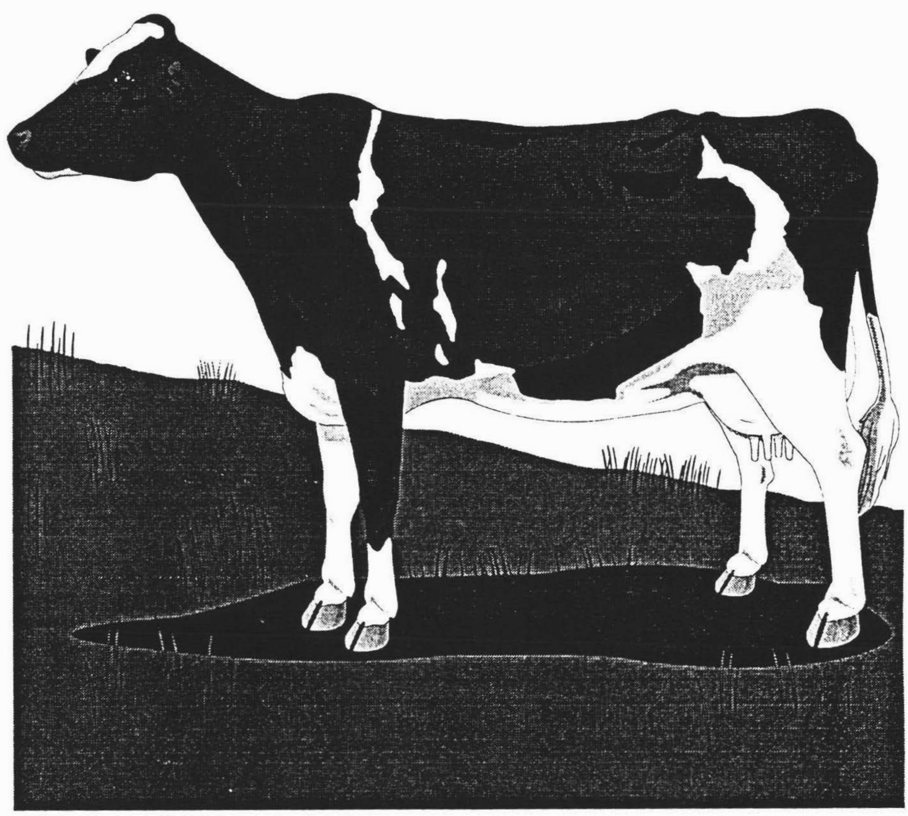
HOW SEASONAL DAIRY FARMERS IN THE LOWER NORTH ISLAND OF NEW ZEALAND ACHIEVE:

High Per Cow Production

- a participatory case-study



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Abstract

How Seasonal Dairy Farmers in the Lower North Island of New Zealand Achieve High Per Cow Production: a participatory case-study.

New Zealand's 14,000 seasonal dairy farmers supply 16 co-operative companies that operate 40 milk processing factories. While the industry produces only 1.5% of the world's milk, it supplies 25% of the world trade in dairy products, which was worth $5 billion to the New Zealand economy in 1994/95. In order to remain internationally competitive, dairy production research in New Zealand has focused on achieving 'low cost' milk production from pasture. Recent high prices for dairy land and the need to reduce the seasonality of milk supply have promoted greater interest in increasing per cow production. Greater milk yields per cow would allow greater utilisation of the genetic potential of the New Zealand dairy cow for milk production and reduce per cow costs for non-feed items.

At present only 1% of seasonal supply dairy farmers consistently achieve in excess of 350 kg milksolids (MS) per cow per year. These farmers achieve this level of production with resources that appear to be similar to those of other dairy farmers, but little is known about how these resources are managed to consistently achieve high per cow production. The objective of this research was to describe the management processes used by farmers who achieve high per cow production.

Milk supply records from Tui Milk Products Limited were used to identify seasonal dairy farmers who had averaged 350 kg MS/cow/year for at least three seasons (n=31). All of these farmers were surveyed by telephone to obtain information about themselves and their farms. A sub-sample of ten farmers was then chosen from this group for in-depth study and of these 8 farmers agreed to participate. Through three semi-structured interviews, each farmer was asked to describe their management processes. The interviews were recorded, transcribed verbatim and analysed using the NUD.IST computer program to identify concepts associated with high per cow production. A 'model' of a high per cow production system was developed from these concepts and this was compared with the recommendations in the literature.

The results suggest that while the resources available to the farmers influenced per cow production, they did not constrain the achievement of high per cow production. Farmers strategically managed the resources available to enable them to achieve high production levels and used tactical adjustments to account for seasonal variation in pasture production and feed demand. All of the case-farmers reared their herd replacements 'well', concentrated on fully feeding the herd throughout lactation, and had superior pasture management systems in place. In addition, these farmers were genuinely interested in the state of their farms, particularly their livestock, and closely observed livestock behaviour as part of their management system.

Keywords: Per cow production, pastoral dairying, farm management, strategy, tactics, case-study

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Introduction

Chapter 1 Introduction

1.1 Industry Overview and Problem Statement

The New Zealand dairy industry, based on a farmer co-operative ownership structure, is a major export earner for the New Zealand economy. From early beginnings in the 1840s when the first settlers bought in Shorthorn dairy cattle for household milk, the industry now produces more than 700 million kilograms of milksolids per annum (1993/94) that is worth in excess of $5.0 billion (1994/95) to the New Zealand dairy farmer (NZDB, 1994(a); NZDB, 1995(b)). In Chapter 1 a brief history of the dairy industry in New Zealand is presented. This outlines some of the changes that have occurred and the effect that these changes have had on the industry and the family farm. In addition, a synopsis of dairy production research over the last three decades is presented. Finally, problems and opportunities confronting the dairy industry are discussed.

Milk processing organisations proliferated in the late 1880s in response to increased local demand, and, because of the development of refrigerated shipping, the ability to export excess production (Philpott, 1937). Cheese and butter factories, often only a mile apart, were set up by entrepreneurs and farmer owned co-operatives to process milk (Yerex, 1989), and by 1918 there were 564 milk processing factories (Hamilton, 1944). Improvements in milk processing capacity, bought about by amalgamations of smaller factories, allowed economies of scale that to a large extent negated the cost of transporting dairy products to overseas markets (Grigg, 1974). In addition, improvements in transport and production technologies, have reduced the number of factories to just 40 in 1993, and relaxation of government controls on the industry has permitted the rationalisation of the ownership of these factories to 16 co-operative dairy companies (Ward, 1975; Parker, 1993).

The 40 dairy factories are supplied by approximately 14,000 seasonal dairy farms (NZDB, 1994(b)) that are, in the main, owned and/or operated by farming families. Initially quite small, the 'family farm' by 1992 averaged approximately 70 hectares and milked 171 cows (Holmes & Hughes, 1993; LIC, 1994) (Appendix 1.1). Originally a 'poor' life, the family farm often failed to make sufficient money to provide the dairy farm family with an acceptable standard of living. Milking was initially done outside, before moving into lean-to sheds and then purpose built cows sheds in the late 1890s (Warr, 1988; Yerex, 1989). Further innovations such as the walk-through shed, 'home' separation and milking machines in the early 1900s, the 'lorry' and reticulated electricity in the 1920s, and herd testing in the late 1920s and 30s all contributed to the improvement in the life of the dairy farmer and productivity of the family farm. Increases in dairy farm productivity and profitability were also bought about by the development of the herringbone milking shed in the 1940s, which enabled a larger number of cows to be milked per person than the existing sheds (Lauridsen, 1989), and by the introduction of the milk tanker in the 1940s to 1950s (Warr, 1988). The latter allowed the amalgamation of smaller less efficient milk processors and facilitated an increase in the farm price for milk. The use of electric fencing and artificial insemination (AI), combined with improvements in farm management, have also played their part in improving the productivity and financial returns of the family farm (Yerex, 1989).

The small New Zealand population (3.5m) does not provide a significant local market for milk and over 90% of dairy production is exported (NZDB, 1993; 1994(b)). While these exports represent only 1.5% of total global dairy production (NZDB, 1992; Lockhart & Cartwright, 1994), they account for 25% of the world trade in dairy products. The New Zealand industry therefore has a high exposure to world dairy markets and this has created numerous problems for the industry over the years. These problems have included: restrictive government policies, (both off-shore and on-shore), stock-piling of product, dumping of surplus product, exchange rate fluctuations and a high internal (manufacturing) cost structure (Ward, 1975). However, due in part to the co-operative nature of the industry, and the diligence and determination of the people leading the industry, these problems have largely been overcome through dynamic marketing strategies, product diversification and cost effective milk processing (Ward, 1975).

The New Zealand Dairy Board (NZDB) vision is, *'To be the most profitable unsubsidised dairy industry in the world, providing farmers with increasing wealth and seasonal returns superior to other land uses'*, (NZDB, 1995(b)). This vision will be achieved through an organisation that comprises 80 subsidiary or associate companies that export to over 100 counties worldwide (NZDB, 1994(a)). The single multi-national marketing arm of the NZDB had a turnover in 1993 of $5 billion and export earnings of $3.3 billion (NZDB, undated), and is supplied by processing companies and technical units owned and directed by the New Zealand dairy farmer. At that time the total net value of the New Zealand Dairy Board was $1,457 million which equated to an average 'off-farm' investment by the New Zealand dairy farmer in excess of $100,000. In addition, the dairy farmer had a co-operative interest in the 'local' dairy company estimated to be at least $65,000 (Lockhart & Cartwright, 1994).

The value of the average 'family farm', including livestock, in 1993 was estimated[1] at $1,114,000, and the average dairy farmer's equity in farm assets was $821,000 (NZDB, 1994(a)). Combined with the off-farm investments this equated to an average 'stake' of $986,000 by each farmer in the industry. From this capital base the average farmer had gross earnings of $219,040 in 1993/94, that resulted in a cash surplus from farming of $73,720 from which capital repayment of debt and personal living expenses were met (NZDB, 1994(a)). The calculated return on capital, before tax and after adjustment for managers wages, was 4.41%. For sharemilkers, the average investment in the 1993/94 season was $302,400, of which $180,000 was equity and the return on capital was 8.66% (NZDB, 1994(a)).

Because the New Zealand dairy industry relies on selling most of its produce on the open world market, low cost milk production has been, and some say must continue to be (Bryant, 1993), the backbone of the industry (Yerex, 1989; NZDB, 1993). In order to achieve low cost milk production, New Zealand dairy farmers manage their farms and livestock to efficiently convert pasture into milk. In doing so, they have gained international respect, by some, for their ability to achieve high stocking rates on pasture-based systems (Sapienza, 1994), and for having the lowest cost milk production system of the major dairy industries of the world (Murphy, 1993). This low cost pasture-based system is enhanced by a favourable climate, and year round pasture growth.

The early reliance of the dairy industry on a small number of products, mainly butter and cheese, forced dairy farmers, and researchers, to devise low cost production systems for two reasons. First, the low cost production system was required to enable the small range of products to be manufactured and transported to overseas markets and yet remain competitive with locally produced dairy products. Second, because of the need to maintain low farm gate payments to remain

[1] These values were derived from a survey of 346 farmers during 1994 (NZDB, 1994).

competitive, a low cost system was necessary to enable farmers to maintain a reasonable standard of living (Ward, 1975; Bryant, 1993). Despite the fact that the dairy industry now has substantially less reliance on commodity products, due to the development of a wide array of added value products by the NZDB, many researchers and dairy industry personnel hold the view that low cost pasture systems must be preserved, in order for the dairy industry to retain its international competitiveness (Bodeker, 1993).

The international competitiveness of New Zealand's low cost dairy system, however, has been eroded by recent increases in the value of dairy farmland (Ridsdale, 1993; Parker, 1995). Figure 1.1 shows that the unadjusted capital cost of dairy farmland has increased from \$4.90 /kg MS (\$8.60/kg MF) in 1979 to \$21.60 /kg MS (\$37.60/kg MF) in early 1994. In addition, the competitiveness of the industry is under threat from the development of grassland systems, based on New Zealand technologies, in other countries which have similar or lower cost structures (Parker, 1995).

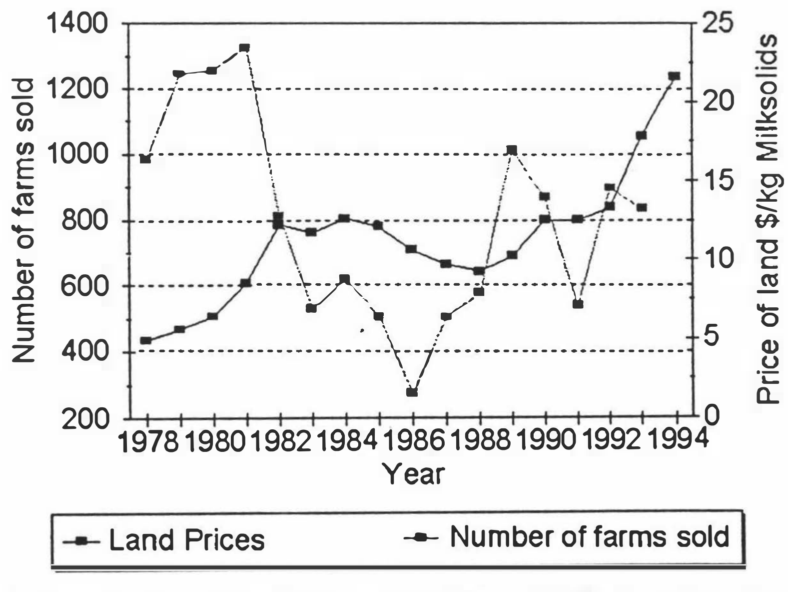

Figure 1.1 Trends in dairy land prices from 1978 to 1994. Price per kg milksolids are derived from price per kg milkfat data. Figures for 1994 relate to the half year to 30 June (source LIC, 1994).

One consequence of the historical reliance on a low cost pasture system is that, research emphasis has been placed on milk production per hectare rather than per cow (Holmes, 1989). Furthermore, increased milk output per farm has been achieved primarily by increasing stocking rates and farm size, rather than increasing per cow production (Holmes, 1989; Edwards & Parker, 1994). Per hectare production and stocking rate were the primary focus of dairy research during the 1980's (Bryant 1982, 1984, 1990; Bryant & MacDonald, 1983; Phillips, 1983). In addition, due to the problems of matching the seasonal feed supply of pasture with feed demand, research also focused on cow condition, pasture cover, and pasture utilisation. However, little research was carried out on the quality of pasture and its effects on milk production (Wilson & Moller, 1993).

The research and associated emphasis on production, both total farm and per hectare, has contributed to marked changes in the character of the New Zealand dairy industry over the last three decades. For example, herd size has increased steadily in response to falling (inflation adjusted) farm gate pay-out for milk produced (LIC, 1994). Stocking rate has increased from 2.1 cows per hectare in 1980/81 to 2.4 cows per hectare in 1993/94 (LIC, 1994). Over the same period milksolids production per hectare has risen from 539 kg MS/ha to 708 kg MS/ha and, despite the lack of emphasis from research, per cow production has risen steadily from 201 kg MS/cow in 1950 to 278 kg MS/cow in 1993/94 (Figure 1.2).

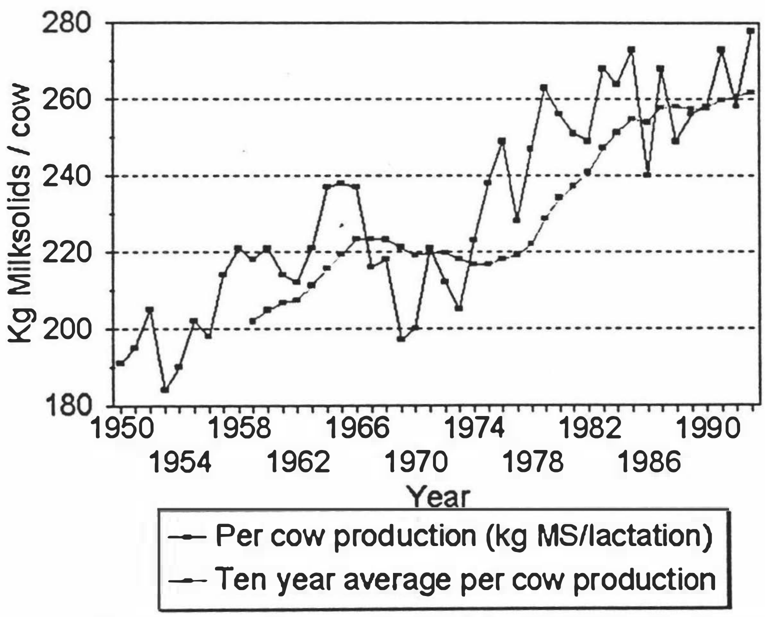

Figure 1.2 Per cow production trends from 1950/51 to 1993/94 showing annual production for the period and the ten year moving average from 1960/61 to 1993/94(source LIC, 1994).

The increases in cow numbers and average milk production have lead to increases in the total supply of milk to dairy companies especially at the peak of the season (Yuretich, 1992; Gray *et al.* 1993).

The short milking season of many dairy cows, combined with higher stocking rates and larger herds has also resulted in greater increases in peak milk production relative to that produced at other times of the year (Paul, 1985). This increase in supply has required significant new investment in processing capacity by the dairy companies (Gray *et al*., 1993). Therefore, the marginal value of the milk supplied for processing during the period when daily milk supply is greatest, is low and maybe negative if milk has to be dumped due to lack of processing capacity. The oversupply of milk during peak periods has lead to the introduction of differential payments for milk by some dairy companies in an effort to shift production to the shoulder periods in order to increase utilisation of milk processing plant (Paul, 1985; Yuretich, 1992; Gray *et. al*., 1993). More recent developments have seen milk processing companies introduce mechanisms whereby suppliers, existing and/or new, are required to pay an entry fee, either in the form of shares, capital notes or share premiums, before supply commences, or when increases in production are expected (Watters, pers. comm.). This payment is required to provide capital to expand processing capacity and maintain the farm gate payout for milk.

As stated above, differential price signals are being given by the dairy companies to improve the value of milk, particularly during peak production periods. Options available to the dairy companies to reduce the volume of milk supplied during peak production periods include: restricting the number of new suppliers; limiting increases in production from existing suppliers; and asking farmers to lower stocking rate to reduce the oversupply of milk to the factories during the peak supply months. Farmers could take advantage of these price signals by: increasing milk production per cow through longer lactation lengths, exploiting the genetic potential of the New Zealand dairy cow for milk production, changing the calving date (pattern) of the herd to move a greater portion of milk production into that part of the year that attracts the highest milk payments and perhaps by lowering stocking rates.

The genetic merit of the New Zealand cow has been clearly demonstrated in trials in Canada and Poland (Jasiorowski, 1987; Stolzman et al., 1981; Petersen, 1988; Graham et al., 1991). Production levels achieved by the progeny of the New Zealand sires in these trials were 394 kg MS (225 kg MF) in Canada and 357 kg MS (204 kg MF) in Poland yet in New Zealand average production per cow was 278 kg MS (160 kg MF) (LIC, 1994). Recent farm trials in New Zealand (Gerke, 1994;

Edgecombe & Edgecombe, 1994) have proven that cows are able to produce well above the national herd average provided they are fed appropriately. Because of this, and the increasing capital cost of dairy farmland, and because many small to medium sized dairy farms are landlocked and do not have options for herd expansion, there is an increasing interest from farmers in the use of supplementary feeds to increase production per cow (Edwards & Parker, 1994).

Farmer interest in increasing per cow production has arisen despite the focus on high per hectare production by researchers and extension workers which presumed that high milksolids production per hectare was synonymous with high levels of profitability (Holmes, 1990). However, limited research has been undertaken into the economics of the high stocking rate-high production per hectare farm. Although, a financial analysis of the stocking rate research by Bryant (1982 - 85) has indicated that higher stocking rates and high production per hectare lead to high profitability (Holmes & Parker, 1992), it also showed that farm profitability fell at higher stocking rates, largely due to discrete increases in labour requirements as herd size increased.

It should be noted that the majority of the direct expenses on a dairy farm are determined on a per cow basis not a per hectare basis. The unit cost of producing milk is therefore closely linked to per cow production. Thus, by increasing milk production per cow, income will increase, but per cow expenses remain unaffected. In addition, if a decrease in stocking rate could be combined with an increase in per cow production the average cost of milk production could be decreased further. However, a reduced stocking rate does not automatically lead to increases in per cow performance and in practice the opposite often occurs (Holmes & Wilson, 1987). Reducing cow numbers in order to increase per cow production also decreases capital requirements for the herd, and reduces the need for changes to milking facilities or farm layout that are normally associated with a larger herd size. Other benefits such as: less labour, reduced stress on both the farmer and the herd, an improvement in herd health and well-being may also be captured by reducing stocking rates.

Lowering stocking rate may also enable lactation length to be increased. Any increase from the current average of 226 days (Holmes & Hughes, 1993) to 260 days (Holmes, 1986) would enable farmers to take advantage of any price differential for shoulder milk and spread the costs pregnancy and animal health expenditure (which mainly occur in the first trimester of lactation) over a longer period. If the industry trend towards higher shoulder milk payment and greater capital requirements for dairying continue, a move towards high per cow production systems may be the most effective way for farmers to increase farm profits. There is considerable potential for the latter to occur, because, despite the ability of the New Zealand dairy cow to produce at high levels, less than 1% of dairy farmers consistently achieve levels of production in excess of 350 kg MS/cow/year (LIC, 1991). At present, little has been reported in the scientific literature on the management processes used by these dairy farmers to consistently achieve this level of production, or the profitability of these systems.

1.2 Objectives of the Study

The overall aim of the study was to investigate, and report on, how farmers in New Zealand consistently achieve high per cow production. Specific objectives of the study were :

1) to develop, from the literature, a conceptual model of pasture-based per cow production.

2) to identify the management practices associated with high per cow production, and to elicit from farmers what they believed to be the important factors in consistently achieving high per cow production.

3) to develop a farmer model for high per cow production, and to compare this with the conceptual model developed from the literature. This comparison would identify gaps in knowledge and indicate where further research should be carried out.

4) to critically evaluate the research method used.

1.3 Area of study and thesis structure

One of the difficulties of undertaking farm-based case-study research is the cost involved with time and travel to interview farmers. The study was therefore limited to Tui Milk

Products Limited suppliers. However, this supplier base provided the opportunity to select farms from a diverse range climate, topography and soil conditions in the lower North Island (see Appendix 1.2 for a brief outline of the area).

This thesis reports on the results of a study of seasonal supply dairy farmers in the lower North Island who achieved high per cow production over the period 1990 to 1993. In Chapter 2 a literature review of dairy farm production research is presented. A conceptual model is developed from this information for later comparison with the data collected from the case-study farmers. In Chapter 3 the selection of the study method for the research is discussed. In addition, the method and results of a preliminary survey of the characteristics of farmers and their farms are reported. In Chapter 4 a detailed description of the selection and study of the case-study farms is provided. The results of the study and the development and discussion of a 'model' of high per cow production, and comparison with the literature, are presented in Chapter 5. In Chapter 6 the method used for this research is critically examined and conclusions drawn about the data and suggestions for future research are made.

2

Literature Review of Dairy Production Factors

Chapter 2 Literature Review of Dairy Farm Production Factors

2.1 Introduction

In this chapter resource, animal, and management factors affecting milk production on New Zealand dairy farms are discussed. Components within each of these are reviewed to facilitate the development of a theoretical model of per cow milk production on New Zealand dairy farms.

2.2 Resource Based Factors

Farmers have limited control over factors such as climate, soil type, and farm location. The level of control over other factors such as pasture, and environmental (exercise, herd interaction, water, milking, parasites, and farm layout) varies according to the farmer's situation. Nevertheless, these impact on farm productivity, and management actions to mitigate negative effects and to take advantage of positive aspects of these factors are necessary if milk production is to be optimised.

2.2.1 Pasture Factors

The reliance on pasture as the major source of feed for livestock places the New Zealand dairy farmer in a unique position (Holmes & Hughes, 1993). However, the level of control over pasture factors is limited by the farmer's ability to manage the herd, influence stocking rate, and monitor the pasture to make the best advantage of this resource. Seasonality of growth, total annual growth and the effects of pasture quantity and quality must all be considered if the farmer is to optimise milk production from the farm.

The level of milk production on New Zealand dairy farms is strongly affected by the seasonal nature of pasture growth. The quality and quantity of pasture available to the dairy cow is affected by changes associated with plant maturity, pasture management, species, and climatic conditions

(Bines, 1979; Ulyatt & Waghorn, 1993; Wilson & Moller, 1993) (Figure 2.1). These aspects also affect the nutritional composition of the pasture. For this reason it is in the farmer's best interests to grow as much pasture, as evenly distributed through the year as possible, and to maximise the use of this through grazing (Holmes, 1987[a]). However, to manage seasonal changes in pasture production farmers are often required to restrict the amount of pasture available to the cow for periods of up 100 days to avoid subsequent feed shortages (Holmes & Wilson, 1987). This directly impacts on cow milk yields and body condition.

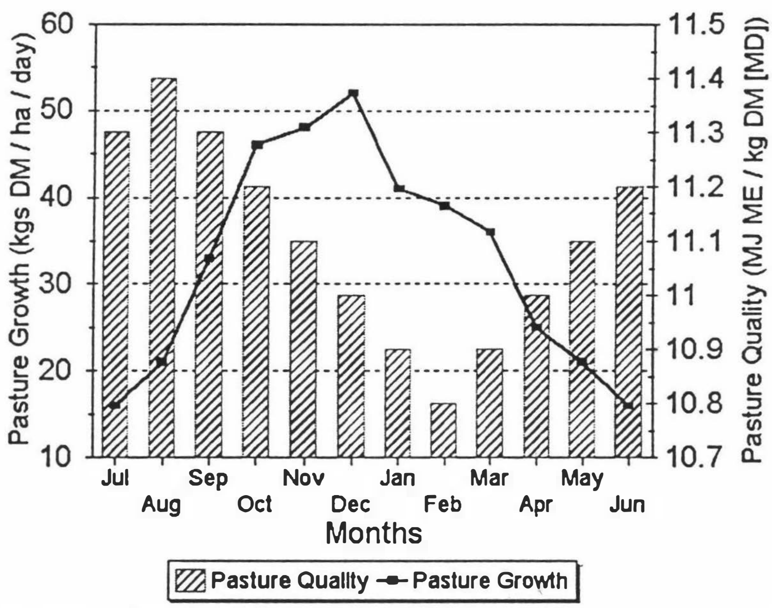

Figure 2.1 Annual pattern of pasture growth and feed quality on a typical Manawatu dairy farm (source M A F; Brookes et al., 1992)

The amount, availability, and management of pasture grown annually determines the amount of milk that can be produced on New Zealand dairy farms (Edwards & Parker, 1994). A theoretical maximum yield of 21 tonnes dry matter (DM) per hectare for C3 plants has been suggested by Hodgson (1990). However, actual yields achieved on 'top' dairy farms is likely to be lower (up to 15 tonnes DM), and on average dairy farms lower again (10 to 12 tonnes DM). To achieve greater DM production different management techniques are needed (Hodgson, 1989) such as the use of nitrogenous-based fertilisers (Holmes & MacMillan, 1982), special purpose seasonally-based pasture species (Hodgson, 1989), irrigation (Holmes & MacMillan, 1982), and pasture renovation (Hodgson, 1989). The availability of pasture can also be altered by conservation (Holmes & MacMillan, 1982) and deferred grazing (McCallum *et al.*, 1991). However, the use of the latter two methods to alter the availability of pasture leads to wastage and a reduction in the quality of the saved feed. Another method to improve the feed distribution on dairy farms is to plant forage crops such as maize or brassica. The need to maintain feed supplies to ensure cow intakes are at their maximum throughout lactation requires a high degree of pasture management skill.

Seasonal pasture growth, composition, and availability affect the amount and quality of the pasture offered to cows. However, in the short term, the physical characteristics of the pasture sward and daily grazing management can markedly affect the amount of pasture eaten by the dairy cow. Milk production falls when cows are on pasture of low (> 7 cm) (Le Du *et al.*, 1981) sward height or are forced to graze to low residuals (8 - 10 cm under rotational grazing regimes) (Le Du & Hutchinson, 1984). The importance of sward height is highlighted by considering the formula for intake (Allden & Whittaker, 1970):

DMI = IB * RB * GT, where: IB = intake per bite (bite size); RB = bites per minute; GT = grazing time.

When cows are offered pasture above 10 cm, bite size increases, and the cow spends less time grazing (Le Du *et al.*, 1979). The upper limit on the number of bites a cow can take in one day is about 36,000 (Stobbs, 1973), while RB varies from 50 to 60 per minute (Leaver, 1985). Cows fed fresh pasture will graze up to 10 hours per day (Leaver, 1985; 1986). When pasture availability is low, GT will increase to compensate (Journet & Demarquilly, 1979) and for this reason Combellas & Hodgson (1979) suggest that cows need to be offered twice the amount of pasture that they require to achieve maximum intakes of pasture to maintain milk production. In New Zealand allowances of 4 - 5 times requirements have been suggested to increase feed intake and therefore milk yield (Bryant, 1980[a]; Glassey *et al.*, 1980). Milk production from pasture will be depressed when cows are forced to consume more than 50% of the pasture on offer (Le Du *et al.*, 1979; Ulyatt & Waghorn, 1993).

However, allowing the cow *ad lib* access to pasture, in the long-term, decreases utilisation and increases wastage of available pasture (Bryant, 1980[a]; 1980[b]). Therefore, the balance between pasture intake and pasture availability and the level of pasture utilisation affects the level of milk production from New Zealand cows. In practice, consistently high levels of DMI, and high levels of milk production are difficult to achieve on pasture-only diets (Journet & Demarquilly, 1979) and this is reflected by the relatively low average milksolids (MS) yields of New Zealand's pasture fed cows.

To achieve the multiple objectives of high pasture DMI, pasture utilisation, and milk yield, new management techniques are required. In addition, under intensive rotational grazing systems cows are forced to eat pasture quickly to minimise fouling by excrement and trampling (Ulyatt & Waghorn, 1993). The use of stand-off pads to prevent trampling and pugging damage can increase pasture growth and milk production, despite the cows being removed from grazing for extended periods of time. In these circumstances feed utilisation could be increased by more frequent feeding of cows rather than an increase in stocking rate (Broster *et al.*, 1976) (e.g. by offering fresh breaks of pasture 2 - 3 times during the day (McGrudy & McGrudy, 1994; Oldfield, pers. comm.). However, increases in milk production through this method have yet to be fully investigated (Edwards, pers. comm.). Offering cows more frequent feeds benefits rumen digestion by reducing the fluctuations of the digesta in the rumen, and also provides a more constant flow of volatile fatty acids (VFA) and amino acids (AA) to the blood and mammary gland (Bines, 1979; Ulyatt & Waghorn, 1993). More frequent feeding is a characteristic of high production systems in the UK and US (; Broster & Alderman, 1977; Bines, 1979; Chase, 1993).

The nutrient balance of the pasture may also be sub-optimal for high milk production (Muller, 1993). New Zealand's ryegrass/white clover mix is a high quality feed; however, it does not ideally match the nutrient requirements of a cow producing in excess of 25 litres of milk per day. Fresh ryegrass/clover pasture mixes are very high in protein (>20%), particularly in early lactation, and much of this is unable to be utilised by the cow. Therefore to maximise milk production from New Zealand's dairy pastures, a better balance of nutrients in the diet may be required (Wilson & Moller, 1993; Hutjens, 1994; Sapienza, 1994). The feeding of high energy rations (grain, meal etc) maintains rumen activity and increases vital nutrients that are lacking in early spring pasture (Clarke & Davis, 1980). However, care must be taken to avoid substitution effects and pastures from becoming rank and unpalatable (Phillips, 1994).

2.2.2 Climatic Factors

Climatic factors affect the rate of pasture growth and the eating patterns of dairy cows. Seasonal variations in the weather pattern influence the pattern of pasture growth (Holmes & Wilson, 1987) and set an upper limit to the amount of pasture that can be produced during the year (Mathew, 1992). Even in districts where rainfall is evenly spread throughout the year, cooler temperatures in the winter months and the lower levels of transevaporation lead to wet soil conditions, which in turn can contribute to trampling damage of pasture by livestock, and reduced pasture growth rates. Variation in soil temperature, rather than rainfall determine the rate of pasture growth, although periods of drought and excess rainfall affect pasture growth in some areas (Holmes & Wilson, 1987). Lower air temperatures and increased rainfall can also increase a cow's exposure to cold stress and lead to increased DMI to compensate for extra body heat loss; the addition of wind chill factors and behavioural changes at very low temperatures can lower DMI (Lean, 1987) and lead to lower milk production.

2.2.3 Soil Factors

Soil type, fertility, nutrient levels, structure, acidity, and applications of fertiliser influence the yield of pasture (White, 1987; Hodgson, 1990). However, high levels of soil water can lead to waterlogging and damage of soil structure by pugging. The level of fertility and nutrients, particularly nitrogen, phosphorous, potassium and sulphur (N P K S) in the soil can be manipulated by the application of fertiliser (Hodgson, 1990; Kruiger & Kruiger, 1992). Increased nutrient levels through the application of fertiliser increase the level and timing of pasture growth (Roberts *et al.*, 1991; Thomson *et al.*, 1993). Potentially the increased pasture grown on fertile or well fertilised soils enables the farmer to offer more pasture to their cows, and increase milk production.

2.2.4 Environmental Factors

Environmental factors, including those already discussed, contribute to 84% of per cow production (Lean, 1987). Factors other than pasture, climate, and soil which influence per cow production include: the amount of exercise required to graze pasture and walk to and from the milking shed (Bines, 1979; Lean, 1987); herd mate interaction (Lean, 1987); supply of adequate drinking water (NRC, 1978; Mead, 1983; Lean, 1987); efficiency and operation of milking machines (Lean, 1987; Kruiger & Kruiger, 1992; Mein & Thompson, 1993); stock handling in the milking shed (Holmes et al., 1993[a]; Mein & Thompson, 1993); control of parasites (Michel *et al*., 1982); and physical farm layout (Dewes, 1978; Lucey *et al*., 1986; Collick *et al.,* 1989). These are each discussed briefly in the following paragraphs.

Exercise

Additional DMI is required by dairy cows to meet the energy requirements of grazing fresh pasture and for walking to and from the milking shed (Mathewman *et al.,* 1989; Mathewman *et al.,* 1990). Exercise for grazing pasture is estimated to add 10% DMI to the maintenance requirements of cows grazing fresh pasture (Lean, 1987). A further 10 MJ ME / 1.6 kilometres of walking (.58 kg DM / kilometre at 10.8 MD) is required for walking to and from the milking shed (Bines, 1979). The total amount of time spent walking and standing in holding yards can lower pasture intake if it reduces the time available for grazing (Lean, 1987). Shed and race location is therefore an important consideration to minimise the extra energy demands associated with walking and to avoid reductions in milksolids yield and milk quality (Thomson & Barnes, 1993; S Pratumswan, 1994).

Herd Mate Interaction

The pecking order of a herd of cows affects those animals likely to be bullied. The group most affected by the herd pecking order are the two year old heifers and the DMI of this group of animals can be limited by the anti-social behaviour of more dominant cows (Lean, 1987). In New Zealand herds have been split into different milking herds to minimise anti-social cow behaviour. Split herds are most often found in large-herd (greater than 300 cows) situations. Herds may be split by age, breed, size, and calving date to avoid bullying in the yard and whilst grazing (Bartlett, 1976). In 1977, 34 out of 90 large herds surveyed had split-herds with 21 splitting by age/size/breed (Tempero & Bartlett, 1977). No production information was provided by these authors who focused on the management advantages or disadvantages of operating split herds.

Although, Thomson *et al.* (1991) reported increased production from two year heifers wintered separately from older cows, Thomson & Barnes (1992) reported similar milk production levels from heifers and matured cows wintered separately despite significant winter liveweight gains, which suggests that herd behaviour after the heifers joined the herd may have affected production.

Water Supply

Dairy cows need access to a reliable and clean water supply to ensure peak production levels are achieved. Estimates of the amount of water needed for peak production range from 100 to 170 litres per cow per day (NRC, 1978; Lean, 1987). Farmer experience suggests cows will drink between two and six times per day and that at least two watering points are needed to provide ready access to water at all times (Mead, 1983). In New Zealand where herds in excess of 150 cows are common, access to troughs is of paramount importance if milk production is not to be depressed.

Milking Sheds and Milking Management

Stress-free milking is required if the milk production of the herd is not to be affected (Mead, 1983; Lean, 1987). Quiet and pleasant handling in the yards and the shed may improve, and certainly will not reduce, milk yield (Holmes *et al.*, 1993[a]), and it is the author's experience that daily milk yield of the herd can be reduced by up to 10% if cows are placed under stress by unusual milking routines or rough treatment whilst in the milking shed (see also Lamb, 1975; Shultz 1992). Stresses associated with milking have depressed milk yield by up to 34.7% in stress susceptible cows in trials in the USSR (Ustinova *et al.*, 1990)

In the USA milking cows three times a day is common practice; some herds are even milked four times a day. Milking three times a day increased milk yield by up to 10%, although the effect of milking three times a day was more noticeable later in lactation (Pearson *et al.*, 1979). This suggests that there are factors other than milking frequency that effect milk yield in early lactation. Other studies have indicated that cows milked three times a day have an improved persistency of lactation, although peak milk yield was unaffected particularly in high producing cows (Szücs *et al.*, 1991). However milking three times a day increases the level of stress on the herd (Bohling *et al.*, 1984).

These factors suggest that the genetic potential of New Zealand cows needs to be more fully exploited before milking three times a day is adopted in this country.

An important aspect of stress-free milking is the provision of well-maintained and efficient milking machines (Mead, 1983). Cows producing in excess of 25 litres of milk/day have a high (greater than 5 litres/min) peak milk flow and milk for longer (up to 9 minutes in total) than low (> 18 litres milk/day) producing cows. A quick, complete and gentle (stock handling and milking machine operation) milking is required to obtain peak production and to avoid costly increases in the incidence of teat orifice lesions and mastitis (Mein & Thompson, 1993). Efficient (appropriate capacity and correct vacuum levels) well-maintained machines will reduce milking time, increase milk yield, reduce mastitis and increase the longevity of individual cows (Lean, 1987). High per cow production in the USA is achieved with milking machine pulsation rates and vacuums set at similar levels to New Zealand recommendations (Clare, 1972; Bray, 1992; Holmes, pers. comm.) although a change from a 60:40 to 70:30 pulsation ration is required in herds milked three times a day.

Parasite Control

Keeping dairy cattle parasite free (internal and external) may raise the level of production. In overseas trials Michel *et al.*, (1982) found that drenching cows at calving with an anthelmintic drench increased milk production by 0.03 kg MS/cow/day. However, the results of these trials and others, both overseas and in New Zealand are variable due in part to differences in treatment and drench applications. Todd *et al.*, (1972) reported increases of 0.06 kg MS/cow/day as did Frechette & Lamothe (1981); Bliss and Todd (1976) reported increases of 0.05 kg MS/cow/day, and Bliss *et al.*, (1982) reported increases of 0.13 kg MS/cow/day. In New Zealand an increase of 10 - 15 kg MS/cow/lactation was reported (McQueen *et al.*, 1976). Although the response was economic it was not significant. Cows with parasitic infections are under increased stress and increased energy demands of immune responses will lead to reduced milk production. Although drenching of adult cattle should be controlled to avoid drench resistance, it will, depending upon the level of parasite burden, show milk production responses to annual drenching with parasitic drenches (Gilmour, pers. comm.) Also, cows infested by lice have shown reductions in production until treated (Gilmour, pers. comm.).

Subdivision & Races

The physical layout of the farm can affect the level of milk production achieved. The subdivision of the property helps the farmer manage pasture, and races provide access to and from the milking shed.

An adequate number of paddocks allows the farmer to ration pasture and provide the herd with a supply of fresh pasture at least once per day, and can be used as a tool to reduce stress on younger cows (Mead, 1983; Kruiger & Kruiger, 1992). Access to paddocks via inadequate and poorly constructed races, particularly soon after calving, can cause lameness which leads to significant reductions in milk production and reproductive performance (Dewes, 1978; Lucey *et al*., 1986; Collick *et al*., 1989). Long distances walked in wet conditions, abrasive materials on holding yards and poorly constructed races are primary causes of lameness and lost milk production in dairy cows, particularly two year old heifers (Dewes, 1978). Loss of income from milk production due to lameness caused by inadequate races in New Zealand was estimated at $1,536 per farm (Kirton, 1982). Construction materials, race width and length, race surface, annual maintenance, and race profile were identified by Bridges (1986) as factors that contribute to or affect lameness in dairy cows. In addition, management factors such as farmer patience and the use of a dog were identified by Chesterton *et al*., (1989) as factors influencing the level of production on dairy farms.

2.3 Animal Based Factors

Milk production by dairy cows is affected by genetic ability, breed, size, and level of feed intake. Although farmers do not have total control over the genetic level of their dairy herd, relying on the dairy industry to provide superior genetics, management actions can influence the rate of genetic gain as well as cow size, and feed intake (MacMillan & Murray, 1974; Garrick, 1991).

2.3.1 *Genetic Merit*

Cows with a higher genetic merit, measured by breeding index (BI), produce more milk than cows of a lower genetic merit if managed in the same environment (Bryant 1982 - 1985; Grainger *et al.*, 1985[a]). However, to achieve increased production, cows with a higher BI consume more energy (Bryant, 1982; Grainger *et al.*, 1985[b]), and partition a greater portion of this to milk production than those with a lower BI cows (Broster & Alderman, 1977; Grainger *et al.*, 1985[a]; 1985[b]).

The genetic ability of the New Zealand dairy cow has been demonstrated in overseas trials. In Canadian trials daughters of New Zealand-sired Holstein-Friesians produced in excess of 400 kg MS and at levels similar to Canadian sired cows (Peterson, 1988; Graham *et al.*, 1991). In an international trial conducted in Poland, daughters sired by bulls from 10 different countries were compared. The New Zealand-sired daughters ranked third for milk yield, second equal for MF yield and third for MF percentage (Stolzman *et al.*, 1981). In further trials, that involved back-crossing to bulls from overseas countries, New Zealand-sired cows ranked fifth for milk yield , and first for MF percentage and yield (Jasiorowski *et al.*, 1987). Production levels above New Zealand averages were recorded in both Canada and Poland.

The farmers' ability to influence the rate of genetic progress, and associated production gains, rests with their ability to get the cow ready for mating (feeding levels and condition score) and to recognise when cows are ready to be mated. The milk production increase available from herd genetic improvement, can easily be reduced by poor herd management during mating. However, by using a planned approach to the breeding program the farmer has the opportunity to take advantage of the genetics available from the dairy industry to increase the herd's milk production. A planned approach to breeding should include: heifer replacements that are genetically superior to the average cow in the herd (Holmes & Wilson 1987); culling cows that are genetically inferior to the average cow in the herd (Holmes & Wilson 1987); mating high producing cows of superior genetic merit to genetically superior sires (MacMillan 1972, 1985); reducing unplanned and avoidable wastage of genetically superior cows by careful and controlled management techniques (MacMillan 1976); mating 15 month heifers to genetically superior sires (Garrick 1991); carrying out regular herd-testing of the dairy herd in order to identify the highest producing cows (Garrick 1991); and using an optimum replacement rate to increase the genetic merit of the herd and productivity (MacMillan, 1976; Murray, 1977; Jackson 1983).

The challenge presented to cows on New Zealand dairy farms to withstand the rigours of the climate, periods of underfeeding, and the physical conditions cannot be under-estimated. Not only must the dairy cow be capable of producing well during each lactation under these conditions, she must also be capable of having a high lifetime production (Broster, 1979), which is particularly important where the dairy cow is required to calve every 365 days and to produce well, often under sub-optimal feeding conditions.

2.3.2 Breed

The debate about the milk production capabilities of different breeds has been contested for many years. Milk production comparisons between the Jersey and Friesian breed have been made and production efficiency differences reported (Wilson & Davey, 1982; Bryant & MacMillan, 1985; Bryant *et al.*, 1985; Holmes *et al.*,1989). Holmes *et al.* (1989) calculated from survey data that Jersey cows require less pasture to produce an equivalent weight of milkfat than her Friesian counterparts (8.2 tonnes/ha *cf* 8.4 tonnes/ha). However, the Friesian cow will produce more milk per kg DM/ha, and a similar weight of protein per kg DM/ha consumed than the Jersey. Recent studies show that at high stocking rates Friesians will earn more per cow than Jerseys, but due to stocking rate differences Jersey cows will outperform Friesians in terms of net income per hectare (Ahlborn & Bryant, 1992). New Zealand cross-bred cows out-perform their pure-bred herd mates in all age groups (Ahlborn-Breier, 1989), yet the choice of which breed of cow to milk is a matter of personal preference of the farmer. Changes in the value of milkfat components and the milk:meat price ratio affect the relative profitability of different dairy breeds.

Little research appears to have been carried out into the ability of the predominant breeds in New Zealand to achieve high per cow, as opposed to per hectare, production levels under grazing conditions. World and New Zealand per cow production records are held by Friesian or Holstein-Friesian cows (Trimberger *et al.*, 1987; Ulyatt & Waghorn, 1993) but it is unlikely that these levels of milk output have been achieved under commercial conditions.

2.3.3 Weight and Size of Cow

A major determinant of the energy requirements of lactating dairy cattle is liveweight (Blaxter, 1967; Geenty & Rattray, 1987). Therefore, larger heavier cows have a higher maintenance requirement for DMI than smaller lighter cows (Geenty & Rattray, 1987). However, research on liveweight and milk yield interactions suggests that heavier cows produce more milk (Thomson *et al.*, 1991). Other research suggests that larger heavier cows, at the same level of milk yield, are less efficient, than smaller lighter cows, at converting DMI to milk (Holmes *et al.*, 1993[b]). However, neither of these trials were designed to test liveweight and milk production correlations. The effect of an increase in milk yield by heavier animals would increase conversion efficiency and decrease some of the economic costs associated with per kg milk production (Parker & Edwards, 1994).

Little research data is available about the physical size (stature and capacity as defined in TOP models) of a cow and her ability to produce milk. Studies on the size of dairy cows in the USA have focussed on feed intake, and feed and production costs (Morris & Wilton, 1977). A recent study suggested that there are moderate and positive genetic correlations (r = 0.35) between body size and milk yield (Ahlborn & Dempfle, 1992). However, the physical capacity of the cow to eat and convert feed into milk may be related to the physical size of the cow and may set an upper limit to the production performance of the cow (Bauman *et al*,. 1985). Botto & Karika (1979) reported a significant correlation between liveweight and milk yield (r = 0.44*) and a smaller correlation (r = 0.18) for height at withers and milk yield.

2.3.4 Feed Intake

To achieve high levels of milk production the dairy cow must consume sufficient pasture to meet the nutrient requirements of maintenance, pregnancy (for part of the lactation), and lactation. The effect of the level of dry matter intake (DMI) on milk production has been reported by Chase (1973), Bines (1979), Stockdale (1985), and Holland (1994). Restricted pasture allowance often below optimal quality (Wilson & Moller, 1993), can limit the level of nutrients and energy that is available to the dairy cow and therefore milk production (Holmes & MacMillan, 1982; Muller, 1993).

It has been accepted at DMI of 15 to 17 kg DM/cow/day that the New Zealand dairy cow consumes (in DM terms) approximately 3% of liveweight daily (Brookes, pers. comm.). This is consistent with reported data (Suksombat *et al.*, 1994). However, Holmes (1987[b]) summarises a number of New Zealand intake data which show that DMI of lactating cattle from less than 2% (at low pasture allowances > 5 kg DM/100 kg LW in the summer) to greater than 4% (at high pasture allowances < 15 kg DM/100 kg LW in the spring) of liveweight. These data are consistent with those reported by Lean *et al.*, (1995). Anecdotal evidence, where 500 kg cows are eating in excess of 20 kg DM/head/day to achieve high levels of milk production, suggest that feed intakes of 4% of liveweight are attainable. Some overseas data for high yielding cows (Leaver, 1985) suggested that DMI can be over 3.25% of liveweight, yet under grazing conditions there are other factors which will limit DMI to 3.0% or below (Leaver, 1976). However, it is not clear whether the upper limit to DMI on grazed pasture is due to physical limitations of the cow or the physical characteristics of the pasture (i.e. water content in early spring, contamination and digestibility) (Leaver, 1985; Lean *et al.*, 1995). Despite this evidence, overseas data suggested that the DMI for cows producing greater than 12,000 kg milk per lactation is poorly understood, and can vary between 4.4% and 6.7% of body weight (Chase, 1993).

2.4 Management Factors

Both strategic and tactical management decisions affect milk production. These are discussed in two parts. First strategic management, which determines overall farm policy, is discussed under the headings: stocking rate, drying off, winter feeding, calving, mating, mid and late lactation and replacement stock. Second the role of tactical management decisions, which are necessary for shorter term management of the farm system,is outlined.

2.4.1 Stocking Rate

Stocking rate, measured in cows per hectare, is probably the single most important factor contributing to the level of per cow and per hectare production on a dairy farm (McMeekan, 1961; Pringle & Wright, 1983; Holmes & Wilson, 1987). However, the expression of stocking rate as cows per hectare may conceal differences in the grazing systems present on New Zealand dairy farms (Holmes & Parker, 1992; Crawford, 1994[b]). An appropriate measure of stocking rate will then depend upon the type and number of stock on the farm, and the length of time they are on the farm, relative to the amount of pasture grown. Whether stocking rate is 'high' or 'low' for a particular property will depend upon the level of pasture grown and for this reason the 'optimum' stocking rate will be unique for each farm (Pringle & Wright, 1983; Holmes & Parker, 1992).

The upper limit to stocking rate for each farm is a function of the management system, pasture production, soil characteristics and the farm's physical size and the layout of it's resources such as milking shed, and races and yards (Parker, 1993[b]). Any variation to stocking rate will affect: milk production (per ha and per cow); reproduction; animal and farmer health; milking routines (Pringle & Wright, 1983); and finally lactation length (Parker, 1993[b]). A theoretical maximum stocking rate of 5.28 cows per hectare has been calculated (Holmes & MacMillan, 1982). However, optimal stocking rates of 4 cows per hectare for 'self contained dairy units' where all stock including calves and heifers are retained 'at home' or five cows per hectare where 'other' stock are grazed off the farm were derived by Crabb & Wilson (1983) and Pringle & Wright (1983).

Changes to stocking have generally had little effect on early season milk production, but farms with lower stocking rates in the second half of the season (after 1 December) generally achieve higher per cow production (Gordon, 1979; Holmes & Parker, 1992). The desire to minimise pasture wastage, particularly during late spring-early summer, has lead to increased stocking rates (Gordon, 1979; Pringle & Wright, 1983; Parker 1993[b]). Thus, high pasture utilisation has been achieved by relying on hungry cows consuming the pasture made available, and this is reflected in low (240 - 270 kg MS) per cow milk yields and low (4.0 - 4.5) body condition scores. Achieving low rates of pasture wastage at low (> 2.4 cows / ha) stocking rates, with well-fed high producing cows may result in changes to, and rely on, skilful management (Holmes & Parker, 1992).

2.4.2 *Drying Off*

The last day of milking or `drying off date' is important, especially on high stocking rate farms, because of its influence on: pasture growth (both winter and spring), cow condition, and the amount of pasture cover on hand at the commencement of the new season, and therefore the new season's milk production (Wilson & Davey, 1982; Holmes & Wilson, 1987; Gray *et al.*, 1994) (Figure 2.2).

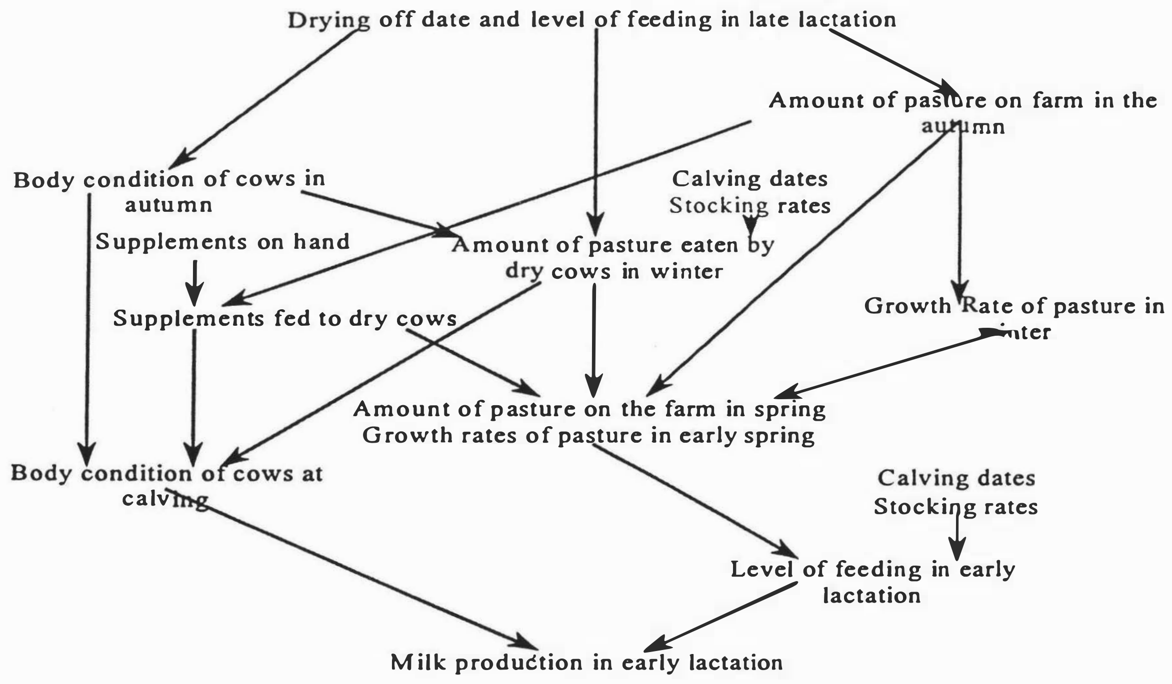

Figure 2.2 The selection of drying off date and late lactation feeding levels and the influence on and interrelationship of factors that influence milk production early in the following lactation (adapted from Holmes & Wilson, 1987).

Due to the cyclical nature of seasonal dairy farming and the interrelationships of these factors the selection of the 'correct' drying off date is important (Grimmett, 1986). The 'correct' drying off date ensures an appropriate balance between current and forthcoming production per lactation, changes in cow body condition, and farm pasture cover at the planned start of calving (Holmes & Wilson, 1987; Gray *et al.*, 1992; Gray *et al.*, 1994).

Factors affecting the selection of drying off date include: pasture growth rates in late lactation (Holmes & MacMillan, 1982); the amount and form of the winter feed available; as well as the condition score of the cows (Parker *et al.*, 1992; 1993). However, the drying off date has less significance where cows are grazed off the property, or low stocking rates are maintained (Bryant, 1982) because these strategies remove or reduce winter feed demands. A condition score of 4.5 at drying off has been suggested as adequate for New Zealand cows (Holmes & Wilson, 1987; Bryant, 1990). Because lactating cows gain weight more efficiently than dry cows, it is desirable to have cows at their calving condition score before drying off rather than increase condition over the winter (Clark & Davis, 1980; Bryant, 1990). As higher condition scores (4.5 - 5.0) at calving result in increased milk production (55 kg MS/CS), it is important to achieve recommended CS (Bryant, 1982; Grainger *et al.*, 1982; Johnson & Tran, 1990). The New Zealand condition score guidelines for dairy cows appear to be based on the need to balance the fact that most cows need to gain weight over the winter period with that of saving pasture to fully feed cows post-partum at the start of next season. Farmers in the US are able to hold cows at a higher CS profile as they do not rely on the need to conserve pasture during the winter (Muller, 1993). However, Edwards (1994) suggested that higher condition scores (5.5) at calving enable cows to maintain higher milk production even during periods of feed shortages.

2.4.3 Winter Feeding

Winter management affects milk production for two important reasons. First, the cows must be fed sufficiently to reach (or maintain) cow condition and liveweight targets (Section 2.4.2). Second, and of particular importance if the cows remain on the farm during their dry period, sufficient pasture cover must be accumulated on the property by the planned start of calving to fully feed the cows post-partum (Bryant, 1984). The amount of pasture that can accumulate will depend on factors influencing pasture growth (Section 2.2.1), grazing management, and winter stock numbers. Where cows are grazed on the farm benefits can be gained from a slow (long) winter rotation, and accumulating pasture ahead of the cows for use in early lactation (Bryant & Cook, 1980). Bryant & MacDonald (1983) and Bryant & L'Huillier (1986) suggest these benefits related to the amount of pasture on hand rather than an increase in total milk production, although increases in per cow performance due to the extra feed on hand did occur. However, Clark *et al.*,

(1994) reported inconsistent affects on pasture productivity, composition or milk yield from different wintering options, although simulation models showed increases in milk production if cows were to be wintered off if September pasture cover was predicted to fall below 1,750 kg DM/ha. This suggests that it is more important to fully feed cows after calving than be concerned about the length of the winter rotation and is consistent with Bryant (1984).

Although there is a positive relationship between the amount of pasture on hand at planned start of calving and milk production, care must be taken to avoid excess amounts of pasture at this time (Bryant, 1982). Thus a compromise should be reached between the amount of pasture on hand, it's quality and it's ability to recover after grazing (Bryant & Cook, 1980; Hodgson, 1990). In addition, the ability of the farmer to match feed demand with feed supply, the amount of autumn-winter saved pasture available, and the condition of the cows at calving, also affect milk production (Holmes & Wilson, 1987; Holmes, 1993[a]), by enabling greater utilisation of rapidly growing pastures and maximising lactation length (MacMillan *et al.*, 1984; Holmes, 1986, 1993[b]).

2.4.4 Calving

Calving date and calving pattern significantly effect herd milk production (MacMillan, 1976). To achieve 'optimum' milk production levels cows in seasonal, spring-calving, dairy herds generally calve over a ten week period (range six to 16) in the late winter and early spring (MacMillan *et al.*, 1984; Simmonds, 1985). However, to maximise production cows should be calved over a six week period (MacMillan *et al.*, 1984).

Calving usually starts before pasture growth rates (supply) exceed herd feed demand (Holmes 1987[a]). Calved cows require autumn-winter saved pasture to ensure *ad lib* feeding. Cow DMI increases until they reach peak production 6 - 8 weeks after calving (Stabus, 1986). By this stage pasture growth should at least match herd feed demand, otherwise arrangements to provide additional saved or supplementary feed should be made. Maximum feed demand of the herd does not occur until 10 - 12 weeks after the start of calving. The 'optimum' calving date (planned start of calving [PSC]) therefore differs from farm to farm and region to region and is dependent upon: stocking rate, pasture growth, pasture composition, and farmer attitude to risk (Holmes &

MacMillan, 1982; Paul & Benseman, 1983).

The effect of calving earlier is to place more pressure on autumn-winter saved pasture, and risk feed shortages prior to the spring growth period. However, providing the cows can be fully fed, milk production increases of up to 24 kg MS/cow can be achieved by calving the herd 16 days earlier (Simmonds, 1985). Data presented by Holmes (1986) suggests that calving dates of New Zealand herds moved towards later (approximately 19 days) dates from the 1950s to early 1980s. This has been reversed in recent years and there has been a return to earlier calving dates, largely supported by a willingness of farmers to introduce supplementary feed to overcome early lactation feed shortages. It is imperative to fully feed dairy cows in early lactation as losses of up to 118 kg MS reductions in per cow performance have been reported during the first 60 days of lactation where cows are underfed (Stockdale *et al.*, 1981).

There is a positive relationships between the amount of pasture on hand at calving and milk production levels (Bryant, 1982; 1984), this is despite the risks of lower MD, and lower post-grazing pasture growth rates of autumn-winter saved pasture. Not only does the extra feed available at the planned start of calving increase early lactation milk production (4 - 11 kg MS / cow), it also improves the cow's return to oestrus after calving (1 day earlier /kg DM/day extra feed available). In addition, early return to oestrus will also affect the level of milk production in subsequent seasons. Part of the increase in milk production from the amount of pasture on hand at the start of calving is related to the amount of liveweight that needs to be mobilised by the cow to aid production early in lactation (Kellaway & Porta, 1993).

To obtain high milk yields (1.4 - 1.7 kg MS/ day) soon after calving, and reduce the incidence of metabolic disorders, it is vital to ensure the condition of the cows at calving is adequate (at least 5.0) (Clark & Davis, 1980; Grainger *et al.*, 1982; Johnson & Tran, 1990). Bryant (1984) suggested a condition score of 4.5 to 5 as the 'optimum' level, some authors suggest 4 to 5 as being adequate (Holmes & Wilson 1987) whilst others, (Johnson & Broster, 1980; Kellaway & Porta, 1993) suggest that condition scores of greater than 5 are needed to allow cows to mobilise fat reserves without being subjected to metabolic disorders. However care needs to be taken as there may be some deleterious effects of 'over-fat' or 'over conditioned' cows at calving as anecdotal evidence suggests that there may be some susceptibility to hypomagnesaemia and hypocalcaemia in over-fat dairy cows (i.e. condition score > 6) (Stabus, 1986; Brookes, 1993 pers. comm.). However, cows in good condition (> 5.0 CS), but not overweight, will yield up to 18 kg MS per annum per additional condition score at calving and will return to oestrus up to 5 days earlier than those below 4.0 CS (Holmes *et al.*, 1993[b]).

One of the most important effects of calving pattern, as measured by the median calving date, is the potential average length of the lactation of the herd and the affect on milk production (Holmes, 1993[a]). Provided sufficient feed is available to fully feed the herd, longer lactations of individual cows, and the herd, lead to higher the levels of per cow performance, and increased milk production (Holmes *et al.*, 1993[a])(Table 2.1).

Table 2.1 Effect of the herd calving pattern on average lactation length of the herd (source Holmes 1993[a]).

	"Average" pattern		Compact pattern	
Week of calving (start 1 August)	Percentage of herd calved	Days in milk before 1 May	Percentage of Herd Calved	Days in milk before 1 May
1	22	270	25	270
2	19	263	25	263
3	17	256	25	256
4	12	249	25	249
5	9	242		
6	9	235		
7	5	228		
8	5	221		
9	2	214		
Weighted average		252		260
Median calving date:		22 August		14 August

A condensed calving pattern can be achieved by inducing cows to calve early (Johnson *et al.*, 1981). The use of Corticosteroids (Day, 1977; 1979; MacDiarmid, 1983[a]; 1983[b]) for this purpose is common in 90% of New Zealand dairy herds (MacMillan, 1992). However, the use of induced parturition as a means of reducing calving spread decreases the cow's production for the current lactation, increases the incidence of reproductive diseases, and increases animal health costs, and often does not prevent the cow from being induced in subsequent lactations (MacDiarmid, 1983[b]). It is more advantageous to the dairy farmer to pay close attention to their feeding and mating management in order to achieve, and maintain, a condensed calving pattern, than to rely on the use of induced calving.

2.4.5 Mating

Herd mating performance is an important contributor to the achievement of a condensed calving pattern and increased milk production of the herd. The cow's reproductive tract requires 30 - 60 days for involution of the uterus, repair and shrinkage before oestrus can recommence (Jainudeen & Hafez, 1987; Brightling, 1985). As gestation length is 282 days, the dairy cow must be ready to conceive within 83 days of parturition if the same calving date is to be achieved the following year.

A concentrated calving pattern, and associated increases in milk production, (providing the herd is able to be fully fed) will be achieved if five key targets of dairy mating programs are met (Holmes & Wilson, 1987). These are: a 92 % submission rate[2] by the end of week 4; a 100% submission rate by the end of week 7; a 90% pregnancy rate[3] by the end of week 7; a further 6% of the 10% not pregnant by the end of week 7 should get in calf during the follow up mating with a bull run with the herd (MacMillan, 1982). The achievement of these targets leads to a seasonally concentrated calving pattern and the production of sufficient heifer calves, for herd replacement and / or herd expansion programs (MacMillan, 1972, 1985[a]).

To achieve these objectives the dairy farmer must understand the reproductive cycle of the dairy cow and be able to recognise when a cow is ready to be mated (oestrus). In essence this requires effective visual observation of cows during the mating period (MacMillan & Smith, 1978;

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2 Submission rate is the proportion of total cows mated or inseminated.

3 Pregnancy rate refers to the proportion of cows that have not returned to oestrus and are assumed to be pregnant.

MacMillan, 1985[b]). This can be assisted by tail-painting or other heat detection aids (MacMillan, 1985[b]) and should be carried out at least 3 times a day (Jordan & Fourdaine, 1993). Cows with reproductive problems (i.e. those which do not return to oestrus) should be attended by the veterinarian for treatment. In addition, the mating period can be shortened by using prostaglandins for oestrus synchronisation (MacMillan & Smith, 1978; Upjohn, 1985; Britt, 1987).

2.4.6 Mid- and Late-Lactation (December to March)

Variations in pasture quantity and quality during this period of the year will result in variations in milk production levels, and cows should be as fully fed as possible (King *et al.*, 1980; Wilson & Davey, 1982). To avoid losses in milk production supplementary feeds can be introduced, at levels up to 50% of the diet, (King & Stockdale, 1981; 1982; Ridler, 1982; Phillips, 1994) during this period. In addition, the maintenance of condition score during this period is important if the following lactation's milk production is to remain unaffected (Rogers *et al.,* 1979; King & Stockdale, 1981).

2.4.7 Replacement Stock

The future of any dairy herd, and the ability of a cow to produce milk, relies on the breeding and rearing of good quality replacement stock. By Northern Hemisphere standards New Zealand replacement stock are small (Murphy, 1993), and target liveweights for two year old heifers at calving are over 100 kg lighter than those set in Ireland and France. As these target liveweights are often not achieved, milk production of heifers in their first lactation has been estimated to be only 62% of potential (Murphy, 1993).

To achieve maximum production in their first and subsequent lactations heifers should: calve at 2 years of age during the first six weeks of calving; have few calving difficulties; be back in calf in the first six weeks of mating (Bryant & McRobbie, 1991; Peno, 1994). These targets are achievable if heifers are as close to mature liveweights as possible when they enter the milking herd (MacKenzie & Brookes, 1992). However, few New Zealand data exist to assess the full lifetime benefits of increased milk production from rearing good quality livestock. McMeekan (1956) assesses 'well' and 'poorly' reared Jersey replacements and reported a 14 kg milkfat (24 kg MS) advantage to the 'well' reared heifers (0.3 kg fat/kg liveweight). A reduced effect was experienced in the second lactation and there was no effect by the third. Other estimates range from 0.11 kg fat/kg liveweight (Ahlborn & Dempfle, 1991) to 0.33 kg fat/kg liveweight (Wickham, 1990 cited by Bryant & McRobbie, 1991). Overseas analysis of milk production data has indicated that liveweight at calving had a small (8% of variation) effect on production for Friesian heifers (Thomas & Mickan, 1987). There was no significant effect for Jersey heifers, and size (height at wither and hips) had no effect for either breed. This contrasts with other reports which show correlations of 0.39, 0.29 and 0.22 for liveweight at calving and milk yield, 0.35 and 0.18 for milkfat yield and liveweight at calving, and 0.24 and 0.05 for height at withers and milk yield (Butendieck *et al*., 1977; Anacker *et al*., 1979).

2.4.8 Tactical

To implement the management strategies for the dairy farm, the farmer relies on tactical decisions to utilise the farm's resources to the best effect. Tactical management decisions are made to avoid seasonal shortages of pasture, ensure the dairy herd is properly fed and improve the herd's genetic quality. Effective tactical management of the farm's resources will be associated with the care and management of the herd for the prevention of disease and metabolic disorders. The role of tactical management therefore is to ensure the farm system performs to it's optimal level at all times.

2.5 Models of Per Cow Production

The factors that contribute to milk production on dairy farms have been discussed in sections 2.2, 2.3 and 2.4. Many of these (condition score, pasture cover, drying off date), particularly in New Zealand, have been studied in relation to high (< 3 cows/ha) stocking rates and per hectare production levels and little investigative work has been carried out on factors relating to per cow milk production. At a recent symposium, *Increased Production for Profit*, held as part of the Massey University Dairy Farmers Conference the principles and factors affecting per cow production on New Zealand dairy farms were outlined (Holmes *et al*., 1993[a]; Deane 1993).

The factors considered important by Deane (1993) were days in milk and production per day. Production prior to 31 December was considered important to avoid the effects of dry summers and autumns and this was influenced by calving spread and date. Production per day was influenced by soil fertility (particularly fertiliser application levels), winter spring management (with respect to levels of feed available to cows), pasture damage (the effects of 'block' vs 'strip' grazing), CS at calving (CS 5 *cf* 4), animal health (measured by somatic cell count [SCC]), cow quality (in terms of BI), and breed (e.g. the difference in per hectare production of Friesian, Jersey and Friesian x Jersey cross; see Section 2.3.2). No attempt was made to quantify the effects of these factors and Deane (1993) concluded, "*Research has identified many factors other than stocking rate which affect per cow performance. ... Before making the decision to reduce stocking rate on your farm, consider these other factors first. Unless they have been dealt with a reduction in stocking rate will reduce production and profitability*".

Holmes *et al.* (1993[a]) considered the principle of per cow production and noted that the New Zealand average yield of 280 kg MS/cow (range 70 - 580) was well below their genetic potential. However, under the current cost/price structure of the New Zealand dairy industry they concluded "*... feeding to achieve genetic potential is unlikely to be most profitable*". They identified the two important components of per cow production as days in milk and average daily milk production as illustrated, with sub-components, in Figure 2.3.

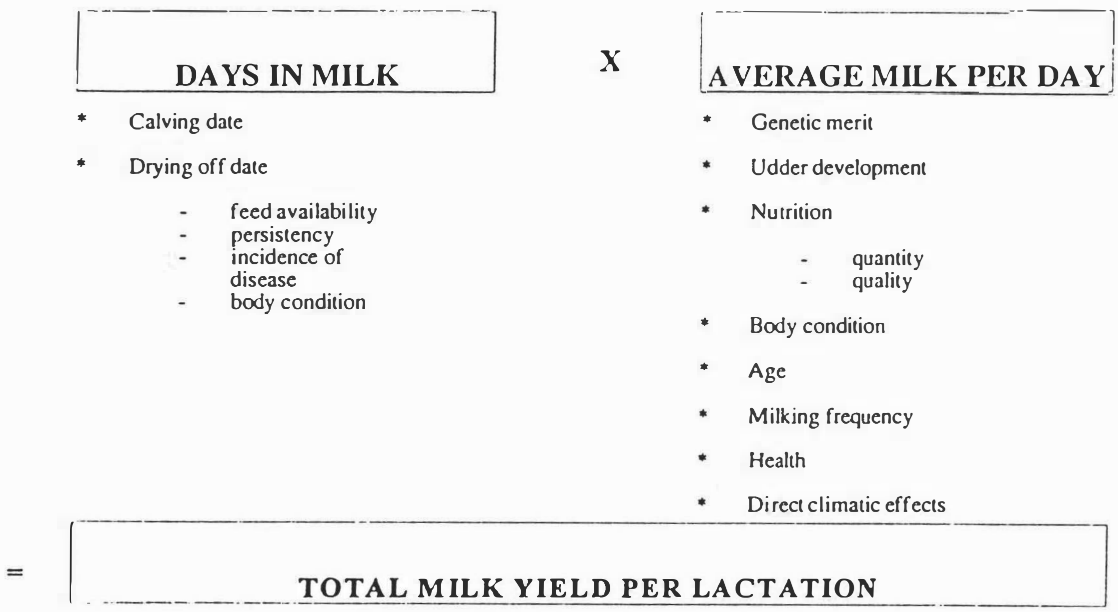


Figure 2.3 The main components of per cow milk yield (Holmes *et al.*, 1993).

Average milk per day was limited by the level of feeding under New Zealand pastoral conditions, the cows ability to produce (determined by genetic merit), udder development, health, and husbandry. Other principles discussed (but not modelled) included, heifer growth before first calving, feeding of cows, and management.

Although the factors and principles presented by Holmes *et al.* (1993[a]), and Deane (1993), as contributors to per cow production are undeniable, the way they are presented in Figure 2.3 does not represent the full nature of per cow production from pasture. To more accurately represent these factors, and those revealed during the literature review, the relationship between the factors needs to be explored further.

A revised model of per cow production

A more comprehensive model of per cow production (Figure 2.4) would show that daily milk yield is an expression of the potential milk production less the influence of walking distance (including time in holding yards), herd mate interaction (which influences the expression of genetic potential) , water supply, milking shed and milking management, parasite control, subdivision and races, and animal health. Furthermore, potential milk production is the combination of two elements, the potential ability of the cow to produce (genetic merit), which is phenotypically affected by rearing systems employed to get replacement stock to genetic potential (size and weight) and herd management practices which influence growth of heifers after calving, and the level of feed available (quality, quantity, type and nutrient balance). The level of feed availability is influenced by the amount of supplements on hand and the level of pasture production, which is in turn influenced by the level of fertiliser applied, soil conditions, pasture species and time of year. The cows ability to consume this pasture depends on the pasture management system employed by the farmer and the amount of, and frequency which, pasture is offered to the cows. Finally, the effect of climate on pasture conditions and growth direct influences the cow's desire to eat pasture and ability produce milk.

The model illustrates that days in milk is affected by two components. First, the difference between calving date and drying off date, for individual cows, and the averages of these dates for herd per cow averages. Second, climate (or at least extreme climatic conditions) will also effect the number of days in milk. The decision when to calve is dependent upon the amount of pasture, and supplements available, to meet the feed demands of freshly calved cows. The decision when to dry off depends upon the amount of pasture available to feed cows for milk production in the current lactation relative to that required to fully feed cows at the start of the next lactation. Other factors in the drying off decision include: cow condition, supplements available, expected climatic conditions in the future and daily milk production of the herd.

