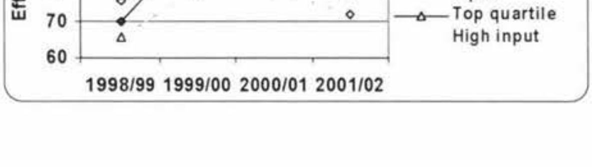
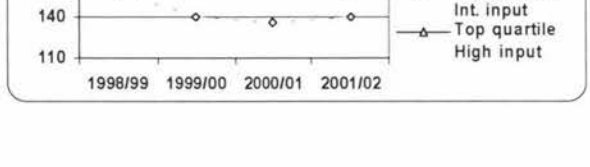
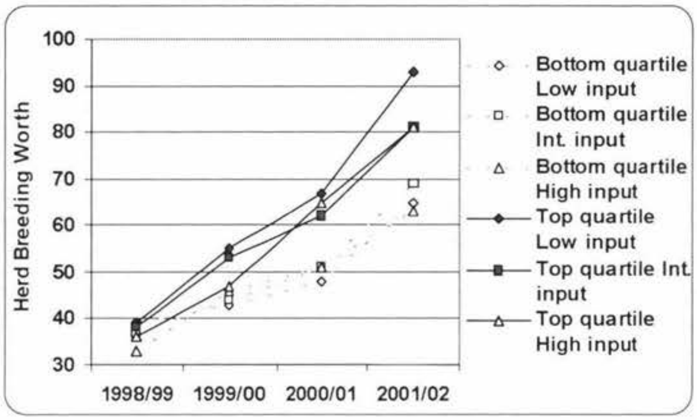


Figure 5.2: Herd size of low, intermediate and high input farms in the top or bottom quartiles for EFS/ha, between 1998/99 and 2001/02.



Within each feed input system, in 1998/99 and 1999/00 there were not significant differences in herd BW between farms in the top or bottom quartiles for EFS/ha (See Figure 5.3). But in 2000/01 and 2001/02, there were significant differences in herd BW between quartiles, in all 3 feed input systems (See Table 5.1). With exception of the top quartile in 2001/02, within each quartile, there were not significant differences in BW between feed input systems. There was also an interaction between dairy season, quartile for EFS/ha and breeding worth ($P<0.0001$).

Figure 5.3: Herd breeding worth of low, intermediate and high input farms in the top or bottom quartiles for EFS/ha, between 1998/99 and 2001/02.

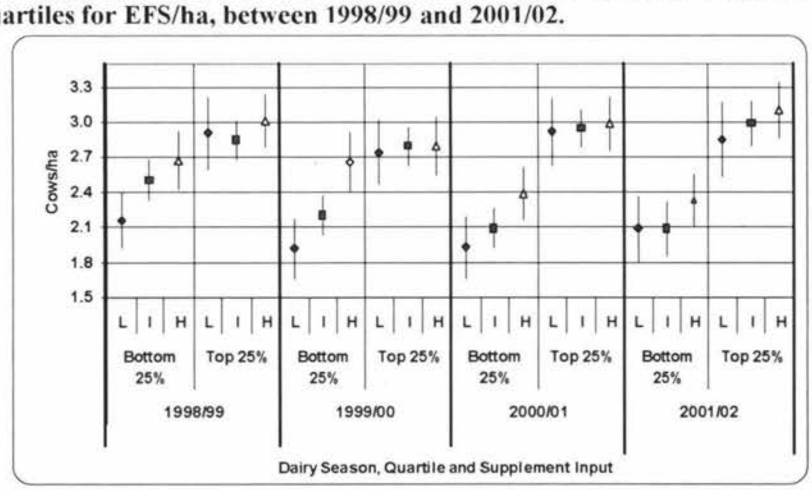


With the exception of low input systems in 1998/99, there were not significant differences in the average liveweight of the cows between farms in the top or bottom quartiles for EFS/ha within each feed input system (See Table 5.1).

5.3.1.2.- Stocking Rate (cows/ha) and Comparative Stocking Rate (kg LWT/t DM)

Within each feed input system, farms in the top quartile for EFS/ha had higher stocking rates than their corresponding farm system in the bottom quartile (See Figure 5.4). Within the top quartile, there were not significant differences in stocking rate between feed input systems (See Figure 5.4). Within the bottom quartile, high input systems had significantly higher stocking rates than low input systems in 1998/99, 2000/01 and 2001/02 (See Figure 5.4).

Figure 5.4: Average stocking rate of low (L), intermediate (I) and high (H) input farms in the top or bottom quartiles for EFS/ha, between 1998/99 and 2001/02.



However, in all 3 feed input systems, farms in the top quartile had lower comparative stocking rate than farms in the bottom quartile, in all dairy seasons. This implies that these farms had compensated their higher stocking rate with extra feeds (See Table 5.1).

5.3.1.3 Milksolids Production (kg MS/cow, kg MS/ha, days in milk, kg MS/kg LWT, kg MS/t DM)

Within each feed input systems farms in the top quartile for EFS/ha had significantly higher milksolids production, per cow and per hectare, than their corresponding farm system in the bottom quartile (See Figures 5.5 and 5.6). Within each quartile, high input systems had higher milksolids production, per cow and per hectare, than intermediate and low input systems (See Figures 5.5 and 5.6). There was a significant interaction between feed input system, quartile for EFS/ha and milksolids production per hectare (P=0.0475).

Figure 5.5: Milksolids production per cow in low (L), intermediate (I) and high (H) input farms in the top or bottom quartiles for EFS/ha, between 1998/99 and 2001/02.

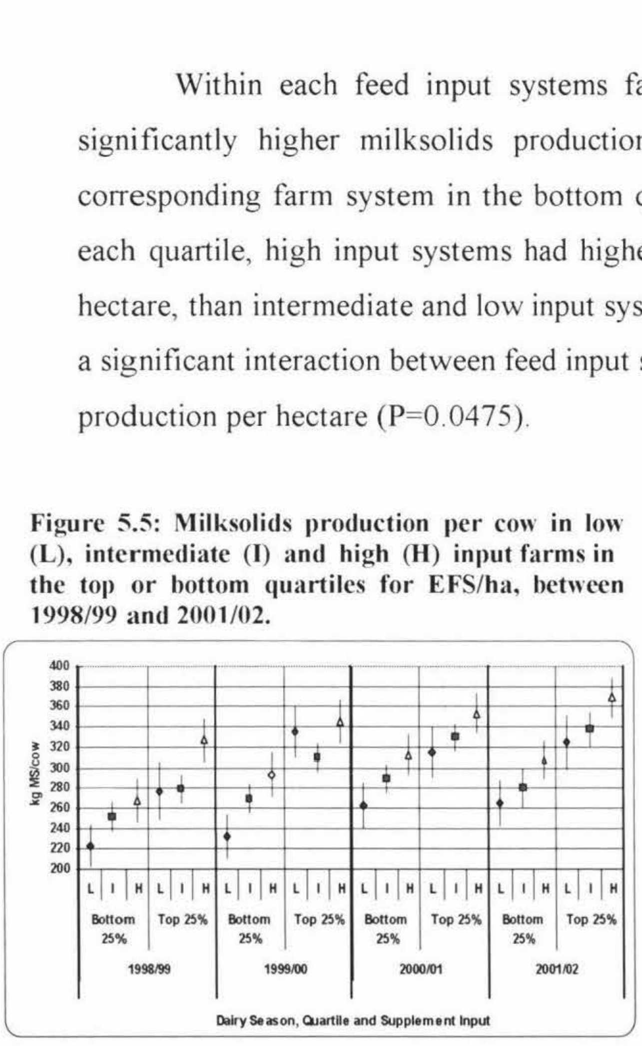
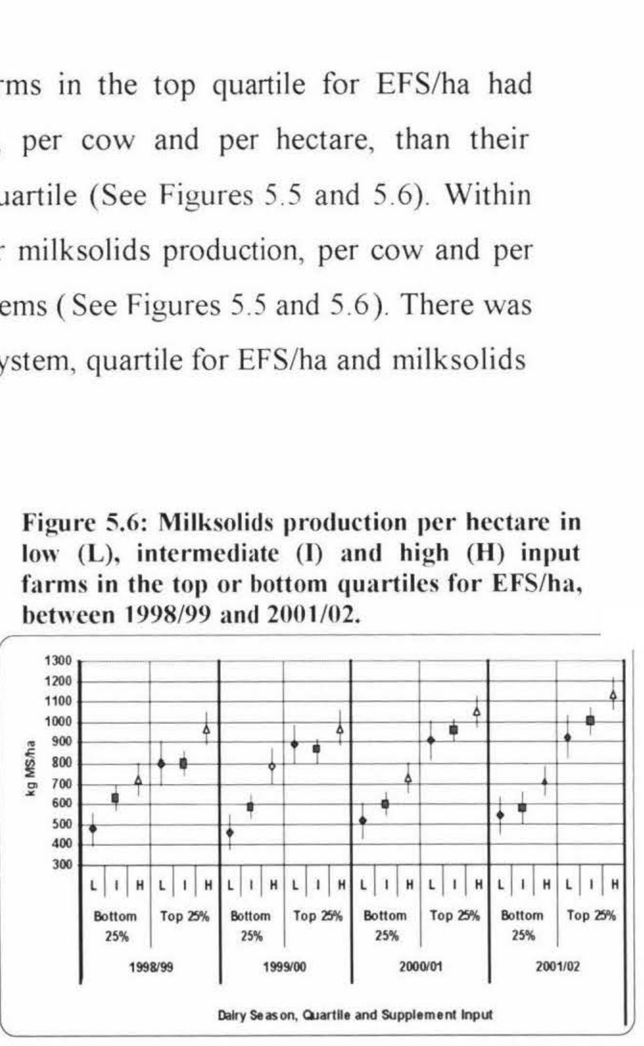


Figure 5.6: Milksolids production per hectare in low (L), intermediate (I) and high (H) input farms in the top or bottom quartiles for EFS/ha, between 1998/99 and 2001/02.



Between 1999/00 and 2001/02, low input farms in the top quartile for EFS/ha had longer lactation lengths than low input farms in the bottom quartile, although the differences were significant only in 1999/00 and 2001/02 (See Table 5.1). In all 4 dairy seasons, there were not significant differences in lactation length between quartiles in intermediate and high input systems.

5.3.1.4 Reproductive characteristics of the herd

Table 5.2 shows the reproductive characteristics of dairy farms according to their feed input and EFS/ha. Between 1999/00 and 2001/02, within each feed input system, there were not significant differences in replacement rate, use of CIDR's, cows culled (late calvers or empty) and planned start of calving date between farms in the top and bottom quartiles for EFS/ha (See Table 5.2).

Table 5.2: Reproductive characteristics of low and high feed input dairy farms in the top and bottom quartiles for EFS/ha, in 1998/99 and 2001/02 (Low input <50kg DM extra feed/cow, Intermediate input 50-500 kg DM extra feed/cow; High input: >500kg DM extra feed/cow)[1]

Parameters	1999/00 [2]				2001/02 [2]			
	Low input		High input		Low input		High input	
Quartile for EFS/ha	Bottom	Top	Bottom	Top	Bottom	Top	Bottom	Top
Number of farms	16	9	14	17	12	9	19	16
Replacement rate (%)	22% [a]	20% [a]	24% [a]	21% [a]	21% [a]	20% [a]	26% [a]	24% [a]
Spring calving date (Start)	25-Jul-98	31-Jul-98	23-Jul-98	4-Aug-98	26-Jul-01	22-Jul-01	23-Jul-01	26-Jul-01
Days from start of calving to mean calving date	---	---	---	---	23 [a]	19 [b]	22 [a]	23 [a]
Cows induced (% of the herd)	9% [a]	4% [b]	7% [a]	10% [a]	4% [a]	6% [a]	3% [a]	7% [b]
Use of CIDR's (% of the herd)	2% [a]	3% [a]	11% [a]	6% [a]	1% [a]	4% [a]	8% [a]	13% [a]
Cows culled or empty (%)	11% [a]	10% [a]	9% [a]	7% [a]	6% [a]	6% [a]	8% [a]	7% [a]

[1] Feed input: supplements imported + winter grazing + maize grown on farm

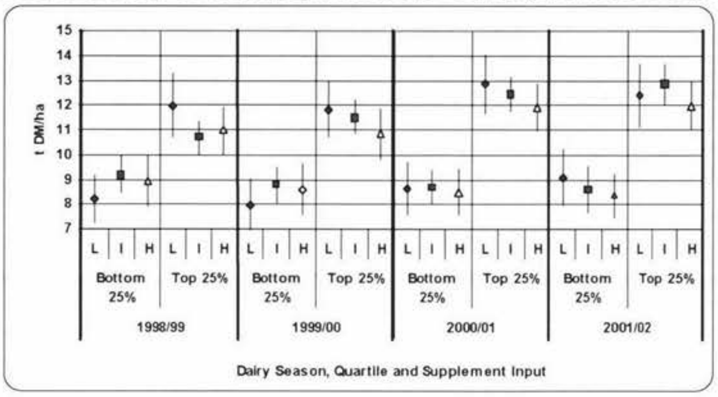
[2] Values with different superscript letter are statistically different (it refers to statistical difference within each system and year only)

5.3.1.5 Estimated pasture consumed (t DM/ha) and use of nitrogen fertiliser (kg N/ha)

Within each feed input system, farms in the top quartile for EFS/ha had significantly higher estimated pasture consumed per hectare than farms in the bottom quartile. This result was observed in the 4 dairy seasons analysed (See Figure 5.7)

In all 3 feed input systems, farms in the top quartile used more nitrogen fertiliser per hectare than farms in the bottom quartile, in all 4 dairy seasons (See Table 5.1). However, the differences between quartiles were significant only in 2000/01, for intermediate and high input systems; and in 2001/02, for all 3 feed input systems.

Figure 5.7: Estimated pasture consumed per hectare (t DM/ha) in low (L), intermediate (I) and high (H) input farms, in the top or bottom quartiles for EFS/ha, between 1998/99 and 2001/02.



5.3.2 FINANCIAL CHARACTERISTICS

Table 5.3 shows the financial characteristics of dairy farms in 1998/99 ($3.58/kg MS) and 2001/02 ($5.30/kg MS), according to their feed input and EFS/ha.

