The Effects Of Wet Winters And Winter Management On Early Season Milk Production.

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Abstract

The effect of a wet winter on milksolid production in early lactation was measured for the years 1994 and 1995, against the 1993 year which had a dry winter. Data for milksolid production to the end of December, and for the whole season, were collected from 70 farms in the Manawatu region that had remained relatively unchanged in area and cow numbers over the three years. Management information was also collected from 18 selected farmers, whose milksolid production was either affected or unaffected by the wet winters. These farmers were also visited to obtain supplementary information about their management.

For the 70 farms, the effect of the wet winters on production in early lactation was a significant reduction ($P<1\%$) in milksolids for both wet years studied. (-24 KgMS/ha;-9 KgMS/cow in 1994, and -66 KgMS/ha;-26 KgMS/cow in 1995). These effects could have been caused by 0.2tDM/ha and 0.5tDM/ha less pasture being eaten in the wet springs of 1994 and 1995 respectively. However the effect on the total lactation milksolid production was not significant, with increases in late lactation compensating for the decreases apparent in early lactation.

The effect of the wet winters was probably to increase the incidence of pugging damage and to lower the pasture growth rates and pasture cover through calving and into early spring, reducing the ability of the farmers to feed lactating cows in early lactation.

For the 18 farms selected in the management survey, the effect of the wet winter (1995) on production in early lactation was larger on the affected farms (-133 KgMS/ha; -45 KgMS/cow), than for the unaffected farms (-4 KgMS/ha; -11 KgMS/cow). There was a significant decrease in the total seasons production for the affected farmers with lower production (-93 KgMS/ha; -25 KgMS/cow) in 1995 than 1993. The total seasons production for the unaffected farmers was a significant

increase of 80 KgMS/ha, and an increase of 13 KgMS/cow for 1995 compared to 1993.

There was no one single management strategy that was used during the wet winter of 1995 by unaffected farmers that was not used by the affected farmers. Instead, more unaffected farmers used off farm grazing, on-off grazing, and had better overall farm drainage. This decreased the risk of pugging damage during the winter, and early spring to enable more pasture to be converted to milksolids. There were differences in goals between the groups, because the affected farmers had more goals associated with lifestyle, while the unaffected farmers had more production orientated goals, with the unaffected farmers constantly monitoring the system to ensure the achievement of their production goals.

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List Of Abbreviations.

SR - Stocking rate

ha - Hectare

CS - Condition score

kgDM/ha - Kilogram(s) of dry matter per hectare

tDM/ha - Tonne(s) of dry matter per hectare

kgMS - Kilogram(s) of milksolids

kgMS/ha - Kilogram(s) of milksolids per hectare

kgMS/cow - Kilogram(s) of milksolids per cow

kgMF - Kilogram(s) of milk fat

kgMF/cow - Kilogram(s) of milk fat per cow

kgMF/ha - Kilogram(s) of milk fat per hectare

MJME - Mega joules of metabolisable energy

MJME/CS - Mega joules of metabolisable energy per condition score

$/ha - Dollars per hectare

Chapter 1: Introduction.

Winter management is the link between two milk producing seasons on seasonal supply dairy farms. It begins with drying off and ends with the start of calving. Between these two strategic management decisions, are various factors which interact individually and together to affect the achievement of the farmers goals and targets in the following lactation.

Research into dairy farm management over the past 20 years has established the importance of target values at drying off and calving, particularly in relation to cow condition and pasture cover on the farm which influence early lactation. Farmers also recognise the importance of management decisions and the attainment of targets particularly at calving. In a recent survey, farmers considered cow condition and pasture cover to have the greatest influence on early season milk production, followed by winter management (Parker, Gray, and Lockhart, 1995). (Table 1).

Table 1. Factors Influencing Milk Production in Early Lactation.
Influence Rating : No =1; Little = 2; Average =3; Large =4.

	Average Score
Condition Score at Calving	3.8
Pasture Available at Calving	3.9
Drying Off	3.0
Winter Management	3.6

(Source: Parker *et al,* 1995).

Farm management decisions during one period result in "carry over" effects into the following period. The autumn management sets up the winter management, and winter management sets up spring management (Ridler, 1985). Therefore farmers need to know the critical factors influencing each seasonal management period and to make certain that appropriate decisions are made to ensure positive carry over effects into the next period, rather than adverse effects (Ridler, 1985)

Previous studies by Elliot (1994) and Robinson (1993) have examined the effects of weather conditions experienced and the effects on milksolid production. Elliot (1994) studied the production differences between the two years 1992/93 and 1993/94, where milk production in the 1993/94 year was higher due to the better weather conditions over winter and spring. He concluded that top farmers are able to achieve key management factors such as cow condition and pasture cover ensuring a successful start to the lactation regardless of seasonal variations and difficulties (Elliot, 1994).

The purpose of this study is to examine the effect of a wet winter on early lactation milksolid production, and to compare different farm management strategies used during this period.

The objectives of this study are:

- to calculate the cost of a wet winter on the early part of lactation in terms of 'lost' milksolids (kgMS/ha and kgMS/cow).
- to calculate the cost of a wet winter on the total seasons lactation in terms of 'lost' milksolids (kgMS/ha and kgMS/cow).
- to find out management strategies used during the winter and spring periods to reduce the effect of winter wetness.
- to compare management strategies used during the winter and spring periods between farmers that were affected by wet winters to farmers that were unaffected.

Chapter 2: Review Of Literature.

2.0 Introduction.

This chapter will focus on the review of literature about the main factors that affect milksolid production in early lactation. The effect of stocking rate on milk production is examined. Drying off and the reasons behind the decisions are reviewed, in regards to the influence on the following lactation. Calving targets in relation to pasture cover and cow body condition score and the advantages on milksolid production in early lactation examined. The types of grazing management options used by farmers during winter are reviewed, with reference made to advantages and disadvantages of each system, particularly with the importance of avoiding pugging damage. The literature review concludes with a review of the functions of farm management.

2.1 Stocking Rate.

Stocking rate is one of the major determinants of productivity on New Zealand dairy farms (Gray *et al*, 1992), with the importance recognised by McMeekan in the 1950's and 60's, who said that "no more powerful force of good and evil exists than the control of the stocking rate in grassland farming" (McMeekan, 1961). The stocking rate is probably the most important decision that influence a herds feeding during the year (Holmes & McMillan, 1982). The appropriate stocking rate of any farm is dependent upon a number factors such as soils, pasture growth and composition, breed of cow, management practices (grazing off, supplementation) and the farmers management ability.

Stocking rate (SR) affects pasture utilisation, feed conversion efficiency and pasture growth, via its influence on herd feeding levels averaged over the whole year (McMeekan, 1961; Holmes & Wilson, 1987). The greatest effect of SR is on pasture utilisation, where term utilisation refers to the pasture consumed by the animal. A higher SR will increase pasture utilisation up to some upper limit, probably 80-90% (Holmes *et al*, 1987), resulting in more pasture being converted into milk production rather than being wasted and decaying in the paddock. The increase in pasture converted to milk is a result of an increase in the harvesting efficiency, in spite of reduced individual feed intakes which reduce the feed conversion efficiency of individual cows (Holmes & McMillan, 1982). The decrease in the feed conversion efficiency is due to the fixed maintenance cost of the cow becoming a proportionally larger part of the cows intake at lower levels of feeding (Holmes & Parker, 1992). A higher SR also has other benefits with an increase in pasture growth, due to a reduction in the rate of senescence, an increase in pasture digestibility and an increase in the proportion of clover and ryegrass species in the pasture is also associated with higher stocking rates (Stockdale & King, 1980).

As the SR increases, the pasture utilisation increases, but the individual cow intake falls. This reduces milk production per cow, but up to some optimum value for SR milk production per hectare is increased. There is also associated decrease in body condition of the cows at drying off with increasing SR (Holmes *et al*, 1992). Research data summarised by Holmes *et al,* (1982), gave a decrease of 18 kg MF/cow and an increase of 70 kg MF/ha for every additional increase in stocking rate (SR) of 1 cow/ha. In contrast Simmonds (1991) used commercial data to show that as the SR increased the decrease in per cow production is minimal, with the per hectare production increasing as expected. The production differences per cow for a Matamata/ Piako 1989/90 Cow Census showed only a 5 kg MF/cow difference across the SR's <2 - >4 cows/ha, which is a minimal difference for the 350 kg MF/ha difference (Simmonds, 1991). A similar result to Simmonds (1991) was also found when commercial data were compared to the experimental data by Holmes *et al,* (1982), with increases in both per hectare production and per cow production being associated with higher SR's. The reasons for this difference between the research and commercial data were that the commercial farms with higher SR's were probably associated with more productive land , and may have been managed better (Holmes *et al*, 1982). The relative management practices between the commercial and experimental observations is also likely to be a factor, with the experimental conditions being more controlled with the treatment groups differ only in SR. Supplement input from commercial farms may also help to counter the difference between SR's, as well as the use of off farm grazing.

Table 2. Average Stocking Rates in the New Zealand Dairy Industry.

Year	SR(Cows/Ha)
1981/82	2.1
1983/84	2.2
1988/89	2.4
1994/95	2.5

(Source: Dairy Statistics 1994/95, LIC).

The New Zealand dairy farming system has seen an increase in the average stocking rate over the years (Table 2). This has been brought about by improved knowledge and management practices, as well as the increasing use of off farm grazing, which reduces the pasture demand throughout the year (if young stock are grazed off) and directs more pasture on the home farm towards milk production. Off farm grazing also changes the pasture demand during the times of feed deficit, such as winter, with the whole or part of the herd removed off the farm to allow pasture cover to build up before calving. This may also reduce the risk associated with winter management, with reductions in pugging and other associated possible adverse effects of grazing in the winter (Nixon, 1990). Off farm grazing is a cost to the farmer, which must be smaller than the value of the resultant extra production achieved to be profitable.

The correct stocking rate of a farm will enable costly feed surpluses and deficits to be kept to a minimum (Nixon, 1990). Due to the effects of differences between seasons, and the variability of pasture growth, these surpluses and deficits will vary in size. Management strategies such as supplementation, fertiliser inputs, and culling will be required to either increase the feed supply to satisfy the SR, or to reduce the SR to meet the availability of the feed. Management strategies to reduce surpluses include shortening the rotation length to provide a greater pasture allowance to the stock, pasture renovation (taking paddocks out), deferred grazing, conservation and topping (Bryant & L'Huillier, 1986; Nixon, 1990). In order to be successful , planning and monitoring of the farming system is essential to anticipate future surpluses and deficits.

2.2 Drying Off.

The beginning of the dry period can be considered as the start of the next seasons lactation. The drying off decision can be defined as that management decision made in the latter half of a lactation affecting the suspension of milking in preparation for the next season (Gray *et al*, 1992). The drying off decision affects the lactation length of the current season. Therefore the optimal drying off date will not rob the current lactation to benefit the next lactation or vice versa (Holmes *et al*, 1987). There is no magic drying off date or number of days for the length of lactation. Rather the date is influenced by factors such as pasture availability, cow condition, weather conditions, milk production, and milk collection from the dairy companies (Parker *et al*, 1995). Because of these factors and their interactions, the drying off dates vary between regions in New Zealand and between years. It can happen as early as February due to a combination of factors. The actual date of drying off is of minor importance, relative to the decisions made prior to and following drying off (Bryant, 1984). Herds are generally dried off in stages, rather than all at once, with first calvers or cows in low condition dried off first (Parker *et al*, 1995). This increases the pasture allowance to the remainder of the lactating cows and gives the cows which were dried off early additional time to put on condition before calving. Therefore the drying off decision is not a single event, rather a series of decisions through time which finally results in all the herd being dried off (Gray *et al*, 1992).

The management practice employed towards the end of the lactation is usually once a day milking. This has beneficial effects for the farmer and the dairy cows. It reduces the labour commitment required, and since less milk is produced in the current lactation there is a reduction in the loss of cow liveweight (Lynch, Hunt, & MacKenzie, 1991). Milksolid production losses are in the range of 10-15% per day in late lactation (Carruthers & Copeman, 1990). The benefit of additional liveweight can be carried over to the next lactation, benefiting the productive and reproductive performance of the cow (McMillan & Bryant, 1980; Grainger, Wilhelms & McGowan, 1982a). The reduction in measured liveweight losses is not consistent across research findings with Carruthers *et al,* (1990) showing no differences in liveweights between cows milked once and twice daily. Liveweight will only increase with once daily milking if the intake remains the same as the intake if milked twice daily (Carruthers *et al*, 1990). The experiment carried out by Lynch *et al,* (1991) showed that once a day milking reduced liveweight losses and production yields in late lactation. The differences in liveweight at drying off were maintained throughout the dry period, until post calving when there were no significant differences. This resulted in no differences between the treatment groups (once daily vs. twice daily) in productive or reproductive performance in the early part of the following lactation. The conclusion from the trial was that once a day milking did result in losses of milk production and reduced losses of liveweight in late lactation, but subsequent effects on the following lactation are less certain.

Farmers views of the importance of drying off in relation to the next lactation's early milk production is mixed. In a recent survey farmers gave the influence of drying off on early season production an average rating (Table 1), with farmers particularly in Northland and Southland regarding the influence as minor (Parker *et al*, 1995). This may reflect the shorter lactation lengths and the longer length of the corresponding dry period for those areas in particular, but may also reflect the result of Lynch *et al,* (1991), that the effects of drying off, may not carry-over into the following lactation.

2.3 Calving Date.

The choice of calving date is probably the second most important management decision, after the choice of SR. The calving date and the periods preceding and following it have major influences on total milk production for a season, through effects on the level of feeding in early lactation and on the length of lactation (Holmes *et al*, 1982). Early lactation is a period where the pasture demand and the management requirement of a farm are greatly increased, with farms grazing both lactating and non lactating cows. The date of the start of calving and the mean calving date are important factors, as they dictate the rate of increase in feed demand and also indicate the time to pasture balance date, (the date when pasture growth rates (feed supply) have increased to be equal to the pasture consumption rate (feed demand) (Holmes & Brookes, 1993)), resulting in the pasture cover of the farm remaining static.

The calving date influences the production level of the herd, with the appropriate calving date allowing the cows to achieve high levels of daily production and a long lactation length. Herds calving earlier than the optimum period are likely to be underfed in early lactation, but have longer lactations, than herds calving later than the optimum period, which are likely to be fully fed, but have shorter lactation lengths (Holmes, 1986). Results from an experiment comparing calving date and its influence on milk production, found that the early calvers had reduced production in early lactation, with the late calvers commencing their lactations with higher daily milk yields, and maintaining this advantage throughout the lactation (Wilson, 1964). The differences in the production levels was probably due to the lower quantity and quality of pasture available to the early calvers. Similar results were achieved at Ruakura with the late calvers having a higher production in early lactation, but both the early and late calvers having similar productions for the whole lactation (Bryant, 1982). The results from Bryant (1982), differ to Wilson (1964), with the early calvers out producing the late calvers in later lactation for all three years of the experiment. The reasons for this difference is probably due to the difference in mean calving dates between the early and late calvers for each experiment, with Wilson (1964), having a greater interval between the groups than Bryant (1982), resulting in the Wilson (1964) early calving group being underfed for a longer period than the Bryant (1982) group. The early calvers performance could have been increased in both experiments with improved feeding levels by the addition of supplements or other management to prevent feed shortages (Bryant, 1982). The advantage of later calving may be a reduction in the amount of pasture required to be saved over the winter, and less pugging damage of pastures in late winter (Wilson, 1964), which will allow for a composed management style. The disadvantage of later calving is the difficulty in controlling pasture quality in the spring/summer period, which can reduce milk production due to higher pasture covers (Clark, Carter, Walsh, Clarkson, & Waugh, 1994).

To help overcome this time of feed deficit in early lactation on a dairy farm before the pasture balance date is reached, calving targets have been suggested. The main targets are for the pasture cover required on the farm, and the cow condition (condition score) required at the time of calving.

2.4 Targets for Winter Management.

The general aims of winter management are to ensure that the cows are fed adequately before calving, and that there is sufficient pasture on the farm to ensure that the herd can be fed adequately after calving. Average pasture cover at calving is a useful target for the first aim, while body condition score is a useful target for the second aim.