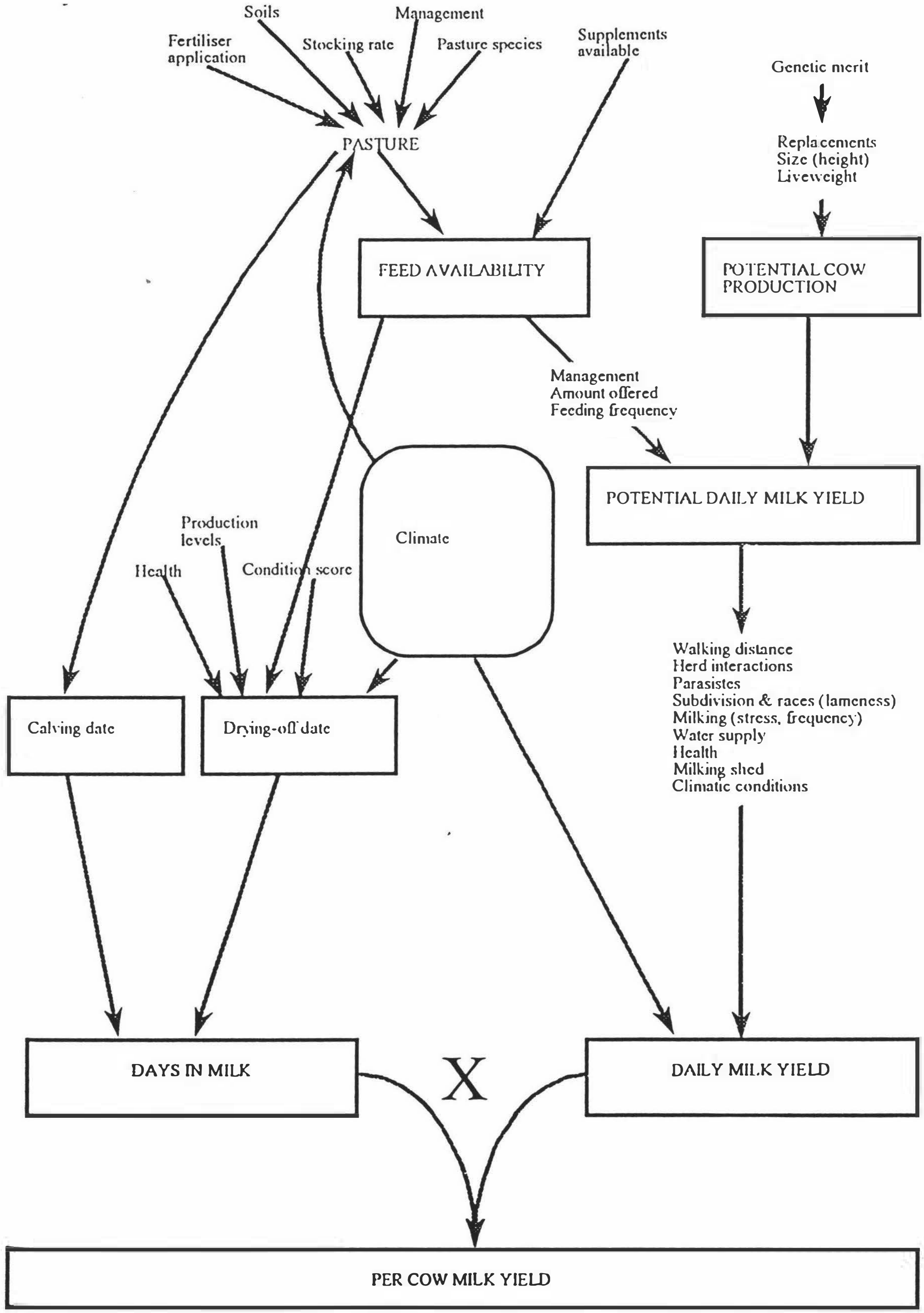


Figure 2.4 Theoretical model of per cow production developed from the review of literature

2.6 Summary

In this chapter those resource, animal and management factors which affect milk production on New Zealand seasonal dairy farms have been reviewed. From this review in which literature from New Zealand and overseas was studied a conceptual model of per cow production from a pastoral-based production system has been developed. This conceptual model was tested for validity by carrying out an in-depth study of farmers who consistently achieved high levels of per cow production on their farms. The method and results of this study are discussed in Chapters 3,4 and 5 and comparisons between the conceptual model and the literature are discussed in Chapter 5.4. Conclusions from the study and suggestions for future research are drawn in Chapter 6).

3

Selection and Design of Research Method and Telephone Survey

Chapter 3 Selection and Design of Research Method and Telephone Survey[4]

3.1 Introduction

Choosing an appropriate research method and design are critical phases of any research project (Miles, 1979; Sandelowski, 1986; Patton, 1990). The research method selected is a function of: the research objectives, i.e. the research questions to be answered; the degree of control the researcher requires over the events to be studied; and the type of data to be collected (Yin, 1994). The research design should ensure that the data necessary to fulfil the research objectives are collected.

In this study the research method and design needed to answer the question - *'How do seasonal supply dairy farmers consistently achieve high per cow production?'* Factors considered in the selection and design of the research method are discussed in Sections 3.2 and 3.3. The identification of farmers and the factors used to select farms for in-depth study is discussed in Sections 3.4 and 3.5.

3.2 Research Method, Design and Selection

3.2.1 Research Methods Available

In the first instance the choice of research method is dependent upon the types of question raised by the research problem. Yin (1994) defined five broad types of research question - *who, what, where, how,* and *why* - and suggested that each could be answered by different research methods

[4] Parts of this Chapter are published in Crawford, H. K.; Gray, D. I.; Parker, W. J.; Edwards, N. J. 1995. Characteristics of seasonal dairy farms achieving high per cow production in the lower North Island of New Zealand. *New Zealand Society of Animal Production* 55:72-76.

(Table 3.1). Experiments, surveys, archival analysis or case-studies, can be used to answer exploratory *'What'* questions, i.e. *'**What** are the outcomes of a particular management decision?* Surveys and archival analysis can also be used to answer exploratory questions of the type *'how many'* or *'how much'*, e.g. *'**How many** cows did you milk in 1992/93?'* and *'**How much** land do you have?'* Survey methods can also address *'Who'* and *'where'* exploratory questions through direct questioning of farmers, or by analysing statistical records and other secondary data sources. Although case-study methods also answer these questions, the size of the sample and the cost of case-study investigations often make them a less effective way of carrying out the research. However, case-study, or experimental methods are favoured for answering *'how'* and *'why'* questions that are explanatory in nature, and that deal with more than the frequencies of events. In addition, the case-study method is favoured where in-depth information is needed on how or why something is done, (e.g *'**How** do you manage your farm during the period 1 August to 30 October?'* or *'**Why** do you ensure there is 2,000 kg DM / ha at calving?).'*

Table 3.1 Relevant situations for different research methods (adapted from Yin, 1994).

Methods	Proposed research question	Requires control over events?
Experiment	how, why, what	yes
Survey	who, what, where how many how much	no
Archival analysis	who, what, where how many how much	no
Case-study	how, why	no

The second factor when selecting an appropriate research method is the degree of control required over the behaviour of the people studied. This is especially important when determining cause and effect relationships. Control is required to ensure that the effect of one variable on another is able to be determined accurately. In other words the possible influence of other variables either needs to be accounted for or removed by the experimental design (John, 1971; Hedrick *et al.*, 1993).

Although, control over sources of variation is desirable when comparing factors within disparate groups, in this study *'control'* was neither required nor desirable because the study focussed on what farmers did in their natural setting. However, it was important to obtain data on as many variables that could influence milk production per cow as possible, in order that an explanatory model could be devised.

3.2.2 Suitability of Research Methods

In this study in-depth answers to the question *'How do seasonal supply dairy farmers consistently achieve high per cow production?'* were required. Experimental methods were therefore not suitable for this study because the focus was on what farmers actually did. In addition, no form of control needed to be imposed on the farmers. Although the use of survey methods would answer the *who, what* and *where* questions, which would be important for obtaining background information about the characteristics of the farms, they were not suitable for generating the detailed information on the management processes used by the farmers (e.g. *How did farmers manage their herd from calving until mating*?). In addition, the *how* and *why* questions could not be answered in sufficient depth using mail or telephone survey methods. Likewise, archival analysis can provide historical data, but they may not provide relevant information on what farmers are doing in terms of management decision making. Case-studies, on the other hand, could provide the data required.

The case-study method, defined as "*...a research strategy which focuses on understanding the dynamics present within a single setting*" (Eisenhardt, 1989), generally results in an in-depth study of particular case(s) (site[s]). As well as answering the *who, what* and *where* questions the case-study method would also answer the *how* and *why* questions (Yin, 1994; Gummesson, 1991; Silverman, 1993). At the same time, apart from the selection of a sample of a specific farming type, i.e. seasonal dairy farms producing more than 350 kg milksolids (MS) over three years, current management systems could be investigated in their natural setting, individual farms could be viewed, and farmer comments interpreted, within the context of their 'real' world.

The case-study method was also selected because Eisenhardt (1989) argued that case study research was suited to new research areas, and for developing theories. This study focussed on understanding how high per cow production was consistently achieved - an area that had not previously been extensively researched.

3.3 Design of Research Method

Before selecting the case-study design it is necessary to address the question '*What is a case?*' (Ragin, 1992; Vaughan, 1992). Comparative social science has a conventional answer to this question; '*Boundaries around places and time define cases*' (e.g. seasonal dairy farms, autumn 1992). In this study, a 'case' was defined as **'a seasonal supply dairy farm (bounded by the resources needed for the farm to operate, usually the farm boundary and run-off) which had achieved an average per cow production of greater than 350 kg MS/cow for the period 1990/91 to 1992/93 in the Tui Milk Products Ltd supply area'**. The research method for this study needed to be designed to obtain as much information about how high per cow production was achieved on these farms (cases).

Case-studies can be designed to involve single, or multiple, examples of a phenomenon. In addition, the case, or cases, can be studied as a whole or by multiple-level analysis (i.e. the use of sub-units within cases to replicate data analysis) (Eisenhardt, 1989). Research involving a single case, similar to a single experiment, is used when the case: can test a well-formulated theory; represents an extreme or unique situation; may reveal facts about a phenomenon previously unable to be studied; or, can be used as a lead-in to further research. The use of a single-case is common when dealing with rare clinical disorders where the study of a single incidence may provide valuable insights into the disease. However, single-cases need to be selected carefully to ensure that the case represents the phenomenon being investigated (Yin, 1994).

Multiple-case case-studies, on the other hand, are particularly useful where it is possible that different solutions to the same problem may exist. Cases are selected to show the range of solutions that exist. Multiple-case case-studies may also be used to replicate findings and therefore increase the robustness of the research (Yin, 1993). The cases can be selected so they will show similar solutions, and thus replicate findings, or so they will show a range of theoretically explainable solutions, and thus also replicate findings (Yin, 1994).

A second consideration, when designing case-study research is the type of data analysis to be carried out. This can involve either holistic or embedded analysis. The former is advantageous when no subunits or subgroups within individual case(s) can be identified. In this situation, the case is analysed as a whole. The latter involves the selection of a number of different subunits or subgroups, i.e. roles, locations, proceedings, or periods of the year, and examining these within the context of the case(s), both within and across cases (Yin, 1994) (Figure 3.1).

		Single case designs	Multiple-case designs
Holistic	(single units of analysis)	TYPE 1	TYPE 2
Embedded	(multiple units of analysis)	TYPE 3	TYPE 4

Figure 3.1 Basic types of designs for case studies (Source: Yin, 1994).

A multiple-case design was selected for this study, because it was assumed that there would be a range of ways in which farmers could achieve high per cow production, and this would enable the different farm management processes used by farmers to be identified. Embedded-analysis was selected because a number of subunits could be identified within each case (e.g. cattle feeding systems, herd management, and pasture management).

3.4 Identification of Cases for In-depth Study

As explained previously (Chapter 1; Section 3.3), cases for in-depth study were selected from farms consistently achieving high per cow production. Because farms achieving an average of at least 348 kg milksolids per cow represent less than 1% of New Zealand seasonal dairy (LIC, 1991), it was expected that these criteria would identify approximately twelve farmers from the TMPL supply base and that an in-depth study of the whole population could be carried out. In fact, TMPL records showed that 31 (2.67%) farmers, from 1162 suppliers, met the case criteria.

Insufficient information was available about these farmers to develop selection criteria to draw a sub-sample of ten farmers for in-depth case-study. A telephone survey was therefore developed to obtain descriptive information about the farmers, their farms and herds, and the farm inputs that they used. A telephone survey was chosen, rather than a mail survey, because the population size was small, the information was required quickly, the researcher was trained in telephone survey techniques, and a high response rate was likely (Fowler, 1993). Furthermore, it provided the researcher with person-to-person contact with the farmers, and this initial contact helped establish an understanding for later in-depth interviews.

3.4.1 Telephone Survey

Questionnaire Design

The questionnaire was designed to obtain information about the characteristics of the 31 farms identified as having high per cow production (Appendix 2). Factors identified from the literature (Chapter 2) as being important contributors to high per cow production were included in the questionnaire in three broad sections: resources, management strategies, and farm inputs (Table 3.2).

Table 3.2 The division of factors contributing to high per cow production.

Important Area	Contributing Factors
Resources	Soil fertility Pastures Climate (climatic zone & location) Herd breeding index Water supply Subdivision and races Farm size (walking distance, herd interaction) Breed of cow Herd size (herd interaction)
Management strategies	Stocking rate Animal health Calving date, drying off date Lactation length (days in milk) Grazing management (cover at calving, feed available) Replacement rate & breeding management Lactation persistency Young stock (herd replacement size and weight)
Inputs	Supplements fed Fertiliser inputs (nitrogen & phosphate) Feed bought in vs feed grown on farm Genetic improvement (breeding, AI)

Questions about farm resources focussed on the land and soil fertility; the latter identified as an important contributor towards per cow production (Section 2.2.3). The former, although not by itself important, was perceived to have meaningful linkages with herd interaction, walking distances and other environmental factors (Section 2.2.4). The questions about the herd resource focussed on, breed, breeding index (BI), (Section 2.3.1), herd size, and replacement rates (Section 2.4.5). The employment of labour outside the farm family was considered an important issue because of its potential links to profitability and the handling of the cows. (Section 2.2.4). The employment and management of labour has received much less emphasis that other aspects of herd management in dairy farming literature, but nevertheless, the employment of labour has affects on milk yields, herd health and overall profitability (Umphrey, 1992; Umphrey *et al.*, 1995).

Information collected to measure herd performance included past production levels, and information about calving and drying off dates, (which would be used to calculate lactation lengths and calving patterns); (Section 2.4.2. and Section 2.4.4). In addition, information on the use of AI was obtained and included how long it was used and the genetic merit of the bulls used (Section 2.3.1).

Questions about the level of inputs used were asked on the rate, and type, of fertiliser applied, because soil fertility influenced pasture growth and therefore, indirectly, milk production (Section 2.2.2). Data on the level of supplements, including concentrates fed to cows and the use of off-farm grazing was obtained, because additional feed could impact on lactation length and per cow milk yields (Section 2.2.1). Additional questions about special pasture species, topping of pasture, and any minerals fed to cows were included because these items could influence the quantity and quality of the feed supply (Section 2.2.1).

Finally, in order to gain an impression about the characteristics of farmers achieving high per cow production, questions were asked about their overall farming goals and personal circumstances. The farmer was also asked to comment on factors that they considered limited milk production on their farms and their goals for milk production.

Time constraints on the telephone survey prevented the author asking in-depth questions about factors such as young stock management and grazing management policies. However, performance data was also collected from the farmers to cross-check with that obtained from TMPL records.

Pretest

The telephone questionnaire was pretested on two local Manawatu farmers. Five questions were altered due to difficulties in recalling information about the age structure of the herd, milk production levels for previous years (more than two), annual applications of fertiliser and the harvesting of supplements.

Implementation

The questionnaire (Appendix 2) was administered in May 1994, and 30 (97%) of the eligible farmers responded. Of these, 18 farmed on the eastern side of the Ruahine / Tararua ranges, within an area from Southern Wairarapa to Dannevirke, and 12 farmed on the western side, within an area from Foxton to Kimbolton (Map 2). The response rate was improved by phoning farmers at a more convenient time if they were busy at the time of initial contact.

Data was coded and entered into the SPSS/PC program for analysis. Some data, such as calving and drying off dates, were modified[5] to enable statistical analysis to be carried out. The information collected about supplementary feed data was converted to pasture DM equivalents assuming that dairy cows grazed-off the farm consumed 6 kg DM/head/day (MAF, 1987), each bale of hay contained 15 kg pasture DM (MAF, 1987), and grass silage comprised 27% pasture DM equivalent (Lean, 1987). Other assumptions included, a response rate of 10 : 1 for applications of nitrogen based fertilisers (Flemming & Burtt, 1991), crop yields of 10,000 kg DM/ha equivalent[6], and concentrates fed to dairy cows were converted to an energy value of 10.8 MJ ME/kg DM (Lean, 1987). Lactation length was calculated from the median calving date until the last day of milking. The effective milking area of the farm was adjusted for the period when young stock (rising 2 year heifers) were grazed on the farm assuming that a rising 2 year heifer consumed 2,083 kg DM/ year (Crawford, 1994[a]). Fertiliser application rates were analysed and converted to equivalent quantities of phosphate, nitrogen, sulphur and potassium (Burtt & Flemming, 1992)to facilitate between farm comparisons.

Data obtained via the survey and TMPL records were subjected to simple descriptive statistical procedures (frequencies and correlations) to determine relationships between input and resource variables, and per cow production. However, the production function for milksolids is clearly multivariate. Accordingly variables such as, peak milk production, herd size, effective milking area, supplements fed, herd BI and lactation length were subjected to backward stepwise multiple regression analysis (Parker, 1984; Townsley & Parker, 1987).

5 Calving dates and drying off dates were converted to numbers to allow a mathematical calculation of the intervals between selected events.

6 This figure was based on an estimate of dry matter provided by one of the survey farmers. The estimate is supported by evidence of crop yields from data provided by Daniels *et al.*, (1995)

3.4.2 Results

Farm Resources

The average age of the respondent farmers was 51 ± 11 (mean ± SE) years, with 31± 10 years dairy farming experience (Table 3.3). The average farm size of 81 ± 40 ha, included an adjusted milking area of 67 ± 38 ha. Half of the farmers owned or leased a runoff (average area of 71 ± 77 ha). The mean herd size of 164 cows (range 52 -515) was farmed at a stocking rate of 2.48 ± 0.43 cows per ha. Herds were milked by an average of 1.5 labour units (including the principle partner), equivalent to 113 ± 43 cows per labour unit. Farm production was 56,787 ± 27,415 kg MS or 881 ± 220 kg per ha. Average soil fertility measured by phosphate levels (Olsen P) was 28.4 (range 16 - 38) and mean soil acidity level (pH) was 5.9 (Table 3.3).

Friesian and/or Friesian x Jersey cows predominated and were present in 26 herds (87%). Jersey cows were present in 8 herds, and 4 herds comprised only Jerseys (Table 3.3). Ayrshire cross cows were present in 3 herds. Registered pedigree animals were present in 11 of the herds and 4 of these comprised 100% registered animals. The average BI for the 26 herds for which this information was supplied was 126 ± 6. Only two of these herds had a BI below 120.

Table 3.3. Characteristics of farmers and farms in the lower North Island where high per cow production was achieved and corresponding data for all suppliers to Tui Milk Products Ltd.

Characteristic	Survey data				Tui Milk Products Ltd	
	N [1]	Mean	SD	Range	All Suppliers	Top 1/4 of Suppliers
Farmer age (male) (years)	33. [2]	51	11	33 - 84		
(female)(years)	25. [3]	46	7	33 - 61		
Farming experience (years)	30	31.3	10	13 - 60		
Farm size (ha)	30	81	40	30 - 230		
Effective area (ha)	30	67	38	27 - 203	75	62
Runoff area (ha)	15	71	77	3 - 320		
Herd size 1992/93	30	164	87	52 - 515	172	192
Breeding Index (BI)	26	126.5	6	103 - 132		
Breed (% of herd)						
Friesian	16	92.6		50 - 100		
Jersey	8	68.2		1 - 100		
Friesian x Jersey	16	57.0		5 - 100		
Ayrshire cross	3	20.0		5 - 50		
Labour units [4]	30	1.5	0.73	1 - 4		
Cows per labour unit	30	113	43	54- 230		
MS production (kgs)	30	56787	27415	19,575 - 163,560	46,719	59,046
MS per hectare (kgs)	30	881	220	715 - 1545	651	950
Soil fertility Olsen P value	20	28.4	6.9	16 - 38		
pH levels	25	5.9	0.14	5.5 - 6.2		

[1] Number of responses

[2] The number of males includes other male partners where family partnerships consisted of other members of the family.

[3] One of the farms owned by a family trust was operated by a husband and wife team.

[4] Includes principle partner's labour.

Effective milking area was positively associated with per cow production (r = 0.32) (Figure 3.2). Soil fertility was also positively and significantly (r =0.40**, P<0.01) associated with per cow production (Figure 3.3). Neither herd size (r =0.22); (Figure 3.4) or herd BI (r = -0.32); (Figure 3.5), was significantly associated with per cow production. However, when farmers were questioned about the BI of their herds, seven farmers expressed concerned that the recorded BI did not reflect the performance ability of their herd.

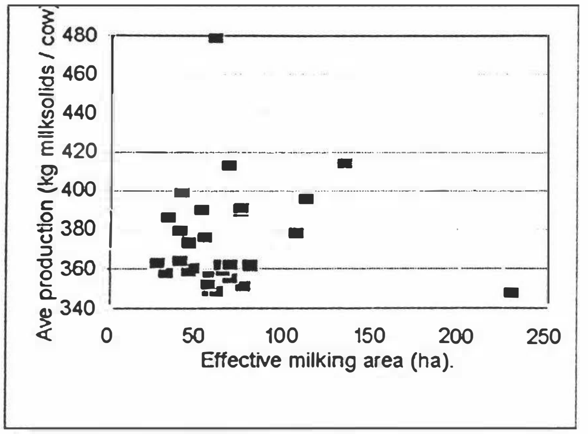


Figure 3.2 Effective milking area (ha) and per cow production (kg milksolids/cow).

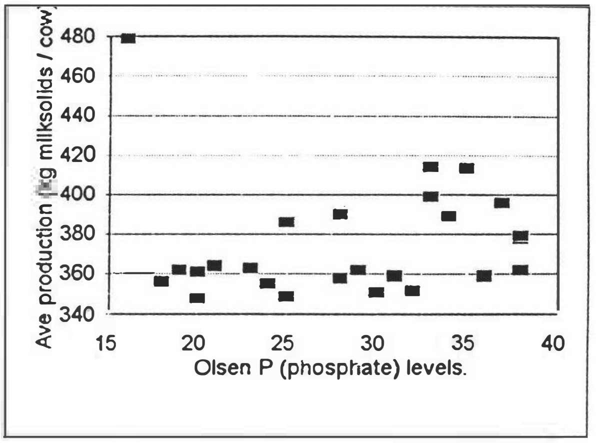


Figure 3.3 Soil fertility levels (Olsen P (phosphate)) and average production per cow (kg milksolids/cow).

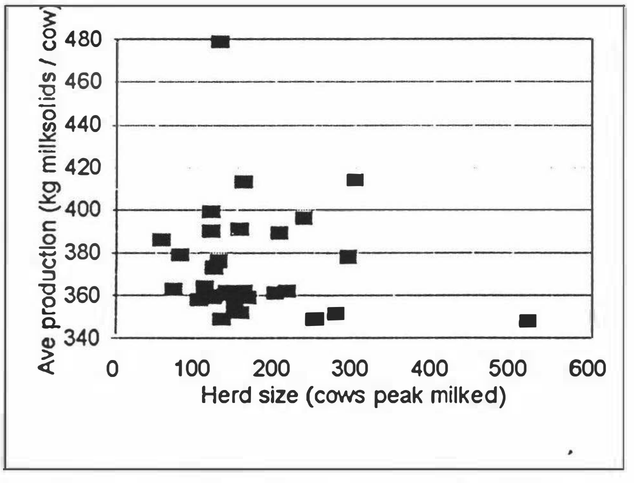


Figure 3.4 Average herd size (cows peak milked) and average per cow production (kg milksolids/cow).

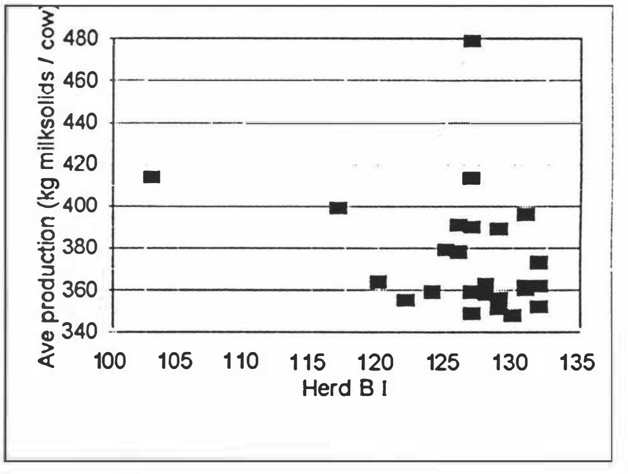


Figure 3.5 Herd BI and average per cow production (kg milksolids/cow).

Management

Milk production per cow averaged 386 ± 28 kg MS and was attained from a lactation length of 274 ± 6 days. Average peak milk production was 1.72 ± 0.16 kg MS per cow per day (range 1.46 - 2.09). The mean date for planned start of calving (PSC) was 29 July, and the median calving date (the date when 50% of the herd had calved) occurred 21 days after the planned start of calving. Calving spread averaged 72 ± 25 days, with the mean calving date (MCD) being

3 September. The PSC for farms on the western side of the ranges was 25 July compared to 1 August for farms in the east (Table 3.4).

Artificial insemination was used by all farmers with an average AI mating period of 6 ± 3 weeks. The total mating period was 13 ± 3 weeks. One farmer used AI for all matings whilst another only used AI when introducing new genetics to the herd, preferring to use home-bred pedigree bulls. The average BI of the bulls used for AI service was given as 145.

Overall annual herd wastage was 20.3 ± 6.5% and 4.03 ± 6.5% of the herd were culled for low production. The values for *replacement rate* and number of *low production* culls were distorted because 10 farmers had increased cow numbers during the study period. In addition, three farmers involved with sales of pedigree livestock had difficulty estimating the number of cows sold for low production. Care therefore needs to be taken when interpreting the herd replacement data (Table 3.4).

Table 3.4. Characteristics of dairy herds achieving high per cow production in the lower North Island and in the Waikato region (MacMillan et al., 1990).

Characteristic	Lower North Island				Waikato herds	
	N [1]	Mean	SD	Range	Mean (SD)	Range
Herd Size	30	164	87	53.5 - 512.5		
Milksolids per cow	30	386	28	348 - 479	274[6]	311[6]
Peak production per cow (kgs MS)	29 [3]	[4]1.72	0.2	1.46 - 2.09		
Lactation length (days)	30	274	10	250 - 299		
Calving dates						
PSC [7]	30	29 Jul		10 Jul to 20 Aug	5 Aug	23 Jul to 8 Aug
Median [8]	30	21	7	13 - 41	18 (3.5)	12 - 25
Mean [9]	30	3 Sept		17 Aug to 15 Oct	26 Aug	11 Aug to 5 Sep
Calving spread (days)	30	72	25	36 - 184	72 (17)	45 - 107
Mating period (weeks)	30	13	3	8 - 20		
A I Period (weeks)	29	6	3	0 [5]- 16		
BI of Bulls used	28	145	4	137 - 160		
Replacement rate (%) [2]	27	20.3	6.5	7.1 - 38		
Low production culls (%) [2]	29	4.0	6.5	0 - 32		

1 Number of farm responses.
2 See text.
3 Data for one farm system altered in 1993/94 was not included in these calculations.
4 Peak production per cow was calculated from the average daily production supplied to TMPL during October and November divided by the number of cows peak milked.
5 One farmer did not have a set A I mating period. Mating was carried out using home-bred pedigree bulls, with some AI being used to introduce new genetics into the herd.
6 Figures from Tui Milk Products Limited annual statistics
7 Planned start of calving
8 The number of days after PSC when 50% of the herd has calved
9 The mid point of the calving period.

The association between high per cow milksolids production with stocking rate was not significant and negative (r = -0.35). However, the relationship between stocking rate and production per hectare was positive and significant (r = 0.7***, P< 0.001); (Figure 3.6). Lactation length was not associated with high per cow production (r = 0.22); (Figure 3.7).

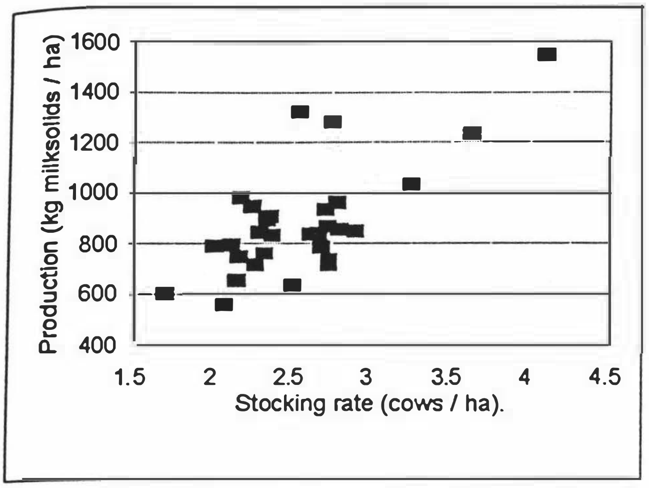


Figure 3.6 Stocking rate (cows/ha) and production per effective hectare (kg milksolids).

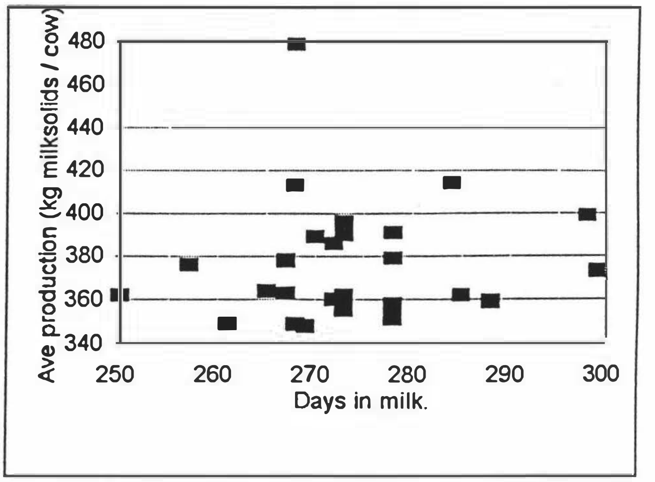


Figure 3.7 Number of days in milk (lactation length) and average per cow production (kg milksolids/cow).

Inputs

Fertiliser

Nutrients applied annually to each hectare of the milking area, irrespective of the type of fertiliser, were: 48 ± 33 kg of nitrogen; 47 ± 21 kg of phosphate, 56 ± 34 kg of potassium; and 45 ± 26 kg sulphur. Phosphate was the only nutrient applied by all farmers (Table 3.5). However, the annual application rate of phosphate fertiliser was not significantly associated with high per cow production (r = 0.10); (Figure 3.8). Fertiliser was more commonly applied in the spring and autumn, than the summer or winter.

Table 3.5. Soil fertility status and fertiliser use on farms achieving high per cow production in the lower North Island.

Parameter	N[1]	Mean	SD	Range
Olsen P level	20	28.4	7	16 - 38
Soil pH	25	5.9	.14	5.5 - 6.2
Fertiliser applied (kg/ha)				
Nitrogen	25	47.92	33	9.2 - 108.6
Phosphate	30	47.12	21	18.7 - 95
Potassium	21	55.8	34	22.5 - 110.4
Sulphur	29	44.68	26	4.2 - 107.5

[1] Number of farm responses.

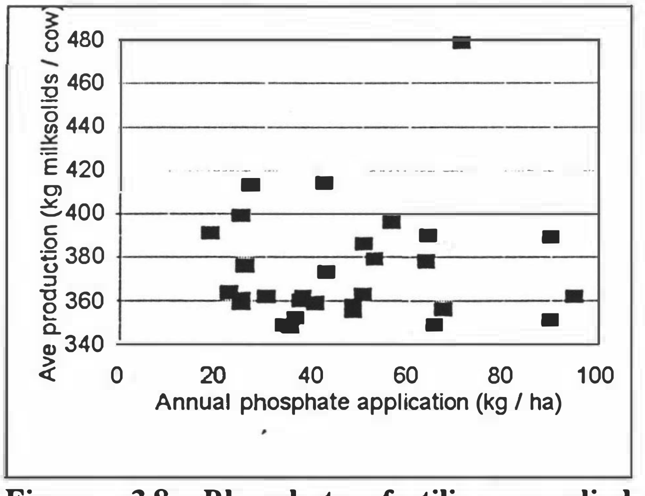


Figure 3.8 Phosphate fertiliser applied (kg/ha/annum) and average per cow production (kg milksolids/cow).

Grazing off and supplement use

All except six of the farmers grazed stock off the farm during the year. Milking cows were grazed off for an average of seven weeks by 18 farmers, and young stock were grazed off for an average of 44 weeks by 23 farmers (Table 3.6). Only 15 of the 23 farmers grazed their young stock off the property for the full year.

All farmers fed some hay to their cows and 17 farmers used grass silage in addition to hay. An average of 20 bales of hay per cow (estimated to be equivalent to 315 kg DM/cow) and 0.972 tonnes of silage per cow (342 kg DM/cow) were fed as supplements. In addition, extra pasture was grown due to applications of nitrogen on 25 farms (Table 3.6). Crops were grown by nine farmers (maize, kale, turnips or brassica) but, crop yields were unavailable except in one instance. The average area planted in crops was 3.4 ha. Concentrates, such as meal and barley, were fed to nine herds for all or part of the year. The average amount of concentrates fed per farm amounted to 61.5 tonnes (range 1.5 - 500), but this was reduced to 6.7 tonnes when one outlying farm, where concentrates were fed all year round, was removed (Table 3.6).

Table 3.6 Levels of annual feed inputs including, supplements, concentrates, crops and grazing-off on farms achieving high per cow production in the lower North Island.

Feed type (per year)	N [1]	Mean	SD	Range
Hay (bales)	29	3182	N/A	1,000 - 10,000
(kg DM / cow)	29	315	178	43.9 - 886.9
Silage (tonnes)	18	296	N/A	35 - 1760
(kg DM / cow)	18	342	243	51.1 - 801.9
Crops (ha)	9	3.4	3	1 - 10
Nitrogen response (kg DM / cow)	25	198	134	39.4 - 435.4
Concentrates (tonnes)	9	62 (6.7)[2]	N/A	1.5 - 500 (1.5 - 15)[2]
Grazing off (weeks)				
Cows	18	7	4	3 - 10
Young stock	23	44	13	8 - 52

[1] Number of respondents.
[2] Figures in brackets exclude one outlying farm.

The quantity of supplements fed per cow was not associated with per cow production (r = .13) (Figure 3.9), lactation length (r = 0.50); (Figure 3.10), effective milking area (r = 0.19), or stocking rate (r = 0.16).

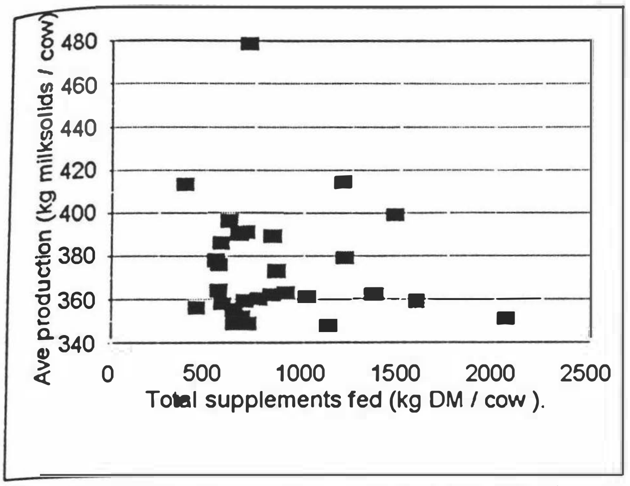


Figure 3.9 Total supplements fed (kg DM/cow) and average per cow production (kg milksolids/cow).

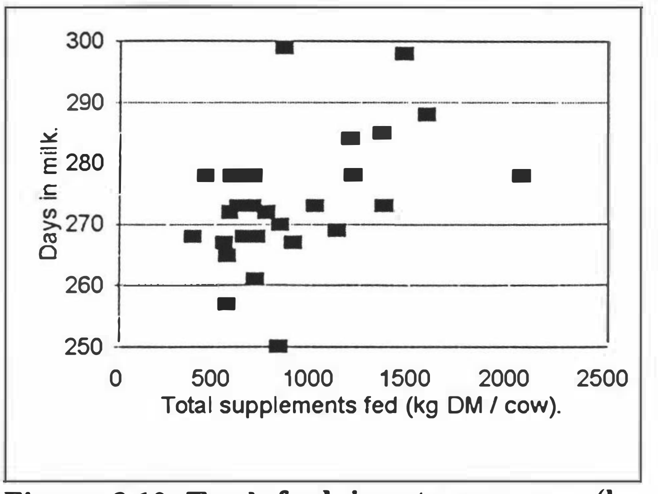


Figure 3.10 Total feed inputs per cow (kg DM/cow) and days in milk (lactation length).

Other inputs

Paddocks were topped regularly by 24 of the respondents to achieve pasture control and maintain pasture quality. Minerals and trace elements were used by 27 farmers. Selenium was the most common (n = 22 farmers), followed by magnesium (19) and copper (11). Other minerals and trace element supplements used were: Aloe Vera (2), molasses (1), zinc (1), cobalt (3), salts (4). A multi-mineral supplement was used by eight farmers which may have contained all or some of the aforementioned minerals.

Herd testing was carried out on 25 of the 30 farms. Eight weekly was the most common (16 farmers) followed by monthly testing (6), and six weekly testing (2). One farmer tested his herd twice a year.

Production Constraints and Farmer Goals

Climate, either due to variability or lack of summer or autumn rain, was considered to be an important constraint to farm production by 11 of the farmers (Table 3.7). Two farmers used irrigation in an attempt to overcome summer dryness. Soil constraints, such as fertility level or drainage/soil type were mentioned by 10 farmers. Pasture constraints were mentioned by eight farmers, with pasture species being the most common limiting factor amongst these farmers (6 farmers). Four of the respondents believed that they did not have complete or up to date technical knowledge about some aspects of management, and that this may have limited production on their farm.

Table 3.7. Factors identified by farmers limiting annual production on the high per cow production seasonal farms in the Tui Milk Products Ltd collection area.

Group Heading	Comment	Number of farms [1]
No Limiting Factors		5
Climatic		11
	Weather (general)	5
	Summer / Autumn dry	6
Resource constraints		24
	Pasture growth rates	2
	Pasture species	6
	Lack of fertility	5
	Drainage / Soil type [2]	5
	Topography (rolling)	2
	Labour	2
	Old plant	1
Herd constraints		9
	Cow numbers [3]	4
	Feeding levels [4]	1
	Stocking rate	2
	Lactation Length	2
Management constraints		4
	Lack of technical knowledge	4

1 Many Farmers gave more than one reason.

2 This reason was also associated with farm constraints where the wet winter / spring caused on farm pasture damage due to stock treading.

3 Low cow numbers in three of these cases related to other constraints that limited the number of cows able to be carried on the farm. The other case was from a high stocking rate farm aiming for increased production.

4 This farmer felt that the use of improved genetics over the years had produced cows that required more to feed to achieve high levels of production and that he was not able to feed his cows to enable them to meet their full potential.

In response to the question, "*What are your goals in relation to milk production?*" 25 farmers indicated that they related to per cow production, (e.g. "*Achieve over 200 kg milkfat per cow; Keep per cow production as high as possible; Aim for total production with high per cow production as the base*" (Table 3.8)). High per cow production was an aim of 21 farmers because of the satisfaction it's achievement provided when high genetic merit, healthy, dairy cows were well fed (Table 3.9). Twelve farmers saw high per cow production as a means to achieve high profits, lower costs and better utilisation of pasture for milk production. Four farmers adopted the goal of high per cow production because of resource constraints such as the size of the farm, the age of the shed or the inability to employ labour.

Table 3.8. Summary of goals relating to milk production on the high per cow production seasonal farms in the Tui Milk Products Ltd collection area.

Goal Category	Comment	Number of farmers [1]
Per cow production		25
	Aim for total production with high per cow production as the base	5
	Over 200 kgs per cow	8
	Aim for per hectare then per cow	3
	Keep per cow production as high as possible	7
	High production for stock sales	1
	Per cow rather than per hectare	1
Non per cow production		8
	Constant improvement	2
	To keep up with the neighbours	1
	As much as possible	2
	Increase per hectare production	1
	Use production to purchase a run-off	1
	Maintain production	1

[1] Some farmers had more than one goal.

Table 3.9. Summary of reasons why farmers have per cow production as a milk production goal on the high per cow production seasonal farms in the Tui Milk Production Limited collection area..

Heading	Comment	Number of farmers [1]
Satisfaction / Challenge		21
	Farming philosophy / Personal satisfaction	4
	Enjoy getting good production out of a good cow	2
	Getting high genetic merit cows producing well by good feeding	7
	Healthy stock / Look after cows	6
	Something to achieve / 200 kg a magical goal	2
Production and profitability		12
	Maximise production of the cow and profitability	5
	A plus when trying to sell	1
	Milking less cows for the same production, the same cost to milk a low producer as it does to milk a high producer	5
	Increase amount of dry matter used for milk production	1
Resource constraint		4
	Old shed	1
	Small size of farm	2
	'One man band', more cows too many	1

[1] Some farmers had more than one reason.

Regression Analysis

Results from the backward stepwise regression of factors contributing to milk production per cow were inconclusive. Two regression models were considered. The first contained variables, identified from the literature, that were likely to contribute to per cow production and those which had shown some univariate correlation (see Section 3.4.2), with high per cow production. Variables selected on this basis were: silage dry matter fed to cows, hay dry matter fed to cows, dry matter grown as a result of nitrogen applications, dry matter eaten per cow whilst they were grazing off the milking area, herd size (the average number of cows peak milked for 1991/92 and 1992/93 seasons), lactation days, annual replacement rate, calving spread, and herd BI (Table

3.10). After backward elimination only two variables, herd BI and annual replacement rate, remained in the model. This model (Table 3.11) accounted for 24.3% of the variation between case farms. However, data for herd replacement rates and herd BI were both tentative, first because of differences in farm life-cycle, i.e. several farmers were expanding their herds and replacement rates were distorted, and second because some farmers questioned whether their herd BI accurately reflected the productive ability of their herds (see Section 3.4.2).

Table 3.10 Simple correlation coefficients between variables included in the multivariate regression model (n = 23 case farms).

	SDM [1]	HDM	NDM	COWS	OFFDM	LACT	REPL	SPRED	AVE	BI
SDM	1.000									
HDM	-.115	1.000-								
NDM	.037	-.093	1.000							
COWS	.557	-.355	.244	1.000						
OFFDM	-.349	.016	-.155	-.205	1.000					
LACT	-.167	.676	-.068	-.104	.425	1.000				
REPL	-.363	-.155	.267	-.115	-.101	-.123	1.000			
SPREAD	.022	.432	.099	.158	-.291	.288	-.056	1.000		
AVE	-.222	.346	.175	-.137	-.039	.054	.259	.284	1.000	
BI	-.186	-.538	-.070	.104	-.013	-.478	.336	-.497	-.379	1.000

[1] SDM = Silage dry matter fed to cows, HDM = Hay dry matter fed to cows, NDM = dry matter grown as a result of nitrogen applications, COWS = herd size, OFFDM = Dry matter eaten by cows whilst they were grazing off the milking area, LACT = Lactation days, REPL = Annual replacement rate, SPRED = Calving spread, AVE = Average production per cow, BI = Herd BI.

Table 3.11 Regression model of variables associated with per cow milk production (n = 23 case farms).

Item	Coefficient	Student t value
Constant	382.265	5.591
Herd BI	-1.500	-2.666
Annual replacement rate	1.108	2.210
Adjusted R^2 value	24.287	
Residual Mean Square (df)	227.742	20

A second model, using variables contained in the first, but without herd BI and replacement rate, and including variables associated with improving herd BI, pasture production and animal feeding was tested. Variables in this model included: effective milking area, average herd size, number of labour units employed (including owner's labour), calving date (expressed as days after the first of January), drying off date (expressed as days after the first of January the previous year), length of AI mating period, average BI of the bulls used for AI mating, annual application of phosphate (kg/ha), annual application of sulphur (kg/ha), annual application of potassium (kg/ha), concentrate dry matter fed to cows, dry matter of crops grown, dry matter grown as a result of nitrogen application, hay dry matter fed to cows, silage dry matter fed to cows, dry matter eaten by cows when grazed off the milking area, lactation length, and average stocking rate (cows /ha based on cows peak milked). After backwards stocking rate, length of AI mating, annual application of sulphur, annual application of phosphate, dry matter eaten by cows while grazing at a run off, number of labour units employed and average herd size remained in the model (Table 3.12). This model accounted for 43% of the variation between farms with high per cow production (Table 3.13).

Table 3.12 Table of simple correlations between variables included in the second regression model (N = 26 case farms).

	AREA	COWS	LAB	CALF	LAST	AI	BLLBI	KGSP	KGSS	KGSK	SDM	HDM	CODM	CPDM	NDM	OFDM	LACT	RATE	AVEC
AREA	1.000																		
COWS	.955	1.000																	
LAB	.728	.781	1.000																
CALF	-.410	-.325	-.310	1.000															
LAST	-.370	-.312	-.114	.343	1.000														
AI	.099	.083	.218	-.427	-.137	1.000													
BLLBI	.281	.288	.041	.186	.369	-.366	1.000												
KGSP	-.072	-.006	.053	.471	-.082	-.362	-.114	1.000											
KGSS	.060	-.008	-.115	-.062	-.058	.073	-.246	.088	1.000										
KGSK	-.084	-.181	-.203	-.185	.008	.033	-.121	.010	.581	1.000									
SDM	.626	.583	.378	-.176	-.445	-.147	.184	.131	.107	.024	1.000								
HDM	-.285	-.381	-.102	-.291	.293	.171	-.096	-.250	-.103	.004	-.292	1.000							
CODM	-.062	.133	.392	.178	.147	.196	-.074	.362	-.312	-.284	.014	-.039	1.000						
CPDM	.016	-.058	-.112	-.438	.056	.013	.150	-.369	-.157	.163	.010	.143	-.170	1.000					
NDM	.243	.214	.330	-.106	-.387	.230	-.183	.296	.044	-.181	.137	.073	.314	-.383	1.000				
OFDM	-.289	-.167	-.028	.288	.427	.075	.087	-.185	.159	-.007	-.407	-.086	.151	-.229	-.162	1.000			
LACT	-.085	-.088	.159	-.463	.432	.315	-.010	-.267	.133	.118	-.211	.640	.163	.088	-.014	.240	1.000		
RATE	-.097	.186	.186	.209	.155	.026	.070	.117	-.179	-.290	-.093	-.368	.546	-.280	-.158	.466	.029	1.000	
AVEC	-.012	-.111	-.234	.030	.010	.004	.192	.190	-.157	-.100	-.210	.241	-.200	-.026	.241	-.139	.004	-.374	1.000

AREA = effective milking area, COWS = average herd size, LAB = number of labour units employed (including owner's labour), CALF = calving date (expressed as days after the first of January), LAST = drying off date (expressed as days after the first of January the previous year), AI = length of AI mating period, BLLBI = average BI of the bulls used for AI mating, KGSP = annual application of phosphate (kg/ha), KGSS = annual application of sulphur (kg/ha), KGSK = annual application of potassium (kg/ha), CODM = concentrate dry matter fed to cows, CPDM = dry matter of crops grown, NDM = dry matter grown as a result of nitrogen application, HBM = hay dry matter fed to cows, SDM = silage dry matter fed to cows, OFDM = dry matter eaten by cows when grazed off the milking area, LACT = lactation length, and RATE = average stocking rate (cows /ha based on cows peak milked) with AVEC = average per cw production.

Table 3.13 Second regression model for factors associated with per cow production (n = 26 case farms).

Item	Label	Coefficient	Student t Value
Constant		227.498	10.423
Average stocking rate (cows peak milked/ha)	RATE	-23.225	-3.211
Length of AI mating (weeks)	AI	2.041	1.975
Annual application of sulphur (kg/ha)	KGSS	-0.301	-2.967
Annual application of phosphate (kg/ha)	KGSP	0.523	3.635
Drymatter consumed by cows during grazing off (kg/hd/yr)	OFDM	0.048	2.525
Drymatter as hay consumed by cows (kg/hd/yr)	HDM	0.042	1.990
Labour employed on farm (including owner)	LAB	-21.219	-3.493
Average herd size (cows)	COWS	0.174	3.194
Adjusted R^2 Value		0.430	
Residual Mean Square (df)		139.332	18

The results suggest that milk production was most strongly influenced by stocking rate (which could be a proxy for the level of feeding) and the amount of labour used (i.e. production was best in owner-operator labour situations). Nevertheless, the data obtained thus far inadequately explains high per cow production, probably because incomplete information about the management techniques employed had been included. If these data were utilised a clearer picture may emerge, although, it is usually only possible to express management decisions crudely as dummy variables (Townsley & Parker, 1987).

Discussion and Conclusions

Many of the factors that the literature suggested were important contributors towards per cow production were recorded from the survey farms. However, the only univariate associations found to be significant were between soil fertility and high per cow production (r = 0.48, P<0.01), and stocking rate and production per hectare (r = 0.7, P<0.001; Table 3.14). This outcome may reflect the relatively small sample size and the narrow band of per cow performance within this.

Table 3.14 Important factors identified from the literature review and their respective correlations for farm data collected through a telephone survey of lower North Island dairy farmers.

Important factors	Correlation with per cow production (except where stated)	Comments
Effective area	0.32	
Soil fertility	0.48**	
Herd size	0.22	
Herd BI	-0.24	Some farmers were concerned about the accuracy of this measure
Stocking rate	-0.35	
Stocking rate	0.70***[1]	
Lactation length	0.22	
Supplements	0.13	
Supplements	0.50[2]	
Supplements	0.19[3]	
Supplements	0.16[4]	
Fertiliser applied	0.10	Uncertain reliability due to new areas of land purchased
Replacement rate		Difficult to determine due to herd expansions and sales of stock
Calving spread	0.15	

[1] Production per hectare
[2] Lactation length
[3] Milking area
[4] Stocking rate

Although high per cow production was positively associated with effective milking area, those farms with high per cow production had smaller effective milking areas, fewer cows and a slightly higher stocking rate when compared with the 'average' dairy farm supplying Tui Milk Products Limited. In contrast, when compared to farms in the upper quartile for production per hectare, - farmers often described as 'top' farmers-, the high per cow production farms were larger, but had smaller herds at lower stocking rates and lower production per hectare and per farm (Table 3.3).

The positive association between by Olsen P (soil fertility) and per cow production suggests that farms with higher phosphate levels will achieve greater milk output than those with lower phosphate levels, other things being equal. The survey results suggest that the base soil fertility level is more important than the amount of fertiliser applied and this is in agreement with results for Taranaki soil types (Roberts *et al.*, 1991; Thomson *et al.*, 1993).

The negative relationship between herd BI and per cow production is not consistent with published data (Broster & Alderman, 1977; Bryant 1982; Grainger *et al.,* 1985a; Grainger *et al.,* 1985b). The reason for this is not known, however some farmers suggested that their herd BI did not reflect their herd's overall performance.

The survey farms with high stocking rates achieved lower production per cow, probably because of less feed being available per cow (Holmes & McMillan, 1982). The strong positive relationship between stocking rate and per hectare production agrees with Deane (1993). The positive association between production per cow and lactation length mirrored the data for all Tui Milk Products Limited suppliers. The relationship between peak milk production and per cow production showed a strong positive association confirming the earlier reports by Clark & Davis (1980), Johnson & Broster (1980), and Holmes & Wilson (1987).

The lower North Island high per cow production farms had a mean calving-spread identical to that reported by MacMillan *et al.* (1990) for Waikato herds. However, median and mean calving dates were later than those for the Waikato herds most likely because of the differences in the timing of seasonal pasture growth. MacMillan *et al.* (1990) reported that 89% of the farmers induced at least one cow, whereas only 43% of farmers in the present study did so, and this factor may explain the longer calving spread.

Supplementary feeding was not significantly associated with per cow or lactation length, although the farmers who had fed higher levels of supplements per cow tended to milk their herds for longer (278 days *cf.* 268 days). Phillips (1994) indicated that the greatest benefits to supplements were likely to occur during the last third of lactation under New Zealand conditions and a consequence of this should be longer lactations. Supplementary feed was not associated with stocking rate, although, farmers with high per cow production maintained stocking rates slightly above the Tui Milk Products Limited average (Table 3.3).

The multiple regression analysis indicated that, no single factor stood out as having a large effect on per cow production except that the majority of farmers aimed to feed their cows as well as possible. High per cow production appeared to be achieved through a number of different systems and confirmed earlier assumptions that there were a range of ways in which farmers could achieve high per cow production. Using factors identified from the literature (Chapter 2), and the results of the telephone survey, a sample of farmers was selected to obtain the detailed information about the management systems that these farmers employed to achieve high per cow production (Chapter 4).

4

Case Study Method - Selection of Cases, Data Collection and Transcript Analysis

Chapter 4 Case Study Method - Selection of farmers, data collection and transcript analysis

4.1 Introduction

Although average per cow production in New Zealand seasonal supply herds is low by international standards, a small proportion of farmers consistently achieve high per cow production (LIC, 1992). Because no literature describing the management processes that these farmers use was available, it was necessary to talk directly with them. On the basis of national data (LIC, 1992), it was expected that approximately 12 farmers would be identified from the TMPL suppliers and that an in-depth study could be carried out on the whole group. However, an analysis of TMPL supply data showed that 31 farmers achieved high per cow production over the three years 1990 to 1993 (Chapter 3.4). Time constraints meant that not all of these farmers could be studied in detail. A sample of these farmers was therefore selected for an in-depth multiple-case case-study of their management strategies and philosophies.

The multiple-case case-study methodology, which is described in this chapter, requires several important steps to be carried out (Figure 4.1). First, a theoretical understanding of the domain to be studied needs to be developed (Chapter 2). Second, the process to select the case studies should be determined (see Section 4.2). Third, data collection and methods of data analysis need to be decided (see Section 4.3 and 4.4) and implemented (Section 4.5). Normally the initial data analysis, which provides a within-case understanding of the data, is followed by a 'between case' comparison to provide an overall interpretation of the data (Section 4.6).

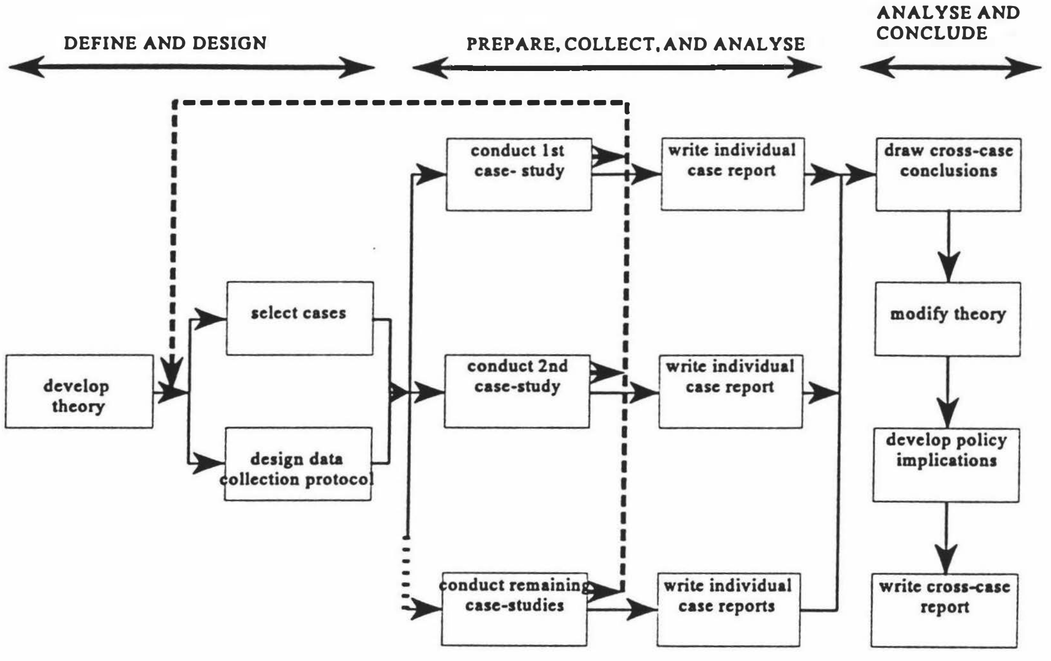


Figure 4.1 Case-study method involving multiple-cases (source: Yin, 1994).

4.2 Selection of farmers for case study

Sample selection strategies are divided into two broad categories, random and purposeful (Patton, 1990). Random sampling occurs when each member (case) of the population has an equal probability of being selected. Simple random sampling is used when generalisations are to be made about a population. Stratified random sampling or cluster sampling, as opposed to simple random sampling, is used when increased confidence is required for generalisations about sub-groups within the population. In contrast to random sampling, purposeful sampling strategies result in the deliberate selection of cases with specific attributes (Patton, 1990) to enable the researcher to learn about issues of central importance to the study.

The focus of this study was farmers who achieve high per cow production (see Chapter 3). The strategy used to select case-farms was a combination of theory based 'theoretical' sampling and 'maximum variation' sampling (Eisenhardt, 1989; Patton, 1990). Maximum variation meant the sample of farmers should reflect both the range of management systems used, and the climatic conditions in the TMPL collection area. The use of theoretical sampling enabled farms with factors identified as important contributors to per cow production (Chapter 2) to be included in the study.

Factors used to select case-farms were per cow production and stocking rate, supplements fed per cow, breeding index, lactation length, replacement rate, herd size, farm size, calving spread, soil fertility, and farm location. Herd size, farm size and farm location were used to select farms because they were theoretically linked to production through aspects such as herd interaction, walking distance and climatic conditions (Section 2.2.4). With the exception of location, the highest and lowest case for each of these factors were selected for study (Table 4.1). Because there is a variation in climatic conditions and soil types on either side of the Rimutaka-Tararua-Ruahine range axis (Thompson, 1982; Noble, 1985; Burgess, 1988) the maximum variation for climate was satisfied by selecting the northernmost and southernmost farms on the eastern and western sides of the ranges (see Maps 3 & 4).

Of the 30 farmers initially surveyed by telephone, 24 were willing to assist with the follow-up study and of these 13 were potential candidates for the case-studies. A final sample of 10 farmers was selected from this sub-group (Table 4.1). Subsequently two farmers withdrew during and before the interviews respectively (Section 4.5 1 and 4.5.2).

The rationale for including each farm in the final sample of eight farmers is outlined briefly below. Case one, on the eastern side of the Tararua ranges, was the northern-most farm in the sample and had the largest effective milking area. Case two had the highest soil fertility levels (Olsen P of 38), the longest calving spread (82 days) and the lowest herd BI (126) of the eight farms. Case three had the lowest level of supplements fed per cow (383 kg DM/head/year). Case four had the herd with the shortest lactation (250 days) and the highest herd BI (131). Case five had the smallest effective milking area (33 hectares) and herd (54 cows), and the lowest stocking rate (1.7 cows per hectare). This farmer had not herd-tested in recent years and was unable to provide a herd BI. Case six was selected because it had the highest per cow production, exceeding average per cow production within the sample, by 93 kg MS/cow (479 kg *vs.* 386 kg). This farm also had the lowest average soil fertility (Olsen P level of 16), and had the only fully registered herd of pedigree cows. Case seven was selected for having the highest stocking rate (3.6 cows per hectare), largest herd size (273 cows), greatest supplements fed per cow (2,066 kg DM/cow /year), shortest calving spread (36 days), and the longest lactation length (278 days). While Case eight had the lowest per cow production (349 kg MS) in the 'high per cow' sample, it had the highest level of production per cow per day (2 kg MS/cow/day) during the peak months of October and November.

Table 4.1 Summary of factors, for all farms, that were used for farm selection. N/A = not available.

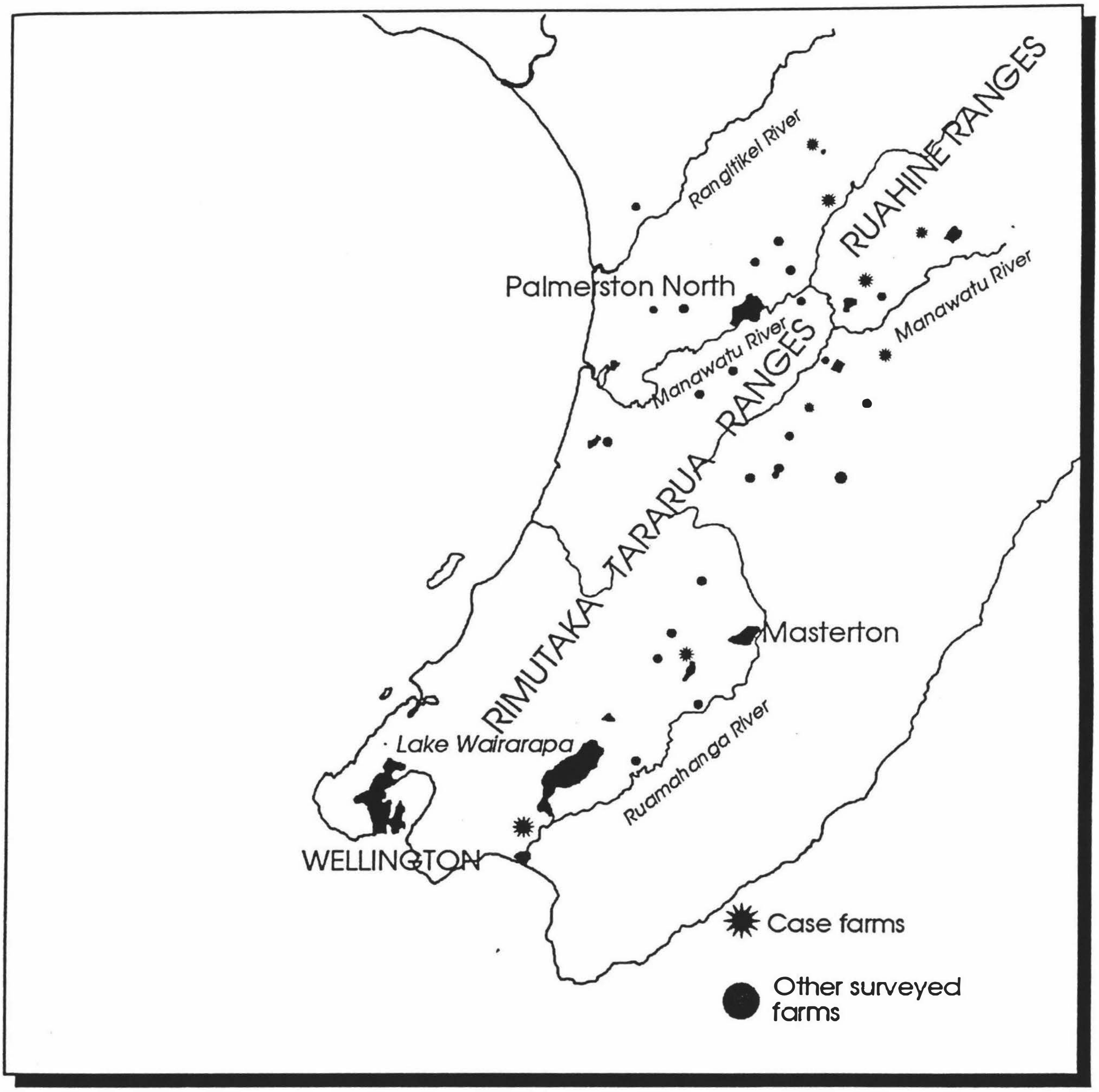
Farm [1]	Production (kg MS per cow)	Milking area (hectares)	S Rate (cows / hectare)	Supps (kg DM / hd/pa)	BI	Lact length (days)	Olsen P	Cows	Calving Spread (days)	Location
A (1)	396	112	2.34	618.97	131	273	37	230	72	
R (2)	378	106	2.56	548.57	126	267	38	271	82	
X (3)	413	68	2.3	383.13	127	268	35	148	75	
AA (4)	362	69	2.41	834.69	131	250	19	151	61	
N (5)	386	33	1.7	575.21	N/A	272	25	53	67	
G (6)	479	60	2.15	717.58	127	268	16	129	70	
E (7)	350	76	3.6	2065.76	129	278	30	273	36	
C (8)	349	57	2.13	647.21	127	268	25	121	70	
B [2]	414	134	2.23	1202.4	103	289	N/A	285	98	
DD [2]	362	80	2.25	1369.96	132	273	38	180	60	
D	359	45	2.67	1587.58	127	288	31	120	96	
F	360	47	2.46	766.77	131	272	N/A	112	61	
I	390	52	2.44	667.29	127	273	28	115	63	
J	358	32	3.22	583.46	128	278	28	103	50	
K	389	75	2.47	836.04	129	270	34	185	53	
P	359	65	3.04	696.61	124	273	36	198	66	
O	355	69	2.17	644.24	122	273	24	142	70	
Q	348	61	3.44	710.89	N/A	261	N/A	210	70	
S	361	80	2.25	1017.78	128	273	20	180	82	
T	379	40	1.85	1212.49	125	278	38	74	64	
U	363	27	2.57	905.96	128	267	23	69	52	
V	373	45	2.66	858.3	132	N/A	N/A	120	N/A	
W	362	64	2.17	1359.32	N/A	285	29	136	57	
Y	352	56	2.73	680.76	132	278	32	153	58	
H [3]	376	54	2.31	563.62	N/A	257	N/A	125	58	
L [3]	356	57	2.49	447.89	129	278	18	142	61	
M [3]	399	41	2.8	1473.02	117	298	N/A	115	77	
Z [3]	348	230	2.23	1127.48	130	269	20	512	77	
BB [3]	391	75	2.06	699.31	126	278	N/A	135	98	
CC [3]	364	40	2.7	560.33	120	265	N/A	108	66	

Farms originally selected for study (shaded) **Farm used for comparison after two farmers withdrew** (hatched)

[1] The numbers in brackets refer to the case study number of the farms listed in the text throughout the remainder of the thesis.

[2] These farmers subsequently withdrew from the study.

[3] These farmers declined or were unable to take part in the follow up in-depth study.



Map 1 Location of seasonal dairy farms achieving high per cow production in the southern North Island (n = 30).

4.3 Data Collection Protocol

The collection of in-depth qualitative data using the multiple-case case-study method requires an explicit protocol to be followed (Yin, 1994). The protocol focuses on how the researcher will carry out each case-study in order to collect, record and analyse data. The design is also important if converging and corroborating evidence is to be located from multiple cases.

Data in earlier farm case-studies was usually collected through face-to-face farmer interviews (Wright, 1963; Cronin, 1968; Jackson, 1971; Lockhart, 1990). Common characteristics of these studies included an approach to the farmer to explain the study and elicit their cooperation, an arranged time to meet and interview the farmer, an inspection of the property to gain some insight into the farm, a checklist for interviewing, a wide knowledge of the subject matter by the interviewer, and preparation of a summary of each farm visit before proceeding to the next property.

Successful personal interviews require the researcher and respondent to understand, and be comfortable with, the procedures to be followed. Wright (1963) and Brulé & Blount (1989), both suggested that a meeting between the researcher and the respondent prior to the interview period was important in order to build rapport, introduce the research topic and correct misunderstandings. Following this initial meeting, a semi-structured personal interview, based around a checklist to guide questioning, is used to collect detailed and complex information (Firlej & Hellens, 1991). '*How*' questions allow the farmer to talk their way through processes more effectively than static '*what*' questions. It is also recommended that interviews be recorded (Scott *et al.*, 1991) to provide a 'permanent' record of the conversation. However, it is equally important to ensure that the interviewee is comfortable with the interview being taped or filmed, and this aspect should be covered during the introductory period (Firlej & Hellens, 1991).

The initial analysis of the characteristics of the high per cow production farms suggested that a variety of ways were used to achieve high per cow production (Chapter 3). As there was little written information available about the systems employed on these farms, it was important to devise ways to obtain farmer knowledge about their management systems. Much of this knowledge is implied or hidden (tacit) knowledge, so the method employed needed to be able to record answers that varied from preconceived ideas. Structured questions may constrain the farmer's responses and fail to uncover tacit knowledge (Chard, 1991). Semi-structured interviews, on the other hand, allow more in-depth material to be obtained. Thus, a broad set of guidelines of topics that could be expected to be covered during an interview, and the use of probing question to explore how the farmers managed to achieve high per cow production, were required.

4.4 Analysis of Data

Data analysis in qualitative research is labour intensive and may last many months (Miles & Huberman, 1984). This is because, unlike quantitative analysis where there are formal decision rules and procedures for identifying significant or non-significant relationships, there are no agreed formalised procedures for analysing qualitative data (Miles & Huberman, 1994(a)). Also, the analysis of qualitative data focuses on finding 'how' systems operate, or 'how' people behave, rather than cause and effect relationships within systems or people's situations (Strauss, 1987; Dey, 1993).

Qualitative data analysis has been likened to an investigative process similar to detective work (Miles & Huberman 1984), or doing a jigsaw puzzle (Dey, 1993). In these instances the investigator or puzzle maker must make sense of the facts of the case, or pieces of the puzzle by comparing, contrasting, classifying, and cataloguing the data that they have before arriving at a conclusion to the case or completion of the puzzle. The fact finding, piece location, (sampling) and comparing, contrasting, classifying and cataloguing (analysing) activities are conducted progressively and iteratively by the investigator or puzzler as part of the process of solving their problem (Miles & Huberman, 1984; Dey, 1993). In a multiple-case example such as this study, the data collection and analysing activities are carried out in order to find differences and similarities between cases, to help decide when to pursue ideas further or abandon unfruitful leads, and to arrive at an understanding of what is being studied. The analysis of data helps the researcher find new categories of information and to draw connections between these and existing theory (Richards & Richards, 1994). Therefore, data analysis forms part of the data collection process in qualitative research because it allows data collection techniques to be modified during the research period in order to ensure that accurate and complete records are collected (Hedrick *et al*., 1993).

Dey (1993) presented the process of qualitative data analysis as three steps to enable the researcher to proceed from raw data collection to presentation of analysed data. These three steps, description, classification and connection, are carried out iteratively and can be represented as a spiral (Figure 4.2) The first step, description, results in longhand field notes, interview transcripts, and detailed case descriptions (with-in case analysis (Miles & Huberman, 1994 (b))). In addition, matrices of case information setting out the data about individual cases will also describe the case(s) under investigation.

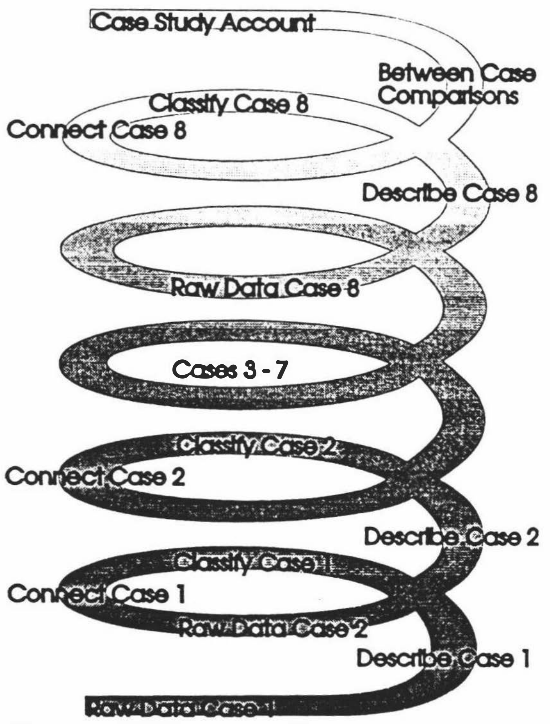


Figure 4.2 The iterative analysis spiral for multiple-case qualitative research (adapted from Dey, 1993).

The second step, classification, involves sorting the pieces of the puzzle into different groups. The classification of the data obtained during semi-structured interviews is needed to 'order' the data so that sense can be made of the situation under investigation. Classification involves reducing the data (words, sentences, paragraphs) contained in verbatim transcripts and field notes into data-bits (text blocks) so these may be later allocated to defined categories.

Dey (1993 p 94 to 151) also suggested that the classification process consisted of three steps. Glaser (1978 & 1992) and Strauss & Corbin (1994) described this process as coding rather than classification. First categories are developed under which the data-bits can be classified (sorted).

Second the data-bits are classified under each category, and third the data-bits allocated to each category are re-classified if required by splitting categories into sub-categories if they are too broad, or joining categories if they overlap. Super categories can be created if the categories relate to underlying concepts (Figure 4.3). In order to classify the data-bits into categories, decision rules need to be developed which enable similar data-bits from different cases to be consistently allocated each time a transcript is analysed, yet be flexible enough to enable new categories or sub-categories to be created during the classification process. Computer program such as NUD.IST (QSR, 1993) make it possible to combine steps two and three.

The advantages of using clearly delineated decision rules are that the classification process can be repeated for each case in a multiple-case case-study, and that the allocation of data-bits to particular categories is able to be clearly described and explained. The rules also allow the process to be repeated by different researchers using the same data or when investigating the same system. The use of decision rules also results in a structured hierarchy of categories and sub-categories that are useful when establishing links between the data. The criteria to decide if a data-bit is part of a category / sub-category or not can also be specified, and logical relationships (links) between sub- and super-categories can be established.

Maykut & Morehouse (1994) called this coding process unitising where blocks of text are allocated to categories based on 'units of meaning', i.e. a block of text that must be able to be fully understood without additional explanation. Despite differences in terminology, Glaser (1990), Strauss & Corbin (1990), Dey (1993) and Maykut & Morehouse (1994) all recommend sorting data into appropriate categories to describe the situation being studied.