Table 5.3: Financial characteristics of low and high feed input dairy farms in the top and bottom quartiles for EFS/ha, in 1998/99 and 2001/02 [1]

Parameters	1998/99 [2]				2001/02 [2]			
	Low input		High input		Low input		High input	
Quartile for EFS/ha	Bottom	Top	Bottom	Top	Bottom	Top	Bottom	Top
Number of farms	16	9	14	17	12	9	19	16
Farm Income								
Milksolids payout ($/kg MS)	3.58	3.58	3.58	3.58	5.30	5.30	5.30	5.30
Income from the sale of milksolids ($/ha)	1756 [a]	2914 [b]	2678 [a]	3521 [b]	2914 [a]	4822 [b]	3767 [a]	5963 [b]
Total Dairy Income ($/ha)	1924 [a]	3116 [b]	2907 [a]	3818 [b]	3276 [a]	5210 [b]	4083 [a]	6520 [b]
Farm Expenses (FWE)								
Animal costs								
Average number of cows per labour unit	101 [a]	125 [a]	101 [a]	124 [a]	89 [a]	133 [b]	98 [a]	125 [b]
Labour cost ($/cow) [3]	281 [a]	210 [b]	245 [a]	230 [b]	398 [a]	252 [b]	358 [a]	282 [b]
Animal costs excluding labour ($/cow) [4]	125 [a]	112 [a]	155 [a]	154 [a]	139 [a]	143 [a]	173 [a]	178 [a]
Expenditure on fertilisers and feed								
Fertilisers ($/ha)	241 [a]	278 [a]	303 [a]	340 [a]	264 [a]	386 [b]	390 [a]	460 [a]
Total feed costs ($/cow) [5]	52 [a]	55 [a]	175 [a]	167 [a]	69 [a]	103 [a]	259 [a]	274 [a]
Total feed costs ($/ha) [5]	114 [a]	160 [a]	473 [a]	501 [a]	145 [a]	299 [a]	596 [a]	849 [a]
Expenditure on overheads								
Total expenditure on overheads ($/ha) [6]	794 [a]	695 [a]	1051 [a]	962 [a]	843 [a]	879 [a]	1130 [a]	1160 [a]
Total Farm Working Expenses ($/ha)	1355 [a]	1383 [a]	1934 [a]	2153 [a]	1369 [a]	1862 [b]	2423 [a]	2927 [b]
Total Farm Working Expenses ($/kg MS)	2.90 [a]	1.70 [b]	2.70 [a]	2.20 [b]	2.40 [a]	2.00 [b]	3.30 [a]	2.60 [b]
FWE excluding wages ($/kgMS)	2.50 [a]	1.50 [b]	2.40 [a]	1.90 [b]	2.20 [a]	1.80 [b]	2.90 [a]	2.30 [b]
Wages incl labour adjustment ($/kg MS)	1.30 [a]	0.76 [b]	0.94 [a]	0.72 [b]	1.52 [a]	0.78 [b]	1.18 [a]	0.77 [b]
Exp. On feed /total farm exp. (%) [5]	8%	12%	24%	23%	11%	16%	25%	29%
Economic Farm Surplus ($EFS/ha)	-51 [a]	1072 [b]	-7 [a]	1044 [b]	962 [a]	2767 [b]	972 [a]	2913 [b]

[1] Feed input: supplements imported + winter grazing + maize grown on farm

[2] Values with different superscript letter are statistically different (it refers to statistical difference within each system and year only).

[3] Labour costs = wages + labour adjustment. (family unpaid labour)

[4] Animal costs excluding labour ($/cow) = Animal health, herd improvement, farm dairy and electricity

[5] It comprises the costs of supplements made on farm (crop and regrazing), supplements purchased, winter grazing and young stock grazing. Total expenditure on feed per hectare is an estimation based on average stocking rate for each year and system.

[6] Repair and maintenance, vehicles, freight, weed and pest control, administration, standing charges, run-off lease and other expenses.

Farms in the top quartile for EFS/ha had significantly higher gross farm incomes per hectare, and similar or higher farm working expenses per hectare, than farms in the bottom quartile (See Table 5.3). Farms in the top quartile had also lower farm working expenses per kilogram of milksolids, and lower labour costs per cow and per kilogram of milksolids, than farms in the bottom quartile (See Table 5.3). All these characteristics were observed within each feed input system and in all dairy seasons analysed.

5.3.2.1 GROSS FARM INCOME PER HECTARE (GFI/ha)

Within each feed input system, farms in the top quartile had significantly higher GFI/ha than farms in the bottom quartile, in all 4 dairy seasons (See Figure 5.8). Within each quartile, with exception of the top quartile in 1999/00, high input systems had significantly higher GFI/ha than low input systems (See Figure 5.8). There were not significant differences in GFI/ha between feed input systems in the top quartile in 199900 (See Figure 5.8).

Figure 5.8: Gross farm income ($/ha) in in low (L), intermediate (I) and high (H) input farms, in the top or bottom quartiles for EFS/ha, between 1998/99 and 2001/02.

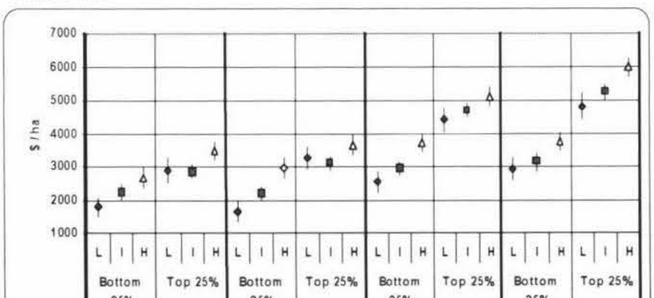
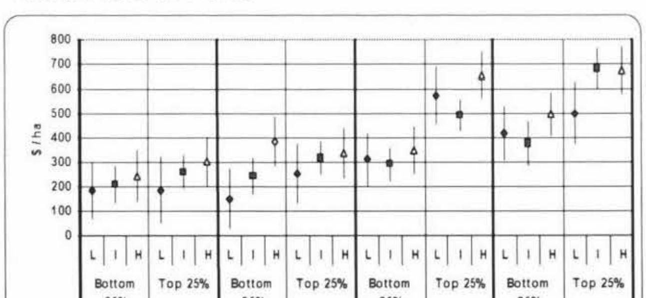


Figure 5.9: Stock income per hectare ($/ha) in low (L), intermediate (I) and high (H) input farms, in the top or bottom quartiles for EFS/ha, between 1998/99 and 2001/02.



In all 4 dairy seasons, low, intermediate and high input farms in the top quartile had significantly higher income from the sale of milksolids than their corresponding farm systems in the bottom quartile (See Table 5.3). Within each quartile, high input systems had higher income from the sale of milksolids than intermediate and low input systems, in all 4 dairy seasons. There were significant differences in stock income between farms in the top or bottom quartiles, in 2000/01, in all 3 feed input systems; and in 2001/02, in intermediate and high input systems (See Figure 5.9).

5.3.2.2 FARM WORKING EXPENSES PER HECTARE ($ FWE/ha)

Within each feed input system, there were not significant differences in FWE/ha between farms in the top or bottom quartiles in 1998/99 and 2001/02 (See Figure 5.10). In 2000/01 and 2001/02, with exception of high input systems in 2000/01, farms in the top quartile had significantly higher FWE/ha than farms in the bottom quartile, in all 3 feed input systems (See Figure 5.10). Within each quartile, high input systems had significantly higher FWE/ha than intermediate and low input systems (See Figure 5.10).

Figure 5.10: Farm Working Expenses per hectare ($/ha) in low (L), intermediate (I) and high (H) input farms, in the top or bottom quartiles for EFS/ha, between 1998/99 and 2001/02.

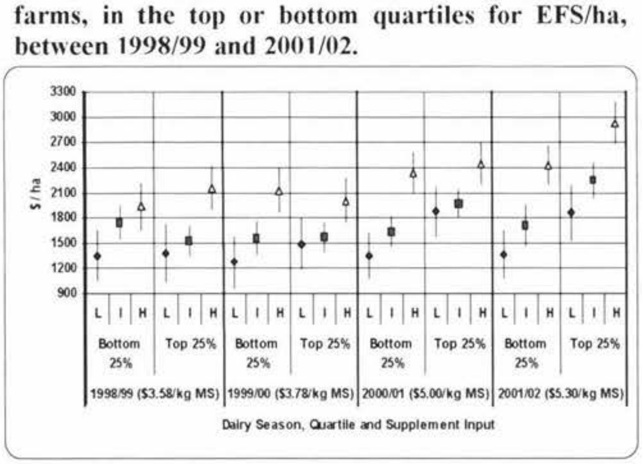
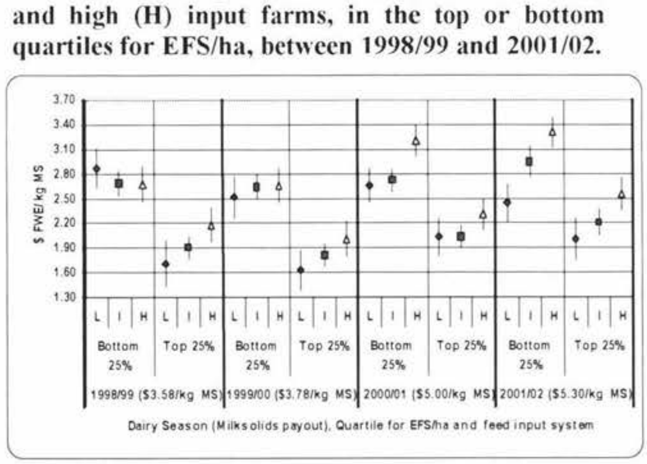


Figure 5.11: Farm Working Expenses per kilogram of milksolids ($/kg MS) in low (L), intermediate (I) and high (H) input farms, in the top or bottom quartiles for EFS/ha, between 1998/99 and 2001/02.



In all 3 feed input systems, and in all dairy seasons, farms in the top quartile had significantly lower FWE/kg MS than farms in the bottom quartiles (See Figure 5.11). With exception of the bottom quartile in 1998/99, high input systems had higher FWE/kg MS than intermediate and low input systems (See Figure 5.11).

5.3.2.2.1 Animal costs: labour, animal health, herd improvement, farm dairying and electricity

In all 4 dairy seasons, within each feed input system, animal costs per cow excluding labour (animal health, herd improvement, farm dairy and electricity) were not significantly different between farms in the top or bottom quartiles (See Table 5.3).

In all 3 feed input systems, farms in the top quartile had more cows per labour unit than their corresponding farm system in the bottom quartile (See Figure 5.12). With exception of low and high input systems in 1998/99, the differences in cows per labour unit between quartiles were significant in the 4 dairy seasons. Within each feed input system, farms in the top quartile had lower labour costs per cow than farms in the bottom quartile (See Figure 5.13). With exception of high input systems in 1998/99, the differences in labour costs per cow between quartiles were significant in the 4 dairy seasons.

Figure 5.12: Cows per labour unit in low (L), intermediate (I) and high (H) input farms, in the top or bottom quartiles for EFS/ha, between 1998/99 and 2001/02.

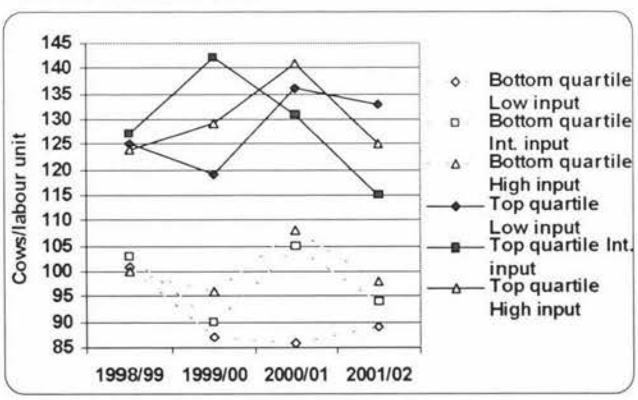
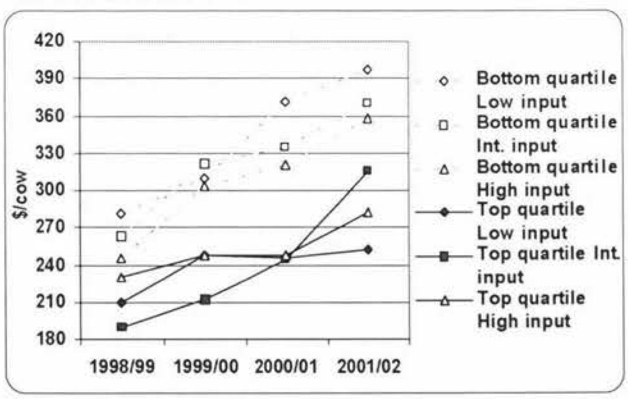


Figure 5.13: Labour costs ($/cow) in low (L), intermediate (I) and high (H) input farms, in the top or bottom quartiles for EFS/ha, between 1998/99 and 2001/02.



5.3.2.2.2 Fertiliser costs ($/ha) and Feed costs ($/cow)

With exception of intermediate input systems in 1998/99, between 1998/99 and 1999/00 there were not significant differences in fertiliser costs ($/ha) between farms in the top or the bottom quartiles, in all 3 feed input systems (See Figure 5.14). In 2000/01 and 2001/02, with the exception of high input systems in 2001/02, farms in the top quartile had significantly higher fertiliser costs ($/ha) than farms in the bottom quartile (See Figure 5.14).

Within each feed input system, there were not significant differences in feed costs per cow between farms in the top or the bottom quartiles, in all 4 dairy seasons (See Figure 5.15). But within each quartile, high input systems had significantly higher feed costs than intermediate and low input systems (See Figure 5.15).

Figure 5.14: Fertiliser costs ($/ha) in low (L), intermediate (I) and high (H) input farms, in the top or bottom quartiles for EFS/ha, between 1998/99 and 2001/02.

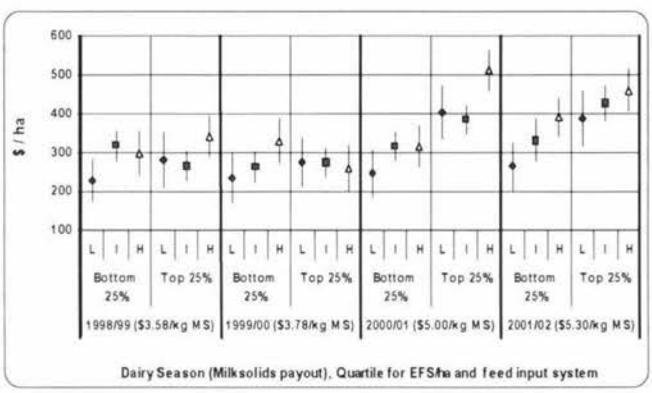
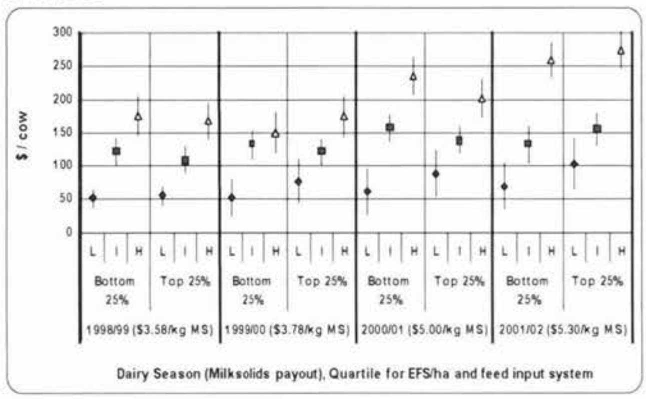


Figure 5.15: Feed costs ($/ha) in low (L), intermediate (I) and high (H) input farms, in the top or bottom quartiles for EFS/ha, between 1998/99 and 2001/02.

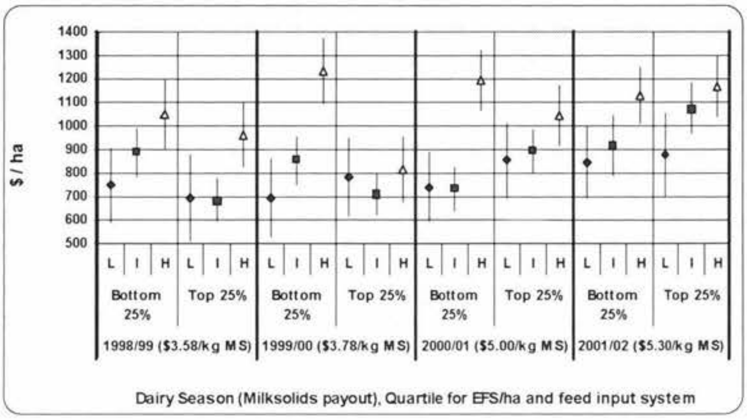


5.3.2.2.3 Overhead costs ($/ha)

With exception of high input systems in 1999/00, there were not significant differences in overhead costs between quartiles in low and high input systems (See Figure 5.16). In intermediate input systems, farms in the top quartile had significantly lower overhead costs ($/ha) than farms in the bottom quartile in 1998/99 and 2001/02 (See Figure 5.16). In 2000/01 and 2001/02, farms in the top quartile had higher overhead costs than farms in the bottom quartile (See Figure 5.16).