2.4.1 Pasture Cover at Calving.

The pasture growth rate during early lactation is usually slower than the rate of pasture consumption, therefore the pasture cover can represent stored feed, similar to supplements, except the pasture is standing. Achievement of target pasture cover at calving (kgDM/ha) has several effects. It allows newly calved cows to rapidly increase their intakes, which is important for two reasons. Firstly at the start of lactation, the cows efficiency of converting pasture into milk is at a peak for the lactation. Table 3 shows that at any time during the year extra feed is available, it should be fed in early lactation when the cow is at its highest efficiency for conversion of pasture into milk. Secondly there is a direct relationship between milk production in the first 2-3 months of lactation and the entire lactation's production (Bryant & Cook, 1977), with high early season production being a prerequisite for high total production (Bryant *et al*, 1986). Therefore by maximising the early lactation production, the entire lactations production will benefit.

Table 3: Marginal feed conversion efficiency (kg extra pasture DM/ kg extra milk fat).

	Conversion during period of extra feeding.	Total conversion.
Early lactation	21 to 24	13
Late lactation	34 to 71	15 to 24*
Dry period	No milk produced	22*

(* Calculated assuming 1 unit of condition score is equivalent to 30 kg liveweight and 10 kg extra milk fat). (Source: Holmes and McMillan, 1982).

Higher pasture cover at calving will make it possible to offer the cow higher pasture allowances in early lactation, which will result in increased intake and milk production (see Table 4 from; Bryant *et al*, 1977). The production differences between the groups in Table 4, still existed a month after the different feeding levels had finished, with the previously well fed cows continuing to produce more than the other cows, even though all the cows had spent four weeks grazing together (Bryant *et al*, 1977). These results help to show the importance of pasture cover and quantity of pasture at calving, to ensure that adequate herbage allowance can be offered in early lactation. It also highlights the importance of cow condition, as the group with the lowest allowance lost weight, which may explain the continued production differences noted after four weeks of common grazing.

Table 4: Effect of Increasing Pasture Allowance on Cow Performance.

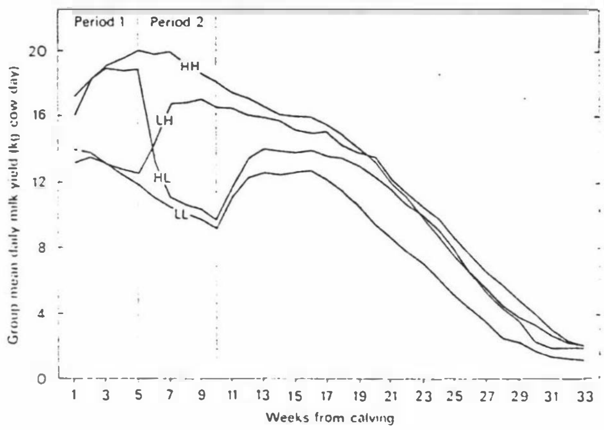
Group	1	2	3	4
Herbage allowance (kgDM/cow/day)	52	40	26	13
Milk fat (kg/cow/day)	0.81	0.76	0.69	0.64
Liveweight change (kg/day)	+0.30	+0.70	+0.25	-0.14

(Source: Bryant & Cook 1977).

There is a strong association between feed (average pasture cover) on the farm during July to September and milkfat yield (Bryant and MacDonald, 1983). The reason for this was presumed to be because the increased amount of feed at this time allowed for better feeding of the cows in the early part of lactation, with the cows probably having a higher herbage allowance due to the higher pasture cover, with the final result being an increase in the milkfat production in the early part of the lactation (see above). However in another experiment there were no significant advantages in milksolid production in early lactation associated due to a 30-40% increase in the pasture allowance at a higher pasture cover (Clark *et al,* 1994). The lack of any effect of pasture cover and allowance may have been due to reduced pasture quality at the higher pasture cover (the pasture cover was not given). The fact that the other treatments had an average pasture cover of 2000 kgDM/ha at calving probably provided an adequate pasture allowance, and therefore no further increases in production were caused by further increases in the pasture allowances to even higher levels.

The effects of underfeeding in early lactation have been shown to reduce milk fat yields, with a reduction in milk fat production by 10% in the first six weeks of lactation due to underfeeding, and a reduction of 20% if underfeeding continued for a further six weeks (Bryant & Trigg, 1979). The effects of underfeeding at the start of lactation are also illustrated in the results of Grainger and Wilhelms (1979) (Figure 1). Underfeeding during the first 10 weeks of lactation significantly reduced milk production over the period, with the effects of underfeeding in the first five and last five weeks being equal and additive. Over the entire lactation the group which was under fed for 10 weeks (LL) was unable to recover production at any point of the lactation, with the production for the whole lactation being reduced significantly. The group which was under fed in the first 5 weeks of lactation (LH) were able to recover to produce the same on a daily basis as the group with no feed restrictions (HH), from week 11 to the end of lactation. The group restricted in the second 5 weeks of lactation (HL) only produced 88%, and the group restricted for 10 weeks (LL) produced 72% of the milkfat yield of the HH group in week 11 to the end of lactation.

Figure 1: Effect of stage and duration of underfeeding in early lactation on mean daily milk yields.



(Source: Grainger *et al*, 1979).

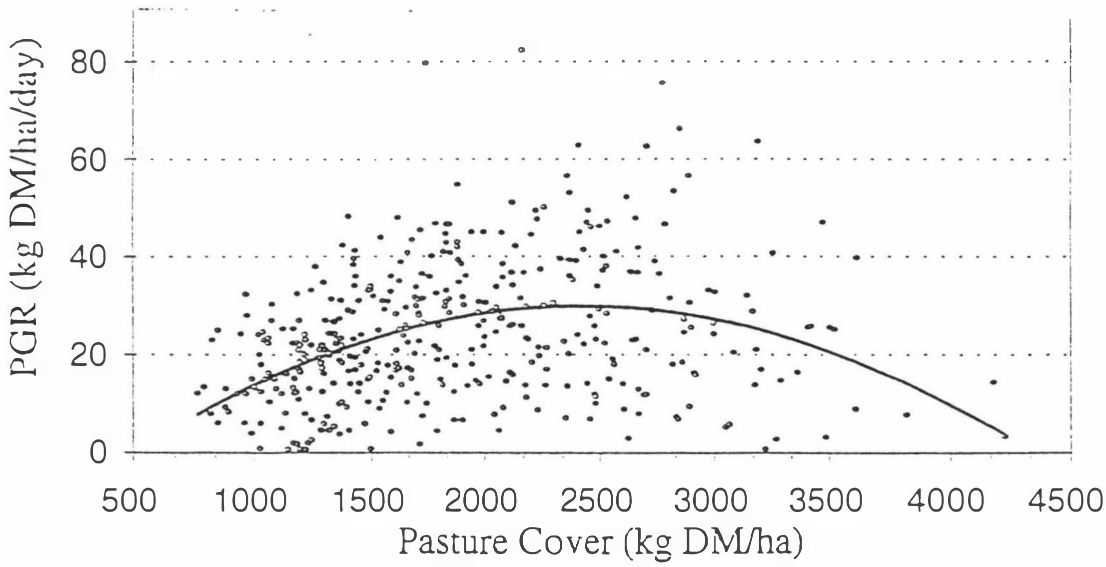
With the intakes of the cows at the high level of feeding (H), not been measured during the experiment, the production result of the LH group producing 12% more from week 11 to the end of lactation, and 8% more milk fat overall than the HL group was questioned. Grainger *et al*,(1979) believed that the intakes for the high feeding period would have differed between the LH and HL groups, with the LH group having a higher intake than the HL group due to the voluntary intake increasing as the lactation progresses. If this intake difference is taken into account, there were no differences in milk fat production between the HL and LH groups for the whole lactation, and with this correction made, the pattern of under feeding in early lactation has little effect on production. With this result, Grainger *et al,* (1979) believed that if underfeeding is imposed at the start of lactation in order to ration the limited amount of pasture, then there is the possibility that feeding will be restricted more than necessary, and therefore the best approach is to delay underfeeding for as long as possible.

An experiment at Ruakura imposed a 6 week feed restriction at weeks 3 and 6 of lactation. Milk fat yields decreased by 12 to 22% during the underfeeding period, with these effects disappearing within 6 weeks of resumption of full feeding (Bryant, 1982).The effect of the underfeeding on the whole lactation's production was not shown. A point raised by Bryant (1982) is that experiments such as the one at Ruakura and Grainger *et al,* (1979), only considered the effects of underfeeding the cows, and avoided any pasture affects resulting from severe grazing that is a consequence of underfeeding stock.

The suggested range of targets for pasture cover at the time of calving is 1600 - 2000 kgDM/ha (Holmes *et al*, 1993). The target for each individual farm will differ, but should allow the lactating herd to be fed satisfactorily until spring balance date is reached (Holmes *et al*, 1993), for most farms the pasture cover will decrease by 200 to 600 kgDM/ha before the spring balance date is reached and feed supply is in surplus, with the decrease in pasture cover dependant upon factors such as management and weather conditions (Holmes *et al*, 1993).

The suggested pasture cover targets are not a maximum level of pasture cover to be achieved, and should be treated as a minimum target. The reasons for this are firstly that the target is based on the minimum amount of pasture cover that is required to feed the herd adequately to the balance date, and secondly pasture cover above these levels reduces the risk of adverse conditions affecting early season production. There are also other benefits associated with achieving a higher target pasture cover. Firstly, for every increase of 100 kgDM/ha in the average pasture cover during July and August, there is an associated increase in production of 3 kg milkfat per cow (5.2 kgMS/cow) (Bryant & MacDonald, 1983). Secondly, an increase of 100 kgDM/ha in the pasture cover during winter and early spring will cause an increase in the pasture growth rates for the same periods over the range of 1000 to 3000 kgDM/ha (Santamaria & McGowan, 1982). A similar result was reported by Matthew, Hodgson, Matthews & Bluett (1995), with an increase in pasture growth rates of 2 kgDM/ha/day for every 100 kgDM/ha increase in pasture cover, up to 2000 - 2500 kgDM/ha. Above this range there was a decrease in pasture growth rates due to an increase in senescence rate decreasing the net accumulation of pasture. (See figure 2, for May to August pasture covers and growth rates). The maximum rates of pasture accumulation occur at pasture covers in the range of 2000 - 3000 kgDM/Ha, with the higher pasture covers returning more organic material to the soil and improving the long term sustainability of the pasture (Matthew *et al,* 1995).

Figure 2: The relationship between pasture accumulation rate and pasture cover during May to August.



(Source: Matthew *et al*, 1995).

A similar relationship between pasture cover and pasture growth rates was shown by Robinson (1993) for September pasture covers, with increasing pasture growth rate associated with higher pasture covers. Robinson (1993), said that some farmers aim for the maximum amount of pasture on the farm at calving, with the average pasture covers being as high as 2400 to 2500 kgDM/ha, enabling a longer rotations to be maintained, minimising underfeeding in the early spring and also keeping the pasture cover at a higher level.

2.4.2 Early Spring Management.

Results from the effects of spring rotation on production infer that the poorer the spring, the greater the penalties are for adopting a faster rotation than a slower rotation (Bryant *et al*, 1986). This may reflect the results from Bryant *et al*, (1983), that there is a strong association between pasture cover on the farm during July and September and the milk fat yield, with a faster rotation decreasing the pasture cover faster than a slower rotation. There is a limit to the pasture cover mass carried in the spring period, with higher pasture masses reducing digestibility and the quality of the pasture, and effecting the subsequent milksolid production in the late spring period (Clark *et al*, 1994). To control pasture quality during the spring period, the grazing management needs to maintain rotations longer than 20 days for feed shortages and less than 20 days for feed surpluses (Bryant *et al*, 1986). The grazing residual is also important, with no greater than 1500 kgDM/ha during the spring, which increases pasture growth rates and quality through the spring and early summer period (Hoogendoorn, Holmes, & Chu, 1988). With a higher calving pasture cover, the issue of pasture control becomes more critical for pasture quality to be maintained, either by adjusting grazing management and/or the timing and amount of conservation (Clark *et al*, 1994)

A cows intake does not peak until eight to ten weeks after calving. Therefore it is essential that the lactating cows have sufficient feed up until and beyond this point for maximum health and production, but the actual date will vary for early and late calvers. Four to eight weeks after the start of calving is about the time when spring balance date is reached. Therefore an aim after calving is to have sufficient pasture to feed the herd until the time of balance date, so intakes and pasture growth rates are not reduced.

Feed Restrictions.

For farmers in difficulty at calving the options are either to feed the herd well at the start of lactation or to restrict the pasture intakes for a period of time to reduce the pasture deficit and to maintain sufficient pasture cover to ensure maximum pasture growth rates. Some underfeeding may be avoided with the feeding of supplements during this period, allowing for the milk production levels to be maintained and the demand on pasture to be decreased. Grainger *et al*, (1979) concluded that the pattern of underfeeding had little effect on production, but recommended that restriction is delayed. This result conflicts with what seems to be the favoured option by farmers, which is to restrict intakes initially, perhaps reflecting the difference between the aims of a farm and the experiment. A farm aims to maximise production, where as the experiment design was to measure and compare groups equally. In Grainger *et al,* (1979), the LH group out produced the HL group, but were considered equal when the difference in total intakes were included, as the LH group were able to consume more food in their high feeding period than the HL group in theirs. When farmers restrict intakes early, they are decreasing the time to spring balance date, so when intakes are at a maximum so is pasture availability, optimising production at that point and recovering losses later in the lactation. The experiment done by Bryant *et al,* (1983), supports the management of farmers, with feeding levels being limited until the onset of spring growth, in order to maintain high pasture cover levels in the July to September period.

Supplementation.

There is also the option of feeding supplements in early lactation to prevent underfeeding and reduce the demand on pasture. Supplementation is also able to reduce the severity of grazing and reduce liveweight losses (Bryant, 1982). When cows consume supplements, they preferentially consume the supplement over the pasture, consuming less pasture than is expected. This is termed as the substitution rate, with the rate of substitution depending upon the supplement (Mudford & Thomson, 1995).The result of this substitution is to increase the residual pasture after grazing, but this has little effect on pasture accumulation over the winter period (Mudford *et al*, 1995). The responses to supplementation differ, due to differences in quality of the supplement, level and method of feeding, and the when the supplement is fed (Bryant, 1978). In the experiment by (Mudford *et al*, 1995), it was also noted that pasture and soil damaged were greater for the unsupplemented and lower supplemented groups as weather conditions become increasingly wetter. This latter result may reflect a higher pasture cover from the supplements as well as a reduction in stock movement due to the stock fed supplements grazing for shorter periods.

2.4.3 Body Condition Score at Calving.

Extra body condition at calving can be viewed as "energy stored on the cows back", which results in increased milk production with positive effects on fertility during the first months of the subsequent lactation. The actual condition at calving is much more important than the rate or direction of change in condition before calving (Rogers, Grainger & Earle, 1979). The management of cow condition begins in the previous autumn with drying off. Drying off determines the condition at the end of lactation, and therefore how much condition must be gained during the winter period, and the length of time in which it can be gained. The longer the previous lactation, the less time available to increase bodyweight before calving.

The energy requirements of a lactating cow will peak four to six weeks after calving, with her intake peaking eight to ten weeks after calving (Holmes *et al*, 1987). Therefore during this period of energy deficit the cow will use the "energy stored on her back" to met her energy requirements, and will lose weight.

Extra body condition at calving causes an increase in subsequent milk production and in the fat percentage of the milk during the first twenty weeks of lactation (Grainger *et al*, 1982a). Cows in lower condition partitioned a higher proportion of their energy intake towards liveweight, at the expense of milk production, than cows in higher condition (Grainger *et al*, 1982a). The higher condition score at calving results in more favourable partitioning of energy into milk production at the expense of liveweight (Grainger *et al*, 1982a), particularly with high feeding levels. Table 5 shows the benefits of a higher condition score, and the extra production advantage when higher body condition at calving is followed by higher levels of feeding. There is a difference of 24.5 kgMF between cows at a condition score 3 and cows at a condition score 6, at the same level of feeding (14 kgDM/day). The higher the level of feeding, the less the body reserves are mobilised with increased production still remaining. Table 5 shows that cows at a condition score 3 yielded an additional 9.6 kg MF with higher feeding levels. Cows at a condition score 6 at calving yielded 15.7 kg MF with the higher feeding level. Higher feeding levels will result in higher production and reduce the need for cows to mobilise body reserves (Grainger *et al*, 1982a), but does not reduce the benefits of a higher condition score, with the combination of higher condition score and higher feeding levels giving the best overall result (Grainger & McGowan, 1982b). The important point is that production is increased by an increase in condition score at calving.

Table 5: The Effect of Cow Condition at Calving and the Level of Feeding On Milkfat Production Over The First Twenty Weeks of Lactation.

Condition Score	3		4		5		6	
Feeding Level (kgDM/day)	8	14	8	14	8	14	8	14
Fat Production (kg)	82	91.6	88.4	100.1	94.9	108.6	101.4	117.1

(Source: Grainger *et al*, 1982a).