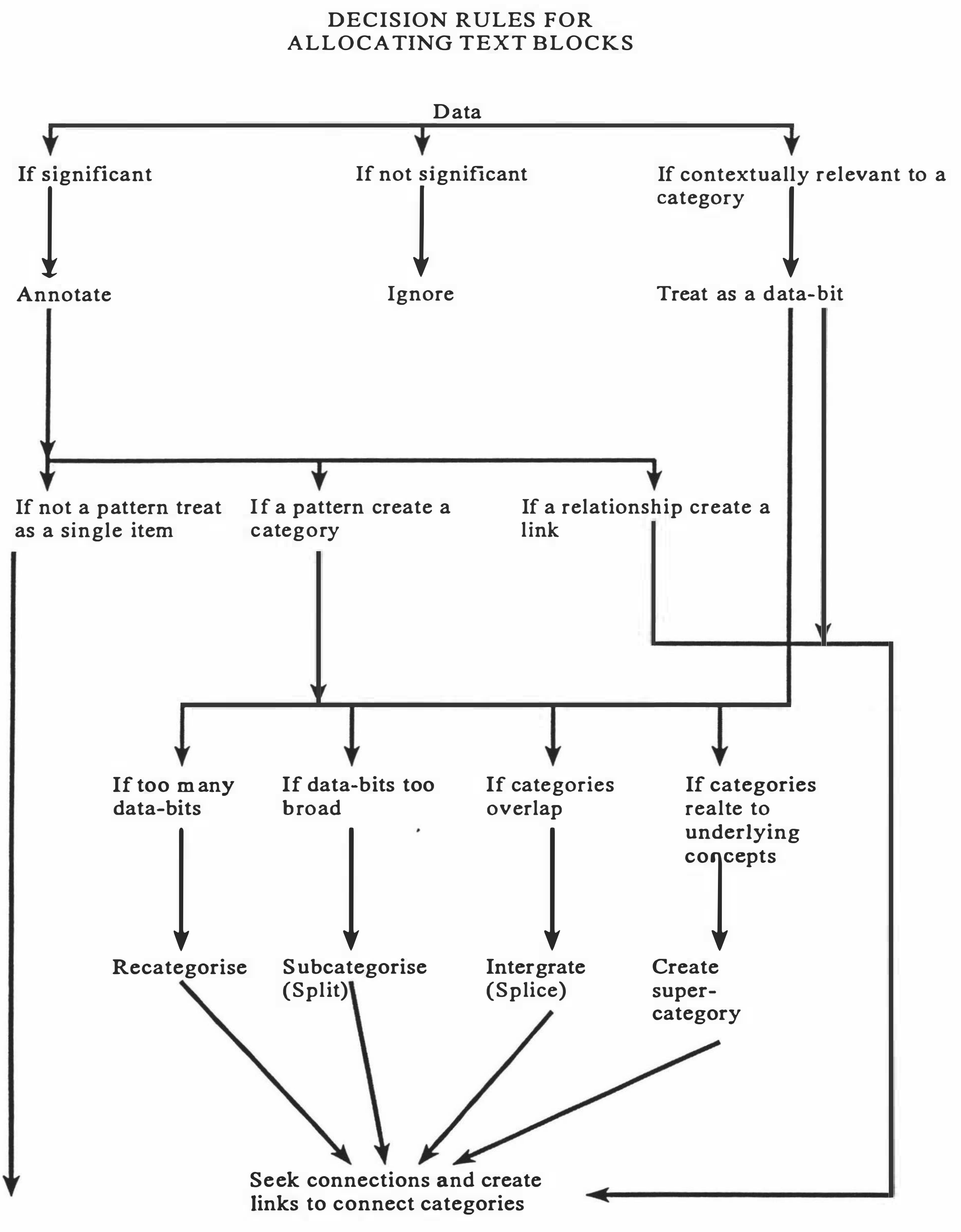


Figure 4.3 Decision rules for allocating data-bits to categories (adapted from Dey, 1993).

Although the transcripts of interviews used to classify categories are usually analysed by the researcher, the use of the interviewee in this role has distinct advantages (Ewing-Jarvie, 1994; Kemp, 1994 pers. comm.). First, it assists the researcher in pin-pointing the important concepts from each interview. Second, promising to provide the interviewee with a copy of the transcript may lower their resistance to the interview being recorded (Firlej & Hellens, 1991).

The third step, connection, can be undertaken once classification has been completed. This process involves identifying links between the categories (Dey, 1993; Maykut & Morehouse, 1994). The links between data-bits extracted from verbatim transcripts, are identified by words. However, the words by themselves are often insufficient for determining links, and the context of the data-bit must also be considered when links are identified (Belkin *et al.*, 1987). Decision rules are needed to link data-bits consistently. These rules, established qualitative data analysis, are determined by the context of the data as well as inferences drawn from the words surrounding the data-bit. Link-words, such as *because* and *therefore*, create clear messages of a link between two data-bits, whereas links inferred by context should be labelled in the same way as categories, i.e. X causes Y, X explains Y, doing Y leads to X, and so on (Dey, 1993).

Having analysed the data from each transcript, the resulting categories are then compared across-case, i.e. categories existing in the individual cases are compared for similarities and differences. Matrices showing similarities and differences also show where there are gaps in the data. This is particularly useful where follow-up interviews are to be carried, as and these 'gaps' can be filled. The between-case data comparisons can then be summarised to account for the data in a more general way (Eisenhardt, 1989), and can be reported as a summary of the system being studied or presented graphically or pictorially, in order to aid understanding (Miles & Huberman, 1994). As the researcher is able to focus on similarities and explainable differences, conclusions can then be drawn about the system.

4.5 Case-study Method

4.5.1 Introductory Interview

The farmers selected for the personal interviews were each sent a letter advising them of their selection for the in-depth study(Appendix 3.1). They were later phoned to arrange a date and time for a one hour meeting to discuss the research project and interview techniques. One farmer withdrew because of farm commitments, reducing the sample to nine (see comments regarding the timing of the interview in Chapter 6). The date and time of the meeting was confirmed by letter. Farmers were also contacted immediately prior to visit to ensure that the agreed time was still convenient.

The objectives of the research were outlined during the farm visit and the research procedures and methods of data collection were explained to the farmer. All of the farmers agreed to assist in the analysis of interview transcripts.

4.5.2 Farmer interviews and analysis

Interviews, originally arranged for late September 1994, had to be postponed until late October due to the author's illness (see Section 6.1). Another farmer withdrew because of a family illness, reducing the final number of cases to eight. Time constraints did not permit the inclusion of substitute cases.

The purpose of the first interview was to obtain as much information as possible from the farmer about their farming system, how they achieved high per cow production, and to inspect the farm. One visit per day was carried out and this lasted between two and four hours. The interview portion of the visit took between one and one and a half hours to complete. The recorded interviews were semi-structured (Appendix 3.2), based on 'points of interest' (Table 4.2) to ensure that the management of the farm through time was covered. This format allowed the farmers to focus on the management techniques used at different times of the year identified during the literature review (Chapter 2).

Probing and clarifying questions were asked to ensure that the terminology used, and the systems described, by the farmer were clearly understood by the researcher.

Table 4.2 Guide 'points of interest' used by the researcher to assist in interview management.

General points of interest
- Special facilities
- Cowshed type etc
- Young stock

Winter from drying off date (may/June to July/August)
- Pasture cover
- Grazing regime / feeding of livestock
- Cow condition

Calving / early lactation (August & September)
- Cow condition
- Pasture cover
- Fertiliser use
- Grazing regime
- Supplementary feeding
- Minerals
- Calving pattern (mating)

Mating (including breeding programme) (October & November)
- Cow condition
- Use of AI
- Bull and cow selection
- Mating patterns
- Pre-mating heat detection
- Heat detection
- Feeding regime

Mid lactation (late spring / early summer) (December to February)
- Grazing regime
- Pasture covers
- Use of supplements
- Pasture controls
- Pasture conservation

Late lactation Summer / Autumn (March to May)
- Grazing regime
- Pasture covers
- Pasture quality controls
- Cow condition
- Fertiliser use
- Supplements
- Tactical drying off

Late lactation / drying off (May/June)
- Pasture covers
- Cow condition
- Drying off decision

A farm walk was undertaken after the interview to allow the researcher to 'see' and comment further on what the farmer had talked about during the interview. The interview continued, if necessary, after the farm walk if new items of interest had been raised. This occurred on three of the farms.

At the end of each day, notes were made about the interview. These notes were used, where appropriate, to improve interviewing technique and the structure of subsequent interviews (Appendix 3.3 and 3.4). Additional notes were made about the farm walk, the farm, and the farmer.

The verbatim transcript of each interview (Appendix 3.5) was usually typed within 48 hours of the farm visit. Wright (1963) stated that was important to produce a summary of each visit before proceeding on to the next property (Section 4.3). As interviews had been arranged on consecutive days, and the short delay in picking up transcripts from the typist, the transcript of the previous day's interview was not available before the next farm visit in all but two cases (see discussion in Chapter 6). Later, the accuracy of the transcription was checked by the researcher, corrected, and a copy was sent to the farmer for analysis within one week of the interview.

The analysis of the verbatim transcript involved the farmer and the researcher independently highlighting, (using a highlighter pen), what they considered to be important factors in the achievement of high per cow production (Tables 4.3 and 4.4). The author selected these factors from knowledge of the literature, the context of what was said during the interview, and visual observations made on each farm. Farmers were also asked to make notes on the transcript if factors had been missed or needed clarification. However, they were not asked to explain why these factors were important, as this would be covered in the follow up interview.

Highlighted sections within each transcript were summarised to find areas of agreement and identify mis-matches between farmer and author (Table 4.5). The farmers were sent a copy of the grouped summary in preparation for discussion at the second interview. The summaries were prepared by sorting the highlighted blocks of text (data bits) into groupings of similar (related) ideas (Table 4.6).

Table 4.3 An example of an interview transcript analysed by a farmer (I =researcher, F = farmer).

I The number of cows that you actually get in calf in a fairly short period of time?

F I would have to say there hasn't been a big emphasis on that in the past **but I'm trying to keep the calving more compact and we have achieved that and I think that's production being increased. It's important.**

I Does that relate to per cow production or just the total production?

F I think in terms of total but obviously the sooner a cow calves. It's a bit of a joke I mean I find we have by making the calving more compact we brought about problems in feeding them in spring because like you start calving them at the same time but you've bought your mean date forward and how are we going to feed all these cows. So the juggling that there's a juggling act, there's all those different factors, we don't induce cows so that spreads it out, things like that you've got to **be real careful because you start doing things like that and you change your feed demands more than you ever think.** We do AB for basically 4 weeks just and the bull goes out so that's we get all AB heifers that we ever want so that basically the idea behind that is to get them in calf as early as possible.

I From say November/December/January that's the late spring early summer, what are you doing on the farm for the herd management, the amount of feed your area of the farm and you're looking at pasture covers and sort of management of the farm what sort of regimes do you have going?

F **Right through that period basically we've got them on a fast round,** I call fast, 15 but we don't actually get down to that really, it's really sort of **20** reasonably fast. And basically we're just going round and just I mean pasture growth is pretty good and then you start **topping when we need it** and we basically top the whole farm virtually. I don't set it out, I don't pasture walk, once calving starts and I get too busy I stop and that's it I don't start again till autumn. I don't set about calculating growth rates and things like that, I basically, only because I've found that it doesn't work, basically you keep them on your round and you watch what's happening and as far as **shutting up paddocks for supplements** or for hay for us, **only a genuine surplus.** We basically **try and maintain quality and feed them everything,** if we don't look, we haven't got enough hay we buy it, we don't...

I How do you determine you've got a surplus to shut up?

F Basically you keep on that sort of 20 per round and you kind of see it's getting away on them and they're leaving a lot behind. You basically; that's not so much a problem as just find there's a paddock that really is just looking a bit to long so you drop it out and because they're leaving a lot behind you know you can do it pretty safely. And it just really tends to evolve.

I So you're looking at that stage to make that decision to shut up, for supplements you're looking at what you're leaving behind rather than what's in front of them?

Table 4.4 An example of the same interview transcript analysed by the author (I =researcher, F = farmer).

I The number of cows that you actually get in calf in a fairly short period of time?

F I would have to say there hasn't been a big emphasis on that in the past but **I'm trying to keep the calving more compact and we have achieved that and I think that's production being increased. It's important.**

I Does that relate to per cow production or just the total production?

F I think in terms of total but obviously the sooner a cow calves. It's a bit of a joke **I mean I find we have by making the calving more compact we brought about problems in feeding them in spring because like you start calving them at the same time but you've bought your mean date forward and how are we going to feed all these cows.** So the juggling that there's a juggling act, there's all those different factors, we don't induce cows so that spreads it out, things like that you've got to be real careful because you start doing things like that and you change your feed demands more than you ever think. We do AB for basically 4 weeks just and the bull goes out so that's we get all AB heifers that we ever want so that basically the idea behind that is to get them in calf as early as possible.

I From say November/December/January that's the late spring early summer, what are you doing on the farm for the herd management, the amount of feed your area of the farm and you're looking at pasture covers and sort of management of the farm what sort of regimes do you have going?

F Right through that period basically we've got them on a fast round, I call fast, 15 but we don't actually get down to that really, it's really sort of 20 reasonably fast. And basically we're just going round and just I mean pasture growth is pretty good and then you start **topping when we need it and we basically top the whole farm virtually.** I don't set it out, I don't pasture walk, once calving starts and I get too busy I stop and that's it I don't start again till autumn. I don't set about calculating growth rates and things like that, I basically, only because I've found that it doesn't work, basically you keep them on your round and you watch what's happening and as far as **shutting up paddocks for supplements or for hay for us, only a genuine surplus. We basically try and maintain quality and feed them everything, if we don't look, we haven't got enough hay we buy it, we don't...**

I How do you determine you've got a surplus to shut up?

F Basically you keep on that sort of 20 per round and you kind of see it's getting away on them and they're leaving a lot behind. You basically; that's not so much a problem as just find there's a paddock that really is just looking a bit to long so you drop it out and because they're leaving a lot behind you know you can do it pretty safely. And it just really tends to evolve.

I So you're looking at that stage to make that decision to shut up, for supplements you're looking at what you're leaving behind rather than what's in front of them?

Table 4.5 Examples of the summaries of transcripts showing factors highlighted from the interview and sent to the farmer concerned.

RESEARCHER	FARMER
topping when we need it and we basically top the whole farm virtually. shutting up paddocks for supplements or for hay for us, only a genuine surplus. We basically try and maintain quality and feed them everything, if we don't look, we haven't got enough hay we buy it, we don't	topping when we need it shutting up paddocks for supplements.....only a genuine surplus try and maintain quality and feed them everything,
When we identify that we need to top we basically start topping and basically go for it and we do most of the farm as we can	
	don't use the cows to clean up pastures
Yes basically giving them absolute top priority and basically letting them just go for it, really. In line with that sort of thing we look after the cows and try and keep them happy and an example of that is our cows come up to be milked in the morning we don't get them we just leave the gate open and they'll roll up at quarter to six sort of thing. And in the afternoon, once they get well into the routine we will tend to open the gate and come back and have a cup of tea and then milk the cows, so we don't hassle them and don't shift them around a lot and things like that. Our cows are feed when they want to feed	basically giving them absolute top priority and basically letting them just go for it Our cows feed when they want to feed

RESEARCHER	FARMER
I take a pride in my stock, take a pride in my stockmanship, the way I treat the animals for a start.	I don't know if it's so much as one of my goals. I take a pride in my stock, take a pride in my stockmanship, the way I treat the animals for a start.
Yes, I think some of the production is lost just in stockmanship and especially around the cowshed area. Leading basically up to the shed, pushing, having to push cows into the shed too hard, and same thing with mis-use of backing gate and chunks of alkathene and that sort of thing. I believe those things really put a strain on your young stock, on your heifers, and you know, you're looking after your stock basically.	
So stress-free milking.	So stress-free milking..
Is important yes.	Is important yes
As quiet as possible?	As quiet as possible
not trying to go like hell necessarily in the spring and then come a gutsa in the autumn	
And avoid pugging at all costs	Yes. Avoid pugging
take the cows off	
I don't believe in feeding cows and getting them up to ultimate	

Table 4.6 Examples of the data bits and the idea headings used by the author to group the highlighted text from the interview transcripts.

Idea	Text blocks (Data bits)
Pasture quality	......Topping when we need it etc..... shutting up paddocks for supplements...... . .
Stockmanship	..... I take a pride in my stock, take a pride in my stockmanship, the way I treat animals for a start ... . .
Young stock/replacements	.....basically in stature and height hopefully about the same..... the aim is really to get them as close to that mature size as possible when they enter the herd..... . .
Herd management at mating	..... get onto that rising plane, over the three weeks.....so they're actually improving in condition as they're coming into mating. . .
Animal health	..... give them copper.....we drench them at drying off.....we've been feeding them causmag..... . .
Feeding levels	Then I will feed them as well I can afford to..... and they're getting 15 kg [DM] at least..... right through that period basically we've got them on a fast round..... 20 [days]..... . . .

4.5.3 Second Interview and Analysis

The objectives of the second interview were to confirm, or correct, the key factors identified from the interview transcripts; second, to elicit from the farmers why they considered these factors contributed to high per cow production on their farm and why they were important; and third, to obtain a definition of high level concepts associated with high per cow production. The format of this interview differed from the first. Whereas the first interview was semi-structured and focussed on obtaining information about *how* the farmers achieved their high per cow production, the second was structured, using the transcript summary sheet, to focus on the key factors identified from the first interview, in order to obtain information about why the farmers considered the key factors contributed towards high per cow production. Differences between the farmer's and the researcher's analysis of the first interview transcripts were discussed. In addition, an interpretation of each idea grouping was obtained and recorded on the researcher's copy of the summary (Table 4.7). The second interview was not taped and relied on the accurate recording of the points bought up in the discussion of the transcript summary.

As well as the discussion of the key factors, financial information for the preparation of farm gross margins was obtained during the second interview to assess the economic performance of the farming systems. Information was also collected from seven of the farmers about the calving pattern and the number of cows milked and wintered, for the 1991/92 and 1992/93 seasons. This information when combined with milk production data obtained from Tui Milk Products Limited enabled an estimate of the pasture dry matter consumed on the farm to be calculated [7].

After the interview, the interpretations of each idea grouping were summarised on a 'farmer concept sheet', and recorded the words and phrases that related to each grouping. This summary was sent to the farmer along with a summary of farm facts and a gross margin of milk production

[7]The following parameters were used in the calculation of dry matter consumed: Pasture MD 10.8; Cow liveweights: Jersey 450 kg, Crossbred 475 kg, Friesian 500 kg; MJ ME/kg milkfat: Jersey 109, Crossbred 113.5, Friesian 118; an allowance for maintenance based on 0.6 MJ ME/kg liveweight $^{0.75}$; an average allowance for pregnancy 3.5 kg DM/day eight weeks pre-partum. (source Nutrition and Feeding of Livestock Study Guide 2, Department of Animal Science).

for the farm (Appendix 3.6). Farmers were later contacted to confirm the details of this information before phase two of the data analysis commenced.

Table 4.7 Example of notes and descriptions made on the researcher's copy of the transcript summary during the second interview. (The text in italics are the notes made by the author during the interview. The bold headings in the left-hand column are the group headings used by the author when the summaries were prepared).

Farmer 1	
Researcher	
Stockmanship I take a pride in my stock, take a pride in my stockmanship, the way I treat the animals for a start.	*Stockmanship* I don't know if it's so much as one of my goals. I take a pride in my stock, take a pride in my stockmanship, the way I treat the animals for a start.
Yes, I think some of the production is lost just in stockmanship and especially around the cowshed area. Leading basically up to the shed, pushing, having to push cows into the shed too hard, and same thing with mis-use of backing gate and chunks of alkathene and that sort of thing. I believe those things really put a strain on your young stock, on your heifers, and you know, you're looking after your stock basically.	***Considerate*** ***Looking at things from the animals point of view*** ***Animal welfare***
So stress-free milking.	So stress-free milking..
Is important yes.	Is important yes
As quiet as possible?	As quiet as possible
Consistency not trying to go like hell necessarily in the spring and then come a gutsa in the autumn	***Planning etc, consistency***
Soil Quality And avoid pugging at all costs	***Soil Quality / Pasture Quality*** Yes. Avoid pugging
take the cows off	
Feeding Levels I don't believe in feeding cows and getting them up to ultimate condition score, and then standing around and starving them in spring and losing all that you've gained.	***Feed ahead of them*** ***Consistent feeding levels - consistent with milk production***

4.6 Data Analysis

4.6.1 Introduction

As previously discussed (Section 4.4), data analysis and data collection occur in tandem during qualitative studies (Dey, 1993; Miles & Huberman, 1994). The first step of data analysis, which leads to an understanding of the cases being studied, is the preparation of detailed case-descriptions following a within-case analysis. The second step, leading to an understanding of the phenomena being studied, is a cross-case analysis where the individual case-descriptions are compared and contrasted, and similarities and differences between them are located before generalisations about the phenomena under study can be made. Not only does cross-case analysis allow generalisations to be made, but also it helps highlight deviations from the norm. Deviations from normal practice need to be investigated and explained within the context of how they occur.

In this section the second phase of the data analysis used in this study is described. A description of the within-case analysis is presented in Section 4.6.2. In Section 4.6.3 a description of the cross-case analysis is presented.

4.6.2 Within-case analysis

Description

In the present study, raw data from the taped interviews was prepared for analysis by typing verbatim transcripts of the conversations and preparing field-notes about the farms and interviewees (Section 4.5.2) (Appendix 3.2). The first step of the data analysis, 'description' (Section 4.4), began with the farmer and the researcher highlighting key factors associated with high per cow production on each farm (Section 4.5.2). These were discussed with the farmer during the second interview (Section 4.5.3), and the results from this discussion were used to summarise the initial transcript. Finally, a draft case-description was prepared in order for the author to gain an initial understanding of how each farm was managed before the second data analysis step, classification, commenced.

Classification

To commence step two of the data analysis process, 'classification', an hierarchy of simple and broad categories was developed from the literature (Chapter 2), and the classification process, described in Section 4.4, was applied to the data. Under the broad category, resources, the hierarchy included the sub-categories of land, labour and capital. These sub-categories were further subdivided into individual attributes. For example attributes of the land included soil, climate, farm and pastures (Figure 4.4). Subsumed under each of these sub-categories were further divisions relating to characteristics of each attribute which were contributory factors towards per cow production.

The broad category, management was divided into two aspects, tactical and strategic. Tactical management was subdivided into the seasonal management defined in the literature review (Chapter 2) and used when interviewing farmers (Section 4.5.2) (Figure 4.5). Tactical management not only covers temporal aspects of the seasonal dairy farm but the management of resources such as land, replacements, feed and soil. In order to draw out the seasonal management of each resource the tactical seasonal management sub-categories were split into resource sub-categories, herd, replacements, feed and soil. The sub-categories defined under strategic management were, fertiliser, stocking rate, calving date, inputs / supplements, breed and lactation length and related to the policy decisions that farmers made on their farms.

These initial category sets were used to classify the data from the case-descriptions and transcripts of the interviews. During the classification process further categories were developed to allow more detailed descriptions of the cases to be prepared (Section 5.1). These categories are discussed in more detail in Section 5.3).

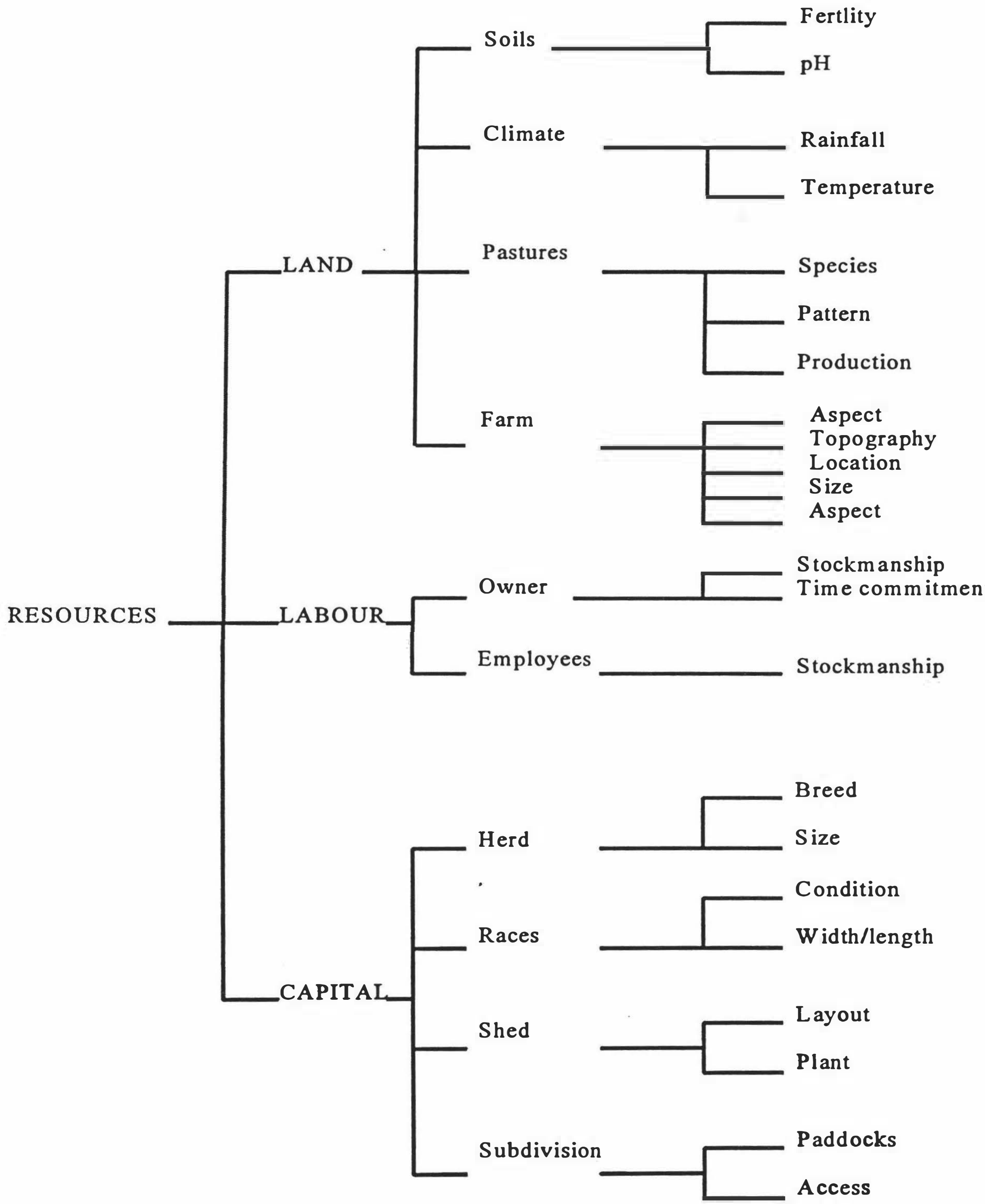


Figure 4.4 Hierarchy of resource categories used to analyse the data relating to the resources on a high per cow production farm.

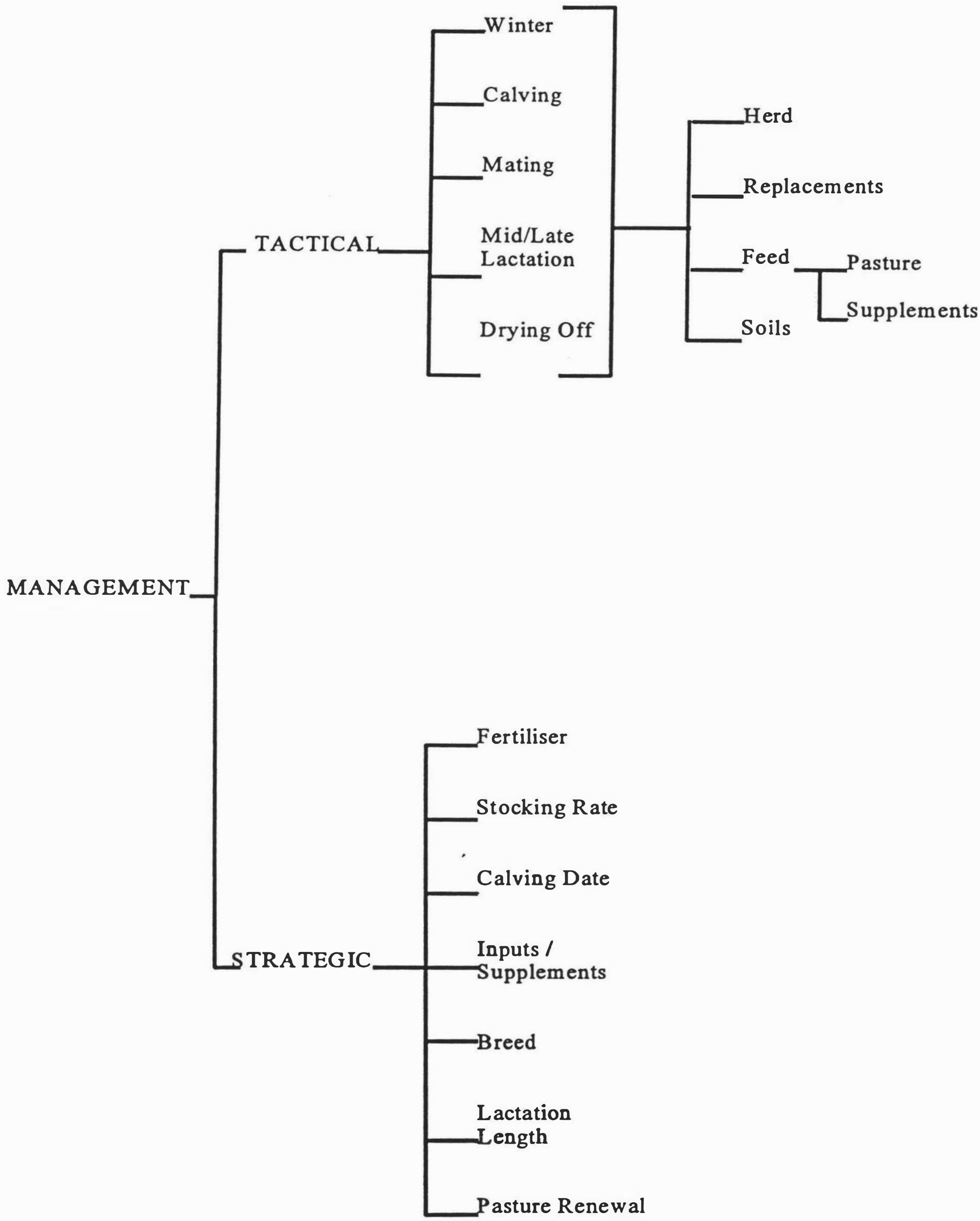


Figure 4.5 Hierarchy of management categories used to analyse the data relating to the management of high per cow dairy farms.

The computer program NUD.IST (QSR, 1993) was used to categorise the data. NUD.IST allows the researcher to delineate blocks of text as single words, lines of text, sentences, paragraphs or whole speeches (QSR, 1993). The verbatim transcripts were, therefore, delineated into text units of one sentence before entering them into NUD.IST. Sentences were chosen as a convenient block of text because they generally related to one topic, but were long enough to retain the context of the data. Paragraphs, or question answers, tended to contain too many categories and too much irrelevant data, while the use of single words would have lost the context of the data. Breaking the transcripts into single lines of text resulted in many meaningless phrases being allocated to categories. When 'spoken' sentences represented more than one category there were some difficulties in classification. These were overcome by allocating the sentences to the different categories that were talked about. Sentences with multiple ideas did, however, enable links to be clearly established between categories spoken of in tandem. Decision rules were used to classify each text block (Figure 4.6 & 4.7) into a specific category or categories. Where existing categories did not allow the inclusion of a text block a new category was created to contain the text block (Figure 4.6). These rules were used to ensure consistency of analysis across transcripts and to improve the repeatability of the research method. Dey (1993 p. 113 to 151) suggested that data should be allocated into categories and then reclassified according to certain decision rules (see Figure 4.3 Section 4.4). NUD.IST allowed new categories and sub-categories to be created easily during the classification process, therefore the two processes described by Dey (1993) were combined.

To complete the third step in data analysis, 'connection', links between categories were identified. Dey (1993) suggested that there is a discrete process between classification and connection. However, as discussed previously, data-bits that contained more than one category were allocated to the different categories using NUD.IST. At the time of the multiple allocation, links were established between data-bits using the rules of inference, contextuality, and link words discussed in Section 4.4 (Figure 4.8). The printout after the classification process allowed these links to be easily identified.

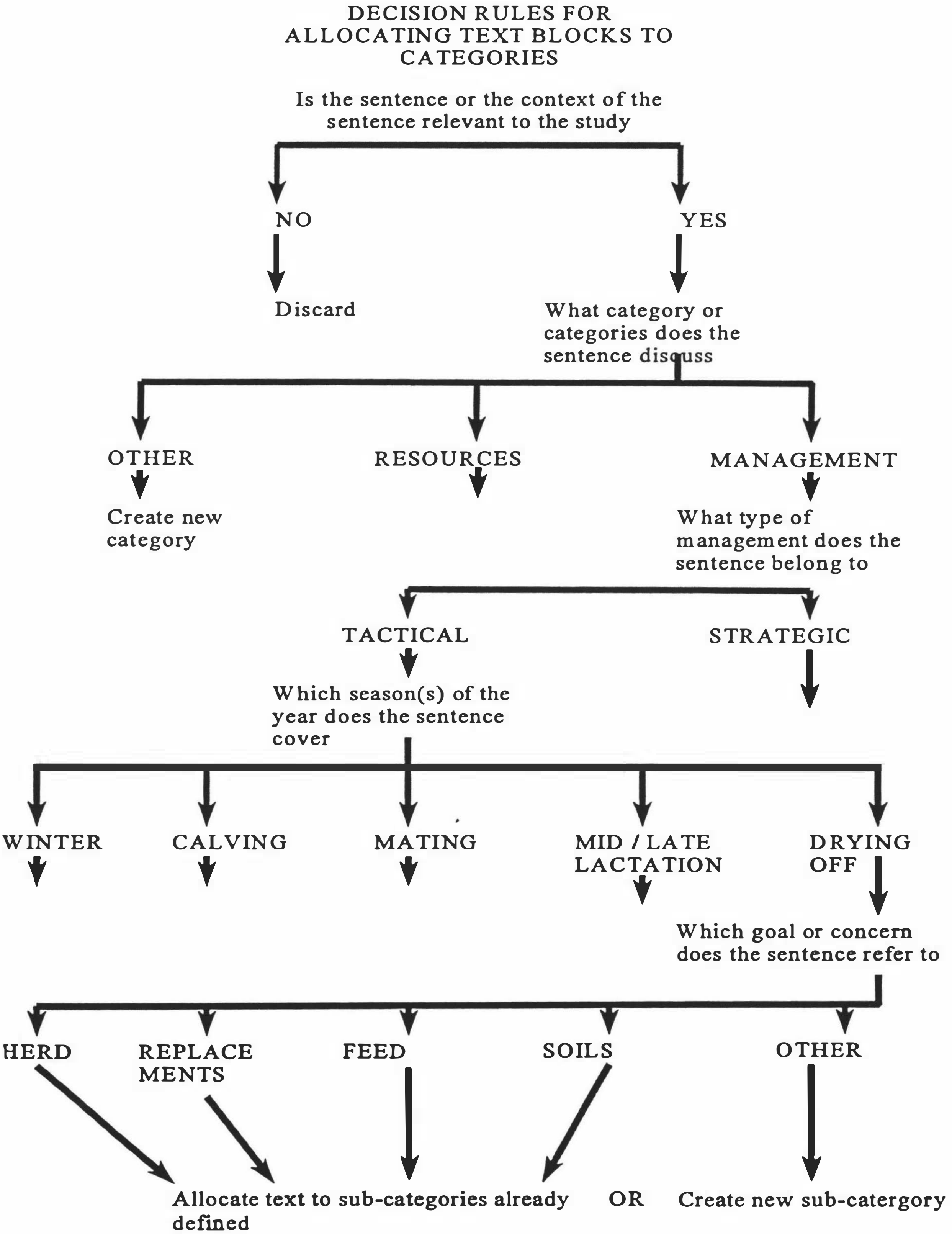


Figure 4.6 The decision rules used to determine the categories for text blocks in the verbatim transcripts of farmer interviews.

AN EXAMPLE OF THE APPLICATION OF DECISIONS RULES TO ALLOCATE A BLOCK OF TEXT

Conversation: Dry them off, start them onto your winter block grazing., into block grazing, we always block graze, haven't done a lot of days, dry off at the beginning of May and you go right round until your calving, the whole farm's that's 90 days, 90 days from the block grazing paddock, until the last cow has calved it's more or less 120 days the farm is block grazed, well grazed out some way or other, from the time I'm drying off like 10 May to when they first come in is about 90 days, the right sort of quality, but not too long.

Decision Rules:

Is the sentence(s) or context of the sentence relevant to the study?

↓

YES

What category or categories does the sentence discuss?

↓

MANAGEMENT

What type of management does the sentence cover?

↓

TACTICAL MANAGEMENT

Which period(s) of the year does the sentence cover?

↓

WINTER

Which goal or concern does the sentence refer to?

↓ ↓

HERD

What aspect of herd management does the sentence cover?

↓

Block Grazing

FEED

What aspect of feed management does the sentence cover?

↓

Provide sufficient feed at calving

How does this aspect of feed management provide sufficent feed at calving

↓

Block Grazing

gure 4.7 An example of the allocation of a block of text into categories using the decision rules tlined in Figure 4.6.

the first step of data analysis described in Section 4.6.1 a draft case-description was prepared to :n an understand of the management issues associated with high per cow production on each farm. llowing the detailed classification process, where text-units relating to these issues were extracted ım the transcripts, a taxonomy of the categories associated with high per cow production was ꝫpared from the data stored in the computer program (see Section 5.2). From this taxonomy, the ginal hierarchy of categories could be compared with the list resulting from the data analysis, and : areas where 'new' information had been discovered were identified. Using the NUD.IST report category links, a detailed picture of the management systems associated with high per cow ɔduction was obtained. Although Dey (1993) suggested that the first step in data analysis was scription, it was necessary in this study to re-write the case description using the data taken from ꝫ analysis to get a full understanding of each farm before cross-case analysis could begin (see gure 4.8 for a revised data analysis spiral).

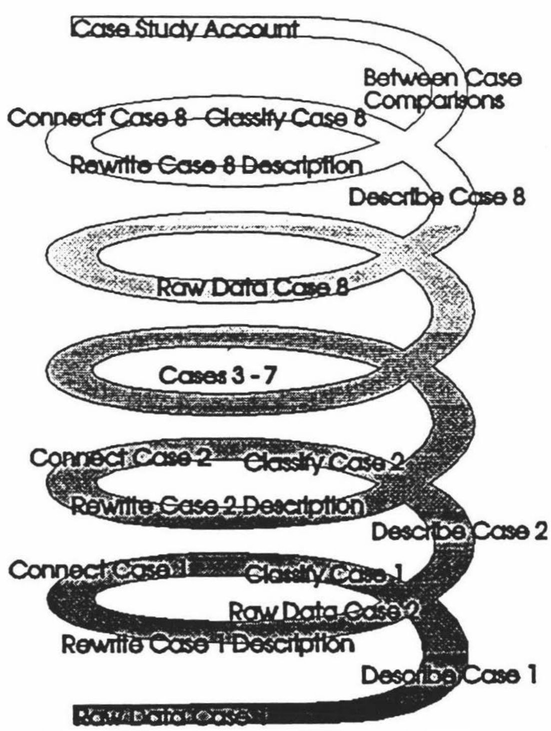


Figure 4.8 The revised iterative analysis spiral used for this study showing the need to rewrite the case description (adapted from Dey, 1993).

Cross-case Analysis

The purpose of a cross-case analysis is to develop an understanding of the phenomena being studied. In this study the cross-case analysis was carried out in three distinct phases. First, the individual case-descriptions were used as the basis for writing a summary of individual cases under the headings described previously (see Section 5.1). These summaries were then used to synthesise a written description or cross-case report (See figure 4.1) of the eight case farms studied (Section 5.2) and from this the differences and similarities between the cases identified. Conclusions were also drawn regarding the likely affect of the different management strategies on high per cow production. In the final synthesis stage a 'model' of high per cow production was developed (Section 5.3). In this study the model comprised two distinct parts; the contribution of the various factors towards high per cow production, and the management strategies and goals used to achieve high per cow production. Data analysis was completed by comparing the 'model' for high per cow production with the management strategies reported the literature (Section 5.4).

5

Results - How case-study Farmers achieved High Per Cow Production

Chapter 5 Results - How Case-study Farmers Achieve High Per Cow Production[8]

The purpose of this chapter is to present the results of the in-depth study of eight seasonal supply dairy farmers and to develop a model of how they consistently achieve high per cow production. In Section 5.1 the detailed case-description and gross margin for each farm is referenced, to provide the reader with the context of the important factors and management decisions associated with high per cow production. In Section 5.2, the results of a cross-case analysis of the data are presented and 'how' eight case-study farmers achieve high per cow production is described. In Section 5.3, a 'model' of high per cow production is synthesised from these results and discussed. This model is compared with the literature reviewed (Chapter 2) in Section 5.4.

5.1 Case-Descriptions

The case-descriptions presented in Appendix 4 are structured to show the data in the section headings used in Chapter 2. Consequently, data are presented under the following major headings: resource factors, animal factors and management, with sub-headings under each section. Although the tactical management of the farm and herd is discussed chronologically, stocking rate and lactation length, rearing replacement stock, and planning and monitoring are presented separately, because these factors are more easily presented on an annual rather than seasonal basis. Readers are directed to the case-descriptions to gain a full appreciation of the context under which high per cow production is achieved on each farm.

8 Parts of this chapter are published in Crawford, H. K. Gray, D. I. Parker, W. J. 1995. How farmers achieve high per cow production - A case study of seasonal supply dairy farmers in the lower North Island. Dairyfarming Annual, Massey University: 175 - 180.

5.2 Cross-Case Analysis

During the cross case analysis a taxonomy of categories was developed. At the highest level these categories were resources and management (Figure 5.1). Under these high level categories lower, more detailed taxonomies were developed. Resources were split into land, labour and capital, management into strategic and tactical (Figure 5.1). Further dissection of categories was undertaken during the analysis and more detailed taxonomies developed under each of the sub-categories. The resources are described in Section 5.2.1 and the management in Section 5.2.2 (Figures 5.7 and 5.8).

5.2.1 Resources

The taxonomy of resource categories (Figures 5.1 & 5.2) developed during the cross case analysis describes the hierarchical, and therefore logical, relationships between resource categories, and are described in the text which follows. Causal relationships which exist between resource categories (Figure 5.4) are described following the hierarchical descriptions.

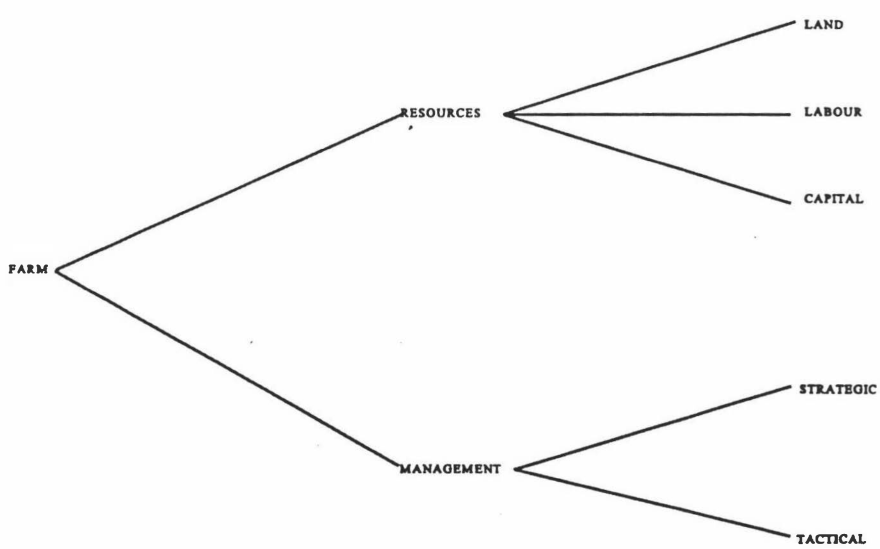


Figure 5.1 High level taxonomy of categories developed during the classification of data from interview transcripts.

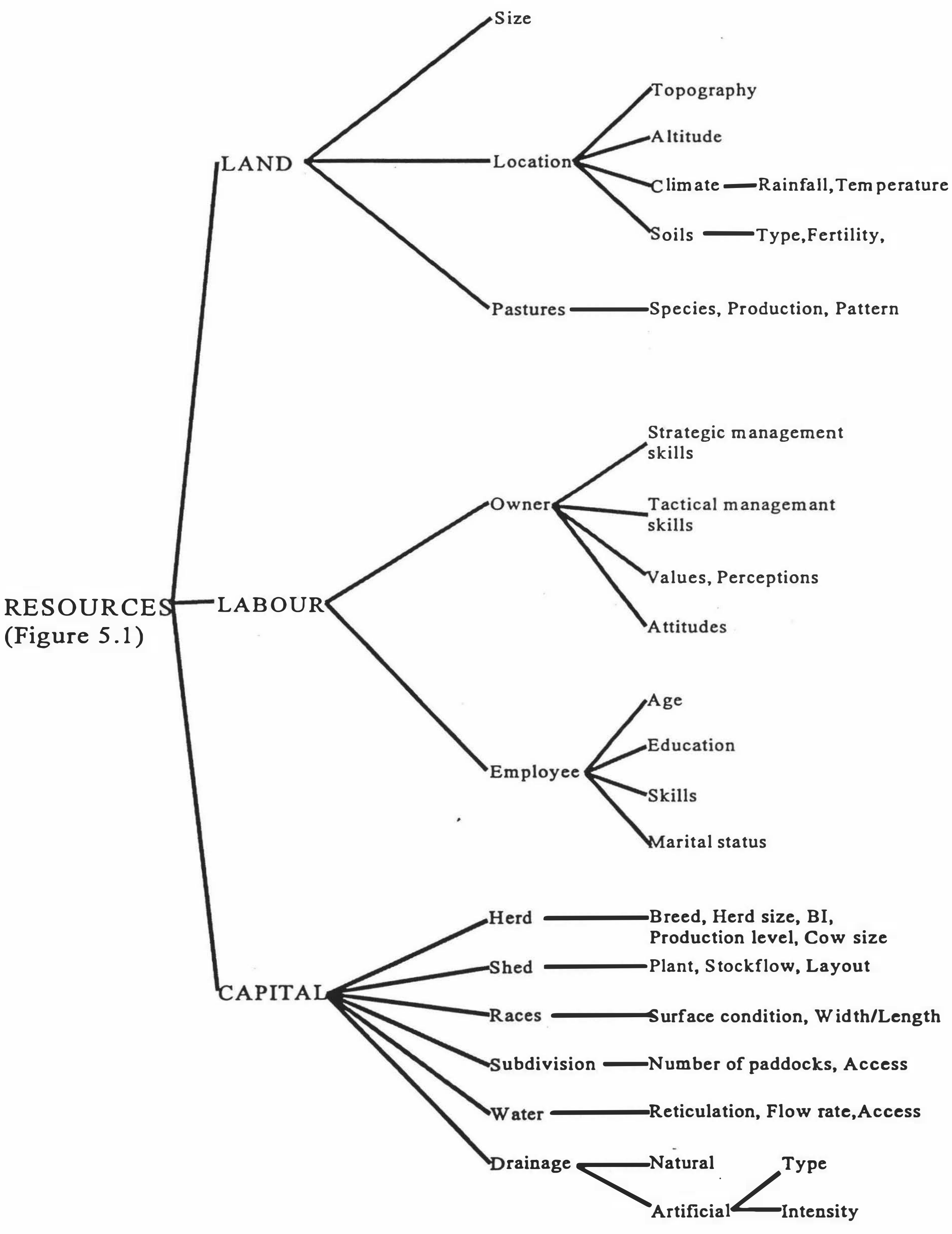


Figure 5.2 Taxonomy of categories developed for resources during the classification of data from interview transcripts.

Land

Farm

The average farm size for the eight case farms was 76 ha (range 36 to 117 ha). with an average effective milking area of 69 ha (range 31.5 to 106 ha). Topography varied from flat land to rolling hills and river terraces, and from 10 to 440 metres above sea level. Two of the case study farmers owned run-off blocks, and four used off-farm grazing for dairy cows during the winter, and/or replacement heifers for all or part of the year. Six farms were located on the eastern side of the Rimutaka/Tararua/Ruahine ranges in 'summer wet' locations, and two were located on the western side of the ranges in areas that were not prone to regular, long term, dry periods.

Pasture

A visual assessment of the pastures showed they were predominantly a ryegrass-clover mixture with other species such as cocksfoot and prairie-grass also present. Pasture was renewed regularly on three farms (see Strategic Management).

Estimated[9] pasture consumed by the herd, for seven farms, averaged 8,415 kg DM/ha (Table 5.1) or 9,144 kg DM/ha if pasture grown as a result of nitrogen applications is included. No estimate of pasture grown could be made as insufficient data was available to estimate the percentages of pasture wasted through harvesting and feeding out, or the amount of pasture lost via senescence.

The pattern of pasture growth for all farms generally corresponded to the seasonal pattern found in each of the TMPL regions where the case farms were located (Figure 5.3). Typically, the pattern of pasture production was high pasture growth in the spring and early summer, followed by lower summer pasture growth rates before increased pasture growth in the autumn and low winter pasture growth. Farms on the western side of the ranges (Manawatu Wet) experienced higher growth rates

[9] See Section 4.5.3

during the late summer than those on the eastern side (Wairarapa Wet, Pahiatua, Southern Hawkes Bay Wet) (Figure 5.3). One farmer, case Seven, on the eastern side Pahiatua), believed high soil fertility prompted earlier pasture growth in the spring and later growth in the autumn than other farms in the surrounding district, *"the grass grows longer, it jumps a week, 10 days before anybody else's and goes 10 days longer"*.

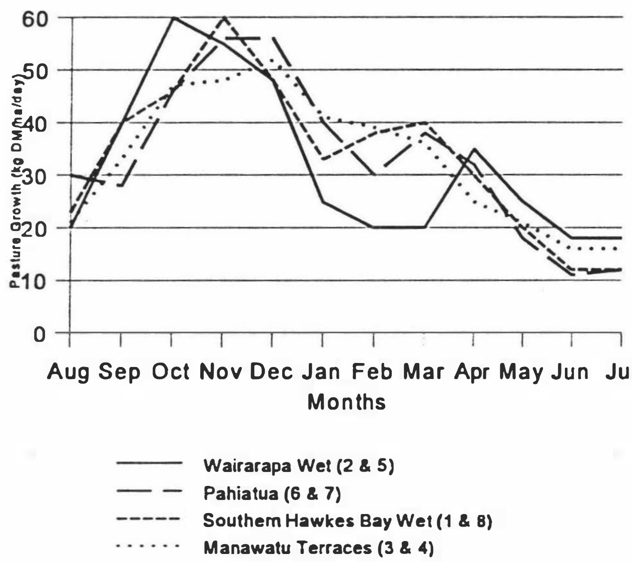


Figure 5.3 Typical pasture growth patterns for TMPL regions where case farms were located (source Riddick 1991; Brookes 1991, MAF)

Table 5.1 Resource factors and their influence on the estimated amount of pasture consumed on eight case-study farms.

	1	2	3	4	5	6	7	8
Land								
Location [1]	SHBW	WW	MT	MT	WW	PAH	PAH	SHBW
Size (effective milking area ha)	98.5	106	68	50	32	55	76	57
Altitude (metres above sea level)	216	10	133	442	160	153	114	137
Topography	Flat	Flat	Terraced	Rolling	Terraced	Flat	Terraced	Flat
Climate								
Annual rainfall (mm)	1210	1,150	1,200	1.100	1,000	1,400	1,050	1,000
Soil groups	1,2	3	1,2,3	3,4	2	1,3,5	2,3,4,6	4,5
Olsen P	18-48 [a]	35	35+	18-20 [a]	20-30	23 [a]	30-60	25
Pasture								
Species	Rye/Clover	Rye/Clover	Rye/Clover/ Cocksfoot/ Prairie	Rye/Clover	Rye/Clover	Rye/Clover/ Cocksfoot	Rye/Clover	Rye/Clover
Consumed (kg DM/ha) (without nitrogen)	N/A	8,982	8,808	7,904	6,936	9,814	9,398	8,060
Consumed including nitrogen grown pasture (kg DM/ha)	N/A	9,740	8,939	8,178	7,202	10,656	10,484	8,808
Stocking rate (cows/ha)	2.34	2.56	2.3	2.41	1.7	2.15	3.6	2.13

[1] Location areas; WW = Wairarapa Wet, SHBW = Southern Hawkes Bay Wet, PAH = Pahiatua, MT = Manawatu Terraces.

1	Yellow grey earths.	2	Yellow brown earths.	3	Recent gley and organic soils
4	Brown granular loams and clays	5	Recent soils.	6	Yellow brown loams.

[a] These farms had recently had more land added to the milking area (see text).

Climate

Annual rainfall averaged 1140 mm (range 1000 to 1400 mm) (Table 5.1). Farms located on the eastern side (WW, PAH, SHBW) of the ranges experienced a relatively even spread of rainfall, with slightly more falling during winter and spring months than summer and autumn. On five farms periods of low rainfall could be experienced in the summer (ranging from

December to February), however, long periods of low rainfall, i.e. drought conditions, were atypical. Farmer Seven (PAH) believed the farm was in a reliable summer rainfall area and that this helped to reduce the seasonal variation in pasture growth. Farmer Six (PAH) felt that low temperatures and wet winters limited the length of lactation available to farmers in the district, but the farm had reliable pasture growth during the lactation period, *"... grew grass more regularly all year round rather than say a peak of grass"*.

The two case-farms on the western side (MT) of the ranges also experienced a relatively even spread of rainfall, although summer rainfall was generally more reliable than that on the eastern side. Farm four, in particular, seldom suffered from extended periods of low rainfall during the summer whereas farm three occasionally experienced dry spells during January and February. However, low winter temperatures, altitude and occasional spring snow on farm four shortened the growing season and therefore lactation length.

The prevailing wind for all farms was from the westerly quarter, although due to its proximity to the southern coast of the North Island and the ranges, farm two also experienced winds from the south. Strong, often gale force winds were common on three farms due to their proximity to the coast or the Manawatu Gorge. On farm two, shelter belts had been planted to protect the pasture and herd from the wind (see Plate 4, Appendix 4).

Soils

Although a wide range of soil types were present on the case farms, they were predominantly yellow brown or yellow grey earths (Table 5.1), and any difference in pasture growth caused by soil based factors was likely to be caused by fertility rather than soil type. Olsen P levels ranged from 18 - 60. Some of the farm soil test averages were low because five of the farmers had recently acquired more land, and soil fertility was lower on this land than the existing farm.

Labour

Owner

All farmers had attributes which enabled them to manage the farm and herd. As well as dedication to the farm and herd, all farmers commented on the need to have good stockmanship skills. They believed that stockmanship skills, in particular, contributed towards high per cow production, *"...some of the production is lost just in stockmanship, especially around the cowshed area"* and *"... we are relatively quiet with them [the cows]."* In addition, dedication to the farm and herd which gave them a 'sense of pride' and a desire to make sure the farm was managed properly (see Planning and Monitoring). No measurement of the level of skills or managerial ability was made and future research is needed to assess the attributes of the farmers who are consistently able to achieve high per cow production (see Chapter 6). These are likely to include strategic and tactical management skills and abilities and values and abilities associated with the care of stock and the land.

Employees

It was generally accepted by the four farmers who employed labour that achieving high per cow production and employing labour did not go hand in hand. The staff employed by these four farmers were generally young (i.e. under 25 years old), unskilled, and had no tertiary education. In addition, the owners believed that farm staff did not have the same interest in the farm as they did and therefore did not have the same commitment to the tasks that were undertaken, *"they consider they're doing their job ... getting the cows in, putting them back in the same paddock, that's their job ... I've done my job..."*, and *"staff lose their way ... personal life interferes, ... they haven't got the same goals or interests as me."* Although employees may have been motivated to work, their motivation was not the same as the farmer's. Three of the farmers who employed labour had herds greater than 200 cows and the fourth had a pedigree herd of 129 cows, which involved additional work, particularly at calving and mating.

Capital

Herd (Animal Based Factors)

The average herd size on the eight case-study farms was 172 cows (range 53 - 273). The herds consisted of Friesian x Jersey, Jersey, Friesian and Ayrshire cross cows (Table 5.2). Herd BI averaged 129 (seven herds) (range 126 - 131) and the recorded ancestry was 82 (six herds) (range 61 - 98) (Table 5.2). The cows, based on a visual assessment, appeared to larger than breed averages found on other seasonal dairy farms. Average milk production per cow was 389 kg milksolids (range 350 to 479 kg) (see Strategic Management of Lactation Length).

Table 5.2 Summary of animal based factors and per cow feed consumption on case-study farms.

Farm	1	2	3	4	5	6	7	8
Herd size	230	271	148	151	53	129	273	121
Breed	FxJ	F (95%) J (5%)	FxJ	J	FxJ (50%) A x (50%)	F (ped)	FxJ (95%) Ax (5%)	FxJ (50%) J (50%)
BI	131	126	127	131	N/A	130	129	127
Ancestry (%)	85	61	67	88	N/A	98	95	N/A
Milksolids per cow (kg)	394	378	412	362	386	479	351	350
Pasture consumed kg DM/cow	N/A	3,509	3,830	3,280	4,080	4,565	2,611	3,784
Total feed consumed kg DM/cow	N/A	4,057	4,213	4,115	4,655	5,283	4,677	4,431
Herd numbers	increasing	increasing	increasing	increasing	stable	stable	stable	increasing

N/A Not available

Shed

The cowsheds on seven farms were either 'new' (i.e. built within the last ten years), or had new plant installed (Table 5.3). The remaining shed was a walk-through with old style milking claws. Providing a stress free environment in which to milk the cows was important to all of the farmers. This environment was created either by shed design *"since we've changed to this shed they've settled down ... it does make a big difference"*, *"no fuss sort of shed ... less stress on cows, even on milkers"*, and/or milking management (see Labour (owner)). All farmers noted that the stress free environment was an important aspect of high per cow production. Farmer Five believed that the walk-through shed allowed all cows to receive individual attention during milking and *"If somebody's a slow milker, well she just stands in her bale alone"* and that this helped achieve high per cow production. Another important component of a stress free milking environment (for both the cows and the milkers) was the time taken for milking. Farmers felt that the length of time the cows spent away from grazing affected feed intake, and the length of time cows are held on concrete yards contributed to the incidence of lameness in the herd and impacted on the level of per cow production. Apart from one farm where a small shed (18 cups for 270 cows), relative to herd size, was considered a constraint because milking regularly took in excess of two hours, shed design, herd size and milking management meant that milking times were less than one and a half hours on all other farms.

Table 5.3 Characteristics of capital improvements on case-study farms.

Farm	1	2	3	4	5	6	7	8
Shed								
Type	Herringbone	Herringbone	Herringbone	Rotary	Walk through	Herringbone	Herringbone	Herringbone
Size	20 a side	18 a side	18 a side	35 bail	6 bail	12 a side	24 a side	14 a side
Milking plant age (years)	2	6	2	4	30+	4	6	3
Races								
General condition	Very good	Very good	Very good	Good	N/A	Very good	Very good	Good
Surface	Smooth sand and gravel	Gravel	Gravel	Gravel	N/A	Gravel	Gravel	Gravel
Estimated maximum length (km)	1.5	1.75	1	1	N/A	1.75	2.5	1.5

N/A Apart from race access around the cowshed this farm did not have races.

Races

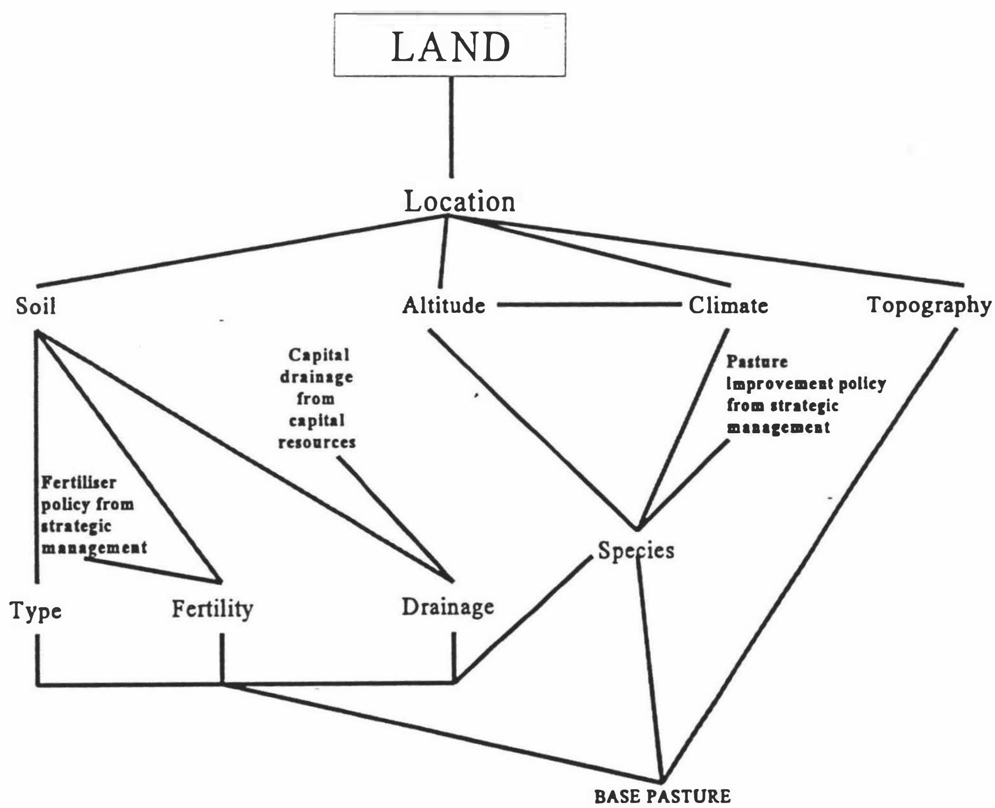
The second important aspect of the environment on the case-farms was the condition of the race to and from the shed to the paddocks (Table 5.3). Seven farms had a smooth, well graded, well compacted races with a gravel base, and a good crown to allow surface water to run off. These characteristics minimised stress on cows during movement to and from the shed and helped avoid lameness. However, one farmer commented that a newer section of the race on the farm had caused some lameness until the gravel on the races had fully compacted. On farm five, apart from a short length of race around the cow-shed, cows were set stocked and had access to all paddocks during the day. There were no races on this farm and cows were moved across paddocks to get to and from the shed. Herds on two farms had to cross small streams before reaching the shed, but, provided care was taken in moving the herd, few problems were encountered and the farmers did not think this caused any loss of production. The estimated maximum walking distance to the shed for all herds was under 2.5 km.

Subdivision and Water

Only one farmer commented on the advantages of adequate subdivision, particularly access to each paddock. In this case, farm four, gateways were provided at each corner where the paddock bounded races, to allow for easy stock movement and therefore reduced time away from grazing. Farmer one commented that if the weather was wet during the winter fences would be cut to give cows access to paddocks to avoid damaging gateways. Although data on the number of paddocks on each farm was not collected, all farms were well subdivided and appeared to have sufficient paddocks for at least 30 days grazing. During 1994/95 Farmer Seven removed the internal fences on part of the farm and allocated the area for each grazing period by using temporary electric fences. The farmer believed that this allowed more 'control' over the daily allocation of feed and earlier identification of pasture surpluses.

ıtionships Between Resources

hierarchical taxonomy described in the preceding paragraphs suggests that there are :ionships between resource factors. The relationships between the 'land-based' resources ıarily affect pasture; production, pattern and variability (Figure 5.4). Although 'pasture' is an bute of 'land', the pasture resource is affected in many ways by the other land attributes ure 5.4). Primarily location contributes to pasture as location determines soil, topography, ate and altitude, which in turn affects climate (Figure 5.4). The attributes of soil (type, fertility, natural drainage) also have a direct affect on pasture. The combination of these factors rmines the 'base' level of pasture that is grown on the property.



gure 5.4 Land based resources that affect pasture production, pattern, variability and ıality. N.B. Fertiliser, capital drainage and pasture improvement can also be an existing :source when land is purchased.

Attributes of capital resources were: herd, shed, races, water, subdivision, and drainage (Figure 5.5). The herd attribute has attributes such as, size (number of cows), BI, breed, age (including age structure) and size (phenotypic size of the cows). The size of the herd is influenced by the size of the farm (Figure 5.5) and establishes a direct link with the land attribute of farm resources. The shed, type, size, age and plant also affect the size of the herd able to be milked and establishes a link between capital resources. The attributes of the shed, races and water supply contribute to the level of stress placed on cows by the farm environment and therefore affect per cow production (see Figure 5.6). Strategic decisions relating to capital resources were also made and the effects of these decisions are described under strategic management (Section 5.2.2). Attributes of subdivision affect the farmer's ability to tactically manage pasture and are discussed in Section 5.2.2.

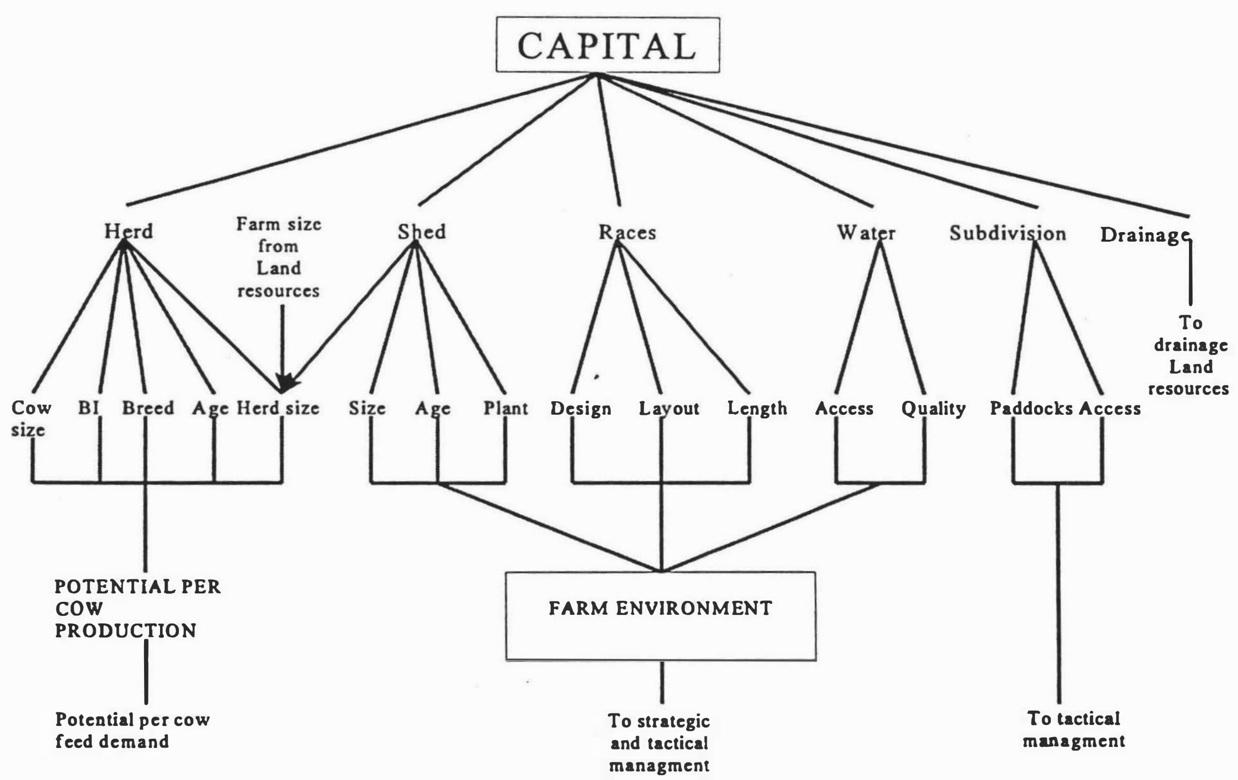


Figure 5.5 Relationships between capital resource factors associated with a diary farm and their effects on potential per cow feed demand, and linkages with land based factors and strategic and tactical management.

The effect that land-based and capital resources have on actual per cow production is illustrated in Figure 5.6. The resources described, and illustrated in Figures 5.4 and 5.5 create a base feed production and potential feed demand. The labour resource is used to manage the farm resources to achieve high per cow production. Farmer attributes and skills determine the ability to manage the resources, whereas the employee attributes and skills determine the affect, usually negative, that outside labour has on the achievement of high per cow production.

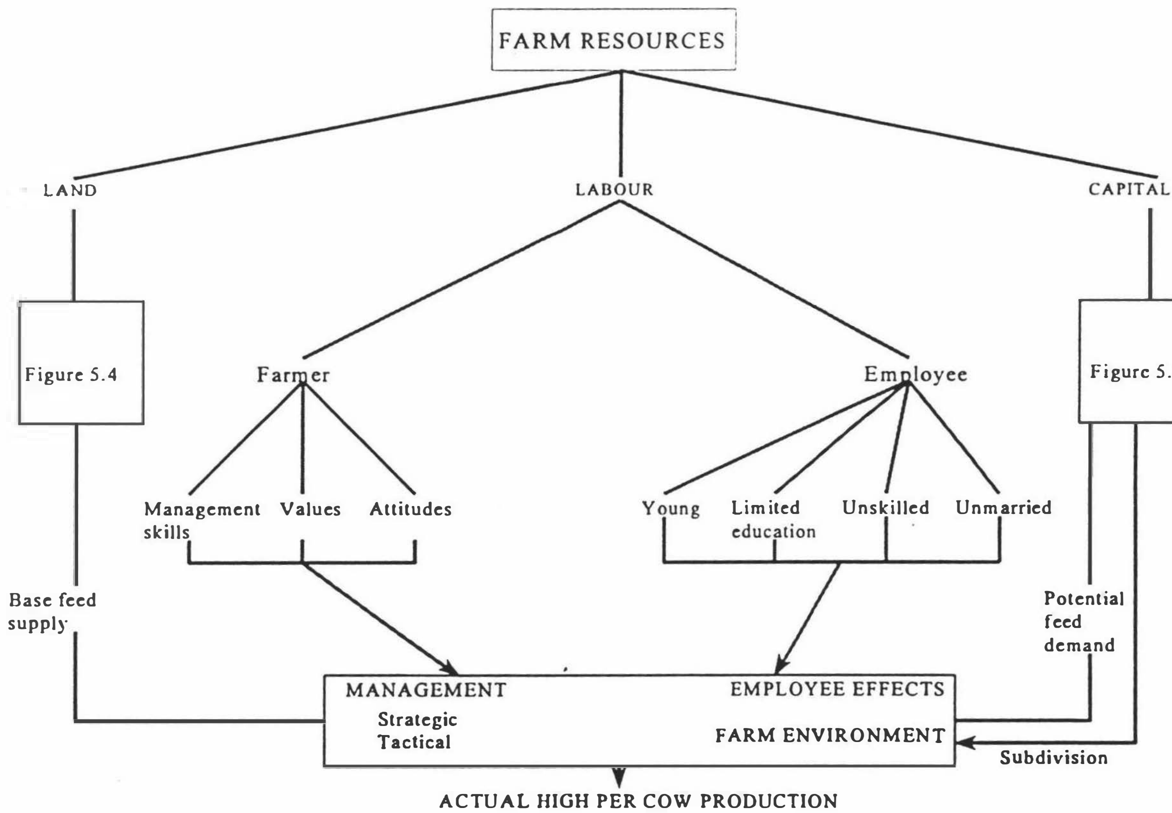


Figure 5.6 Relationships between resources associated with a dairy farm and their effects on high per cow production. The impact of management on high per cow production is clearly illustrated.

Summary

It appears, from the results presented thus far, that the resource base is not critical for the achievement of high per cow production. The location of the farm and consequent variation in climate, altitude, soil type, fertility and topography influence pastures and level, pattern and variability of pasture production. The capital resources influence potential feed demand through cow based factors and shed design. Other capital factors and the ability and effects of labour, through management, result in the achievement of high per cow production. The variation in the resource base on the case-farms suggest, that provided the farm is suitable for dairy farming, high per cow production can be achieved. This implies that farmers use management strategies to overcome resource constraints (Figure 5.6). The strategic and tactical management techniques used to overcome resource constraints are presented in Section 5.2.2.

5.2.2 Management

The taxonomy of management for high per cow production was separated into two distinct parts (Figure 5.1 & 5.7). First, strategic management, which deals with decisions that have a long-term effect (i.e. greater than one season) on the farm were identified. These decisions related to stocking rate, lactation length (particularly as regards calving date), supplement policy (type and amount), herd and herd improvement, rearing replacement stock (strategic targets i.e. size), pasture renewal, fertiliser policy (type and amount), employing labour and capital improvements (shed, races and plant) (Figure 5.7 & 5.8). Second, tactical management which deals with decisions made within a season to achieve high per cow production (Figure 5.19). These tactical decisions were further split into seasonal elements, winter, calving, mating, mid/late lactation and drying off as presented in the literature review and used during the interviews with farmers. For example, decisions made regarding the use of summer and winter crops as part of the farmer's general policy were labelled strategic. However, the decisions made regarding the timing of sowing, and which paddock to plant, within a given year, were labelled as tactical, and related to how the herd, replacements, feed supply and soil were managed. However, labour and milking management and rearing of replacements were each identified as separate management tasks and are therefore described separately.