With the exception of the top quartile in 1999/00, within each quartile, high input systems had higher overhead costs than intermediate and low input systems.

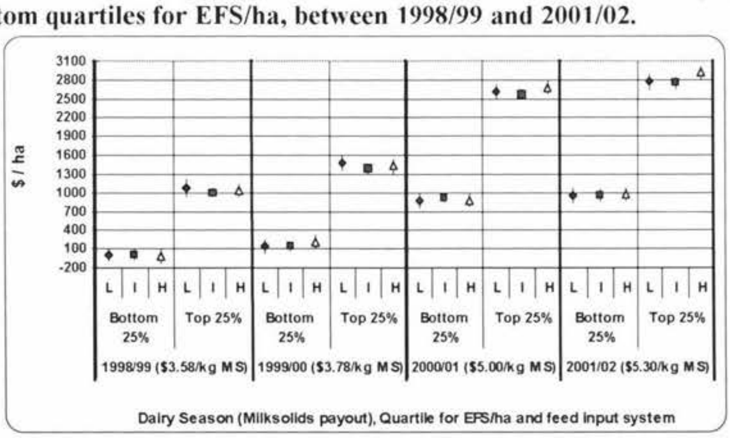
Figure 5.16: Overhead costs ($/ha) in low (L), intermediate (I) and high (H) input farms, in the top or bottom quartiles for EFS/ha, between 1998/99 and 2001/02.



5.3.2.3 Economic Farm Surplus per hectare ($/ha)

Within each feed input system, the difference in EFS/ha between the top and bottom quartiles for EFS/ha increased with the increase in milksolids payout (See Figure 3.16). Within each quartile, there were not significant differences in EFS/ha between feed input systems, in all 4 dairy seasons (See Figure 3.17).

Figure 5.17: Economic Farm Surplus ($/ha) in low (L), intermediate (I) and high (H) input farms, in the top or bottom quartiles for EFS/ha, between 1998/99 and 2001/02.



5.3.2.4 Percentages of Return on Assets, excluding capital appreciation, (% RoA) and Return on Equity (% RoE)

Within each feed input system, farms in the top quartile had higher RoA than farms in the bottom quartile, in all dairy seasons (See Figure 5.18). However, the differences in RoA between quartiles were not significant in 1998/99 and 2001/02

(See Table 5.4). Within each quartile, there were not significant differences in RoA between feed input systems (See Figure 5.18).

Table 5.4: Return on assets and Return on Equity in low and high feed input dairy farms in the top and bottom quartiles for EFS/ha, in 1998/99 and 2001/02.

Parameters	1998/99 [1]				2001/02 [1]			
	Low input		High input		Low input		High input	
Quartile of EFS/ha	Bottom	Top	Bottom	Top	Bottom	Top	Bottom	Top
Number of farms	16	9	14	17	12	9	19	16
Return on Assets (%)	0.02% [a]	5.63% [a]	0.57% [a]	5.92% [a]	6.26% [a]	17.10% [b]	5.92% [a]	11.76% [b]
Return on Equity (%)	-7.90% [a]	3.90% [b]	-8.30% [a]	5.00% [b]	5.60% [a]	24.70% [b]	4.20% [a]	14.80% [b]
Operating assets ($)	1 031 349 [a]	1 453 610 [a]	1 229 004 [a]	1 530 238 [a]	1 181 667 [a]	1 637 970 [a]	1 878 099 [a]	2 167 329 [a]
Owner's equity ($)	703 358 [a]	864 623 [a]	781 920 [a]	949 424 [a]	990 574 [a]	750 990 [a]	1 327 552 [a]	1 433 705 [a]
Equity as % of Assets	65% [a]	57% [a]	61% [a]	65% [a]	84% [a]	47% [a]	71% [a]	63% [a]

[1] Values with different superscript letter are statistically different (it refers to statistical difference within each system and year only).

Within each feed input system, there were significant differences in RoE between farms in the top or the bottom quartiles, in all dairy seasons (See Figure 5.19). Within the top quartiles in 2000/01 and 2001/02, there were significant differences in RoE between feed input systems (See Figure 5.19).

Figure 5.18: Return on Assets (%RoA) in low (L), intermediate (I) and high (H) input farms, in the top or bottom quartiles for EFS/ha, between 1998/99 and 2001/02.

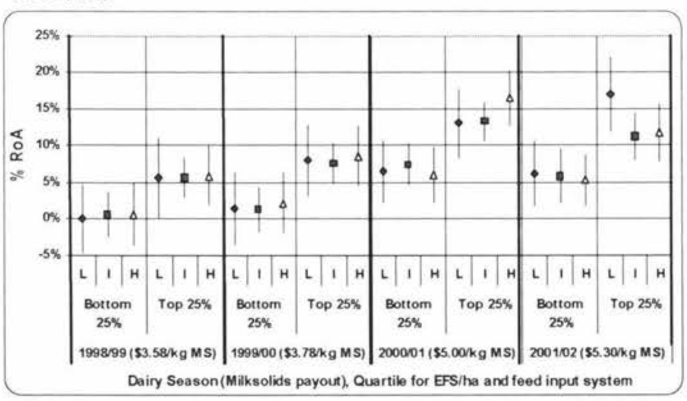
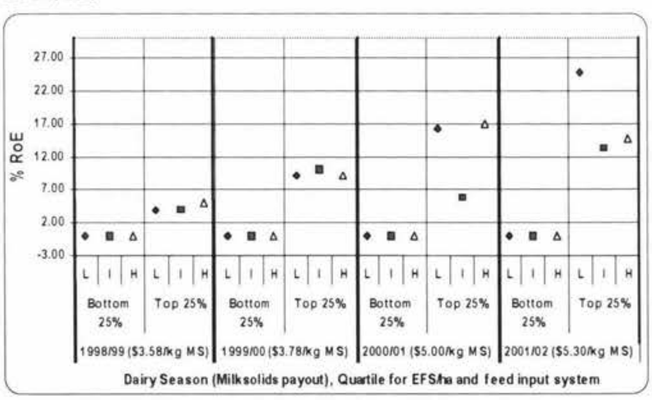


Figure 5.19: Return on Equity (%RoE) in low (L), intermediate (I) and high (H) input farms, in the top or bottom quartiles for EFS/ha, between 1998/99 and 2001/02.



5.3.2.5 Cost of milksolids production ($/kg MS)

Within each feed input system, farms in the top quartile had significantly lower variable and fixed costs per kilogram of milksolids than farms in the bottom quartile (See Table 5.5). This result was found in all 4 dairy seasons.

Table 5.5: Cost of milksolids production in low and high feed input dairy farms in the top and bottom quartiles for EFS/ha, in 1998/99 and 2001/02.

Parameters	1998/99 [2]				2001/02 [2]			
	Low input		High input		Low input		High input	
	Bottom	Top	Bottom	Top	Bottom	Top	Bottom	Top
Number of farms	16	9	14	17	12	9	19	16
Variable costs per kg MS ($/kg MS)	1.67 [a]	1.13 [b]	1.80 [a]	1.50 [b]	1.49 [a]	1.33 [a]	2.26 [a]	1.87 [b]
Fixed costs per kg MS ($/kg MS)	1.58 [a]	0.86 [b]	1.48 [a]	0.97 [b]	1.47 [a]	0.96 [b]	1.58 [a]	1.03 [b]
Total cost of production ($/kg MS) [3]	5.38 [a]	3.52 [b]	4.94 [a]	3.61 [b]	5.18 [a]	3.68 [b]	5.50 [a]	4.07 [b]

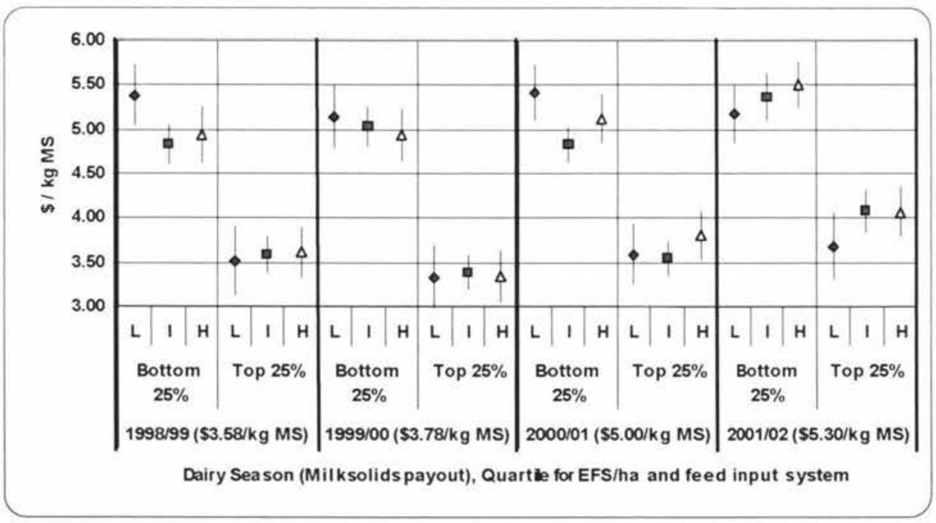
[1] Feed input: supplements imported + winter grazing + maize grown on farm

[2] Values with different superscript letter are statistically different (it refers to statistical difference within each system and year only).

[3] Cost per kg MS includes labour adjustment, depreciation, stock income and capital cost

Within each feed input system, there were significant differences in milksolids production costs between farms in the top or the bottom quartiles for EFS/ha, in all 4 dairy seasons (See Figure 5.20). Within each quartile, there were not significant differences in milksolids production costs between low and high input systems, in all 4 dairy seasons (See Figure 5.20).

Figure 5.20: Total cost of milksolids production (including the opportunity cost of capital) in low (L), intermediate (I) and high (H) input farms in the top and bottom quartiles for EFS/ha, between 1998/99 and 2001/02.



5.4.- DISCUSSION

The results of this study showed that in all three feed input systems, farms in the top quartile for EFS/ha differed from their corresponding feed input systems in the bottom quartiles in that they had:

- Higher stocking rates.
- Lower comparative stocking rates.
- Higher milksolids production, per cow and per hectare.
- Higher estimated pasture consumed per hectare.
- Higher use of nitrogen fertiliser per hectare.
- Higher gross farm incomes per hectare.
- Similar or higher farm working expenses per hectare.
- Lower labour costs per cow and per kilogram of milksolids.
- Lower FWE and total costs of production per kilogram of milksolids.

Most of these characteristics have also been reported in previous studies (Leslie, 2001; MAF, 2001; Holmes, 2000; Deane, 1999; McGrath, 1997; Howse and Leslie, 1997).

Within the top quartile for EFS/ha, high feed input farms differed from intermediate and low input farms, in both the top and bottom quartiles, in that they had:

- Higher stocking rates.
- Lower comparative stocking rates.
- Higher milksolids production, per cow and per hectare.
- Higher use of nitrogen fertiliser per hectare.
- Higher gross farm incomes per hectare.
- Higher farm working expenses per hectare.

- But there were no significant differences between systems in the estimated pasture consumed per hectare, costs of production per kilogram of milksolids and EFS/ha.

5.4.1 STOCKING RATE AND COMPARATIVE STOCKING RATE

Relatively high stocking rates are one of the main characteristics of farms in the top quartile for EFS/ha. Since stocking rate determines feed demand per hectare, farms in the top quartile had higher feed demand per hectare than farms in the bottom quartiles, especially high feed input farms. As a consequence, feed utilisation was maximised in farms in the top quartile. The lower stocking rates in farms in the bottom quartiles suggest that these farms did not utilise all the feed available in the farm (Leslie, 2001; Howse and Leslie, 1997).

The lower comparative stocking rate in farms in the top quartile indicates that although low, intermediate and high input farms in the top quartile had more cows per hectare, they had also slightly lower feed demand per unit of feed supply.

5.4.2 MILKSOLIDS PRODUCTION (kg MS/cow and kg MS/ha)

The higher milksolids production per cow in farms in the top quartile is mostly related to the higher feeding level of the cows in these farms. This conclusion is based on the effect of feeding level of the cow on milksolids production (Kolver, 2000) and the lower comparative stocking rates observed in farms in the top quartile (See Table 5.1).

The differences in milksolids production per cow between quartiles were higher in low input systems than in high input systems. This can be because in low input systems, intake per cow depends on pasture production and the farmer's grazing management skills. High input systems are more independent of pasture grown in the farm and can offset losses of pasture dry matter, and increase the feeding level of the cow, with the use of extra feed regardless of the farmer's skills.

Farms in the top quartile had higher milksolids production per hectare than farms in the bottom quartile due to their higher stocking rates and their higher milksolids production per cow. The interaction between milksolids production per hectare, feed input system and quartile for EFS/ha suggests that a well-managed high input system can result in high milksolids production per hectare. Poor management skills (defined as the inability to achieve high EFS/ha), are associated with low milksolids productions per hectare, especially in low input systems.

As for milksolids production per cow, the differences in milksolids production per hectare between the top and the bottom quartiles were higher in low input systems than in high input systems. This can be because in low input systems the feed intake of the cow can be more variable, in quantity and quality, than in high input systems (Kolver, 2000).

5.4.3 ESTIMATED PASTURE CONSUMED PER HECTARE (t DM/ha)

In all 3 feed input systems, farms in the top quartile had higher estimated pasture consumed per hectare than farms in the bottom quartiles. Howse and Leslie (1997) and Holmes (2000) found similar results. However, these results should be interpreted with caution since pasture consumed per hectare is an estimation based on the energy requirements of the cow for maintenance, growth, pregnancy and milksolids production (See Appendix 2.8).

The conclusion that farms in the top quartile for EFS/ha had more pasture consumed per hectare is supported by other characteristics observed in farms in the top quartile (higher stocking rates, higher milksolids production per cow and per hectare, and higher use of nitrogen fertiliser). The level of skills in low input farms in the top quartile must have been high. This is because it is difficult to maintain relatively high stocking rates and at the same time achieve high feed intakes and milksolids production per cow. The ability of farms in the top quartile to maximise pasture production is also reflected in their higher use of nitrogen fertiliser per hectare and in their higher amount of pasture conserved on farm.

As differences in estimated pasture consumed per hectare were not apparent between high, intermediate and low input systems, intermediate and high input farms in the top quartile should have also had high grazing management skills. This is because intermediate and high input systems in the top quartile were able to maintain high stocking rates, maximise pasture production and utilisation, achieve high feed intakes and milksolids production per cow and, at the same time, include extra feed into the system.

High input farms in the top quartile for EFS/ha imported similar or higher amounts of extra feed than high input farms in the bottom quartile. This result suggests that high input farms in the bottom quartile for EFS/ha were importing extra feed but were no also maximising pasture production and pasture utilisation.