However, an experiment carried out by Bryant and MacDonald (1983) reported that an additional condition score at calving caused increases in milk fat yields of only 1.6 kg MF/cow (2.8 kgMS/cow). It was emphasised that the average condition score at calving was 4.5, and therefore the additional benefits of cow condition may not be the same for cows with a lower body condition. McMillan and Bryant (1980), surveyed 31 Waikato farms and gave each unit increase in condition a value of an additional 11 kg MF, but the correlation between average herd condition and milkfat production was only 0.29, indicating that on a between herd basis, differences in condition accounted for only about 10% of the differences in milk production. Within a herd, cow condition was significantly associated with production during September/October, and over the whole lactation (McMillan *et al,* 1980). A field study concluded that cow quality is also an important factor in influencing the response of cow condition at calving (McMillan, Bryant, & Duganzich, 1982). In contrast to this, it has been shown that there is no difference between cows differing in genetic merit in their response to additional condition at calving (Holmes, Brookes, Ngarmsak, Mitchell & Davey, 1985).

Cows which calved at a CS 4 ate more pasture for the first five weeks of lactation than cows at CS 6 when fed to appetite in stalls, with the effect disappearing by week eight when cows were grazing together (Grainger *et al,* 1982a). This difference in intake would reduce the benefits of higher cow condition, however it was suggested that the difference in intakes for animals at condition scores 3 to 6 in the field were not important (Grainger *et al,* 1982a). In a study with first calving heifers differences in body condition did not affect dry matter intake possibly because these young growing animals still required nutrients for growth regardless of their initial body condition (Mackle, Parr, Stakelum, Bryant, McMillan, & Auldist, 1996).

The advantage of body condition at calving has also been shown with heifers. A gain in heifer liveweight over winter was associated with an increase in milksolid production (Thomson & Barnes, 1992). Another experiment showed an advantage from extra condition for heifers at calving with an additional 8.3 kgMF per condition score, over the first 20 weeks of lactation (Stewart & Taylor, 1990). However the total seasons advantage of extra cow condition at calving is questioned by Mackle *et al,* (1996), with no significant differences in the average milksolid yields across the whole lactation and equal liveweights between the higher and lower body condition groups at the end of the lactation, with no additional dry matter consumed by heifers calving in lower condition.

During a lactation, not all body condition will be mobilised after calving. There are also other carry over benefits associated with achieving the target condition score at calving which can occur later in the lactation. Such a benefit of higher condition score at calving along with suitable feeding in early lactation, is a reduction in the anoestrous period by 6 days for each additional condition score. This relationship is particularly strong for improved feeding levels during the first five weeks of lactation (Grainger *et al*, 1982a).

The feed required to increase the condition score of a cow varies according to the energy content of the feed, the breed of the cow, and her physiological status (pregnancy requirements and current condition). Estimates from various authors ranged from 1260 to 2900 MJME/CS (Grainger *et al*, 1982b). Holmes *et al*, (1987) calculated theatrical requirements for Jerseys at 1351 MJME/CS and Friesians 2365 MJME/CS, and averages for the two authors are 1909 and 1858 MJME/CS respectively. This requires approximately 180 kgDM for an increase in one condition score assuming 10.5 MJME/kgDM for a Friesian Jersey cross cow.

Table 6: Condition Score Targets At Calving.

	Calving Condition Score
Rising 2 and 3 year olds	5
Mature cows	4.5 - 5

(Source: Holmes *et al*, 1987).

Table 6 shows the suggested cow condition targets required at calving. The target condition score for the heifers is higher than that for cows, because heifers have additional requirements of growth during the first lactation, as well as having new stresses such as milking, and competing with older cows. A field study of 31 Waikato farms found that heifers calving in thin condition had early lactation milk production affected to a greater extent than older cows (McMillan *et al*, 1982), with the study by Thomson *et al*, (1992), also showing heifers to be more affected by body condition at calving than mature cows

An important point is that the production advantages associated with cows calving in better condition are less apparent if they cannot be adequately feed in early lactation (McMillan *et al*, 1982). Therefore to gain full advantage at the start of lactation, both the cow condition and pasture cover targets need to be achieved.

2.5 Grazing Management

As previously mentioned in sections 2.4.1 and 2.4.2, there are important targets in relation to pasture cover and cow condition which must be met at calving in order to ensure a successful start to the lactation. The aim of winter management is to achieve the desired level of feeding during the dry period without prejudicing feed supply between calving and the onset of spring growth (Bryant & Cook, 1980). This can be expanded to include the aims of keeping pasture in a growing state throughout winter, with minimal soil damage and efficient use of supplements (Ridler, 1985).There is no one correct or optimal grazing system that can be employed during the winter period to achieve the calving targets. Grazing management varies for individual farms depending on many factors including stocking rate relative to the feed grown, locality, whether or not the farm is self contained, climatic variation, and the objectives of the owner (Bryant, 1990). Because of these factors and their variations, grazing management should be flexible to suit changes that occur within and between each year.

In New Zealand, rotational grazing has become the standard management practice on dairy farms (Bryant, 1990). Farmers adopt a slow rotation during the winter period, such as a 100 to 120 day rotation, in order to restrict daily pasture intakes by offering smaller areas to graze each day, resulting in a decrease in the pasture consumption. A slower rotation also allows for longer periods between successive grazings in keeping with the slower pasture growth rate of winter. The slower the rotation, and the earlier in winter that it is established, the more pasture will be present on the farm at calving (Bryant, 1990). This causes increased liveweight and cow condition at calving, and increased milksolid production up until the end of November (Bryant *et al*, 1986). The significant increase in milk production per cow recorded up until the end of November, was related to increased amounts of pasture cover on the farm in July, from the slower rotation. However the effect of the winter rotation on total lactation was not significant with effects largely disappeared by February (Bryant *et al*, 1986). Another experiment also compared the speed of the winter rotation and its effect on subsequent milk production. The slow rotation resulted in the greatest milk production due to better feeding in the last few weeks of pregnancy and in early lactation, which was reflected in extra liveweight and condition score at calving (Bryant *et al*, 1980). In conclusion, it was said that accumulating pasture ahead of the cows in autumn assured feed for winter and early lactation and reduced the uncertainties of relying on pasture growth rates over the winter period. Consequently the level of feeding in early lactation is less dependent on the vagaries of the winter weather, and is more dependent on previous management. The same conclusion was reached by Elliot (1994), in a survey which showed that top farmers achieved their targets regardless of the weather conditions.

A number of grazing management options such as on-off, block, paddock, strip grazing and off farm wintering, can be used by the farmer to achieve the specific targets. All of these can be used to restrict or control intakes.

On- off grazing- animals graze a paddock for a period of time, before being removed for the remainder of the day.

Block grazing- animals confined 24 hours to an area of the paddock with a back fence (Thomson, Judd & Johnson, 1993).

Paddock grazing- similar to block grazing, except that animals are given the entire paddock without back fencing for the time it takes for it to be grazed (Thomson *et al*, 1993).

Strip grazing- animals confined to paddock, without back fence, and have access to previously grazed area (Thomson *et al*, 1993).

Off farm wintering (grazing off)- all or part of the herd are taken off the farm for a period of time.

The first three strategies are used in a slow rotation over the farm. Bryant (1990) questioned the adoption of rotational grazing, especially after results such as McMeekans in the 60's, which showed that grazing management is associated with only small effects on milksolid production. Bryant (1990), suggests that farmers have adopted rotational grazing because it enables them to accumulate pasture and also maintain a visible pasture reserve ahead of the herd. The aspect of pasture accumulation, via controlling intakes with rotational grazing, gives the farmer the ability to control the pasture demand to more closely match the pasture supply, and the ability to achieve pasture cover targets at calving.

A number of trials have studied the effect of different grazing management strategies on cow condition, pasture cover and subsequent pasture growth in the medium term (late spring). Thomson & Laurence (1992) measured the effect of on-off, block and strip grazing strategies in late June/ early July (all grazed to the same post grazing residual mass), on pasture growth during the subsequent fourteen week period, until mid October. Table 7 shows the total pasture production measured in September/October, and the percentage decrease in pasture production relative to the mown control.

Table 7: Effect of defoliation treatment on subsequent pasture production measured over 14 weeks.

Treatment	Pasture Production kgDM/ha	% Decline
Mower (Control)	2030	0
On-off grazing (4hrs)	1980	2
Block grazing (24hrs)	1680	17
Strip grazing (5 days)	1440	29

(Source: Thomson *et al*, 1993).

The on-off grazing treatment resulted in a minor decrease (2%), compared to block and strip treatments. Possible reasons for these differences are continued defoliation and damage to plants, roots and soil occurring from cattle treading, which would be more prevalent in the treatments where cattle grazed for longer intervals. Thomson *et al* (1993), compared block and paddock grazing, where paddock grazing is essentially block grazing without a back fence, allowing the stock to graze and tread over the previously grazed area, in the case of the experiment, for 5 days. The results were similar to those presented above, with a 23% decrease in pasture regrowth following the paddock grazing trial. In the summary it was stated that the method of grazing management over the winter period can have considerable effect on pasture regrowth with differences in pasture production of 200 - 500 kgDM/ha recorded by early spring, from treatments applied in late June and early July (Thomson *et al,* 1993). This conclusion is different from that of Matthews (1971), where the main variable affecting the initial regrowth of pasture after winter grazing appeared to be the tiller population of the pasture present. In that study the grazing intensity (the low grazing intensity treatment of 120 cows/acre out produced the higher intensity treatment of 200 cows/acre), rather than the grazing methods used were critical. The pasture regrowth was 25% greater in the low intensity treatment plots by the end of 60 days post grazing, than the high grazing intensity treatment, due to higher tiller populations following the grazing to a low intensity (Matthews, 1971). Only under wet conditions did the grazing method on-off grazing provide an advantage, in which pasture damage was reduced.

The objective of winter management is for the provision of sufficient feed at calving and cows in a reasonable condition, with these being achieved with minimal pasture damage during winter (Bryant, 1984). Pasture damage is frequently termed "pugging", which refers to excessive treading of pasture. Pugging reduces the current pasture cover, utilisation, pasture growth rates and damages the soil structure (Horne & Hooper, 1990). Pugging has an immediate effect of reducing pasture cover, damaging roots, soil damage reducing aeration and water flow, and reduced earthworm activity. The reduced numbers and activity of plants results in the soil remaining wetter and cooler for a longer period, further reducing pasture growth in the long term (Mackay, Betteridge & Barker, 1996). The ability of a soil to withstand compaction is inversely related to the soil water content, therefore wetter soils compact and deform more readily. This soil damage has an adverse effect on the soils drainage ability, which is reduced, resulting in wetter soils and an increased risk of pugging damage for longer periods (Greenwood & McNamara, 1992). Wetter and waterlogged soils are associated with reduce plant production due to an oxygen deficiencies in the root zone, reducing root growth and activity (Gradwell, 1965). To avoid pugging damage a flexible grazing plan is needed, and management that is capable of responding and adapting to changes in the climatic conditions (Horne *et al*, 1990). A flexible grazing plan that removes stock from the pasture during wet periods will reduce treading damage more effectively than change in the stock grazing intensity (cows/ha/ for 24 hours) (Matthews, 1971). Some work done in this area using beef cattle and high stocking rates on wet plots has seen a reduction in the subsequent pasture growth from the winter through until summer (see Table 8).

Table 8: The Effect Of Treading Damage On Wet Plots Grazed In Successive Winters At A High Stocking Rate (300 cows/ha/day).

	Year 1	Year 2
Reduction In Pasture Production	35%	54%
Reduction In Legume Production	50%	75%

(Source: Mackay *et al*, 1996).

Table 8 shows the loss in pasture production from plots that were pugged 15 times in two successive years at a high stocking rate and a soil moisture content greater than 40%. The overall pasture production losses in the first year for the damaged plots was 35%. The initial reduction in pasture growth rates was 50%, but the pasture growth rates had recovered by autumn. A drop in white clover production of over 50% also resulted, reducing the pastures ability to fix nitrogen. The soil drainage capacity and earthworm numbers were also reduced in the first year (Mackay *et al*, 1996). After the second year of the treatment, the trodden plots did not recover by the autumn, with the annual pasture production reduced by 54% and legume growth reduced by 75% (Table 8). A possible reason for the continued reduction in pasture growth rates during the second year is also the reduction in the pastures ability to fix nitrogen due to reduced legumes growth after the first years pugging damage, compounding the continued effects of the second years pugging. Similarly a study of compaction in two Southland soils, concluded that the resulting soil damage from stock treading was a cumulative effect (Greenwood *et al*, 1992), with the soils natural ability to overcome the effects of stock treading being too slow to compensate for the damage incurred.

The risk of pugging is increased with poor natural drainage, high rainfall, and a higher stocking rate. Pugging on wet soils can limit pasture and cow production in early to mid spring. In conditions with severe and widespread pugging, cows can be in poorer condition at calving due to low utilisation and associated low intakes of soiled pasture, and a reduction in pasture growth rates which will also reduce the pasture cover at calving and increasing the time until the pasture growth rate is equal to the cow intakes (Horne *et al*, 1990).

Table 9. Pasture growth rates and cow requirements in early spring after average and wet winters.

End of Period	Aug 31	Sep 10	Sep 20	Sep 30	Oct 10
Cow Intake/ha (kgDM/day)	30	35	37	38	40
Growth Rate (Average winter) (kgDM/ha/day)	24	32	37	42	48
Growth Rate (Wet winter) (kgDM/ha/day)	21	28	33	37	42

(Source: Horne & Hooper, 1990).

Table 9 compares the average daily pasture growth rates at Massey University's No.4 Dairy Farm, to those growth rates that might be expected after a wet winter when one third of the farm suffered treading damage. The wet winter scenario has assumed that the treading damage suffered by one third of the farm has reduced pasture growth rates by 30% of the expected growth rate for the area, with the remaining undamaged area having expected pasture growth rates. The result of the pugging damage in the wet winter, is a 12.5% reduction in the average pasture growth rate over the whole farm and a delay of approximately 20 days before the pasture balance date would be expected to be reached. This has important implications in that cows are reaching their full intakes and peak production at the time of pasture balance date, and therefore it is important that sufficient feed is available to maximise the cows daily intakes. Table 9 shows the results from pugging of only one third of the farm, more widespread damage would cause greater effects on average pasture growth. Other effects also not considered are the effects on cow condition, milksolid production, and possible carry over effects on pasture growth rates into the following year as found by Mackay *et al*,(1996).

The risk of pugging damage occurring can be judged with two criteria to be considered, the water table level and the amount of rain enter the soil profile (Horne, 1987). Methods that are able to be used by farmers to minimise treading and pugging damage are artificial drainage, which is able to remove excess water, and on-off grazing for days when the rainfall exceeds the capacity of the drainage system and when the rainfall wets the soil surface before it is drained away (Horne, 1987).

The use of on-off grazing can limit the treading damage to pasture and soils, benefiting pasture growth and pasture cover (Thomson *et al*, 1993; Blackwell, 1993). On-off grazing can also be used in early lactation helping to achieve a longer first rotation with no apparent detrimental effect on daily milk yields, provided that the lactating cows are well fed and in good health (Blackwell, 1993). On-off grazing requires an area for stock to stand during the period off the paddocks. Farmers are able to use sacrifice paddocks, races, the dairy yard, loafing pads or feed pads. The use of a sacrifice paddock or race leads to considerable damage to the paddock, which can require regrassing, or to the race which can require increased maintenance. The final option is the use of a loafing or feed pad, which are specifically designed for concentrated numbers of stock, and are also more versatile, in that supplements can be fed on them, giving more flexibility for management, but feed pads involve capital expenditure.

Table 10: Production Advantages Of A Feed Pad Vs No Feed Pad.

Average Production Advantage	2.6%
Variations In Annual Production Advantages	-3.1% to +9.0%

(Source: McQueen, 1970).

A major study done by McQueen between 1962-69 on a heavy soil (Tokomaru silt loam) compared the performance of two farmlets, one with a pad and one without a pad. The conclusion from the trial was that the feed pad had gains of only 2.6% in milk production over the whole season (Table 10), an advantage which could be accounted for by experimental error. As shown in Table 10, the advantage of the feed pad varied considerably throughout the duration of the experiment, with the feed pad group producing 3.1% less milk fat in one year, and then in the following year producing 9% more milk fat. In only four of the eight years of the trial did the group with a feed pad out produce the group without a pad. In the first eight weeks of the lactation the overall result concealed an important 7.5% increase in production achieved by the farmlet with the pad. This result was clearly evident in the years after the stocking rate increased above 3 cows/ha and in years with a wet winter. The herd with the pad were generally heavier pre and post calving, than the herd without the pad for six of the eight years of the trial. This difference was not considered as an effect of the feed pad, as the difference in liveweight could be the result of the herd on the pad being naturally heavier. However this additional liveweight has benefits for milk production in early lactation and for reproduction, in which the empty rate of the herd with the pad was an average of 9.5% for the trial compared to 15.5% for the herd without the feed pad. The "peace of mind" benefit of a feed pad in reducing the risk of adverse management decisions, and the added security that the feed pad option offers should not be overlooked (McQueen, 1970).