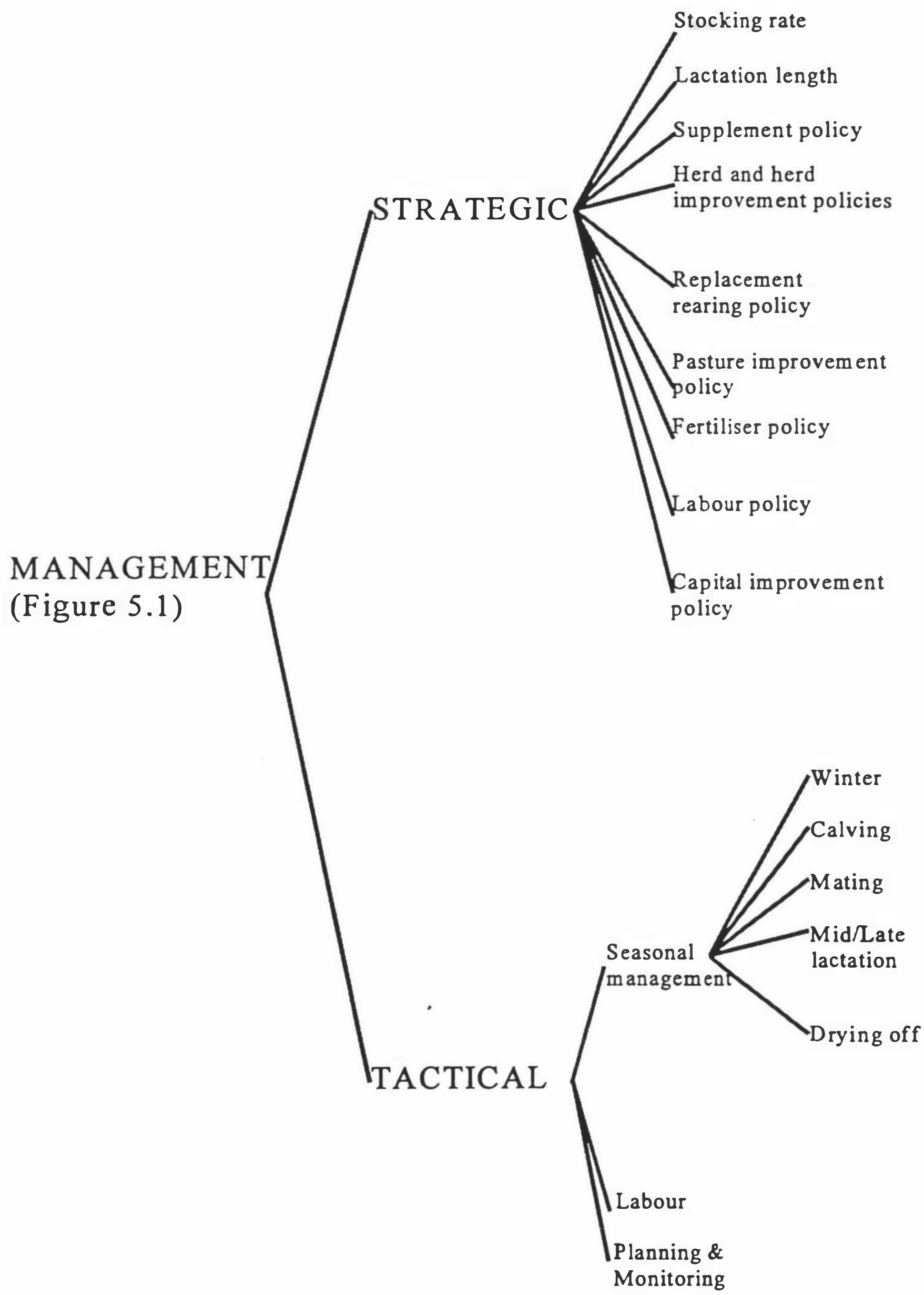


Figure 5.7 Taxonomy of categories developed for management during the classification of data from interview transcripts.

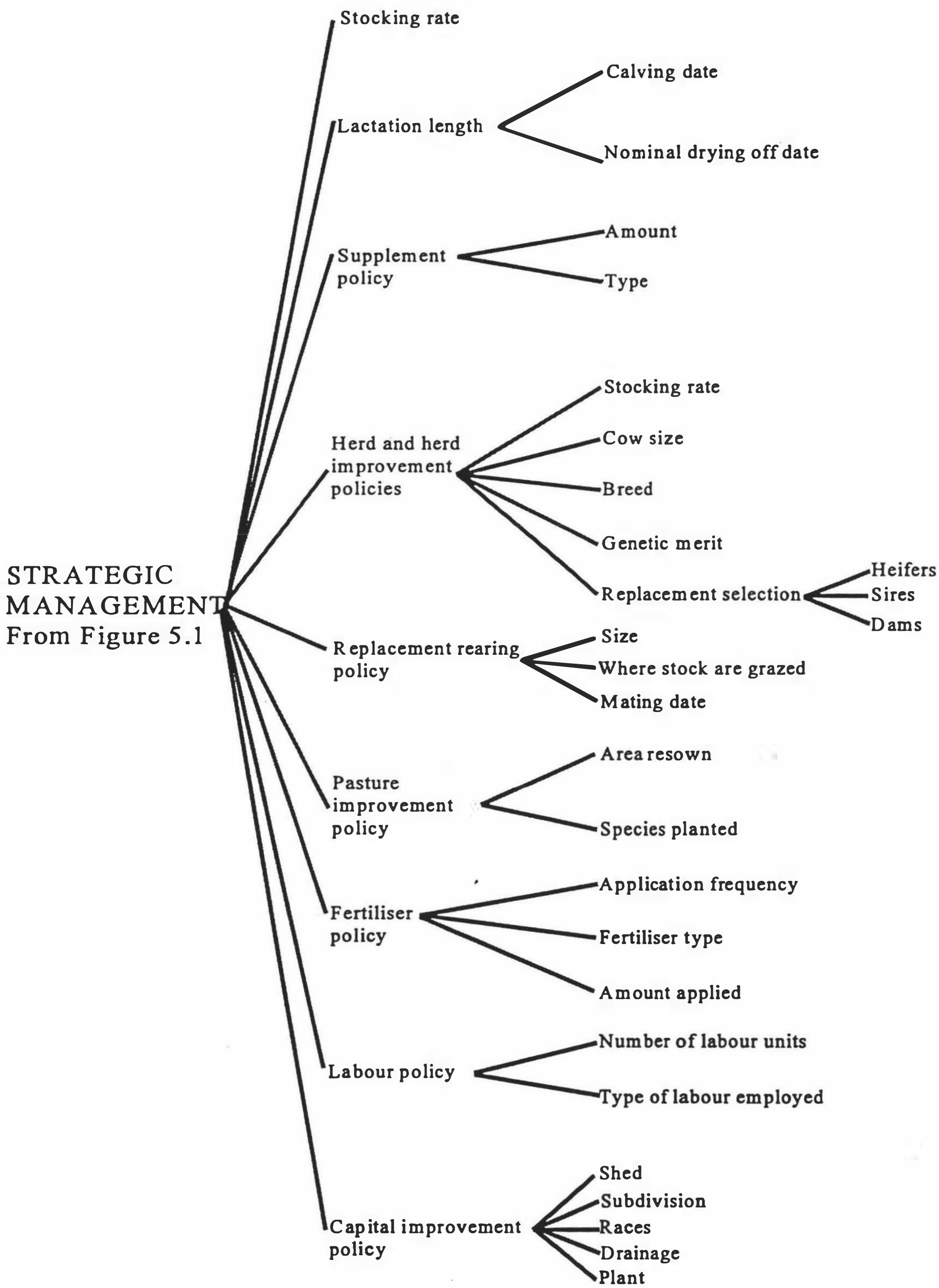


Figure 5.8 Taxonomy of strategic management developed during classification of the data from the interview transcripts.

Strategic Management

Strategic decisions were made to manipulate the 'resource bundle' of the farm, to enable high per cow production to be achieved. The specific decisions made were dependent on the resources available and the goals and attitudes of the farmer.

Stocking Rate

The average stocking rate (cows peaked milked/ha) for the effective milking area of the farms[10] was 2.4 cows/ha (range 1.7 to 3.6 cows/ha) which is the same as that for all TMPL seasonal suppliers (TMPL statistical data). Stocking rate on seven farms remained stable over the period June 1990 to June 1993.

Only two farmers made specific comments regarding stocking rate. Farmer seven said it contributed directly to the level of per cow production and that a higher stocking rate allowed spring pasture quality, in particular, to be maintained more easily. The farmer also suggested that at high stocking rates, supplements could be introduced into the feed ration if pasture supply could not meet feed demand. Farmer six commented that stocking rate was influenced by the level of soil fertility, although the relationship was not defined.

Although the average stocking rate was calculated using the number of cows peaked milked, the actual stocking rate of individual farms was influenced by the amount of pasture grown, the level of supplementation, including where and how cows were wintered, and the grazing policy for replacement heifers (Table 5.4 & Figure 5.9). All mixed age cows were wintered on six of the farms and on two of these they were confined to specific areas of the farm (i.e. on a winter crop planted for the purpose, or on pasture saved earlier in the year (Table 5.4)). On the seventh farm, part of the herd (approximately 50%) were grazed off-farm if winter pasture supplies were limited. The grazing would be arranged by the farmer each year prior to drying off, but it would only be

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10 See Chapter 3.4.1 Telephone Survey for calculation of effective milking area.

used if required. In this case the decision to use off farm grazing was strategic, the decision whether to use it in a particular year was tactical. On the remaining farm cows were grazed on a runoff block for five to six weeks (Table 5.4).

Table 5.4 Stocking rates, and techniques used to manipulate stocking rate of case-study farms and strategies for achieving high per cow production at different stocking rates.

Farm	1	2	3	4	5	6	7	8
Stocking Rate	2.34	2.56	2.30	2.41	1.70	2.15	3.60	2.13
Milksolids per cow (kg)	394	378	412	362	386	479	351	350
Lactation Length	273	267	268	250	272	268	278	268
Pasture consumed per hectare	N/A	9,740	8,939	8,178	7,202	10,656	10,484	8,808
Supplements fed including nitrogen grown pasture								
kg DM/cow	N/A	548	383	835	575	718	2,066	647
kg DM/ha	N/A	1,403	881	2,012	978	1,544	7,438	1,378
Heifers	On farm	Grazed off 12 months	Grazed off 26 weeks	On farm	On farm	Grazed off 12 months	Grazed off 20 months	Grazed off 12 months
Cows wintered	On farm saved feed	On farm	On farm	On farm	On farm winter crop	Half on farm	Grazed off 4 - 6 weeks	On farm

N/A Data not available to estimate pasture consumed on this property.
✔ Farmers who use technique to manipulate stocking rate.
✗ Farmers who do not use technique to manipulate stocking rate.

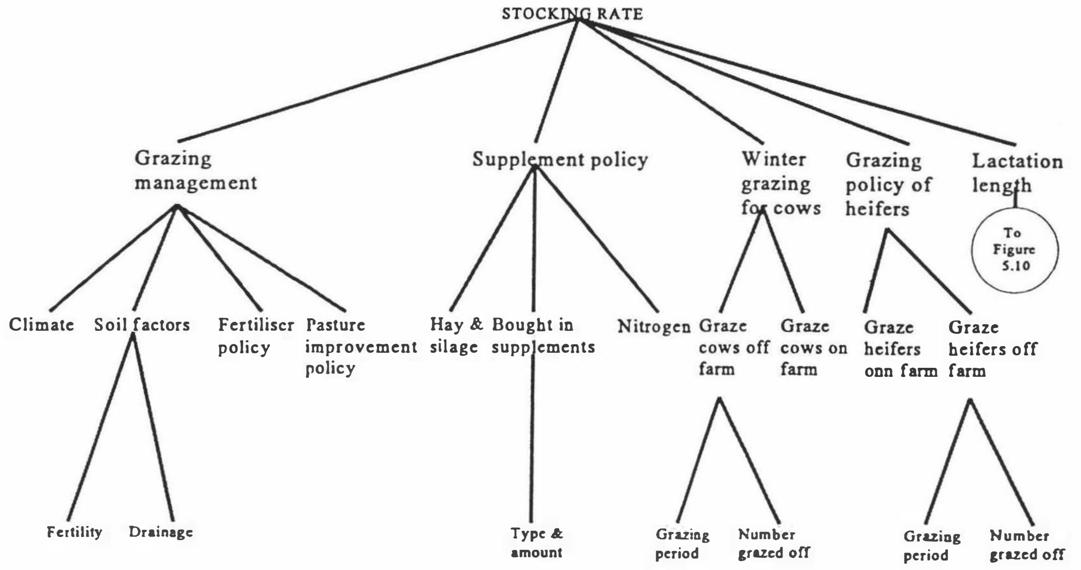

Figure 5.9 Factors influencing the stocking rate decision on high per cow production dairy farms.

Lactation Length, Calving Date and Drying off Date

Lactation length on high per cow production dairy farms was influenced by strategic decisions relating to calving date, stocking rate and a nominal drying off date (Figure 5.10). The length of lactation in a given year was determined by the tactical decision when to dry off at the end of the season (Figure 5.10). The average lactation length on the case-farms was 268[11] days (Table 5.54) which compares favourably with TMPL data presented by Watters (1995) (276 milking days [12]), given that the average period from start of calving to median calving date was 12

11 Determined from the median date of calving until the last day of milking.

12 Milking days - defined as the total number of days a farm supplies the factory during a season. This figure differs from the above definition as it includes the period from the first day of milk supply to the factory until median calving, which is not included in the calculation for the eight case-study farms.

- 25 days (Simmonds, 1985). Lactation lengths ranged from 250 days (farm four) to 278 days (farm seven) (Table 5.5). On all farms the length of lactation was influenced by the strategic selection of calving date and the tactical decisions made in relation to drying off at the end of each season (see Drying Off). For example, the lactation length on farm four was delayed because climatic conditions caused the spring flush of pasture to occur later in the year. On farm five the length of lactation, as well as being influenced by the calving date, was influenced by the strategic decision to milk as close to the last day as tanker pick-up as possible (nominal drying off date), provided other conditions were met (see Drying Off) (Table 5.5, Figure 5.10). However, the long lactation length on farm seven was also associated by the generally high soil fertility levels found on that property (see Pasture and Soil).

In order to achieve long lactations, three farmers managed their herds to start calving on the 20 July, three on the 1 August, one on the 10 August and one on the 20 August (Table 5.5). Heifers start calving on the 20 July and M.A. cows on the 10 August on one farm. Farmer seven, whose herd stated calving on the 10 August, had a short (15 day) period between calving and median calving dates, and the mean calving date of the herd was the same as the district. The strategic setting of calving date was influenced as much by the farmer's attitude towards supplementary feeding as the balancing of early spring pasture supply with early lactation feed demand (Figure 5.10). The achievement of long lactations required the nominal drying off date to be set as long as possible after calving date.

Table 5.5 Factors associated with the strategic setting of lactation length.

Farm	1	2	3	4	5	6	7	8
Stocking Rate	2.34	2.56	2.30	2.41	1.70	2.15	3.60	2.13
Lactation Length	273	267	268	250	272	268	278	268
Calving date	20/7 & 10/8	120/7	1/8	20/8	1/8	1/8	10/8	1/8
Nominal drying off date	20/5	10/5	10/5	12/5	30/5 - 10/6 Last pick-up	10/5	30/5 - 10/6	1- - 20/5

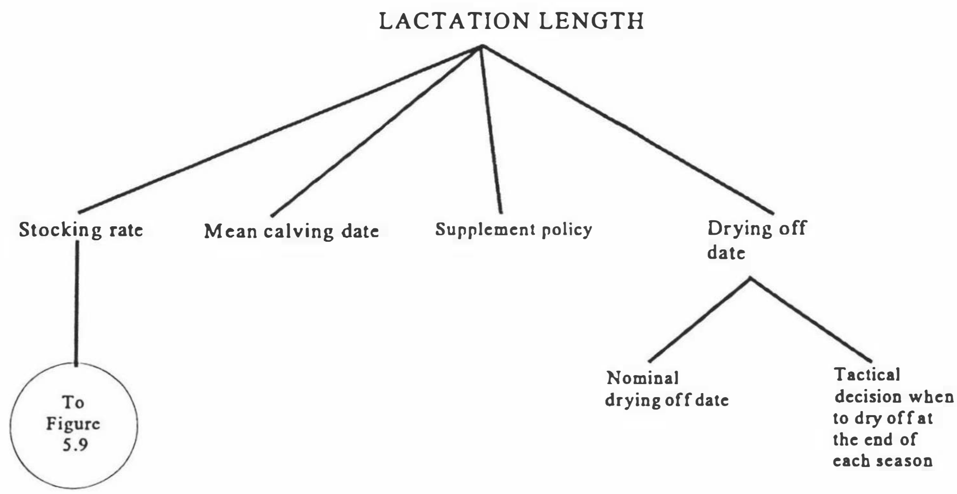

Figure 5.10 Factors influencing the lactation length decision on high per cow production dairy farms.

Average milk production of 389 kg milksolids (range 350 to 479 kg) was achieved by reaching peak production early and maintaining lactation persistence throughout the year (Figures 5.11 and 5.12). After peak production was achieved, the average monthly fall in milk production until April was less than ten percent (270 days after the start of lactation) (Figure 5.13). Milk production was achieved from an estimated 3,665 kg DM (range 2,611 to 4,080) pasture consumption per cow (including pasture grown as a result of nitrogen applications). Total feed consumption, including all pasture, supplements and concentrates, was estimated to average 4,546 kg DM/cow (range 4,057 to 5,283). On Farm Four, where the climate restricted lactation length, peak production was reached earlier than other farms, and although lactation persistence was greater than the TMPL average, a greater proportion of annual production was achieved in the first half of lactation than on the seven remaining farms (see 'Four' Figure 5.11).

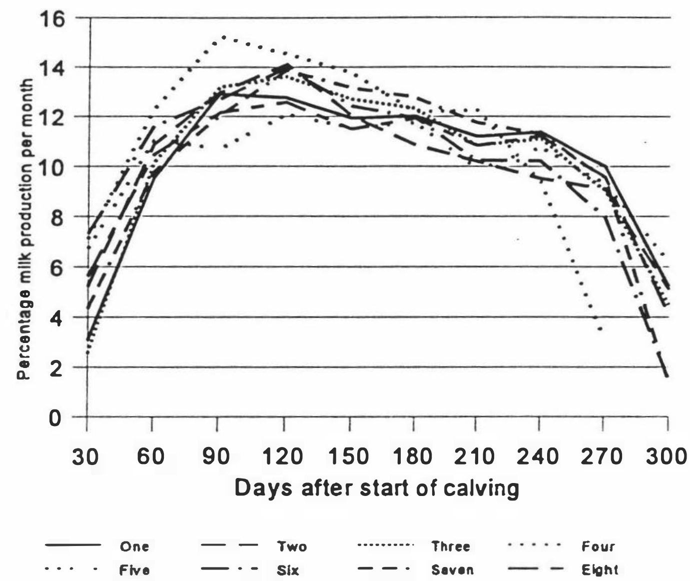

Figure 5.11 Lactation curves of eight case study farms showing percentage milk production per month of lactation (source TMPL data).

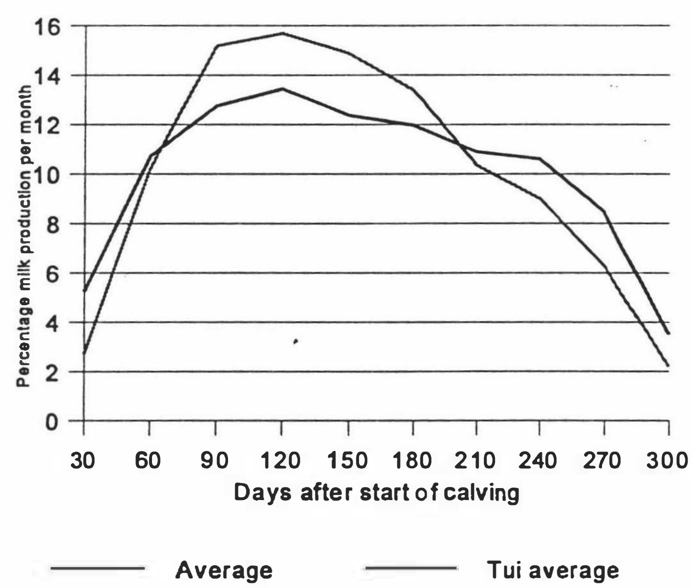

Figure 5.12 Average percentage milk production for eight case-study farms and for Tui Milk Products Limited suppliers (source TMPL data).

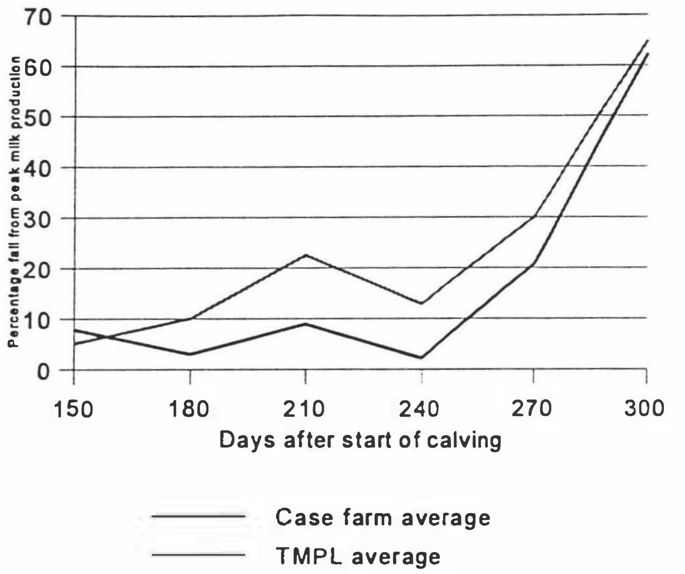

Figure 5.13 Percentage fall from peak for eight case-study farms and the 'average' Tui Milk Products Limited Supplier.

Supplement Policy

All farmers made the strategic decision to conserve pasture as hay or silage (Figure 5.15). However, one farmer did not conserve surplus pasture on the milking area, but used the run-off property on which to conserve supplements. On two farms, a summer crop was sown to provide feed for a possible dry summer[13], and farmer five grew a winter crop for the herd. Pasture surpluses were harvested in the spring and summer to be fed to the herd during periods when pasture supply was insufficient to meet herd demand (usually the late summer/autumn period and winter to early spring).

The strategic decision to use supplements allowed farmers to milk more cows (i.e. increase stocking rate) than would otherwise have been the case, increase per cow intake and therefore milk production and lengthen lactation (Table 5.6) (Figure 5.14). In particular, farmer seven had decided that supplements would be used to enable a much higher stocking rate to be carried on the farm

13 In October/November 1994 another two farmers, including Case Farm two where surplus pasture was not conserved on the milking area, had decided to plant crops for the summer to provide extra feed during possible dry periods.

(3.6 cows/ha cf. 2.4 cows/ha on average). In this case supplements, made on the farm and/or purchased from elsewhere, were fed to the cows at all times during the year. In addition, the use of supplements enabled the feed intake of high producing cows to be maintained throughout a longer lactation than for the average TMPL seasonal supply dairy farm (see Lactation Length). Although herds that were fed more supplements were milked for longer (Figure 5.15), in the case of farm four, supplementation was associated more with low winter pasture growth than lactation length. Apart from farm seven and farm four, the eight case-study herds had lactation lengths of between 268 and 273 days.

Table 5.6 The level of supplementation used on case-study farms and corresponding stocking rates and lactation lengths.

Farm	1	2	3	4	5	6	7	8
Stocking rate (cows/ha)	2.34	2.56	2.3	2.41	1.7	2.15	3.6	2.13
Lactation length (days)	273	267	268	250	272	268	278	268
Total feed consumed kg DM/cow	N/A	4,057	4,213	4,115	4,655	5,283	4,677	4,431
Total pasture consumed including nitrogen grown pasture kg DM/ha	N/A	9,740	8,939	8,178	7,202	10,656	10,484	8,808
Supplements fed including nitrogen grown pasture								
kg DM/cow	N/A	548	383	835	575	718	2,066	647
kg DM/ha	N/A	1,403	881	2,012	978	1,544	7,438	1,378
Percentage of diet consumed as supplements (%)	N/A	13.51	9.09	20.29	12.35	13.59	42.89	14.60

N/A Data not available from this farm to calculated feed consumed.

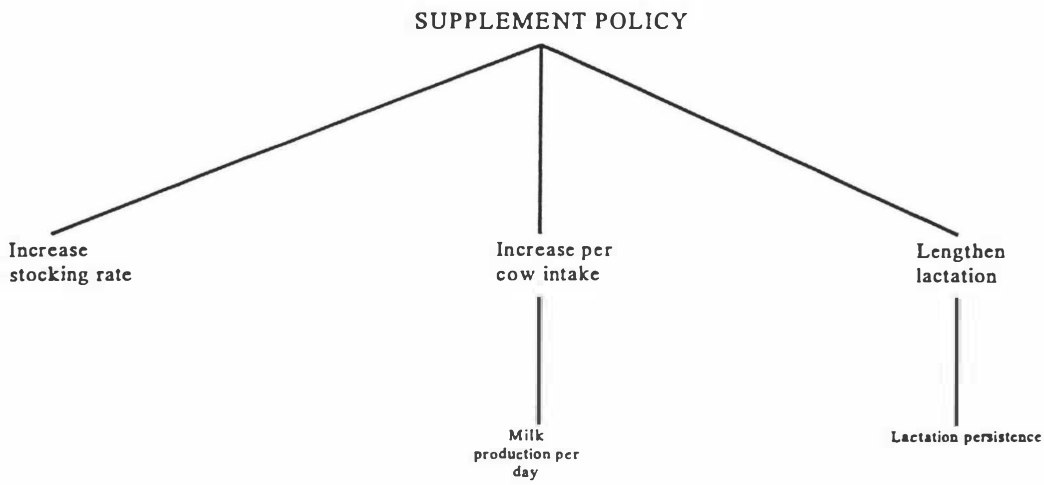

Figure 5.14 Factors influencing the supplement policy decision on high per cow production dairy farms.

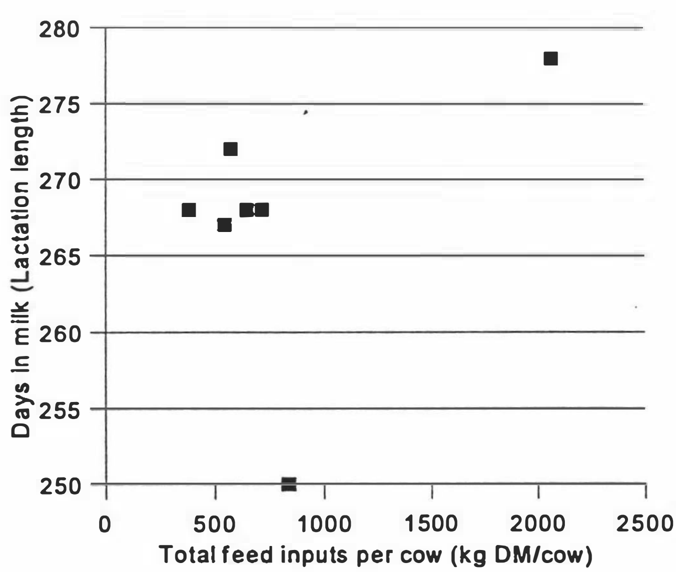

Figure 5.15 Total feed inputs per cow (kg DM/cow) and days in milk (lactation length).

Strategically all farmers made hay and/or silage to provide supplementary feed for the herd during periods of feed shortage, and, for seven farmers, to maintain pasture quality (Figure 5.16). Although the data presented in Figure 5.16[14] suggests that pasture was conserved and fed out at specific times of the year, the decisions about when pasture would be conserved and fed to cows was tactical and timing varied from year to year and farm to farm. Only on case farms one and four would paddocks be shut up based on the strategic supplement policy, rather than as part of tactical seasonal management decisions to conserve surplus pasture or maintain pasture quality according to the amount of pasture surplus to herd requirements (see Seasonal Management).

Total feed consumption on the case-farms was estimated to be 4,490 kg DM/cow/year (range 4,057 kg DM/cow to 5,283 kg DM/cow) (Table 5.6). To achieve these levels of consumption it was estimated that the use of supplements averaged 824 kg DM/cow/year (range 383 kg DM/cow (881 kg DM/ha) to 2,066 kg /cow (7,438 kg DM/ha)) (Table 5.6). This level of supplementation represented an estimated 18% of the cow's diet (range 9% to 43%) (Table 5.6). In addition to the use of hay, silage, winter and summer crops, and bought in feed (Figure 5.16), nitrogenous fertilisers were used to increase pasture supply.

[14] This figure is an adaptation of diagrams used by Jaubert (1986) and Leybourne(1993). These authors used this type of diagram to illustrate when, and what type of feed, was fed to sheep grazing on the Syrian Steppe.

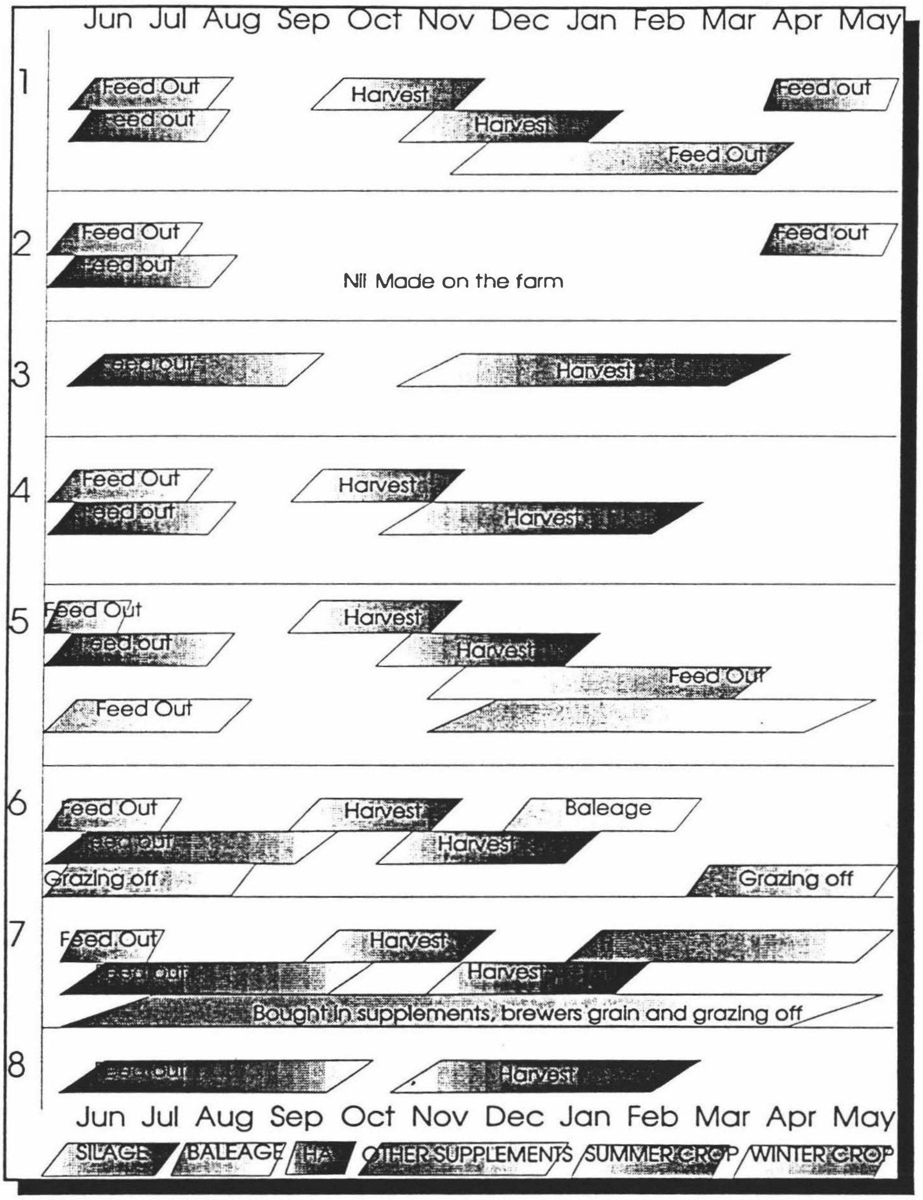

Figure 5.16 The type and use of supplements on eight case-study farm to achieve high per cow production.

Herd and Herd Improvement

Farmers had selected breeds that they liked to milk. Apart from selecting sires to continue the breed of cow that they had selected, no farmer mentioned the superiority of one breed over another.

The strategic or long term improvement of the genetic merit of the herd was a goal identified by all farmers interviewed. The foci of herd improvement included milk production, cow conformation and temperament (Table 5.7). Herd replacements were selected from all cows in the herd on four farms, from selected cows (i.e. those cows that were mated to dairy sires) on one farm, from the first calving cows on one farm and from the highest producing 50% of cows on two farms. Those farmers who selected their replacement heifers from the 'top' cows had a higher level of per cow production (Figure 5.17). However, because many farmers had increased cow numbers, herd replacement rates could not be regarded as an indicator for achieving high per cow production (see also Section 3.4.2).

Table 5.7 Methods used by farmers for improving their herds.

Farm	1	2	3	4	5	6	7	8	Total
Breed selection important [1]	✗	✗	✗	✗	✗	✗	✗	✗	0
AI mating used for breeding replacements									8
Premier Sire Services [2]	✔	✔	✔	✔	✗	✔	✔	✔	4
Nominated sires [2]	✗	✗	✔	✗	✔	✔	✗	✔	4
Stud bulls used	✗	✗	✗	✗	✔	✔	✗	✗	2
Replacements selected from	Top cows	All cows	First born calves	Selected cows	All cows	Top 50% cows	All cows	All cows	
Selection Criteria									
Production	✔	✔	✗	✔	♯	✔	✔	✔	6
Conformation	♯	✔	✗	♯	✔	✔	♯	✔	4
Good Temperament	♯	♯	✔	♯	♯	✔	♯	✔	3
Udder Conformation	✔	✔	✗	♯	✔	✔	♯	✔	5
Milkability (speed)	♯	♯	✗	♯	♯	✔	♯	✔	2
Culling criteria									
Age	✔	♯	♯	♯	♯	♯	✔	♯	2
Empty	✔	✔	✔	✔	✔	♯	✔	✔	7
Disease (including mastitis)	♯	♯	♯	♯	♯	♯	✔	♯	1
Production	♯	✔	♯	♯	♯	✔	✔	✔	4

1 Selection of breed unimportant except that farmers generally selected sires of the same breed as the cows in the herd.

2 Where Premier Sire Services (PSS) and Nominated sires are shown with a ✔ farmers may have nominated sires from the PSS 'team'.

✔ Farmers advised that these criteria or techniques were used.

✗ Farmers advised that these criteria or techniques were not used.

♯ Insufficient information available to indicate whether these criteria or techniques were used.

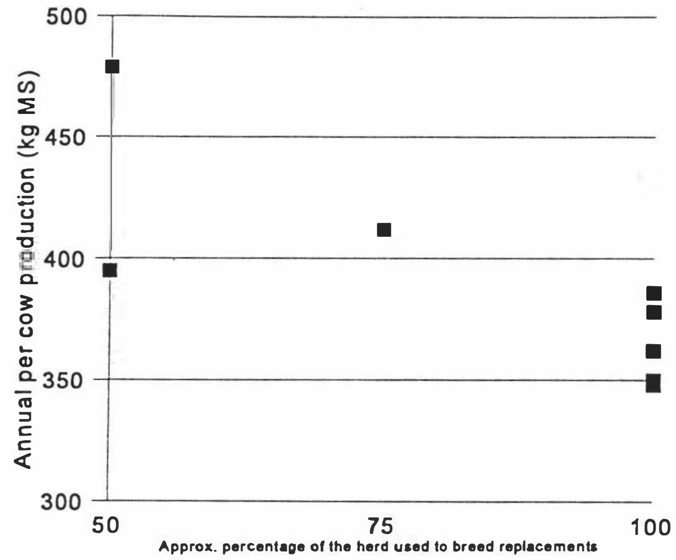

Figure 5.17 Relationship between method of selecting heifers and annual per cow production on high per cow production farms.

Rearing Replacement Stock

All farmers agreed that the rearing of replacement stock to ensure that replacement heifers were close to their mature size when they entered the milking herd was important, "... *look down a line of first calvers and cows ... can't see a massive difference in terms of height.*" (Table 5.8). The strategic decision to rear replacement stock to achieve this goal meant that heifers received top priority when allocating feed, either on the milking area or when they were grazed off the dairy unit (Table 5.8).

In two cases replacement heifers were grazed off-farm as yearlings and returned as in-calf two year olds. On two other farms heifers were sent to grazing as soon as they had been weaned, and returned as in-calf two-year-olds. On a fifth farm heifers were grazed off-farm for approximately 26 weeks of the year. On the remaining three farms, replacement heifers were grazed on the farm at all times, although one farmer would send the heifers to grazing if there were pasture shortages in the spring (see Tactical Management Table 5.15). If heifers were grazed on the farm, they were usually run midway in the rotation. Where heifers were grazed off the property, on a run-off owned by the farmer, they were able to be given top priority without infringing on the milking herd. Obtaining specific details about 'how' farmers reared their young stock was not part of this study, and although methods of rearing young stock have been researched (Bryant & McRobbie, 1991; MacKenzie & Brookes, 1992; Penno, 1994), information about how farmers manage their heifers would be useful (see Chapter 6, suggestions for further study).

Table 5.8 Goals for rearing replacement stock and where replacements are grazed on eight case-study farms.

Farm	1	2	3	4	5	6	7	8
Breed	FxJ	F (95%) J (5%)	FxJ	J	FxJ (50%) Ax (50%)	F	FxJ (95%) Ax (5%)	FxJ (50%) J (50%)
Where Grazed	In rotation	Run off block	In rotation, 26 weeks grazed off	In rotation	In rotation	In rotation until yearlings	Run off block	In rotation until yearlings
Size at joining herd	Mature height and weight	Mature size	Mature size	Mature body size	As big as possible	Mature size	Mature size	Mature size

Pasture Renewal

Pasture was renewed regularly on five farms. It was considered important by three farmers. Whilst the other two farmers replaced pasture as part of their annual management system, these farmers did not comment on its level of importance. "... *then rip her up and sow her back in grass*". For these two farmers pasture renewal appeared to form part of a cropping program rather than a conscious attempt to increase pasture production through new species. Of the three farmers who considered pasture renewal 'important' one replaced poorly performing pasture on a regular basis, another replaced pasture in 'rough paddocks as part of a redevelopment program and the third replaced pasture in paddocks as a part of regular renewal program. Farmers who had renewed pasture gained an appreciation of the potential of the new pasture by comparing differences in growth rates between new and existing pasture on their own properties, *"we buy a new grass species for the farm, we grow more grass so we can run more cows. But it does show us what we* *could do ... doing that work with the pasture has shown us the potential of the new grass species."* Of those farmers who did not have a regrassing program one commented that it was "... *not crucial*". Regrassing programs appeared to have had no effect on the amount of pasture consumed per hectare, although on the farm with the highest per cow production, farm six, and the farm with the highest stocking rate, farm seven, pasture consumed per hectare was estimated to be much greater than on any of the other farms studied.

Fertiliser

Fertiliser was applied to maintain fertility levels, and additional fertiliser was applied to those areas where soil fertility was lowest to increase Olsen P levels. Nitrogenous fertilisers (Urea, DAP and MAP) were applied in the winter and early spring to increase pasture growth in early lactation, and in the summer/autumn to increase pasture growth in the autumn and early winter.

Employing Labour

Four farmers decided that labour needed to be employed in order to run their farms (see Labour resource, Section 5.2.1). Farmer two commented that labour was required once the herd reached 100 head and the decision to employ labour was based on getting *"the job right and do it every day not every second day..."*. Farmer two employed labour because, "... *we couldn't milk the number of cows we have without staff, and we couldn't do our other enterprises without staff, ...*". Farmer seven made no specific comment about why staff were employed, however, the comments made by farmer two, who ran a similar sized business, are likely to apply equally to case-farm seven.

Shed / Races / Plant

Farmers are able to make strategic decisions about the shed, plant and races. Decisions regarding changes to layout, design, or the type of plant was claimed by one farmer to have affected per cow production on the farm. *"Changed their [the cows'] character, it changed the* *length of time we were in the shed,... we don't have to fight animals,... 140 odd cows we've got in an hour, the old one you'd be talking 2.5 hours sort of thing. We've done away with mastitis and temperament of the stock is 100% better than it was."* These changes were believed to have been responsible for increased per cow and total farm production and were one of the reasons that stocking rate on this farm could be increased. The farmers believed that by maintaining the shed, races and plant in good order and condition, stresses associated with moving and milking cows could be minimised. However, the level of stress was largely influenced by the handling of stock on the races and in and around the milking shed (see Tactical Management). The farmers were of the opinion that poor quality facilities reduced per cow production, and that good quality facilities, on their own, would not increase production but provided the environment in which high per cow production could be achieved.

Summary

The results presented in this section indicate the strategic management techniques farmers use to achieve high per cow production. The variations in the quality of farm resources presented in Section 5.2.1 are overcome, in part, by the strategic management of stocking rate, lactation length and supplementary feeding. However, as alluded to in the discussion of these strategic management techniques, season by season, tactical management is required to fine tune the farm system for increased production (Figure 5.18). The strategic management system adjusts the resource bundle to match feed supply with feed demand to ultimately achieve high per cow production. The techniques used to do this will be presented in the Tactical Management which follows.

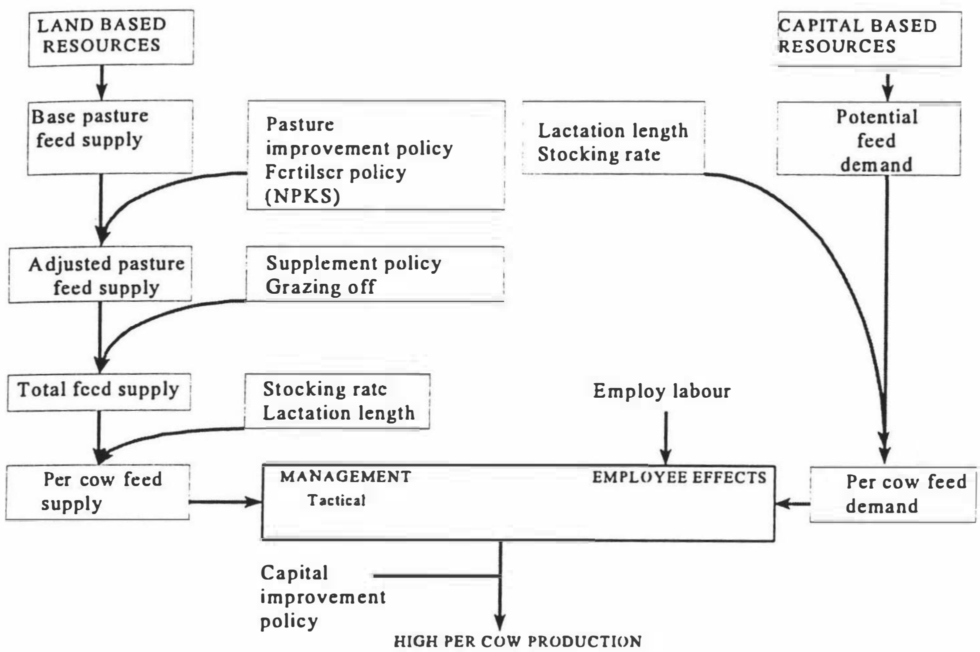

Figure 5.18 System to strategically adjust the resource bundle to match feed demand with feed supply to achieve high per cow production.

Tactical Management

The taxonomy of tactical management developed from the classification of data was initially split into five seasonal parts as well as labour, and planning and monitoring (Figure 5.1). The seasonal elements were further split into four main areas, feed (pasture and supplements), herd, replacements and soils (Figure 5.19). These subcategories have been dissected further to indicate individual tactical decisions, and again to show day-to-day, operational decisions.

As described earlier tactical management covers those short term, within-year decisions made to achieve the goal of high per cow production. In this section the discussion of tactical management has been separated into its seasonal elements: winter, calving, mating, mid/late lactation and drying off, as well as labour management, milking management, and planning and monitoring because many of the decisions are common to all seasons. Within each seasonal element farmer goals are identified, and the techniques used to achieve them are presented. All goals identified by the farmers, irrespective of how many times they were identified, are outlined in order to present a full understanding of how farmers achieve high per cow production.

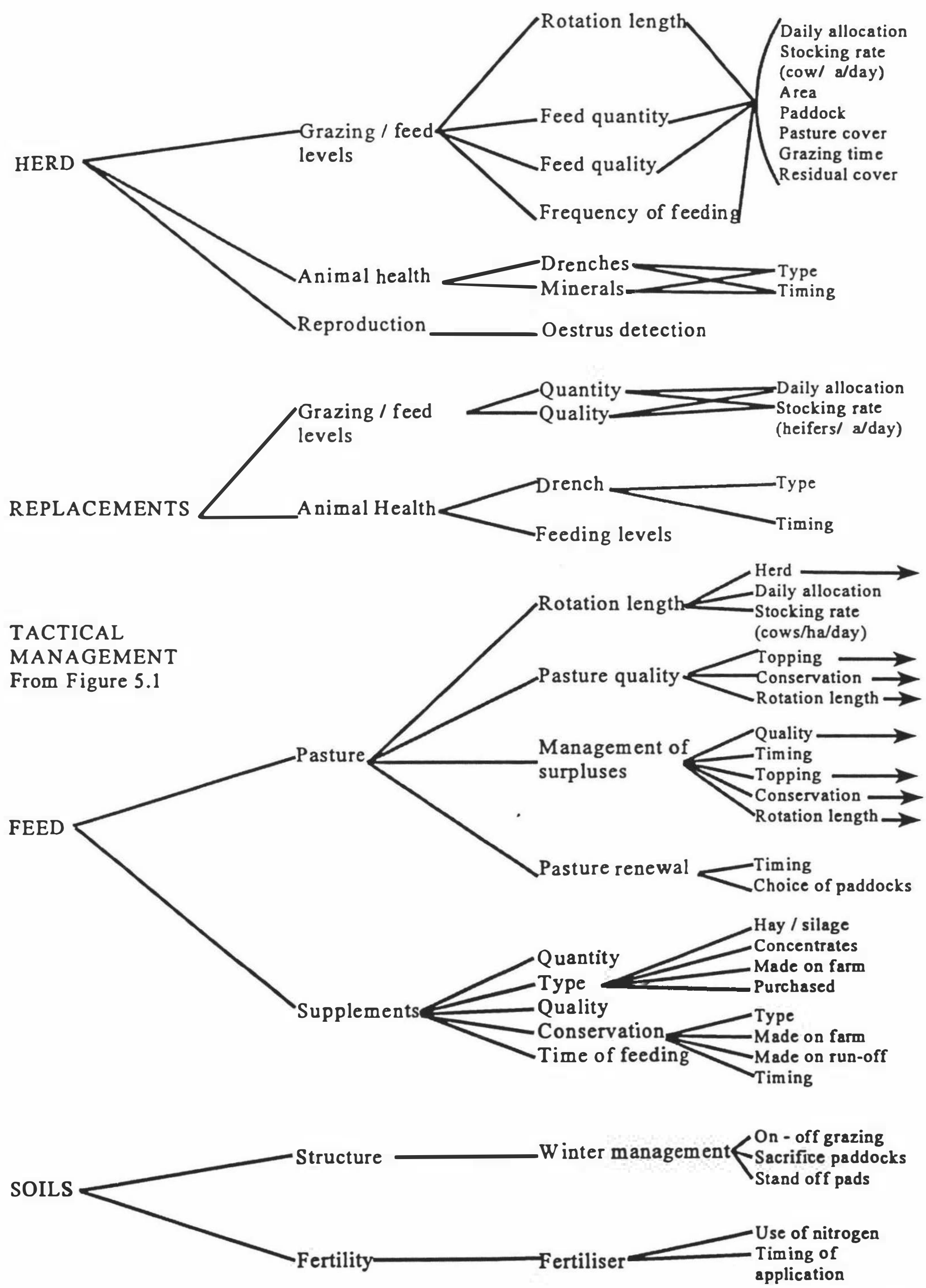

Figure 5.19 Taxonomy of tactical management developed during classification of the data from the interview transcripts.

Seasonal Management

Winter (June & July (August))

For seven farms the period of winter management covered June and July, and for the remaining farm which calved late, the period included August. The primary goal of winter management was to prepare the cows and the farm for calving and lactation. To achieve this the main goals for the winter management period were: to ensure sufficient pasture cover at calving in order to fully feed the cows thereafter; calve the herd at a specific condition score (commonly CS 5 - ranging from 4.5 to 6) to ensure milk production started early; maintain, or improve (i.e. increase disease and parasite resistance) animal health; and protect the soil and pasture from pugging damage, to ensure spring pasture growth rates were as high as possible. Two farmers also had a goal of 'building cows up' (i.e. increasing feed levels) prior to calving to ensure high milk production immediately after calving (Table 5.9) (Figure 5.20).

Table 5.9 Main goals for the winter on high per cow production farms.

Farm	1	2	3	4	5	6	7	8	Total
Main goals for the winter period									
To ensure sufficient pasture cover at calving to fully feed the cows thereafter	✔	✔	✔	✔	✔	✔	✔	✔	8
To calve the herd at specific condition score	✔	✔	✔	✔	✔	✔	✔	✔	8
To maintain or improve animal health	♯	✔	✔	✔	♯	✔	✔	✔	6
To protect soil and pasture from pugging damage	✔	✔	♯	♯	✗	✔	✔	✔	5
To 'build cows up' before calving	✗	✗	✗	✗	✗	✔	♯	✔	2

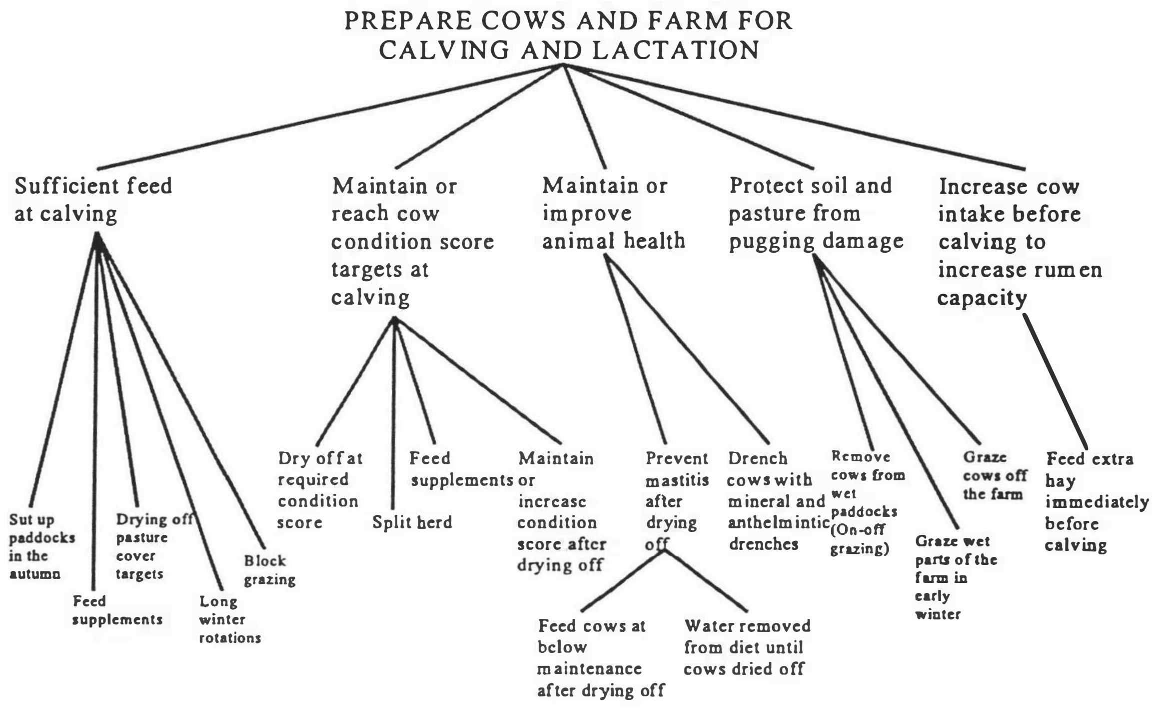

Figure 5.20 The goal hierarchy for tactical winter management.

All farmers had a goal to ensure there was sufficient pasture cover at calving to provide the cows with adequate feed thereafter. However, every farmer had a different method of achieving pasture cover targets at calving (Table 5.10).

Table 5.10 The methods used by farmers to achieve pasture cover targets at calving and to provide sufficient feed to feed the cows post-partum.

Farm	1	2	3	4	5	6	7	8	Total
Pasture cover target at calving	✔	✔	✔	✔	✔	✔	✔	✔	8
Level of pasture cover required at calving	1900 to 2000	2400 to 2500	2000 to 2100	N/D	N/D	2000 to 2100	2400 to 2500	22 cm	
Stocking rate (cows per hectare)	2.34	2.56	2.3	2.41	1.7	2.15	3.6	2.13	
Method used to achieve pasture cover targets									
Shut up paddocks in Autumn for calving	✔	✗	✗	✗	✔	✗	✗	✗	2
Dry off at pasture cover targets	✔	✔	✔	N/D	✗	✔	✔	N/D	5
Pasture cover target at drying off	1900 to 2000	2000	N/D	N/D	✗	1800	1600 to 1700	N/D	
Long rotation length (90 plus days)	✔	♯	✔	✔	✗	✔	✗	✔	5
Block grazing with back fence	✗	✗	✗	✗	✗	✔	✗	✗	1
Routine use of supplements									
Hay	✔	✔	✔	✔	✔	✔	✔	✔	8
Silage	✔	✔	✗	✔	✗	✔	✔	✗	5
Grazing cows off	✗	✗	✗	✗	✗	✗	✔	✗	1
Winter Crop	✗	✗	✗	✗	✔	✗	✗	✗	1
Supplements used if required and/or available									
Silage	R	R	✗	R	✔	R	R	✗	1
Grazing cows off	✗	✗	✗	✔	✗	✔	R	✗	2
Bought in maize silage or other supplements	✗	✗	✗	✗	✗	✗	✔	✗	1
Apply nitrogenous fertiliser	✗	✔	✔	✗	✗	✗	✗	✗	2
Controls feed residuals	♯	♯	♯	♯	♯	✔	✔	♯	1

N/D The level of pasture cover on these farms was not defined. However, these farmers had a visual impression of the amount of cover required.
✔ Techniques used by these farmers.
✗ Techniques not used by these farmers.
♯ Insufficient information available to indicate whether these techniques were used.
R These techniques were used routinely by these farmers.

All farmers had a pasture cover target at calving. Pasture covers had been 'measured' on five farms and these ranged from 1,900 to 2,500 kg DM/ha. On one farm a pasture cover target of 22 cm was required, whilst on the two remaining farms pasture cover targets were not specifically defined.

Instead, these farmers had a 'visual picture' of how the farm should look. All farmers used different winter management techniques to reach their 'target'.

For example, farmer one shut up one third of the farm in March and April (see Mid / Late Lactation), aimed for a pasture cover at drying off of approximately 1,900 to 2,000 kg DM/ha, employed a long winter rotation on two thirds of the farm, and fed hay and silage to the herd. This allowed pasture cover of 1,900 to 2,000 kg DM/ha to be achieved at calving. Farmer five, on the other hand, shut up two or three paddocks in late April to 'guarantee' pasture cover at calving, did not specify a pasture cover target at drying off, or maintain a long winter rotation. However, by utilising a winter brassica crop and feeding hay to the herd and not grazing pasture during the winter sufficient feed accumulated prior to calving.

Although all farmers used supplements during the winter to accumulate pasture in front of the herd, there was no common overall strategy used by the case-study farmers to achieve pasture cover targets at calving. Hay was the most common supplement fed to cows followed by silage. A winter crop was used by one farmer (see above) and cows were regularly grazed off by another. If required, other supplements (silage, maize silage) and grazing cows off the milking area were used to increase thew winter feed supply.

Achieving a pasture cover target at drying off gave farmers a pasture 'base' from which to accumulate pasture for calving. Although three farmers did not specify the amount of pasture cover required at drying off they were aware of the need to have strategies in place to achieve pasture cover targets at calving. One commented that *"we don't like to dry off and have the farm completely bare"* and used a 120 rotation to accumulate pasture for calving, another, that cows can be put *"on to a diet of hay for a period"* because there was a good supply of hay on hand, and the third elected to grow a winter crop and not graze pasture during the winter.

Other means of accumulating pasture cover at calving and to provide sufficient feed after calving were to: block graze the cows, *"you back fence all the time ... cut it into blocks so they don't go back on and nip off emerging shoots"* and apply nitrogenous fertiliser during the winter. Not restricting pasture regrowth was also the aim of farmer seven who prevented the herd from grazing pasture to low residuals. *"It's this taking the grass down to the deck that concerns me."* By leaving higher pasture residuals, the farmer believed pasture regrowth was more rapid and therefore pasture cover targets were achieved more easily.

As well as aiming for pasture cover targets at calving, all farmers aimed to calve their cows at specific condition scores to ensure milk production started early and post-partum health problems were avoided. Although farmers were aware of the LIC 10 point condition score system, the consistency of their condition scoring was not tested. To achieve condition score targets, cows were usually dried off close to the level required at calving (Table 5.11). However, four farmers aimed to increase the condition score of all their cows during the winter, while a fifth aimed to increase the condition score of those cows that were underweight at drying off. Four farmers aimed for a condition score of 5, three for a condition score of 5.5 and the eighth farmer aimed for a condition score of 4.5 at calving. The farmer with the lowest target did not *"believe in feeding cows and getting them up to ultimate condition score and then starving them in the spring and losing all that you've gained."* Farmers fed their cows as much as required to achieve their condition score targets, although there were some differences in the way this was done as outlined in (Table 5.11).

Table 5.11 Methods used by the eight case study farmers to achieve condition score targets at calving.

Farm	1	2	3	4	5	6	7	8	Total
Condition score targets at calving	✔	✔	✔	✔	✔	✔	✔	✔	8
Level of condition score at calving	4.5	5.5 to 6	4.5 to 5	5	5	5.5	5.5	5 +	
Average cow condition score target at drying off	4.5 ①	4.5 to 5	N/D	N/D	N/D	< 4.5	N/D	N/D	
Feeding levels (kg DM/cow/day)	♯	♯	9 to 10	♯	♯	9 to 13	♯	♯	
Method used to achieve condition score targets									
Split herd	✔	✔	✗	✗	✗	✗	✗	✗	2
Dry off at condition score targets	✔	✔	✔	✔	✗	✔	♯	✔	6
Maintain condition score	✔	N/A	N/A	✔	✔	N/A	N/A	✔	4
Increase condition score	✔	✔	✔	N/A	N/A	✔	✔	N/A	5
Routine use of supplements									
Hay	✔	✔	✔	✔	✔	✔	✔	✔	
Silage	✔	✔	✗	✔	✗	✔	✔	✗	
Other	✗	✗	✗	✗	✔	✗	✔	✗	

N/D These farmers either did not have a specific condition score target at calving or did not define what that score was.
N/A This method not applicable in this case.
① Cows below condition score four at drying off on this farm were given additional feed over winter (see text).
✔ Techniques used by these farmers.
✗ Techniques not used by these farmers.
♯ Insufficient information available to indicate whether these techniques were used or what the level of feeding during winter was.

On two farms, herds were split for the achievement of condition score targets at calving. Both farmers separated rising two year old heifers from MA cows and on one of these farms cows which were dried off at below condition score 4, *"anything that is looking a bit light"*, were run with the heifers. In these cases the animals were fed at above maintenance levels in order to gain weight to reach condition score targets. Specific condition score targets at drying off were only defined on three farms. However, on the remaining farms cows were maintained at high condition scores (relative to those suggested in the literature (Holmes & Wilson, 1987)) throughout the year and no specific targets were set for drying off. Two farmers stipulated feeding levels, and indicated that cows were fed between 9 and 13 kg DM/head/day while they were dry, although in both cases these farmers were aiming to increase condition score.

On six farms the management programme during the winter included specific techniques for maintaining or improving animal health. Generally these techniques involved drenching the livestock with mineral or antibiotic drenches. On some farms steps were taken to ensure cows did not contract mastitis after drying off (Table 5.12). Farmers believed that maintaining animal health reduced stress in their cows and therefore was important contributor towards high per cow production.

Table 5.12 Methods used by six of the farmers to maintain animal health on their farms.

Farm	1	2	3	4	5	6	7	8	Total
Specific techniques for maintaining health during winter	♯	✔	✔	✔	♯	✔	✔	✔	6
Cows drenched for internal parasites	♯	✔	✔	♯	♯	✔	♯	♯	3
Special methods used to control mastitis in cows after last day of milking									
Below maintenance feed	♯	♯	✔	♯	♯	✔	✔	♯	3
Water removed from the diet	✗	✗	✗	✗	✗	✗	✔	✗	1
Mineral drenches used during the winter	♯	✔	♯	✔	♯	✔	♯	✔	4
Selenium	♯	✔	♯	♯	♯	✔	♯	✔	3
Other minerals	♯	♯	♯	✔	♯	✔	♯	♯	2

✔ Techniques used by these farmers.
✗ Techniques not used by these farmers.
♯ Insufficient information available to indicate whether these techniques were used.

Although there was no specific mention of 'wet' soils being a constraint on the case-farms, preventing soil and pasture damage by pugging was considered important by six of the farmers (Table 5.13) to ensure that early spring pasture growth was as high as possible. All methods used to prevent soil and pasture damage, involved removing cows from paddocks susceptible to pugging in periods of wet weather. Direct methods (i.e. those used when the cows were grazed on pasture on the milking area) were to stand cows on the race, on a sacrifice area set aside for the purpose, or on specially constructed feed/stand-off pads. In one case the farmer used the variety of soil types on the property to advantage by grazing cows on wetter areas initially and the drier sandy areas later in the winter which reduced the level of damage to pasture and soils on wetter areas of the farm. The indirect methods used were to graze the cows off the milking area during the winter, either on a separate run-off area, or on winter crop on the farm (Table 5.13).

Table 5.13 Methods used to prevent soil and pasture damage.

Farm	1	2	3	4	5	6	7	8	Total
Preventing soil and pasture damage considered important	✔	✔	♯	♯	✔	✔	✔	✔	6
Direct methods									
Graze wet part of farm early winter	✗	✔	♯	✗	✗	✗	✗	✗	1
On off grazing (races or feed pads)	✔	✗	♯	✗	✗	✗	✔	✔	3
Cows stood off on sacrifice paddock	✗	✗	♯	✗	✗	✔	✗	✗	1
Indirect methods	✗	✗	✗	✔[3]	✔[1]	✔[3]	✔[2]	✗	4

1 Cows grazed on a winter crop during the winter.
2 Cows grazed off the milking area for 40 to 50 days during the winter.
3 Cows were grazed off these properties if required. The prevention of pasture and soil damage was not necessarily the reason that cows were removed from the property.
✔ Techniques used by these farmers.
✗ Techniques not used by these farmers.
♯ Insufficient information available to indicate whether these techniques were used.

Two farmers increased the amount of hay they fed to cows immediately prior to calving. This technique was used to increase the size of the rumen and to adapt it to the large increase in feed intake after calving. They believed this enabled the cow to produce at high levels more quickly. This process is similar to that known as 'steaming up' in drylot feeding situations (Lean, 1987). In addition, farmer eight liked to ensure that the cow's energy intake increased to prevent post-partum health problems and that they milked to their full potential for all of the coming lactation. Other farmers increased feed intake immediately after calving to achieve high early production levels (see Calving).

Calving (August & September) (September & October)

Calving covered the period August and September, except for the farm with the later calving date where the period was September and October. The primary goal for the calving period was to ensure cows began lactation early and reached peak production as soon as possible. To achieve this the main goals identified for the calving period were: to fully feed the cows after calving, to maintain animal health, to ensure pasture is of a high quality, as well as, reduce calving spread, detect anoestrus cows and maintain cow condition (Table 5.14) (Figure 5.21).

Table 5.14 Planned start of calving dates and main goals for the calving period on high per cow production farms.

Farm	1	2	3	4	5	6	7	8	Total
Planned start of calving									
Heifers	20/7	20/7	20/7	20/8	1/8	1/8	10/8	1/8	
M A Cows	20/7	10/8	20/7	20/8	1/8	1/8	10/8	1/8	
Median calving date (days after planned start of calving)	31	24	14	15	30	14	15	19	
Main goals for calving period									
Fully feed cows after calving	✔	✔	✔	✔	✔	✔	✔	✔	8
Maintain animal health	✔	✔	✔	✔	♯	✔	✔	✔	7
Ensuring pasture is of high quality	✔	✔	✔	✔	✔	✔	✔	✔	8
Reduce calving spread (induce cows)	✔	✔	✗	✗	✗	✗	✔	✔	4
Detect anoestrus cows	✔	✔	✔	✗	✗	✔	✔	✗	5
Maintain cow condition	✔	✔	✔	✔	✔	✔	✔	✔	8

✔ Techniques used by these farmers.
✗ Techniques not used by these farmers.
♯ Insufficient information available to indicate whether these techniques were used.

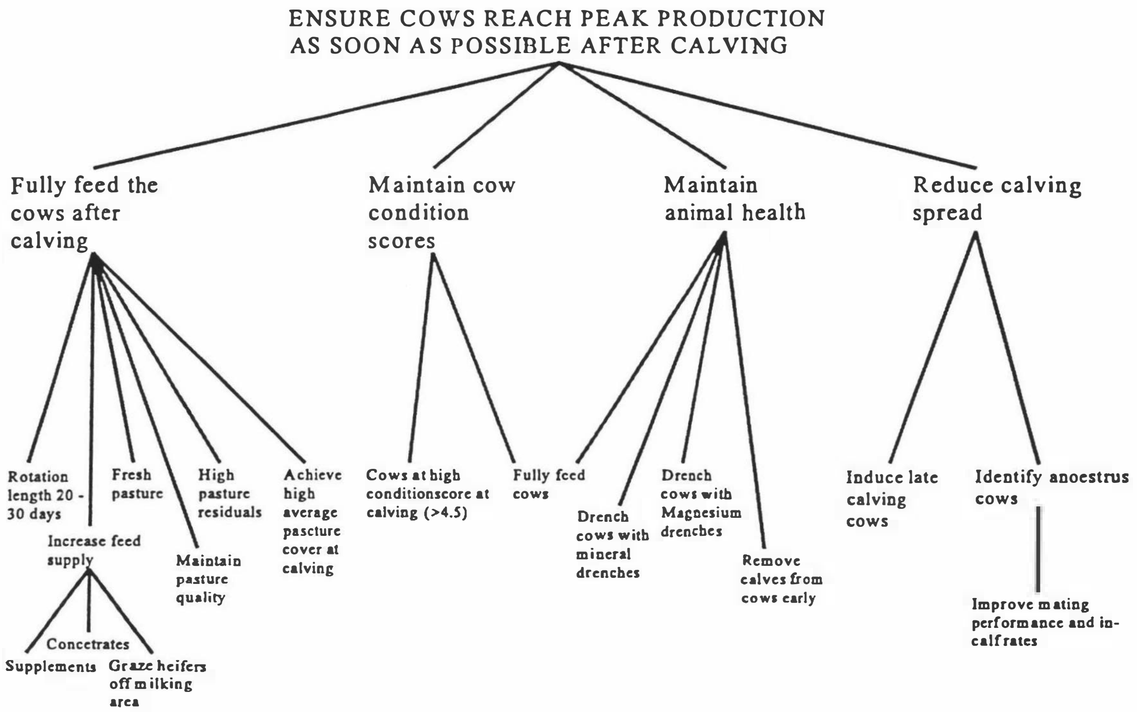

Figure 5.21 Goal hierarchy for tactical management during Calving.

All farmers had a goal to fully feed cows after calving, six specifically stating that this was to ensure that the cows began lactation quickly and reached peak production as soon as possible. To fully feed cows immediately after calving farmers ensured there was sufficient feed available at calving (see Winter) (Table 5.10). However, to fully feed the cows after calving the methods used to manage the herd and farm differed (Table 5.15).

Table 5.15 The methods used to fully feed cows immediately after calving and to ensure cows commence high levels of milk production.

Farm	1	2	3	4	5	6	7	8	Total
Ensure adequate pasture cover at calving	✔	✔	✔	✔	✔	✔	✔	✔	8
Pasture cover target at calving (kg DM/ha)	1900 to 2000	2400 to 2500	N/D	N/D	N/D	2000 to 2100	2400 to 2500	22 cm	
Feed intakes (kg DM/head/day)	♯	♯	15	♯	♯	15 to 18	20	♯	♯
Methods used to fully feed cows									
Rotation length (days)	20 to 30	20 to 25	20 to 30	30 to 35	Set stock	20 to 25	♯	20 to 25	
Fresh pasture offered every (hours)	24	12	12	12	N/A	12	12	>12	
Pasture residuals	♯	1500 to 1600	High N/D	♯	N/A	♯	High 10 cm	♯	
Routinely feed supplements	✗	✗	✗	✗	✗	✗	✔	✗	1
Maintain pasture quality	✔	✔	✔	✔	✔	✔	✔	✔	8
Remove paddocks from grazing rotation for later conservation	✔	✗	✗	✔	✗	✗	✔	✗	3
Paddocks topped	✗	✗	✔	✔	✗	✗	✔	✗	3
Rotation length progressively reduced	✗	✔	♯	♯	✗	✔	♯	✔	3
Graze paddocks with yearling heifers	✗	✗	✗	✔	✗	✗	✗	✗	1
Methods used to ensure cows produce well early									
Fully feed cows				See above					
Routinely feed hay	♯	♯	✔	♯	♯	✔	✔	✔	4
Feed other supplements if required	✔	✔	♯	✔	✗	✗	✔	✗	4
Remove calves from cows early	♯	♯	♯	♯	✗	✔	♯	✔	2
Fully milk out cows after removing calves	♯	♯	♯	♯	♯	♯	♯	✔	1
Methods used to increase feed supply if pasture growth low									
Supplements	✔	✗	✔	✔	✗	✔	R✔	✗	4
Meal or concentrates	✗	✔	✗	✗	✗	✗	✔	✗	2
Graze heifers off milking area	✔	R	✗	✗	✗	R	R	R	1

N/D The level of pasture cover or pasture residuals on these farms was not defined.
R These techniques were already routinely used on these farms.
N/A These techniques were not applicable on this farm.
✔ Techniques used by these farmers.
✗ Techniques not used by these farmers.
♯ Insufficient information available to indicate whether these techniques were used.

Earliest calving cows were initially fed on the pasture 'saved' during the winter period. Once the whole herd had calved, usually mid September, it was fully fed by maintaining grazing rotations of 20 - 35 days, with shorter rotation lengths occurring towards the end of the period as more cows entered the herd. Seven farmers had predetermined contingency plans to maintain feed intake if pasture shortages were experienced during this period. These strategies included feeding hay and/or silage, purchasing meal or concentrates and grazing yearling heifers off the milking area. The eighth farmer, who set stocked his herd, break-fed the herd until the middle of September as a precautionary strategy to avoid pasture deficits. However, if they did eventuate the farmer had no 'back up' strategy, unless the supply of hay and silage had not been exhausted during the winter.

Making sure pasture residuals remained high (1,500 - 1,600 kg DM/ha (10 cm)) was used as an indicator whether cows were being fully fed by three farmers. Four other farmers monitored residuals but did not define the levels they considered necessary to indicate cows were being fully fed. One farmer commented that *"they leave a lot behind, you can't make them graze it down"*, and that high residuals were necessary to achieve high per cow production, *"... we don't use cows to clean up pastures"*. High feed intake from the commencement of lactation was important, and intakes of 15 to 20 kg DM/cow /day were reported by three farmers, *"...cram as much into them as they'll eat right from the word go..."*. One farmer, stocked at 3.6 cows per hectare, fed supplements daily from the beginning of lactation irrespective of the level of pasture available.

Another important aspect for ensuring cows were fully fed was to offer fresh, and non-fouled pasture. Fresh pasture was offered to cows on six farms through 12 hour grazing, *"they're getting fresh pasture night and day, ... better to go back to the paddock onto something fresh rather than go back to something that's been fouled up..."*. On the remaining two farms, one used a 24 hour grazing system (cows were only offered fresh pasture after every second milking), and the other set stocked the cows on one half of the farm during the day and the other half at night. Although the cows were not offered 'fresh pasture', they were able to select the 'best' pasture to graze which in effect is offering cows fresh feed after each milking.

The last three farmers interviewed believed that cows were not able to obtain the greatest benefit from the fresh pasture early in lactation. Because fresh pasture was offered after each milking, and cows were encouraged to eat as much as possible, the rumen was unable to process all the nutrients available, particularly proteins, these farmers fed hay to their cows. *"... feed them a bit of hay to start with because of the pasture being 85 - 90% water, ... 1 bale for every 5 cows."* Hay was fed to 'slow' the flow of digesta through the rumen, to enable more of the available nutrients to be processed, *"... 1 bale for every 10 cows ... to slow the gut down when they've got fresh lush grass, it's just so to get more out of that grass, it's very good for us to get that fibre in the diet."* as well as increase cow intake. *"You give them a bit of hay as well, try to get their stomach exploded, about a bale to 20 [cows]."* Information from the first five farmers was not collected (see comments Chapter 6).

Finally, two farmers commented on the need to remove calves from their dams early in order to get cows producing milk straight away. One farmer removed the calves from the cows within 12 hours after birth. This was *"... because the cow settles down very quickly ..."* and also *" we can look after their calves far better ..."* (see Animal Health). On farm eight cows were fully milked out to encourage early high milk production as soon as their calves were removed, usually within 24 hours. However, on farm five the calves were left on their dams for up to four days to ensure that they got all the colostrum milk available. The cows were then bought into the herd for milking. The first two farmers believed that their tactics influenced high per cow production, whereas, the third farmer was more concerned with ensuring calves obtained their full allocation of colostrum than about the delays in getting the cow machine milked.

To achieve a long lactation targets, inductions were used to shorten calving spread by four farmers (Table 5.16). The other farmers did not use inductions to reduce calving spreads and relied on mating management techniques to ensure that calving spread was as short as possible. Although inductions were used, calving spread for the eight case-farms still averaged 66 days. The median calving period for the case-farms averaged 20 days (range 14 days to 31 days). The farmer with the pedigree herd did not induce cows because of the loss of valuable progeny.

Pasture quality during early lactation (Table 5.16) was considered important by all farmers to enable full feeding of cows in early lactation. Pasture quality was maintained by removing paddocks from the rotation when pasture became surplus to herd requirements for later harvesting as silage, achieving a short rotation length by the end of September (October for farm four), topping pasture if required, and grazing paddocks with yearling heifers (Table 5.15).