5.4.4 GROSS FARM INCOME PER HECTARE (GFI/ha)

Due to their higher milksolids production per hectare, farms in the top quartile had significantly higher GFI/ha than farms in the bottom quartile. This is because approximately 90% to 92% of GFI/ha comes from the sale of milksolids (See section 4.3.1).

5.4.5 FARM WORKING EXPENSES PER HECTARE (FWE/HA)

Although, within each feed input system, farms in the top quartiles had higher FWE/ha than farms in the bottom quartiles, they had lower farm working expenses per cow and per kilogram of milksolids (See Table 5.6).

Table 5.6: Farm working expenses per hectare, per cow and per kilogram of milksolids in high and low input systems in 1998/99 and 2001/02.

Dairy Season	Feed input system	FWE/ ha ($/ha)		FWE/cow ($/cow)		FWE/kg MS ($/kg MS)	
		Bottom	Top	Bottom	Top	Bottom	Top
1998/99	Low input	1355	1383	634	475	2.9	1.7
	High input	1934	2153	714	716	2.7	2.2
2001/02	Low input	1369	1862	646	650	2.4	2.0
	High input	2423	2927	1021	946	3.3	2.6

This is because farms in the top quartile had higher stocking rates and higher milksolids production per hectare than farms in the bottom quartiles. This results suggest that FWE/ha are not the main determinant of farm profitability and that achieving high milksolids production per hectare is essential to decrease farm working expenses per kilogram of milksolids.

Milksolids payout appears to have influenced farm working expenses per hectare. This is because at low milksolids payouts there were no significant differences in FWE/ha between quartiles for EFS/ha. At high milksolids payouts farms in the top quartile had significantly higher FWE/ha than farms in the bottom quartile.

5.4.5.1 Animal costs ($/cow)

Farms in the top quartile for EFS/ha were more efficient in diluting labour costs than farms in the bottom quartile. This was done by managing more cows per each labour unit and by expending less on labour per cow (See Table 5.5). Howse and Leslie (1997) and Holmes (2000) also reported lower labour costs per cow in farms in the top quartile for EFS/ha.

5.4.6 ECONOMIC FARM SURPLUS PER HECTARE ($EFS/ha)

Within the top and the bottom quartiles for EFS/ha, the lack of significant differences in EFS/ha between the 3 feed input systems suggests that there are other factors that, with New Zealand systems and costs of production, have a greater influence on EFS/ha than the amount of extra feed used per cow. For New Zealand systems and costs, management skills are probably more important than the amount of extra feed used.

The differences between the top and the bottom quartiles increased as milksolids payout increased. This is due to the significant increase in the differences of GFI/ha between quartiles. The results related to FWE/ha suggest that EFS/ha is not determined by farm working expenses per hectare. The main financial difference between quartiles was GFI/ha. This study confirms the statement made by Leslie (2001) that high farm incomes per hectare are essential for high EFS/ha.

5.4.7 RETURN ON ASSETS, WITHOUT CAPITAL APPRECIATION, (%RoA) AND RETURN ON EQUITY (%RoE)

Low, intermediate and high input farms in the top quartile for EFS/ha had higher RoA and RoE than their corresponding farm systems in the bottom quartile due to their higher EFS/ha. Similar results were reported by Leslie (2001).

Since there were no significant differences in EFS/ha between feed input systems, and high input systems had higher net operating assets than low input systems, it was expected that RoA is lower in high input systems. However, within each quartile for EFS/ha there were no significant differences in RoA between feed input systems. This can be due to the higher EFS per farm in high input systems (See Table 5.7). Small differences in EFS/ha and farm size determined a higher EFS/farm in high input systems than in low input systems, although the differences were no significant.

Table 5.7: EFS per farm (payout adjusted) in low, intermediate and high input systems in New Zealand, between 1998/99 and 2001/02.

Year	Quartile for EFS/ha	Low input	Intermediate input	High input
1998/99	Bottom quartile	1153 [a]	2511 [a]	1992 [a]
	Top quartile	77928 [a]	75264 [a]	87289 [a]
1999/00	Bottom quartile	10686 [a]	14021 [a]	19248 [a]
	Top quartile	136743 [a]	133790 [a]	137505 [a]
2000/01	Bottom quartile	62695 [a]	98290 [a]	104271 [a]
	Top quartile	220142 [a]	238482 [a]	279563 [b]
2001/02	Bottom quartile	70857 [a]	74409 [a]	93264 [a]
	Top quartile	231500 [a]	216463 [a]	239715 [a]

The lack of significant differences between systems in RoA indicates that all 3 feed input systems can be equally profitable. High input systems require more net operating assets to achieve high farm incomes. Net operating assets in low input systems are lower but their incomes are also lower.

In all 4 dairy seasons and in all 3 feed input systems, the percentages of RoA in farms in the bottom quartile were lower than their percentages of RoE. This suggests that the costs of funding in these farms were higher than their return on borrowed capital. In farms in the top quartiles for EFS/ha, the percentages of RoE were higher than the percentages of RoA in 1999/00, 2000/01 and 2001/02. This suggests that their costs of funding were lower than their returns on borrowed capital.

In 2000/01 and 2001/02, there were differences in the percentages of RoE between low, intermediate and high input systems in the top quartile. This can be associated with differences in owner's equity. In these quartiles, farms with higher equity capital had lower RoE than farms with lower equity.

5.4.8 FARM WORKING EXPENSES PER KILOGRAM OF MILKSOLIDS (Cash costs/kg MS) AND TOTAL COST OF MILKSOLIDS PRODUTION (INCLUDING THE OPPORTUNITY COST OF CAPITAL)

Although farms in the top quartile had higher Farm Working Expenses per hectare, their high milksolids production per hectare determined their lower total cost of production per kilogram of milksolids (See Table 5.6).

Farms in the top quartile for EFS/ha had lower total costs of production per kilogram of milksolids. This is also due to their higher milksolids production per hectare. These results agree with those found by Leslie (2001), and indicates that high milksolids production are essential for high profits.

Within each quartile there were no significant differences in the cost of milksolids production. This can be due to the inclusion of the opportunity cost of capital in the calculation of milksolids production costs, and to the higher milksolids production per hectare in high input farms. These results suggest that the income per kilogram of milksolids can be similar in all 3 feed input systems.

5.5.- CONCLUSIONS

5.5.1 In all 3 feed input systems, farms in the top quartile for EFS/ha had higher stocking rates, lower comparative stocking rate, higher milksolids production (per cow and per hecare), higher use of nitrogen fertiliser and higher estimated pasture consumed per hectare than farms in the bottom quartiles.

5.5.2 In all 3 feed input systems, farms in the top quartile for EFS/ha had significantly higher Gross Farm Incomes per hectare (GFI/ha) than farms in the bottom quartile. The higher GFI/ha was determined by their higher milksolids production per hectare.

5.5.3 Low, intermediate and high input farms in the top quartile for EFS/ha had similar or higher Farm Working Expenses per hectare than their corresponding farm systems in the bottom quartile.

5.5.4 In all 3 feed input systems, farms in the top quartile for EFS/ha maximised feed utilisation per hectare, and achieved high milksolids production per hectare, through high milksolids production per cow and high stocking rates.

5.5.5 Within the top quartile, there were no significant differences in Economic Farm Surplus per hectare, Return on Assets and Return on Equity between low, intermediate and high input systems.

5.5.6 Low input and high input systems can be equally profitable with good management.

5.5.7 EFS/ha can decrease significantly when pasture grown in the farm is not efficiently utilised by lactating cows, even when extra feed is included into the system.

5.5.8 The use of extra feed per cow results in high gross farm incomes per hectare, but also increases farm working expenses per hectare.

CHAPTER 6

RELATIONSHIP BETWEEN FEED INPUT AND OTHER PHYSICAL AND FINANCIAL FARM PARAMETERS

ABSTRACT

In the dairy system, all components interact with each other. In recent years the use of supplements in New Zealand dairy farms has increased. However, there is little information about the way in which this extra feed has influenced the dairy system. The objective of this paper was to analyse the relationships between the use of extra feed and some physical and financial parameters in the dairy system. ProfitWatch data corresponding to 915 owner-operated dairy farms between 1998/99 and 2001/02 were analysed. The data was classified according to the dairy season (1998/99, 1999/00, 2000/01, 2001/02). For the present study, the definition of extra feed comprised supplements imported, winter grazing and maize silage grown in the farm. The statistical analysis comprised simple and multiple regressions. There were positive relationships between milksolids production, per cow and per hectare, and the inclusion of extra feed into the dairy system ($P<.0001$). On average (average of 4 years), the milksolids responses to the use of extra feed, per cow and per hectare, were 50g/kg DM and 96g/kg DM, respectively. In 1998/99 (low milksolids payout) and 2001/02 (high milksolids payout), the use of extra feed increased gross farm income per hectare by \$0.43/kg DM and \$0.49/kg DM, respectively. Farm working expenses increased by \$0.36/kg DM extra feed in 1998/99, and by \$0.37/kg DM extra feed in 2001/02. There were not significant relationships between the amount of extra feed input per hectare and Economic Farm Surplus per hectare, Return on assets (%) and Return on Equity (%). Although the use of extra feed allowed increases in milksolids production, per cow and per hectare, stocking rate, and gross farm income per hectare; the increase in farm working expenses determined a marginal increase in the cash operating profit and an insignificant increase in EFS/ha, RoA (%) and RoE (%).

6.1.- INTRODUCTION

The dairy system is a dynamic structure in which all their components interact with each other. Several studies have described the relationships between physical and financial parameters in the dairy system (Leslie, 1998; Leslie, 2001; Salles, 2002). Milksolids production per cow is determined by genetics and the environment, especially the nutritional environment (Kolver, 2000). The inclusion of extra feed into pastoral systems can increase milksolids production per cow through higher daily milksolids production per cow and longer lactation lengths (Van der Poel, 1997; Jamieson, 1996).

The inclusion of extra feed into the dairy system can also result in higher milksolids production per hectare due to increases in milksolids production per cow and in stocking rate (Holmes et al., 2002). Negative relationships between milksolids production per cow and stocking rate have been reported in previous studies with unsupplemented pasture-only systems (Macdonald, 2001). This decrease in yield per cow can be minimised by feeding supplements, but high levels of skills are required to maximise the utilisation of the extra feed without reducing pasture utilisation (Van der Poel, 1997).

Macdonald (2001) reported positive relationships between milksolids production per hectare and stocking rate. However, there is a limit in stocking rate beyond which milksolids production per hectare starts to decrease (Macdonald, 2001). Farm income is determined by milk price and milksolids production per hectare (Leslie, 2001). The profitability of the use of extra feed will be determined by the rates at which farm income and farm expenses increase with the use of extra feed.

There is little information about the way in which the use of extra feed has influenced the income and the expenditure of New Zealand dairy farms in recent years. The objective of this paper is to analyse the way in which the use of extra feed has influenced milksolids production per cow, milksolids production per hectare, gross farm income, farm working expenses and EFS/ha. The understanding of how these components interact with each other is essential for an adequate management of the dairy system.

6.2.- MATERIALS AND METHODS

6.2.1 MATERIALS

See section 3.2.1 in chapter 3 (Page 44). Data from dairy farms in the ProfitWatch database corresponds to commercial dairy farms, and they represent the "average" dairy farm in New Zealand.

6.2.2 METHODOLOGY

6.2.2.1 DATA MANAGEMENT

6.2.2.1.1 Classification of the data by season

See section 3.2.2.1.1 (Page 45). The data corresponded to 4 dairy seasons (1998/99, 1999/00, 2000/01, 2001/02).

6.2.2.1.2 Classification of the data according to operating structure

See section 3.2.2.1.2 (Page 45).

6.2.2.1.3 Relationships studied

6.2.2.1.3.1 Relationship between feed input per cow (kg DM/cow) and milksolids production per cow (kg MS/cow).

6.2.2.1.3.2 Relationship between feed input per hectare (kg DM/ha) and milksolids production per hectare (kg MS/ha).

6.2.2.1.3.3 Relationships of milksolids production per hectare (kg MS/ha) and milksolids payout ($/kg MS) with Gross Farm Income per hectare ($/ha) and Farm working expenses per hectare ($/ha).

6.2.2.1.3.4 Relationships of milksolids production per hectare (kg MS/ha) with Gross Farm Income per hectare ($/ha) and Farm Working Expenses per hectare ($/ha).

6.2.2.1.3.5 Relationships of extra feed input per hectare (kg DM/ha) with Gross Farm Income per hectare ($/ha) and Farm Working Expenses per hectare ($/ha).

6.2.2.1.3.6 Relationship between feed input per hectare and Economic Farm Surplus per hectare ($EFS/ha).

6.2.2.1.3.7 Relationship between feed input per hectare and the percentages or Return on Assets (%RoA) and Return on Equity (%RoE).

See Appendix 2 and Appendix 4 for more information about the methods used for the calculation of these variables.

6.2.2.2 STATISTICAL ANALYSIS

See section 3.2.2.2 (Page 50).

6.2.2.2.2 Regression Analysis

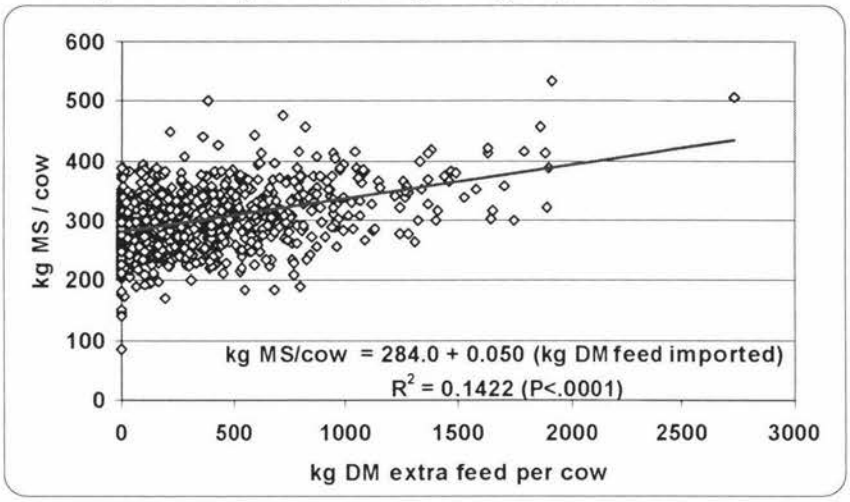
The statistical analysis of the data (915 dairy farms, See Appendix 3.3) comprised simple and multiple regressions. The SAS statistical software was used in the analysis of the data.

6.3.- RESULTS

6.3.1 Relationship between extra feed input per cow (kg DM/cow) and milksolids production per cow (kg MS/cow).

Between 1998/99 and 2001/02, milksolids production per cow was positively related to the amount of extra feed used per cow (See Figure 6.1) (See Appendices 5.1 and 5.2 for individual years).