The final option of grazing management is off farm grazing, where all or part of the herd is grazed off during the winter period. This option has the advantage of reducing the risk of pasture and soil damage during winter, and of helping to ensure that calving targets are achieved. It also has the benefit of allowing the previous lactation to be extended as the pasture cover at drying off can be lower than if stock are wintered on the farm. It has been suggested, using simulation models, that off farm grazing increases milksolids per hectare when the average farm pasture cover would have fallen below 1750 kgDM/ha in September without off farm grazing (Clark *et al*, 1993). Wintering off can also lead to greater pasture regrowth in July and August (Clark *et al*, 1993). Disadvantages of off farm grazing can be a decrease in milksolid yield from late October to mid December, because the higher pasture cover on the farm in the spring period, decreasing the pasture quality and adversely affected milksolid production (Clark *et al*, 1993). To avoid this, the timing and amount of conservation is more critical to maintain pasture quality. Other disadvantages are the cost of the off farm grazing and the risk of having to rely on the grazers management to ensure that the cows are in sufficient condition for calving.

2.6 Management Factors.

The previous sections 2.4 and 2.5 have described targets and grazing management for the winter period, with the farm management influencing the calving targets and grazing management between individual farms. Management involves three functions, planning, implementation and control (Boehlje, 1993).

Successful farm management requires clear goals and objectives (Poole, 1989), with goals and success intimately related (Olsson, 1988). Goals and objectives are required to formulate the basis of a plan, the first part of management. Goals and objectives can be short (tactical) or long (strategic) term, and can be financial, technical or personal in nature. Financial and technical objectives include profit and production targets such as $/ha or kgMS/ha. Personal goals are also important and likely to change with the development of a business, with profit initially overriding personal goals, and when a business is established the need for lifestyle becomes more important (Poole, 1989). The objectives of winter management are mainly tactical, and related to technical objectives with the achievement of a level of pasture cover (kgDM/ha) and body condition score at the start of calving. These technical goals will influence milksolid production, which may be a profit or personal objective. High target levels of both production, such as milksolids, and the factors influencing its achievement such as pasture cover at calving, are also a risk management strategy used by farmers to reduce variations and to adapt to changing circumstances (Martin, 1996).

After a plan has been defined, the next part of farm management is the implementation of the plan in order to achieve objectives. During the winter this involves the grazing management (section 2.5), which is to influence body condition and pasture accumulation over the winter to the desired objective at the start of calving.

After the implementation of the plan, the control and monitoring of results becomes an essential part of management (Poole, 1989). Control involves the measuring performances and correcting deviations from established standards to assure success of goals and objectives. The types of control can be placed in three categories, preliminary, concurrent, and feedback control (Boehlje, 1993). Preliminary control focuses on the prevention of deviations from the plan by identifying and solving potential problems before they eventuate. An example of this type of control is the use of off farm grazing to prevent pasture damage and allow for pasture cover targets to be achieved. Concurrent control is the monitoring and adjustment of the system to maintain objectives and goals. An example of this control is supplementary feeding which can begin and end when required to assure the achievement goals. Feedback control is the inability to solve a deviation from a plan with concurrent control, with it being recognised that it could be handled more effectively in the future (Boehlje, 1993), and would relate to changes such as the calving date.

The success of the achievement of goals and objectives can mean different things to different individuals (Olsson, 1988). There are two concepts of success, subjective and normative success. Subjective success is the fulfilment of personal goals and normative success is the fulfilment of goals that a farmers surroundings (associations, other suppliers etc.), consider important (Olsson, 1988). With both subjective and normative success a farmer can be considered successful by his own point of view and that of his surroundings.

Chapter 3: Materials And Methods.

3.0 Introduction:

The aims of this study were firstly to estimate the cost of a wet winter in terms of lost milksolid production (kgMS), and secondly to identify management strategies used to reduce the loss of production. Data were obtained for three years, one "dry winter" and two "wet winters", from farms which had maintained relatively unchanged area and herd size over the three years. Differences in milksolid production between years (within farms) were used to measure the effects of wet winters on milksolid production. Management strategies were studied on two groups of farms, one with no decrease in early season milksolid production after a wet winter, and the other with a decrease in production after a wet winter. The method of the study was conducted in two sections, firstly the within farm milksolid comparisons over the three years to calculate the effect of a wet winter, and secondly a farm survey and visits of farms for details on farm management practices.

3.1 Farm Production Data.

3.1.1 The Years:

Data were collected for the years 1993,1994, and 1995; with the 1993 year having a "dry winter", and the 1994 and 1995 years having "wet winters". Only the 1993 year was considered to have a "dry winter", with the rainfall for the winter period (May to August) being below average rainfall levels. The 1994 and 1995 years were classified as wet winters because they had above average total rainfalls and percentage of rainy days (days of >1mm of rainfall). Table 11 shows the dry winter of 1993 had below average rainfall, while the wet winters of 1994 and 1995 had above average rainfall, and a higher percentage of rainy days. 1994 had a total rainfall just above the average, however the higher percentage of rainy days making the winter effectively "wet".

Table 11. Total Rainfall And Percentage Of Rainy Days For The Winter Periods (May-August) Of 1993 - 1995.

Year.	Winter Period (May - August).	*30 Year Average*	% Rainy Days (< 1mm/day).	*30 Year Average*
1993	255.6 mm		27.6	
1994	369.5 mm	*364 mm*	48.0	*39.0%*
1995	394.6 mm		47.2	

(Source: R. Heerdegen, Department of Geography, Massey University).

Use of the three most recent years, was expected to provide the greatest number of suitable farms, and the most reliable data. Having a longer period would have reduced the number of suitable farms, and at the same time provided less accurate information. The 1996 year was not considered as part of the study because data required included total milksolid production up to December and the total for the whole season, and with the analysis of data done before these dates, it was not possible to include the year.

3.1.2 Selection of Farms:

The farms were selected from the records of Tui Milk Products Ltd (which became Kiwi Co-operative Dairies Ltd in December 1996), with farms having to satisfy the following selection criteria (listed in order of priority):

(i). The farm had to be located on the western side of the Tararua ranges, and within the geographical area between Feilding and Opiki (in the Manawatu region).

(ii). The farm had to have maintained a spring calving herd, and had to have supplied Tui Milk Products for each of the three years (1993,1994, and 1995).

(iii). The effective area of the farm had to remain relatively unchanged, and the number of cows had to vary by less than 10% between the three years.

(iv). The variation in stocking rate (cows/hectare) had to have varied by less than 20% between the three years.

There were 350 farms located in the area which only had spring calving herds, and 70 of these farms satisfied the final selection criteria (iii) and (iv).

3.1.3 Farm Data Collected:

For each of the 70 selected farms, the following data were collected from Tui Milk Products records for each year (1993, 1994, and 1995):

- Farm total area and effective area.
- Number of cows milked.
- Breed of cows.
- Starting and ending dates of milk supply to the factory.
- Monthly milksolid total yields up to and including December.
- The seasons total milksolid production.
- Farm soil group

The soil groups used were the same groupings as used by the dairy factory. The soil groups were Manawatu clays, Manawatu sands, and Manawatu silts, and have been classified accordingly to individual farm records from the Tui dairy factory, upon whether a farm is on a clay, sand, or silt based soil. The individual soil groups do not define an area or differences between soils such as heavy or light soils.

3.1.4 Analysis of Farm data.

All farm data collected were entered into an Microsoft Excel (5.0) spreadsheet, where it was then checked for data entry errors. The spreadsheet was then used to calculate the following variables for each individual farm:

- Per hectare and per cow milksolid production up to the end of December.
- Differences between the years in per hectare and per cow production up to the end of December.
- Total per hectare and per cow milksolid production for each year.
- Differences between the years in the total per hectare and per cow production.
- Percentage of milksolid production up to the end of December and the years total for each year.
-Each years stocking rate, and the average stocking rate over the three years.

The variables calculated were averaged for all farms, as well as total monthly milksolid production figures for each year, with the dry year of 1993 used as the control year for milksolid production variables. The differences between means of variables were tested using SAS (Statistical Analysis System for Windows 6.11). Variables tested for significant differences were the milksolid production up to the end of December and the years total production, percentage milksolid production up to the end of December, and the monthly milksolid yield differences up to the end of December between the dry year of 1993 and wet years of 1994 and 1995. Correlations between stocking rates, soils (coded as either Manawatu clays, sands, or silts) and milksolid production variables were also tested.

3.2 Farm Management Survey.

3.2.1 Selection of Survey Farms:

The aim of the survey was to compare the management practised on farms which were "affected" by the wet winters with those which were "unaffected" by the wet winters. Only the production up until December for each year was considered, as this is the time period where winter and its management can influence milksolid production most strongly. The dry year of 1993 was used as the "control" year, and production differences were calculated from the total production up to December. The criteria for selection of the affected and unaffected farms were:

(i) Farms had to have milksolid production above 400 kgMS/ha.

(ii) The farm had to be continuing to supplying Tui Milk Products in 1996.

(iii) Sharemilkers had to be on the same farm in 1996.

(iv) The total milksolid yield up to the end of December for the 1993 dry year was used as the base production level for each individual farm. The total milksolid production up to the end of December for 1994 and 1995 wet years was compared to the production of 1993. The difference between 1993 & 1994, and 1993 & 1995 were compared to the average for all 70 farms, with the loss in production having to be above the average losses for both wet years for a farm to be selected as an 'affected' farm.

(v) A similar criteria as (iv) was used for the selection of unaffected farms, except the milksolid production losses to the end of December were required to be below average, with preference given to farms with no change to the total yield to the end of December for both the 1994 and 1995 wet years, compared to 1993.

The reason for having (i) in the criteria, was that several farms had a total milksolid yield of less than 400 kgMS/ha in the dry year of 1993. This level of production is considered low, and when production in the wet years of 1994 and 1995 up to the end of December was similar to 1993, it was considered to be the result of having an extensive management system, rather than intensive management initiatives to overcome the wet winter.

The initial selection of farms that met the criteria produced a bias in the soil groups with the farms on the Manawatu clays providing a majority of the affected farms. Therefore to eliminate a possible bias in the survey results due to the soil groups, the three worst and best farms for each of the three soil groups were selected to be surveyed. Selecting more than six farms for each soil group would have meant the selection of farms that did not fully meet the criteria of being affected or unaffected farms.

3.2.2 The Survey:

The aim of the survey was to provide information about the winter management used on farms affected and unaffected by the wet winters. All questions asked in the survey were about the wet winter of 1995. The reason for only questioning the farmers about the most recent year selected was that answers relating to 1993 or 1994 may have provided less accurate information, as well as the need for less specific questions. The questions asked in the survey were to identify management strategies used in 1995, and to provide differences in management between the affected and unaffected farms. The questionnaire considered the period between the herd being dried off and the early part of the 1995 lactation.

The areas of questioning were:

- Herd breeding worth.
- Reasons for drying off.
- Fertiliser applications over the winter period.
- Supplementation during the winter.
- Off farm grazing.
- On-off grazing.
- Farm drainage.
- Management to prevent pasture damage.
- Calving targets in relation to pasture cover and cow condition.
- Early lactation feeding.

The survey was conducted via the telephone. Reasons for this were the probable delay in waiting for the return of questionnaires if conducted via the post, and the need for a 100% return rate. Due to the small sample size and the surveyed farms being purposely selected a 100% return rate was desirable. A copy of the survey (Appendix 1), with a covering letter was sent to all farmers before they were contacted by telephone. This introduced farmers to the research and its aims, and also allowed the farmers time to think about the questions, which was important because the information sought related to the winter one year ago.

3.2.3 Farm Visits:

A number of the farms selected in the survey were also visited after the survey was completed. An attempt was made to visit as many of the farms surveyed as possible, but due to the unavailability of some farmers and time constraints, 14 of the 18 surveyed farms were visited. Of the farms visited, 6 were affected farms, and 8 were unaffected farms. The purpose of the visit was firstly to confirm the information collected by telephone for each farm. Secondly, the farm visits were aimed at understanding the situation on each farm at the start of calving in 1995, and to understand the farm management both before and after calving and the reasons behind the decisions made. The farm visits also provided an opportunity to ask further questions in relation to issues identified in the survey and the changes that have been made to the farms winter management in particular for the 1996 year. A list of question topics were taken on the farm visits so as to provide similar questioning to all farmers. The information was collected to supplement and add depth to the results of the survey, with the aim to provide better discussion on the factors identified in the survey.

3.2.4 Survey Analysis:

The individual farm data for the farms selected were entered into a new Microsoft Excel spreadsheet. With each farm coded into the appropriate group, either affected or unaffected, the data variables were then tested for differences between the two groups by SAS for Windows 6.11.

Non numerical responses from the survey were either coded into binary variables (e.g. no = 0 and yes = 1) or numerically coded (e.g. Fertiliser types applied: 1 = nitrogen, 2 = super and 3 = DAP). These variables were entered into a separate Microsoft Excel spreadsheet. The data was checked for data entry errors, before SAS was used to derive cross tabulations to describe differences between the affected and unaffected groups. The open-ended questions, in relation to special management to prevent pasture damage, and changes made to management were not coded, with the responses discussed in chapter 5.

Chapter 4: Results.

4.0 Introduction.

This chapter presents the results from (i) the farm production data that was collected from Tui Milk Products to identify the cost of a wet winter in terms of kgMS produced.

(ii) the results from the farm survey to identify winter management strategies used in 1995.

The results of the farm production data and farm survey are presented in graphs and tables with the associated analyses. A description of the average farm used in the present study is presented, along with weather and pasture data for the years studied.

4.1 Farm Description.

Table 12. Statistics for the Average Farm (and Ranges) in the Present Study and values for the Wellington Region and for New Zealand.

	Present Study. 93-95 Average	Wellington Region*	New Zealand*
Total Area (ha)	64 (17-169)		
Effective Area (ha)	58 (16-169)	87	80
Number of Cows (cows)	147 (45-330)	210	193
Stocking Rate (cows/ha)	2.5 (1.51-3.72)	2.5	2.5
Milksolid Production - per hectare (kgMS/ha)	748	661	671
- per cow (kgMS/cow)	290	264	271

(*Source: LIC 1994/95 Dairy Statistics).

Table 13. Ranges In Total Milksolid Production For The Farms In The Present Study.

	1993	1994	1995	Average
kgMS/ha	266-1042	297-1106	356-1110	748
kgMS/cow	118-389	139-406	146-412	290

Table 12 presents the average farm physical variables for farms in the Wellington region, New Zealand, and for farms selected in the study. From this table, it can be seen that the average farm selected in the study is smaller in effective area with fewer cows than the average dairy farm in the Wellington region, or New Zealand. The stocking rate of 2.5 cows/ha for farms in the study is the same as the regional and New Zealand average. Milksolid production for the study farms is greater both per hectare and per cow than the regional or national averages. There is a wide variation between the farms in the present study, as shown in Tables 12 and 13, with farms both above and below the average milksolid production levels given in Table 12, for the dry year of 1993 and the wet years of 1994 and 1995.

4.2 Weather Data.

(All weather data were collected at Ag Research, Grasslands, Palmerston North. It has been supplied by Dr. R. Heerdegen, Department of Geography, Massey University.)

The monthly values for rainfall in the three years are presented in Figure 3 and seasonal totals in Table 14, which show the difference in the rainfall patterns between the selected years 1993 - 1995. Figure 3 shows the monthly rainfall differences between the years, with the winter of the 1993 dry year usually having a lower total monthly rainfall than the 1994 or 1995 wet years except in June when rainfall was slightly higher than in the two wet years. The 1995 wet year had a greater total rainfall in the winter months than 1994, but the only month that there was a major difference between the two wet years was in July (Figure 3). Table 14 shows the winter of 1994 was not above the average rainfall, however it had a greater proportion of rainy days than average. The total rainfall in spring of 1994 was above average, with both 1993 and 1995 having average rainfalls (Table 14).The months of September and November were particularly wet for the 1994 wet year, and September and October for the 1995 wet year (Figure 3).