Rotation lengths were reduced on three farms as a means of maintaining a high level of pasture quality. Rotation lengths on these farms were as short as 20 days by the end of September. This rotation length allowed *"the quality [to be] fairly good because it's [pasture length] not let get too long."* However, on farm six pasture quality was often not a problem due to slower growth rates and pasture surpluses were not usually experienced before the end of September. It is likely that the calving date was earlier, relative to expected high spring pasture growth rates, on this property than the other farms (see farmer comments in Pasture Resource).

Even if pastures get too long early in the season, three farmers were prepared to top paddocks to maintain pasture quality. *"... a lot of our pastures probably do look scruffy, but that's only a mower away from cleaning them up."* Two of these farms had average stocking rates (2.3 and 2.4 cows/ha) and the third a high stocking rate of 3.6 cows/ha. However, this farmer fed additional supplements, brewers grain and cheese whey to the cows, and due to the substitution effect occurring when supplements were fed pastures were often below optimum quality. Dependent upon the quality of the pasture, those paddocks with surplus feed in them may be shut up for silage rather than topping and wasting the pasture.

One farmer commented that fully feeding livestock and maintaining cow condition assists in maintaining animal health. Information about the other farms and observation of their cows indicated that this belief is likely to be common amongst all farmers, however, this was not confirmed during the follow up interviews (see Chapter 6). In addition, farmers ensured metabolic problems were kept to a minimum after calving and that animal health was maintained by drenching with minerals and Causmag (Table 5.16).

Table 5.16 Methods used to maintain animal health on eight case-study farms in the lower North Island of New Zealand.

Farm	1	2	3	4	5	6	7	8	Total
Method used to maintain animal health									
Drench cows or dust pasture with Causmag or other magnesium product	✔	✔	✔	✔	✗	✔	✔	♯	6
Drench cows with multi-mineral drench	✔	✔	♯	♯	✗	♯	✔	✗	3
Drench cows with selenium	✔	♯	♯	✗	✗	♯	✔	✔	3
Drench cows with aloe-vera	✗	✗	✗	✗	✗	✗	✔	✗	1
Drench cows with molasses	✗	✗	✗	✗	✗	✗	✔	✗	1
Fully feed cow to maintain cow condition	♯	♯	♯	♯	♯	♯	♯	✔	1
Remove calves from cows early to protect calf and ensure sufficient replacements (rearing replacements)	✗	✗	✗	✗	✗	✔	✗	✗	1

✔ Techniques used by these farmers.
✗ Techniques not used by these farmers.
♯ Insufficient information available to indicate whether these techniques were used.

Drenching cows with Causmag was the most common method of reducing metabolic disorders after calving (six farmers). Doses ranged from 20 to 70 grams per day. One farmer, because they were unable to drench in the rotary cowshed, dusted the paddocks prior to the night grazing. Other drenches used to maintain mineral levels were used on four farms. On farm eight the farmer concentrated on maintaining cow condition by fully feeding the herd rather than drenching with Causmag, although selenium was used to overcome a deficiency on the farm. Only one farmer, who set stock the herd during this period, did not comment on the health of the herd.

Detection of oestrus during mating was considered an important part of management during mating by all farmers (see Mating). However, five farmers also considered it important to detect anoestrus cows before the planned start of mating (Table 5.14) and those with unusual oestrus behaviour, in order for them to be attended to by a veterinarian prior to mating. Cows were tail-painted to identify anoestrus cows and farmer six kept accurate records of all pre-mating heats. Other farmers did not keep pre-mating heat records and relied on oestrus detection during mating to put cows up for AI (see Mating).

Maintaining cow condition as high as possible was an important goal for the calving period, particularly leading up to mating. This was achieved by fully feeding the cows from the day they entered the milking herd as previously discussed, and ensured animal health and contributed to a concentrated calving pattern (see Mating).

Mating (October & November) or (November and December)

Mating management covered the period October and November, except for the farm with the later calving date where mating occurred during November and December. The primary goal for mating was to achieve a concentrated calving pattern. This was achieved by fully feeding the cows (which also maintained milk production); and maintaining pasture quality; maintaining animal health and correctly detecting oestrus activity (Table 5.17) (Figure 5.22). Other goals were to prepare feed for a dry summer, to harvest silage and hay and conserve feed for the winter (Table 5.17).

Table 5.17 Important goals identified for the mating period on high per cow production farms.

Farm	1	2	3	4	5	6	7	8	Total
Planned start of mating									
Main goals for mating period									
Fully feed cows	✔	✔	✔	✔	✔	✔	✔	✔	8
Shut up and/or harvest supplements									8
Silage	✔	a	✗	✔	✔	✔	✔	✗	6
Hay	✔	a	✔	✔	✔	✔	✔	✔	8
Achieving a concentrated calving pattern	✔	✔	✔	✔	✔	✔	✔	✔	8
Maintaining pasture quality	✔	✔	✔	✔	✔	✔	✔	✔	8
Implement strategic decision to provide feed in preparation for a dry summer	✔	✔	✗	✗	✔	✗	✗	✗	3
Implement strategic decision to provide additional feed for winter	✗	✗	✗	✗	✔	✗	✗	✗	1
Maintain animal health	✔	♯	♯	♯	♯	♯	♯	✔	2

a This farmer did not make hay and silage on the milking area. Conserved supplements were provided from a run-off property owned by the farmer.

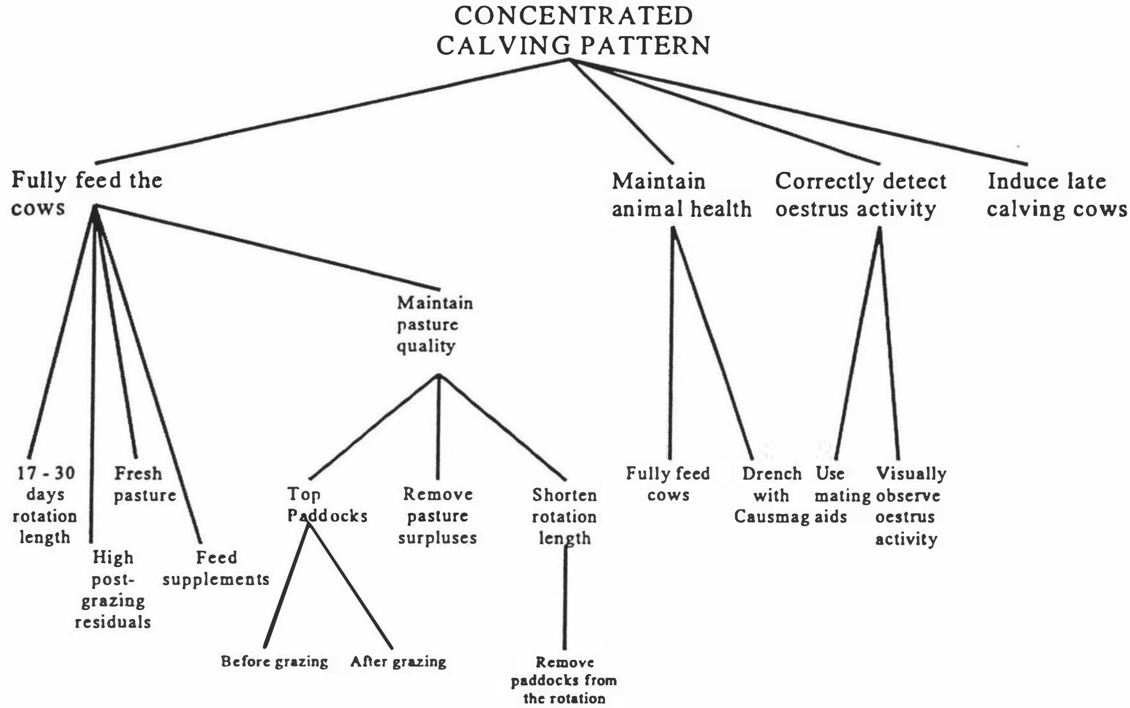

Figure 5.22 Goal hierarchy for tactical management during Mating.

All farmers aimed to fully feed their cows during the mating period in order to achieve a concentrated calving or a good conception rate. One farmer stated that " *AB's the hardest part* [of tactical farm management] *"if you get that wrong you've got the whole lot wrong"*. Different methods were used to ensure the cows were fully fed during this period (Table 5.18).

Table 5.18 Methods used by case-study farmers to fully feed their dairy cows during mating.

Farm	1	2	3	4	5	6	7	8	Total
Rotation length (days)	30	20 to 25	20	30	set stock	18 to 20	♯	17 to 25	
High feed residuals (kg DM/ha)	♯	1500 - 1600	High N/D	♯	♯	1500 - 1700	High N/D	♯	
Routine use of supplements	✗	✗	✗	✗	✗	✗	✔	✗	1
Fresh pasture offered every (hours)	24	12	12	12	set stock	12	12	>12	
High quality pasture	✔	✔	✔	✔	✔	✔	✔	✔	8
Topping paddock	♯	✔	✔	✔	✗	✔	✔	✔	6
Top after grazing	♯	✔	✔	✔	✗	✗	✔	✔	5
Top before grazing	✗	✗	✗	✗	✗	✔	✗	✗	1
Surpluses removed as hay or silage	✔	N/A	✔	✔	✔	✔	✔	✔	7
Paddock removed from rotation									
Shut up for hay and silage	✔	N/A	✔	✔	✔	✔	✔	✔	7
Summer or winter crops being grown	✔	✔	✗	✗	✔	✔	✗	✗	4
Supplements / concentrates fed if required	✗	✔	✗	✗	✗	✗	✔	✗	2
Rotation length shortened	✗	✔	✔	✗	✗	✔	✔	✔	5

N/D The level of pasture residual was not defined by these farmers.
N/A This technique was not applicable to this farm.
✔ Techniques used by these farmers.
✗ Techniques not used by these farmers.
♯ Insufficient information available to indicate whether these techniques were used or to specify what the rotation length or pasture residuals were.

To ensure cows were fully fed four farmers shortened their grazing rotations. Others farmers, one and four, maintained the 30 days rotations set earlier in the year. Rotation lengths were often shortened as a consequence of shutting paddocks up for silage or hay. Similar pasture residuals (1,500 to 1,600 kg DM/ha) were desired as discussed previously and cows were offered as much to eat as possible. Farmer seven continued to feed brewers grain, or other supplements if required to maintain full feeding levels and keep intake as high as possible. To encourage cows to consume as much pasture as possible cows were offered fresh, high quality pasture as previously discussed. The feeding of hay was discontinued by those farmers who used it in early lactation as a means to improve the nutritional balance of their cow's diets.

Although fully feeding cows at this time of the year was considered important, accurate oestrus detection was also an important component in achieving a concentrated calving pattern. Regular oestrus detection, from two to six times a day, was used to identify cows that were ready for mating (Table 5.19). Farmers observed cows in the paddock two, three or four times a day, and if cows were also observed at the cowshed, oestrus activity could be checked up to six times within a 24 hour period. Frequency of detection helped maximise submission rate (Table 5.19). The farmer who observed the cows most often had the shortest calving spread, although some cows were induced to further reduce calving spread. Farmers with calving spreads of 61 to 70 days observed oestrus from two to four times a day while those with calving spreads greater than 70 days only detected oestrus twice a day or the observation pattern was not obtained. Mating aids, for example tail-painting, were used to aid oestrus detection, although one farmer commented that using tail paint during mating made him lazy, however, tail paint was used to identify anoestrus cows prior to mating.

Table 5.19 Oestrus detection frequency and mating aids used on case-study farms. The resulting calving spread is also shown.

	1	2	3	4	5	6	7	8
Detection frequency (times per day)	2	♯	♯	4	2	2 - 3	6	2
Number of people observing oestrus	1 (2)	1 (2)	2	2	1	2	2 (3)	1 (2)
Where cows observed	Paddock	♯	♯	Paddock and cowshed	Paddock	Paddock	Paddock and cowshed	Paddock
Mating aids used	None	Tail painting x2	Tail painting	None	None	Tail painting x3	Tail painting x3	None
Calving spread	72	82	75	61	67	70	36	70
Inductions used at calving	✓	✓	♯	✓	✗	✗	✓	♯

✓ Techniques used by these farmers.
✗ Techniques not used by these farmers.
♯ Insufficient information available to indicate whether these techniques were used.

Maintaining pasture quality in early summer was considered an important prerequisite for fully feeding cows by all farmers. To maintain pasture quality farmers chose from a selection of three methods (Table 5.18), and used either short rotations (< 25 days), topping paddocks or removing paddocks from the grazing rotation.

Farmers who maintained pasture quality by using fast rotations maintained them throughout the mating period. Those farmers who topped pasture monitored post grazing residuals to determine which paddocks should be topped. They chose either pre-grazing (one farmer) or post-grazing (five farmers).

Pasture quality was also maintained by removing paddocks either, for harvesting surplus pasture as silage or hay, or for planting crops for the summer and winter. This technique reduced the number of paddocks available for grazing, increasing the effective stocking rate of the herd and effectively reducing the grazing rotation. Conserved pasture in these cases (five out of eight farms) was a by-product of a good growing season rather than the result of a specific strategy to conserve pasture.

Five farmers harvested silage during to provide feed for summer/autumn dry periods and for winter feed. The remainder, who set aside pasture to maintain pasture quality, monitored pasture residuals and quality to determine the course of action that need to be implemented. *"... got to start looking at your pasture quality ... identify the pasture that's getting away and they might go into silage or whatever."* To ensure paddocks returned to the grazing rotation as quickly as possible, silage was generally harvested within two months of the paddock's last grazing date. Four farmers aimed to make good quality silage by harvesting it early, as this resulted in both good pasture regrowth and quality, *"... don't like it to be out of the rotation for too long, ... another full rotation, about 40 days, then its cut when it was due to come back into the rotation."* Hay was made during this period by only one farmer to conserve surpluses.

Animal health was specifically stated as a goal by two farmers. Cows continued to be drenched with Causmag until late November on farm two, although the dose rate was progressively reduced as pastures matured. On farm eight regular drenches with selenium are continued because of the deficiency on that farm; the selenium drenches also improve cow oestrus. Animal health issues on the remaining six farms for the mating period were not detailed although maintaining cow condition was an important consideration and linked by farmers to animal health.

Mid / Late Lactation (End of mating period to April)

The main goal identified for the period from the end of mating until the end of April was: to fully feed the herd to maintain high levels of milk production throughout lactation. This was associated with the goal of maintaining pasture quality. Other goals such as maintaining cow condition, and conserving pasture surpluses as hay were also identified. Farmer specific goals identified were to: renew pasture (3 farmers) and provide feed for the winter (4 farmers)(Table 5.20) (Figure 5.23).

Table 5.20 The main goals identified as important on high per cow production farms for mid and late lactation.

Farm	1	2	3	4	5	6	7	8	Total
Main goals for mid / late lactation									
Fully feed the cows	✔	✔	✔	✔	✔	✔	✔	✔	8
Maintain pasture quality	✔	✔	✔	✔	✔	✔	✔	✔	8
Conserve pasture surpluses as hay	#	N/A	✔	✔	✔	✔	✔	✔	6
Implement the strategic decision to renew pastures	✔	✗	✗	✗	✔	✔	✗	✗	3
Provide feed for the winter (in addition to conserved supplements)	✔	✔	✔	✗	✔	✔	✗	✗	5

N/A These techniques were not applicable on these farms.
✔ Techniques used by these farmers.
✗ Techniques not used by these farmers.
Insufficient information available to indicate whether these techniques were used.

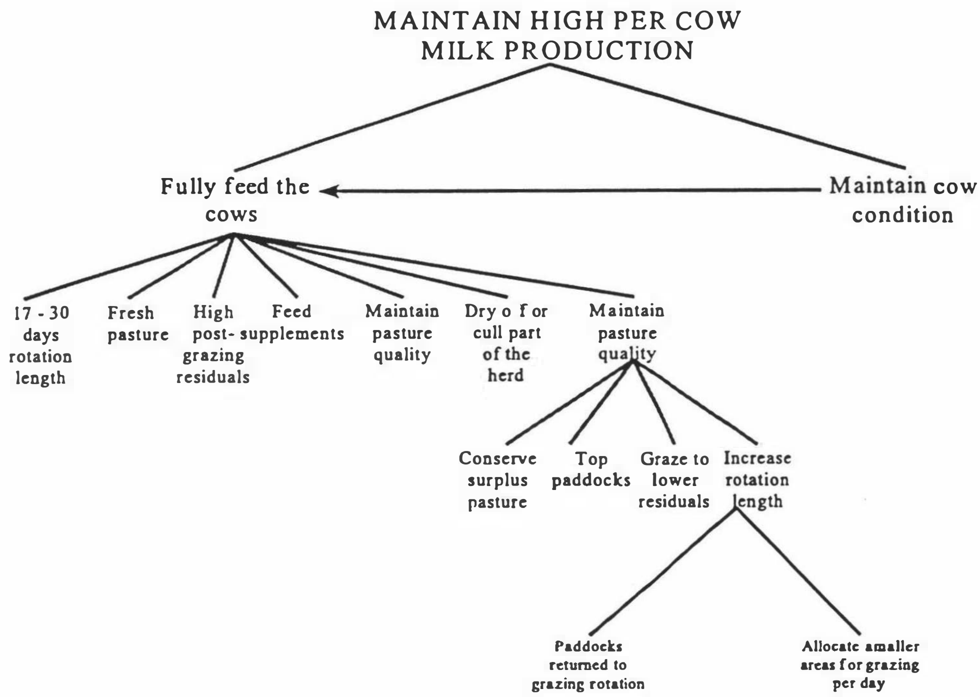

Figure 5.23 Goal hierarchy of tactical management during mid / late lactation.

All farmers continued to feed their cows as much as possible during this period in order to maintain per cow production at high levels (see Figure 5.21). While pasture was the predominant source of feed used some farmers used greenfeed crops or supplements (conserved pasture) to increase the feed supply (Table 5.21).

Table 5.21 Methods used, and goals of, fully feeding dairy cows from the end of mating until the end of April on eight case-study farms.

Farm	1	2	3	4	5	6	7	8	Total
Rotation Length	30	25	20	30	set stock	28	♯	17 to 25	
Pasture quality maintained	✔	✔	✔	✔	✔	✔	✔	✔	8
Method used to maintain pasture quality									
Topping pasture	✔	✗	✗	✔	✗	✗	✔	✔	4
Grazing pasture to lower residuals	✔	✔	♯	♯	♯	✔	✗	✔	4
Rotation length increased	✗	♯	✔	♯	N/A	✔	♯	✔	3
Surplus pasture removed as hay (baleage)	✗	N/A	✔	✔	✔	✔	✔	✔	6
Fresh pasture offered to cows (hours)	24	12	12	12	set stock	12	12	12	
Pre grazing pasture height (kg DM/ha)	♯	2000	♯	♯	♯	♯	♯	♯	
Post grazing residuals (kg DM/ha)	♯	1500	♯	♯	♯	♯	♯	♯	
Regular feeding of supplements									
Summer crop	✔	a	✗	✗	✔	a	✗	✗	2
Silage	✗	✗	✗	✗	✗	✗	✔	✗	2
Other supplements	✗	✗	✗	✗	✗	✗	✔	✗	1
Irrigation	✗	✔	✗	✗	✗	✗	✗	✗	1
Supplements fed if required									
Silage / hay	✔	✗	✗	✗	✗	✗	✔	✔	3
Deferred grazing	✔	✗	✗	✗	✗	✗	✗	✗	1
Concentrates (meal or other bought in feed)	✗	✔	✗	✗	✗	✗	✔	✗	2
Other methods used to increase feed for milking cows if required									
Cows culled early	✔	✔	✗	✗	✗	✗	✗	✔	3
Part of herd dried off	✗	✔	✗	✗	✗	✗	✗	✗	1

a These farmers planted a summer crop in the 1994/95 season.
N/D These techniques not defined for these farms.
N/A These techniques were not applicable on these farms.
✔ Techniques used by these farmers.
✗ Techniques not used by these farmers.
♯ Insufficient information available to indicate whether these techniques were used.

Those farmers who had used short rotations (< 25 days) from September until the end of December tended to lengthen their rotations, during the period from January to March, to 20 - 28 days. However, farmer eight, who had a lower than average stocking rate, maintained the short rotation period of 17 - 25 days. Although increasing grazing rotation length often reduced the area the herd grazed each day and hence potentially feed intake, it was lengthened for three reasons. First, to encourage cows to eat more of the pasture in the paddock, and second, to accumulate feed in front of the cows in anticipation of a dry period during summer / autumn, and third to build up feed prior to the winter (see later discussion). "... *start to make the cows eat a little bit lower to lengthen that rotation, because you could be coming into a drier time...*". In addition, paddocks removed from the rotation earlier in the season for the conservation of hay and silage were now available for grazing and this increased the area available to the herd. "... *and those paddocks you've taken out for silage or whatever should be coming back into the rotation, so you lengthen it that way.*" One farmer explained, that despite the increased rotation length, cows were fully fed because pre-grazing pasture covers of 2,000 kg DM/ha were required, and pasture residuals were maintained at 1,500 kg DM/ha. The higher DM in the pasture allowed the cows to graze to lower sward heights over this period without being underfed. "... *because at 1,500 dry matter by then the pasture's high in dry matter, 1,500 dry matter would lower [in height] than the spring so probably [the dry matter content is] around about the same, ...*".

On farms where pasture could not provide enough feed to meet cow requirements, supplements were provided to maintain per cow production levels (see Figure 5.21). Summer greenfeed crop available on two farms (maize and turnips), were break fed to the cows between January and March. Farmer seven continued to feed brewers grain on a daily basis, but would regularly provide other supplements when required. Farmer two irrigated part of the farm to increase the supply of fresh pasture available to the herd, "... *we only irrigate 35 hectares ... we irrigate it a lot ...*". All farmers continued the grazing pattern established at the start of the season (i.e feeding cows a fresh break after each milking, set stocking or 24 hour grazing).

If feed supply was especially low (i.e. pasture supply could not meet feed demand) a range of techniques were used to maintain cow intake. Farmer one would break feed the paddocks harvested for hay and silage and not yet returned to the rotation (deferred grazing) or cull cows early, "... *if it's still dry, then I'll breakfeed my hay paddocks as a crop, ... cull the ones you want to cull, ... cut your numbers down.*" Farmer two would introduce meal to the herd to maintain feed intake, and regularly culled cows early or dried off low producing cows, "*I would weigh up ... whether it was two weeks of meal, ... whether I want to feed meal, ... we would start culling in December/January ... the thin 10/20% ...*". Farmer seven, increased the supply of supplements to overcome any feed shortages, "... *if we get short the silage stack comes in.*" Farmer eight, would cull cows or dry off low producers when feed became limited, "... *we'll look at getting rid of some culls, ... drying a few skinny heifers off...*". In severe dry spells hay would be added to the ration to increase feed availability.

All farmers used at least one technique, chosen from: topping pasture, grazing pasture to lower residuals than earlier in the year, lengthening the grazing rotation and conserving surplus pasture as hay or baleage, for maintaining pasture quality during the mid- and late-lactation period. Pasture topping continued into December on four farms because it was regarded as an essential part of the quality maintenance program. "*a lot of topping, just require it. Don't hesitate, don't top too short.*", "*a lot of topping of paddocks as well ... keeping the paddocks in order, ... keep the whole paddock growing.*", and finally "*we will be doing a bit of topping to control the pasture*"

Other methods were used later in the season to control pasture quality. The conservation of surplus pasture as hay (or baleage), except on farm one, was opportunistic, and although it occurred regularly on at least two other farms, the quantity of hay reflected the amount of surplus pasture available rather than the specific amount required for the winter. Hay making was used to conserve surplus pasture and to assist in the control of pasture quality. "*its just getting rid of a surplus, we do need it for the winter but we don't shut up thinking of the winter*", "... *not shutting up a big area, shutting up only a surplus.*"

Grazing to lower residuals to remove long pasture remaining after previous grazing was used to improved pasture quality for future rotations, as well as providing an even pasture sward ready to take full advantage of any autumn rain and subsequent increases in pasture growth. "... *we just try* *and feed them as well as we can but we are slightly harder on them [the cows], ... more conscious of, have they chewed that paddock out? So it will be reasonable quality when they get back there again."*

Towards the end of summer four farmers aimed to provide additional feed for the winter , over and above that conserved from pasture surpluses. One shut up one third of the farm, another applied DAP to the whole farm to increase pasture growth and create a 'feedbank' of pasture for late autumn and a third planted a brassica crop in late November/December for winter grazing. Farmer six slowed the late summer/autumn grazing rotation to maintain pasture quality, and build up a 'feedbank' for the winter.

Drying Off (May)

The final management period of the year generally covered May, although, two farms often continued milking into June. The primary goal for the drying off period was to prepare the herd and farm for the winter and calving next season. To achieve this farmers ensured there was sufficient pasture cover at drying off for pasture cover targets at calving to be met, ensured cow condition at drying off was sufficiently high to ensure cow condition targets at calving were met and provided enough pasture to feed the cows for the winter (Table 5.22) Figure 5.24).

Table 5.22 The main goals identified for drying off on high per cow production farms.

Farm	1	2	3	4	5	6	7	8	Total
Main goals for drying off									
Ensure there is sufficient pasture cover to feed the cows during the winter and/or to meet targets at calving	✔	✔	✔	✔	✔	✔	✔	♯	7
Ensure adequate cow condition at drying off	♯	✔	♯	♯	♯	✔	✔	✔	4
Provide sufficient feed for the winter	✔	✔	✔	✔	✔	✔	✔	✔	8
Pasture cover targets at drying off	1900 to 2000	N/D	N/D	N/D	✗	1800	1600 to 1700	N/D	

N/D These techniques not defined for these farms.
✔ Techniques used by these farmers.
✗ Techniques not used by these farmers.
♯ Insufficient information available to indicate whether these techniques were used.

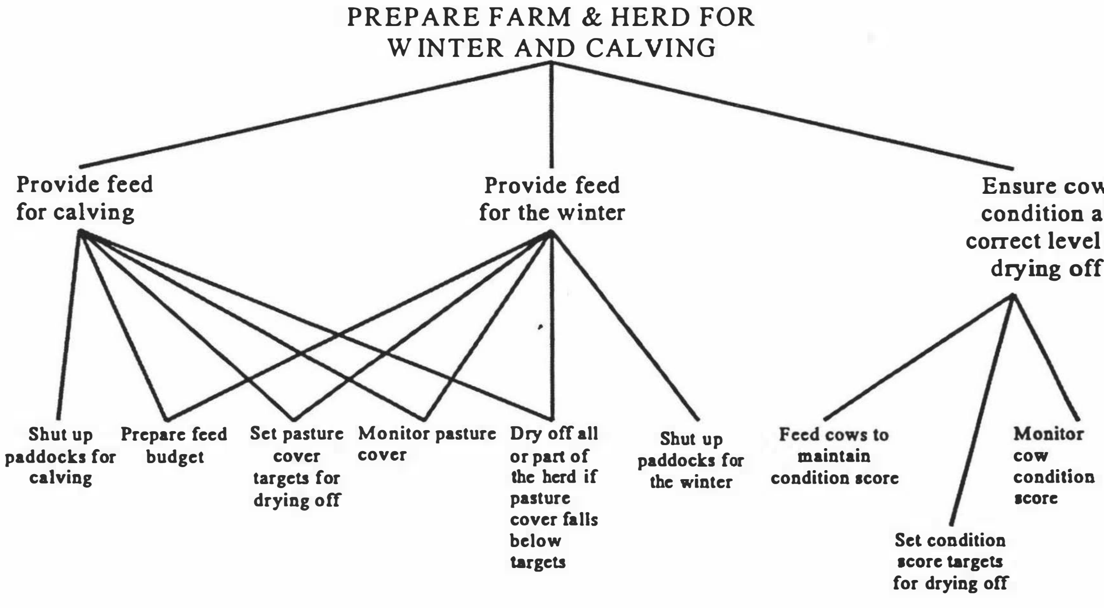

Figure 5.24 Goal hierarchy of tactical management during drying off.

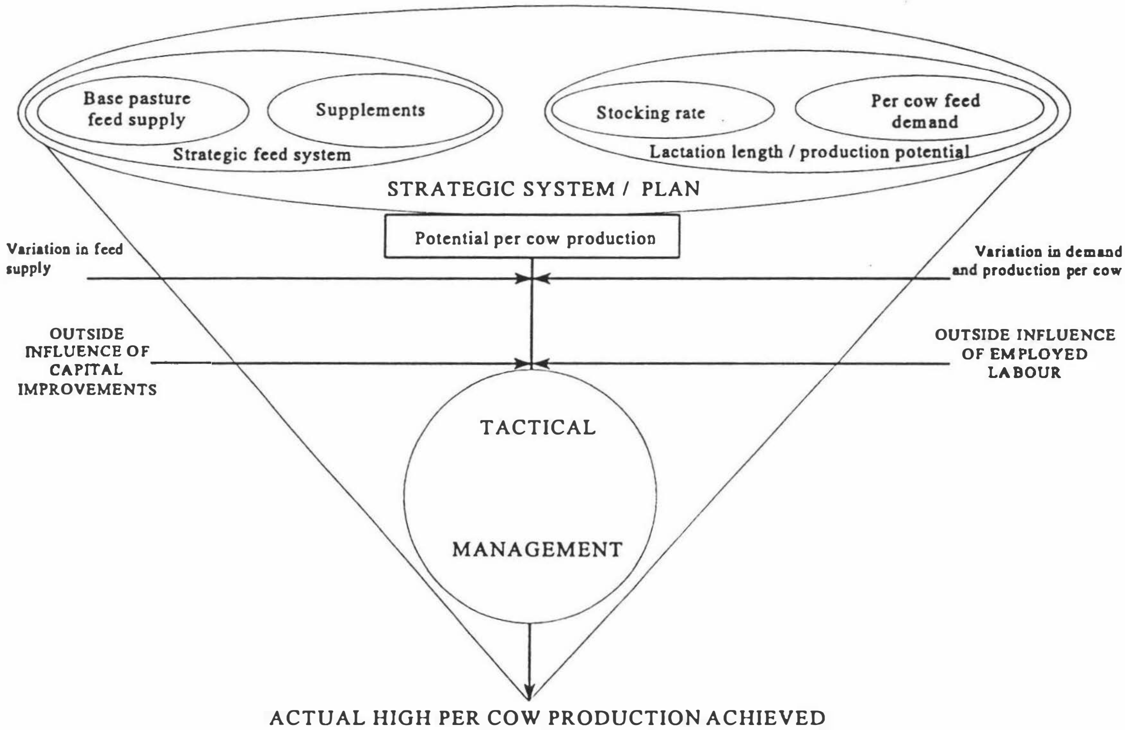

Figure 5.25 Schematic representation of the effects tactical management has on the strategically adjusted resource bundle to achieve high per cow milk production.

Gross Margins

As part of the study each farmer was asked to provide income and expenditure data to calculate a milk production gross margin[15]. A summary of the gross margins is presented in Table 5.26.

15 Milk income was calculated using the average Tui Milk Products Payout figure and average milk production figures for 1991/92 and 1992/93. Costs were calculated from taxation records for 1991/92 and 1992/93, supplied by the farmers and averaged between the two years. Where possible unusual one off costs were removed from the figures to allow for more accurate comparisons to be made. However, in some instances not all anomalies could be removed (see notes in Table 5.33).

Table 5.26 Milk production gross margins for eight case study farms.

Farmer	1	2[1]	3	4	5	6	7	8
$ / hectare								
Income	3,067	2,688	2,687	2,857	2,640	3,574	4,510	2,846
Expenses								
Fertiliser	238	273	98	306	127	338 [5]	254	113
Supplements [2]	46	186	51	45	63	160	367	19
Animal Health [3]	91	158	74	44	44	163 [6]	308 [7]	92
Shed expenses	30	65	30	24	19	64	62	21
Electricity	32	37	54	33	63	55	56	65
AI / HT [4]	46	22	51	69	16	144 [6]	72	43
Total costs / ha	484	740	358	521	333	924	1,118	353
Total GM / ha	2,583	1,948	2,330	2,336	2,307	2,650	3,392	2,494
Income / cow	1,280	976	1,142	1,125	1,485	1,512	1,242	1,220
Total costs / cow	202	268	152	205	187	390	308	151
Total GM / cow	1,078	708	990	919	1,297	1,121	934	1,068

1 The taxation accounts for farmer two were a combination of all enterprises and it was very difficult to extract those costs which applied to the dairy farm only. Therefore it is possible fertiliser, supplements and animal health costs may be overstated in this table.

2 The fixed costs associated with owing and running machinery and equipment have not been included when calculating the cost of supplements. However, contactors costs associated with harvesting silage and hay are included. N.B. Farmer eight owns their own equipment to make hay.

3 Costs of animal health include any costs associated with replacement and dry stock.

4 All AI and herd testing costs are included except the purchase of bulls run with the herd.

5 This figure includes two years extra fertiliser applied to a new area which had low Olsen P levels.

6 These costs include unidentified costs associated with proving sires for AI and Embryo Transfers.

7 This figure includes the cost of Aloe Vera.

Table 26 indicates that all farmers achieved good gross margins per hectare and per cow in comparison to those calculated by Holmes & Parker (1992). The highest gross margin per hectare was achieved by the farm with the highest stocking rate, farm seven, which, apart from farm two, also had the lowest gross margin per cow. The lowest gross margin per hectare was achieved by the farm with the lowest stocking rate, farm five, but it achieved the highest gross margin per cow.

Costs per cow were highest on farm six, followed by farm seven due to the high levels of supplementation used on that farm. However, if the additional costs associated with breeding and managing pedigree cows were removed from the figures for farm six the gross margin per cow for this case would be significantly higher that the other farmers due to the much higher per cow production on this farm. The lowest costs per cow were on farm eight and farm three. Farm eight supplement costs were low because pasture conservation is carried out by the farmer, and farm three has low costs because of low fertiliser expenditure. It should be noted that the gross margins are only indicative of the systems used on the case-farms and a detailed cost analysis has not been carried out (see Chapter 6 for further research).

5.3 A Model of a High Per Cow Production System

In this section the data extracted from the cross-case is synthesised into a generalised model of high per cow production. Due to the systems's complexity the model is presented in a number of parts. First, an overview model (Figure 5.26) summarises the land and herd resources as outlined in Section 5.2.1, the resulting base pasture supply and potential feed demand, the need to balance per cow feed supply with per cow feed demand and where strategic and tactical management manipulate these factors and annual variations to achieve high per cow production. Second, sub-models of strategic and tactical management are presented separately to show the complex interactions between and within the components and attributes of land and capital resources and strategic and tactical management systems.

The strategic management sub-model illustrates the hierarchy of decisions made to alter the resource bundle to achieve high per cow production. As many of the tactical management decisions were common to some or all of the chronological periods presented in Chapter 2 the tactical management sub-models are not presented chronologically. The sub-models show tactical management techniques used to achieve farm goals and therefore high per cow production, and illustrate the range of different tactics used to overcome and manage resource constraints, and the links between tactical management decisions.

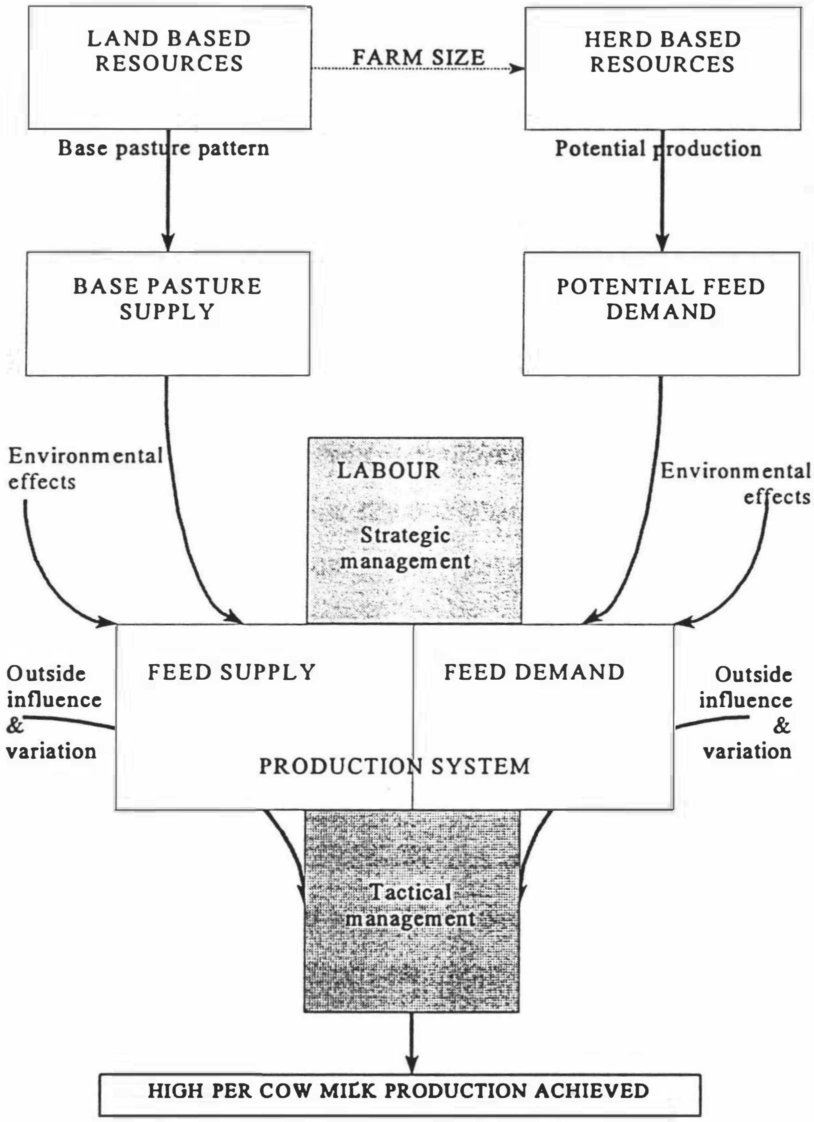

Figure 5.26 High per cow dairy production model.

5.3.1 Resources

AS indicated in Section 5.2.1 the variation in the resource bundle between farms appeared to have no major impact in the ability to consistently achieve high per cow production. The location and size of the farm is determined by the farmer who also provides, in the first instance, labour. Thus, the critical component in achieving high per cow production on the case farms was the application of appropriate strategic and tactical management (Section 5.2.1).

The location of the farm determines altitude, topography, climate and soils, fertility and drainage. The latter characteristics are also influenced by farming practices such as fertiliser application and drainage. Altitude has a bearing on the prevailing climate, and with climate, topography and soil, influences pasture production, its growth patterns and the species present.

Variation in pasture growth between the case-study farms did not appear to be an important factor in explaining differences between high per cow production. Rather, lactation performance was dependent on the management strategies for overcoming seasonal variation in pasture growth associated with climate and other environmental influences. In this study, regional variation in climate appeared to have little effect on per cow performance even where colder than average winters contributed to shorter lactations.

Soil type and average soil fertility varied markedly between case-farms. However, average soil fertility levels could be misleading, as lower soil fertility on new land lowered the overall fertility on four farms. While all farmers applied fertiliser to maintain and improve fertility, and monitored the level soil fertility regularly, earlier analysis of the quantity of fertiliser applied (Section 3.4.2) suggested no significant association with per cow production.

All or part of the labour on the case-farms was provided by the farmers. On four farms labour was employed to assist with the day-to-day running of the farm particularly when herd size exceeded the labour capacity of the farmer (or the family). Although particular skills, and attributes, the farmers and employees possessed were not determined, stockmanship, dedication to the farm and herd and a 'sense of pride' were identified during the interviews.

The cowshed, plant, races, subdivision and herd, are usually classified under capital resources (Kay, 1986; Makeham & Malcolm, 1993). Apart from the milking plant on the case-farms (except one) being less than ten years old, and races designed to prevent lameness and allow the herds to move quickly and easily to and from the shed, the data did not suggest that the design of the shed or races contributed to high per cow production. A stress free environment, for both cows and farmers, was provided by the behaviour of milkers rather than the physical layout of the shed nd races. Walking distances were estimated to be less than 2.5 km on all farms; problems associated with walking herds over long distances were, therefore, avoided. The level of subdivision (i.e. the number of paddocks) was not investigated, however, all farms appear to have a sufficient number of paddocks to effectively manage the herd and pastures.

Friesian, Jersey and Friesian x Jersey were all well represented in the herds studied, and Ayrshire cross cows were present in two cases. No one breed was found to be better than another for high per cow production. Herd BI and ancestry were not strongly correlated with high per cow production, although the rearing of herd replacements to their mature sizes before they entered the herd did appear to influence production levels. Overall, cows in the herds involved in this study more closely meet their genetic potential than those found on the average dairy farm and therefore more easily achieve high per cow production.

However, before high levels of production could be achieved from the available resources (resource bundle) farmers set several high level goals. Goals common to all farmers were to fully feed cows throughout lactation, achieve a compact calving, maintain a high level of pasture quality and to rear replacement heifers to their mature size before they entered the herd. In order to achieve high level goals and therefore high per cow production over the long term farmers 'adjusted' their resource bundle by making strategic decisions about their farm system.

5.3.2 Strategic Management

The strategic management decisions which affected the resource bundle and helped farmers achieve their high level goals were the selection of: stocking rate; lactation length; breed, size (i.e. stature of animals) and genetic merit of the herd; supplement policy; drainage; pasture renewal; fertilisers, type and quantity, used; capital improvements and the number of staff.

The selection of stocking rate (i.e. cows per effective hectare) was influenced by the breed, size and genetic merit of the herd, as well as strategic decisions about supplement policy and base pasture production (Figure 5.27). Farmers with lower (less than 2.4 cows/ha) stocking rate either had larger than average cows, grew less pasture or had selected not to feed high levels of supplements. High stocking rates (3.6 cows/ha) were supported by supplementary feeding and other feed inputs (nitrogen and grazing off).

Although the initial survey data (Section 3.2.4) suggested that the genetic merit of the herd (BI) did not influence high per cow production, all farmers made strategic herd improvement decisions (Figure 5.27). Farmers selected cows and bulls to improve production, udder conformation, overall conformation, temperament and milking speed (Table 5.5). Selection strategies were made to improve the 'quality' of the herd, but data on the effectiveness of these strategies were not collected. Removing cows from the herd was also used as a strategy to improve the 'quality' of the herd (Table 5.5). However, five herds increased in size during the study period, and therefore could not be used to determine whether culling policy had any effect on per cow production. Although the percentage of cows removed from the herd for low production was not clearly defined (see Section 3.4.2), the farmer who culled the highest percentage of cows based on production had the highest per cow production. This would suggest, as would be expected, culling low producing cows as rapidly as possible will increase average per cow production in the herd.

There was also some indication that the strategy to rear well-grown herd replacements influenced high per cow production (Figure 5.27). All farmers had made a strategic decision to rear their replacement stock well and to their mature size by first calving. There was uniform agreement that rearing of replacement stock was probably the most important job on the farm and that the future production of the herd depended on how well this was done. Although no physical measurements were taken of the cows in the high production herds, they did appear to be larger than those in dairy herds with lower average milk yields.

Lactation length was influenced by calving date (a strategic decision) (Figure 5.27)and tactical decisions made to dry the herd off. Calving date was selected to closely match feed supply with feed demand so that reliance on supplements to fully feed cows immediately after calving was low. Calving date was therefore related to climatic conditions and farmer knowledge of when pasture growth rate would exceed herd demand. However, calving date *per se*, did not influence high per cow production; rather it was influenced by the tactical management at mating and calving, to influence the length of the calving period, and drying off, to manipulate the average lactation length of the herd (see Tactical Management).

The level and type of feed supplementation on each of the farms varied considerably (Figure 5.27). Higher stocking rates were associated with higher supplement inputs (see also Section 3.4.2). Farmer seven had consciously selected a high stocking rate, and a high supplement input was required to ensure cows were well fed. Typically the decision to feed supplements was based on the desire to consistently feed cows well. The level of supplement input (including grazing off and nitrogen applied) was associated with the stocking rate and the estimated quantity of pasture grown on the farm (see Resources).

Pasture renewal, if used, was carried out to improve the quantity and distribution of pasture production (Figure 5.27). The level of pasture production was also altered by the annual application of fertiliser, which also appeared to have no affect on the level of per cow production (see Section 3.4.1) (Figure 5.27).

The farmers employed permanent labour once herd size increased beyond the level where they were able to carry out day-to-day tasks regularly and well (Figure 5.27). The 'critical' herd size varied between farms according to factors such as the size of the farm, herd and the size of farming operations. Farmers commented that employing labour affected the level of per cow production unless employees were managed to make sure tasks were completed properly. The quality of the labour influenced the way stock was handled in and around the shed; therefore owners must be skilled in labour management to make sure that employees recognise the skills that are required to achieve high per cow production.

Finally, there was an element of strategic decision making in relation to the capital resources. Farmers believed the quality of their milking plant influenced the levels of per cow production, and apart from one, all farmers had, within the last ten years replaced or ungraded their milking plant to ensure labour efficient and effective milking of the herd. In all cases the shed, plant and races were regularly maintained and upgraded to ensure they operated at peak efficiency. However, it was the management of the herd within the environment created by these resources that most affected per cow production.

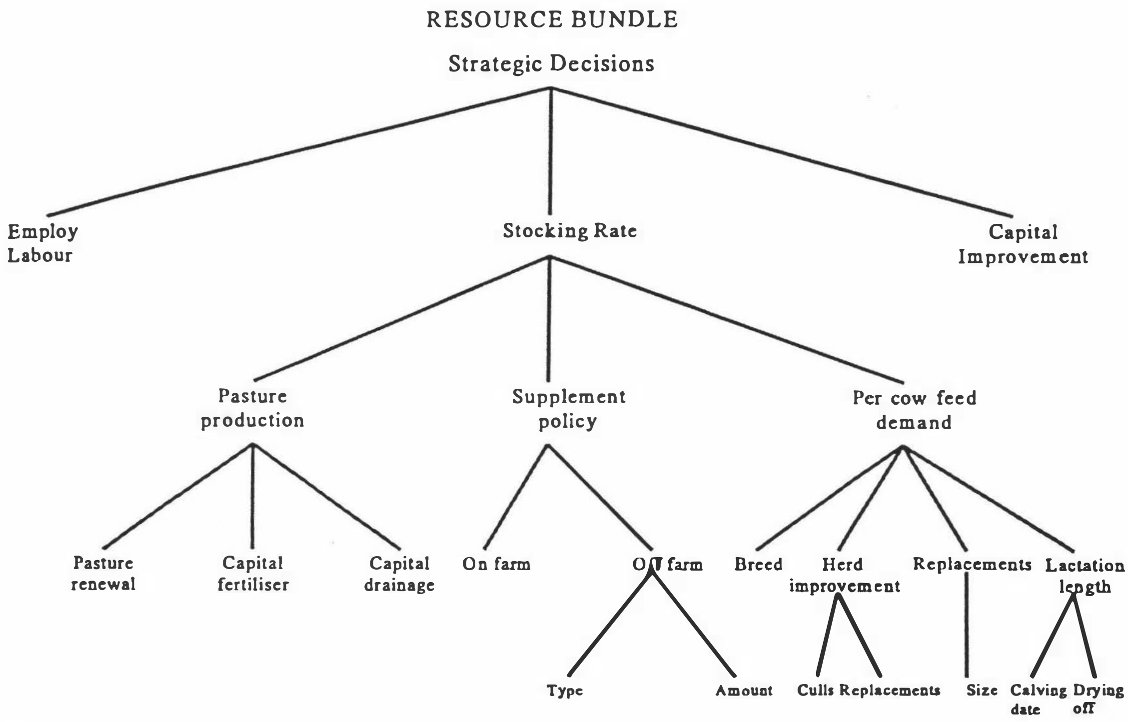

Figure 5.27 Hierarchy of strategic decisions made to alter the resource bundle to achieve high per cow production.

5.3.3 Tactical management

Once farmers had 'adjusted' the resource bundle with strategic plans tactical management decisions were needed to manage the land, labour and capital resources. These decisions were based on realising the important high level goals identified in Section 5.3. All farmers aimed to: fully feed their cows throughout lactation; achieve a compact calving; and maintain pasture quality throughout lactation. In addition, the management of the herd and farm during the winter, and the period leading up to the end of the season (drying off) were considered important. Other high level goals that resulted in high per cow production on some farms were, the conservation of pasture and the making of high quality hay and silage, achieving high milk yield per cow early in lactation, achieving lactational persistence, and efficient and effective labour and milking management.

The discussion in this section follows the high level goals identified during the analysis of the data rather than the chronological, 'seasonal' management structure followed in the literature review (Chapter 2). In addition, the tactics discussed in this section represent all those identified by the farmers during this study. As there was a wide variation in the combinations of tactical management techniques used to overcome resource constraints, they are not discussed in their respective combinations. Rather, the techniques are discussed individually, and any decisions made about their grouping to best suit a particular management problem are left up to the reader.

Fully Feeding Cows During Lactation

Perhaps the most important goal of all farmers was to fully feed cows throughout lactation. Stocking rate and supplement policy strategies were managed to ensure cow intake was as high as possible from parturition to drying off. Farmers used a combination of tactics depending on their individual circumstances to achieve high feed availability. However, a feed ration containing pasture and supplements was used by all farmers to fully feed cows, although the proportions fed at different times of the season varied between farms. Only one farmer fed supplements daily throughout lactation; the others fed additional silage and/or hay, seasonal crops, irrigated pasture and feed concentrates (Figure 5.28).

All farmers ensured 'sufficient' feed (i.e. pasture cover) was available at calving to be able to commence full feeding of the cows immediately thereafter (Figure 5.28). However, only five farmers defined the amount of pasture in terms of kg DM/ha. Pasture cover targets ranged between 1,900 kg DM/ha and 2,500 kg DM/ha. Farmers with higher stocking rates generally preferred high pasture covers at calving, although one farmer with a stocking rate of 2.15 cows/ha had a pasture cover target of 2100 kg DM/ha (see Table 5.10). This farmer's herd was significantly above average in size and per cow production.

Pasture intake was maintained by offering cows high quality pasture (Figure 5.28). Cows were usually put onto fresh pasture after each milking; one farmer set stocked his cows to achieve this (Section 5.2.2, Tactical Management). Only one farmer had a 24 hour grazing regime and offered cows fresh pasture every second milking (Figure 5.28). High pre- and post-grazing (1,500 to 1,600 kg DM/ha) pasture residuals also assisted in achieving high pasture intake (Figure 5.28).

In order to maintain high pasture intake, rotation lengths were varied during the year (Figure 5.28). As pasture residuals and growth rate increased in the spring farmers would generally decrease the rotation length to 17 - 25 days, while in the summer / autumn, when growth rates were lower, and farmers wanted to build a feed bank in front of the cows the rotation length was increased to 20 - 30 days. Rotation lengths were shortened by offering the herd larger areas of the farm each day, particularly early in the season, removing paddocks from the grazing round for later conservation for hay or silage, or removing paddocks and planting them in summer or winter crop. The converse was the case when rotations were lengthened. Smaller areas of the farm were grazed, and paddocks that had been shut up for conservation were returned to the round. Planting crops had a duel advantage for those farmers who decided to do so. First, it removed paddocks from the grazing round at a time of the year when pasture growth is high and rotation lengths are usually being shortened. Second, the crop once it has grown was fed to the cows during a period when pasture growth was lower. The number of paddocks planted in crop was determined by the estimated amount of feed required during the period when the crop would be fed off, and the area of each paddock.

One farmer retained a rotation length of 30 - 35 throughout the year and believed that this rotation length offered the greatest flexibility to manage seasonal variations in pasture growth and keep the cows fully fed. This farmer shut paddocks up earlier in the season for silage and hay than other farmers, which helped remove surplus pasture. When these paddocks were returned to the round after harvest, 30 - 35 days growth later in the season provided sufficient feed for the cows. The farmer who set stocked the cows from the end of September believed that this enabled the cows to eat enough pasture throughout the year to avoid wide fluctuations in milk production. The low stocking rate on this farm meant that seasonal variation in pasture growth had a smaller impact than on other more highly stocked farms, because the cows were not restricted by rotational grazing regimes and 'restricted' feed intakes when compared to 'average' seasonal dairy farms. This farmer also removed paddocks from the grazing area when surplus pasture was evident.

To manage feed deficits, farmers introduced supplementary feed into the ration. Supplements were used tactically to increase cow intake on all farms. Hay, silage and summer crops were used when required to fully feed the cows. Two farmers culled or dried off part of the herd if pasture supplies were limiting late in the season (see Table 5.21; Figure 5.28). Extra feed would also be introduced at other times of the year if necessary. In this regard, one farmer fed meal concentrates after calving to ensure feed supply was sufficient to fully feed cows. On another farm yearling heifers were grazed off the milking area to increase pasture availability to the milking herd if pasture was limiting after calving.

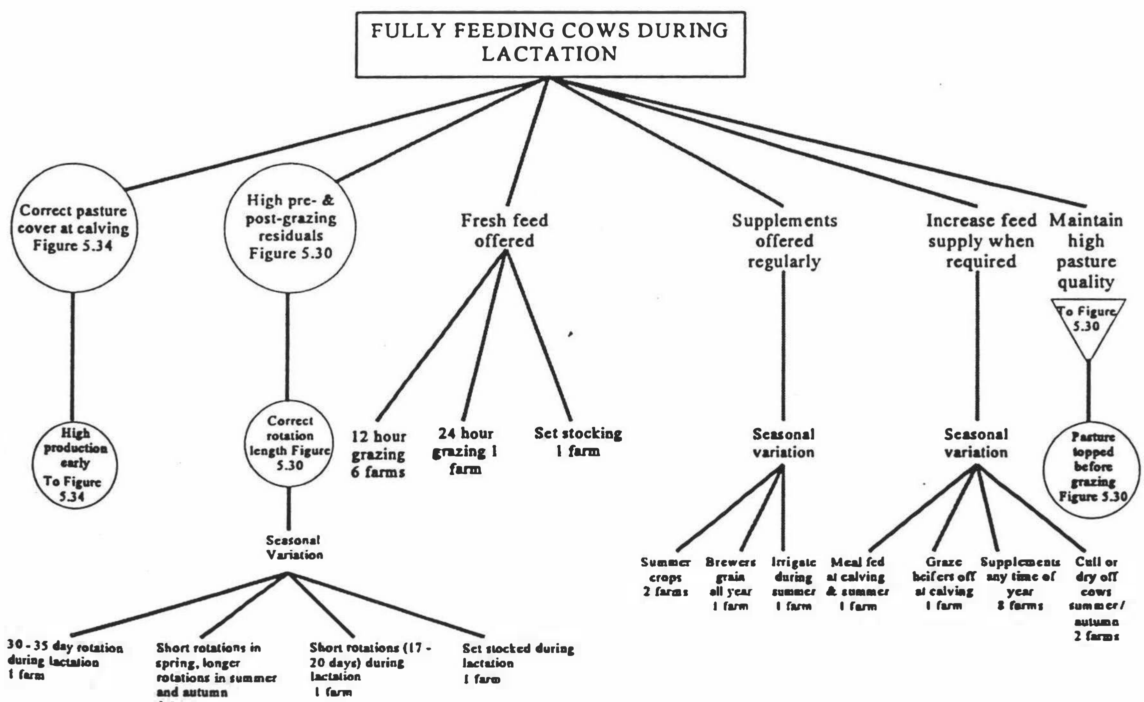

Figure 5.28 Tactical management techniques used to fully feed cows during lactation on high per cow production farms and the linkages with other tactical management techniques and farmer goals.

Achieve Concentrated Calving Pattern

The achievement of a compact calving spread was a goal of all farmers. A compact calving was achieved either, by inducing cows during the calving period, and/or mating management techniques which ensured as many cows got in calf as quickly as possible (Figure 5.29). Prior to mating farmers identified cows (anoestrus and those with unusual oestrus patterns) that needed veterinary attention. During the AI mating period cows were fully fed so condition score improved, and reproductive performance was enhanced. Careful observation of the herd for oestrus activity and the correct detection of oestrus activity helped achieve a concentrated calving pattern (Figure 5.29).

The herd was most often observed twice daily, in the paddock, immediately prior to milking. The cows were also observed at other times during the day (for example, mid-day and early evening, as well as at the shed when the cows arrived for milking (one farmer observed the herd a total of six times a day). The data suggested that increasing the frequency of observation, and observation by more than one person, increased the likelihood of a more concentrated calving pattern. Although only one person observed oestrus on farm five, the herd size was small (55 cows), therefore oestrus detection may have been simplified.

The other important component for the achievement of a concentrated calving pattern was improving the condition of the herd and maintaining animal health (Figure 5.29). Cows needed to be in good condition prior to mating, and be fed enough so condition score was at least maintained, preferable increased, during the mating period. Farmers made sure cows were healthy by drenching the herd with selenium and continued drenching them with Causmag during this period. Veterinary checks were made of anoestrus cows or cows with unusual oestrus behaviour, and CIDRs would be used where appropriate (Figure 5.29).

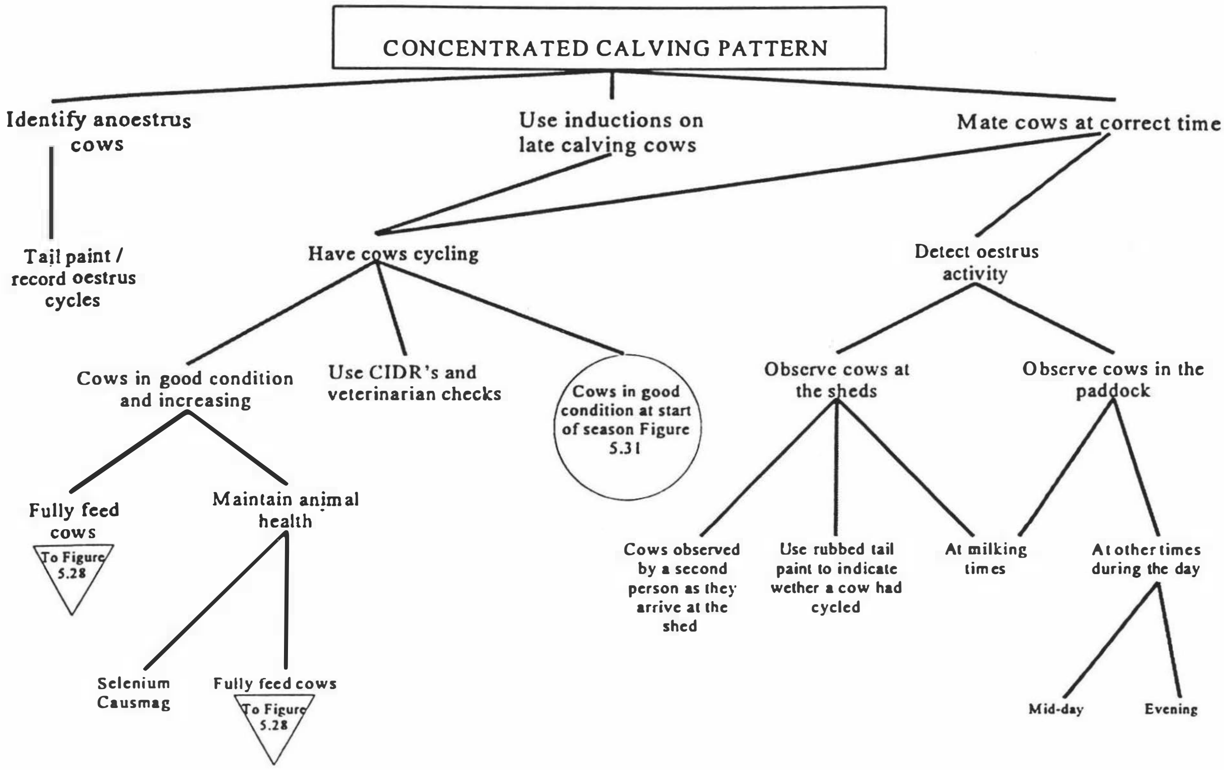

Figure 5.29 Tactical management techniques used to attain a concentrated calving pattern on high per cow production farms and linkages with other tactical management techniques.

Pasture Quality

The quality of the pasture fed to the herd was an important goal because of its links with fully feeding the herd and making high quality supplements (Figure 5.30). To maintain pasture quality farmers topped paddocks, manipulated rotation length (as previously discussed), conserved surplus pasture as silage and hay, removed paddocks from the rotation for planting of summer or winter crops and monitored and controlled the levels of pre- and post-grazing pasture residual (Figure 5.30). During the winter they endeavoured to reduce pugging, which if not controlled, had a deleterious effect on pasture quality in the subsequent season.

If pasture quality fell, paddocks would be topped to maintain quality (Figure 5.30). Topping was usually carried out after the cows had grazed the paddock. However, one farmer topped the pasture before the cows entered the paddock after the night milking, and stated, that provided pasture was topped at the correct time the pasture was well utilised by the cows. Little was wasted as would have been the case if the pasture was topped after the cows had grazed the pasture. Topping before the cows also avoided fouling the pasture and dirtying machinery saving time and effort to clean equipment. Another method of 'topping' the paddock included grazing the heifers behind the cows, although this practice ceased in 1994/95 (Figure 5.30).

Where cows were set stocked they were able to graze the 'best quality' pasture at any time. The farmer who used this technique also removed paddocks for conserving supplements and for planting winter and summer crops. Removing paddocks increased grazing pressure by raising the effective stocking rate, and forced the herd to graze the pasture 'hard' enough to maintain quality. Manipulating the rotation length during the year had the same effect. Shortening the rotation resulted in larger areas being grazed and more 'lax' grazing pressure, while lengthening the rotation had the opposite effect and resulted in more grazing pressure and 'harder' grazing.

The timing of conserving surplus pasture was also an important factor when maintaining quality pasture (Figure 5.30). In order to retain high quality pasture after harvesting supplements, particularly silage or baleage farmers harvested 'crops' as soon as possible after they were removed from the round. Usually this meant that paddocks were harvested at approximately the same time as they would have been grazed, if they had remained in the round. The paddock was only 'shut up' for the equivalent of one grazing rotation, but had two round's growth (i.e. 40 to 50 days). This technique resulted in high quality pasture regrowth.

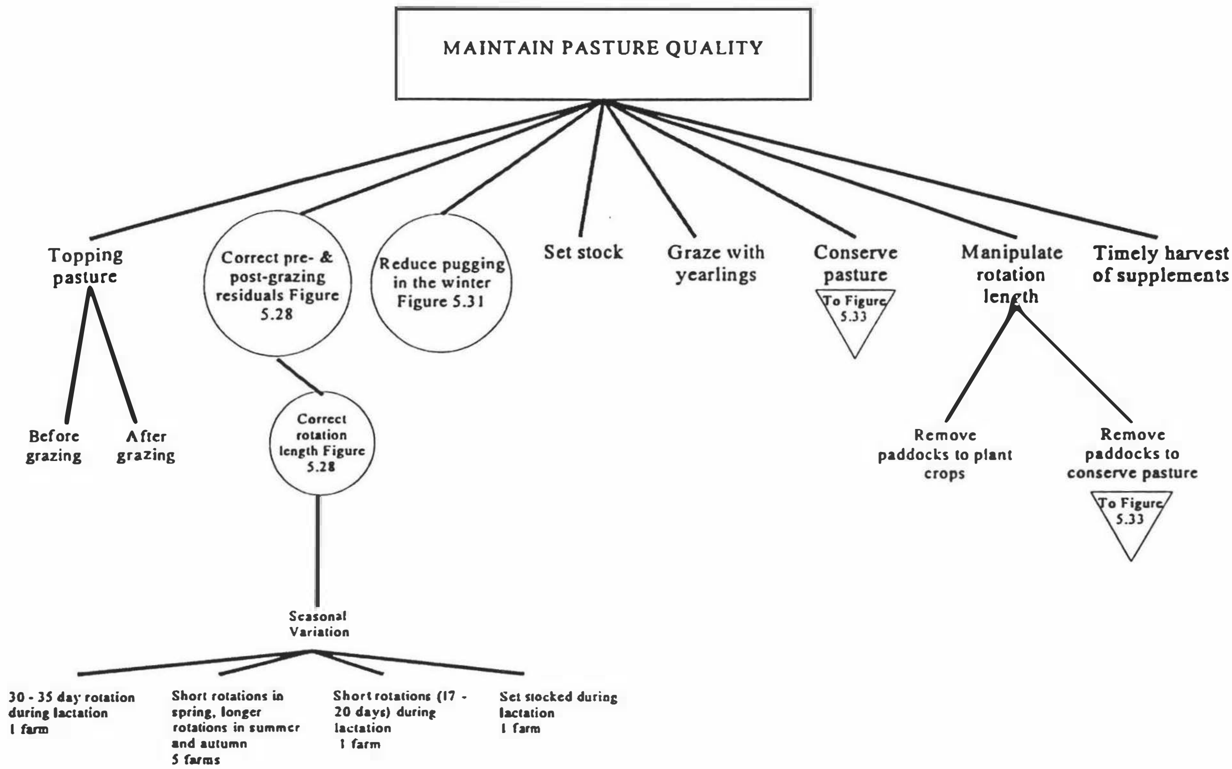

Figure 5.30 Tactical management techniques used to maintain quality on high per cow production farms and linkages with other tactical management techniques.

Winter Management

Feeding of cows during the winter focused on saving sufficient pasture to ensure cows could be fully fed immediately after calving, maintaining condition score or achieving condition score targets at calving, and animal health issues (Figure 5.31). On some farms cows were 'built up' prior to calving in order to increase early lactation milk production and make sure cows reached high production levels early.

This period of the year was the only time that farmers did not aim to fully feed cows. The ability to 'restrict' cow intake allowed farmers to achieve pasture cover targets at calving. Using a long winter rotation was the most common method of achieving pasture cover targets (Figure 5.31). If cows were grazed pasture on the milking area, rotations of greater than 90 days were usual. To achieve the same effect as a long winter rotation (i.e. paddocks ungrazed for long periods) cows were grazed on a winter crop, grazed off the milking area for a minimum of 40 days, and grazed on different areas of the farm. Other techniques for achieving pasture cover targets included feeding hay and silage to reduce pasture demand, and applying nitrogenous fertiliser to increases pasture growth (Figure 5.31).

Cow condition scores were achieved by adequately feeding cows to achieve condition score targets or maintain condition. Techniques to adequately feed cows were, splitting the herd, so lighter cows could be fed more, and feeding supplements (Figure 5.31). The amount fed to cows was dependent on the goal of the farmer. Cows which needed to put on condition were fed at higher rates than those that were required to maintain condition (Figure 5.31).

Animal health was targeted and cows could be drenched to reduce parasite burdens and improve mineral balances in the herd (Figure 5.31). Selenium, cobalt and copper were used on some of the farms; the amount used was based on blood analysis. If the cows were not drenched during the winter mineral and magnesium drenches were used immediately after calving.

To protect soil and pasture from pugging damage cows were removed from wet areas of the farm (Figure 5.31). On farms where cows were not removed from wet areas, other methods were used to achieve the same effect. Grazing cows on a winter crop achieved the same result without specifically removing cows from the pasture. However, not all farmers removed cows from paddocks. One farmer was concerned that grazing cows off pasture during the winter affected feed intakes too much and did not use the practice. Another grazed off if pasture was limited, but the 'free draining' soil on the farm presented less of a problem than on other farms and reduced the need to graze cows off pasture during wet weather.

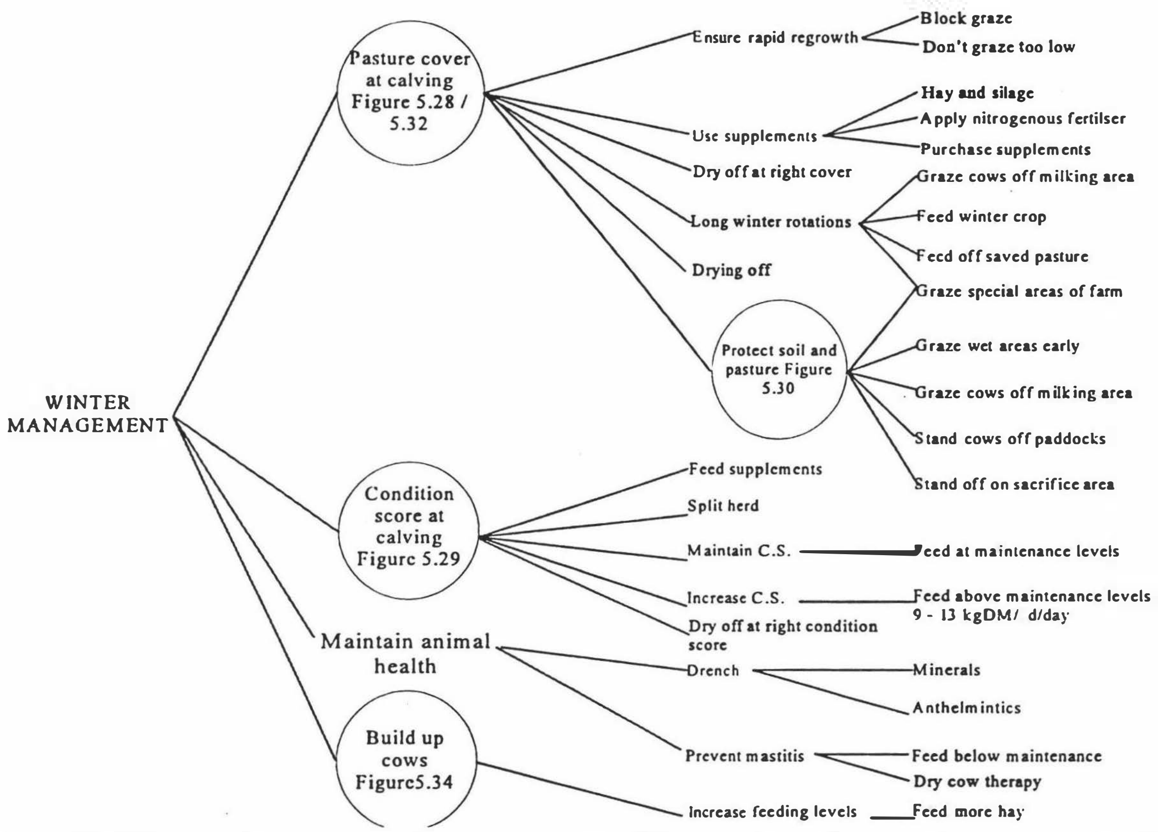

Figure 5.31 Tactical management techniques used during the winter period to achieve winter goals.

Drying Off

The main goals for drying off were to ensure sufficient feed was available to feed the cows during the winter, meet pasture cover targets at calving, provide feed for the winter and maintain cow condition (Figure 5.32).

To provide sufficient pasture cover at calving farmers were aware of the feed supply and demand from drying off until calving. The basis of providing sufficient pasture cover at calving was the pasture cover at drying off, and the amount of feed required by the herd during the dry period (Figure 5.32). The level of pasture cover at drying off varied with the management techniques used during the winter to build up pasture cover in front of the cows (Figure 5.31). Farmers who grazed cows off the milking area, fed cows on specific areas of land or provided high levels of supplementation during the winter, tended to have a lower pasture cover target at drying off than those who did not. The exception to this was the farmer with the highest stocking rate. In this case a higher pasture cover was required at drying off to allow sufficient feed to build up over winter to enable the herd to be fully fed after calving.

To determine the drying off date a feed budget was prepared either formally or informally (Figure 5.32). If a formal feed budget was not prepared, farmers were aware of the pasture required at drying for sufficient pasture to be available at calving. These farmers had a 'view' of what the farm should look like at drying off to provide the required pasture cover at calving. Those who prepared a 'formal' feed budget had pasture cover targets of 1,600 to 2,000 kg DM/ha.

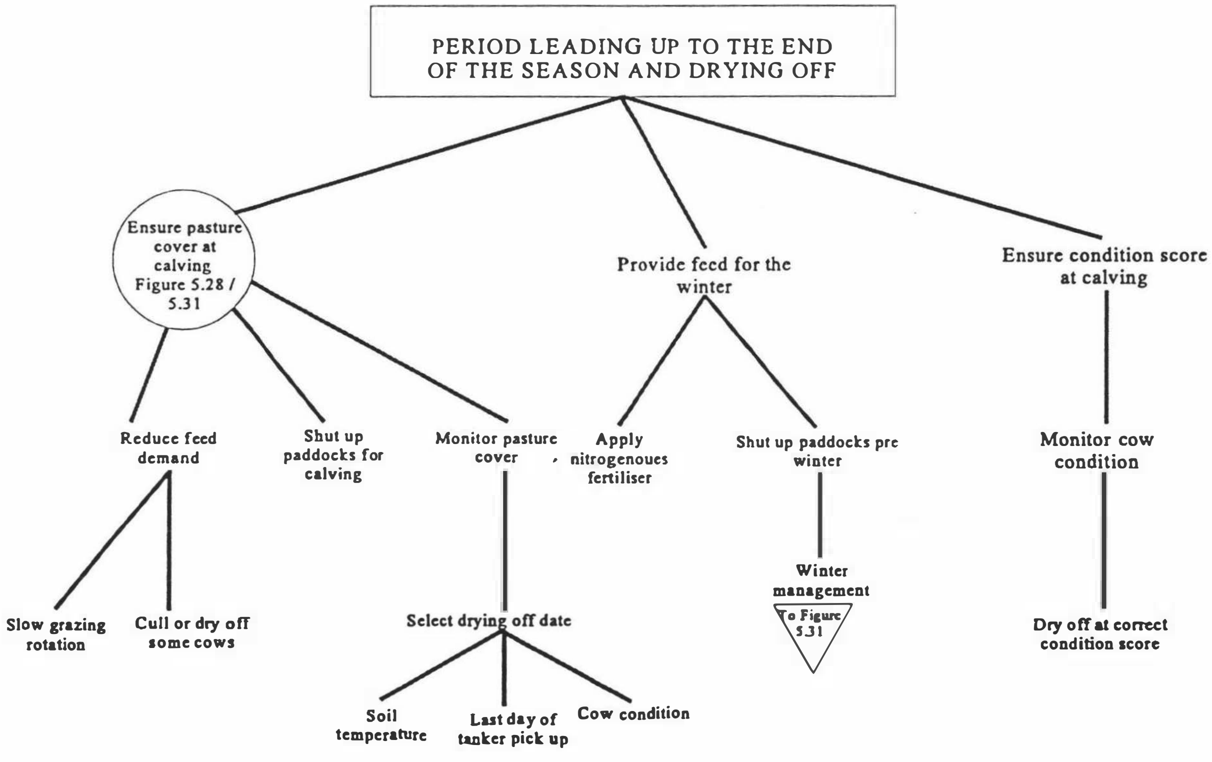

Figure 5.32 Tactical management techniques used at the end of the season and for drying off on high per cow production farms and linkages with other tactical management techniques.