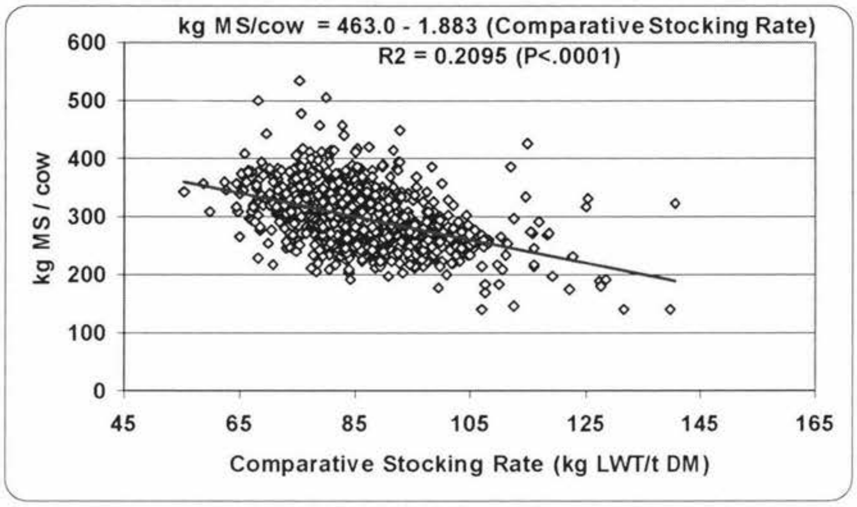
Figure 6.1: Relationship between extra feed input per cow and milksolids production per cow in owner- operated dairy farms (Average of 4 years, n=915).



The average milksolids response (average of 4 years, n=915) to extra feed used per cow was 50 g MS/kg DM of extra feed (See Figure 6.1). There was a wide variation in the milksolids yields at any particular level of extra feed input per cow (See Figure 6.1). Figure 6.1 also shows that high milksolids productions per cow were also achieved without the use of extra feed.

Between 1998/99 and 2001/02, there was a negative relationship between milksolids production per cow and comparative stocking rate (See Figure 6.2) (See Appendices 5.3 and 5.4 for individual years). On average, milksolids production per cow decreased by 1.9 kg MS for every increase of 1 kg in comparative stocking rate (See Figure 6.2).

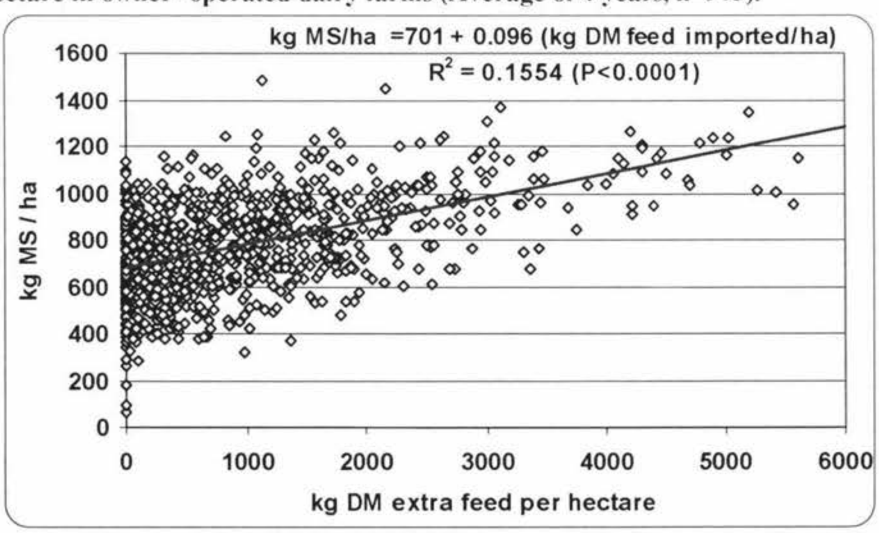
Figure 6.2: Relationship between Comparative Stocking Rate and milksolids production per cow in owner- operated dairy farms (Average of 4 years, n=915)



6.3.2 Relationship between extra feed input per hectare (kg DM/ha) and milksolids production per hectare (kg MS/ha).

In all 4 dairy seasons, there were positive relationships between the amount of extra feed used per hectare and milksolids production per hectare (See Figures 6.3) (See Appendices 5.5 and 5.6 for individual years).

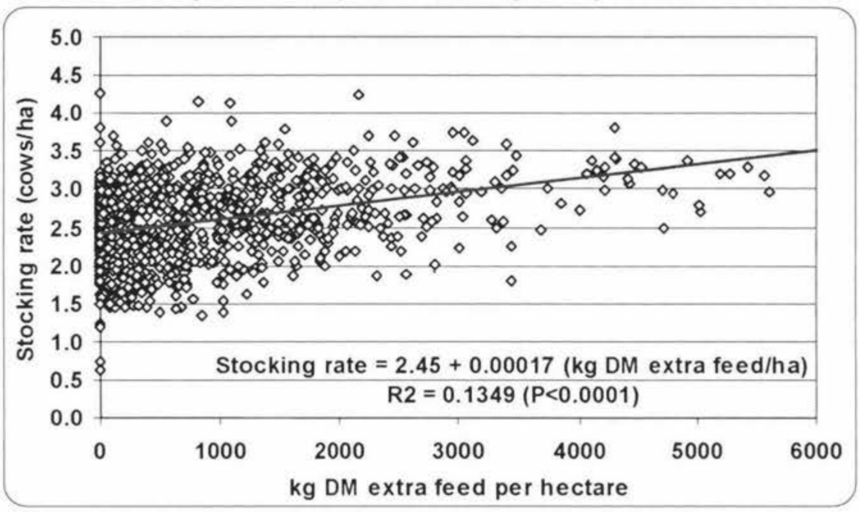
Figure 6.3: Relationship between extra feed input per hectare and milksolids production per hectare in owner- operated dairy farms (Average of 4 years, n=915).



On average (average of 4 years), milksolids production per hectare increased by approximately 96 kg MS for every tonne of extra feed dry matter used per hectare (See Figure 6.3). Figure 6.3 also shows that there was a wide variation in the data, and that relatively high milksolids productions per hectare were also achieved without the use of extra feed.

Between 1998/99 and 2001/02, stocking rate increased by approximately 1 cow for every 6 tonnes of extra feed dry matter used per hectare (See Figure 6.4).

Figure 6.4: Relationship between extra feed input per hectare and milksolids production per hectare in owner- operated dairy farms (Average of 4 years, n=915).



Multiple regression analysis showed that stocking rate has more influence on milksolids production per hectare than the amount of extra feed used per hectare (See Table 6.1).

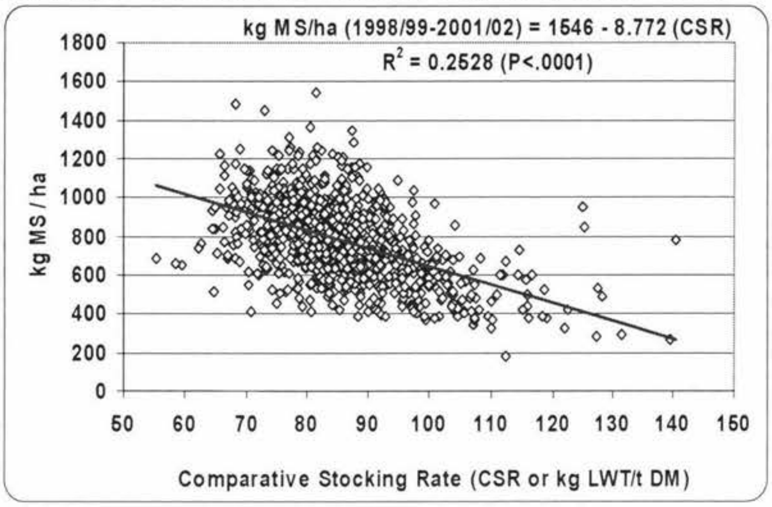
Table 6.1: Regression equation for the prediction of milksolids production per hectare from stocking rate and extra feed input (Average of 4 years, R^2= 0.6881; P<.0001)

kg MS/ha	=	26.7 + 274.7 (Stocking rate) + 0.047 (kg DM extra feed/ha)

Partial $\mathbf{R^2}$: Stocking rate = 0.6347 (P<.0001); kg DM extra feed/ha = 0.2575 (P<.0001)

In all 4 dairy seasons, there was a negative relationship between milksolids production per hectare and comparative stocking rate (See Figure 6.5).

Figure 6.5: Relationship between Comparative Stocking Rate and milksolids production per hectare in owner- operated dairy farms (Average of 4 years, n = 915).



6.3.3 Relationships of Gross Farm Income per hectare ($/ha) with milksolids production per hectare (kg MS/ha) and milksolids payout ($/kg MS).

Between 1998/99 and 2001/02, milksolids payout increased from $3.58/kg MS to $5.30/kg MS. During this period, the increase in milksolids payout caused a significant increase in GFI/ha (P<.0001). For every $1 increase in milksolids payout, GFI/ha increased by approximately $878 (See Table 6.2).

Table 6.2: Regression equation for the prediction of $GFI/ha from milksolids payout and milksolids production per hectare (Average of 4 years, n=915) (R^2= 0.9148; P<.0001).

$GFI/ha	=	- 3687.8 + 877.8 (Milksolids payout) + 4.6 (kg MS/ha)

Partial R^2: Milksolids payout = 0.3931 (P<.0001); kg MS/ha= 0.69133 (P<.0001)

6.3.4 Relationship of milksolids production per hectare (kg MS/ha) with Gross Farm Income per hectare ($GFI/ha) and Farm Working Expenses per hectare ($FWE/ha).

In all 4 dairy seasons there were positive relationships between milksolids production per hectare and GFI/ha; and between milksolids production per hectare and FWE/ha. Figures 6.6 and 6.7 show these relationships in the years 1998/99 and 2001/02, years in which milksolids payout increased from $3.58/kg MS to $5.30/kg MS.

Figure 6.6: Relationship of milksolids production per hectare with GFI/ha and FWE/ha in owner-operated dairy farms in 1998/99 (n=237).

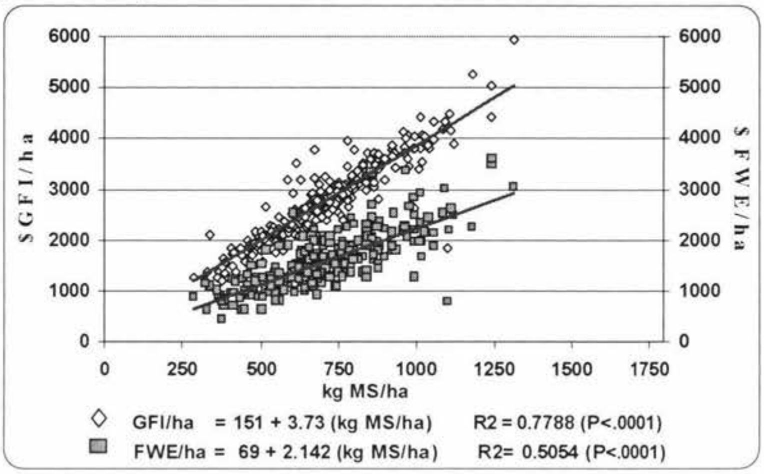
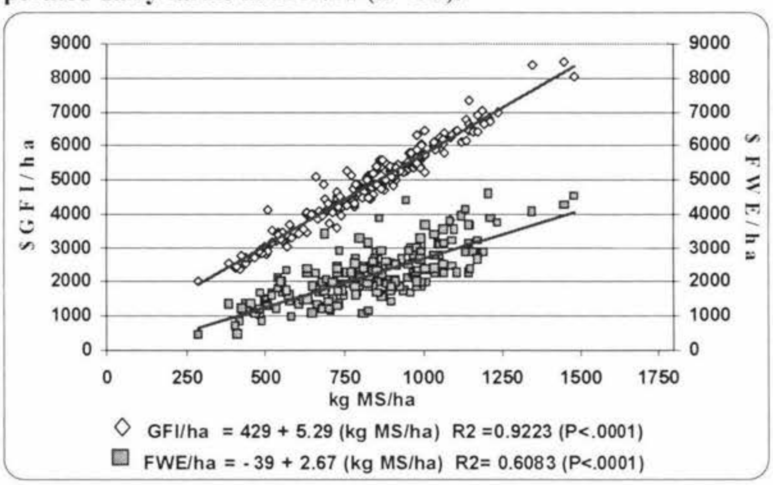


Figure 6.7: Relationship of milksolids production per hectare with GFI/ha and FWE/ha in owner-operated dairy farms in 2001/02 (n=192).



GFI/ha and FWE/ha, both increased as milksolids production per hectare increased. At the higher value for milksolids payout, GFI/ha and FWE/ha increased at faster rates with increases in milksolids production per hectare (See Figures 6.6 and 6.7). But as milksolids payout increased, the increase in GFI/ha was larger ($3.73 to $5.29/kg MS) than the increase in FWE/ha ($2.14/kg MS to $2.67/kg MS) (See Figures 6.6 and 6.7).

6.3.5 Relationship of extra feed input per hectare with Gross Farm Income per hectare ($GFI/ha) and Farm Working Expenses per hectare ($FWE/ha).

In all 4 dairy seasons (1998/99, 1999/00, 2000/01 and 2001/02), there there were positive relationships between the amount of extra feed used per hectare, GFI/ha and FWE/ha. Figures 6.8 and 6.9 show these relationships in the years 1998/99 and 2001/02, years in which milksolids payout increased from $3.58/kg MS to $5.30/kg MS.

Figure 6.8: Relationship of extra feed input per hectare with GFI/ha and FWE/ha in owner-operated dairy farms in 1998/99 (n=237).

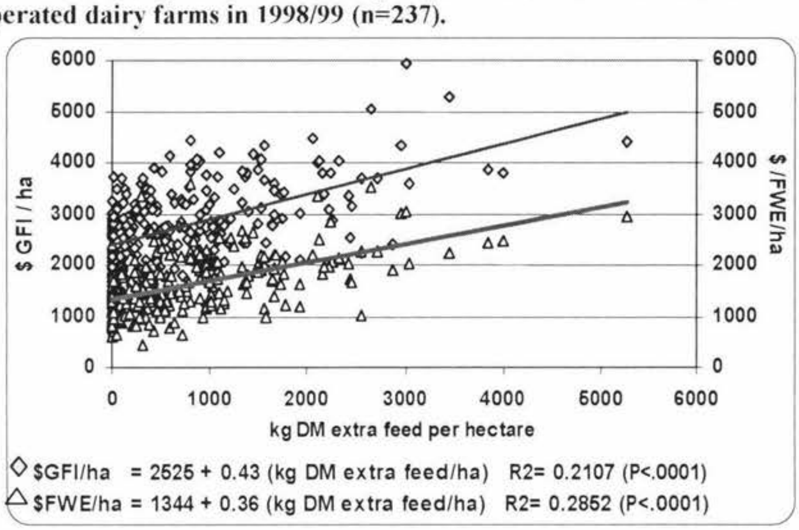
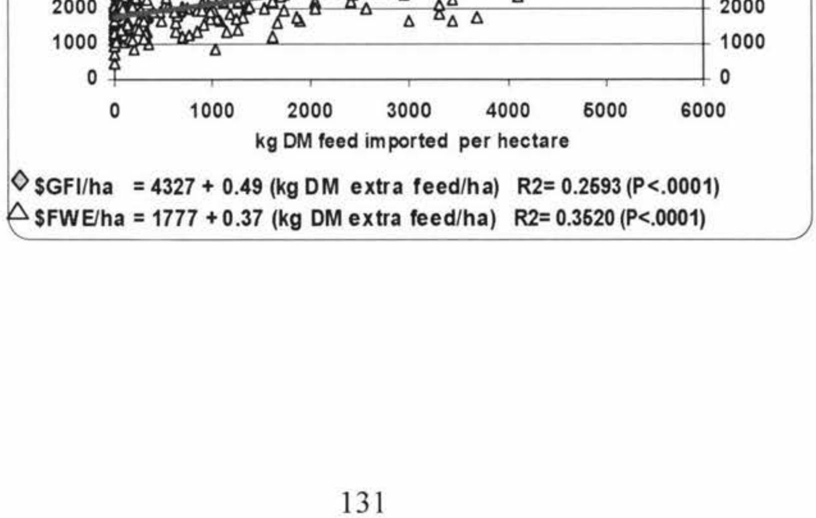


Figure 6.9: Relationship of extra feed input per hectare with GFI/ha and FWE/ha in owner-operated dairy farms in 2001/02 (n=192).