Figure 3. Monthly Rainfall Totals for years 1993 - 1995.

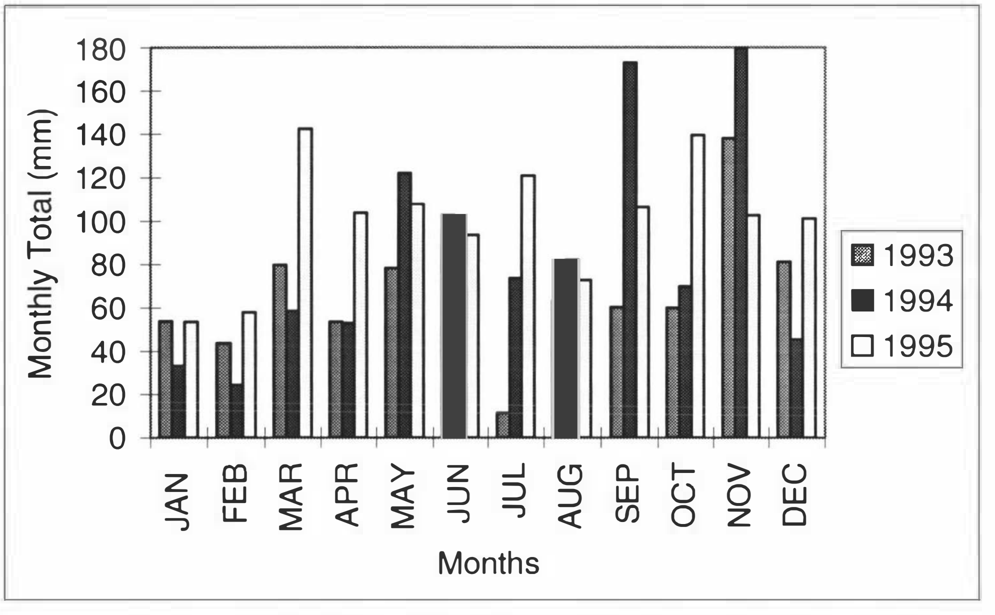


Table 14. Total Rainfall for the Winter and Spring with Percentage Rainy Days.

Year.	Winter Period (May - August).	% Rainy Days (< 1mm/day).	Spring Period (Sept - Dec).	% Rainy Days (< 1mm/day).	Total Rainfall.
1993 (Dry)	256 mm	28	340 mm	30	596 mm
1994 (Wet)	370 mm	48	468 mm	37	838 mm
1995 (Wet)	395 mm	47	348 mm	34	743 mm
30 Year Average	*364 mm*	*39*	*345 mm*	*36*	*709 mm*

Figure 4. Mean Daily Temperatures for the years 1993 - 1995.

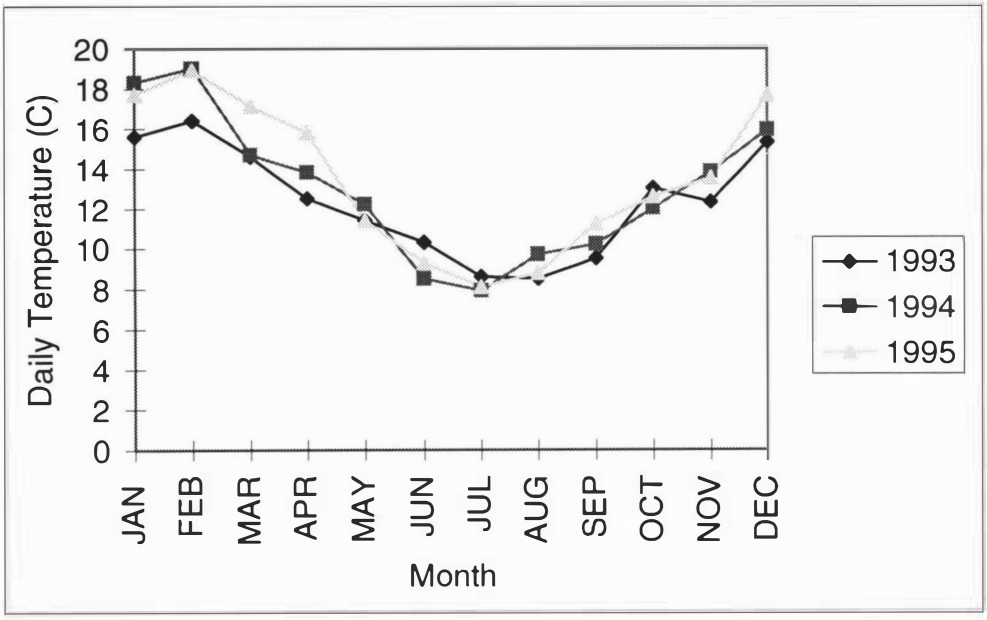
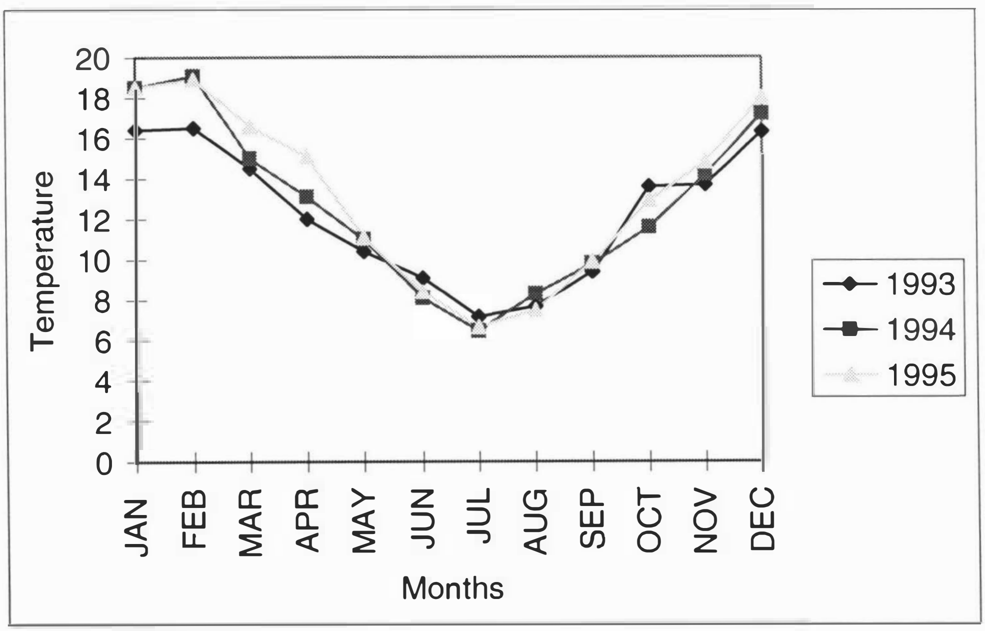


Figure 5. Mean Monthly Soil Temperatures (10 cm depth) for the years 1993 - 1995.

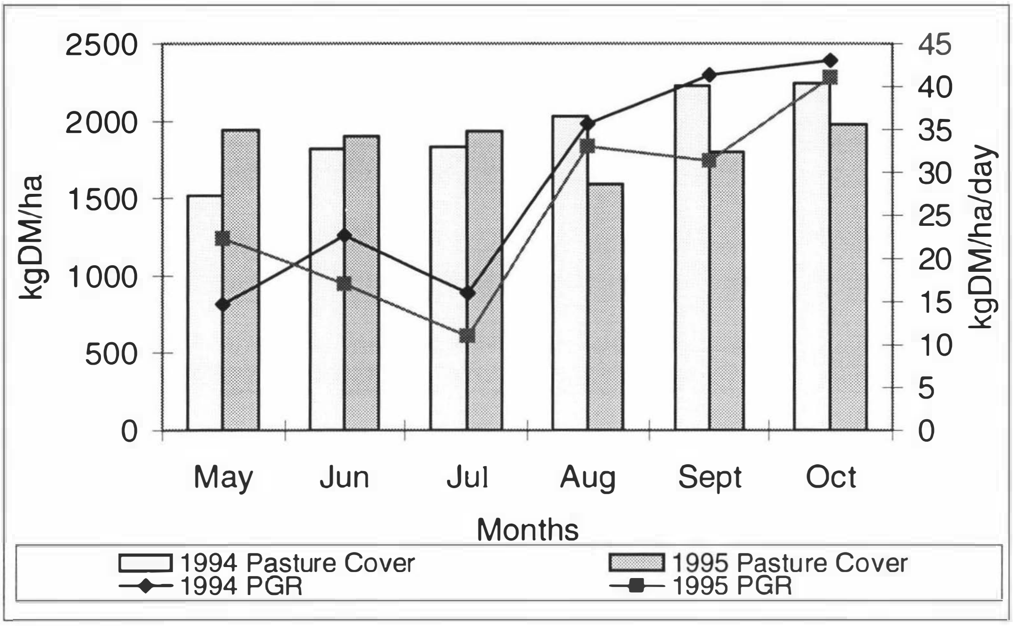


Figures 4 and 5 show the average daily air and soil temperatures for the years 1993 - 1995. Both of the figures follow a similar pattern with the temperatures at their lowest in the winter and then increasing again in the spring months. The difference between the years is that both of the wet years had lower temperatures in the winter months of June and July, and again in the month of October. The dry 1993 year had both a lower daily air and soil temperature in August, and in the latter spring months of November and December.

4.3 Pasture Cover and Pasture Growth.

Figure 6 shows the average farm pasture covers and pasture growth rates for monitor farms on the three soil groups measured by Tui Milk Products, over the winter months and early spring for the 1994 and 1995 years. (Data were not available for 1993). The graph shows that in 1994 there was a lower pasture cover during the winter period, but a higher pasture growth rate for most of the winter and early spring, The average farm pasture cover in 1994 was higher than 1995 during August through to October. The pasture growth rates for this early spring period were also greater in 1994 than 1995, with the September 1995 pasture growth rate being much lower than 1994.

Figure 6. Average Pasture Covers and Growth Rates for Tui Monitor Farms in 1994 and 1995.



(Source: Tui News. A monthly publication from Tui Milk Products)

4.4 Farm Production Results.

This section presents the results of the production data that were obtained from Tui Milk Products for 70 farms.

Tables 15 and 16 show the production difference between the dry winter of 1993 and the wet winters of 1994 and 1995 for milksolids per hectare and per cow. There was a highly significant decrease in milksolid production up to the end of December for both of the years with wet winters, in both per hectare and per cow production. These differences were reduced by the end of each years lactation, with the 1994 year having an increase in the total milksolid production, with a significant increase in milksolid production per cow. The differences for the 1995 year were not significant for total milksolid production per hectare or per cow.

Table 15. Mean Values with Standard Deviations for Milksolid Production Per Hectare (kgMS/ha) to December and for the Total Season, with differences between 1993 & 1994, and 1993 & 1995.

	To 31st December	Difference to 1993	Season Total	Difference to 1993
1993	483 (118)		748 (178)	
1994	457 (116)	-26 *** (41)	762 (187)	+14 (65)
1995	417 (109)	-66 *** (63)	735 (185)	-13 (90)

P<5% ** P<1%***

P>5% NS

Table 16. Mean Values with Standard Deviations for Milksolid Production Per Cow (kgMS/cow)to December and for the Total Season, with differences between 1993 & 1994, and 1993 & 1995.

	To 31st December	Difference to 1993	Season Total	Difference to 1993
1993	186 (33)		288 (48)	
1994	177 (30)	-9 *** (18)	295 (48)	+7 ** (26)
1995	162 (30)	-24 *** (22)	286 (52)	-2 (31)

P<5% ** P<1%***

P>5% NS

Figure 7 summarises the total milksolid production to the end of December and for each years total production. The graph shows the trend of a decrease in the milksolid production to December, but no large differences in the total seasons production between the years.

Figure 7. Milksolid Production (kgMS/farm) to the end of December and the Total Season Production for the years 1993 - 1995.

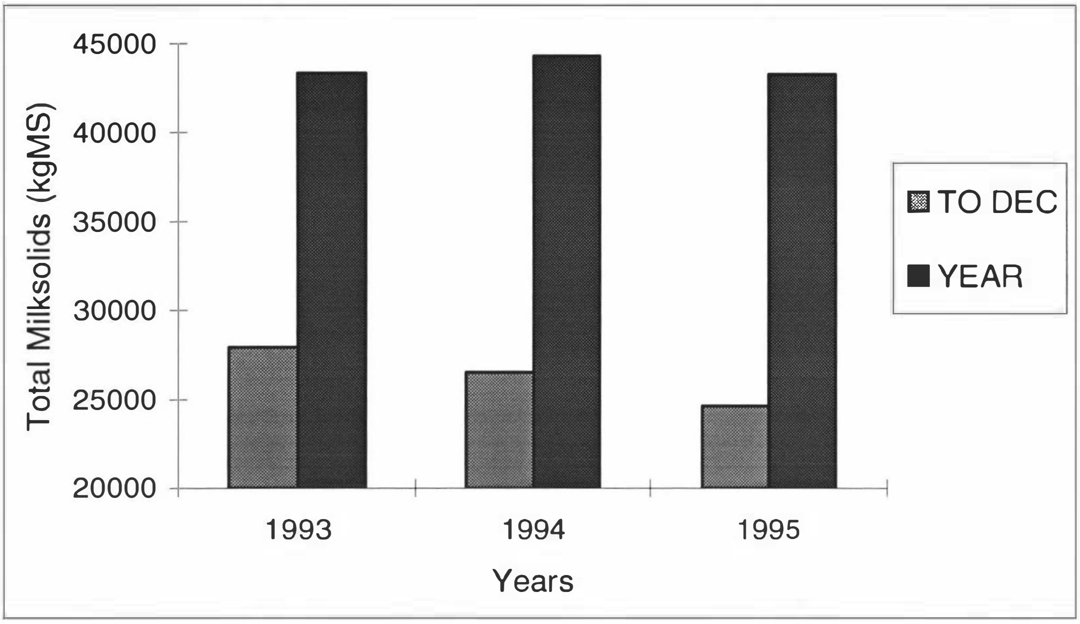


Figure 8. Monthly Average Milksolid Production per farm for the years 1993 - 1995.

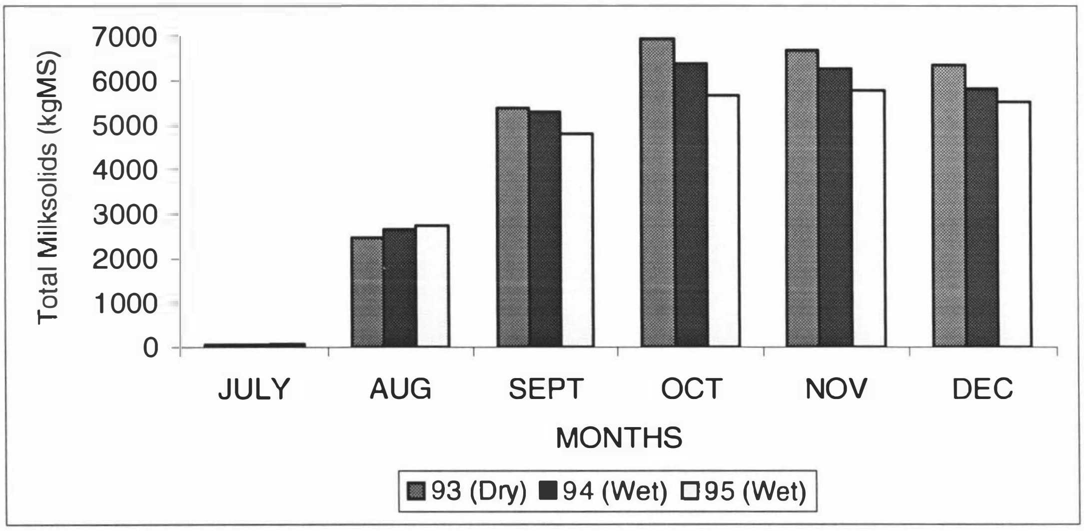


Table 17. Differences (and Standard Deviations) in Monthly Milksolid Production (kgMS/farm) between the 1993 dry year and the two wet years of 1994 and 1995.

	July	August	September	October	November	December
1994	0 (115)	+190** (731)	-77 (584)	-566*** (702)	-409*** (497)	-528*** (596)
1995	-11 (102)	+279*** (803)	-586*** (904)	-1269*** (976)	-896*** (700)	-836*** (702)

P<5%** P<1%***

P>5% NS

Figure 8 shows the total monthly production per farm for the three years. The two wet years 1994 and 1995 were initially ahead in milksolid production compared to 1993, but in September this had changed, particularly for the 1995 year, with the total production for both the wet years falling behind 1993 from September to December. Table 17 shows the average monthly differences in total milksolid production per farm of the two wet winter years against the control dry year of 1993. Only in July for both wet years and September in 1994, was the difference not significant. In August for both wet winter years, there was an increase in milksolid production. After this month, for both wet years, there was a decrease in the total production, with the differences being highly significant from October to December for 1994, and September to December for 1995 (P<1%).