Quality Supplements

The tactical decisions about when to conserve pasture surpluses were made by monitoring post-grazing pasture residuals (Figure 5.33). However, on two farms paddocks were set aside for silage and hay as part of the strategic decision to provide feed for dry summer/autumn, although, the amount shut up could be altered if necessary (Figure 5.33). To conserve quality supplements pasture removed from the rotation was harvested as soon as possible so the quality of the pasture was preserved and to allow the pasture to regrow quickly (see Pasture Quality, Figure 5.30). One farmer often made hay out of paddocks that had been topped to avoid wastage and to increase the supply of hay for later in the year.

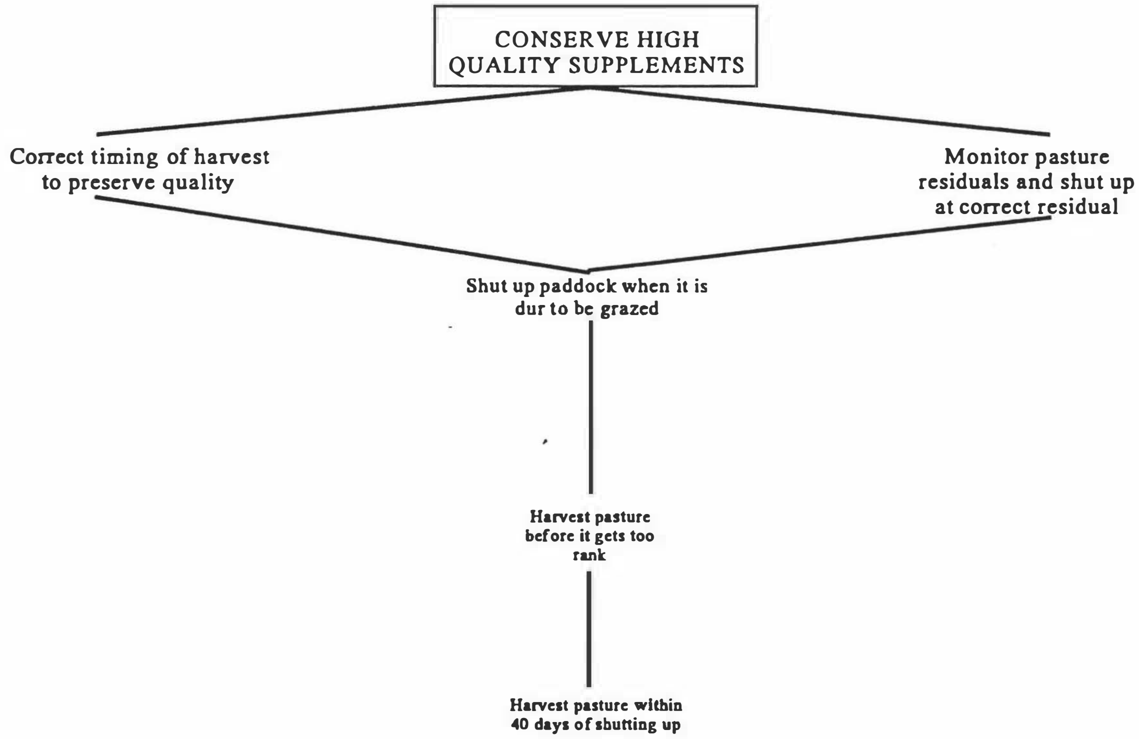

Figure 5.33 Tactical management techniques used to attain high quality supplements on high per cow production farms and linkages to other tactical management techniques.

High Production Early

Tactics to encourage cows to reach high production early in lactation were only found on three farms. However, it is likely that the techniques employed on these farms are, to some extent, found on other farms. To reach high production levels early in lactation the three farmers ensured cows had a high (<5) condition score at calving, had sufficient feed at calving to fully feed cows and fed additional hay either before and/or after calving to 'push' the cow into production early (Figure 5.34). The process is similar to 'steaming up' which is practised in intensive systems in the USA (see Section 5.2.2). The importance of this procedure needs to be more fully investigated if its value is to be measured (see Chapter 6).

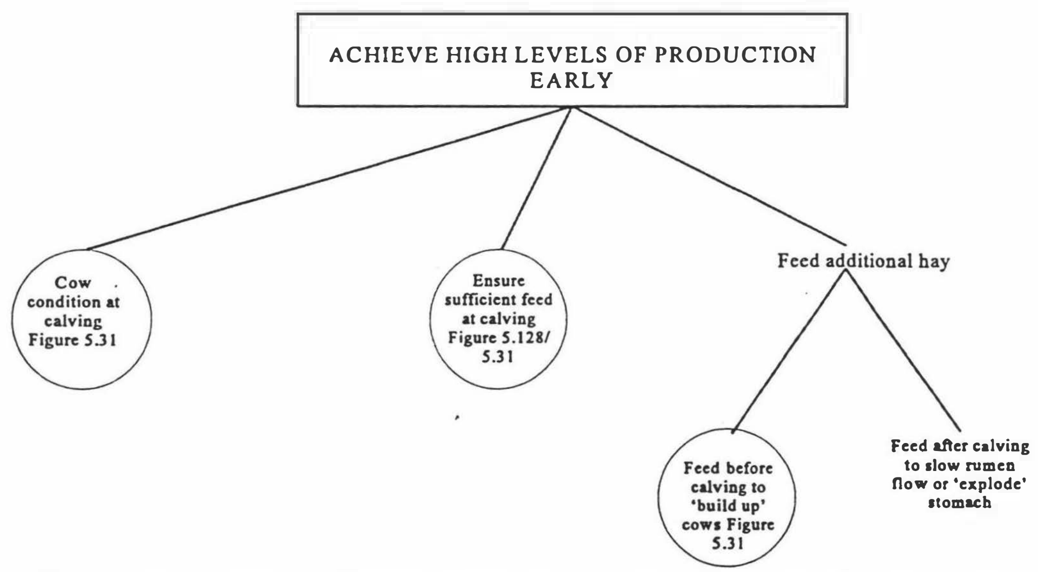

Figure 5.34 Elements of tactical management for achieving high levels of milk production early in lactation and links with other tactical management decisions.

Lactation Persistence

A review of the lactation curves of the herds on the case-farms (Figures 5.11, 5.12 & 5.13) suggested that the maintenance of lactation persistence was common to all farms. As a result of the management systems in place, which aimed to fully fed cows to maintain lactation throughout the season, cows were able to produce at high levels for long periods before production fell off at the end of the season. Apart from fully feeding the cows (see earlier discussion) farmers provided a stress free milking environment (see Labour and Milking Management), ensured cows were kept in a healthy condition throughout the year and that the condition score of the herd was maintained at high levels during the year (Figure 5.35).

Maintaining high (relative to those suggested in the literature (Bryant, 1984; Holmes & Wilson, 1987; Bryant, 1990)) condition scores during the year appeared to have an important contribution to high per cow production. Condition score played an important role because of its contribution to achieving a compact calving (Figure 5.29), animal health (Figure 5.29) and maintaining milk production at high levels (Figure 5.35).

Animal health played an important role in maintaining lactation persistence. By removing parasite burdens during the winter (Figure 5.31) and maintaining regular mineral drenching regimes farmers reduced stresses on the cows. Farmers perceived that these stresses reduced milk production and monitored animal health by taking blood tests, usually one a year.

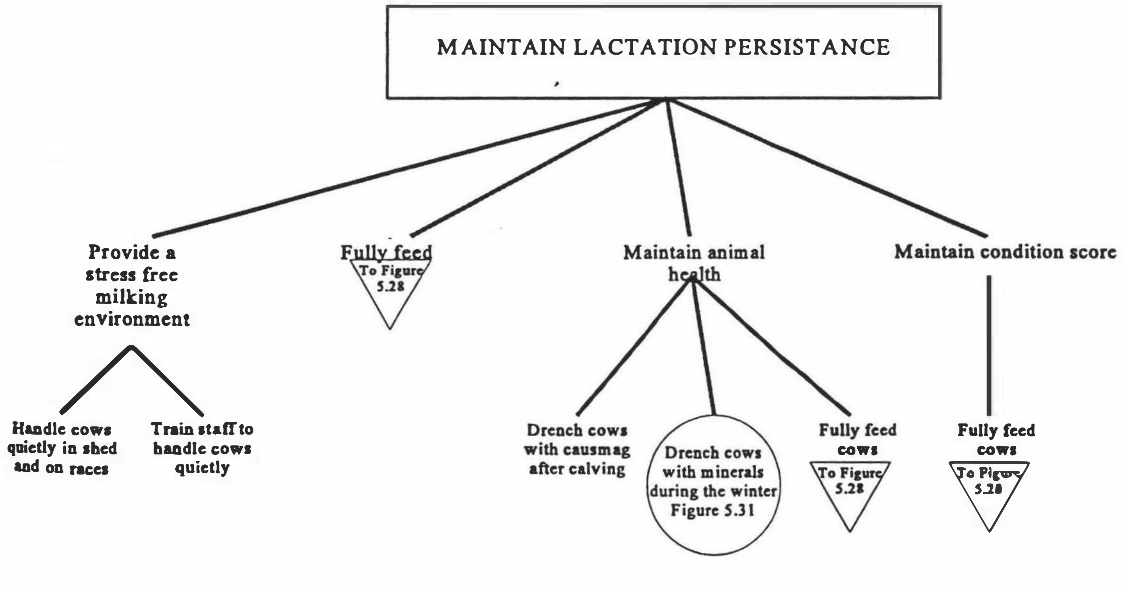

Figure 5.35 Tactical management techniques used to maintain lactation persistence on high per cow production farms and linkages with other tactical management techniques.

Labour and Milking Management

Of the farmers who employed labour only one commented on the requirements for managing labour. This farmer stated that employers needed to make the employees feel like member of a 'team' if they were to work to their potential and that tasks set would be done to the high standards that were set (Figure 5.36). In addition, employers needed to be very careful to set a good working example so as not to influence farm staff and have them take the same shortcuts. Staff needed to be trained to carry out the tasks set well, particularly milking procedures, because of the adverse effects rough handling in the shed.

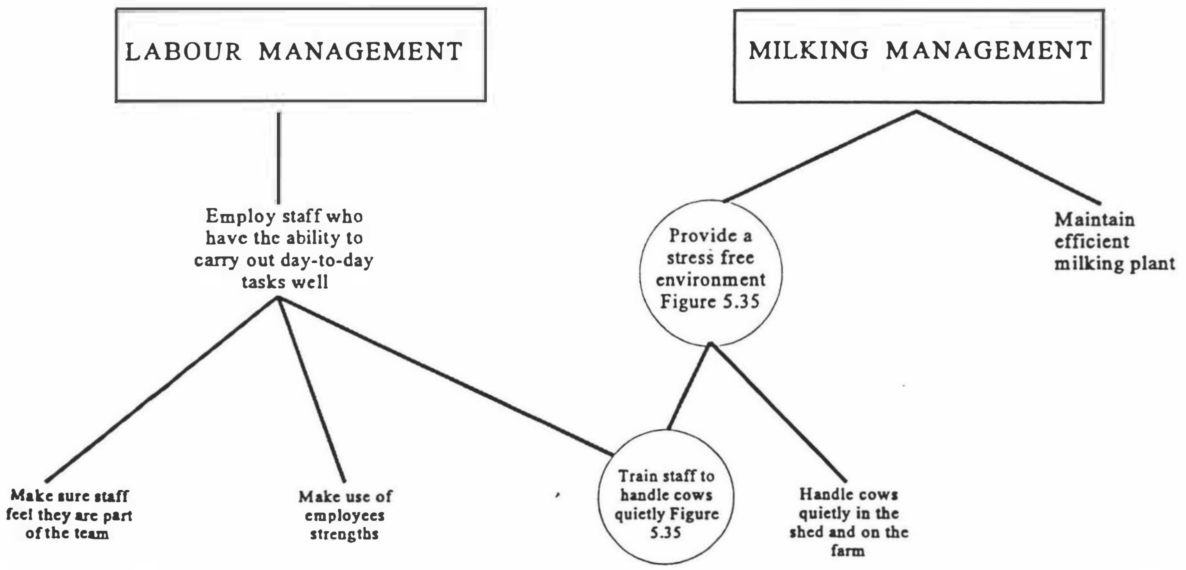

Figure 5.36 Tactical management techniques associated with labour and milking management on high per cow production farms and linkages with other tactical management techniques.

5.4 Comparison of Model with the Literature

In this final section of Chapter Five, the 'model' for high per cow production developed from the farm case-studies is compared with the literature, in terms of the resources used and the strategic and tactical management. Management, as well as resources, play an important role in achieving high levels of milk production (Figure 5.26). Previous models of milk production from pasture, such as that of Holmes *et al.* (1993), or the one developed in Chapter 2 (Figure 2.4), did not strongly emphasise the role of management. Therefore, the model presented in this study differs from previous models in that it illustrates strategic management and the diversity of 'possible' tactical management techniques that can be used to achieve high levels of production.

5.4.1 Resources

The soils, climate, topography and altitude on the case-farms were all conducive to growing pastures in a pattern suited to seasonal dairy farming. Although pasture growth patterns on the case-farms appeared, on the basis of milk yields, to be similar to those reported by Brookes *et al.* (1992), the estimated amount of pasture consumed (Table 5.1) is much lower than that suggested by Hodgson (1989) for 'top' dairy farms. The reasons for this are not clear, but Bryant (1980[a]; 1980[b]) noted that *ad lib.* access to pasture, such as that required for consistent full feeding of cows, decreases utilisation and perhaps lower utilisation figures should have been used to estimate pasture grown on the case-study farms.

Pasture intake on the case-study farms was influenced by factors associated with the herd: breed, animal size and genetic merit, which is consistent with data provided by Bryant (1982), Grainger *et al.* (1985[b]), Geenty & Rattray (1987), Ahlborn-Breier (1989), Ahlborn & Bryant (1992) and Holmes *et al.* (1993). In this study the genetic merit (BI) of herds was high (126 or greater), and all farmers used AI or stud bulls to breed replacements. The high BI places the case-study herds in the top 10% for New Zealand in terms of genetic merit (LIC, 1992). Friesian, Jersey and Friesian x Jersey cows were all represented in the herds studied, and no breed appeared to be any better than another in terms of milk production per cow. The levels of productivity of the different breeds reported by Holmes *et al.* (1989) and Ahlborn & Bryant (1992) were not verified in this study, although profitability, determined via gross margins, was high for all farms (Table 5.26). An assessment of the profitability of individual breeds was not made in this study because of the variability of management systems employed on each farm (see Crawford, 1994[a]).

In most cases, the cows on the case-farms appeared to be bigger than breed averages. Thomson *et al.* (1991) reported that, provided they are fed to do so, heavier cows produce more milk, and Ahlborn & Dempfle (1992) reported small, positive, genetic correlations between body size and milk yield. Research results seem to be support the aim of farmers to rear replacement livestock to the size of the mature cows in the herd by first calving. However, management factors, such as fully feeding cows (see Tactical Management) suggest that high per cow production was achieved by concentrating on the management of the farm and the herd rather than any genetic or size advantage.

Milk production is not only affected by pastures and herd factors, but also by the quality of 'capital' resources. Although, the effects of these factors have not previously been modelled, they have been reported in the literature and were recognised by farmers. These effects include losses in production due to: increased walking activity (Dewes, 1978; Bines, 1979; Pratumswan, 1994); poorly constructed races (Dewes, 1978; Kirton, 1982; Bridges, 1986; Lucy *et al.*, 1986; Collick *et al.*, 1989); inefficient milking machines (Mead, 1983; Lean, 1987); and inadequate subdivision and water supply (Mead, 1983, Lean, 1987).

5.4.2 Management

Strategic Management

Strategic management decisions (i.e. those decisions that have a long term effect greater the one season) affect high per cow production in two ways (Figure 5.18). First, decisions which affected feed supply, such as, stockings rate (which also affected feed demand), supplement policies, pasture renewal and fertiliser policy. Second, decisions which affected feed demand, such as, stocking rate (see feed supply)herd improvement, size of replacements and lactation length.

The average stocking rate on the case-farms was low compared to those calculated by Holmes & MacMillan (1982) (2.4 *vs* 5 cows/ha), Crabb & Wilson (1983) (4.2 cows/ha for 'self contained farms') and Pringle & Wright (1983) (5 cows/ha for farms where non-productive stock are grazed off the farm). However, the comparison of stocking rates based on cows peak milked is misleading, as many cows on three of the case-farms were wintered-off and on other farms early culling reduced seasonal stocking rates and therefore summer - autumn grazing pressure (Holmes & Parker, 1992; Crawford (1994[b]). The variation in the stocking rate on the case-farms illustrates that stocking rate is farm specific as suggested by Holmes & Parker (1992), and stocking rates are 'optimised' with respect to the farm production system.

Genetic merit was influenced in the case-study herds by selecting replacements from the better cows in the herd (Holmes & Wilson, 1987), using high BI bulls as sires (MacMillan, 1972; 1985), culling cows in the herd with low production and regular herd testing to identify 'top' cows (Garrick, 1991). The replacement rate on some farms was not reliable, because cow numbers were being increased, and therefore could note reliably be not compared with those suggested by (MacMillan (1976) or Jackson (1983).

As indicated earlier, the case-farmers aimed to rear young stock to their mature size when they first entered the herd. Murphy (1993) and MacKenzie & Brookes (1992) suggested that this strategy was important for achieving high per cow production, particularly in the first lactation. However, other authors such as Ahlborn & Bryant (1991) and Wickham (1990 cited by Bryant & McRobbie, 1991) report that the benefits, of rearing replacement heifers well, dissipates after the first lactation, although this contradicts the findings of this study, and those reported by Butendieck et al. (1977) and Anacker et al. (1979), which suggest that the effects of rearing replacement throughout the animals' lifetime, if they continue to be well fed.

The full feeding of cows was reflected in their overall body condition, which was maintained at high levels (i.e. relative to that reported), and this has been reported as a prerequisite to high per cow production (Bryant, 1982; Grainger *et al.,* 1982; Johnson & Tran, 1990; Muller, 1993).

Lactations lengths of between 250 days and 268 days were longer than the average for New Zealand seasonal dairy farms (LIC, 1994). Lactation lengths on two farms were affected by low winter temperatures, but this factor was managed by calving later (Holmes & Wilson, 1978).

Tactical management decisions at drying off, consistent with those reported elsewhere, also influenced lactation length (see Tactical Management).

The pattern of feed supply was manipulated by the use of supplements and influencing the amount of pasture grown on the farm. The use of conservation and special purpose crops reported by Hogdson (1989), Holmes & MacMillan (1982), McCallum *et al.*, (1992) were all used by farmers in this study to increase feed supply. The use of strategic supplementation was suggested by Parker & Edwards (1994) and was a system also used to achieve high per cow production. Pasture renewal, nitrogenous fertilisers and deferred grazing were also used to increase pasture supply (Hogdson, 1989; Holmes & MacMillan, 1982; McCallum *et al.*, 1992).

Soil fertility levels were manipulated by the strategic application of fertiliser and the distribution of pasture growth was therefore improved, relative to herd requirements. The strategic management decisions for applying phosphate and nitrogen based fertilisers are as suggested by White (1987), Hogdson (1990) and Roberts *et al.* (1993), although in some cases applications were higher than that recommended following soil tests.

Strategic decisions about employing labour has been less well documented, than other aspects of dairy farming systems. Farmers, who employed labour, suggested that high levels of production were more difficult to achieve when labour, outside that provided by the farm family, was employed. These data are confirmed by Umphrey, (1992) and Umphrey *et al.* (1995). Strategic decisions were made to improve the quality of 'capital' resources and helped provide the stress free environment farmers aimed for at milking. The environment was managed by maintaining 'free-flowing' sheds with new or near new (within the last ten years) milking plant.

Tactical Management

Fully Feeding Cows

To fully feed cows after calving was perhaps the most important management focus of farmers in this study (Figure 5.28). Pasture cover at calving of between 2,000 and 2,500 kg DM/ha were achieved (Bryant & Cook, 1980; Bryant, 1984) by particular management techniques prior to and during the winter (see later discussion). Having reached this target, farmers fully fed cows (estimated intake at greater than 15 kg DM/hd/day) immediately after calving to ensure high levels of milk production were achieved from the outset of lactation (see later discussion). This data is consistent with Stabus (1986), although he suggested that cow intake peaked 6 - 8 weeks after calving.

To maintain high feed intake during lactation, grazing rotations were maintained at 17 - 30 days, and cows were allocated as much pasture as possible (King *et al.*, 1980; Wilson & Davey, 1982). If pasture became limiting supplements were offered to maintain high feed intake (King & Stockdale, 1981; 1982; Ridler, 1982). High feeding levels throughout lactation maintained cow condition and is consistent with data reported by Rogers *et al.* (1979) and King & Stockdale (1981).

Farmers monitored pasture residuals, and the amount of feed offered per cow suggested that milk production on the case-farms was not affected by forcing cows to graze to low residuals (Le Du, *et al*., 1981; Le Du & Hutchinson, 1984). Fresh pasture was offered to the herd after each milking, in all but one instance, as farmers believed that this stimulated cow intake (Leaver, 1985; 1986). In addition, the use of a fresh break of pasture minimised fouling of herbage (Ulyatt & Waghorn, 1993). Fresh pasture was offered more than twice a day on one farm to increase intake. The results of this practice are confirmed by Broster *et al.* (1976), McGrudy & McGrudy (1994) and Oldfield (pers. comm.). The farmer who fed supplements all year round commented that pasture composition in early spring was sub-optimal because cows substituted pasture for the supplement being fed (Phillips, 1994).

Concentrated Calving Pattern

The importance of tactical management, particularly of the herd, during mating was recognised by the farmers studied. The two major components of reducing the length of the calving period were:

to fully feed the cows to minimise initial liveweight loss in early lactation and increase condition score leading up to mating combined with accurate detection of oestrus (Figure 5.29). These techniques ensured high conception rates, low numbers of empty cows and a compact calving. Frequent observation of oestrus activity (i.e. at least three times a day) was a prerequisite for good mating management (Jordan & Fourdaine, 1993) and farmers in the study observed cows up to six times a day. Farmers also used CIDRs as suggested by MacMillan & Smith (1985), Upjohn (1985) and Britt (1987) to improve submission rates and shorten calving.

Herds on the case-farms calved, on average, over a period of 66 days, which was consistent with data reported by MacMillan *et al,* (1984) and Simmonds (1985) for Waikato and Bay of Plenty herds respectively, but longer than the optimum period (42 days) suggested by MacMillan *et al.* (1984). However, most farmers had a short period (14 - 19 days) between planned start of calving and median calving date. Four farmers used induction to shorten their calving spreads, a procedure suggested by Day (1977; 1979) and MacDairmid (1983[a]; 1983[b]).

Pasture Quality

Feed quality was an important issue throughout lactation and farmers maintained short rotations, (17 - 30 days), topped rank pasture and removed paddocks from the rotation in order to maintain leafy and immature herbage (Figure 5.30). Maintenance of actively growing pasture swards to achieve high cow intake, and production, was recommended by Muller (1993), Ulyatt & Waghorn (1993), McGrudy & McGrudy, (1994) and Phillips (1994), and farmers believed that this was an important component of high per cow production.

Winter Management

The targets suggested by Bryant (1984) to accumulate pasture to feed cows after calving and to maintain or reach condition score targets were prime management *foci* of farmers during the winter (Figure 5.31). The pasture cover targets at calving (usually between 2,000 and 2,500 kg DM/ha), suggested by Bryant & Cook (1980) and Bryant (1984), were achieved by maintaining, or planning a slow winter rotation of greater than 90 days, accumulating pasture prior to winter, grazing cows off the property, planting a winter crop and feeding conserved pasture (hay and silage) to reduce pasture intake. Tactical management techniques to prevent soil and pasture damage were similar to those typically practised by other seasonal supply dairy farmers (Holmes & Wilson, 1987).

Drying Off

The goals for drying off were concerned with providing the right pasture and herd conditions to maximise the following year's production. They were consistent with the findings of Wilson & Davey (1982), Holmes & Wilson (1987) and Gray *et al.* (1994) to provide sufficient feed at calving to fully feed the cows post-partum (Figure 5.32). Before drying off farmers set aside pasture, planted winter crops, applied nitrogenous fertiliser and lengthened the rotation to provide feed for the winter. If pasture was limiting production, farmers would also cull low producing cows to increase feed availability for the remaining cows in the herd. Gray et al. (1992) identified similar management practices amongst four 'expert' dairy farmers in the Manawatu.

The final drying off date was selected on the basis of cow condition and pasture cover as reported by Gray *et al.* (1992; 1994) for other seasonal supply farmers, although one farmer also monitored soil temperature because of its link with pasture growth rates.

The amount and type of feed available at drying off was important. However, farmers who had developed strategies that placed little or no demand on pasture grown during the winter placed less importance on the amount of pasture drying off. This data is consistent with that reported by Bryant (1982), Holmes & Wilson (1987) and Parker *et al.* (1992; 1993). Farmers generally set drying off condition targets close to what was required at calving as suggested by Bryant (1990), although targets were also dependent on winter management practices (see earlier discussion).

Quality Supplements

By maintaining a high quality pasture sward, high quality supplements were harvested, provided they were harvested at the correct time (Figure 5.33). High quality supplements were a requirement to maintain cow intake when supplements were offered to the milking herd (King & Stockdale, 1981; 1982).

High Production Early

Apart from fully feeding the herd immediately after calving, two farmers used methods to increase feeding levels to cows before calving to make sure high levels of milk production were achieved as soon as the cows calved. These farmers used a practice similar to 'steaming up' as reported by Lean (1987) and increased the level of hay in the diet to cows to ensure that the cows milked to their full potential as soon as possible after calving.

Maintaining Production Persistence

The goal of maintaining high daily MS yield throughout lactation was achieved by attention to four areas (Figure 5.35). First, cows were fully fed throughout lactation (see previous discussion). Second, farmers achieved condition scores of 4.5 to 6 at calving. The lower level condition scores are consistent with those suggested by Holmes & Wilson (1987), while the higher levels concur with USA recommendations (Muller, 1993). Peak production was achieved at a similar time to the area average, but the herds usually achieved higher levels of production (Clark & Davies, 1980; Grainger *et al.,* 1982; Johnson & Tran, 1990). Although there were no reports of susceptibility to hypomagnesaemia or hypocalcaemia in well conditioned cows as reported by Stabus (1986), to reduce the possibility of metabolic disorders post-partum cows were regularly drenched with Causmag.

Condition score was maintained at high levels throughout the year as reported by Muller (1993), and suggested by Edwards (1993). Only one farmer was prepare to sacrifice cow condition score for production towards the end of lactation. These data are not consistent with that reported by Gray *et al.* (1992) for four 'expert' farmers in the Manawatu who were willing, under given circumstances, to sacrifice some condition before drying off in order to keep the herd milking.

Third, to maintain animal health during the year cows were drenched during the winter period to help combat parasitic infestations. Reduced worm burdens placed less stress on the cows post-partum and milk production was better because of this. This policy is consistent with that reported by McQueen et al. (1976) for New Zealand cows, and Todd *et al.* (1972), Frechette & Lamothe (1981) and Bliss *et al.* (1982) for overseas cows. Cows were also drenched with minerals and vitamins to improve general health and minimise stress, although this practice could not be verified from the literature.

All farmers dried off abruptly as suggested by the SAMM plan (National Mastitis Advisory Committee, undated), rather than use a period of once-a-day milking. However, on three farms cows were fed at sub-maintenance levels after drying off to prevent mastitis and stop them producing milk. Although not reported in the literature, farmers who used this method, emphasised the importance of preventing milk production after drying off to prevent mastitis and depression of milk production in the next season. In addition, animal health was maintained with selenium and other mineral drenches (copper and cobalt) where needed.

Labour Management and Milking Management

A stress-free milking environment was important at all of the farmers (see earlier comments) (Figure 5.36), and this is consistent with reports by Lamb (1975), Chesterton et al. (1989), Shultz (1992) and Holmes et al. (1993[a]). An important aspect of this was the ability of employed labour to handle stock. Staff training in stock handling in the shed and along races was a priority.

Rearing Young Stock

Although some tactical management decisions were reported by the farmers for rearing replacement stock, they were beyond the scope of this study and are not reported here.

6

Reflection and Conclusions

Chapter 6 Reflection and Conclusions

It is important at the end of a research project to pause, draw conclusions, and reflect on what has been achieved, learned, and to identify areas requiring further study. In Section 6.1 the conclusions with respect to management practices for high per cow production are presented. The method used in the study is then critically examined in Section 6.2. Finally, in Section 6.3 areas for further study with respect to high per cow production and the research method are suggested.

6.1 Results

A case-study farmer commented during the course of a conversation that they did not think that they were doing anything 'out of the ordinary' to achieve high per cow production. Having completed the analysis of the data and developed a 'model' of high per cow production it is possible that the same conclusion could be drawn. Despite that fact that the farmers studied do not seem to be doing anything 'out of the ordinary', it was found they largely followed the recommendations suggested in the literature, and had developed systems to consistently achieve high per cow production. How do they do this?

First, the level and mix of resources available to farmers was not an obvious constraint to high per cow production. This implies that the strategic and tactical management techniques could be applied to overcome the constraints imposed by the resource bundle.

Second, irrespective of the resources available, cows need to be fully fed throughout lactation. Stocking rate, the level of supplementation and pasture quality are important factors here, as is the achievement of a concentrated calving pattern.

Third, replacement heifers need to be reared as close as possible to their mature size by first calving. Also, the selection of the heifers appeared to have some bearing on the level of production achieved, as those farmers who selected their replacement heifers from the 'top' cows achieved higher levels of per cow production than those who selected their heifers from all cows in the herd.

Finally, the results strongly imply that farmers who achieve high per cow production pay close attention (i.e. monitor) to their stock and their farm. All farmers in this study had a keen interest in their livestock and many decisions were based upon regular observations of their stock. This particularly applied to the detection of oestrus, and to daily feeding levels for the herd ans its replacements (when they were on the farm).

6.2 Critical Examination of Method

The objectives of this study were :

1) to develop, from the literature, a conceptual model of pasture-based per cow production .

2) to identify the management practices associated with high per cow production, and to elicit from the farmers what they believed to be the important factors in consistently achieving high per cow production.

3) to develop a farmer model for high per cow production, and to compare this with the conceptual model developed from the literature. This comparison would identify gaps in knowledge and indicate where further research should be carried out.

4) to critically evaluate the research method used.

The method used for this study was a multiple-case case-study of eight seasonal dairy farmers in the lower half of the North Island of New Zealand who consistently achieved high per cow production. The method used to study these was a semi-structured interview technique followed by a qualitative data analysis of verbatim transcripts recorded during the interview with the farmers. In addition, the farmers participated in the analysis of the interviews to permit the interviewer to verify the analysis with them.

One of the problems with a case-study approach of this nature is the selection of cases. Eisenhardt (1989) suggests that a theoretical knowledge of the phenomenon to be studied is required to enable selection to be carried out correctly. In this study little was known about the farmers who achieved high per cow production (the phenomenon being studied). A telephone survey was therefore carried out to obtain data about the characteristics of these farms and their managers. The questionnaire proved reasonably easy for the farmers to answer and was completed in approximately 15 minutes and a high response rate of 97% was achieved. The telephone survey results suggested a range of contrasting systems were used to achieve high levels of per cow production. Consequently, maximum variation sampling was used to select ten (later reduced to eight) the farms for follow-up, in-depth case-studies.

The multiple-case case-study method with semi-structured interviews proved successful in gathering information about 'how' farmers achieved high per cow production. However, because of the amount of information collected from farmers the sample size of eight farmers proved to be too large given the time constraints placed on the study.

In choosing to interview eight farmers and fully dissect their individual systems to find out 'how' they each achieved high per cow production, a compromise had to be reached concerning the number of times each farmer was visited and therefore the amount of information that could be collected, and the amount of analysis that could be carried out, before moving on to the next case. Because of illness and the timing of the interviews (early October) all eight farmers were visited over a period of 10 days. As a result, little analysis of each interview, apart from some field notes and a cursory listen to the tapes, was completed between interviews. Delays in typing the transcripts, even though only two to three days, meant that the first interview was not read and analysed until after the fourth interview had been completed. These problems could simply have been overcome by allowing more time between interviews.

In hind-sight, and well after the interview process had been completed, it became obvious that there were some deficiencies in the way the study method had been implemented. First, the conceptual understanding of the theoretical structure of the high per cow production model (Figure 2.4) from the literature review was poor; the literature review was not completed in time to fully develop data categories to be collected. Second, the perhaps shortsighted, use of the 'grounded theory' approach initially suggested by Glaser & Strauss (1967) to enter the field without prior knowledge of the phenomenon being studied meant some data was not collected. Previous authors, for example Wright (1963), and later, the same authors and others (Glaser, 1978; 1992; Strauss, 1987; Eisenhardt, 1989; Strauss & Corbin, 1990; Dey, 1993) suggested that knowledge of the phenomenon was important to prevent information being overlooked during the farm visit. The 'shortsightedness' resulted from a desire to prevent interviewer bias and lead to an insufficient number of probing questions being asked. Third, the procedure suggested by Yin (1994) (Figure 4.1, Chapter 4) was interpreted to mean that cases could be interviewed one after another. It was thought that cases could be revisited as necessary to redefine the collection protocol and perhaps reinterview the farmer, rather than fully understand one case, which is the required approach, before moving onto the next case. However, even this method had been selected the illness referred to earlier would have prevented the author being able to reinterview the farmers in-depth. As suggested earlier, it is preferable that each case (assuming more than one case was being studied) be fully investigated before proceeding to the next. Therefore, each case should be visited and revisited until it is fully understood before moving onto the next (Figure 6.1). Also, if additional information is collected from subsequent interviews, then the previous case(s) should be revisited to collect more data. In this manner, a full understanding of the system being studied would be built up without missing any details from individual farmers.

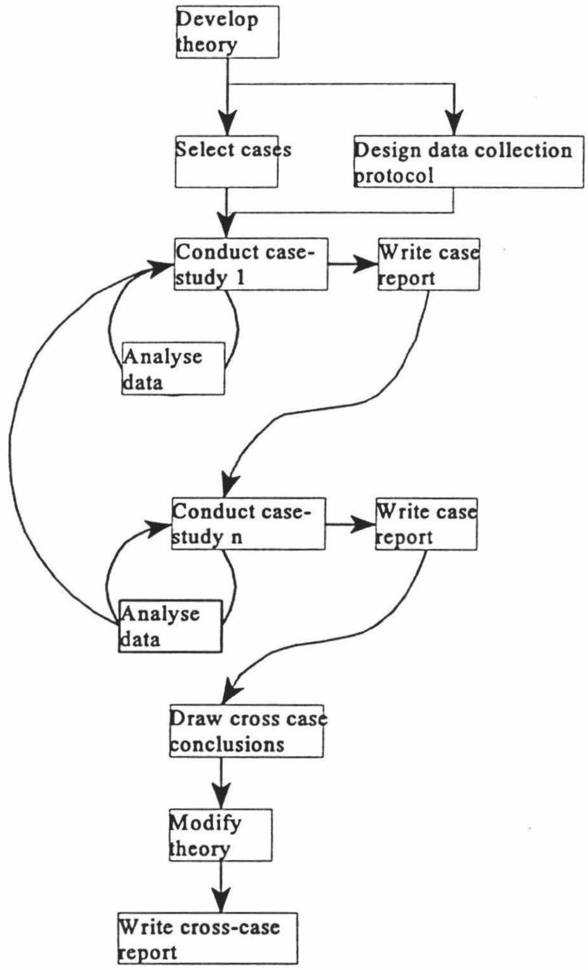

Figure 6.1 Modified multiple case-study approach for collecting qualitative data from farmers (Adapted from Yin, 1994).

As previously described, Glaser and Strauss (1967) recommended that interviewers should enter the field without preconceptions about what they were studying. Conversely, Wright (1963) and others suggest that the interviewer should have a more intimate knowledge of what was being studied to prevent vital information being missed. Despite these conflicting views, both viewpoints agree that interviews should be conducted without interviewer bias. To prevent bias in this study farmers were asked to express their views in their own words without the use of closed questions, and thus the interviewer had little influence on the responses. The interviews were taped as recommended by Scott *et al.* (1991) and farmers were sent a copy of the subsequent transcript for analysis. Providing a copy of the transcript to the farmer, and asking the farmer to participate in the initial data analysis helped establish a rapport between the participants.

Despite the rapport built up with the farmers during the study, there were difficulties in obtaining information for some cases primarily because these farmers felt that their system was not interesting or different from what other farmers were doing. The difficulties experienced in this regard resulted from the author's lack of experience in dealing with this type of situation. The failure to analyse transcripts until all interviews were completed compounded the difficulties. Greater use of probing questions, and better identification of the theoretical issues and categories relating to high per cow production. More time with farmers who found it difficult to 'explain' their system would have allowed the author to probe more deeply into the reasons why particular management practices were used. Despite the interviewing problems all farmers seemed to enjoy the process and each farmer expressed a strong interest in the research.

It should also be noted that experience in interviewing is required to ensure that the correct probing questions are asked. Researchers contemplating qualitative research will face a dilemma between the time available and the need to gain interviewing experience. Following the case-study method outlined in Figure 6.1 should help overcome problems associated with inexperience and guide the number of cases that should be selected. Fully analysing each interview before the next, and discussing the transcript with other researchers or with supervisors (in the case of student projects) would help to identify and correct errors in judgement or questioning technique.

One of the difficulties in analysing data obtained using qualitative techniques is that an hierarchy of data categories and linkages between categories should be developed before interviews commence. This means that literature reviews must be completed before cases are selected and interviews commence. In this study, despite the author's 'knowledge' of the production system under investigation (he was a dairy farmer in the late 1908s and early 1990s), the hierarchies of data categories had not been constructed before cases were selected and interviews commenced.

Consequently, some category areas were not correctly identified (and therefore not collected), and the 'best' cases may not have been selected. These problems may not necessarily be a concern, provided case-farmers are able to be interviewed in-depth, and on more than one occasion, to fill in 'gaps' in data at subsequent interviews. If researchers intend to interview a case only once, and it is not recommended that they do, then the hierarchies must be completed before case selection and interviews commence.

The computer program NUD.IST proved to be invaluable for the qualitative data analysis. Despite an incomplete checklist from the interviews and an incomplete hierarchy of data, the program enabled data categories to be developed from the interview transcripts. Following the category analysis via NUD.IST the use of matrices as suggested by Miles & Huberman (1984), proved useful for identifying similarities and differences between farms and locating data 'gaps' (see Tables 5. 1 to 5.24). However, as suggested earlier this analysis should have been completed at the conclusion of each interview and then verified with the farmers before proceeding with the next case..

Despite the method's logical shortcomings which mainly arise out of inexperience with a relatively untried approach in agriculture, the knowledge acquisition process itself was appropriate for the study.

6.3 Suggestions for Future Research

This study was exploratory and it is important that the theoretical framework of high per cow production be confirmed before separate, follow-up, research proceeds. In particular the data 'gaps' identified in this study should be filled by reinterviewing the farmers. Once this has been completed there are five fruitful research projects that could easily follow this study.

First, farmers were unanimous in their views on rearing replacements to be as close to 'mature' size as possible for their dairy herds. Research in the past has studied the effects of rearing young stock at various stages of their lives and the influence on rearing strategies on first lactation performance (McMeekan, 1956). McMeekan (1956), focused on feeding the replacement heifers at the same levels as the rest of the herd. His study showed that there are benefits in rearing replacement stock well up to the first lactation, but thereafter the advantage dissipated. Future research could focus on rearing heifers well up to first calving, but also on continuation of feeding levels commensurate with their size to see whether the rearing advantage persists beyond the first lactation.

Second, a study of dairy farmer management techniques at different levels of production within the same locality would show whether the results of this study are consistent with the practices of other farmers and whether differences exist between management systems associated with different levels of production. Also, with higher prices being paid for dairying land, per cow production may become a more viable way of increasing total farm production on those farms with low production, rather than increasing herd size or land area (Edwards & Parker, 1994). However, before these techniques can be 'transferred' to farms with lower production, the management of farmers with low per cow production, should be investigated. This investigation may uncover areas that extension agents can focus on to enable these farmers, if they wish, to profitably increase total farm production.

Third, the technique of 'steaming up' cows prior to calving requires investigation. Although the procedure was identified only on three farms, it is likely that similar techniques may be practised with other high production herds. Holmes (pers. comm.) had also identified the procedure in other areas of New Zealand and suggested that it seemed to lack nutritional validity, yet farmers in this study believed it helped them initiate lactation for high levels of milk production. The physiological and nutritional rationale behind 'steaming up' deserves investigation.

Fourth, as suggested in Section 5.2.1 this study did not investigate the level of skill or managerial ability possessed by the farmers interviewed. The results of this research suggest that these farmers may have better managerial skills than other diary farmers. Due to the complex nature of the farm management system these are a number of areas where managerial research may be undertaken.

These include, decision making, knowledge acquisition and processing, adult learning, and attitudes and beliefs of farmers.

Finally, a full economic assessment of the farming systems should be undertaken to ascertain the profitability of high per cow production systems. Whilst the simple gross margin analysis carried out in this study indicates that these systems are 'profitable', a more detailed analysis of all farm costs needs to be carried out. This will enable extension agents and farmers to obtain a fuller appreciation of the financial implications of high per cow production systems, such as those described within this thesis.

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Appendix 1 Dairy Industry Information and Overview of Study Area

Appendix 1.1 The 'Average' dairy farm in 1991/92

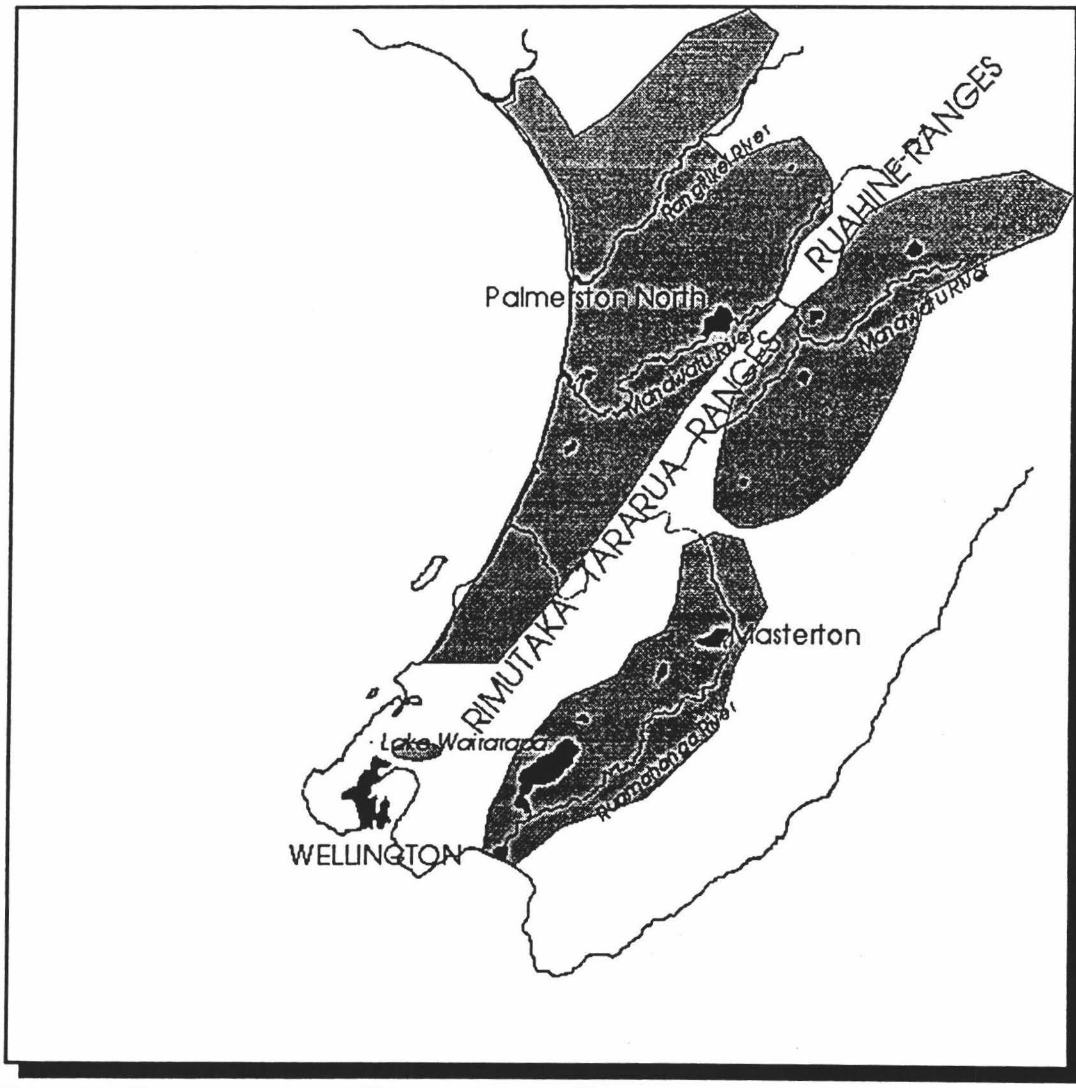
The Farm (December)	The Cow
70 hectares	226 days in milk
2.4 cows / hectare	3360 litres of milk
170 milking cows	4.83% milkfat
44 heifer calves	3.7% protein
42 yearling heifers	162 kg milkfat
27,500 kg milkfat	124 kg protein
389 kg milkfat / hectare	2821 somatic cells / ml
298 kg milk protein / hectare	

(source Holmes & Hughes, 1993)

Appendix 1.2 Overview of study area

Introduction

The Tui Milk Products Limited supply area from which the farmers were selected for study is located in the southern portion of the North Island of New Zealand (Map 2). The seasonal dairy farms supplying Tui Milk Products Limited are located predominantly in the Southern Rangitikei, Manawatu, Wairarapa and Southern Hawkes Bay.The area has a diverse range of topographical features, soils and climate (Maps 3 & 4).



Map 2 Map of the lower North Island of New Zealand showing the approximate areas in which Tui Milk Products Limited dairy farmers are located.

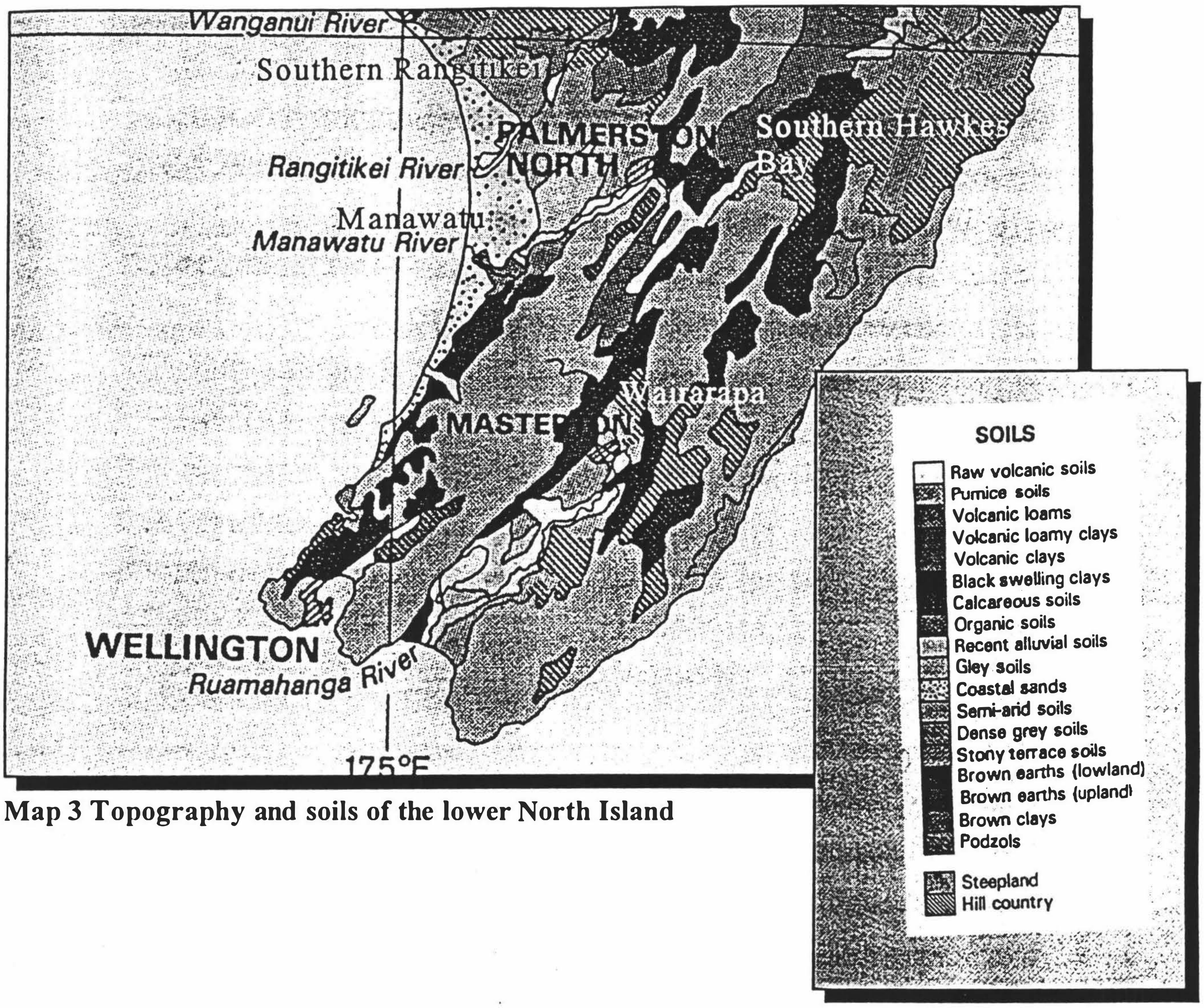
Topography

Southern Rangitikei.

The southern part of the Rangitikei where seasonal supply dairy farmers are located extends from the coast to the river terraces of the Rangitikei River basin (Map 2 & 3). The soils in this area range from the lighter sand country along the southern coast through heavy clay based soils to alluvial gravels and wind blown loess soils further to the north. The dairy farms in this area are located on flat to rolling, and terraced areas often close to existing townships or close to where settlements previously existed.

Manawatu

The Manawatu extends west of the Ruahine/Tararua ranges to the Rangitikei River and the west coast. The ranges which dominate the region overlook dissected uplands and coastal lowland plains (Heerdgen, 1990). The landscape rises gradually to the north. The plains are divided into three distinct river terraces flanked by the Rangitikei, Orua, and the Manawatu Rivers. These terraces are largely covered with wind blown loess soils which have been compacted into an impermeable clay layer which has poor drainage. The lowlands between the ranges and the sea consist of a coastal sand plain and an area of alluvial plain built up by major river deposits. Low elevations of less than 15 metres, flat and even topography and a mixture of gravel strands (old stream beds), fine sands, silts and peats characterise these alluvial plains. The sand plain adjacent to the coast varies in width from 2 to 20 kilometres, and consists of windblown sand-dunes up to 30 metres high which are very prone to wind erosion. (Heerdgen, 1990) (Map 3)



Map 3 Topography and soils of the lower North Island

Wairarapa and Southern Hawkes Bay

The topography of this area is dominated by the mountain ranges to the west, central lowlands and eastern hill country and a rugged coastline (Noble, 1985) (Map 3). One of the characteristics of the area, is that less than 30% of the land has a gradient of less than 15° and this limits the area where dairying can be carried out. Because of the steep slopes erosion is serious but this does not affect the dairying areas of the region which is limited to the lowland river plains between the mountain axis and where rainfall generally exceeds 1200 mm per year (Noble, 1985).

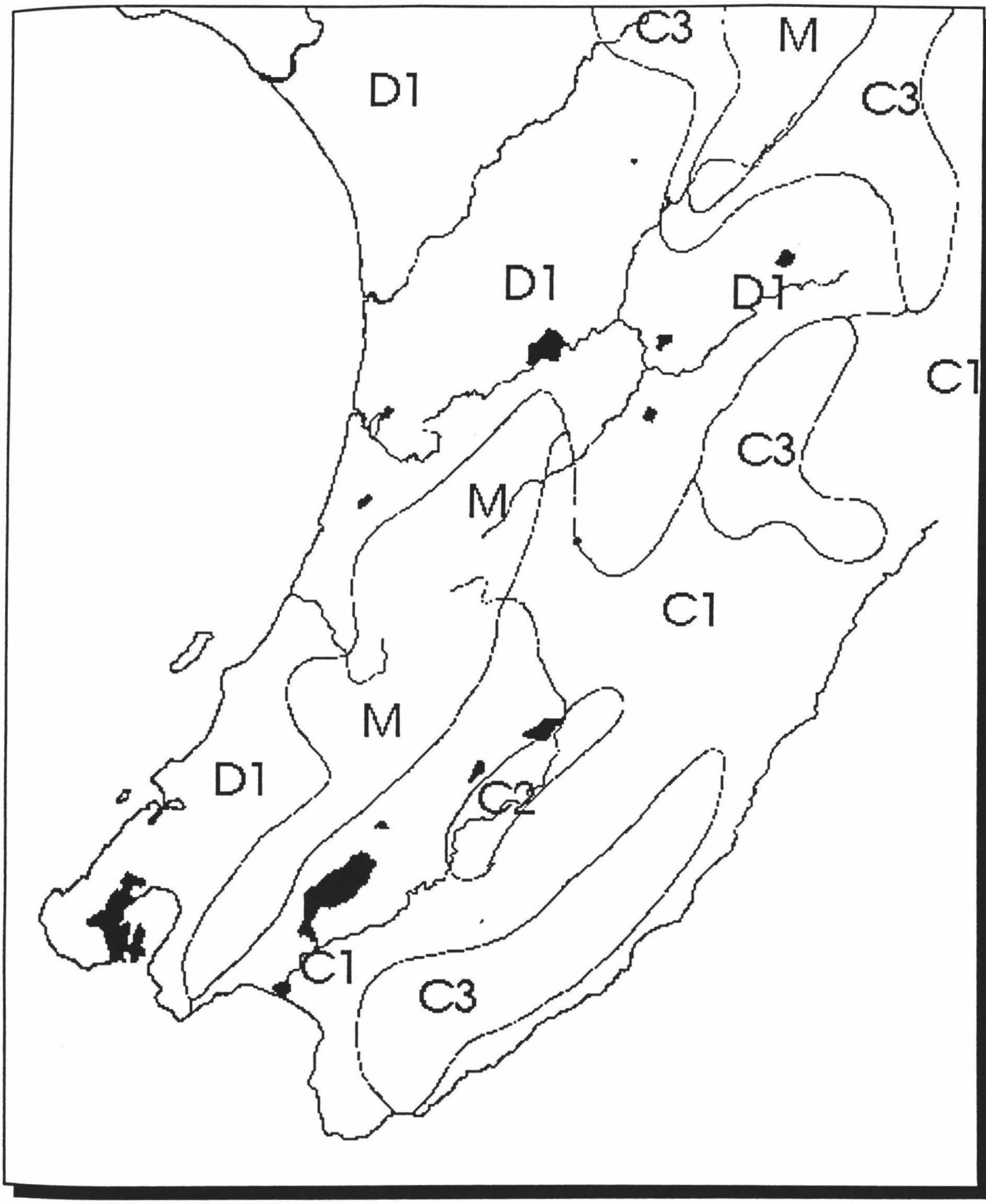
ioils

he soils for those areas where TMPL supplier dairy farms are located are dominated by alluvial oils laid down by the Rangitikei, Orua, Manawatu and Ruamahunga Rivers. The three classes of soils on which dairy farming is carried out include silt loams, with a high natural fertility, andy soils, with lower natural fertility, and silty clay loam, low in natural fertility (see Map 3); Sellars, 1987). On both sides of the ranges there are regions where peat type soils exist, in particular the lower Manawatu River basin and the area south west of Lake Wairarapa.

Climate

Southern Rangitikei and Manawatu

The region of the Manawatu (extending into the Horowhenua to the south and Southern Rangitikei to the north and Eketahuna and Dannevirke to the west.) is characterised by a high wind run (from the West and North West) particularly in exposed places and near the Manawatu Gorge. Rainfall in the area varies from 900 mm to 1200 mm annually except in the high country areas where rainfall totals are much greater (Map 4). The rainfall is evenly distributed throughout the year with less than a 2.5% variance month to month (Heerdgen, 1990). February is usually the driest month with December and July experiencing the greatest rainfall. The climate is described as mild and the area does not experience extreme variances in temperature. However the weather is often cloudy due to the proximity to the ranges and experiences between 2000 hours of sunshine (near the coast) and 1750 hours at Palmerston North and Dannevirke (closer to the ranges). Soil temperatures are above 10.0°C for at least 225 in many regions from the middle of September until the middle of May, a period which coincides with the seasonal dairy farming year. (Burgess, 1988).



Map 4 Climatic conditions in the lower North Island of New Zealand. (C1 = Very warm summers with dry foehn northwesterlies, decrease in reliability of spring and summer rain, moderate winter temperatures; C2 = Drier than C1, summer droughts common; C3 = Cooler and wetter than C1; D1 = Warm summers and mild winters, rainfall reliable and evenly distributed; M = High rainfall mountain climates).

Wairarapa

The climate of the Wairarapa and Southern Hawkes Bay is characterised by hot and dry summers and cold wet winters. Rain varies in the region from 4,000 mm to 800 mm with the higher rainfalls being experienced in the western ranges and is higher in the winter (Noble, 1985) (Map 3). The area is also prone to winter floods (e.g. the severe flooding of 1992 which severely curtailed milk production in the area). The rainfall in the areas where dairy farming is situated is generally above 1,200 mm per year. The effects of the rainfall in the region are often reduced by a high wind run. Strong winds are often experienced in the region from the South to West in the southern part of the region and from the North West in the northern part (Thompson, 1982; Noble, 1985). Droughts (periods exceeding 15 days with no rain) have occurred 87 times between 1884 and 1981 (97 years) and dry spells (period exceeding 15 days with less than 1mm of rain per day) have occurred 151 times in the same period. Another characteristic of the region is the marked temperature variations, up to 20°C between maximum and minimum daily temperature (Thompson, 1982).

Appendix 2 Telephone Survey Questionnaire

SEASONAL DAIRY FARMER PROFILE SURVEY FOR

HIGH PER COW PRODUCTION HERDS

Department of Agricultural and Horticultural Systems Management
MASSEY UNIVERSITY

MAY 1994

NOTES FOR THE INTERVIEWER

* Instructions are in capital letters and in **Bold** print. The questions to be answered are in lowercase letters. **Answer options are in lower case bold.**

* Confirm the Tui supply number at the start of the interview.

* The questions are to asked in the numbered sequence.Answers are to be written verbatim where indicated or the correct answer option circled.

* Assure the utmost confidentiality if the problem arises. The results will not be traceable to any individual farmer.

* Do not suggest an answer to any question apart from question 43 where it is permissable to try and draw the farmer into giving a full response to the question.

* Record comments or remarks even if they are not applicable to the question being asked.

QUESTIONNAIRE

THE QUESTIONS MUST BE ASKED AS WRITTEN AND IN THE PRESCRIBED ORDER.

INTRODUCTION

"Good evening. This is Ken Crawford from Massey University could I speak to Mr or Mrs ------ ?"

IF THE RESPONDENTS ARE NOT AVAILABLE CONTINUE AS FOLLOWS.

" When would be an appropriate time to call them "

NOTE THE RECALL TIME. ________________________.

" I am ringing as part of a study that I am undertaking for my Masters Degree in Agricultural Science. I am studying the management systems used by dairy farmers who have consistently achieved high per cow production. As you will be aware Tui Milk Products have acknowledged the benefits of this study and your name has been obtained from them as one who has a herd with an high per cow production over the last three seasons from 1990 to 1993. Would you be willing to give me approximately 10 minutes of your time to answer a few questions to enable me to obtain an overall profile of these high per cow production farms. The data obtained from this survey will be kept confidential at all times and individual farmers will be unable to be identified in the results.

IF WILLING GO TO QUESTION 1

IF UNWILLING

NOTE THE REASON WHY ____________________________________.

" Thank you for your time, good night".

SEASONAL DAIRY FARM SURVEY OF HIGH PER COW PERFORMANCE HERDS

Tui Dairy Milk Supply Number ____________

CONFIRM WITH THE RESPONDENT

SECTION I [a]
RESOURCES (Land)

1. What is the area of you farm ?

Total Area ____________

Effective Area ____________

Area used for stock other than the milking herd ____________

2. What is the average soil fertility level of the milking area ?

Olsen P ____________

pH ____________

Don't have soil test results ____________

Year soil tested ____________

3. What is physical the location of your property (address) ?
LOCATE THE PROPERTY ON THE AA MAP

____

____

4. Do you own or lease a run off ? **YES / NO**

What is the area of the run off ? ____________

SECTION I [b]
RESOURCES (Herd)

5. Stock on hand at 30 June 1993 ?

M A Cows including in-calf heifers ____________

R 1 Yr Heifers ____________

Other Stock ____________

6. How many cows did you peak milk in the following years ?

1993/94 1992/93

7. What is the breed composition of your herd ?

	Percentage
Friesian	________
Jersey	________
Friesian / Jersey Cross	________
Ayrshire	________
Ayrshire Cross	________
Other	________

8. Is all or part of you herd made up of registered pedigree animals ?
YES / NO

What percentage ? ________

9. What is the average BI of your herd ?

____

10. Do you graze the cows off the milking area during the winter ?
YES / NO

Number________ Period________

11. Are the young stock grazed off the farm ? **YES / NO**

12. If yes. How long are they grazed off in weeks ?

____

13. What are the average annual number of cow

Deaths ? ________

Culls ? ________

14. What % of the culls are culled each year for reasons other than disease, mastitis, temperament, empties and old age ?

____

SECTION I [c]
RESOURCES (Labour)

15. How many permanent labour units are employed on the farm ?

16. For what purpose, if ever, do you employ casual labour ?

Milking **Calving** **Silage and Haymaking** **Fencing**

Showing cattle **Holidays** **Calf Rearing** **Other**

None

SECTION II
PERFORMANCE MEASURES

17. What was the annual milkfat production of the farm in Kgs ?

	1993/94	1992/93
Milk fat		

18. What date does calving usually start?

____

19. By what date will 50% of your cows usually have calved ?

____

20. By what date does the last cow usually calve ?

____

Do you use inductions? **YES / NO**

21. What is the usual length of the mating period ?

AI ____________________

Total mating period ____________________

IF AI NOT USED GO TO Q 24

22. Do you use nominated semen or premier sires bull of the day ?

Nominated **Premier Sires** **Both**

23. What is the average BI of the bulls that you use ?

____

24. On what date do you usually finish milking for a season ?

____

ION III

TS

ıat fertiliser is usually applied to the milking area ?

	Rate (kgs per/ha)	Area	Timing / month
Maintenance			
Nitrogen (annual)			
Nitrogen (tactical)			
Lime			
Other			
Trace Elements			

s question is about which of the supplements that you have fed to your n the past 3 years. I will also ask for details about where they have ade, the land area used, the quantity used and when they are fed to the would like you to indicate a average for the past three years and make mments that you feel are relevant.

	Area Made	Quantity	Where*	When**
Hay ?				
Grass silage ?				
Maize silage ?				
Crops (Type) ?				
Deferred grazing ?				
Other ?				

	*	Indicate the location of the supplement by
1	=	Milking area
2	=	Run off
3	=	Bought in
4	=	Combination

	**	Indicate the period the supplement is fed by
1	=	Winter (dry period)
2	=	Spring (calving until end of November)
3	=	Summer (November until March)
4	=	Autumn (March until end of milking)

27. Which of the following concentrates, if any, have been fed to you cows in the last three years, and what amounts, in kilograms or tonnes were fed during each year? Would you also indicate the season when these concentrates were fed to your cows and make any comments that you feel are relevant.

	1992/93	Timing	1991/92	Timing	1990/91	Timing
Meal						
Barley						
Oats						
Other						

Comments ______________________

____

28. Are any special purpose pasture species grown (other than ryegrass and clover) ?

YES / NO

What are they? ______________________

29. Do you top your paddocks regularly ?

YES / NO

Comments ______________________

30. What minerals and or other nutrients have you given to your dairy cows in the past 3 years. ?

Selenium **Copper** **Iodine (Salt)**

Magnesium **Zinc** **Other**

Molasses **None**

COMMENTS ______________________

____

31 Do you herd test ? **YES / NO**

IF NO GO TO Question 34

32. How often do you herd test ? ______________________

33. What herd test service do you use ?

Self Sample **Sampling Officer** **Self Sample Assist**

SECTION IV
FARMER

34. What is the farm business ownership ?

Owner / operator (single)

Partnership - Spouse

- Other

Sharemilker - upper

- lower

Corporate

Other

35. NOTE THE SEX OF THE RESPONDENT

Male / Female

36. In what year were you born ? ______________________

37. If you operate a partnership in what year was your business partner was born ?

____

38. What is your highest educational qualification?

____

39. If you operate a partnership what is your business partners highest educational qualification ?

____

40. How many years experience have you had in dairy farming ?

____

41. Do you feel that there are any factors on the farm that are limiting the annual production?

____

If yes, what are they?

____
____
____
____

42. What is or are your goals in relation to milk production

____
____
____

43. If per cow production is a goal, Why ?

____
____
____
____

Would you like a copy of the results of this survey? **YES / NO**

This survey is the initial stages of a more in depth study of farmers who have herds with high per cow production. As a farmer who achieves high per cow production on a regular basis would you be willing to take part in a more in depth study.?

YES / NO

THANK YOU FOR YOUR TIME

Appendix 3 Case Study Method

Appendix 3.1 Letter to farmers advising them of selection for in-depth case study

28 July 1994

....
....
....
....

Tui Milk Supply Number ....

Dear Mr & Mrs ......

re Telephone Survey results and further study

Enclosed, please find a copy of an interim report on the telephone survey that was conducted by Ken Crawford of the Department of Agricultural and Horticultural Systems management at Massey University.

I would like to apologise for the delay in getting these results to you, but there seemed to be a lot more involved in the analysis of the data than I first anticipated. Also, the setting out of this report into a readable document has taken a great deal more effort than I imagined.

You will recall that I asked during the survey whether you would be willing to continue with the second phase of this study. I would like to advise you that you have been selected from the 31 eligible farmers, to be involved in the in-depth study. I will be contacting you within the next ten days to arrange a suitable time to visit you and to explain what the rest of the survey will involve.

I would like to thank you personally for the time you have taken to date to answer my questions and to provide me with some very interesting data to work with in the rest of my study this year. When the study is completed I will send you a copy of the final results of this questionnaire and any report that is provided to Tui Milk Products Ltd.

Once again thank you and I will contact you shortly.

Ken Crawford
Masterate Student

Appendix 3.2 Interview one introductory dialogue and questions.

Farmer Interviews

17 October to 31 October 1994

ALL INTERVIEWS FULLY RECORDED FROM INTRODUCTION.

Thank-you again for agreeing to participate in these in depth interviews. As I suggested when I visited you in August the interview is unstructured, in that I have very few direct questions to ask.

As I do not want to influence the information and knowledge you have in any way I will, unless I need clarification, let you tell me what you do during the year to achieve your high per cow production figures. What I am looking for is the information, knowledge and the management techniques you use to achieve high per cow production on your property. This may mean I ask some silly questions but I need to be sure I understand what you mean. To make the interview easier I though that the year could be split into about six separate sections; winter management, calving and early lactation, mating including breeding programmes, mid lactation (late spring early summer), summer / autumn, and late lactation and drying off. I suggest this separation to make it easier to focus on the years events.

I will try and organise the interview so that it lasts about 1 to 1¼ hours. That will save both you and me getting to tired. It would be better to finish at the end of a topic so the length will depend on when we start and finish each section of the year. After the interview I would like to go for a short farm walk to see what you are doing and perhaps you can then clarify any points that you have bought up. It is probable that we will not get through the whole year today and the rest of the year can be discussed at the next interview.

OK, in order to get used to the recorder on the table, let the typist get used to the different voices and to get a bit of background information I have 5 questions for you.

1) How long have you been on this property for?
2) What is it you like about this property? Comparisons can be drawn against other farms you have farmed on.
3) What is it that you enjoy about dairy farming?
4) What are your overall farming goals?
5) To reiterate Why do you have per cow production as one of your goals?

From now on the floor is yours. What I would like is for you to tell me what you consider are the important factors that contribute to you being able to achieve high per cow performance on this farm. Perhaps we should start with a quick overview of you strategy for achieving high per cow production before we start with your winter management.

Appendix 3.3 Interview One Notes

mer 1

Interview OK
Not as much information as first expected. Interview time was considerably shorter than expected. Does that mean there is data lacking?
Some good concepts came up without prompting.
Care will be needed to avoid influencing answers, got put in place once during the interview.
Getting good information from the process, I am enjoying the interviews. The farmers seem to enjoy giving the information even if they are a bit reticent at first.

mer 2

Interview good and the probing questions I though were better. It is very hard to listen behind what the farmers are saying and make sure I understand what they are saying.
Information good , but nothing innovative.
Time a bit longer. Was that due to my better probing?
There was more detail from this interview and the farmer was able to communicate his ideas better.
Both parties are enjoying the process and I am getting some good information out of the process. Seem keen to continue with the deal.

mer 3

Son interviewed alone, father did not seem at all keen on participating.
Was very nervous to begin with and it was quite difficult to get him to divulge information about his system and what happens on the farm. He had a lot of ideas but was not at all keen on verbalising them. Fear of ridicule?
I think there may be some detail lacking.
Some good concepts however were presented.
Again the prompts seemed to work better, getting more experienced.
Understood system better.

mer 4

Interview quite slow and a bit disjointed.
Very hard to get information out of both participants. Believe they have very little to offer.
After taping and before leaving some other ideas did come up which will need following up at the second interview.
They were willing to talk about what they did.
Seemed very nervous about the tape recorder.

ner 5

Interview difficult.
Although there was some good dialogue from the interviewee questions frequently needed to be asked. Was that because the system was not fully understood?
Not a lot of detail forthcoming.

ner 6

Interview very good.
Partnership which works very well in practice and during general conversation I would imagine that the tape will be very hard to type.
Both very much 'on the ball'. Information flowed like water and much was very interesting.
A large amount of detail and some very firm ideas about what they are doing.

mer 7

Another very good interview, the longest so far.
An excellent partnership this time between father and son. They both along with their spouses want the same things and have the same goals. They even think alike.
Very interested in what is going on with the study and in giving as much information as possible.

mer 8

Interview good although father appeared to get a bit bored towards the end. Did not go over time.
The same information coming out although this was from an 'older' point of view.
Philosophy strong.
Farm not as 'up-market' as some of the others and perhaps slightly less forward thinking but still some good ideas and some readoption of some older concepts.

Appendix 3.4 Farm walk and interview Notes interview one

:r 1 17.10.94

Patented mastitis filters in the sight glass of the cluster.
Very tidy shed and surrounds
Cows small but in good condition.
M.. emphasised planning, paddock cows in tomorrow ready to be shut up after grazing.
Silage paddocks already shut up.
Development work well underway - paddock ripped before ploughing to break up pan.
Small innovations to make the job easier - meal feeder attached to hay rack.
Grating in shed for faeces.
Keeps finger on the pulse of all day to day operations.

:r 2 18 - 10 - 94

Races smooth (driveable) and wide - rough edges in places.
Shelter belts strategic - willows and pines to break wind from west and south west. Very effective - create problems with grass under them but few enough not to be a problem.
Night and day paddocks used due to farm layout rather than by choice - danger of cows being hurt on road if they get out.
Shed older and not totally clean.
Comment made that cows are messy - cause? Shed surrounds tend to confirm this. General appearance around shed untidy.
H... and R... seem to interact well and work together an many things - organise the AI together.

er 3 19.10.94

Clean shed - demonstrates philosophy towards farming, to keep cows and system happy and natural.
stocking rate not high.
no pasture renewal program - but soil type and area seen to hold a good sward - rye and clover for many years. Old rough pasture on new block purchased not resown - simple hoof and tooth and pasture cam back well (Photo).
Races smooth if a bit wet.
No drainage as such - paddocks often wet.
Well grown heifers close to mature liveweight (stature almost fully grown).

ler 4 20.10.94

Herd test maybe important.
speed cows go through shed may also influence.
Jersey cows in very good condition and well fed - hungry on day and time of visit.
no real pasture renovation.

same system in operation on three different farms.
stocking rate at 1/acre.
well established.
length of time with AI.
Very good record keepers (up to pedigree standards).

ıer 5 21.10.94

A time warp - 1950's production system.
no central race.
½ day ½ night.
Shuts up paddocks only if grass too long or in crop etc, otherwise cows roam free.
Shed old 50+ years - old style claws etc.
still keen on breeding and genetics?
bees for pasture?

·er 6 26.10.94

Very clean shed (cleaner later) - free flowing.
races clean, dry wide and well chambered.
washing (stimulation) of cows considered important.
well laid out (and tidy) farm.
residual cover of 1800 - 2000 too much (shut for silage nest round).

er 7 27.10.94

Grass everywhere.
great pride in condition of the farm.
cows in good condition - as good as any seen..
split herd.
races in good condition (some odd bad patches).
no fences - only races.
clean shed and surrounds.

er 8 1.11.94

Older shed with new machines - not quite as clean as others (except Farmer 1).
Proud of farm and what they are doing.
farm development still being undertaken (perhaps increasing).
Old plant replaced three years ago.
stream and swampy areas a constraint.
cows contented and friendly.

Appendix 3.5 Example page of transcribed interview

RM (Grass staggers, one thing we've done this year which I haven't done in the past is actually start feeding the springers Causmag and I think that's less, well help build up their magnesium levels and there's perhaps less milk fever. I'm quite, I think it's quite worthwhile.)

KC And how long do you drench that for?

RM (Right through towards the end of November. When I feel that the perhaps the pasture's maturing up and I wouldn't just cut it out, I'd perhaps halve what they're getting and slowly reduce it).

KC And how do you define when the pasture, as you say is maturing up?

RM (Well it just becomes, as they go into the paddocks, perhaps a little more sign, a bit more seed head. I think the reason why we use quite high levels of Causmag is with a lot of the pasture fairly doped up with nitrogen, it's I think..)