At the lower milksolids payout ($3.58/kg MS) the use of extra feed increased GFI/ha by $0.43/kg DM; and FWE/ha by $0.36/kg DM (See Figure 6.8). At the higher milksolids payout ($5.30/kg MS) the use of extra feed increased GFI/ha by $0.49/kg DM; and FWE/ha by $0.37/kg DM (See Figure 6.9). The difference between the rates of increase in GFI/ha and FWE/ha with the use of extra feed was higher at a high milksolids payout than at a low milksolids payout. The cash operating surplus from the use of extra feed was $0.07/kg DM extra feed at a milksolids payout of $3.58/kg MS; and $0.12/kg DM extra feed at a milksolids payout of $5.30/kg MS.

However, multiple regression analysis reveled that stocking rate had more influence on GFI/ha and FWE/ha than the use of extra feed (See Tables 6.3 and 6.4). In both years (1998/99 and 2001/02), when stocking rate was included in the regression analysis, the use of extra feed increased FWE/ha faster than GFI/ha (See Tables 6.3 and 6.4).

Table 6.3: Regression equation for the prediction of GFI/ha (R^2= 0.5676; P<.0001) and FWE/ha (R^2= 0.5146; P<.0001) from stocking rate and extra feed input in 1998/99 (n=237).

$GFI/ha	=	140.2 + 953.4 (Stocking rate) + 0.230 (kg DM extra feed/ha)
$FEW/ha	=	-18.2 + 544.7 (Stocking rate) + 0.242 (kg DM extra feed/ha)

Table 6.4: Regression equation for the prediction of GFI/ha (R^2= 0.7021; P<.0001) and FWE/ha (R^2= 0.5483; P<.0001) from stocking rate and extra feed input in 2001/02 (n=192).

$GFI/ha	=	140.2 + 953.4 (Stocking rate) + 0.230 (kg DM extra feed/ha)
$FEW/ha	=	168.5 + 647.2 (Stocking rate) + 0.278 (kg DM extra feed/ha)

6.3.6 Relationship between extra feed input per hectare and Economic Farm Surplus per hectare ($EFS/ha).

In all 4 dairy seasons, there were not significant relationships between the amount of extra feed used per hectare and EFS/ha (See Figures 6.10 and 6.11). There were significant relationships between comparative stocking rate and EFS/ha in all 4 dairy seasons (See Figure 6.12).

Figure 6.10: Relationship between extra feed input per hectare and EFS/ha in owner-operated dairy farms in 1998/99.

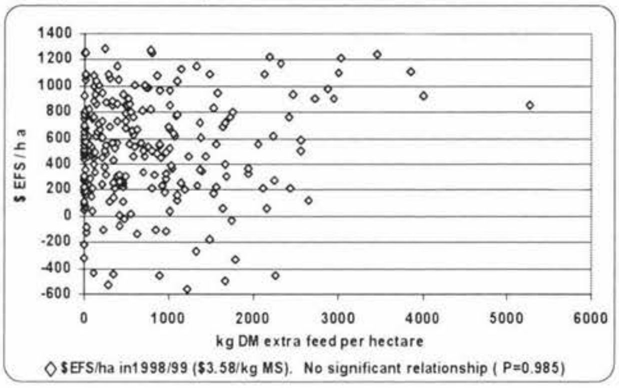


Figure 6.11: Relationship between extra feed input per hectare and EFS/ha in owner- operated dairy farms in 2001/02.

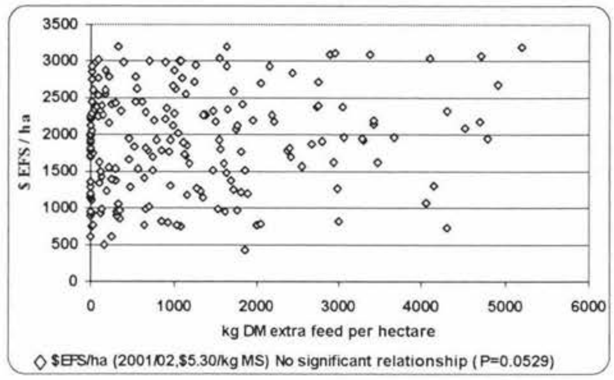
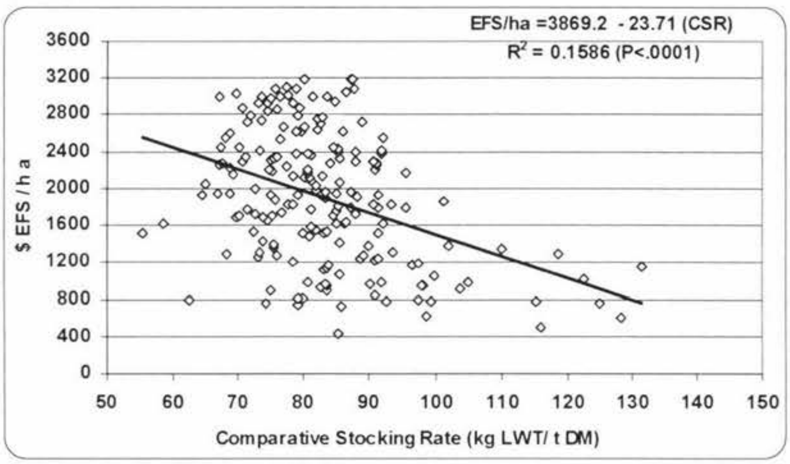


Figure 6.12: Relationship between comparative stocking rate and EFS/ha in owner- operated dairy farms in 2001/02.



6.3.7 Relationship between extra feed input per hectare and the percentages of Return on Assets (RoA) and Return on Equity (RoE).

In all 4 dairy seasons, there were no significant relationships between the amount of extra feed used per hectare and the percentages of RoA and RoE (See Figures 6.13 and 6.14)

Figure 6.12: Relationship between extra feed input per hectare and the %RoA in owner- operated dairy farms (Average of 4 years, n = 915).

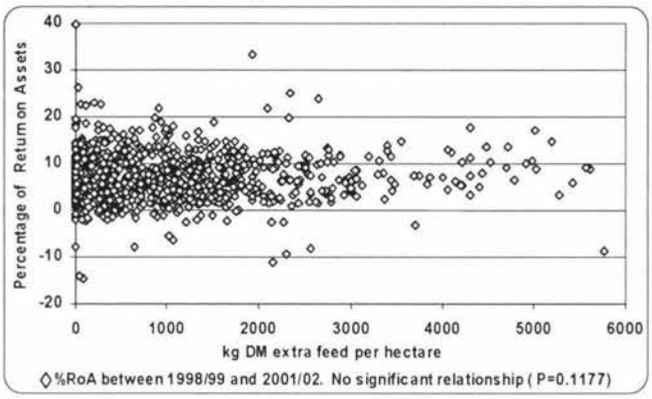
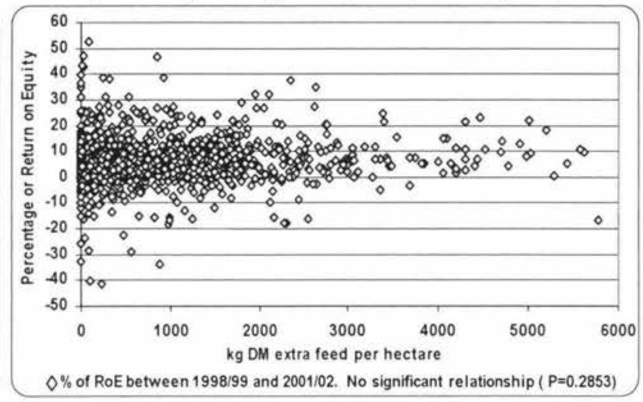


Figure 6.13: Relationship between extra feed input per hectare and the %RoE in owner- operated dairy farms (Average of 4 years, n = 915).



6.4.- DISCUSSION

The positive relationships between the use of extra feed and milksolids production, per cow and per hectare, found in this study agree with reports of high milksolids production, per cow and per hectare, in farms that use supplements (Leslie, 2001; Holmes, 2000; Reid, 1997). In this study, the marginal response in milksolids to the extra feed offered per cow was 50 g MS/kg DM. This response was lower than the marginal response to supplements reported in previous studies (Penno et al., 1999; Thomson et al., 1997; Pinares and Holmes, 1996). This variation can be due to differences in the utilisation of pasture and supplements, and in the type of feed and feed quality, between farms. Furthermore, the marginal milksolids response in this study refers to a mixture of feed (pasture from winter grazing-off, maize silage, concentrates and other feeds). For these reasons it is difficult to make compare the milksolids response found in this study with that of previous studies.

The low correlation coefficients for the relations between extra feed input and milksolids production, per cow and per hectare, also shows that there is a wide variation in the data (See Figures 6.1 and 6.3). The efficiency with with which the total feed available in the farm was utilised (only -pasture or pasture + extra feed), can be the reason for the significant variation in the relationship between milksolids production, per cow and per hectare, and the use of extra feed. This is because farms with the highest EFS/ha are characterised by their high milksolids production, per cow and per hectare, their high stocking rates and their high pasture utilisation (estimated pasture consumed per hectare) (Leslie, 2001; Holmes, 2000; Howse and Leslie, 1997).

Regression analysis showed that the increase in milksolids production per hectare per kg DM of extra feed use per hectare is high (96g MS/kg DM). This high response can be because higher feed inputs per hectare, and milksolids production per hectare, are also associated to higher stocking rates, and possibly with higher pasture utilisation per hectare and higher use of nitrogen fertiliser per hectare. This statement is supported by the decrease in milksolids response to extra feed per hectare (47g MS/kg DM extra feed) when stocking rate is added in the equation for the prediction of milksolids production per hectare (See Table 6.1).

The influence of feed input on milksolids production, per cow and per hectare, is also shown in the relationship between comparative stocking rate and milksolids production per cow and per hectare. As the amount of feed supply per hectare increases, comparative stocking rate decreases and milksolids production, per cow and per hectare, increases. Kolver (2000) reported increases in milksolids production per cow with the use of extra feed. Similarly, Salles (2002) also found that as the energy supply to the cow increases, generally associated to the use of extra feed, milksolids production per cow increases.

The increase in stocking rate with the inclusion of extra feed (See Figure 6.4) agrees with the reports that extra feed can be used to increase the stocking rate (Holmes et al., 2002; Holmes, 2000; Reid, 1997). However, there is also a wide variation in the data. For 1998/99 and 2001/02, high or low stocking rates have been observed in all-pasture farms and farms that used extra feed (See Figure 6.4). Stocking rate influences pasture utilisation, milksolids production per hectare and farm profitability (Holmes et al., 2002; Penno, 1999; Leslie, 2001; Howse and Leslie, 1997). For this reason, it is possible that farms with relatively high stocking rates, with or without the use of extra feed, also had higher pasture utilisation, higher milksolids production per hectare and, consequently, higher EFS/ha than farms with lower stocking rates. For similar reasons, it is possible that low stocking rates in all-pasture farms or farms that used extra feed correspond to farms with low feed utilisation, low milksolids production per hectare and low EFS/ha.

The negative relationship between comparative stocking rate and milksolids production, per cow and per hectare, has also been reported in previous studies (Penno, 2001). This is because at high comparative stocking rates, the amount of feed supply per kilogram of live weight decreases, and with this less energy is available for milksolids production.

The results of this work indicates that the rate of increase in GFI/ha, with each kilogram increase in milksolids production per hectare, is faster than the rate of increase in FWE/ha, especially at high milksolids payouts. Positive relationships between GFI/ha and milksolids production per hectare have also been reported by Leslie (2001). These results agrees with the results found in other studies in which farms with high milksolids production per hectare, generally farms with high EFS/ha, also had higher farm working expenses per hectare (Holmes, 2000; Leslie, 2001; Howes and Leslie, 1997).

The use of extra feed increased GFI/ha and FWE/ha. The results of this study shows that GFI/ha and FWE/ha increased at similar rates with the use of extra feed. The approximate profits from the use of extra feed were $0.07 - $0.12/kg DM extra feed/ha. As consequence, the difference in profit (without including non-cash expenses) between and all pasture farm and a farm that use up to 3000 kg DM extra feed/ha can be low ($210 - $360/ha). However, the use of extra feed can be necessary in same cases, when weather conditions are unfavourable for pasture growth. These results show that, for these analyses between farms, the use of extra feed caused no significant increases in farm profitability. This conclusion is confirmed by the lack of significant relationship between EFS/ha and extra feed input per hectare.

In this study there were negative relationships between comparative stocking rate and EFS/ha. These results agree with those found by Macdonald (2004). Macdonald (2004) found that EFS/ha can be similar at very low or very high comparative stocking rates. In this study, EFS/ha varied considerably at similar levels of comparative stocking rate, but high EFS/ha were achieved within a range of 70 – 90 kg LWT/t DM (See Figure 6.12).

The absence of significant relationships between the input of extra feed and EFS/ha also shows that farms in this study which supply extra feed do not necessarily had higher EFS/ha, presumably because there were other factors that influence farm profitability. It is probable that factors such as stocking rate, milksolids production per cow and per hectare, estimated pasture consumed per hectare and farm management skills played a more significant role in EFS/ha than the amount of extra feed supplied per hectare (Leslie, 2001; MAF, 2001; Holmes, 2000; Howse and Leslie, 1997).

There were no significant relationships between feed input per hectare and the percentages of return on assets and equity. But due to their higher operating assets, the percentages of return on assets and return on equity refer to a greater absolute amount of money in farms that use extra feed. Similarly to EFS/ha, it is possible that the percentages of return on assets and return on equity are more associated to other factors, such as stocking rate, milksolids production per cow and per hectare, and the estimated pasture consumed per hectare.

6.5.- CONCLUSIONS

6.5.1.- The inclusion of extra feed into the dairy system increased milksolids production, per cow and per hectare.

6.5.2.- The average milksolids response to the use of extra feed per cow was 50g/kg DM (Average of 4 years, between 1998/99 and 2001/02).

6.5.3.- The average milksolids response to the use of extra feed per hectare was 96 g MS/kg DM extra feed (Average of 4 years, between 1998/99 and 2001/02). This high response in milksolids per hectare to extra feed is the result of higher stocking rates, higher use of nitrogen fertiliser and other inputs associated with the use of extra feed.

6.5.4.- Milksolids production per cow decreased by 1.8 kg MS for each unit increase in comparative stocking rate.

6.5.5.- The use of extra feed allows increases in stocking rate (approximately 1cow for each 6 t DM extra feed used per hectare).

6.5.6.- The increase in milksolids payout, from \$3.58/kg MS in 1998/99 and 2001/02, caused a significant increase in gross farm income per hectare (\$877/ha for each dollar increase in milksolids payout).

6.5.7.- Increases in milksolids production per hectare causes increases in gross farm income per hectare and in farm working expenses per hectare.

6.5.8.- When extra feed is used, the rate of increase in gross farm income per hectare (\$0.43/kg DM in 1998/99 and \$0.49/kg DM in 2001/02) is only marginally higher than the rate of increase in farm working expenses (\$0.36/kg DM in 1998/99 and \$0.37/kg DMin 2001/02).