Figure 9. Monthly Average Milksolid Production Per Hectare for the years 1993 - 1995.

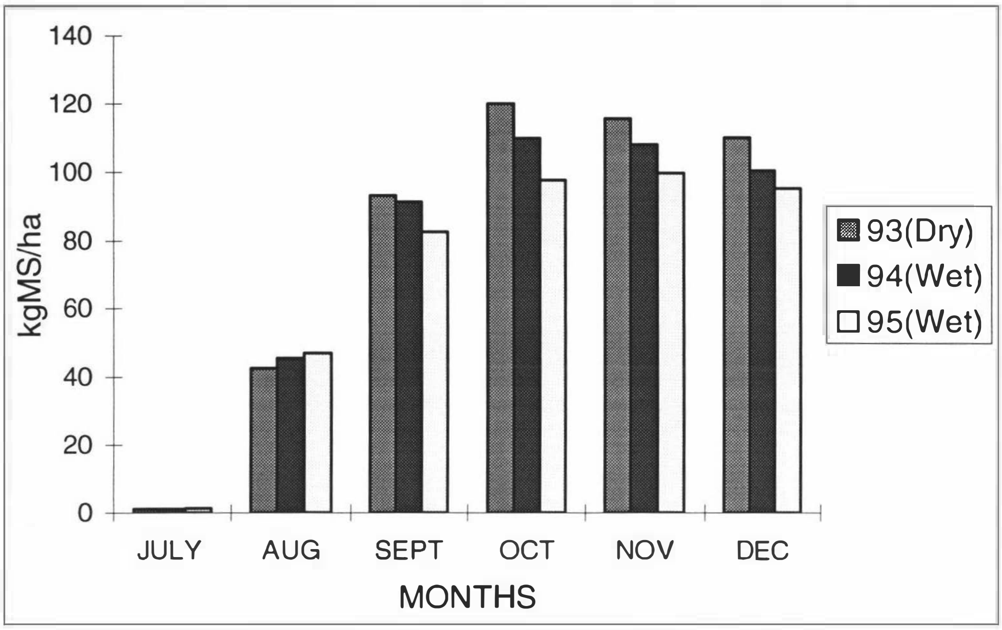
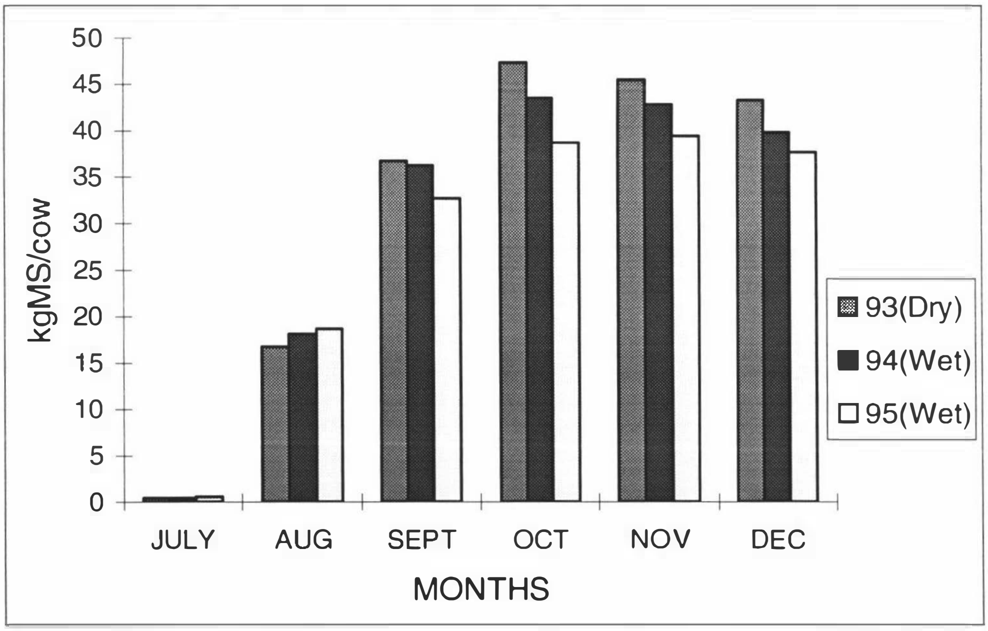


Figure 10. Monthly Average Milksolid Production Per Cow for the years 1993 - 1995.

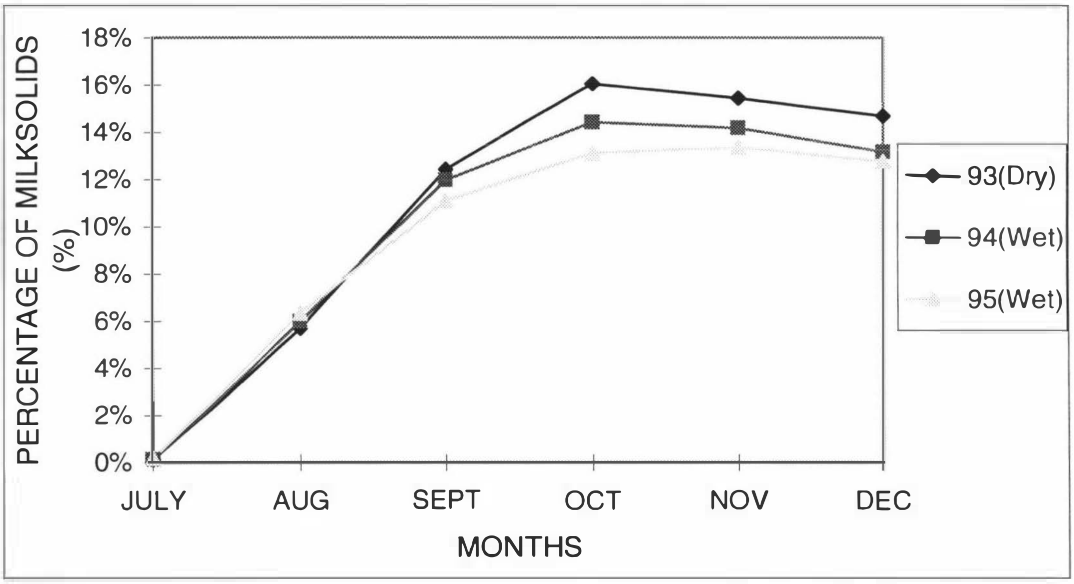


Figures 9 and 10 showing milksolid production per hectare and per cow, are similar to figure 8, with the milksolid production for both wet years 1994 and 1995, initially higher than the 1993 dry year, in July and August. From the months of September to December there is a fall in production compared to 1993. The difference was greatest in 1995, with the difference being clearly seen from September.

Figure 11 shows the changes in the monthly proportion of milksolid produced for the years 1993 - 1995. This has been calculated as:(milksolids produced per month) x 100.
(milksolids produced in total season)

Figure 11 shows that in both wet years the monthly percentage were similar to the dry winter year of 1993 for July and August. From September through to December the monthly percentage of total milksolid production falls below the dry 1993 year, particularly for the month of October for both 1994 and 1995. The general shape of the curve for each year is similar, except the production curve in the wet years does not peak as high as the 1993 curve, and the 1995 curve flattens out in the latter months.

Figure 11. Monthly milksolid production up to December, expressed as a percentage of the total lactations production for the years 1993-1995.



The differences in the percentage of early season production, calculated as:(milksolids produced up to December) x 100; between the years is shown in Table 18,
(milksolids produced in total season)
with the differences between the wet and dry winters being highly significant (P<1%). In 1994 the percentage of early season production is 4.5% less, and in 1995 early season production is 7.8% less than 1993.

Table 18. Percentage (and Standard Deviations) of Milksolid Production up to December 31st for the dry year of 1993 and the wet years of 1994 and 1995.

	Production to 31st December	Percentage Of Total Production
1993 (Dry)	27912 kgMS	64.5% (4.1)
1994 (Wet)	26522 kgMS	60.0%*** (4.3)
1995 (Wet)	24617 kgMS	56.7% ***(3.5)

***P<1% (Different to 1993)

4.5 Survey Results.

This section presents the results from the telephone survey conducted with a group of 18 selected farmers on their winter management for 1995. The farmers were divided into two groups, firstly farmers that had a reduction in milksolid production to the end of December in 1995 compared to 1993, who are referred to as the *affected farmers*, and secondly those that had no reduction in milksolid production to the end of December 1995 compared to 1993, who are referred to as the *unaffected farmers*. There were no differences in soil groups between the two groups of farmers, with each of the three soil groups (Manawatu clays, sands, and silts), represented equally in both groups.

4.5.1 Survey Farms Description.

Table 19. Average Physical Statistics of Nine Affected Farms and Nine Unaffected Farms for the years 1993 - 1995.

	Affected	Unaffected
Total Area	47 ha	77 ha
Effective Area	43 ha	64 ha
Number of Cows	109 cows	186 cows
Stocking Rate (cows/ha) - 1993	2.56	2.84
- 1995	2.44	2.99
3 Year Production Average - per hectare	715 kgMS/ha	912 kgMS/ha
- per cow	283 kgMS/cow	313 kgMS/cow

Table 19 presents the average data for the farms in the two groups surveyed. The *unaffected* farmers had a larger area, more cows and a higher stocking rate than the *affected* farmers. The production levels are also different with the average production for the *unaffected* farmers averaging 912 kgMS/ha, compared to 715 kgMS/ha for the *affected* farmers. Average milksolid production per cow is also different between the groups, with the *unaffected* group producing 313 kgMS/cow and the *affected* group 283 kgMS/cow.

Table 20. Average milk supply period (days) for the two groups and the three years.

	1993/94	1994/95	1995/96
Affected Farmers	264	295	289
Unaffected Farmers	263	294	294

(Note: Figures have been calculated as the number of days for which the farms supplied milk to the dairy factory in each year).

Table 21. Average date for the start of milk collection for the two groups and the three years.

	1993/94	1994/95	1995/96
Affected Farmers	29 July	30 July	1 August
Unaffected Farmers	2 August	2 August	1 August

Tables 20 and 21 show the difference between the *affected* and *unaffected* farmers and differences between years for the length of the milk supply period and the start of milk collection as given in the Tui Dairy Company records. Table 20 shows that the milk supply periods were longer in both of the wet winter years of 1994 and 1995 than 1993. Table 21 shows no major difference in the date for the start of milk collection between farm groups or years, with both groups of farmers beginning milk supply at the start of August.

4.5.2 Farm Production Data.

Table 22. Difference in Milksolid Production (kgMS/ha & /cow) between 1993 (dry) and 1995 (wet) Milksolid Production for Affected and Unaffected farmers.

	Milksolids per hectare (kgMS/ha)		Milksolids per cow (kgMS/cow)	
	Difference to 31st December	Difference for total year	Difference to 31st December	Difference for total year
Affected	-133 ***	-93 ***	-45 ***	-25 ***
Unaffected	-4	+80 ***	-11	+13

P<1%*** P<5%**

P>5% NS

Table 23. Percentage of Milksolid Production up to December 31st for the dry year of 1993 and the wet year of 1995.

	% to December 31st 93	% to December 31st 95	Difference in %
Affected Farms	66%	55%	11 ***
Unaffected Farms	63%	57%	6 ***

P<1%*** P<5%**

P>5% NS

Table 22 shows the difference in the milksolid production up to the end of December and the years total production between the dry and the wet year for the groups of farms. The *affected* farmers had a significant reduction in their milksolid production per hectare and per cow in the 1995 year compared to 1993 both up to the end of December and for the years total (P<1%). The *unaffected* farmers had a slight decrease in their production up to the end of December, and an increase in the years total production for 1993 compared to 1995.

Table 23 shows that for both groups, the production in the first six months of lactation has decreased relative to the years total production. The difference is significant for both groups, but is greater for the *affected* farmers.

Figures 12 and 13 show the daily production per hectare (figure 12) and per cow (figure 13), for *affected* and *unaffected* farmers over the years 1993 - 1995. From figure 12 it can be seen that the small production difference between the two groups evident in 1993 becomes progressively greater in the two wet years 1994 and 1995. The *unaffected* group maintains the production curve, but in 1995 the curve becomes flatter from August to October. Figure 13 shows a similar trend as figure 12, with the difference in production up to December between the groups becoming greater in the wet year of 1995.

Figure 12. Daily Milksolid Production Per Hectare for Affected (A) and Unaffected (U) Farmers for July to December in Years 1993-95.