HM (Takes the balance away)

RM (That's probably it,)

HM (And also the cows are producing so much milk they need the calcium.)

RM (So yes, when we first came here I virtually nearly gave them, and as we stepped up production I perhaps used more nitrogen and the incidence of grass staggers, you start seeing it.)

KC What about your grazing regime?

RM (Well we probably try it probably from the word go, we try whether you could say we fully feed the cows, it's probably that sort of you know we try and feed them quite well. But within that the first round, probably takes we probably get towards the end of August or early September, the first round probably takes 30 days, 35 days).

KC That's to graze every paddock on the property.?

RM (Well no, that's really. There's the area. The farm's split in 3 areas, so that in May when we dry off we winter, we graze for about a month, we graze the wet bit of the farm which then that gives the peat area a month growth without any stock on, so the first paddock would have had 60 days growth on the first of June. So that the cows then go to the peat block and graze that, through until the end of July so that and then they come from there they calve on the dry gravel area that's also close to

Appendix 3.6 An example of farm fact sheet, concept sheet, and gross margin sent to the farmers

Farmer 1 FARM FACTS

Area	117 ha
Effective milking area	98.5 ha [1]
Ohlsen P level	18 - 48 [2]
Location	.... 20 km south west .....
Rainfall	1210 mm
Height above sea level	216 metres
Topography	Flat
Soil Type	yellow grey and yellow brown earths
Stock as at 30 June 1993	236 Mixed age cows
	65 2 yr heifers
Breed	100% Friesian x Jersey
Run Off	No
Breeding Index	131
Recorded Ancestry	85%
Artificial Insemination	Premier Sire Service
Milkfat production 1993/94	51550 kg
Median Calving Date	20 August [3]
Fertiliser Applications	375 kg Superphosphate per ha
	375 kg Potassic 30 per ha
	20 kg Urea per ha [4]
Supplements	619 kgs Dry Matter per cow per year
Top pasture	Yes
Herd testing	8 weekly self sample
Minerals used regularly	selenium & magnesium

1 Allowances have been made for the area used for young stock grazed on the farm during the year.

2 Average Ohlsen P level on old part of farm 46. The 18 level was recorded in 1991 on a recently purchased sheep farm added to the milking area.

3 Median calving date recorded as the estimated date when 50% of the herd has calved.

4 Average applications over a number of years

Important concepts for high per cow production

Stockmanship

Animal welfare
Looking at stock from their point of view
Considerate to stock

Soil quality

No pugging of paddocks

Feeding levels

Consistent feed levels all year
amount of feed ahead of the stock
consistent with milk production

Concentrated calving pattern

replacements born early
better selection of heifers

Animal health

minerals - magnesium

Quality herd

BI
production levels (per cow)
losses kept to a minimum
better culling ability

Culling

must have a good herd base (to be able to build up herd numbers without loosing per cow production levels)
culling able to be deferred if the herd quality good

Feed quality

no pugging
24 hour grazing
topping
surplus feed off early (surplus feed made early and the pasture is not allowed to get rank)

Preventative Health

Calves off the cows within 12 hours (prevents mastitis)
cell count - milk quality
dry off at below maintenance feed levels to prevent mastitis

Dedication

Time input
personal life 2 nd to farm and the herd
creative - find a way out

Fertility

fertiliser applications
prepared to spend money to make money
workmanship - development

Well grown (quality) young stock

the bigger they are the better they are

Milking shed / plant

farmer happier
stock happier

Races / layout

Not a key issue
makes job easier
won't add but will remove

Average Gross Margin for milk production [5]

Income from milk production		$302,122	
Milk production expenses			
Fertiliser	$23,480		
Supplements etc	4,518		[6]
Animal health	9,000		[7]
Shed expenses	3,000		
Shed electricity	3,114		
Reproduction)			
Herd testing)	4,561		[8]
		47,673	
Total Gross Margin		254,449	

Effective milking area 98.5 ha
Cows peak milked 224

Gross Margin per effective milking hectare $2,583
Gross Margin per cow peak milked $,1136

[5] Average of 91/92 and 92/93 years

[6] Running costs of tractor and farm machinery where used for making of supplements has not been included.

[7] Total of animal health for the herd including replacements and dry stock.

[8] All herd testing and reproduction costs included.

Appendix 3.7 Taxonomy of categories developed during data classification using Q.S.R. NUD.IST. Category numbers refer to identification process used by NUD.IST to access category information.

(1)	/Farm
(1 1)	/Farm/Winter
(1 1 1)	/Farm/Winter/feed cows
(1 1 1 1)	/Farm/Winter/feed cows/winter crop
(1 1 1 2)	/Farm/Winter/feed cows/supplements
(1 1 1 3)	/Farm/Winter/feed cows/grazing off
(1 1 1 3 1)	/Farm/Winter/feed cows/grazing off/fully fed
(1 1 1 4)	/Farm/Winter/feed cows/balance hay and pasture
(1 1 1 5)	/Farm/Winter/feed cows/pasture
(1 1 1 5 1)	/Farm/Winter/feed cows/pasture/two mobs
(1 1 1 6)	/Farm/Winter/feed cows/block grazing
(1 1 1 7)	/Farm/Winter/feed cows/increase before calving
(1 1 1 8)	/Farm/Winter/feed cows/fully fed
(1 1 2)	/Farm/Winter/provide sufficient feed at calving
(1 1 2 1)	/Farm/Winter/provide sufficient feed at calving/grazing off
(1 1 2 2)	/Farm/Winter/provide sufficient feed at calving/late calving date
(1 1 2 2 1)	/Farm/Winter/provide sufficient feed at calving/late calving date/location
(1 1 2 2 2)	/Farm/Winter/provide sufficient feed at calving/late calving date/climate
(1 1 2 3)	/Farm/Winter/provide sufficient feed at calving/long winter rotation
(1 1 2 3 1)	/Farm/Winter/provide sufficient feed at calving/long winter rotation/block grazing
(1 1 2 3 2)	/Farm/Winter/provide sufficient feed at calving/long winter rotation/hay
(1 1 2 4)	/Farm/Winter/provide sufficient feed at calving/shut paddocks up
(1 1 2 5)	/Farm/Winter/provide sufficient feed at calving/winter crop
(1 1 2 6)	/Farm/Winter/provide sufficient feed at calving/stand off
(1 1 2 7)	/Farm/Winter/provide sufficient feed at calving/hay
(1 1 2 8)	/Farm/Winter/provide sufficient feed at calving/nitrogen
(1 1 3)	/Farm/Winter/condition score
(1 1 3 1)	/Farm/Winter/condition score/graze separate
(1 1 3 2)	/Farm/Winter/condition score/maintain condition score
(1 1 3 3)	/Farm/Winter/condition score/increase condition score
(1 1 3 3 1)	/Farm/Winter/condition score/increase condition score/pasture
(1 1 3 3 2)	/Farm/Winter/condition score/increase condition score/high intakes
(1 1 3 4)	/Farm/Winter/condition score/heifers in calving condition
(1 1 4)	/Farm/Winter/pasture
(1 1 4 1)	/Farm/Winter/pasture/grazing regime
(1 1 4 2)	/Farm/Winter/pasture/stand off
(1 1 5)	/Farm/Winter/soil
(1 1 5 1)	/Farm/Winter/soil/stand off
(1 1 6)	/Farm/Winter/animal health

(1 1 6 1) /Farm/Winter/animal health/drying off strategy
(1 1 6 2) /Farm/Winter/animal health/drench
(1 1 7) /Farm/Winter/drying off
(1 1 7 1) /Farm/Winter/drying off/feeding strategy
(1 1 8) /Farm/Winter/pre calving management
(1 1 8 1) /Farm/Winter/pre calving management/feeding strategy
(1 2) /Farm/Calving
(1 2 1) /Farm/Calving/feed cows
(1 2 1 1) /Farm/Calving/feed cows/fast rotation
(1 2 1 2) /Farm/Calving/feed cows/high fertility levels
(1 2 1 3) /Farm/Calving/feed cows/buy in feed
(1 2 1 4) /Farm/Calving/feed cows/feed supplements
(1 2 1 5) /Farm/Calving/feed cows/ad lib feeding whole farm
(1 2 1 6) /Farm/Calving/feed cows/feed shortages
(1 2 1 6 1) /Farm/Calving/feed cows/feed shortages/colostrum mob
(1 2 1 6 2) /Farm/Calving/feed cows/feed shortages/graze heifers off
(1 2 1 7) /Farm/Calving/feed cows/high feed intakes
(1 2 1 7 1) /Farm/Calving/feed cows/high feed intakes/fresh pasture
(1 2 1 8) /Farm/Calving/feed cows/hay
(1 2 1 9) /Farm/Calving/feed cows/cover at calving
(1 2 1 10) /Farm/Calving/feed cows/feed balancing
(1 2 1 11) /Farm/Calving/feed cows/make them eat more
(1 2 1 12) /Farm/Calving/feed cows/stand off
(1 2 1 13) /Farm/Calving/feed cows/stocking rate
(1 2 2) /Farm/Calving/rear young stock
(1 2 2 1) /Farm/Calving/rear young stock/colostrum
(1 2 2 2) /Farm/Calving/rear young stock/remove calves quickly
(1 2 2 3) /Farm/Calving/rear young stock/protect calf
(1 2 3) /Farm/Calving/animal health
(1 2 3 1) /Farm/Calving/animal health/feed supplements
(1 2 3 2) /Farm/Calving/animal health/minerals and vitamins
(1 2 3 3) /Farm/Calving/animal health/cow condition
(1 2 4) /Farm/Calving/identify anoestrus cows
(1 2 4 1) /Farm/Calving/identify anoestrus cows/pre-mating heats
(1 2 4 1 1) /Farm/Calving/identify anoestrus cows/pre-mating heats/abnormal cows
(1 2 5) /Farm/Calving/maintain pasture quality and quantity
(1 2 5 1) /Farm/Calving/maintain pasture quality and quantity/grazing regime
(1 2 5 1 1) /Farm/Calving/maintain pasture quality and quantity/grazing regime/fresh pasture
(1 2 5 2) /Farm/Calving/maintain pasture quality and quantity/nitrogen
(1 2 5 3) /Farm/Calving/maintain pasture quality and quantity/graze heifers behind cows
(1 2 5 4) /Farm/Calving/maintain pasture quality and quantity/shut up paddocks
(1 2 5 5) /Farm/Calving/maintain pasture quality and quantity/rotation
(1 2 6) /Farm/Calving/feed quality

(1 2 6 1) /Farm/Calving/feed quality/fast rotation
(1 2 6 2) /Farm/Calving/feed quality/12 hour grazing
(1 2 6 2 1) /Farm/Calving/feed quality/12 hour grazing/fresh pasture
(1 2 6 3) /Farm/Calving/feed quality/best paddock
(1 2 6 4) /Farm/Calving/feed quality/pasture cover
(1 2 7) /Farm/Calving/cow condition
(1 2 8) /Farm/Calving/calving cows
(1 2 8 1) /Farm/Calving/calving cows/monitoring
(1 2 8 2) /Farm/Calving/calving cows/assist
(1 2 9) /Farm/Calving/milk production
(1 2 9 1) /Farm/Calving/milk production/day 1
(1 3) /Farm/Mating
(1 3 1) /Farm/Mating/achieve concentrated calving pattern
(1 3 1 1) /Farm/Mating/achieve concentrated calving pattern/mating aids
(1 3 1 2) /Farm/Mating/achieve concentrated calving pattern/oestrus detection
(1 3 1 2 1) /Farm/Mating/achieve concentrated calving pattern/oestrus detection/in calf cows
(1 3 1 3) /Farm/Mating/achieve concentrated calving pattern/use of AI
(1 3 1 4) /Farm/Mating/achieve concentrated calving pattern/sunshine hours
(1 3 1 5) /Farm/Mating/achieve concentrated calving pattern/full feeding
(1 3 1 6) /Farm/Mating/achieve concentrated calving pattern/CIDRS
(1 3 1 7) /Farm/Mating/achieve concentrated calving pattern/selenium
(1 3 2) /Farm/Mating/maintain genetic merit of herd
(1 3 2 1) /Farm/Mating/maintain genetic merit of herd/A I
(1 3 2 1 1) /Farm/Mating/maintain genetic merit of herd/A I/cows in calf
(1 3 2 2) /Farm/Mating/maintain genetic merit of herd/PSS
(1 3 2 3) /Farm/Mating/maintain genetic merit of herd/select cows for mating
(1 3 2 3 1) /Farm/Mating/maintain genetic merit of herd/select cows for mating/production and udder
(1 3 2 3 2) /Farm/Mating/maintain genetic merit of herd/select cows for mating/temperament
(1 3 2 3 3) /Farm/Mating/maintain genetic merit of herd/select cows for mating/top 50%
(1 3 2 3 4) /Farm/Mating/maintain genetic merit of herd/select cows for mating/milking ability
(1 3 2 4) /Farm/Mating/maintain genetic merit of herd/stud bull
(1 3 2 4 1) /Farm/Mating/maintain genetic merit of herd/stud bull/cows in calf
(1 3 2 4 2) /Farm/Mating/maintain genetic merit of herd/stud bull/temperament
(1 3 2 5) /Farm/Mating/maintain genetic merit of herd/Ambreed
(1 3 2 6) /Farm/Mating/maintain genetic merit of herd/culling
(1 3 2 6 1) /Farm/Mating/maintain genetic merit of herd/culling/low producers
(1 3 2 6 2) /Farm/Mating/maintain genetic merit of herd/culling/purchasing good cows
(1 3 2 6 3) /Farm/Mating/maintain genetic merit of herd/culling/white calves
(1 3 2 6 4) /Farm/Mating/maintain genetic merit of herd/culling/mastitis
(1 3 2 6 5) /Farm/Mating/maintain genetic merit of herd/culling/old cows
(1 3 2 6 6) /Farm/Mating/maintain genetic merit of herd/culling/slow milkers
(1 3 2 6 7) /Farm/Mating/maintain genetic merit of herd/culling/udder and type
(1 3 2 7) /Farm/Mating/maintain genetic merit of herd/replacements

(1 3 2 7 1) /Farm/Mating/maintain genetic merit of herd/replacements/top 50%
(1 3 2 7 2) /Farm/Mating/maintain genetic merit of herd/replacements/first heifers born
(1 3 2 8) /Farm/Mating/maintain genetic merit of herd/mate heifers
(1 3 2 9) /Farm/Mating/maintain genetic merit of herd/A 1 bulls
(1 3 3) /Farm/Mating/rearing young stock
(1 3 4) /Farm/Mating/feed cows
(1 3 4 1) /Farm/Mating/feed cows/fast rotation
(1 3 4 2) /Farm/Mating/feed cows/maintain feed quality
(1 3 4 2 1) /Farm/Mating/feed cows/maintain feed quality/supplements
(1 3 4 2 2) /Farm/Mating/feed cows/maintain feed quality/topping
(1 3 4 3) /Farm/Mating/feed cows/buy in feed
(1 3 4 4) /Farm/Mating/feed cows/pasture cover
(1 3 4 5) /Farm/Mating/feed cows/supplements
(1 3 5) /Farm/Mating/maintain cow condition
(1 3 6) /Farm/Mating/conserve supplements
(1 3 7) /Farm/Mating/fertility
(1 3 7 1) /Farm/Mating/fertility/fertiliser
(1 3 8) /Farm/Mating/pasture
(1 3 8 1) /Farm/Mating/pasture/management
(1 3 8 2) /Farm/Mating/pasture/quality
(1 3 8 2 1) /Farm/Mating/pasture/quality/topping
(1 4) /Farm/Mid
(1 4 1) /Farm/Mid/feed cows
(1 4 1 1) /Farm/Mid/feed cows/buy in feed
(1 4 1 2) /Farm/Mid/feed cows/maintain high residuals
(1 4 1 3) /Farm/Mid/feed cows/supplements
(1 4 1 4) /Farm/Mid/feed cows/maintain levels
(1 4 1 5) /Farm/Mid/feed cows/cull early
(1 4 2) /Farm/Mid/maintain pasture quality
(1 4 2 1) /Farm/Mid/maintain pasture quality/lower pasture residuals
(1 4 2 2) /Farm/Mid/maintain pasture quality/lengthen rotation
(1 4 2 2 1) /Farm/Mid/maintain pasture quality/lengthen rotation/winter feed
(1 4 2 3) /Farm/Mid/maintain pasture quality/fast rotation
(1 4 2 4) /Farm/Mid/maintain pasture quality/topping
(1 4 2 5) /Farm/Mid/maintain pasture quality/maintain regrowth
(1 4 2 6) /Farm/Mid/maintain pasture quality/autumn climate
(1 4 2 7) /Farm/Mid/maintain pasture quality/pasture cover
(1 4 3) /Farm/Mid/conserve supplements
(1 4 3 1) /Farm/Mid/conserve supplements/watch pasture residuals
(1 4 3 2) /Farm/Mid/conserve supplements/quality supplements
(1 4 3 3) /Farm/Mid/conserve supplements/made quickly
(1 4 3 4) /Farm/Mid/conserve supplements/monitor paddocks
(1 4 3 5) /Farm/Mid/conserve supplements/conserve surplus

(1 4 4)	/Farm/Mid/rearing young stock
(1 4 5)	/Farm/Mid/cow condition
(1 4 5 1)	/Farm/Mid/cow condition/supplements
(1 4 6)	/Farm/Mid/fertility
(1 4 6 1)	/Farm/Mid/fertility/apply fertiliser
(1 5)	/Farm/Late
(1 5 1)	/Farm/Late/feed cows
(1 5 1 1)	/Farm/Late/feed cows/lengthen rotation
(1 5 1 2)	/Farm/Late/feed cows/autumn growth
(1 5 1 3)	/Farm/Late/feed cows/summer crop
(1 5 1 4)	/Farm/Late/feed cows/supplements
(1 5 1 5)	/Farm/Late/feed cows/deferred grazing
(1 5 2)	/Farm/Late/maintain soil fertility
(1 5 2 1)	/Farm/Late/maintain soil fertility/fertiliser
(1 5 3)	/Farm/Late/maintain cow condition
(1 5 4)	/Farm/Late/renew pasture
(1 5 5)	/Farm/Late/rear young stock
(1 5 6)	/Farm/Late/feed for winter - calving
(1 5 6 1)	/Farm/Late/feed for winter - calving/dry off part of the herd
(1 5 6 2)	/Farm/Late/feed for winter - calving/culling stock
(1 5 6 3)	/Farm/Late/feed for winter - calving/ensure sufficient supplements
(1 5 7)	/Farm/Late/conserve supplements
(1 5 8)	/Farm/Late/feed quality
(1 5 8 1)	/Farm/Late/feed quality/conserve supplements
(1 5 8 2)	/Farm/Late/feed quality/topping paddocks
(1 6)	/Farm/Drying off
(1 6 1)	/Farm/Drying off/feed cows
(1 6 1 1)	/Farm/Drying off/feed cows/drying off stock
(1 6 1 2)	/Farm/Drying off/feed cows/culling stock
(1 6 1 3)	/Farm/Drying off/feed cows/keep rotation
(1 6 1 4)	/Farm/Drying off/feed cows/supplements
(1 6 2)	/Farm/Drying off/maintain cow condition
(1 6 2 1)	/Farm/Drying off/maintain cow condition/monitor condition
(1 6 2 2)	/Farm/Drying off/maintain cow condition/milk test
(1 6 2 3)	/Farm/Drying off/maintain cow condition/condition for winter
(1 6 2 4)	/Farm/Drying off/maintain cow condition/dry heifers off early
(1 6 3)	/Farm/Drying off/ensure sufficient feed for calving
(1 6 3 1)	/Farm/Drying off/ensure sufficient feed for calving/monitor feed
(1 6 3 2)	/Farm/Drying off/ensure sufficient feed for calving/flexible strategies
(1 6 3 3)	/Farm/Drying off/ensure sufficient feed for calving/shut paddocks up
(1 6 3 4)	/Farm/Drying off/ensure sufficient feed for calving/winter crop
(1 6 3 5)	/Farm/Drying off/ensure sufficient feed for calving/dry off early
(1 6 3 6)	/Farm/Drying off/ensure sufficient feed for calving/set up for next season

(1 6 3 7) /Farm/Drying off/ensure sufficient feed for calving/pasture cover
(1 6 4) /Farm/Drying off/animal health
(1 6 4 1) /Farm/Drying off/animal health/drench
(1 6 5) /Farm/Drying off/sufficient feed for winter
(1 6 5 1) /Farm/Drying off/sufficient feed for winter/pasture cover
(1 6 5 2) /Farm/Drying off/sufficient feed for winter/winter crop
(1 6 5 3) /Farm/Drying off/sufficient feed for winter/grazing off
(1 6 6) /Farm/Drying off/drying off date
(1 6 6 1) /Farm/Drying off/drying off date/ground temperature
(1 6 6 2) /Farm/Drying off/drying off date/last milkings
(1 6 6 3) /Farm/Drying off/drying off date/feed budget
(1 6 6 4) /Farm/Drying off/drying off date/last day of tanker pick up
(1 6 6 5) /Farm/Drying off/drying off date/pasture cover
(1 6 6 6) /Farm/Drying off/drying off date/length of dry period
(1 6 6 7) /Farm/Drying off/drying off date/cow condition
(1 6 6 8) /Farm/Drying off/drying off date/amount of hay
(1 6 7) /Farm/Drying off/cull cows
(1 7) /Farm/other
(1 7 1) /Farm/other/animal health
(1 7 1 1) /Farm/other/animal health/fertility levels (minerals)
(1 7 2) /Farm/other/labour
(1 7 2 1) /Farm/other/labour/calving
(1 7 3) /Farm/other/time commitment
(1 7 3 1) /Farm/other/time commitment/pride in farm
(1 7 3 2) /Farm/other/time commitment/management
(1 7 3 3) /Farm/other/time commitment/pride in stock
(1 7 3 4) /Farm/other/time commitment/commitment to farm
(1 7 3 5) /Farm/other/time commitment/time
(1 7 4) /Farm/other/milking plant
(1 7 5) /Farm/other/milking management
(1 7 5 1) /Farm/other/milking management/fresh feed
(1 7 5 2) /Farm/other/milking management/milking cows out
(1 7 5 2 1) /Farm/other/milking management/milking cows out/slow milkers
(1 7 5 3) /Farm/other/milking management/time spent milking
(1 7 6) /Farm/other/stock management
(1 7 6 1) /Farm/other/stock management/condition score
(1 7 6 1 1) /Farm/other/stock management/condition score/genetics
(1 7 6 2) /Farm/other/stock management/handling cows
(1 7 6 3) /Farm/other/stock management/treatment of stock
(1 7 6 4) /Farm/other/stock management/stress
(1 7 6 5) /Farm/other/stock management/feed cows
(1 7 6 6) /Farm/other/stock management/supplements
(1 7 6 7) /Farm/other/stock management/two herds

(1 7 6 8)	/Farm/other/stock management/split herd
(1 7 6 9)	/Farm/other/stock management/observation
(1 7 7)	/Farm/other/environmental factors
(1 7 7 1)	/Farm/other/environmental factors/farm layout
(1 7 7 2)	/Farm/other/environmental factors/races
(1 7 7 3)	/Farm/other/environmental factors/other factors
(1 7 7 4)	/Farm/other/environmental factors/herd interaction
(1 7 7 5)	/Farm/other/environmental factors/walking
(1 7 7 13)	/Farm/other/environmental factors/pasture quality
(1 7 8)	/Farm/other/climate
(1 7 8 1)	/Farm/other/climate/growing grass
(1 7 8 1 1)	/Farm/other/climate/growing grass/even spread
(1 7 8 2)	/Farm/other/climate/even rainfall
(1 7 9)	/Farm/other/rearing young stock
(1 7 9 1)	/Farm/other/rearing young stock/graze behind cows
(1 7 9 2)	/Farm/other/rearing young stock/spoil pasture
(1 7 9 3)	/Farm/other/rearing young stock/priority feeding
(1 7 9 4)	/Farm/other/rearing young stock/separate
(1 7 9 5)	/Farm/other/rearing young stock/reintroduce meal
(1 7 9 6)	/Farm/other/rearing young stock/size and stature
(1 7 9 7)	/Farm/other/rearing young stock/weaning
(1 7 9 8)	/Farm/other/rearing young stock/health
(1 7 9 9)	/Farm/other/rearing young stock/meal
(1 7 9 10)	/Farm/other/rearing young stock/small mobs
(1 7 9 11)	/Farm/other/rearing young stock/two to a paddock
(1 7 9 12)	/Farm/other/rearing young stock/graze off
(1 7 9 13)	/Farm/other/rearing young stock/own set paddocks
(1 7 9 14)	/Farm/other/rearing young stock/supplements
(1 7 10)	/Farm/other/soils
(1 7 10 1)	/Farm/other/soils/basic soil quality
(1 7 10 2)	/Farm/other/soils/phosphate levels
(1 7 10 3)	/Farm/other/soils/fertiliser
(1 7 10 4)	/Farm/other/soils/effluent
(1 7 10 5)	/Farm/other/soils/drainage
(1 7 11)	/Farm/other/stocking rate
(1 7 12)	/Farm/other/fertility
(1 7 13)	/Farm/other/location
(1 7 13 1)	/Farm/other/location/more even climate
(1 7 13 2)	/Farm/other/location/pests
(1 7 13 2 1)	/Farm/other/location/pests/stress
(1 7 13 3)	/Farm/other/location/pedigree interests
(1 7 13 4)	/Farm/other/location/problems (TB)
(1 7 14)	/Farm/other/lactation length

(1 7 14 1) /Farm/other/lactation length/location
(1 7 14 2) /Farm/other/lactation length/305 days
(1 7 14 3) /Farm/other/lactation length/phosphate levels
(1 7 15) /Farm/other/pasture
(1 7 15 1) /Farm/other/pasture/quality
(1 7 15 1 1) /Farm/other/pasture/quality/topping
(1 7 15 1 2) /Farm/other/pasture/quality/identify your surplus
(1 7 15 1 3) /Farm/other/pasture/quality/harrow after grazing
(1 7 15 2) /Farm/other/pasture/renew pasture
(1 7 16) /Farm/other/pedigree stuff
(1 8) /Farm/Goals

Appendix 4 Case Descriptions

Case 1

Introduction and Characteristics

Case farm one was the northern-most farm on the eastern side of the Tararua ranges and had the largest effective milking area (Section 4.1). The farm covers 117 ha of flat land, has an effective milking area of 98.5 ha (Table 4.2) and is located approximately 5 kilometres (km) west of Dannevirke, at 216 metres above sea level.

Resource Factors

Pasture

The pattern of pasture growth on this farm is typical of farms in the 'Hawkes Bay Wet' region of TMPL supply area (McGrath, 1995); high spring and early summer pasture growth is followed by lower pasture growth in the late summer and increased pasture growth in autumn before low winter pasture growth is experienced. The pattern of pasture growth is managed by conserving pasture in periods of high growth, sowing a summer crop and feeding supplements in winter and summer. A regular pasture renewal program is maintained and three to six hectares (3 - 6% of the farm) of new pasture is sown annually.

Climate

The farm received an average of 1210 mm of rain per annum over the last five years (farmer records). Although droughts are not common, periods of low rainfall are often experienced during the summer months (December to February). During these periods when pasture growth is lower extra supplements are provided to maintain feed intakes. The prevailing wind is generally from the west and south west.

Soil

The soil types on the farm are Dannevirke and Kopua silt loams with an Olsen P level of 48; an area of land purchased recently has an Olsen P level as low as 18 and extra fertiliser is applied as part of a development program. Soil fertility on the rest of the farm is maintained by applying 375 kg superphosphate and 375 kg 30% potassic super/ha/annum. Urea (20 kg /ha/annum) is applied during the late winter to increase pasture growth in the spring.

Environment

A modern milking plant has been installed in a recently renovated shed (Plate 1). An important feature of this plant is the use of patented filters in the milking clusters to enable the early detection of mastitis. Particular emphasis is placed on shed cleanliness. The new shed and plant, in combination with patient stock handling, ensures a 'stress free' milking environment. High quality races (Plate 2) provide cows with quick and easy access to and from the shed without hoof damage; this also reduces stress on the cows and consequent losses of production. The milking shed and race design, and milking management reflect the importance placed on stockmanship by the farmer - "*... some of the production is lost just in stockmanship, especially around the cowshed area*".

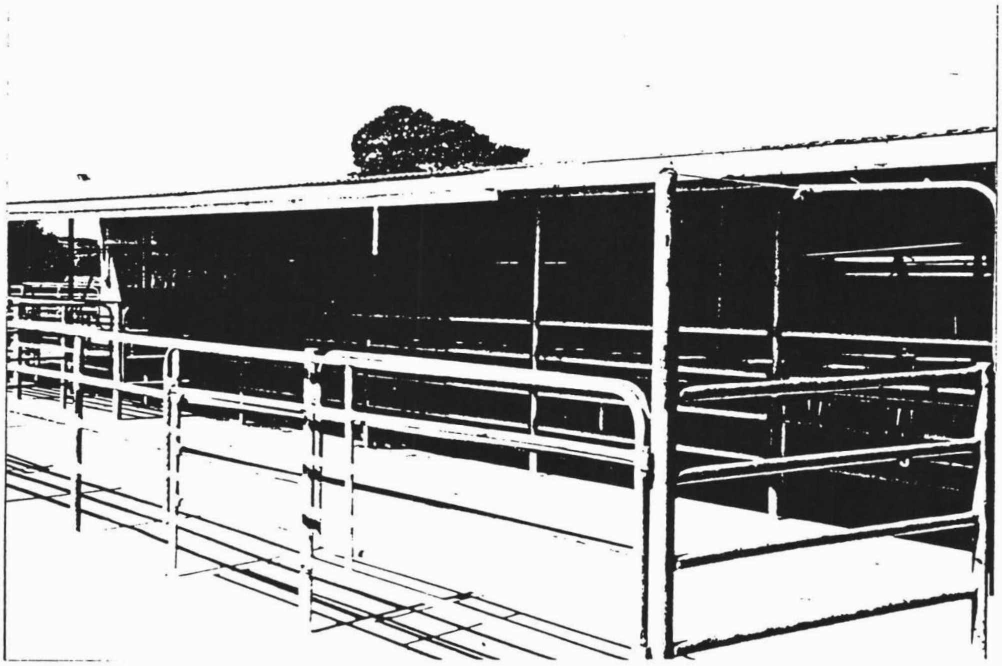


Plate 1 View of the newly renovated cow shed indicating the general cleanliness of the area. The new plant is just visible in the shadow of the shed

Plate 2 Typical quality pasture on farm 1 and the high quality races which assist in preventing lameness in the herd

Labour

Although one full time labour unit is employed to assist with the day to day running of the farm and casual labour is employed for some relief milking, the farmer believes hat, because employees do not have the same 'stake' in the farm, employing labour is not iecessarily conducive to achieving high per cow production, *"they consider they're doing their ob ... getting the cows in, putting them back in the same paddock, that's their job ... I've done nyjob ..."*.

Inimal Factors

All stock are wintered on the farm and in 1993 included 236 Friesian x Jersey mixed aged cows and 65 replacement yearling heifers. The herd has an average BI of 131 vith a recorded ancestry of 85%. Milk production of 394 kg MS per cow per year is achieved by eaching peak production quickly and maintaining lactation persistence through the summer and utumn (Figure A1). Involuntary wastage, i.e. deaths, are kept to a minimum (less than 2%). The proportion of cows culled in recent years has been reduced to enable herd numbers to be ncreased following the purchase of more land. Although cows live weights were not available, he cows were in good condition (CS 4.5 - 5) when the farm was visited in October 1994.

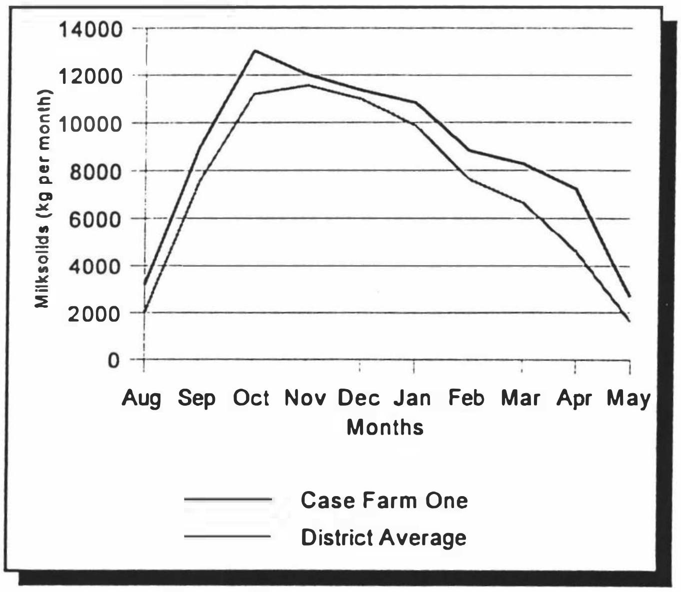


Figure A1 Lactation curve for case farm one compared with the district average for similar sized farms (adapted from TMPL data).

Management

Stocking Rate / Lactation Length

The herd is stocked at a rate of 2.34 cows per effective hectare[1] which is marginally below the district average of 2.54 (Watters, 1995). Although herd size has been increased in recent years, stocking rate has remained relatively stable, because of land expansion. Lactation length of 273 days is longer than other herds in the district (Watters, 1995). The amount of feed consumed by the herd was not calculated for this farm because calving pattern details were not available. However, pasture growth was estimated at 13,400 kg DM/ha (Dairy farmer field days, Tui Farmer of the Year Award information pamphlet), based on average pasture growth rates for the area.

Winter (June and July)

[1] See note Chapter 3 for calculation of effective milking area

The main goals during winter are to: ensure there is sufficient feed for the cows at calving, calve the herd at condition score 4.5, protect the soil and pasture from pugging damage. To ensure there is sufficient feed at calving two thirds of the farm is not grazed during the winter; the cows are grazed on the third of the farm, shut up at the end of March or the beginning of April, and are supplemented with hay and silage. In addition, the herd is dried off to ensure sufficient feed is available to winter the cows; based on a feed budget in May 1993 this was estimated to be 1,900 - 2,000 kg DM/ha. To achieve a target condition score of 4.5 at calving, the cows are dried off in good (no less than 4) condition and fed to at least maintain weight and condition until calving. Feed intakes are closely monitored and the area to be grazed is increased when weather deteriorates. Cows less than condition score 4 at drying off, are put in a separate mob with the rising 2 year heifers and given extra feed so that they will gain weight to reach CS 4.5 by calving. During the winter, cows which show signs of stress or are losing condition also join this group. Pugging damage of pasture and soil is avoided by taking the cows off the paddocks as soon as the weather deteriorates.

<u>Calving (August and September)</u>

The herd starts calving on 20 July (rising two year heifers) and 10 August (M.A. cows). During August and September the main goals are to: reduce calving spread (also see Mating), ensure cows are fully fed immediately after calving, detect anoestrus cows before mating, reduce animal health problems, and shut up paddocks for silage if an early pasture surplus is detected. To assist reduce calving spread to approximately 8 weeks, cows will be induced (10% in 1991/92). To ensure the cows are fully fed after calving an adequate pasture cover at the start of calving is achieved through winter management (see Winter and Mid and Late Lactation). When the whole herd is milking, one to one and a half paddocks of pasture are allocated to the herd per day, depending upon pasture availability and the prevailing weather conditions (i.e. not too cold and wet); this results in a grazing rotation between 20 and 30 days. If a pasture shortage appears possible, determined by the farmer's view of the farm, *"... I've got a clear picture ... a vision of ... what I want to see on the place"*, the yearling heifers are sent off the farm to grazing. To detect anoestrus cows they are tail-painted after leaving the colostrum mob. Animal health problems are minimised by drenching the milking cows with daily doses of magnesium and a multi-mineral drench, as well as weekly doses of selenium. If early pasture surpluses are detected paddocks will be shut up for silage.

Mating (October and November)

During October and November the main focus is on: fully feeding the cows to maintain their condition in order to achieve a concentrated calving pattern of 4-6 weeks, improving the genetic merit of the herd, providing feed for the cows in preparation for a possible dry summer, harvesting the paddocks shut up for silage in late September and early October, and to provide supplements for the winter. Mating is regarded as the critical part of dairy herd management, "*AB's the hardest part, if you get that wrong you've got the whole lot wrong*". To achieve a good (condensed) mating pattern and therefore a concentrated calving pattern, (i.e. a median calving period of 21 days), care is taken to avoid a 'feed pinch' with the herd by grazing yearling heifers off the farm and feeding silage if necessary, because "... *if you run out* [of pasture (sic)] *in the spring mating becomes difficult...* ". Cows are fully fed by maintaining a rotation of approximately 30 days. Anoestrus cows are identified because their tail paint has not been rubbed off; depending upon their calving date they are attended by the veterinarian prior to mating. Late calving cows are treated with CIDR's (Controlled Intrauterine Drug Release) after the third week of mating to attempt to get them in calf as soon as possible. No mating aids (i.e. tail-painting) are used during the mating period, "... *tried it, made me too lazy*", and oestrus behaviour is observed at morning and night milkings. The farmer is "... *particular about what* [cows] *I keep...* " and cows already identified as culls are not mated to AI to ensure replacement heifers are kept only from the better cows in the herd. To provide additional feed during periods of low growth later in the season a crop is sown in November and silage paddocks removed from the rotation earlier in the year will be harvested to provide supplements for the autumn and winter.

Mid- and Late-Lactation (December to April)

The main goals during mid- and late-lactation are to: fully feed the cows to enable the herd to be milked as long as possible and to maintain cow condition, maintain pasture quality, conserve pasture shut up for supplements to provide winter feed for the cows, and renew pasture. The cows are fully fed during this period of the year by: maintaining a 30 day rotation; introducing the summer crop into the rotation; in a dry summer delaying the return of the silage and hay paddocks into the rotation allows the regrowth on these paddocks to be break-fed *in situ* as a crop after the summer crop is finished; and feeding silage if required. To maintain pasture quality, paddocks are topped, *"not too short"*, so regrowth is not retarded, and in the autumn pasture quality is maintained by grazing pastures to lower residuals. To provide more feed for the winter, hay is harvested in December and one third of the farm is removed from the rotation during March and April to build feed reserves for winter grazing. The herd is milked as long as sufficient feed is estimated to be available to winter the cows and to achieve pasture cover targets at calving. If pasture shortages occur cull cows will be sold early to increase the average feed intakes of cows that remain on the farm. Cows that are to be retained are not dried off early because *'if you dry a few off you've still got to do something with them ... another paddock ... your cows are missing out ... better to feed out supplements."*. This means that a high proportion of cows that calve complete the lactation. The paddocks used for the summer crop are replanted in permanent pasture during the autumn after the crop has been fed off. If there is good summer growth the hay and silage paddocks will be returned to the rotation earlier and will not be fed off as a crop.

Drying off (May)

The goal for drying off is to ensure that sufficient pasture cover is available to meet the pasture cover target at calving and fully feed cows thereafter. The cows are dried off depending on weather conditions, and the last day for milking is usually about 20 May, however, the amount of pasture on hand (approximately 1,900 - 2,000 kg DM/ha based on a feed budget carried out in 1993) determines the actual date of the final milking.

Rearing Replacement Stock

Rearing replacement stock 'well' in order to allow them to produce 'well' during their lifetime is considered a priority. Rearing replacement stock 'well' means they are fed to enter the herd as rising two year olds close to their mature height and weight. To achieve this, heifers are weaned off milk at the recommended liveweight (90 kg), determined by the use of a measuring tape (based on girth measurement), and are then grazed in front of the cows (about half way through the rotation) to obtain the best feed available. In a dry summer/autumn heifer pasture intakes are reduced and they will supplemented with silage. They are drenched at three weekly intervals until 12 months of age to maintain health.

Planning & Monitoring

Planning ahead, or thinking about what will happen tomorrow, is a key element of high per cow production on Case Farm one, as is the amount of time put into running the farm, "... *one of the key things ... the high input* [of time (sic)] ... *keep contact with home ... never away from the farm ...* ". Having a vision of what the farm should look like enables the farmer to observe what is happening, compare this with the vision and make the necessary adjustments to achieve the vision. Monitoring the farm by observation allows the farmer to see how the farm is performing, how much the cows are leaving behind after grazing, how healthy the animals are, in order to make timely decisions to maintain pasture quality, fully feed the cows, achieve a concentrated mating and therefore calving pattern and profitable high per cow production.

Gross Margin

Average Gross Margin for milk production [1]

Income from milk production		$302,122	
Milk production expenses			
Fertiliser	$23,480		
Supplements etc	4,518		[2]
Animal health	9,000		[3]
Shed expenses	3,000		
Shed electricity	3,114		
Reproduction)			
Herd testing)	4,561		[4]
		47,673	
Total Gross Margin		254,449	

Effective milking area 98.5 ha

Cows peak milked 224

Gross Margin per effective milking hectare $2,583

Gross Margin per cow peak milked $,1136

1 Average of 91/92 and 92/93 years

2 Running costs of tractor and farm machinery where used for making of supplements has not been included.

3 Total of animal health for the herd including replacements and dry stock.

4 All herd testing and reproduction costs included.

Case 2

Introduction and Characteristics

Case farm two had the highest average soil fertility, the longest calving spread, the lowest herd BI, and was the southern-most farm on the eastern side of the Rimutaka ranges (Section 4.1). The farm covers 112 ha of predominately flat land, has an effective area of 106 ha (Table 4.2), and is located approximately 30 kilometres south-west of Featherston and 5 km north of Lake Ferry, at 10 metres above sea level. The property is run in conjunction with a sheep and bull-beef unit which is also used as a run-off for the replacement dairy heifers.

Resource Factors

Pasture

The pattern of pasture growth on this farm is typical of farms in the 'Wairarapa Wet' region of the TMPL supply area; high spring growth is followed by lower pasture growth in summer and increased pasture growth in the autumn before lower winter pasture growth (Riddick, 1991). The pattern of pasture growth is managed by irrigating part of the farm during periods of low rainfall. No pasture supplements are made on the milking area, although, supplements conserved on other properties owned by the farmer, and bought in concentrates, are fed to the herd during periods of low pasture growth.

Climate

Average rainfall for the area is approximately 1150 mm per annum (Thompson, 1982) usually evenly distributed throughout the year. Dry periods can be experienced after November and part of the farm is irrigated to provide fresh pasture during periods of low pasture growth. The prevailing winds are from the south and west are frequently of gale force which has a detrimental effect on pasture growth and animal intake.

Soils

The soil types on the farm are Ahikura and Opaki silt loams with small areas of Ruamahanga stony sand. The farmer takes advantage of the variety of soil types to balance yearly operations. For example, the herd is calved on the freer draining soils and during the summer an area of peat, which holds its moisture and performs well (grows more pasture than the rest of the farm) enables high feed intakes to be maintained. Due to the range of soil types, the Olsen P levels on the farm vary from 28 to 44. To maintain soil fertility levels 200 kg/ha DAP is applied in the autumn and 200 kg/ha of Cropmaster is applied in the spring. The farmer also applies a further 200 kg/ha 30% superphosphate to the third of the property where fertility is lowest. Urea (80 kg /ha/annum) is applied during the winter, spring and autumn to increase pasture growth rates.

Environment

The milking shed (Plate 3) is considered to be limiting, in terms of its size, for milking a large (300 cow) herd because it only has 18 sets of cups and milking regularly takes up to 2¼ hours, *'... you would think that would be a negative for cows. So long standing around"*. Patient and quiet stock handling around the shed area is practised to create a 'low stress' milking environment. The races on this farm are of good quality and those races seen during the farm walk were constructed with a gravel base graded to a high crown and appeared to be well maintained.

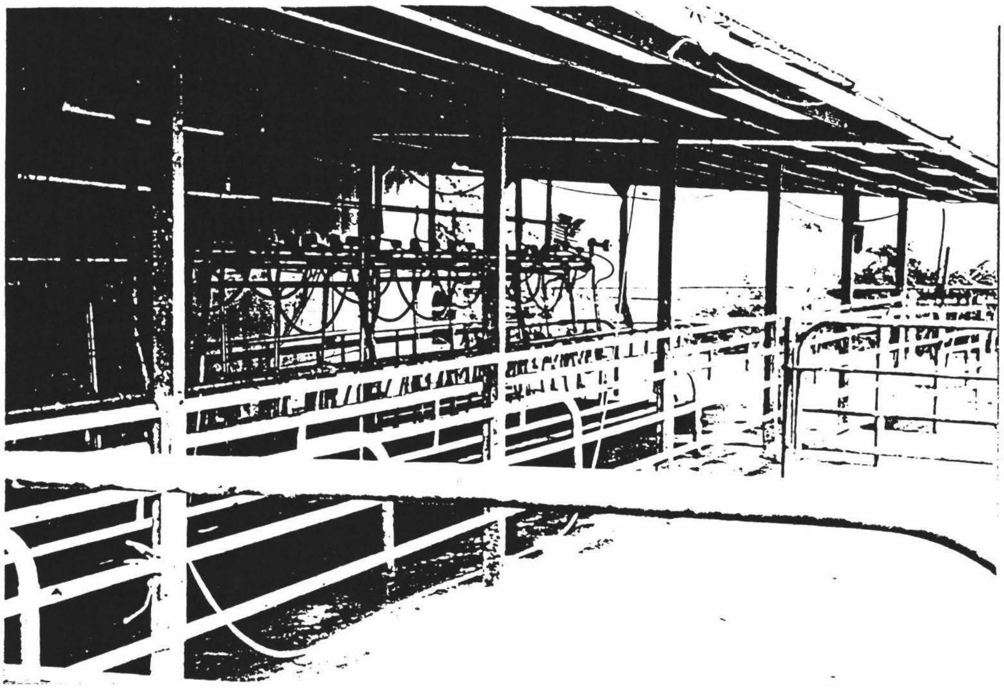


Plate 3 View of shed on Case Farm two showing the milking plant. Cows leave the shed behind where the photograph was taken and through the old walk-through shed and a foot-bath to treat lameness.

Labour

One permanent labour unit is employed to assist with the day to day running of the property. Employing staff gives the farmer time to think about the farm and to have more time to monitor what is happening, *"... we couldn't milk the number of cows we have without staff, and we couldn't do our other enterprises without staff, so staff means that I have ... enough time to monitor things"*. However, it is still important to check up on the quality of the tasks completed by staff, because the ease with which the farm runs, depends on the ability of the employees.

Animal Factors

The herd is wintered on the milking area and in 1993 included 292 mixed age Friesian (95%) and Friesian x Jersey (5%) cows. The herd has a BI of 126 and a 61% recorded ancestry. The 74 yearling replacement heifers are grazed on a runoff block. Milk production of

378 kg MS per cow per year is achieved through reaching high production levels quickly, peak production in November (later than average) and achieving high production levels through the late summer and autumn (Figure A2). Because the herd size has been increased recently, only 15% of the herd has been culled on an annual basis, however the farmer aims to achieve replacements rates of up to 25% when herd numbers have stabilised. Cow liveweights were not available, however when the farm was visited the cows were in very good condition (CS 5+).

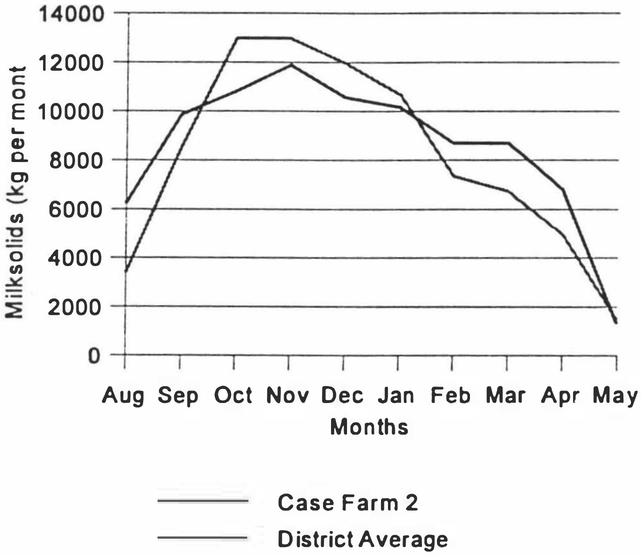


Figure A2 Lactation curve for case farm two compared with district average for a similar sized farm (adapted from TMPL data).

Management

Stocking Rate and Lactation Length

The herd is stocked at 2.56 cows per effective hectare[2] which is slightly above the district average of 2.47 (TMPL, statistical data). Stocking rate on a per hectare basis has been increasing over the last few years, more in response to, "*...accurate feed budgeting ... we physically go out and measure ... gives us the confidence to sneak up the stocking rate*", than

2 See Chapter 3.

other factors. The lactation length of 267 days[3] is similar to other farms on the eastern side of the ranges (Watters, 1995). An estimated 8,980 kg DM/ha was consumed by the herd, or 9,740 kg DM/ha if pasture grown as a result of nitrogen applications is included.

Winter (June and July)

The main goals during the winter are to: ensure there is sufficient pasture cover at calving (2,400 to 2,500 kg DM/ha), increase condition score to 5 for M.A. cows and 5.5 - 6 for heifers, protect soil and pasture from pugging damage, and maintain animal health. To ensure a pasture cover of 2,400 to 2,500 kg DM /ha at calving on 20 July, a detailed feed budget is completed before drying the herd off in May. An application of 30 kg/ha Urea over the whole farm during July and August also assists in achieving the required pasture cover. To achieve a condition score of 5.5 to 6 at calving the rising two year heifers are grazed separately during the winter while the cows, which are usually dried off at the beginning of May, are fed to reach a condition score 5 by calving. Pasture for the winter is provided by applying DAP in March which *"... seems to kick the grass away, ..., and also gets that grass away after they've gone through so you have a feedbank in the winter time"* and cows are fed hay and silage. Because of the nature of the soil types on this property, the cows are first grazed on the wetter, peat area immediately after drying off before being moved to other areas of the farm. They are then calved on the drier, sandy, soils to avoid pugging and pasture damage. During winter, the cows are drenched to control internal parasites and given selenium to reduce post-partum health problems.

Calving (August and September)

The herd starts calving on 20 July. The main goals during August and September are to: fully feed the cows, in order to reach high production levels as quickly as possible; maintain animal health and pasture quality. To fully feed the cows the herd completes the first round of the farm by the end of August (40 - 45 days); second and subsequent rounds last

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3 Median calving date until last day of milking.

approximately 20 - 25 days; high phosphate levels on the farm ensure that sufficient good quality pasture grows to maintain the 20 - 25 day rotation most of the lactation. The farmer believes that by fully feeding the cows (17 - 18 kg DM /head/day) from the start of lactation it is much easier to achieve high per cow production. To maintain feed intakes residual pasture cover levels at this time of the year are not allowed to fall below 1,500 to 1,600 kg DM/ha (Plate 4); "... *a few clumps that look like they haven't touched it, ... without being excessive next time round ... it's all* (the pasture [sic]) *to go down the cows throats*". If pasture cover is insufficient to meet cow feed requirements they are fed meal. Animal health is maintained by drenching the herd with Causmag (60 - 70 grams per day) along with a multi-mineral drench and this will be continued until the end of November, or when the pasture is "*maturing up*", at which stage the dosage is slowly reduced. Before all the cows have calved, and while grazing pressure is lowest, the milking herd is grazed on a wetter area of the farm to avoid pugging damage and therefore maintain pasture quality. In addition the 20 - 25 day rotation after the end of August is used to maintain pasture quality by keeping pasture in a growing state.

Plate 4 Photograph of the Friesian herd on Case Farm two taken at 11.00 a.m showing the levels of pasture residual expected when cows are fully fed. Pine trees in the background provide excellent shelter from strong westerly and southerly prevailing winds.

Mating (October and November)

During October and November the main focus is on: fully feeding the cows to achieve a concentrated calving pattern (6-8 weeks), improving the genetic merit of the herd, maintaining pasture quality and animal health, and providing feed in preparation for a summer dry period. To achieve a successful mating and a concentrated calving pattern, (i.e. all cows in calf as soon as possible) cow condition is increased as the planned start of mating approaches. This is achieved by maintaining the 20 - 25 day rotation, making sure the cows are leaving a reasonable grazing residual (1,500 - 1,600 kg DM/ha) and fully feeding the cows. Cows are tail-painted 21 days before the start of mating and then repainted at the start of mating. Any cows which are anoestrus one week after the start of mating are checked by the veterinarian, and if necessary treated with a CIDR to promote oestrus. To improve the genetic merit of the herd all cows are mated to AI and inseminated with high (150) BI nominated Friesian sires which show ability to transmit udder conformation. This policy has been used because cow numbers have been increasing in recent years and more replacement heifers were required. The policy, however, will continue because the farmer wants to be able to select replacement heifers from as many as possible. To maintain pasture quality a fast rotation of 20 - 25 days is retained, although paddocks that become rank and unpalatable will be topped. Because supplements are not made on the milking area, pasture has to be eaten by the cows or topped to prevent pasture quality from falling. By maintaining a fast rotation of 20 - 25 days as much of the pasture that is grown is eaten and as little topping as possible is carried out. Animal health is maintained by continuing to drench the herd with Causmag (60 - 70 grams per head per day) until the end of November.

Mid to Late Lactation (December to April)

The main goals from December until April are to continue to fully feed the cows, maintain pasture quality and cow condition, as well as provide feed to winter cows on the milking area. To maintain cow intakes as high as possible, the rotation is lengthened to 25 days in January or February, and part of the farm is irrigated to supply some of the cows' daily intake from fresh pasture. However, if pasture availability falls below cow requirements, concentrates will be purchased to maintain high daily feed intakes. The aim is to feed cows 16 kg DM/hd/day, and to achieve this pre-grazing pasture covers of at least 2,000 kg DM/ha are required. Pasture cover is monitored seven days in front of the cows and seven days behind to determine pasture growth rates and to assist in management decisions regarding pasture availability and pasture quality. During January and February, the cows may be offered less area and as a result graze paddocks down to lower pasture residuals. Grazing residuals remain at 1,500 kg DM/ha, but because pasture quality is lower (i.e. DM content is higher) residual pasture sward height is lower. Another method used to maintain the feed intake of the milking cows is to dry off low producing cows and heifers; up to 20% of the herd can be dried off as early as December or January in a dry year. A summer crop of Barkant turnips was planted in the 1994/95 season to provide additional feed during summer and it was anticipated that this crop would be fed out during January and February. A March pasture budget is calculated to assess the state of the farm and regular (weekly) monitoring of the pasture is used to determine the drying off date. An application of DAP fertiliser in March often provides feed for the last rotation in April and May as well as providing a 'feedbank' for winter grazing.

Drying Off (May)

The main goals for drying off are to ensure that sufficient pasture is on hand to meet pasture cover targets of 2,400 to 2,500 kg DM/ha at calving and that cows have sufficient condition to achieve a score of 5 at calving. Therefore, the cows are dried off on the basis of their condition score and farm pasture cover. The feed budget completed in March determines the latter and, *"if that requires that cover to be 2,000* [kg DM/ha] *well that's what it is. So everything's ... worked around that cover at calving and the cows being in reasonable condition ... 4.5 to 5..."* Cows are deliced and worm drenched at drying off to maintain animal health.

Rearing Replacement Stock

Rearing of young stock is considered to be of paramount importance and replacement heifers are grazed on a run-off block and fed good quality pasture, so that they enter the herd as close as possible to the size of the mature cows in the herd, " ... *look down a line of first calvers and cows ... can't see a massive difference in terms of height.* ". Heifers are reared on wholemilk and meal to a reasonable size because the farmer believes that a well fed cow of 'reasonable' size will more easily achieve high per cow production than a 'skinny' underfed animal. The ability to graze the heifers off the milking area means that they can be given top priority at all times without infringing on feed required for the cows.

Planning and Monitoring

By regularly monitoring important aspects of the farm, the farmer is able " *to act in relatively good time* ", to changes that take place on the farm. Monitoring consists of "... *a lot of looking, looking 3 and 4 days ahead of the cows ... what's the paddock like 3 days ago? ... how has the paddock performed? ... week out and a week back ... I know what's going on*". By knowing what is going on and acting in good time, timely decisions are made to maintain pasture quality, fully feed the cows, achieve concentrated mating and calving patterns and to achieve high per cow production.

Gross Margin

Average Gross Margin for milk production [5]

Income from milk production		284,928
Milk production expenses		
Fertiliser		$28,938
Supplements etc		19,716[6]
Animal health		16,748[7]
Shed expenses		6,890
Shed electricity		3,922
Reproduction)		
Herd testing)		2,332[8]
		78,440
Total Gross Margin		206,488
Effective milking area		106 ha
Cows peak milked	288	

Gross Margin per effective milking hectare	$1,948
Gross Margin per cow peak milked	$708

[5] Average of 91/92 and 92/93 years

[6] Running costs of tractor and farm machinery where used for making of supplements has not been included.

[7] Total of animal health for the herd including replacements and dry stock.

[8] All herd testing and reproduction costs included.

Case 3

Introduction and Characteristics

Case farm three had the lowest level of supplements fed per cow and a lower stocking rate than the average for the eight properties studied (2.3 *cf.* 2.4) (Section 4.1). The farm covers 77 ha of flat river terraces adjacent to the Pohangina river, has an effective milking area of 68 ha (Table 4.2) and is located approximately 15 km north of Ashhurst, at 133 metres above sea level.

Resource Factors

Pasture

The pattern of pasture growth is similar to that found on other dairy farms in the Manawatu (Brookes *at al.*, 1992); high spring and early summer growth is followed by lower pasture growth rates through the late summer, autumn and winter. The pattern of pasture growth is managed by making hay out of surplus feed during the late spring and summer and feeding this to cows in the winter and early spring. Pasture renovation has been carried out by 'hoof and tooth'; i.e. heavy grazing of a paddock to allow 'better' pasture species to emerge. The resulting pastures appear to be of very good quality (Plates 5 & 6) .

Plate 5 The lower river terraces on Case Farm 3 showing a typical pasture mix following hard grazing to remove less desirable pasture species

Plate 6 View of Case Farm 3 looking north up the Pohangina Valley. The area in the foreground was recently added to the dairy unit and has been developed for dairy production by heavy grazing of the original pastures.

Climate

The farm receives approximately 1200 mm rainfall evenly spread through the year (Thompson, 1982), although the winter and spring months are generally wetter than summer and autumn (Hedergeen, 1990). While periods of low rainfall can be experienced during the summer, (January and February) they are not common, and when pasture growth rates fall the cows, "... *lose a bit of production but when the grass grows* [in the autumn] *they're still lactating at a level whereby they can pick up their production.*" The prevailing wind is from the west and north west.

Soil

The soils on the farm are Manawatu and Rangitikei silt loams and have an average Olsen P level in excess of 35. This level is maintained by an annual application of 300 kg superphosphate /ha. Urea (30 kg/ha) is applied during the late winter to promote early spring pasture growth.

Environment

The 'free-flowing' shed has recently been upgraded (Plate 7) and the cows are milked in "... *as quiet and pleasant environment as possible*". Cows are able to move quickly through this shed, because of an improved shed design and because the new plant milks the cows out quickly and completely. The shed and milking management are a reflection of the philosophy, and importance, that this farmer places on the welfare of the livestock. The races on the farm were in good condition with a gravel base and were well graded when the farm was visited. An increased incidence of lameness was reported after building new races on the land area recently added to the property, but this was seen as only a short term problem until the new races had been compacted by the cows.

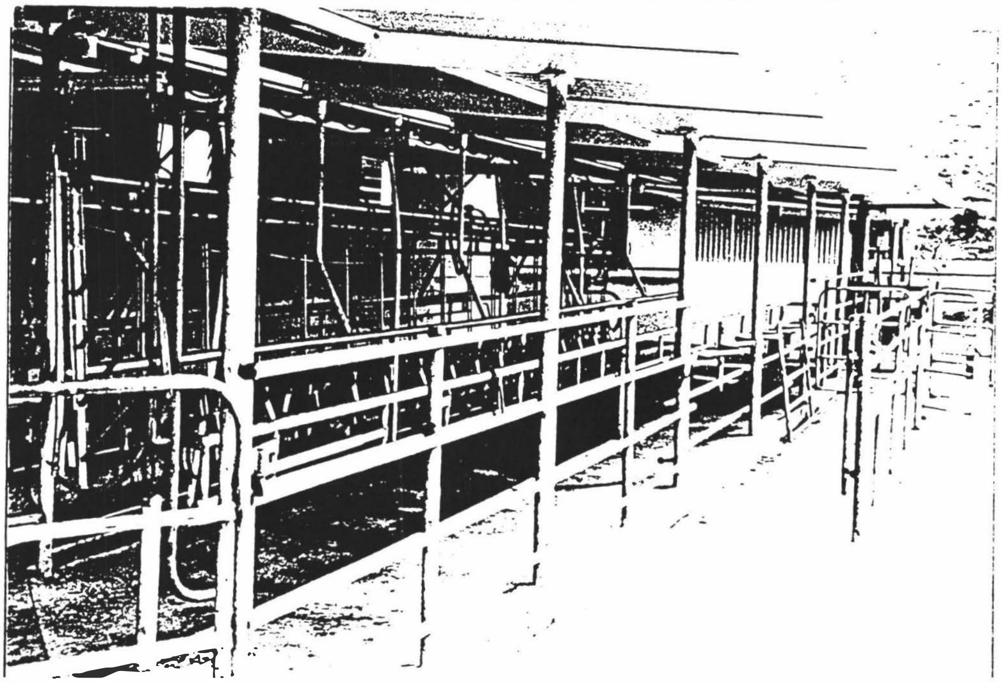

Plate 7 A view of the recently modernised shed on Case Farm 3. The cleanliness of the milking area helps to illustrate this farmers philosophy towards his cows and dairying.

Labour

No labour is employed and the farm is run as a partnership between father, son and mother. This allows the family to farm, "... *without pushing the system to try and make everything work ... do it a more enjoyable way* [for both the farmer and the stock] ... *a lot of ... flexibility ... the system is ... in a way more natural.*"

Animal Factors

The herd is wintered on the property and in 1993 included 160 Friesian x Jersey cows (predominantly Friesian blood). The herd has a BI of 127 and a 67% recorded ancestry. The 34 replacement heifers are grazed off the farm for 26 weeks of the year. Milk production of 412 kg MS per cow per year is achieved by reaching high production early, peak milk production in November and maintaining high production levels through the summer and autumn

(Figure A3). Few deaths are recorded annually (less than 2%) and approximately 17% of the herd is culled. The culling figure is lower than usual as herd numbers were being increased during the study period. Cow live weights were not obtained, however the cows were in very good condition (CS 5+), when the farm was visited. During the interview the farmer recalled that a cow sold the previous year weighed 610 kg, but was uncertain whether this reflected the average weight of the herd.

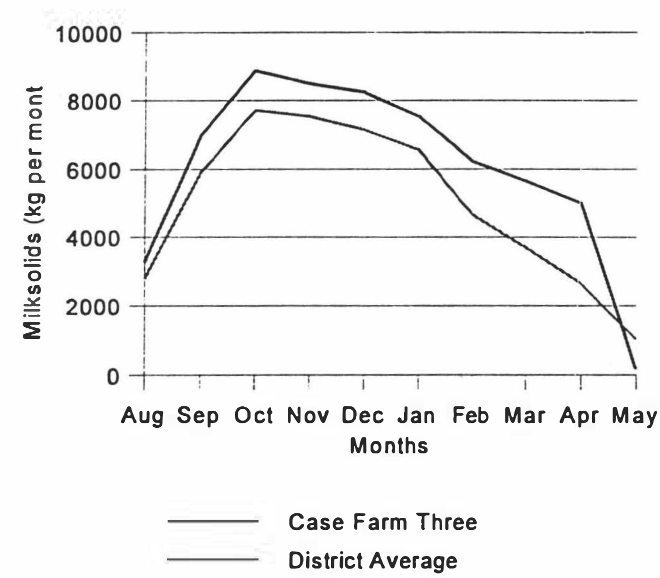

Figure A3 Lactation curve for case farm three compared with the district average for a similar sized farm (adapted from TMPL data)

Management

Stocking Rate and Lactation Length

The herd is stocked at 2.3 cows per hectare[4] which is below the district average of 2.47 cows per hectare (TMPL statistical data). Although the herd size has increased since additional land was bought in 1992/93, stocking rates have been maintained at approximately 1

[4] See Chapter 3

cow per acre. Lactation length averages 268 days[5] or 282 milking days (see Case Farm One). An estimated 8,800 kg DM / ha of pasture was consumed by the herd, or 8,950 kg DM/ha if the pasture grown as a result of nitrogen applications is included.

Winter (June and July)

The main goals during the winter are to: provide sufficient feed for the cows at calving, calve the herd at condition score 5, and maintain animal health. To provide sufficient feed for the cows at calving a feed budget is prepared to determine the level of pasture needed at drying off; the level of pasture required at calving is used as a basis for this figure. Once cows are through the drying-off period (see below), they are grazed on approximately 0.4 ha per day (100 - 120 day rotation) for the winter and are fed 9 to 10 kg DM/hd/day, including hay. This level of feeding is designed to increase condition score to 4.5 - 5 by calving. As cow numbers increase so will the need for off farm grazing for some stock to enable pasture cover targets at calving to be achieved. Nitrogen is applied in July to promote early spring pasture. An important aspect of animal health on this farm is to ensure that the cows dry off completely after the last day of milking. To achieve this, cow intake is reduced to less than maintenance after the last day of milking by confining them to a paddock that needs 'cleaning up' for approximately one week and feeding some hay.

Calving (August and September)

The herd starts calving on 20 July. During August and September the main goals are to: ensure the cows produce well from the start of lactation, by fully feeding the cows; and maintain animal health and pasture quality. To achieve peak production as soon as possible after calving cows are fed approximately 15 kg DM/hd/day, including some hay. Hay is usually fed to the earliest calvers who may be fed less than 15 kg DM/day if pasture cover is low. Reducing these animal's intakes and feeding them hay allows pasture cover to increase. Once the whole

[5] Median calving date until last day of milking

herd has calved an area of 2.4 ha is grazed per day, i.e. 30 day rotation; 1.6 ha during the day and 0.8 ha at night. To further increase cow intake, if the weather is good (i.e. not too wet) and pasture covers are increasing, the rotation length will be reduced to 20 days. However, because cows are offered high levels of pasture allowance, high post grazing residuals result and pasture quality must be monitored closely. Paddocks will be shut up for supplements or pasture topped when feed quality falls below desired levels (see Mating). To maintain animal health, the freshly calved herd is drenched once daily with Causmag.

Mating (October and November)

During October and November the main focus is on: fully feeding the cows to increase cow condition and achieve a concentrated calving pattern, improving the genetic merit of the herd, and maintaining pasture quality. To achieve a condensed mating and therefore a concentrated calving pattern, the cows are tail-painted 21 days before mating to detect oestrus activity and any anoestrus cows. The number of anoestrus cows is minimised by fully feeding the herd and increasing cow condition prior to mating. High feeding levels are achieved by increasing the area grazed from 2.4 ha up to 3.1 ha per day (20 day rotation). Although the farmer attempts to achieve a compact mating, there is an awareness of the resulting changes in feed demand during the next spring, *"... you've got to be real careful ... you change your feed demands more than you ever think"* but *"... we don't induce cows so that spreads it* [calving] *out"*. To increase the genetic quality of the herd the cows are put to AI (nominated sires) for 4 weeks before a bull is run with the herd. Because the cows cycle well on this farm a large proportion of the herd is AI mated in the four week period, which allows sufficient replacement heifers to be selected from AI matings., Although the farmer avoids selecting replacement heifers from cows with poor temperament, there is no 'genuine' selection policy on this farm. To maintain pasture quality over the late spring, and fully feed the cows, the rotation length is shortened to or maintained at 20 days, and paddocks will be topped, *"... we identify when we need to start topping and basically go for it ... we do most of the farm over a period of 30 days."*.

Mid- to Late-Lactation (December to April)

The main goals during mid- and late-lactation are to: fully feed the cows, maintain pasture quality, conserve pasture surplus as hay, and set up the farm for drying off. The cows continue to be well fed throughout lactation by maintaining the 20 day rotation (grazing an area of up to 3.1 ha a day) until late in lactation, *"Weather permitting cows are not restricted until late April/May"*, (i.e. the last rotation of the farm). Pasture quality is maintained by shutting paddocks up for hay when genuine pasture surpluses become evident, and between November and late February up to five paddocks can be taken out of the rotation at any one time. Pasture residuals are used to determine when paddocks are taken out of the rotation. However, the farmer believes that to achieve high per cow production high pasture residuals are inevitable, *"... I mean if they leave a lot behind then they leave a lot behind, that's it"*, and monitoring of the pasture is essential to maintain pasture quality. To set the farm up for drying off (i.e. allowing pasture cover to increase) the last rotation is extended to last 30 days.

Drying Off (May)

The goal for drying off is to ensure that sufficient pasture cover is available to meet the pasture cover target of 2,000 to 2,100 kg DM / ha at calving. The last day of milking is determined by a detailed pasture budget, and the decision to dry off is based on the average pasture cover over the whole farm and the condition score (4 - 4.5) of the cows. High feeding levels for the cows are maintained until the last day of milking at which time they are drenched for worms, dry cow therapy is given where required (determined by Somatic Cell Count (SCC), and the herd is placed on a restricted ration until milk production ceases (see Winter).

Rearing Replacement Stock

The replacement stock, grazed for 26 weeks of the year on an adjacent runoff area, are reared to *"achieve target weights equal or better than those specified by the New Zealand Grazing Company"*. They are weighed monthly and are fully fed at all times.

Occasionally they will be grazed in paddocks after the cows ... " *not to tidy up but because there's enough to be fed there.* " The aim is to rear replacements to be as close to mature size as possible when they enter the herd (Plate 8).

Plate 8 The milking herd showing a mixture of older cows and recently calved two year heifers. The difference in size is not easily detected.

Planning and Monitoring

The strategic plan on Case Farm three reflects the family philosophy of farming "naturally". By not pushing the system, by having a low stocking rate, the family plans the farm year to achieve high production and to ride out adverse weather conditions and other problems if they occur. Because of the low stocking rate monitoring of pasture is important (see Mid to Late Lactation) and regular, weekly, pasture walks are carried out from autumn until calving starts to assess the whole farm pasture cover. Pasture residuals are monitored daily during lactation to: detect pasture surpluses, maintain pasture quality, and fully feed cows, and therefore achieve profitable high per cow production.

Gross Margin

Average Gross Margin for milk production [5]

Income from milk production	114,716	
Milk production expenses		
Fertiliser	$6,664	
Supplements etc	3,468[6]	
Animal health	5,032[7]	
Shed expenses	2,040	
Shed electricity	3,672	
Reproduction)		
Herd testing)	3,468[8]	
	24,344	
Total Gross Margin		158,440
Effective milking area	68 ha	
Cows peak milked	159	
Gross Margin per effective milking hectare		$2,330
Gross Margin per cow peak milked		$990

5 Average of 91/92 and 92/93 years

6 Running costs of tractor and farm machinery where used for making of supplements has not been included.

7 Total of animal health for the herd including replacements and dry stock.

8 All herd testing and reproduction costs included.

Case 4

Introduction and Characteristics

Case farm four had the herd with the shortest lactation, the highest BI, and it was the northern-most farm on the western side of the Tararua ranges (Section 4.1). Farm four covers 56 ha of gently rolling land, has an effective area of 50 ha (Table 4.2), and is located approximately 23 km north east of Feilding and 2 km west of Kimbolton township, at 442 metres above sea.

Resource Factors

Pasture

Due to its location and high altitude the pattern of pasture growth on this farm is atypical of Manawatu dairy farms (Brookes *et al.*, 1992); high spring growth is delayed by up to one month, although peak growth rates are consistent with other farms. High spring pasture growth rates are followed by lower pasture growth in the summer and autumn, however, winter pasture growth rates can be very slow. Pasture growth patterns are managed by conserving silage in October to December and surplus pasture after December as hay, which are then fed out during the winter months and early spring if required.

Climate

The farm receives 1100 mm per annum (Thompson, 1987) which includes occasional falls of snow in the winter and combined with low temperatures cause the low pasture growth rates in the winter. Periods of low rainfall can be experienced in the summer by this is atypical of the area and pasture growth is seldom affected by summer droughts due to the reliable rainfall and the soil type. The prevailing wind is generally from the west.

Soil

The soil types on this farm is Kairanga silt loam with an average Olsen P level of 18 to 20 which is considered to be low "... *we have to catch up a bit on the phosphate*". Fertility levels are increased by the application of 250 kg/ha MAP during the winter and 500 Kg/ha 15% potassic super in the autumn. Fertiliser applications are considered by the farmer to be quite high for the area and selenium prills are added to the autumn application to help overcome a slight deficiency. Nitrogen contained in the MAP fertiliser (27 kg/ha) promotes spring pasture growth.

Environment

The rotary milking platform, installed 5 years ago, allows the herd to be milked very quickly and minimise the time cows spend away from grazing (Plate 9). Despite allowing up to 30 of the slower milking cows to travel around the platform twice milking takes a little over an hour. To avoid lameness the races are clean and tidy and paddocks have more than one gateway. Maximising grazing time reflects the importance placed on fully feeding the cows, "... *there's not much satisfaction if you've got a herd of cows, if they're hungry*".

Plate 9 A view of a typical race on Case Farm 4 also shows the undulating topography of the farm. The race surface and construction is smooth enough to avoid cows being affected by foot problems .

Labour

No labour is employed on the property and the herd is managed by a husband and wife partnership. The farm forms part of a family business, which at the time of the study consisted of three separate dairy properties; one farm adjoins the case farm and shares machinery, and silage storage facilities, and the replacement heifers from both herds are now grazed together on both farms.

Animal Factors

The herd is wintered on the property and in 1993 included 160 Jersey cows and 30 replacement heifers. As noted above replacement stock from the adjacent farm are also grazed on Case Farm Four from time to time. The herd has a BI of 131 and an 88% recorded ancestry. Despite a short lactation milk production of 362 kg MS per cow per year is achieved by reaching high production early, peak production in November and maintaining high production levels through the summer and autumn (Figure A4). There are few cow deaths recorded on the farm (less than 2%) and approximately 17% of the herd has been culled annually. This figure is lower than expected because extra land has been added to the farm in recent years and herd numbers have been increased. Cow live weights were not obtained, however, the cows were in good condition (CS 5) on the day the farm was visited.