6.5.9.- There were no significant relationships between the use of extra feed per hectare and Economic Farm Surplus per hectare, Return on Assets (%) and Return on Equity (%).

CHAPTER 7

GENERAL DISCUSSION

This study is based on the analysis of ProfitWatch data. As ProfitWatch data is collected through surveys (Dexcel, 2003), it is possible that there are some inaccuracies in the data, especially in the estimated parameters. This is because variations in the data collected can also be associated with differences in region and weather conditions. Furthermore, small inaccuracies could have happened during the process of data collection (measurement and reading of values). The accuracy of the results found in this work also depends on the accuracy of the data collected. Although adjustments can facilitate the comparison of data, it can also cause small variations in the results obtained. For this reason, the results obtained from estimated values (such as the estimated pasture production) should be analysed with caution. However, these small variations may have also been minimised by the large number of dairy farms analysed in each year and the exclusion of farms with very extreme values (See Section 3.2.2.2).

In the dairy system all components are interrelated and interact with each other. For this reason, the system should be adapted to the conditions in the farm. The ability to optimise the utilisation of pasture grown in the farm is one of the main characteristics of farms in the top quartile for EFS/ha (See Section 5.3.1.5, Table 5.1; Leslie, 2001; Holmes, 2000). The main determinant of feed demand per hectare, and pasture utilisation, is stocking rate (Holmes et al., 2002; Penno, 1999). For this reason, it is logical that intermediate and high feed input farms in the top quartile for EFS/ha have higher stocking rates than low feed input farms (See Table 5.1). With relatively high stocking rates, intermediate and high input farms not only maintain pasture utilisation in the farm but also maximise the utilisation of the extra feed used (Reid, 1997; Van der Poel, 1996).

One of the main determinants of milksolids production per cow is the feeding level of the cow (Kolver, 2000). Intermediate and high feed input farms in the top quartile for EFS/ha had higher milksolids production per cow than low input farms (See Table 5.1). This is because the feeding level of the cows was higher in intermediate and high input systems than in low input systems (See Table 3.1 and Table 5.1). This conclusion is supported by the lower comparative stocking rate observed in intermediate and high input systems (See Section 3.3.1.2). In low input systems, the feed intake of the cow is determined by the quantity and quality of pasture grown in the farm. In intermediate and high input systems, apart from pasture grown in the farm, the cows were also offered more than 50 kg DM of extra feed per cow (See Table 3.4).

Since farms in the top quartile for EFS/ha had higher stocking rates and higher milksolids production per cow than farms in lower quartiles, their milksolids production per hectare was also higher than in farms in lower quartiles, especially in intermediate and high input farms (See Tables 5.4, 5.5 and 5.6). This characteristics of farms with high EFS/ha have also been reported in previous studies (Leslie, 2001; MAF, 2001; Holmes, 2000; Howse and Leslie, 1997).

The main determinant of Gross Farm Income per hectare (GFI/ha) is milksolids production per hectare (See Section 4.3.1; Leslie, 2001). For this reason, intermediate and high input farms in the top quartile for EFS/ha had higher GFI/ha than low input farms in this quartile (See Figure 5.8). Other studies have also reported higher gross farm incomes per hectare in high input systems than in low input systems (Van der Poel, 1997; Macdonald, 1999).

Similar to previous reports (Leslie, 2001; MAF, 2001; Holmes, 2000; Howse and Leslie, 1997), farms in the top quartile for EFS/ha had similar or higher Farm Working Expenses per hectare (FWE/ha) than farms in lower quartiles (See Figure 5.10). But intermediate and high input farms in the top quartile had higher FWE/ha than low input farms in this quartile (See Figure 5.10). This is because animal costs, feed costs and overhead costs were significantly higher in intermediate and high input farms than in low input farms (See Section 4.3.2).

The results of this study suggest that, on average and between farms, the input of extra feed, although increasing milksolids production (per cow and per hectare) and GFI/ha, did not increase significantly EFS/ha of the intermediate and high input farms in any year and in any of the 3 quartiles (See Table 4.12 and Table 5.17). Van der Poel (1997) also found that the inclusion of extra feed into the dairy system although increasing milksolids production, per cow and per hectare, did not always result in higher EFS/ha. This is due to an increase in the cost of milksolids production with the use of extra feed. Although high input systems had higher GFI/ha than intermediate and low input systems, their higher FWE/ha, associated with the use of extra feed and higher stocking rates, offset the increase in farm income.

The results found in this study also show that the inclusion of extra feed did not affect the Return on Assets (% RoA) and Return on Equity (% RoE) significantly (See Sections 4.3.4 and 5.3.2.4). This indicates that all 3 feed input systems can be profitable and generate similar percentages of RoA and RoE. These results disagree with results from experimental data in which low input farms had significantly higher EFS/ha than high input farms (Macdonald, 1999). In the 1.75t MS/ha trial, high input farms had lower EFS/ha than the all-pasture farms due to the high costs associated with the inclusion of extra feed (Macdonald, 1999). The results of this work also disagree with reports that high input farms results in higher EFS/ha than low input farms (Roche and Reid, 2002). It is possible that the low costs of the extra feed and very high skills in the case of Roche and Reid (2002) determined high EFS/ha.

CHAPTER 8

CONCLUSIONS

In New Zealand, the pastoral dairy system can be modified by the amount of extra feed input. Management of the dairy farm should be oriented to maintain a synchrony between feed demand of the herd and feed supply. For this reason, the stocking rate should generally be increased as the input of extra feed into the dairy system increases. High grazing management skills are necessary to achieve high pasture utilisation, which is essential for high EFS/ha.

There are positive relationships between the amount of extra feed input and milksolids production per cow and per hectare. Milksolids production per cow increased by approximately 50g per kilogram of extra feed offered per cow. But the response to extra feed used per hectare is higher (96gMS/kg DM extra feed) due to the "extra inputs", such as extra cows/ha and extra nitrogen per hectare, associated with the use of extra feed. Comparative stocking rate was negatively related to milksolids production per cow (-1.8 kg MS/unit of CSR extra), per hectare (-8.7 kg MS/unit of CSR extra) and EFS/ha ($0.2805/unit of CSR extra to the power of 2). High input systems also use more kilograms of nitrogen fertiliser per hectare than intermediate and low input systems.

During the period of study, the increase in milksolids payout caused significant increases in the average Gross Farm Income per hectare, Farm Working Expenses per hectare, EFS/ha and the percentages of Return on Assets and Return on Equity. High input systems had significantly higher Gross Farm Income per hectare than intermediate and low input systems. The rate of increase in gross farm income per hectare was $0.43 and $0.49/kg DM extra feed in 1998/99 and 2001/02, respectively. The inclusion of extra feed into the dairy system also increased Farm Working Expenses per hectare, but at a lower rate ($0.36 to $0.37/kg DM extra feed in 1998/99 and 2001/02, respectively). The increase in FWE/ha was due to increases in labour, feed, fertiliser and overhead costs per hectare.

In this analysis of differences between farms, Economic Farm Surplus per hectare and the percentages of Return on Assets and Return on Equity were not significantly affected by the use of extra feed. This was due to the increase in farm operating expenses associated with the inclusion of extra feed. Variable and fixed costs per hectare, and milksolids production costs ($/kg MS) all increased with the use of extra feed.

The main characteristics of low, intermediate and high input farms in the top quartile for EFS/ha were their high estimated pasture consumed per hectare and their high stocking rate. Since high pasture utilisation is essential for high EFS/ha, the use of extra feed should only be considered in farms which are able to achieve high pasture utilisation. With an adequate management, low input and high input systems can be equally profitable per hectare.

However, the results found in this study correspond to randomly selected dairy farms which are more representative of the average New Zealand dairy farm. It is possible that differences between low, intermediate or high input systems, if they exist, can have been minimised by considering an average value. There are reports of low and high input farms with higher EFS/ha than those found in this study. For this reason, more studies are necessary to understand the factors that make some low, intermediate and high feed input dairy farms highly profitable. Further studies can comprise the analysis of physical and financial characteristics of highly efficient systems (farms with high EFS/ha, RoA, and RoE with low, intermediate and high feed input) could help to clarify this uncertainty. These farms are likely to represent extremes of skills and perhaps be in the top 10% of farms. Further studies must also be done taking into account the characteristics of each region in New Zealand. An analysis of the objectives and aspirations of dairy farmers can also help to understand their preferences for a low-input or a high-input system.

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Appendices

1.- Distribution of owner-operated dairy farms in ProfitWatch.

1.1 Distribution of owner-operated dairy farms in Profitwatch data provided by Dexcel (ProfitWatch Database, 2003).

Region	Owner Operators			
	1998/99	1999/00	2000/01	2001/02
Upper North Island	36	40	35	35
Waikato	57	53	59	30
North East, Waikato and Bay of Plenty	58	58	61	46
Taranaki	51	46	48	42
Lower North Island	22	28	29	21
South Island	29	32	35	30
Total per year (surveys)	253	257	267	204
Total Owner-operators (surveys)	981			

1.2 Distribution of dairy farms according to the number of years (ProfitWatch Database, 2003).

Number of years surveyed	Number of dairy farms	Percentage	Number of surveys
1	398	64%	398
2	127	20%	254
3	75	12%	225
4	26	4%	104
Total	626	100%	981

2.- Estimation of the physical parameters of dairy farms studied.

2.1 Estimation of liveweight of the cows (kg) according to breed and body constitution (From: ProfitWatch, 1999).

Breed	Light	Medium	Heavy
Jersey	350	375	400
Friesian	400	450	500

2.2 Calculation of stocking rate (ProfitWatch, 1999).

$$\text{Stocking Rate} = \frac{\text{Herd size (N of cows)}}{\text{Farm size (Eff. Ha)}}$$

2.3 Estimation of comparative stocking rate (CSR) using data from Profitwatch (From: Prewer, 2003)

$$\text{CSR} = \frac{\text{kg LWT / ha}}{\text{Total feed offered (t DM/ha)}}$$

Where:
kg LWT/ha = stocking rate * liveweight of the cows
Total feed offered (t DM/ha) = (kg DM/ha annual pasture requirement per hectare /0.8 /1000) + (stocking rate * kg DM supplement per cow/1000) + (kg DM/ha brought-in winter grazing /1000) – kg DM/ha young stock requirements if young stock is on farm

* The annual pasture requirement per hectare is an estimation based on the estimated pasture consumed per hectare in the farm and assuming 80% pasture utilisation.

2.4 Estimation of milksolids production per cow (ProfitWatch, 1999).

$$\text{kg MS/cow} = \frac{\text{Total fat produced to the dairy factory (kg)}^{1} + \text{Total protein produced to the dairy factory (kg)}^{1}}{\text{Herd size (N cows)}}$$

[1] Total fat or protein produced to the dairy factory from 1st June to 31st May.

2.5 Estimation of milksolids production per hectare (ProfitWatch, 1999).

$$\text{kg MS/ha} = \frac{\text{Total fat produced to the dairy factory (kg)}^{1} + \text{Total protein produced to the dairy factory (kg)}^{1}}{\text{Farm size (Eff. Ha.)}}$$

[1] Total fat or protein produced to the dairy factory from 1st June to 31st May

2.6 Estimation of milksolids production per kg of liveweight.

$$\text{kg MS/kg LWT} = \frac{\text{Average kg MS/cow in the farm}}{\text{Average LWT of the cows in the farm}}$$

2.7 Estimation of milksolids production per tonne of dry matter offered.

$$\text{kg MS/ t DM} = \text{Kg MS/kg LWT} * \text{kg LWT/t DM}^{*}$$

* Comparative Stocking Rate

2.8 Estimation of pasture consumed per hectare (From: Prewer, 2003).

Estimated Pasture consumed per hectare (t DM/ha) = Annual feed requirement per hectare (t DM/ha) less Supplements imported and made on farm (t DM/ha)

Where:
Annual feed requirement per hectare (t DM/ha) =

$$\frac{\text{(Annual cow's requirements (t DM) * Maximum cows milked)} + \text{(Annual yearlings' requirements (t DM)* number of opening R1 heifers)} + \text{(Annual weaner's requirements (t DM) * number of closing R1 heifers)}}{\text{Farm size (Eff. Ha.)}}$$

Cow's requirements comprise requirements for maintenance, pregnancy and milksolids production. Yearlings and weaner's requirements comprise requirements for maintenance and growth.

2.9 Estimation of hay and pasture silage made on farm (ProfitWatch, 1999).

$$\text{Pasture hay or silage made on farm (kg DM/ha)} = \frac{\text{kg DM pasture conserved in bales, pit and stack in the farm}}{\text{Farm size (Eff. Ha.)}}$$

2.10 Estimation of maize silage made on farm (ProfitWatch, 1999).

$$\text{Maize silage made on farm kg DM/ha} = \frac{\text{Maize grown in farm (t DM)}}{\text{Farm size (Eff. Ha.)}}$$

2.11 Estimation of supplements made on farm (ProfitWatch, 1999).

$$\text{Supplements made on farm kg DM/ha} = \frac{\text{kg DM hay and pasture silage made on farm + kg DM maize silage made on farm}}{\text{Farm size (Eff. Ha.)}}$$

2.12 Estimation of supplements imported (From: ProfitWatch, 1999).

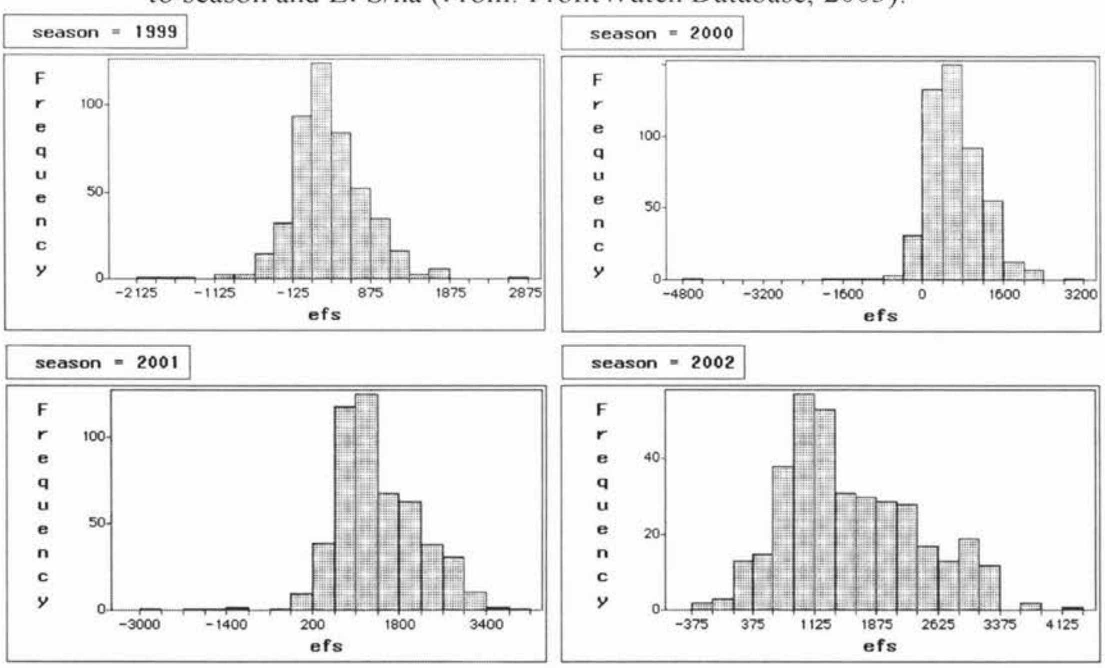
$$\text{kg DM Supplements imported /ha} = \frac{\text{kg DM supplements imported (hay, pasture silage, maize silage, formulated meals, grains, other feeds imported)}}{\text{Farm size (Eff. Ha.)}}$$

2.13 Calculation of pasture imported as winter grazing (From: ProfitWatch, 1999).

$$\text{kg DM/ha} = \frac{\text{(Intake per day * number of cows * number of days)}}{\text{Farm size (Eff. Ha.)}}$$

3. Statistical Analysis of the data.

3.1 Distribution of data from owner operators and sharemilkers according to season and EFS/ha (From: ProfitWatch Database, 2003).