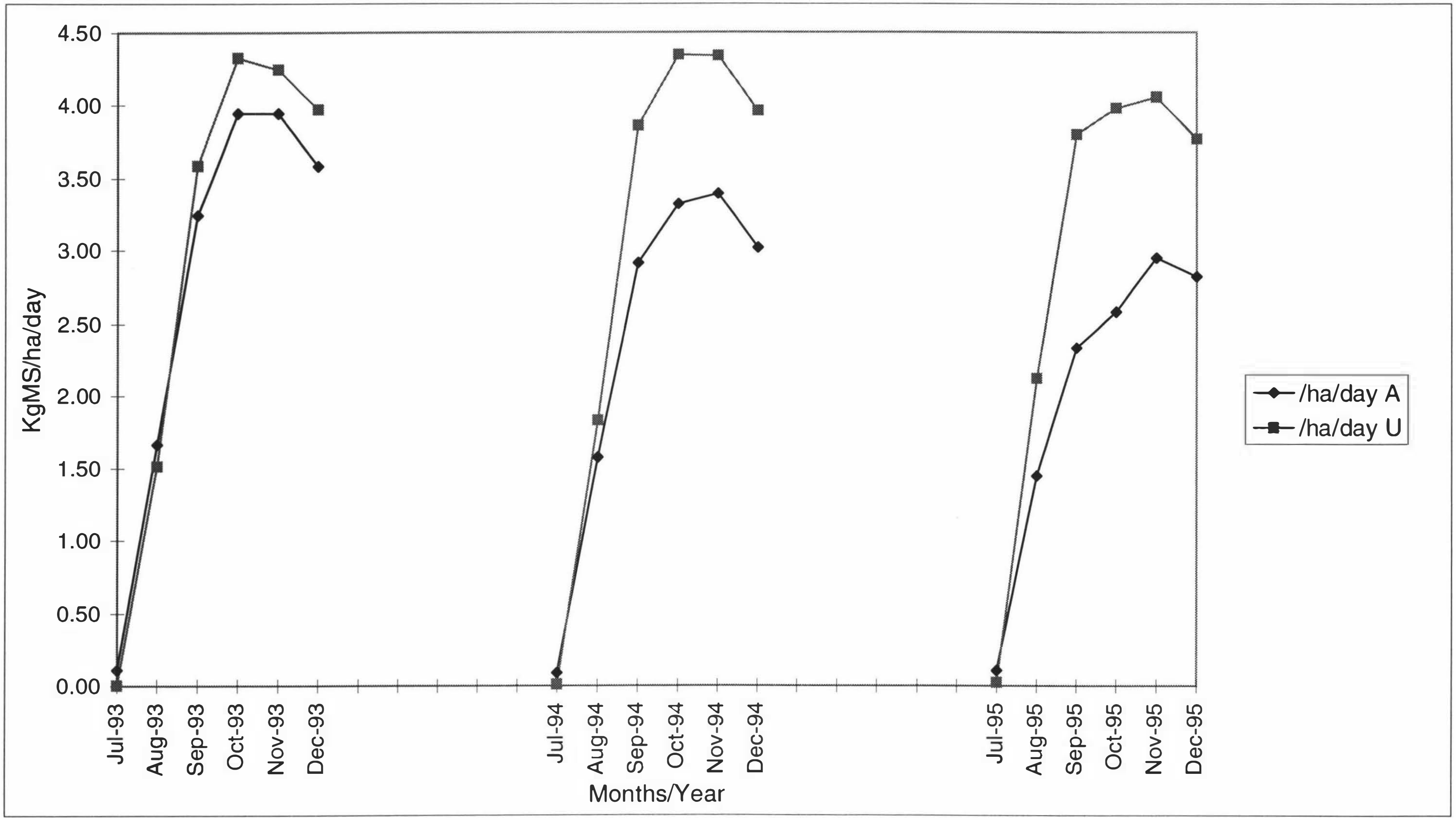
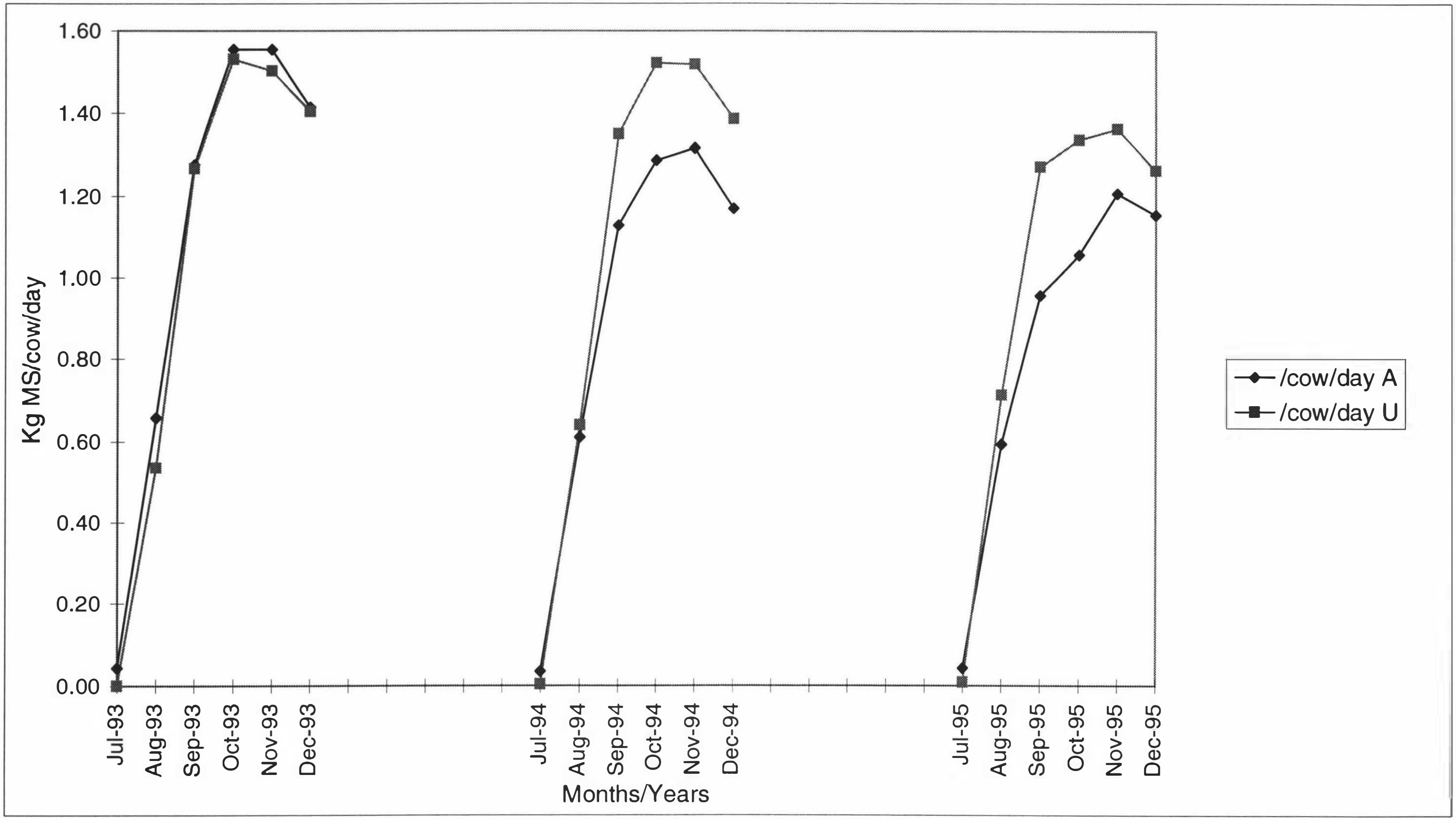


Figure 13. Daily Milksolid Production Per Cow for Affected (A) and Unaffected (U) Farmers for July to December in Years 1993-1995.



4.5.3 Management Survey Results.

Table 24. Reasons for drying off at the end of lactation in 1995 between Affected and Unaffected farmers.

	Affected Farmers	Unaffected Farmers
Cow Condition	67%	56%
Pasture Cover	67%	67%
Milk Yield	67%	33%
Somatic Cell Count	22%	0%
Other Reasons **	0%	33%

P<5%**   P>10% NS

Table 24 shows that farmers in both groups dried off their herds for a number of reasons in 1995. Both groups of farmers dried off because of low or decreasing cow condition and pasture cover, with more *affected* farmers also considering the milk yield and somatic cell count at the time of drying off. The only significant difference between the two groups of farmers was "other reasons"(P<5%), with two *unaffected* farmers drying off because of the time of the year, and one due to the start of a winter grazing contract.

Table 25. Winter fertiliser applications: types and timing of applications between Affected and Unaffected farms.

	Affected Farmers	Unaffected Farmers
Applied Winter Fertiliser	67%	78%
Type Applied: Urea	60%	71%
Superphosphate	40%	14%
DAP	-	14%
Date Applied: Early winter	60%	29%
Late winter	40%	57%
Entire winter	-	14%

P>10% NS

A high proportion of both groups of farmers applied fertiliser during the winter period of 1995, with no significant differences between the groups. Urea was the most common fertiliser applied with superphosphate (on three farms) and DAP(on one farm) also applied. The timing of application differed between groups with more *affected* farmers applying fertiliser during the early winter period (May-June), while more *unaffected* farmers applied fertiliser later (July-August) in the winter. Only one *unaffected* farmer applied fertiliser throughout the whole winter.

Table 26. Winter supplementation: types of supplement and length of feeding between Affected and Unaffected farms.

		Affected Farmers	Unaffected Farmers
Type of Supplement:	Hay	45%	67%
	Silage	11%	-
	Hay & Silage/balage	33%	33%
	Other: Crop, Meal.	11%	-
Length of Supplementation During Winter.		13 weeks	10 weeks

P>10% NS

All the surveyed farmers fed supplements during the winter period. The types of supplements fed included hay, silage, hay and silage/balage, meal, and a winter crop, with no significant differences between the groups. The most common type of supplement used was hay, followed by the combination of hay and silage/balage for both groups of farmers (Table 26). The length of supplementation during winter was longer for the *affected* farmers, who fed supplements for approximately 13 weeks, compared to *unaffected* farmers who fed supplements for an average of 10 weeks.

Table 27. Percentage of farmers who used off farm grazing during the winter period.

	Affected Farmers	Unaffected Farmers
Used Off Farm Grazing	67%	89%
Percentage Of The Herd Grazed Off	59%	86%
Length Of Period Herd Grazed Off	6.5 Weeks	6.2 Weeks

P>10% NS

Table 27 shows that a higher proportion of *unaffected* farmers (88.9%), used off farm grazing during the winter of 1995, than *affected* farmers (66.7%). The proportion of the herd grazed off was higher for the *unaffected* farmers than *affected* farmers. The length of time that the herd was grazed off the farm was similar for both groups, being approximately 6-7 weeks.

Table 28. Percentage of farmers using on-off grazing during the winter period.

	Affected	Unaffected
Used on-off grazing	67%	78%
Used on-off grazing with a feed pad/barn	67%	14%

P>10% NS

Table 28 shows that a majority of the farmers in both groups used on-off grazing during the winter of 1995. A higher proportion of *unaffected* farmers used on-off grazing, but of the farmers that used this grazing method, more *affected* farmers used a feed pad or barn (67% vs. 14%).

Table 29. Percentage of farmers who had specific calving targets

	Affected Farmers	Unaffected Farmers
Pasture Cover Target **	14%	67%
Average Target	2000kgDM/ha	2350kgDM/ha
Cow Condition Target **	43%	89%
Average Target	5.3	5.0

P<5%**

Table 29 shows there were significant differences between the two groups of farmers with respect to the use of target pasture cover and cow condition at calving. Only one farmer in the *affected* group had a specific target for pasture cover at calving, in contrast to 67% (6 farmers) in the *unaffected* group who had specific targets for pasture cover at calving. More farmers in both groups had targets for a cow condition score at calving. Again significantly (P<5%) more *unaffected* farmers had targets than affected farmers (89% compared to 43%), with the actual target values, similar for both groups.

Table 30. Percentage of farmers who fully fed cows and supplements in early lactation.

	Affected Farmers	Unaffected Farmers
Cows Fully Fed In Early Lactation	44%	33%
Supplements Fed	89%	67%

P>10% NS

Table 30 shows the early spring management in relation to the level of feeding and the feeding of supplements in the lactation of 1995. A majority of farmers restricted the intakes of their cows in early lactation (61%), with more *affected* farmers fully feeding their cows than *unaffected* farmers. More *affected* farmers were feeding supplements in early lactation than *unaffected* farmers (89% vs. 67%).

Table 31. Percentage of different types of farm drainage between Affected and Unaffected farms.

	Affected Farms	Unaffected Farms
Tile Drains	33%	67%
Mole Drains	44%	56%
Open Drains	78%	89%

P>10% NS

Table 31 shows the types of drainage between the two groups of farmers. The table shows that open drains were present on most farms surveyed, with a higher percentage of *unaffected* farmers having tile, mole and open drains on their farms than *affected* farmers.

Chapter 5: Discussion.

5.1 Production Data Discussion.

5.1.1 Farm Description.

The average farm selected in the present study is smaller in size than the average farm in New Zealand, but the milksolid production levels, both per hectare and per cow are above average figures (Table 12). These figures vary considerably between the years, particularly the values at the lower end of the ranges for milksolid production yields both per cow and per hectare of farms in the present study (Table 13). This is perhaps an indication of the ability of different farmers, with top farmers able to farm to the conditions in each year, rather than letting the conditions dictate the milksolid production, as also discussed by Elliot (1994).

Appendix 2 presents the correlations between the soil groups, stocking rate, and the milksolid production. It shows that stocking rate significantly influenced both total production per hectare up to the end of December, and the between year differences per hectare for the total season. Although soil groups did influence the difference in early lactation milksolid production between the dry 1993 year and the wet 1995 year, milksolid production differences up to December between years are more likely to be related to the management of the weather conditions, rather than soil or stocking rate differences.

5.1.2 The Effect of Wet Winters.

The data that were collected from the 70 farms show that there were losses in milksolid production per hectare and per cow to the end of December, for the wet winters of 1994 and 1995 compared to 1993. The difference was 26 kgMS/ha in 1994 and 66 kgMS/ha in 1995, with both of the years being significantly different from 1993 (P<1%) (Table 17). Similar significant differences were also recorded for per cow production (P<1%), with differences of 9 kgMS/cow in 1994 and 24 kgMS/cow in 1995 (Table 16). The effects of the wet winters on per cow and per hectare milksolid production to the end of December are shown in figures 9 & 10. The differences in both per hectare and per cow equate to a loss of 5% in 1994 and 14% in 1995, in milksolid yields to the end of December. The result of the present study is similar, but the difference bigger, to the 7% (18 kgMS/ha) loss in milksolid production (to the end of October), on the farmlet without a wintering pad relative to the farmlet with a winter pad reported by McQueen (1970). The reduction in milksolid production was a result of pugging damage, and reduced feed availability during early lactation, which would be similar reasons for the reduced milksolid production in the present study.

Milksolid production for the months of July and August were higher for both the 1994 and 1995 wet years than in 1993 (Table 17). The two months of July and August probably show no effects of the winter period due to farms only having a small proportion of their herd calved, with daily intakes of cows not yet at a maximum. It was not until September, that there was a reduction in the monthly milksolid production, particularly for 1995 (Table 17). This was also the period that for both wet years the rainfall increased, figure 3, which on top of already wet soils would have made management difficult.

The effect of reduced and lost pasture cover would originate from the calving pasture covers, which recorded on monitor farms, were 1930 kgDM/ha in 1994, and 1761 kgDM/ha in 1995, assuming calving began on the 1st August (figure 6). The difference of 169 kgDM/ha at the start of calving explains some of the difference in milksolid production between the two wet years of 1994 and 1995, with the pasture cover present during this period being closely related to milksolid production (Bryant *et al*, 1983).

The value of the milksolid losses in kgDM/ha is approximately equal to 0.2 t DM/ha "lost" 1994 and 0.5 t DM/ha "lost" 1995. (@ pasture = 11 MJME/kgDM; pasture utilisation 85%; efficiency of ME utilisation 0.65; 1kgMS = 46 MJME, (Holmes *et al*, 1987)). (Appendix 3 for calculations).

Pugging damage could explain the 'lost' pasture for the wet years. Over a three month period (92 days), the pugging damage would have had to reduce the average pasture growth rates by 2.2 kgDM/ha/day in 1994, and 5.4 kgDM/ha/day in 1995, to equal the amount of 'lost' pasture for each year (0.2tDM/ha 1994; 0.5tDM/ha 1995). Table 9, from Horne *et al,* (1990), has an average loss of pasture growth of 4 kgDM/ha/day, over forty days, for one third of the farm damaged by pugging. This average daily loss in pasture growth is between the calculated losses in this study, and could easily account for the 1994 pasture growth losses of 2.2 kgDM/ha/day. Table 9 shows that as the pasture growth rate in the spring increased, the relative reduction in pasture growth rate became greater, increasing the total losses from pugging pasture. Therefore if the pasture growth rate continued to show the effects of pugging for more than forty days, as in Table 9, then the average loss would increase towards 5.4 kgDM/ha/day required for 1995. Other reasons for a larger difference in 1995, may be because a greater area of the farm was pugged compared to 1994 or Table 9, or the effect of the pugging on pasture growth rates was higher than 30% (Horne *et al*, 1990; Thomson *et al*, 1993), but closer to a 50% reduction as recorded by Mackay *et al,* (1996). This is possible with a 24% decrease in pasture growth in September in 1995, compared to 1994 (figure 6).

The average milksolid production for New Zealand to the end of December was 11% higher in 1993 than the previous year 1992, which had experienced a wet spring (Elliot, 1994). The difference was probably due to a better cow condition score at calving (+0.5), a higher pasture cover in July (+300 kgDM/ha), and a reduction in early spring pugging damage (Elliot, 1994). These are also the probable reasons for higher milksolid production in early lactation in 1993 than in 1994 and 1995 in the present study. They also explain why 1994 was better than 1995, with 1995 having a lower pasture cover in early lactation, which would have affected cow intakes and subsequent milksolid production. The reasons for the differences between the years are the similar to those given by Elliot (1994). Firstly the weather conditions were a factor, with the wet conditions in 1994 and 1995 probably reducing pasture growth rates and utilisation making it difficult for farmers to build up pasture cover and cow condition. Secondly, the wet conditions in the winter and spring increased the incidence of pugging damage which also reduce pasture growth rates and utilisation.

The effect of the winter on milksolid production in the total season on average was minimal, with no significant differences between 1994 or 1995 and 1993, except for an increase in per cow production of 7 kgMS/cow in 1994 (P<5%) (Table 16). The final production differences between 1993 and the years were +14 kgMS/ha in 1994 and -13 kgMS/ha in 1995 (Table 15 & Figure 7). The variation in total milksolid production between the three years was ±2%. This was because milksolid production which was lost in early lactation was subsequently regained by higher production in the latter part of the season (Table 18). The reason for this is the longer lactation lengths of the two wet years compared to 1993 (Table 20), due to a wetter summer and autumn period (Figure 3) with summer milk production closely related to the summer rainfall (Holmes, 1991). This has allowed the effects of the wet winters to be diluted, with the increase in 'off peak' milksolid production compensating for early lactation production losses. McQueen (1970) also found that the early production losses were regained in the latter part of the season, so that the difference between the farmlets with a pad and without a pad total seasons production was only 3%. McQueen (1970) said that this result indicates that there were compensatory effects in the wet seasons milksolid production, or that the winter damage is transitory. The present study also shows similar significant early season reductions in 1994 and 1995 and no significant differences for the total seasons production.

The reduced milksolid production to the end of December for the wet 1994 and 1995 years, is the result of an accumulated effect of both a wet winter and a wet spring. Figure 3 shows that during the spring period, Septembers rainfall was well above 1993 rainfall for both wet years and this continued in October for 1995 and in November for

1994. The wet conditions would have compounded any problems that have resulted from the previous winter period, but the higher rainfall would also have helped the summer production.

The effect of averaging all the farm data collected for three years studied has tended to underestimate the importance of early lactation and the benefits of maximising early season production every year, no matter what the winter or spring conditions are like. Therefore individual farm data was required for analysis to determine the effects a wet winter can have on both early season milksolid production and total milksolid production.