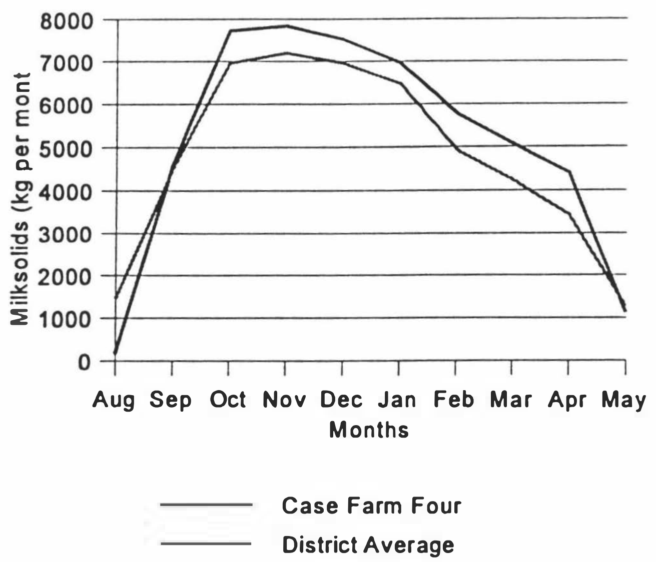

Figure A4 Lactation curve for case form four compared with district average for a similar sized farm (adapted from TMPL data).

Management

Stocking Rate

The herd is stocked at 2.41 cows per hectare[6] which is slightly above the 'Manawatu Terraces' area average of 2.37 cows per hectare (TMPL statistical data). The stocking rate has been maintained at this level for a number of years despite recent increases to the size of the farm. The lactation length of 250 days[7] or 265 milking days (see Case Farm One) is the shortest of the eight farms studied and shorter than other Manawatu farms. An estimated 7,900 kg DM/ha was consumed by the herd, or 8,280 kg DM/ha if the pasture grown as a result of nitrogen applications is included.

[6] See Chapter 3

[7] Median calving date until the last day of milking

Winter (June to August)

The main goals during the winter are to: ensure that there is sufficient feed for the cows at calving, achieve a condition score of 5 at calving, and improve animal health. To increase pasture cover at calving the herd, including rising two year heifers, complete a single 120 day rotation of the farm from June until calving in mid- to late-August. Grazing cows off the milking area, feeding silage to the dry herd and calving late in August are also used to ensure pasture cover is sufficient to fully feed the freshly calved cows and that they are at a condition score of 5 at calving. To improve animal health vitamins A, D & E are given to the cows prone to milk fever immediately prior to calving.

Calving (September and October)

The late commencement to calving on 20 August means less emphasis is placed on pasture cover at calving than earlier calving properties, because, *"... we're not far away from the grass growth ... If there's a shortage it doesn't last for long"*. During September and October the main goals are to: fully feed the cows to ensure they reach peak production early, maintain animal health and pasture quality, identify anoestrus cows, and shut paddocks for silage. Paddocks first grazed after drying off provide the pasture for the early milkers (i.e. they have been spelled for 120 days) and cows are supplemented with silage if required. Once calving is underway the best paddocks (those with the longest pasture sward) are used to feed the cows. When the whole herd has calved it is allocated one paddock during the day and ½ a paddock at night, resulting in a 30 - 35 day rotation. Animal health is maintained by dusting pasture with causmag prior to the night milking. Pasture quality is maintained by offering the cows sufficient pasture achieve reasonably high intakes but also to ensure 'reasonable' pasture control (Plate 10). Paddocks are topped if necessary to maintain pasture quality (see Mating). In the past heifers were grazed behind the herd to keep pastures 'tidy', however, in 1994/95 the heifers, from the two adjacent farms, were only grazed behind the cows to control those paddocks with the highest residuals. In September and October post grazing pasture residuals are used to determine the area o be shut up for silage. Paddocks are dropped out of the rotation if the pasture residuals are too ıigh and the cows are not 'cleaning' them up.

Plate 10 The herd of Jersey cows on Case Farm 4 grazing in mid-afternoon. The level of pasture residual on this particular day was considered low as the cows' behaviour suggested they were still hungry.

Mating (November and December)

During November and December the main focus is on: fully feeding the cows to achieve a concentrated calving pattern, improving the genetic merit of the herd, conserving pasture as silage, and maintaining feed quality. Cow feed intakes are not noticeably increased over this period and the 30 day rotation is retained. However, pasture quality is *"... probably better because the sun's shinning"* during the mating period because the nutrients in the pasture are increasing which helps improve oestrus activity. No mating aids are used, *"G... wasn't all that excited by it"*, however, oestrus activity is observed at milking times when the cows are collected from the paddock, both in the paddock and at the shed. Occasionally cows will be observed in the middle of the day. Cows are AI mated to Premier Sire Services (PSS) 'bull of the day' (BI 149) and in the past cows not required for replacement have been mated to a beef sire.

However, expanding herd numbers has reduced this practice. Pasture shut up in September and October is conserved as silage and paddocks that have high post-grazing residuals are topped to maintain pasture quality and growth ; *"... a lot of topping ... most of the farm gets a mower over it ... that's when our figures started to go up ... keeping the paddocks in order ... made a big difference."*

Mid- and Late-Lactation (January to April)

The main goals for mid- and late-lactation, January to April, are to: continue to fully feed the cows, maintain pasture quality, conserve any pasture surplus as hay, and provide feed for the winter. Because summer and autumn pasture growth is generally reliable the cows are maintained on a 30 day rotation which ensures high pasture intake and good pasture quality. However, if pasture quality deteriorates, as determined by residual pasture levels, surpluses will be conserved as hay *"... really just getting rid of a surplus ... we do need it for the winter but we don't shut up thinking of the winter."* Other paddocks will be topped if required.

Drying Off (May)

The goal for drying off is to ensure that there is sufficient feed to provide adequate intakes for the dry cows during the winter. Although pasture cover is not critical because of the long winter rotation, *" we don't like to dry off and have the farm completely bare."* Drying off is determined by the weather and potential grass growth; historically the start of the May school holidays was chosen as the date to dry off. No pre-drying off culling is carried out unless the situation (pasture shortages) is really drastic, and as many cows as possible complete a full year's lactation.

Rearing Replacement Stock

Although replacement stock are not reared to reach set target weights, and may be lighter than the mixed aged cows when they enter the herd, they are reared to be as close to mature body size (stature) as possible. In the past heifers have been grazed behind the cows after weaning to help maintain pasture quality (see Calving), however, in 1994/95 a policy change was made whereby heifers were combined with those from the adjacent farm and were grazed on the best quality feed. This meant that the mob was moved daily onto the most suitable pasture and one farm to another. For most of the year the mob receives top priority although in the autumn they have lower priority than the milking herd.

Planning and Monitoring

The ability to plan the dairy farm year around the limitations of a high altitude property subject to cold winters is an important aspect of achieving high per cow production on Case Farm Four. Monitoring pasture growth and pasture residuals, conserving surplus pasture for deficit periods, and maintaining pasture quality are important aspects of the farm's management.

Gross Margin

Average Gross Margin for milk production [1]

Income from milk production		$180,000	
Milk production expenses			
Fertiliser	$19,300		
Supplements etc	2,850		[2]
Animal health	2,800		[3]
Shed expenses	1,500		
Shed electricity	2,050		
Reproduction)			
Herd testing)	4,350		[4]
		32,850	
Total Gross Margin		147,150	
Effective milking area		68 ha	
Cows peak milked	150		

Gross Margin per effective milking hectare	$2,164
Gross Margin per cow peak milked	$981

1 Average of 91/92 and 92/93 years

2 Running costs of tractor and farm machinery where used for making of supplements has not been included.

3 Total of animal health for the herd including replacements and dry stock.

4 All herd testing and reproduction costs included.

Case 5

Introduction and Characteristics

Case Farm Five had the smallest effective area, the smallest herd and the lowest stocking rate Section 4.1). Although herd testing had recommenced during the 1994/95 season, the herd BI was unknown. The farm covers 36 ha of generally flat river terraces, has an effective milking area of 31.5 ha (Table 4.2), and is located 4 km north west of Carterton in the lee of the Tararua ranges at 160 metres above sea level. The farm is split by a small tributary of the Ruamahanga river.

Resources Factors

Pasture

The pattern of pasture growth is typical of farms in the 'Wairarapa Wet' region of the TMPL supply area (Riddick, 1990); high spring and early summer growth is followed by lower pasture growth in the late summer and increased pasture growth in the autumn before low winter pasture growth is experienced. The pattern of pasture growth is managed by conserving pasture in periods of high growth, sowing summer and winter crops and feeding conserved pasture to the cows during the winter. A regular pasture renewal program is maintained and between one and two hectares (approximately 5% of the farm) of new pasture is sown annually.

Climate

The farm receives approximately 1000 mm rainfall per annum which is generally evenly spread through the year (Thompson, 1982). Long dry spells can occur in the summer but are atypical of this area. The prevailing wind is from the north and southwest.

Soils

The soil types on the farm are Kopua, Greytown and Ahikouka silt loams with Olsen P levels ranging from 20 to 30. Fertility is maintained by applying 375 kg potassic 30 /ha in the autumn and 125 kg DAP /ha in the spring. In addition, 140 kg cropmaster /ha is applied to the cropped areas. Effluent from the dairy shed and piggery is sprayed onto eight hectares of lighter, shingle soils adjacent to the stream and this helps to improve soil fertility and maintain pasture growth on this area. The variation in soil types on the farm creates differences in pasture growth rates at certain times of the year. These differences are used to advantage, for example the herd is calved on the lighter soil at the centre of the farm to avoid pugging. Pasture growth on the areas closest to the river is slower in the spring followed by the clay based soils at the front of the farm and these factors dictate the areas where the herd is grazed immediately after calving (see Calving). The use of DAP in the spring (September and October) adds 23 kg N/ha to help promote late spring pasture growth.

Environment

The shed, an older style walk-through configuration (Plate 11), allows each cow to receive individual attention and to be fully milked out. Because of the shed, and the attention paid to each cow, milking takes approximately one and a half hours. This reflects the importance placed on achieving good individual per cow performance. Cow temperament is very important to the farmer as the herd must get used to children playing around the milking area.

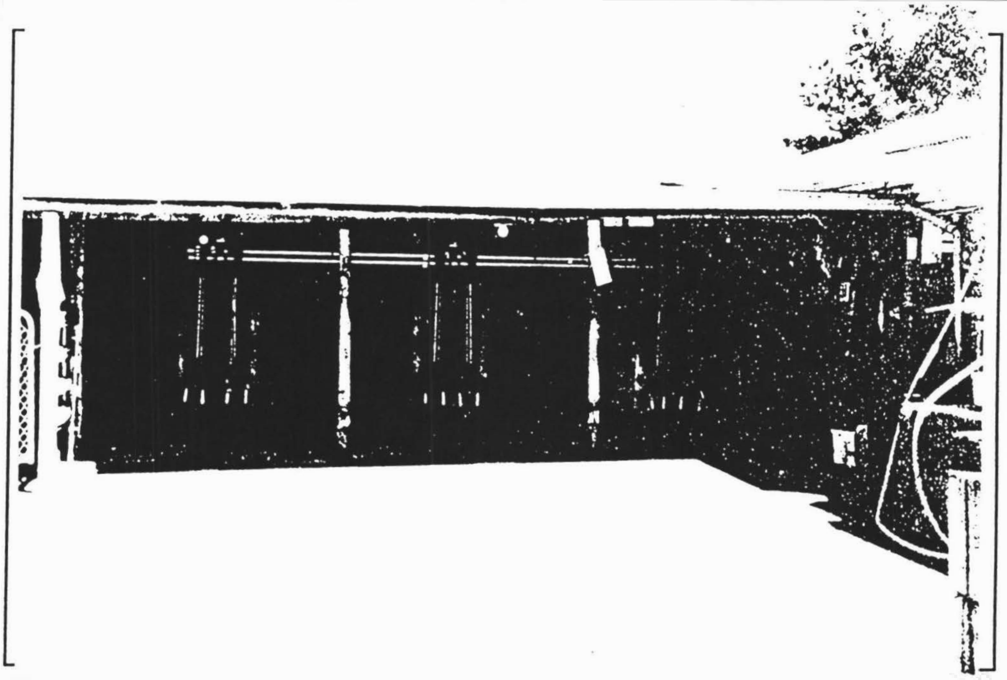

Plate 11 The older style walk-through shed on Case Farm Five which permits individual attention for cows during milking.

<u>Labour</u>

No labour is employed on Case Farm Five. This enables the farmer to run the farm in his own way and progress towards high per cow production.

Animal Factors

The herd is wintered on the property and in 1993 included 56 Friesian x Jersey (50%) and Ayrshire cross (50%) cows and 7 replacement heifers. Herd BI and were not known because herd testing had not been carried out for a number of years. Milk production of 386 kg MS per cow per year is achieved through a long lactation (272 days) and fully feeding the cows throughout the lactation to maintain lactation persistence (Figure A5). Few deaths are recorded (less than 1%) and only 12.5% of the herd is culled each year. Although cow live weights were not obtained, the cows were in good condition (CS 5) when the farm was visited.

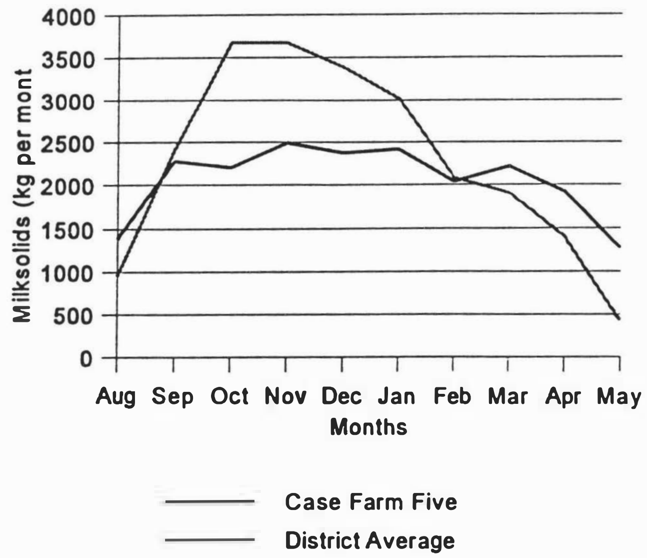

Figure A5 Lactation curve for Case Farm Five compared with the district average for similar sized farms (adapted from TMPL data).

Management

__Stocking rate and Lactation Length__

The herd is stocked at 1.7 cows per effective hectare[8] which is below the district average of 2.47 cows per hectare (TMPL statistical data). This stocking rate has remained stable for a number of years. Lactation length is 272 days[9] or 302 milking days (see Case Farm One) which is considerably longer (up to 20 days) than other farms on the eastern side of the ranges (Watters, 1990). Pasture consumed by the herd was estimated at 6,940 kg DM/ha or 7,200 kg DM/ha if the pasture grown as a result of nitrogen applications is included.

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[8] See Chapter 3

[9] Median calving until the last day of milking

Winter (June and July)

The main goals during the winter are to: ensure there is sufficient feed for the cows at calving and calve the cows in condition score 5. To provide sufficient feed for the cows at calving, the cows are grazed for two weeks after drying off on paddocks that need 'cleaning up' are then break-fed, from mid-June until calving in August, on a winter crop of choumollier and fed hay. The paddocks grazed immediately after the last day of milking are closed to provide pasture for the spring. Cows are dried off at CS 5, and therefore need to be fed a maintenance ration only through the winter.

Calving (August and September)

The herd starts to calve on the 1 August. During August and September the main goals are to: fully feed the cows (once they enter the herd) and maintain cow condition. On Case Farm Five calves are left on the cows or 4 - 5 days after calving to provide calves with colostrum milk. To fully feed the cows once they enter the milking herd they are grazed behind an electric fence until the end of September. Initially pasture shut up in late lactation is fed to the cows, then the herd is set stocked and allowed to graze half the farm during the day and the other half at night. The *ad lib* feeding system allows cows to exercise 'free grazing choice' and achieve high intakes and maintain their condition (Plate 12).

Plate 12 The river flats towards the rear of Case Farm Five. The cows are 'set stocked' on this part of the farm during the day to maintain full feeding levels.

lating (October and November)

During October and November the main focus is on: fully feeding the cows to maintain cow condition to achieve a high conception rate, improving the genetic merit of the erd, making surplus pasture into silage to provide feed for the summer and winter. To fully feed ıe cows and maintain condition *ad lib* grazing of the farm continues throughout lactation. To nprove the genetic merit of the herd half the herd is mated to AI bulls nominated by the farmer. 'he balance is hand mated to bulls purchased from stud breeders. Stud bulls are used because, *I'm a bit sceptical at times about AI ... with them getting in calf ... natural mating I seem to ave more cows in calf first time.*" Oestrus is detected twice a day near milking time and a emale AI technician is now employed to inseminate the cows because of her experience and the vay she handles the cows. Sires are selected for their predicted ability to transmit production nd udder conformation, although the overall look of a cow (conformation) is important. If ıasture surpluses are detected at this time of the year (identified by the rate at which pasture cover is building up) paddocks will be removed from the grazing area and made into silage; pasture conserved after December is made into hay. A summer crop of maize (1.2 - 1.6 ha) is sown in November along with the choumollier crop for winter.

Mid- to Late-Lactation (December to April)

The main goals during mid- to late-lactation are to: continue fully feeding the cows, maintain cow condition, maintain pasture quality, conserve surplus pasture as hay, and renew pasture. The *ad lib* feeding regime is maintained as long as pasture supplies allow and then is supplemented with the greenfeed maize during February and March. Pasture quality is maintained by retaining the set stocking policy and by shutting off surplus growth for hay. Usually 100 - 150 round bales of hay are required for the season, however, if insufficient hay is able to be made on the farm, it will be purchased. After the maize crop has been fed off the paddock is resown in permanent pasture.

Drying Off (May)

The goals for drying off are to milk the cows for as long as possible providing feed targets for calving can be achieved. However, because the herd is wintered on the choumollier crop the amount of pasture on hand at drying off is not considered to be critical. The herd is therefore usually milked through until the last day of tanker pick up; *"I seem to take the view that the weather's pretty good and the factory's still going you might as well milk them."* To guarantee feed will be available for early calving cows two to three paddocks will be shut off from the milkers early in May so *"... that I know I've got at leat 2 - 3 paddocks of really good feed up my sleeve by the 1 st August."*

Rearing Replacement Stock

Rearing herd replacements to mature size is important and young stock are fed as well as possible by keeping them on high quality pasture especially saved for that purpose.

Paddocks are shut off from the rest of the farm to allow the sward to freshen before grazing; the heifers are shifted every fortnight to three weeks. However, if the pasture supply is inadequate meal will be reintroduced to ensure calf growth rates are maintained.

Planning and Monitoring

Forward planning, providing 'standbys' for feed shortages and feed for the winter are important aspects of management for high per cow production on Case Farm Five. The low stocking rate combined with set stocking helps the farmer overcome variations in the weather and feed supply, "... *if a southerly comes through ... we might be only down 20 litres of milk or something.*" Monitoring pasture cover allows the farmer to identify when paddocks should be closed for hay and silage and to maintain pasture quality to increase cow intake to improve per cow production..

Gross Margin

Average Gross Margin for milk production [1]

Income from milk production		$87,120

Milk production expenses

Fertiliser	$4,191	
Supplements etc	2,079[2]	
Animal health	1,145[3]	
Shed expenses	627	
Shed electricity	2,079	
Reproduction)		
Herd testing)	528[4]	
	10,989	
Total Gross Margin	76,131	
Effective milking area	33 ha	
Cows peak milked	52	
Gross Margin per effective milking hectare		$2,307
Gross Margin per cow peak milked		$1,297

1 Average of 91/92 and 92/93 years

2 Running costs of tractor and farm machinery where used for making of supplements has not been included.

3 Total of animal health for the herd including replacements and dry stock.

4 All herd testing and reproduction costs included.

Case 6

Introduction and Characteristics

Case farm Six was the farm with the highest per cow milk production and the lowest average soil fertility (Section 4.1). In addition, the farm had a lower than average stocking rate (2.14 *cf.* 2.4), the shortest median calving period and was the only herd with pedigree cows. The farm covers 63 ha of flat land, has an effective milking area of 55 ha (Table 4.2), is located 9 km south west of Pahiatua at 153 metres above sea level.

Resource Factors

Pasture

The pattern of pasture growth on this farm is typical of farms in the Pahiatua region of the TMPL supply area (Riddick, 1990); high spring and early summer pasture growth is followed by lower, but reliable, summer pasture growth, increased pasture growth in the autumn before low winter pasture growth is experienced. The pattern of pasture growth is managed by conserving pasture in periods of high growth, sowing a summer crop and feeding conserved pasture in winter and early spring. A regular pasture renewal program is maintained and paddocks that are not performing, (i.e. not growing enough pasture) are renewed regularly.

Climate

The farm receives 1400 mm of rain per annum, generally evenly spread throughout the year although, winter/spring is wetter than summer/autumn (Thompson, 1982). Although dry spells can be experienced in the summer (January and February) they are not common. Lower pasture growth rates during these periods are compensated for by growing a summer crop and extending the rotation length. One of the advantages of the climate is that it, "... [this farm (sic)] *grew grass more regularly all year round"*. The prevailing wind is from the west.

Soils

The soil types on the farm are Heretaunga and Manawatu silt loams with an average fertility level of 23 (Olsen P). The average fertility level for the farm is low because land recently added to the farm had a low level of soil fertility. To increase fertility levels, fertiliser applications include 350 kg 30% potassic super per ha in the spring and 250 kg DAP /ha in the autumn. Urea (70 kg/ha) is applied during the late winter and early spring to increase spring pasture production.

Environment

A modern, airless, milking plant has been installed in the herringbone shed to help improve milk quality. The shed, which is kept spotlessly clean (Plate 13), provides a stress free environment, *"... because of a good* [livestock] *flow ... no fuss sort of a shed ... less stress on cows, even on milkers"*, and reflects the importance placed on cow care and quality (milk production, livestock, pasture) on Case Farm Six (see Calving and Rearing Replacement Stock). As part of the 'quality' environment the races are smooth and wide (Plate 14), to allow easy livestock movement to and from the paddocks. Cows spend as little as 10 - 20 minutes walking to and from the shed, *"The race is important, if you've got lame cows on these they're not going to produce anyway."*

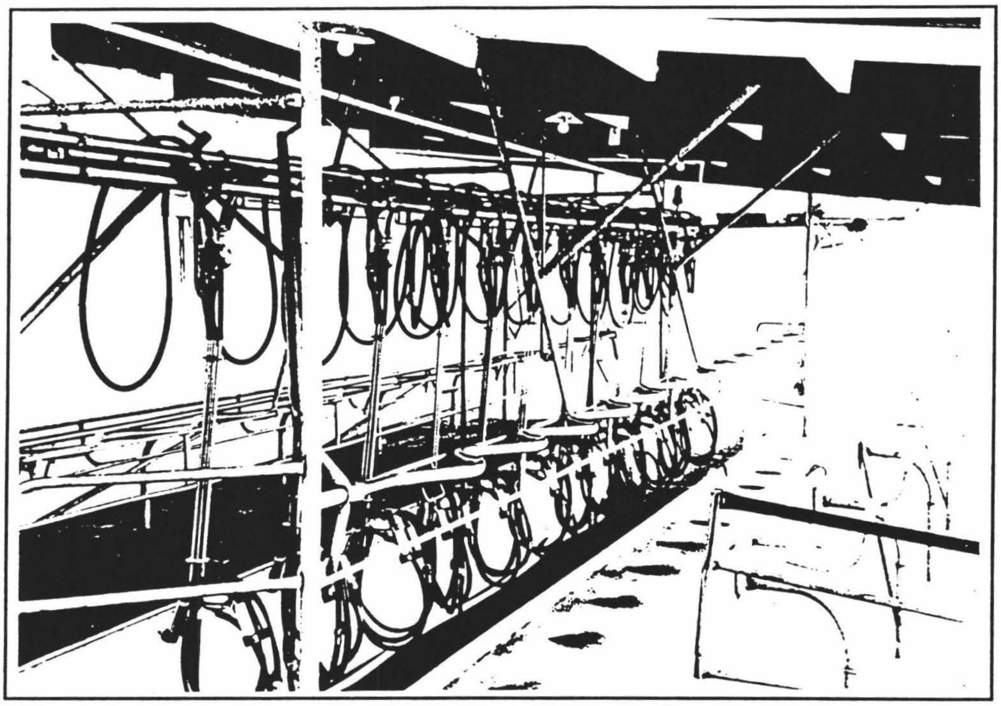

Plate 13 The spotless free-flowing 'no fuss' shed on Case Farm six. An airless milking system is used to improve milk quality.

Plate 14 The smooth wide races for easy access to and from the shed are characteristic of the attention to detail found on Case Farm six.

Labour

Although the labour on Case Farm six was supplied by the farmer in partnership with his wife, in the last eighteen months one full time labour unit has been employed to allow off-farm interests to be pursued and ease work pressure during busy periods. Employing labour is difficult, because, of the long hours that must be put in all year. However, *"I think once you're over sort of 100 cows, I think it is important to employ labour"*. Employing honest, reliable staff enables the job to be done correctly every day rather than every second day, particularly at busy times of the year. For example, during mating staff need, *"to be able to recognise the bullers from the time they saw them in the paddock, by the time they've got to the shed."* In addition staff must possess good stockmanship skills and have a good temperament, and not ask too many questions because, *"... he gets enough of that from me at home"*.

Animal Factors

The herd is wintered on the property, if there is sufficient pasture, and in 1993 included 130 MA pedigree Friesian cows and 6 pedigree bulls. The herd has a BI of 130 and a 98% recorded ancestry. The 37 replacement heifers are grazed off the property for 12 months from May. If the pasture available for feeding cows during the winter appears to be low, up to half of the herd will be grazed off the farm for six weeks to improve pasture cover at calving. Milk production of 479 kg MS per cow per year is achieved by starting production at high levels, reaching peak production early and maintaining high levels of production through summer and autumn (Figure A6). Few deaths are recorded on this farm and cows are seldom slaughtered. However, *" I class 50% of my herd's cullable ... 50% below average"* and selling the lowest producing cows to other dairy farmers has been a major factor in achieving high per cow production from this herd. An average of 35% of the herd is replaced every year. Replacements are only ever kept from the top 50% of the herd, and if there are insufficient heifers available from this group, carefully selected cows from other herds will be purchased to make up the difference. Although cow live weights were not available, the cows were in good condition (CS 5) on the day the farm was visited.

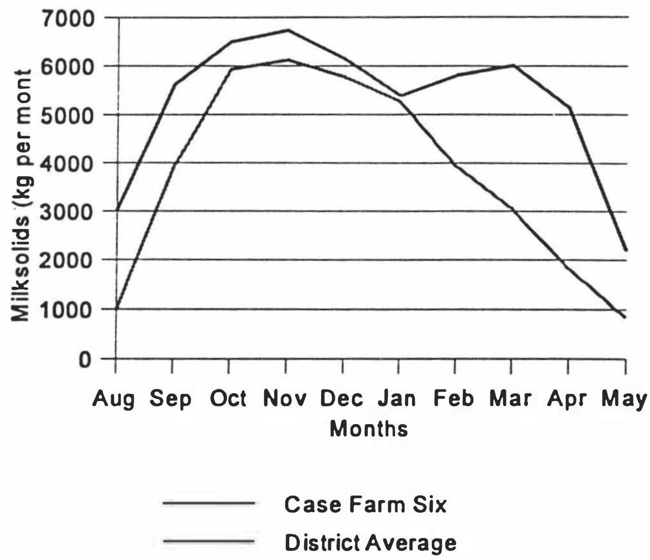

Figure A6 Lactation curve for Case Farm Six compared with the district average for similar sized farms (adapted from TMPL data).

Management

<u>Stocking Rate and Lactation Length</u>

The herd is stocked at 2.15 cows per hectare[10] which is below the district average of 2.48 (TMPL statistical data). Herd size has been increased in response to the purchase of additional land, however, the stocking rate has remained constant. Lactation length is 268 days which is similar other farms on the eastern side of the ranges (Watters, 1995). Pasture consumed by the herd was estimated at 9,810 kg DM/ha or 10,660 kg DM/ha if the pasture grown as a result of nitrogen applications is included.

<u>Winter (June and July)</u>

The main goals during winter are to: ensure there is sufficient feed to meet pasture cover target of 2,000 kg DM/ha at calving, increase cow condition score to calve the herd at

[10] See Chapter 3

CS 5.5, protect the soil and pasture from pugging damage, build up cow feed intakes preparatory to lactation, and prevent animal health problems. To ensure sufficient feed is available at calving the cows are 'block grazed' over the whole farm on a 90 - 120 day rotation. The cows are 'block' grazed to maximise pasture regrowth because cows are not able to return to grazed pasture and graze new growth. In addition, if pasture at calving is budgeted to be low, part of the herd will be grazed off the farm (see Winter and Drying Off) for a period of five to six weeks. Cows are fed 9 - 13 kg DM/hd/day, a balance of one third hay and two thirds pasture, dependent on the amount of pasture available. The high feeding levels are designed to increase cow condition from 4.5 at drying off to a target of 5.5 before calving, *"... like to have them pig fat ... we can put weight on them very quickly if (a) they're dry and (b) they're not too close* [to calving]*".* However, because the weather is often quite cold and cows can be stood off pasture for up to 12 hours achieving CS targets of 5.5 is difficult. During the winter, cows are removed from the paddocks to avoid pasture and soil damage as soon as the weather deteriorates, *"very quick to whip the cows off, stand them on a pad ... no point them ... wrecking spring feed."* To prepare the cows for the levels of feed intake required for lactation the proportion of hay in the diet is increased. Although intake is not increased above 13 kg DM/hd/day, the extra hay in the diet increases the bulk of the feed and therefore the size of the rumen, and this allows cow intake to increase to 15 - 18 kg DM/hd/day immediately after calving without difficulty.

To ensure the cows are healthy for the coming season, they are treated at drying off with a pour-on drench for lice and worms, selenium and copper bullets for mineral deficiencies, vaccinated against leptospirosis, drenched for Rhinotrachiitus (because pedigree bulls are housed at AB centres), given Vitamin B12, as well as, dry-cow therapy where appropriate. To dry-off cows they are fed at sub-maintenance levels until milk production has stopped. Hay is fed to all cows during this period and they are allowed access to water, but are given no other feed. The 'drying off' phase on Case Farm six is critical to prevent mastitis, however, it creates problems because cows can lose condition until milk production ceases and additional feed is required over the winter to regain this condition.

Calving (August and September)

The herd starts to calve on 1 August. During August and September the goals are to: fully feed he cows to reach peak production as soon as possible, maintain animal health and protect new-born calves, detect and records oestrus activity and identify anoestrus cows, and maintain pasture quality. To fully feed the cows they are offered sufficient pasture to achieve a feed intake of 15 - 18 kg DM/hd/day. The diet consists of pasture, but some hay is fed to slow rumen through-put and there-by obtain the full benefit from high quality pasture. To encourage the cows to eat more fresh pasture is offered after every milking which avoids feeding fouled pasture to the herd (Plate 15). To maintain animal health the cows are drenched daily with 20 grams of magnesium at the night milking. To protect new-born calves, and encourage early milk production calves are removed from their mother within 2 - 12 hours of birth. Cows get over the trauma of losing their new born calf quickly using this approach so they can concentrate on producing milk and, *" we've had cows stand on calves and break their legs"*. The calving mob is monitored closely and *"anything that's got feet hanging out, he'll give it assistance ... calves are too valuable"*. Because early spring pasture growth rates in this area can be slow, pasture quality problems, (i.e. high pre-grazing pasture cover) are generally not a problem in August and September.

Plate 15 Freshly grazed pasture late October on Case Farm Six is ready to be closed for silage making in the next round. Pasture in the foreground has been grazed for approximately 3 hours.

On Case Farm Six mating management begins at calving. To detect oestrus activity and anoestrus cows all cows are tail-painted as soon as they calve. Accurate records are kept of all oestrus activity and cows with abnormal oestrus behaviour and anoestrus are treated by the veterinarian.

Mating (October and November)

For the months of October and November the main focus is on: fully feeding the cows to get as many cows in calf as quickly as possible, improving the genetic merit of the herd, maintaining pasture quality, conserving pasture surpluses as silage, and providing feed for cows in preparation for a possible dry summer. To fully feed the cows during October and November the rotation length is decreased from 24 days to 18 - 20 days. Full feeding of the cows is important to ensure cows get in calf as quickly as possible and *" we really try to pay attention to the follicle that's developing"*. Cows tails are re-painted prior to mating to detect oestrus activity and cows are observed 2 - 3 times a day. To improve the genetic merit of the herd cows are mated to high BI (150) nominated sires,as well as mated with home bred pedigree bulls. In addition, replacement heifers are only retained from the top 50% of the herd (see Animal Factors). Toward the end of October pastures are monitored closely as surpluses begin to appear. Depending upon the quality of the pasture the paddocks will either be topped or shut up for silage. To maintain a quality feed, and fully feed the cows, paddocks are topped in front of the cows. By topping during the afternoon (the actual time depends on the weather) the pasture remains palatable (i.e. not too wilted or dry) for the cows when they arrive at the paddock after night milking. Cut pasture must be fresh to enable cows and young heifers to eat as much as possible; topping is done to suit the cows not the farmer. Because silage paddocks are harvested within 40 days of being grazed, to increase supplement quality and optimise pasture regrowth, some harvesting may be completed before the end of November. In 1994 a paddock of Barkant turnips was planted in October to provide summer feed and this is likely to be continued.

Mid- to Late-Lactation (December to April)

The main goals during mid- to late-lactation are to: fully feed the cows to maintain lactation persistence, maintain pasture quality, conserve surplus pasture to provide feed for the winter and renew pasture. To fully feed the cows, and take account of lower growth rates in drier weather in the summer the rotation is lengthened to 28 days during December. This rotation length is retained until January/February at which time it may be lengthened further to start to build up a 'feed bank' for the winter. However, if pasture growth rates increase in autumn and pasture quality deteriorates the cows may be offered larger areas to shorten the round but generally any extra pasture is used to extend lactation and may give an extra grazing round. Hay is made at the end of December if pasture surpluses exist and round-bale silage will be used to harvest single paddock surpluses. If a feed budget in early autumn indicates that pasture targets at calving may be difficult to reach, grazing for up to half the herd will be arranged for the winter. Paddocks identified as needing new pasture will be worked up and resown during the autumn. At the time of the study the first summer crop of Barkant turnips had not been used so dates of feeding off and resowing into pasture are not known.

Drying Off (May)

The goals for drying off are to: ensure that sufficient pasture cover is available to meet pasture cover targets of 2,400 to 2,500 DM/ha at calving, and cows are at a sufficient condition score to enable a CS target of 5.5 at calving to be met. The drying off date is determined by a combination of pasture cover, soil temperature and cow condition. A close watch is kept on soil temperature data from Massey University, and as soon as it is considered they are low enough (approximately 8° C) to slow pasture growth rates, and provided pasture cover (1,800 kg DM/ha) and cow condition (above 4.5) are close to targets the cows will be dried off.

Rearing Replacement Stock

Rearing replacement stock on Case Farm Six is a high priority for management. Calves are reared on whole milk and meal until they weigh 115 - 120 kg. As the weaning weight is approached the amount of milk is progressively reduced and meal increased to avoid growth checks at weaning. In addition, calves are dehomed at an early age to avoid extra trauma and stress at weaning. During the rearing period the calves are run in mobs of 8 - 10 equally-sized animals, spread approximately half way through the herd's rotation to minimise fouling of pasture. After weaning they are spread out, 2 per paddock, until the autumn. In May yearling heifers are sent to graze off farm and rising two year old in-calf heifers return. Heifers are grown so they are as tall as mature cows, and generally they have their mature two year teeth by calving.

Planning and Monitoring

Planning on Case Farm Six not only involves dairy production from the herd, but the extra work involved with owning a pedigree herd. Care of livestock, because of their productive ability and value is strongly emphasised. Cows and pastures are regularly monitored to ensure production targets are achieved. A concentrated calving pattern, high quality feed (including supplements) and healthy stock combine to generate profitable high per cow production.

Gross Margin

Average Gross Margin for milk production [1]

Income from milk production		$196,577	
Milk production expenses			
Fertiliser	$18,613		
Supplements etc	8,776		[2]
Animal health	8,942		[3]
Shed expenses	3,518		
Shed electricity	3,015		
Reproduction)			
Herd testing)	7,944		[4]
		50,808	
Total Gross Margin		145,769	
Effective milking area		55 ha	
Cows peak milked	129		

Gross Margin per effective milking hectare	$2,650
Gross Margin per cow peak milked	$1,130

[1] Average of 91/92 and 92/93 years

[2] Running costs of tractor and farm machinery where used for making of supplements has not been included.

[3] Total of animal health for the herd including replacements and dry stock.

[4] All herd testing and reproduction costs included. This figure may also include some costs associated with proving of own bulls.

Case 7

Introduction and Characteristics

Case farm seven had the highest stocking rate, the largest herd, the highest level of supplements fed per cow per year and the shortest calving spread (Section 4.1). The farm covered 80 ha of flat river terraces dissected by a number of small streams and gullies, an effective milking area of 76 ha (Table 4.2), and is located 8 km north east of Pahiatua, at 114 metres above sea. The farm system includes a run-off where replacement heifers are grazed and the dairy herd is grazed during the winter.

Resource Factors

Pasture

The pattern of pasture growth is typical of farms in the 'Pahiatua' area of the TMPL supply area (Riddick, 1990); high spring and early summer growth is followed by lower pasture growth in the summer, increased pasture growth in the autumn before lower winter pasture growth is experienced. However, the farmer believes that, because of the high soil fertility on the farm, *"The grass grows longer, it jumps a week, 10 days before anybody else's does and goes 10 days longer"*. The pattern of pasture growth is managed by conserving growth surplus to cow requirements and feeding this when pasture supply will not meet herd requirements. Other supplements such as brewers grain, cheese whey (discontinued in the 1994/95 season), and maize silage are fed to maintain cow feed intakes.

Climate

The farm receives approximately 1050 mm of rain per annum which is, *"evenly distributed through out the year ... pretty reliable summer rainfall"*. Dry periods can be experienced although they are not common. The prevailing wind is from the west and north west.

Soil

The soil types on the farm are Heretaunga silt loam and Matamau stoney loam and hill soils. Due to high levels of fertiliser application the farm has a high Olsen P level ranging from 30 to 60. This level is maintained by, *"reasonably generous"* applications of fertiliser and up to 650 kg/ha DAP 13S can be applied in the spring and summer (average applications are 450 kg/ha). Regular applications of Urea (60 kg/ha in the late winter, spring and summer), and 140 kg/ha potassium chloride in the spring. The farmer *"... has never stinted on fertiliser, I've never had to, but I would borrow money to put fertiliser on ... maybe we've speculated on fertiliser ... but to me it's just look after your farm."* This attitude is a reflection of the pride that this family places on having a tidy farm. Extra fertiliser will be used if soil tests indicate that it is required.

Labour

Labour at the time of the study was provided by the farmer, one full time employee and the farmer's son who was employed as the sharemilker on the property. Achieving high per cow production when employing staff is harder because *"staff lose their way ... personal life interferes, ... they haven't got the same goals or interests as me"*. However, *"working on their strengths, using them where their strengths are"* makes planning and management of the farm easier. But to achieve this the farmer asks for concentration on the job at hand, particularly in the shed, and dislikes the use of any coercion of stock anywhere on the farm. In addition, to obtain the best out of employees you must *"try and make them feel that they are not just the cheap labour ...* [but] *an important part of the farm"*, and as employers *"we have to try and be up to scratch all the time"*.

Environment

The shed used during the study period, 1990 to 1993, had been extended first in 1986 when the original farm had been expanded and again before the farm was visited in October

1994, when more land was added to the farm. An important aspect of the shed, particularly at milking time is to try and make the cows 'enjoy' milking. The farmer insists that cows are not hit or slapped with alkathene and makes the environment a pleasant place to be, for the cows and the milkers. Access races on the farm are as wide and smooth as possible, *"you should be able to run down your races in bare feet"* (Plate 16) although some of the older races on the original part of the property undulate up and down due to the farm's topography. This does not seem to affect the movement of livestock to and from the shed in any way.

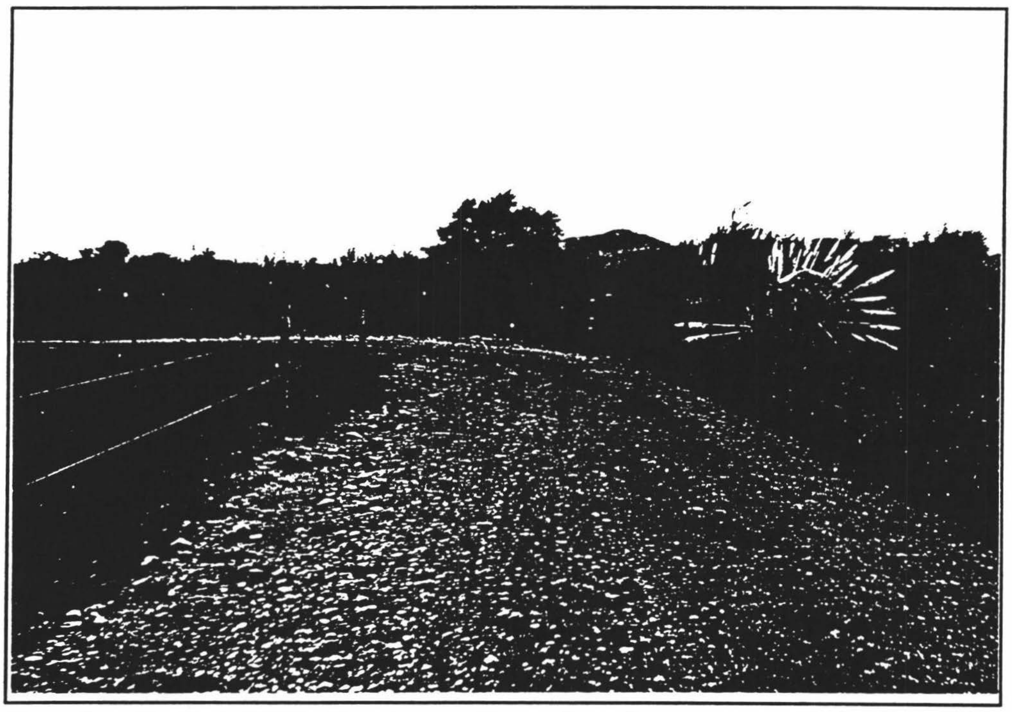

Plate 16 On Case Farm Seven smooth and wide races, particularly on the newer parts of the farm, provide easy access to the cowshed.

Animal Factors

All stock are wintered off the farm, for a period of six weeks, and in 1993 included 276 Friesian (95%) and Ayrshire cross (5%) cows. The herd has an average BI of 129 and a 95% recorded ancestry. The 67 replacement heifers are grazed off the farm from weaning until they return as in calf-heifers. Milk production of 351 kg MS per cow per year is achieved by eaching high production early, peak production in November and maintaining high production evels throughout the summer and autumn (Figure A7). Less than 2% deaths are recorded on the roperty and approximately 20% of the herd is culled annually. Approximately 45% of the cows ulled each year are removed from the herd on the basis of production. The remaining cows are ulled for: empty, age (over 10 years old) and SCC. Although cow live weights were not vailable, the cows were in good condition (CS 4.5 - 5) when the farm was visited.

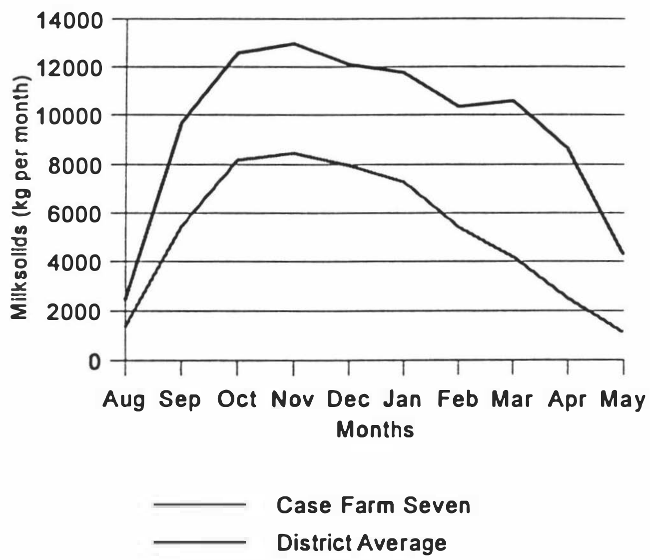

Figure A7 Lactation curve for Case Farm Seven compared with the district average for similar sized farms (adapted from TMPL data).

Management

<u>Stocking Rate and Lactation Length</u>

The herd is stocked at 3.6 cows per effective hectare[11] which is well above the district average of 2.48 cows per hectare (TMPL statistical data). Stocking rate has been maintained within the range 3.5 to 3.7 cows per hectare over the past ten years, however, in the

[11] See chapter 3

past up to 4 cows per hectare have been milked. The farmer only considers his property to be overstocked if there is insufficient pasture to feed the cows. To overcome 'overstocking ' during periods of low pasture availability supplements in the form of silage, and cheese-whey are fed to the cows. Brewers grain is fed to the milking cows every day. A high stocking rate *"makes farming easy because you know through this period* [spring] *you're going to be eating all your grass ... but once you get to the summer ... they go back into a paddock, eat what's there and then they start on their supplements ... they're still being fully fed"*. The lactation length of 278 days[12] is longer than the average for this area. The amount of pasture consumed by the herd was estimated to be 9,400 kg DM/ha or 10,480 kg DM/ha if pasture grown as a result of nitrogen applications is included.

Winter (June & July)

The main goals during winter are to: ensure there is sufficient feed for the cows to meet pasture cover targets of 2,400 to 2,500 kg DM/ha at calving, calve the herd at CS 5.5 plus, protect the soil structure and maintain animal health. To ensure there is sufficient feed and a pasture cover of 2,400 to 2,500 kg DM/ha at calving the cows are grazed at a run-off for 40 to 50 days. This allows the pasture on the home farm to build up, however, due to the high fertility levels pasture levels often reach 2,700 to 3,000 kg DM/ha at calving (Plate 17) which can cause pasture quality problems in August and September (see Calving). To achieve a condition score of 5.5 at calving, cows are fully fed during the winter and will return to the milking area if pasture at the runoff is insufficient to achieve this. Grazing cows off reduces winter pugging of the wet soils on the milking area. The farmer is very concerned about the detrimental effects of block grazing as well as *"taking the grass down to the deck"*, so when cows return 'home' they are frequently 'stood off' the paddocks on a feed pad. Standing the herd off on a feed pad avoids pugging and allows adequate pasture residuals to permit rapid pasture regrowth. To prevent mastitis cows are *"virtually starved for 4 days and you just don't look at what they look like"* after the last day of milking. This phase is particularly important as many of the cows are

[12] From median calving date until the last day of milking.

still producing 20 litres of milk per day on the last day of milking and they must be dried off before being moved to the runoff.

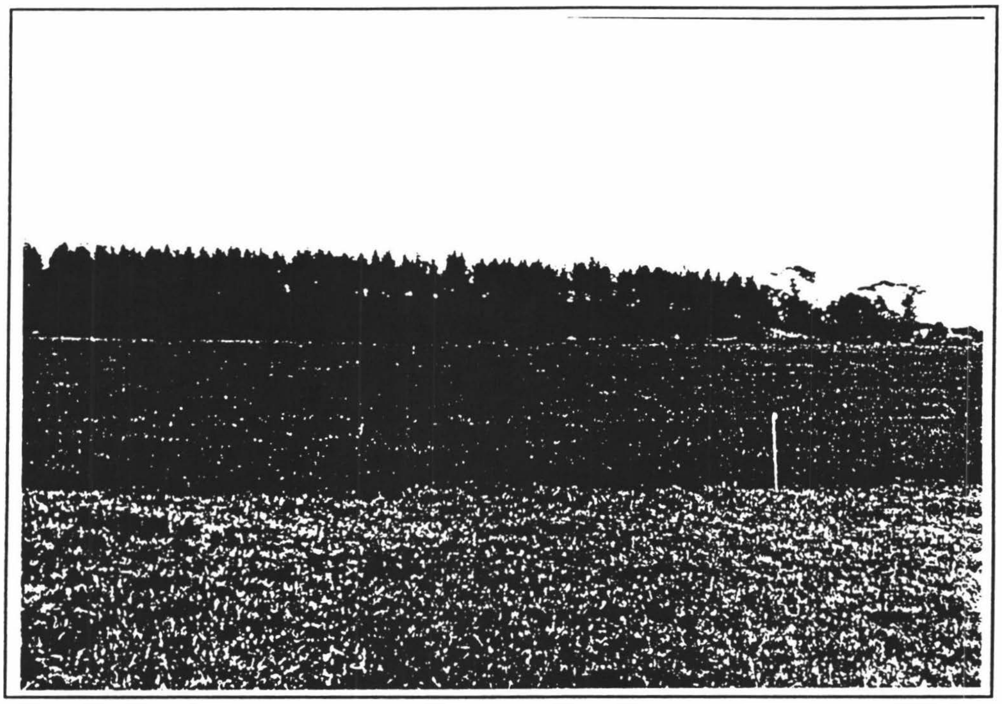

Plate 17 On Case Farm seven fresh breaks of pasture are offered to the cows during the day if required. This pasture had last been grazed less than twenty days previously.

Calving (August and September)

The herd starts calving on the 10 August, which is later than the average for the district, however, the median calving date of 25 August is similar to that of other local herds in the area. During August and September the main goals are to: fully feed the cows as soon as they calve to encourage early and high levels of production maintain animal health, and pasture quality, shut up pasture for silage and identify anoestrus cows. To fully feed the cows after calving they are offered as much pasture as possible, and fed hay (1 bale : 20 cows) and brewers grain. The cows are never restricted at any stage and, *"if they would eat 20 kg DM/hd/day from day 1 ... they could have it"*. Cows are fed hay *"to get their stomachs exploded"* so they are able to eat as much as is put in front of them. Even in poor (wet) years the cows are offered pasture for three to fours hours before being fed supplements, brewers grain and silage, in feed bins along the race (Plate 18). Cows are encouraged to eat frequently and will often be offered a fresh feed of pasture between 11.00 a.m. and 1 p.m. if they seem to need more, or to simply encourage them to eat more particularly if they are lying down. Other supplements may be fed, in feed bins, prior to the evening milking if the farmer considers they are required. To maintain animal health cows are given daily doses of: mag-chloride, aloe-vera (discontinued in 1995), molasses, formula 5 (a multi-mineral drench), and are drenched with selenium and cobalt (to combat a deficiency on the property).

Pasture quality during August and September often causes problems because feeding brewers grain, at a rate of 2.6 to 3 kg DM/cow, often results in high pasture residuals due to pasture substitution. Pastures soon begin to look 'scruffy', *"but that's only o mower away from cleaning them up"*. Topping of pasture, not to low (i.e. no lower than three inches), is common throughout the year. During August and September if the pasture quality is good, paddocks with long pasture will be closed for silage. The herd is tail-painted during September and anoestrus cows are treated by the veterinarian with CIDR's.

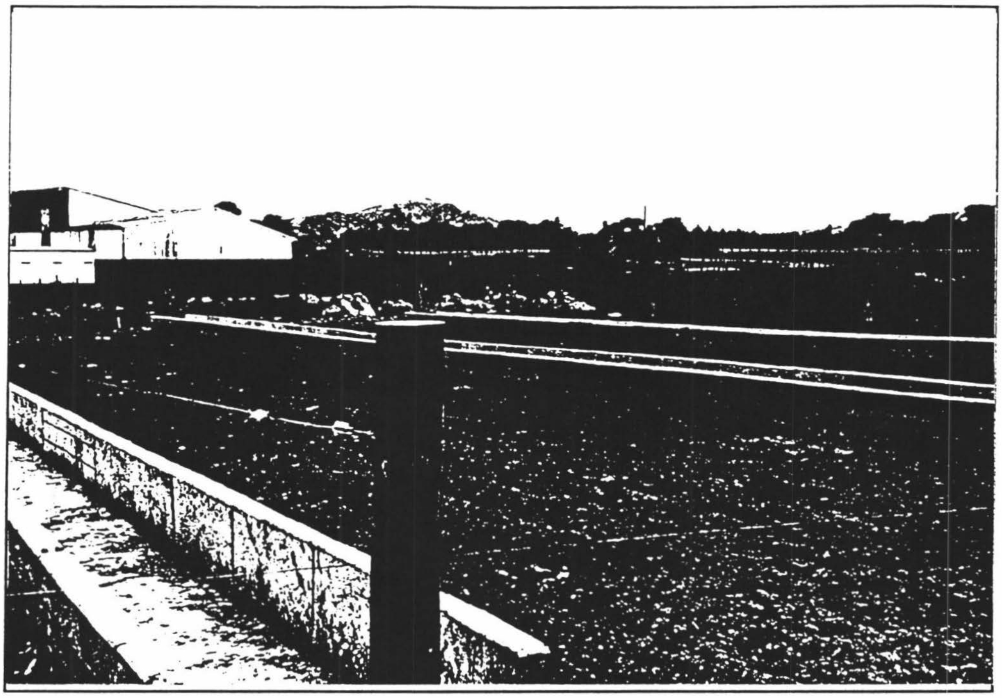

Plate 18 On Case Farm seven feeding bins along side each race are used to feed brewers grain and other supplements during wet weather and when 'extra' feed is required for the cows. The whole herd can be accommodated in this feeding area.

Mating (October and November)

During October and November the main focus is on: fully feeding the cows to increase condition before mating, improving the genetic merit of the herd, and conserving surplus pasture as silage. Fully feeding cows is important, not only for maintaining milk yields but to improve cow condition prior to mating. Cows will be fed as much pasture as possible but if intakes appear to be falling supplements - over and above the brewers grain - will be added to the diet. Improving cow condition reduces the number of anoestrus cows, and even if cow condition is high (4.5 - 5) it is still important for it to be increased from the initial losses experienced after calving. Oestrus behaviour is observed in the paddock at least 4 times a day, before milking morning and night, during the day and last thing in the evening. In addition, cows are observed as they arrive at the cows shed and all cows that appear to have cycled (detected via rubbed tail paint) are submitted for insemination. All cows are inseminated to Friesian PSS 'bull of the day' and no 'selection' is carried out at mating. Cows are culled at the end of the season primarily to improve the genetic merit of the herd (see Animal Factors). Silage is made in mid-November to maintain pasture cover at approximately 2,100 kg DM /ha. Paddocks are harvested within 20 days after they have been taken out of the round to allow pasture to regrow, and to achieve high supplement quality. Surpluses are determined by monitoring post-grazing residuals and observing the amount of pasture accumulated in 10 and 20 day periods post-grazing.

Mid- to Late-Lactation (December to April)

The main goals during mid- to late-lactation are to: fully feed the cows and maintain cow condition, conserve surplus pasture, and maintain pasture quality. To fully feed the cows and maintain cow condition feed intake levels are maintained at 20 kg DM/hd (or better) per day. To achieve high levels of feed intake they are offered pasture that is available plus brewers grain, but, if at any time a feed shortage is detected conserved feed or bought in supplements will be added to the feed supply to maintain animal feed intakes. Surplus pasture will continue to be conserved as either silage or hay, as the summer progresses if surpluses are detected. Pasture quality is maintained by offering the cows as much as possible, topping the paddocks, or making supplements.

Drying Off (May)

The goals for drying off are to ensure there is sufficient pasture available to meet pasture cover targets of 2,400 to 2,500 kg DM/ha, and CS of cows at 5.5 at calving. Drying off on this farm is often determined by the last day of tanker pick up (mid-June) rather than the pasture cover or cow condition score. However, a feed budget is prepared to ensure that there will be sufficient pasture available at calving if a mid-June date is selected as the last day for milking. It is preferred that pasture covers do not fall below 1,600 to 1,700 at drying off.

Rearing Replacement Stock

Rearing replacement stock well is a priority and the ability to graze young stock on a run-off has proven to be one of *"the biggest advances we've made ... we're aiming, if we can get our heifers to 550, 600 kg* [at calving] *well get them* [there] *"*. They are taken off the milking area as soon as practicable after weaning with the aim of getting them as close to their mature size as possible when they enter the herd.

Planning and Monitoring

Planning is an important factor in the running of this farm. Making sure all personnel know where the farm is headed is an important aspect of achieving high per cow production, especially when employing outside labour. Planning enables this farmer to proceed smoothly toward achieving family goals, *"it is surprising what two of you can do with just thinking and talking together"*. Cow feed intake is monitored daily, pasture growth rates are checked weekly to identify pasture surpluses early and produce quality supplements, animal health is checked regularly and a close watch is placed on oestrus behaviour during mating. Combined, these tasks ensure that the herd is fully fed and able to utilise high quality pasture and supplements, and that the whole farm system operates smoothly to achieve profitable high per cow milk production.

Gross Margin

Average Gross Margin for milk production [1]

Income from milk production		$342,786	
Milk production expenses			
Fertiliser	$19,306		
Supplements etc	27,861		[2]
Animal health	23,384		[3]
Shed expenses	4,692		
Shed electricity	4,260		
Reproduction)			
Herd testing)	5,498		[4]
		85,001	
Total Gross Margin		257,785	
Effective milking area		76 ha	
Cows peak milked	274		

Gross Margin per effective milking hectare	$3,392
Gross Margin per cow peak milked	$941

[1] Average of 91/92 and 92/93 years

[2] Running costs of tractor and farm machinery where used for making of supplements has not been included. Includes the cost of Brewers grain.

[3] Total of animal health for the herd including replacements and dry stock. Includes the purchasing of Aloe Vera etc.

[4] All herd testing and reproduction costs included.

Case 8

Introduction and Characteristics

Case farm eight had the lowest per cow milk production (Section 4.1), and the highest level of production per day during the peak months of October and November. The farm covers 59 ha of flat river terrace is split by a small stream, has an effective milking area of 57ha (Table 4.2), and is located 5 km north east of Woodville, at 137 metres above sea level.

Resource Factors

Pasture

The pattern of pasture growth on this farm is typical of farms in the 'Pahiatua' region of the TMPL supply area (Riddick, 1990); high spring and summer growth is followed by lower pasture growth in the late summer and increased pasture growth in the autumn before low pasture growth is experienced in the winter. The pattern of pasture growth is managed by conserving surplus pasture in periods of high growth and feeding supplements in the winter and early spring.

Climate

The farm receives 1000 mm of rain per annum which is generally evenly spread throughout the year (Thompson, 1982). Low rainfall can be experienced during the summer (January and February), and although droughts are not common, lower pasture growth during these months means that hay is fed to cows or some of the herd dried off or culled in extreme years. The prevailing wind is from the west and due to the proximity of the Manawatu Gorge can be very strong at times.

Soil

The soil types on the farm are Heretaunga, Kopua and Matamau silt loams and have an average Olsen P level of 25. The soil fertility is maintained by annual applications of 370 kg/ha sulphur super in the spring and 160 kg/ha DAP 13S in the autumn. These rates are based on recommendations from a fertiliser company. Urea (100 kg /ha) is applied during winter and early spring to improve pasture growth rates.

Environment

In 1991 the milking plant in the herringbone shed was replaced with a new, larger capacity plant. Installing the new, milking plant changed the behaviour of the herd (i.e. improved the temperament of the cows), reduced milking time by 50%, reduced the stress on the cows and the milkers, and lowered the incidence of mastitis in the herd. The improvements effected by the new plant are examples of the environment which the family aims to create on the farm, low stress levels for both livestock and the owners; *"the point of stress in the shed, if they spend too much time in there they get under stress and get upset and so do you"*. The races on the farm are generally in good condition, with a gravel base that was well crowned in most places (Plate 19). Apart from a bottle neck where the herd has to cross the stream, the cows have quick and easy access to and from the shed.

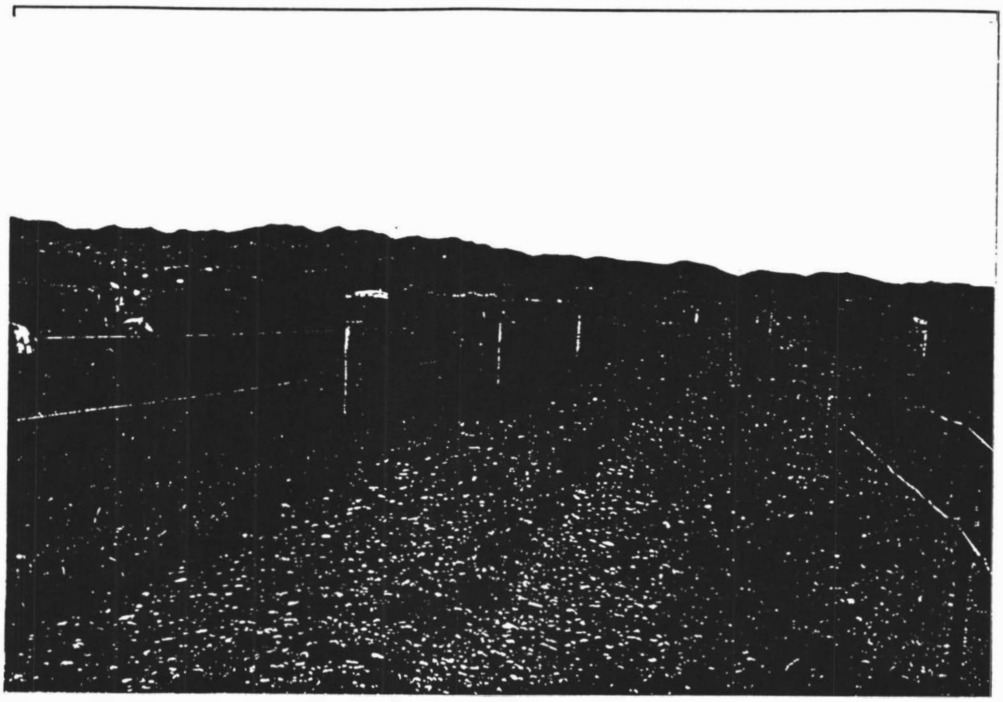

Plate 19 The races on Case Farm eight are smooth and well maintained.

Labour

All labour on Case Farm Eight is provided by a family partnership consisting of the farmer his son and his wife. This allows the family to farm the way they want and to manage their resources to produce a stress-free farming environment.

Animal Factors

All stock are wintered on the farm and in 1993 included 133 Jersey (50%) and Friesian x Jersey (50%) MA cows, and 44 replacement heifers. The herd has a BI of 127, although the recorded ancestry was unknown. Milk production of 350 kg MS per cow per year is achieved by reaching high production early, peak production in November and maintaining high production levels through the summer and autumn (Figure A8). Few deaths are recorded on this property (less than 2%), however up to 30% of the herd is replaced each year. The herd size has been increased recently (see Stocking Rate). Although cow weights were not available, the herd appeared to be in good condition (CS 5) when the farm was visited.

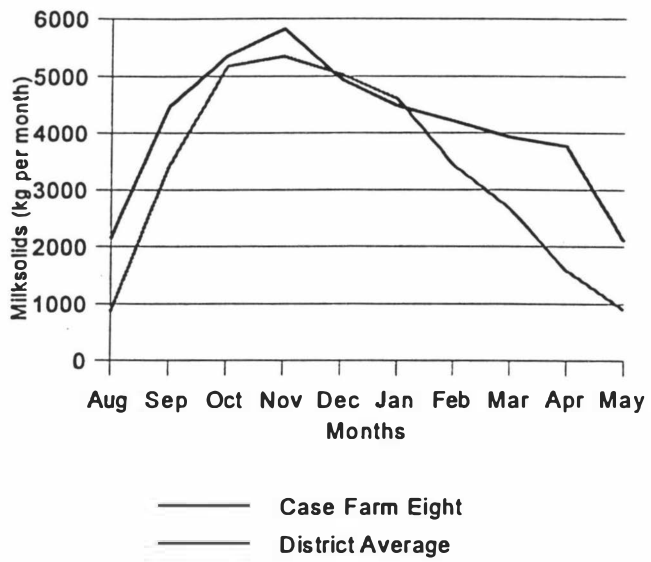

Figure A8 Lactation curve for Case Farm Eight compared with the district average for similar sized farms (adapted from TMPL data).

Management

Stocking Rate and Lactation Length

The herd is stocked at a rate of 2.13 cows per effective hectare[13] which is lower than the district average of 2.48 (TMPL statistical data). Stocking rates have been increased from 1.9 cows per hectare in 1991/92, in response to improved farm performance and upgrading the milking shed (see Environment). The lactation length is 268 days[14] which is similar to other farms in the area. The amount of pasture consumed by the herd was estimated to be 8,060 kg DM/ha or 9,000 kg DM/ha if pasture grown as a result of nitrogen applications is included.

[13] See Chapter 3

[14] Median calving date until the last day of milking

Winter (June and July)

The main goals during winter are to: ensure there is sufficient feed for the cows at calving, calve the herd at condition score 5 plus, protect the soil from pugging damage, maintain animal health and build the cows up preparatory to lactation. In order to ensure there is sufficient feed for the cows at calving and condition score targets are met, the cows graze the whole farm, supplemented with as much hay as required. Planned winter rotations of 90 days usually end up being 75 days in length because of the increased cow intakes during periods of poor (wet and cold) weather. Cows are grazed in a paddock for a given period of time and hay is fed to maintain daily feed intakes. However, the cows are removed from the paddocks to avoid pasture and soil damage if the weather deteriorates, *"... stand them on the race ... feed hay along the bottom of the fence"*. The length of time that cows remain on a paddock in poor weather varies because they may be offered extra pasture to account for higher feed demands and the time that they are allocated to a particular paddock may be reduced. Nitrogen is applied during the winter rotation to increase early spring pasture growth and pasture cover at calving. To maintain animal health, and particularly to negate the effects of a selenium deficiency, the cows will be drenched 2 - 3 times during the winter with selenium. As calving approaches feed intake per cow is increased slightly to improve her energy balance prior to commencing milking, *"you build the cow up to calving, about 3 - 4 weeks before ... take a little bit more care."*

Calving (August and September)

The herd starts to calve on 1 August. During August and September the main goals are to: fully feed the cow immediately after calving to achieve high production levels will be achieved early, maintain cow condition and animal health, and maintain pasture quality. To fully feed the cows an average pasture length of approximately 9 inches (22 cm) long at calving is targeted (approx. 2,000 kg DM/ha). A long pasture sward is important to enable heifers, which may not have their mature two year teeth, to easily graze the pasture. To attain high production early calves are removed from the cows within 24 hours of calving, and the cows are milked out straight away. The farmer believes that the earlier cows are encouraged to milk to their full potential the greater the milk production for the season, *"for that first week or fortnight you've got to ... take that milk away ... got to have the energy ... to replace it ... you've established your season"*. To prevent disease and metabolic disorders that penalise a cow's production potential high feeding levels are maintained. In addition, because of the low dry matter content of spring pasture, cows are fed hay (1 bale : 5 cows) from calving until October to assist the cow obtain maximum benefit from the pasture and to maintain animal health. Selenium is given to the cows on a daily basis, based on veterinarian recommendations, to prevent the negative effects of a selenium deficiency on the farm. To maintain pasture quality the rotation is reduced to 20 - 25 days after 10 September which means that *"something* [is] *left behind ... a couple of inches ... never tried to chew them* [the paddocks] *once we start rotating with the milkers"*..

Mating (October and November)

For the months of October and November the main focus of management is on: fully feeding the cows, achieving a concentrated mating, improving the genetic merit of the herd, maintaining pasture quality, conserving supplements and maintaining cow condition. To fully feed the cows the rotation length is reduced to 17 - 25 days (dependent upon the number of paddocks shut up for hay) and cows are offered as much pasture as possible. To achieve a concentrated mating oestrus behaviour is observed at milking times during mating, but because of high feed inputs and use of selenium anoestrus cows are not common. Tail-painting is not used because, *"since we've used the selenium ... they just rub themselves* [all the hair] *off the tail"*. Cows are mated to 'easy calving' Friesian sires selected for their ability to transmit udder conformation and production traits. Overall production, protein production, milking speed and temperament are important considerations when selecting the cows te breed replacement stock. Slow milking cows are culled because of the detrimental effect they have on the smooth flow stock through the shed. Pasture ahead of the cows is closely monitored to determine what action needs to be taken to ensure feed quality is maintained (Plate 20). Supplements are made in paddocks removed from the round until pasture control is regained. Paddocks with high residuals are topped or a light crop of hay may be made to avoid wastage. Cow condition is maintained above 5 for as much of the year as possible, and the detrimental effects of the selenium deficiency is negated by regular drenches with selenium.

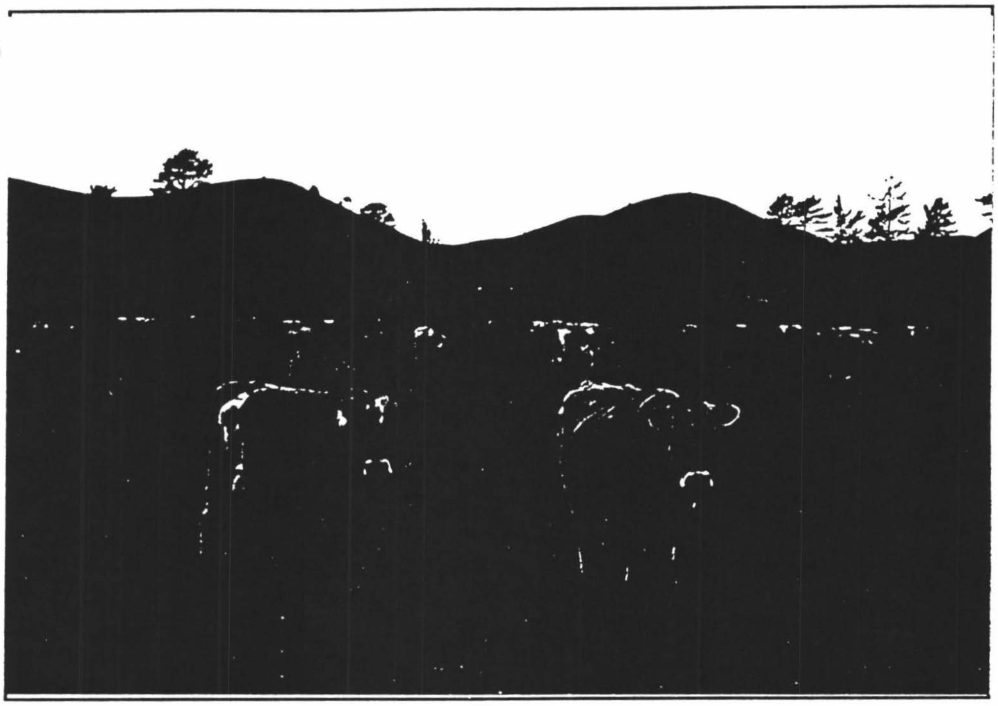

Plate 20 The cows on Case Farm eight are observed regularly to ensure that they are fully fed. Pasture levels are monitored in front of the herd to ensure there is sufficient high quality feed available.

Mid- to Late-Lactation (December to April)

The main goals during mid- to late-lactation are to: fully feed the milking cows, and maintain pasture quality. To fully feed the cows the rotation length of 17 - 25 days is retained for as long as pasture availability allows. In periods of low rainfall the rotation length may be extended and in more severe dry periods cows can be culled. Hay is also included in the diet at these times to maintain feeding levels. However, producing cows will be dried off early to allow their higher producing counterparts to be fed more. Pasture quality is maintained by retaining the short rotation, topping paddocks and conserving any larger surpluses as hay.

Drying Off (May)

The main goal for drying off is to : maintain cow condition at a level that will allow a score of 5 plus to be achieved at calving. Therefore, the drying off date is determined by the condition score of the cows rather than the pasture cover available on the farm. Towards the end of the season cows will be dried off if they begin to lose condition. Pasture cover at drying off is not considered crucial because a good supply of hay (2,000 to 2,500 bales) are on hand and cows can be put *"on to a diet of hay for a period ... to let the pasture sort of build up a bit"* at the start of the winter. The farmers believes that a diet consisting predominantly of hay may also have the added advantage drying off cows more easily after they finish milking.

Rearing Replacement Stock

Rearing of replacement stock is an important consideration on Case Farm Eight. The heifers are fed to achieve their mature size by their first calving. In the past the heifers have been placed in a corner of the farm and rotationally grazed around this block of three or four paddocks. More recently replacement stock have been grazed in the middle of the herd rotation. This has improved heifer growth rates. An added advantage has been greater flexibility because four extra paddocks are available for the herd rotation. The heifers are reared on whole milk until weaning, and during the early rearing periods close attention is paid to maintaining animal health to ensure adequate growth rates are achieved. Yearling heifers are grazed off for 12 months in May of each year.

Planning and Monitoring

On Case Farm Eight planning to ensure the cows are appropriately fed all year round and animal health is retained at high levels are important aspects of achieving high per cow production. Observation is the key to successful implemention of plans for the herd. The herd is observed regularly to assess feed demands. For example, if cows are not grazing contentedly during the day, but appear to be looking for more pasture, extra feed is allocated. Monitoring of pasture levels in front of the cows enables the farmer to assess the amount of pasture the should be shut up for hay or which paddocks should be topped to maintain pasture quality. Profitable, high per cow production, is achieved by close attention to cow behaviour and monitoring pasture levels in an informal way.

2

Gross Margin

Average Gross Margin for milk production [1]

Income from milk production		162,222
Milk production expenses		
Fertiliser	$6,441	
Supplements etc	1,083[2]	
Animal health	5,244[3]	
Shed expenses	1,197	
Shed electricity	3,705	
Reproduction)		
Herd testing)	2,451[4]	
	20,121	
Total Gross Margin	142,158	
Effective milking area	57 ha	
Cows peak milked	120	
Gross Margin per effective milking hectare		$2,494
Gross Margin per cow peak milked		$1,068

1 Average of 91/92 and 92/93 years

2 Running costs of tractor and farm machinery where used for making of supplements has not been included.

3 Total of animal health for the herd including replacements and dry stock.

4 All herd testing and reproduction costs included.