3.2 Mean data for EFS/ha for owner operators and sharemilkers, standard deviation, minimum and maximum values for EFS/ha and data comprised within 2 standard deviations.

Season	N	Mean	Std Dev	Minimum	Maximum	Data within 2 StDev
1998/99	495	341.78	492.03	-2004.07	2650.22	> -642.28 and < 1325.83
1999/00	516	632.52	590.87	-4601.43	3085.00	> -549.22 and < 1814.26
2000/01	515	1389.38	801.14	-2798.36	4124.60	> -212.90 and < 2991.66
2001/02	364	1566.45	820.01	-341.46	4333.90	> - 73.57 and < 3206.47

3.3 Distribution of data for owner operators, according to dairy season and region, after data outside 2 standard deviations was discarded.

Region	Owner Operators			
	1998/99	1999/00	2000/01	2001/02
Upper North Island	35	40	34	35
Waikato	56	48	54	27
North East, Waikato and Bay of Plenty	54	56	57	42
Taranaki	44	40	43	41
Lower North Island	22	26	29	19
South Island	26	27	32	28
Total per year	237	237	249	192
Total observations	915			

4. Estimation of the financial parameters studied

4.1 Average milksolids payouts, and payouts according to milksolids components, between 1998/99 and 2001/02 (From: ProfitWatch database, 2003)

Dairy season	$/kg MS	Value of 1 kg MS		
		Fat	Protein	Volume
1998/99	$3.58	$2.12	$3.57	- $0.50
1999/00	$3.78	$2.12	$3.37	- $0.49
2000/01	$5.00	$1.65	$2.62	- $0.49
2001/02	$5.30	$1.57	$2.50	- $0.49

4.2 Formula to calculate the seasonal milksolids income per hectare, payout adjusted (From: ProfitWatch database, 2003)

$$\text{Income from the sale of milksolids (payout adjusted) (\$/ha)} = \frac{\dfrac{(\text{Fat economic value} * \text{kg fat produced}) + (\text{Protein economic value} * \text{kg protein produced}) + (\text{milk volume economic value} * \text{litres of milk produced}) * \text{Percentage of milk cheque}}{100}}{\text{Farm size (Eff. Ha)}}$$

4.3 Calculation of stock income.

$$\text{Stock income (\$/ha)} = \frac{\text{Net Stock income + stock adjustment}}{\text{Farm size (Eff. Ha.)}}$$

Net stock income = income from stock sale – stock purchased
For the estimation of the stock adjustment see appendix 4.14

4.4 Calculation of Gross Farm Income per hectare (From: ProfitWatch database, 2003).

$$\text{\$ GFI/ha} = \frac{\text{Income from the sale of milksolids + net stock income + other dairy income}}{\text{Farm size (Eff. Ha.)}}$$

4.5 Calculation of labour costs per cow (From: ProfitWatch database, 2003).

$$\text{Labour cost (\$/cow)} = \frac{\text{Total wages + labour adjustments}}{\text{Herd size}}$$

* For the estimation of labour adjustments see appendix 4.11 and appendix 4.12

4.6 Calculation of animal costs excluding wages (From: ProfitWatch database, 2003).

$$\text{Animal costs excluding wages (\$/cow)} = \frac{\text{Animal health costs + Herd improvement costs + farm dairy costs + electricity costs}}{\text{Herd size}}$$

4.7 Calculation of fertiliser costs (From: ProfitWatch database, 2003).

$$\text{Fertiliser Costs (\$/ha)} = \frac{\text{Cost of all fertilisers used in the dairy farm and run-off (N, P, K, S, others)}}{\text{Farm size (Eff. Ha.)}}$$

4.8 Calculation of feed costs (From: ProfitWatch database, 2003).

$$\text{Feed costs (\$/cow)} = \frac{\text{Cost of supplements made on farm + Cost of supplements purchased + Cost of winter grazing off + Cost of youngstock grazing off + Costs of crop and regrassing the farm}}{\text{Herd size}}$$

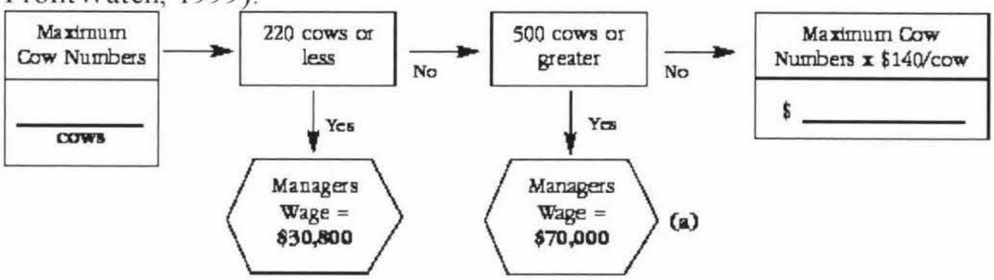
4.9 Calculation of overhead costs (From: ProfitWatch database, 2003).

$$\text{Overhead costs (\$/ha)} = \frac{\text{Vehicle costs + Repair and Maintenance costs + Freight costs + Weed and Pest Control costs + Administration costs + Standing Charges costs + Run-off lease costs + Other Expenses + Depreciation + Run-off adjustment}}{\text{Effective hectares in the farm}}$$

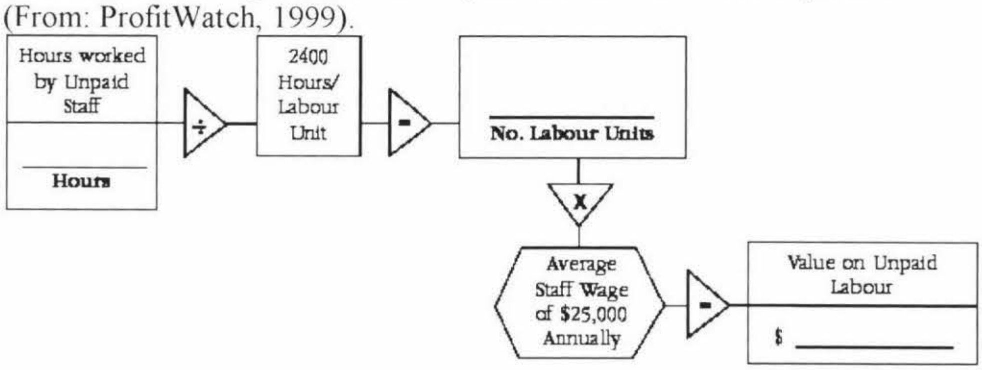
4.10 Calculation of EFS/ha (From: Dexcel, 2003b).

$$\text{EFS/ha (\$/ha)} = \frac{\text{Total dairy income} - \text{total farm working expenses} - \text{adjustments (Depreciation, run-off, labour, stock number)}}{\text{Effective hectares in the farm}}$$

4.11 Calculation of wage for management in labour adjustment (From: ProfitWatch, 1999).



4.12 Calculation of wage for other unpaid labour in labour adjustment (From: ProfitWatch, 1999).



4.13 Calculation of runoff adjustment (From: ProfitWatch, 1999).

Land Quality	**Area**	**Value**	**Adjustment**
Good (flat, fertile)	ha	$	
Average	ha	$	
Poor (steep, infertile)	ha	$	
			$

4.14 Calculation of stock adjustment for EFS (From: Dexcel, 2003b)

	Opening No's (A)	**Closing No's (B)**	**Difference (B-A)**	**Value (2001/02)**	**Adjustment (Diff. x Value)**
R 1yr				$540	
R 2yr				$1065	
Cows				$905	
					$

R1yr and R2yr heifers **- herd scheme values (based on market value) are used.**
Cows **- An average of herd scheme values and budget cow prices**

4.15 Calculation of the percentage of Return on Assets, excluding capital appreciation (From: Dexcel, 2003c).

$$\% \text{ RoA} = \frac{\text{EFS (excluding run-off adjustment)} - \text{non-run-off leases} * 100}{\text{Total Assets Owned (Net Operating Assets)}}$$

4.16 Calculation of the Return on Equity (From: Dexcel, 2003c).

$$\% \text{RoE} = \frac{\text{EFS}^{1} - \text{interest payments} - \text{non-run-off leases} * 100}{\text{Owner's Equity (Assets} - \text{Liabilities)}}$$

EFS[1] = EFS of the farm excluding the run-off adjustment.

4.17 Calculation of the variable costs per hectare and per kg MS (From: ProfitWatch Database, 2003).

$$\text{Variable costs (\$/ha)} = \frac{(\text{Animal costs} + \text{fertiliser costs} + \text{feed costs})^{1}}{\text{Effective hectares in the farm}}$$

$$\text{Variable costs (\$/kg MS)} = \frac{(\text{Animal costs} + \text{fertiliser costs} + \text{feed costs})^{1}}{\text{Total kg MS produced in the farm}}$$

[1] See sections 2.2.1.4.B.1 and 2.2.1.4.B.2

4.18 Calculation of fixed costs per hectare and per kg MS (From: ProfitWatch Database, 2003).

$$\text{Fixed costs (\$/ha)} = \frac{\text{Total overhead costs of the farm}^{1}}{\text{Effective hectares in the farm}}$$

$$\text{Fixed costs (\$/kg MS)} = \frac{\text{Total overhead costs of the farm}^{1}}{\text{Total kg MS produced}}$$

[1] See section 2.2.1.4.B.3

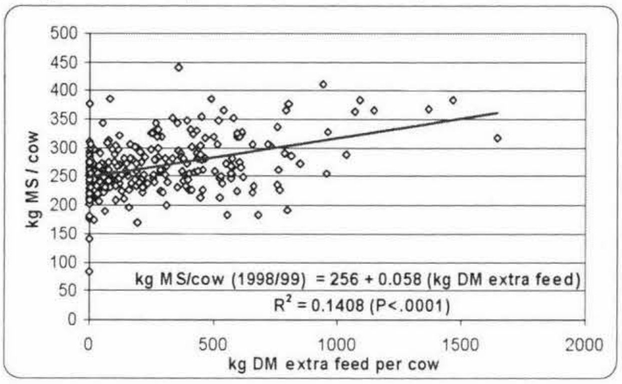
4.19 Calculation of the cost of milksolids production (From: IFCN, 2003).

$$\text{Cost of milksolids production (\$/kg MS)} = \frac{\text{Total farm working expenses} + \text{Depreciation} + \text{Labour adjustment} + \text{non-run-off leases} + \text{Opportunity cost of capital}^{1} - (\text{Net stock income} + \text{stock adjustment})}{\text{Total kg MS produced in the farm}}$$

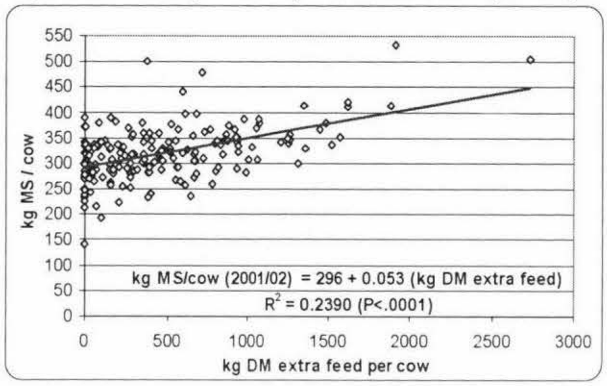
[1] Opportunity cost of capital = 5% of net operating assets (Net Operating Assets= Total Operating Assets – Current Liabilities).
Total Operating Assets = Land and Buildings (current Market Value) + Other Fixed Asset + Plant, Machinery and Vehicles + Livestock (Market Values) + Investments (excluding Non Farm Assets) + Current Assets.

5.- Relationship between physical and financial farm parameters (per year).

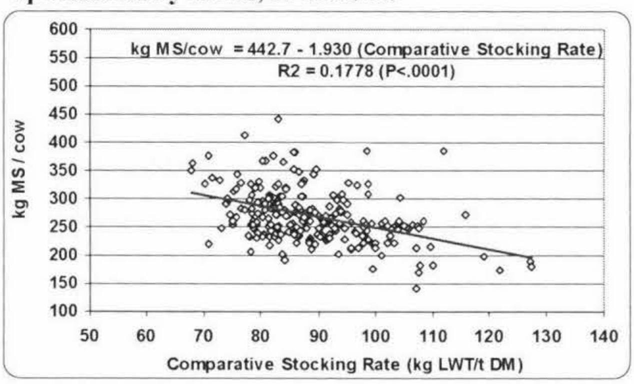
5.1: Relationship between extra feed input and milksolids production per cow in owner-operated dairy farms, in 1998/99 (n=237).



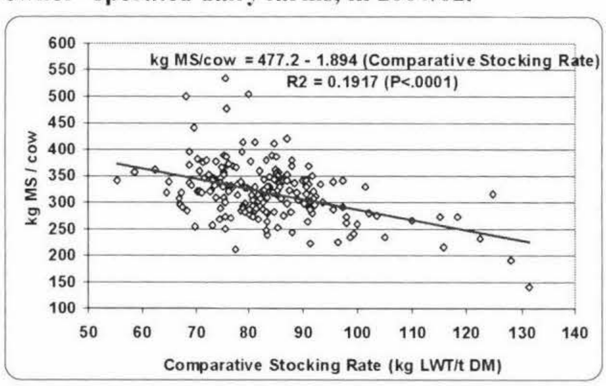
5.2: Relationship between extra feed input and milksolids production per cow in owner-operated dairy farms, in 2001/02 (n=192).



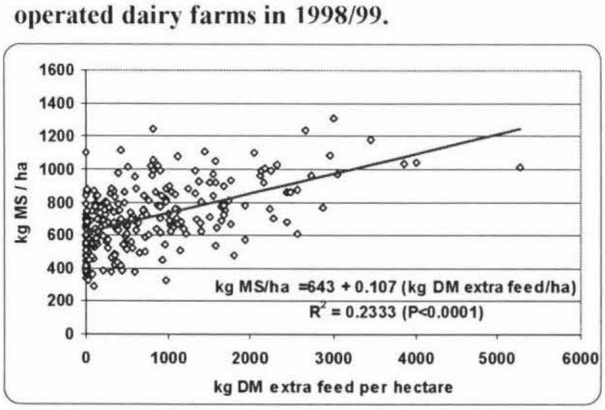
5.3: Relationship between comparative stocking rate and milksolids production per cow in owner-operated dairy farms, in 1998/99.



5.4: Relationship between comparative stocking rate and milksolids production per cow in owner- operated dairy farms, in 2001/02.



5.5: Relationship between extra feed input and milksolids production per hectare in owner-operated dairy farms in 1998/99.



5.6: Relationship between extra feed input and milksolids production per hectare in owner-operated dairy farms in 2001/02.