5.2 Management Survey Discussion.

5.2.1 Farm Description.

Section 4.5.1 describes differences between the two groups of farms selected for the survey. Table 19 shows that *unaffected* farmers generally had larger farms and higher stocking rates than the *affected* farmers surveyed. Both groups had high levels of production, well above the regional and New Zealand averages presented in Table 12. The *unaffected* farmers had a very high production average, above that of the *affected* group, with five out of the nine *unaffected* farmers achieving over 1000 kgMS/ha at least once during the three years studied. The *unaffected* group with the higher stocking rate, and the higher per hectare production average (partly due to the higher stocking rate) is perhaps an indication of differences in a combination of goals and management abilities between the two groups. The start of milk supply (calving date) and milk supply period (lactation length) (Tables 20 & 21) were similar for both groups and therefore did not contribute to the differences in milksolid production.

The difference in milksolid production between the two groups of farmers for the 1995 wet year are presented in Tables 22 and 23, and figures 12 and 13. The *affected* farmers had a significant decrease (P<1%) in milksolid production to the end of December, -133 kgMS/ha and -45 kgMS/cow compared to 1993, while the *unaffected* farmers experienced only a small decrease in production, -4 kgMS/ha and -11 kgMS/cow. The difference between the two groups may have also been affected by changes in stocking rates, with an increase in stocking rate for the *unaffected* farmers reducing milksolid production per cow, but reducing per hectare production losses. The difference in total season milksolid production between 1993 and 1995 was smaller than for the December difference due to a longer lactation in the autumn of 1995 compared to 1993, allowing some of the production lost in the early season to be recovered later in the season. However there was still a significant decrease (P<1%) in total milksolid production for the *affected* farmers. The *unaffected* farmers were able to gain the full benefit of the 1995 autumn period, resulting in a higher total production level than 1993 both per hectare and per cow.

Both groups had a significant decrease in their percentage of early season production in 1995, however the *unaffected* groups change was 6% compared to 11% by the *affected* group (Table 23). This change in proportion of early season production for the *unaffected* farmers is the result of a longer lactation than 1993 (Table 20), and a higher yield of milksolids produced after December, rather than the effect of the wet winter and spring of 1995. Figures 12 and 13 show the early season differences between the two groups over the three years studied. These figures clearly show that the *affected* group was far more affected by the winter conditions than the *unaffected* group, however some of this difference is due to an increase in stocking rate for the *unaffected* group and a decrease in stocking rate for the *affected* farmers.

Another point from Table 22 is that milksolid production after December in 1995 compared to 1993 for each group, was higher for the *unaffected* group than the *affected* group. This poses the question "Is the lower milksolid production in autumn on the *affected* farms a carryover effect of the winter and spring period, particularly due to pugging damage resulting in lower pasture growth rates?"

5.2.2 Survey Results.

Drying Off:

There were no significant differences in the main reasons for drying off in 1995 between the two groups, with both groups drying off due to cow condition and pasture cover, showing that all the farmers were thinking ahead for conditions at calving in terms of liveweight gain and pasture cover required at the start of calving. The significant difference in drying off between the groups was 'other reasons', with some *unaffected* farmers also drying off because of the time of year. However this would not explain early lactation differences between the groups.

Winter Fertiliser:

During the winter period, a majority of farmers applied winter fertiliser to their properties (Table 26). More *unaffected* farmers applied winter fertiliser (67% vs. 78%), but the differences was not significant. More *unaffected* farmers applied fertiliser in the latter part of the winter, presumably in order to increase pasture growth rates and pasture cover at calving. The later applications may also reflect the extent of drainage on farms in the two groups, with *affected* farmers possibly not being able to apply fertiliser at this time, even if they had wanted too, because *affected* farmers had less drainage on their farms (Table 31).

Winter Supplementation:

All the farmers fed supplements during the 1995 winter. There were no major differences between the groups in supplements fed (Table 28). *Affected* farmers fed supplements for a longer period than *unaffected* farmers, perhaps because fewer *affected* farmers grazed their herds off (Table 27), and *affected* farmers had a lower pasture cover at calving (Table 29).

Off Farm Grazing:

Table 27 shows the use of off farm grazing during the winter period, with a majority of the farmers using off farm grazing (which includes the use of run-offs) during the winter of 1995 (72%). A higher number of *unaffected* farmers chose this option compared to *affected* farmers, with the off farm grazing period being 6 to 7 weeks for both groups. The *unaffected* farmers grazed a higher proportion of their herd off the farm, with an average of 86% of their herds grazed off compared to 59% of the herd for the *affected* farmers.

Grazing cows off the farm has both advantages and disadvantages as discussed in chapter 2, section 2.5. Advantages include the ability to achieve a higher pasture cover at the start of calving, and a reduction in the risk of pugging damage during winter. The advantages of off farm grazing were seen by several *affected* farmers, one who decided to incorporate it as part of the 1996 winter management, particularly after pugging damage occurred on the farm during the 1995 winter. Several of the *unaffected* farmers noted that off farm grazing was an essential part of their winter management to achieving their pasture cover targets at calving, and as a reason for their relatively higher production in the early part of lactation in 1995.

The benefits of additional off farm grazing must be less than its cost to be profitable. The increase in the cost of grazing 86% of the herd for 7 weeks compared with 59% of the herd is \$47/ha (@ \$10/cow/week and a stocking rate of 2.5 cows/ha), which may have the benefit of saving 26 - 66 kgMS/ha in early lactation valued between \$86-\$218/ha (@\$3.30/ kgMS). However it is doubtful that off farm grazing alone is the key factor in overcoming a wet winter, with other aspects of management also having effects on milksolid production. Instead, off farm grazing is one component of the farms winter management, which is combined with other management strategies for overall success.

On-off Grazing:

On-off grazing was used by most of the farmers in the 1995 winter (Table 28). On-off grazing has the advantage of maintaining pasture growth rates compared to other grazing treatments and reducing pugging damage (Matthews 1971; Thomson *et al*, 1993). Views on the effectiveness of on-off grazing did vary between farmers, with some finding that pasture damage still occurred, particularly at the times when stock were being moved on and off a paddock. This was one reason why some farmers did not use on-off grazing, either during the winter or in the spring, in addition to the fact that they had no suitable place on which to stand the cows while they were off the paddock. The timing of this management was also important to its success, with several *affected* farmers delaying the use of on-off grazing until pasture damage had already begun. However a majority of farmers in both groups found on-off grazing an effective way of reducing pugging damage.

Places to stand stock off pasture include the dairy yard, sacrifice paddocks and feed pads. A notable point from the survey is that 67% of the *affected* farmers had used feed pads/barns, compared to only 14% (one) of the *unaffected* farmers (Table 28). More *unaffected* farmers used sacrifice paddocks, which were subsequently cropped. The sacrifice paddocks were chosen before the winter period, and allowed to build up high pasture covers, helping to reduce damage and allow the paddock to last longer. This method of management was part of the farms normal management, and if the paddock was not needed as a sacrifice paddock due to favourable winter conditions, then it could easily be grazed in the farms rotation. Some of these farmers using sacrifice paddocks, even though they were aware of advantages that a purpose built feed pad offers in "peace of mind" and security (McQueen, 1970), believed that the economics were questionable and their system was an equally flexible and effective solution to the problem of wet conditions. Nevertheless, one *unaffected* farmer is planning to build a fed pad for future wet periods, due to the advantage of not having a paddock taken out of the rotation, particularly during early lactation when milkers can be fed supplements on the pad more easily.

Unaffected farmers also used on-off grazing with lactating cows in early lactation, particularly in the wet September period, a period when many *affected* farmers lost milksolid production. During the farm visits, some *affected* farmers said that they had successfully progressed through the winter of 1995, with little, if any pasture damage before the start of calving. Pasture levels and cow condition were similar to previous years, and it was not until the wet September of 1995 that pasture disappeared, pasture growth rates were decreased, and pugging damage occurred on the farm, with the total farm being damaged in some cases. The effect of this on the monthly milksolid production can be clearly seen in figures 12 and 13, with a marked fall in the production during September 1995.

Similar conditions were faced by the *unaffected* farmers, but their milksolid production was not affected so severely. One reason for the difference was that four *unaffected* farmers used on-off grazing with their lactating cows, preventing pasture damage and losses. Blackwell (1993), noted that on-off grazing with lactating cows reduced damage to soils and pastures with no detrimental effects on daily per cow production. Underfeeding was also reduced, probably with a reduction in soiled pasture and increased pasture utilisation (Horne *et al*, 1990). Farmers who used on-off grazing with lactating cows noted no detrimental effects to milksolid production in September, and a reduction in the pugging damage that would otherwise have been expected, which would have benefited pasture growth in the following months. This practice could have been used by a majority of the *affected* farmers, particularly those with stand off areas, and would have reduced pasture damage and milksolid losses. If the carry-over effects of pugging on pasture growth rates in the following year are experienced by farmers and are as recorded by Mackay *et al,* (1996), then the benefit of on-off grazing during lactation would be even larger.

Calving Targets:

The use of target levels of pasture cover and cow condition to be achieved at the start of calving has been discussed in chapter 2 section 2.4, which highlighted the importance of pasture cover and cow condition on milksolid production in the early part of lactation (Grainger *et al*, 1979; Grainger *et al*, 1982a). This was a major area of difference between the *affected* and *unaffected* farmers, with 67% of the *unaffected* farmers having a specific target for pasture cover to be achieved at calving, compared with only one *affected* farmer (14%) with such a target (Table 29). Reasons for *unaffected* farmers not having a specific pasture cover target, were because off farm grazing of stock during the winter ensured there would be sufficient pasture cover on the farm at the start of calving and therefore no specific pasture cover target were set. These pasture cover targets were also generally achieved by most of the *unaffected* farmers, with only two having a slightly lower pasture cover at calving than their target. The notable feature is the pasture covers targets for the *unaffected* farmers was an average of 2350 kgDM/ha, well above the minimum pasture cover targets of 1600 - 2000 kgDM/ha at calving suggested by Holmes *et al,* (1993).

Higher pasture covers at July - September were associated with a higher milk fat yield in early lactation (Bryant *et al*, 1983), and increased pasture growth rates during the early spring (Santamaria *et al*, 1982), with an increase of 2 kgDM/ha reported for every additional 100 kgDM/ha (Matthews *et al*, 1995). Therefore, the *unaffected* farmers who did achieve high pasture covers at calving would have had the advantage of additional pasture growth, reducing the time to the balance date, which would also have helped to offset poor pasture growth rates due to poor weather conditions in early spring.

Another benefit of the high pasture cover is that it helps to reduce the risk of a poor start to lactation in two ways. Firstly by aiming for high pasture cover at calving, the risk of it not being achieved and affecting subsequent milksolid production is reduced due to the pasture cover achieved probably still being sufficient. This is what some *unaffected* farmers said was done, because with a high pasture cover targeted, it did not matter too much if it was not achieved as there would still be a satisfactory level of pasture on the farm at calving. Secondly a high pasture cover at calving reduces the risk of a poor spring with the ability to feed cows sufficiently even if conditions are adverse. The higher pasture cover also provides more options in difficult conditions, such as the splitting up of the herd to reduce stock intensity as some *unaffected* farmers were able to do.

High amounts of pasture present in the spring period following off farm grazing can also result in pasture quality deterioration (Clark *et al*, 1994). In order to avoid deterioration in pasture quality during spring, the time of making supplements and the use of topping to control pastures becomes more critical (Clark *et al*, 1994). The farmers who aimed at and achieved the high pasture covers at calving, were aware of the need for pasture control in the spring and used topping or made supplements to maintain the pasture quality with no adverse effects on their spring production that they could note.

A higher number of *affected* farmers had a target cow condition (42.9%), but there was still a significant difference between cow condition target and the groups of farmers. The average condition score required at calving were similar for both groups at about a condition score 5, which is the similar to that suggested by (Holmes *et al*, 1987).

Table 29 shows large differences between the two groups in terms of their use of specific targets for pasture cover and cow condition, however many of the *affected* farmers did have levels of pasture cover and cow condition which they preferred to have at calving time. The difference is that they did not quantify this in terms of kgDM/ha or as a specific condition score target to be achieved at calving. Without quantification and established standards such as kgDM/ha, control of the farm system is more difficult. Therefore the farmers who do not quantify their targets will find it difficult to use concurrent control, and will rely mainly upon feedback control, where they know their situation could be handled better in the future (Boehlje, 1993). The prerequisite of sound decision making is the accurate collection and sensible interpretation of information (Bryant, 1984) and timely implementation.

Early Spring Management:

In early spring of 1995, most cow intakes were initially restricted, with only 44% of *affected* farmers and 33% of *unaffected* farmers fully feeding their cows (Table 30). This may represent normal spring management, with intakes purposely restricted, or it may be the result of the winter and spring conditions creating an early feed deficit due to lower calving pasture covers. The latter is unlikely for the *unaffected* farmers in particular, who all generally achieved their target pasture covers, and with some *affected* farmers commenting that feed levels on the farm were similar to previous years. Table 30 shows that 89% of *affected* farmers fed supplements in early lactation compared to 67% of *unaffected* farmers, which may explain why more of the *affected* farmers stated that they were fully feeding their cows. It may also indicate a greater shortage of available pasture on the farm in this period compared to the *unaffected* farmers. Most *affected* farmers feeding supplements said they either do not usually feed supplements in early lactation or that they fed more than normal, indicating a bigger feed shortage than normal. *Unaffected* farmers said that they also fed more supplements than usual during this time.

Farm Drainage:

Table 31 shows the types of farm drainage on the farms surveyed. Even though there were no significant difference between the groups and the types of drainage, the table does show that the level of drainage on the *unaffected* farms was higher than *affected* farms, which would provide benefits in wet conditions to drain excess water away, reducing the risk of pugging damage. All farmers visited acknowledged that their farm drainage could be improved, either by new drainage development, or by improved maintenance.

Special Winter Management To Prevent Pasture Damage:

Special management used during the winter period to prevent pasture damage, was mainly on-off grazing and/or off farm grazing. Other methods used included "backward grazing", where a paddock is grazed from the back to the front, rather than the conventional method of grazing a paddock from the front to the back (where the front is the end with the gate). This minimised pasture and soil damage because the cows were moved over long pasture which protected the base of the plants and the soil surface from hooves when used with on-off grazing. This method is used with a back fence to prevent further grazing and damage occurring on previously grazed areas. The advantages of back fencing were shown by Thomson *et al,* (1993), in their comparison of paddock and block grazing. The pasture damage and pasture loss caused by the stock walking over it was minimal, and is probably easily justified when compared to the results of pugging damage, with reduced pasture cover and future growth rates (Mackay *et al,* 1996). This method of management was used by several *unaffected* farmers who had a high pasture cover on the farm, and therefore were more at ease with stock treading on pasture due to a higher pasture cover.

Another method used by one *unaffected* farmer, and suggested by another, was the use of two gateways (entrances) into a paddock. One gateway is used as an entrance, and the other gateway is used as the exit point. This has the effect of spreading stock movement over a wider area, and reducing the severity of pasture damage that would occur with a single paddock entrance. This method of pasture damage prevention has the advantage of not interrupting existing management, and it can be used in the spring period with lactating cows. Other methods to reduce pasture damage included the fencing of stock into squares, reducing stock movement, and the splitting of the herd to reduce grazing intensity and probably antagonistic behaviour. Matthews (1971) reported however that on-off grazing was more effective in reducing pasture damage than reduced grazing intensity, and splitting of the herd into several groups during lactation will speed up the first grazing rotation with adverse effects, particularly in a poor spring (Bryant *et al*, 1986).

5.3 Discussion From Farm Visits.

Affected farmers that were visited were able to explain why milksolid production had fallen in the early part of lactation. Two *affected* farmers said they were producing well in the early part of the lactation, with initial pasture cover and cow condition at similar levels to those in previous years. The poor spring weather conditions in 1995 resulted in lower milksolid production, due to lower pasture growth rates and greater pugging damage on the farm in the winter period and/or early spring. As discussed with the farmers, most of the *affected* farms were damaged by pugging, with 50-100% of the area pugged on four *affected* farms. The pugging damage had a major impact on the feeding levels of lactating cows, with a reduction in the pasture cover at the time damage was incurred, reduced pasture growth, and reduced pasture utilisation. This is in contrast to the *unaffected* farms where pugging damage was minimal. This meant that the *unaffected* farmers maintained normal pasture covers and utilisation, and if pasture growth rates were reduced by the climatic conditions, this deficit was filled with supplements to allow cows to be fully fed, particularly when peak intakes occurs. The difference between the two groups in 1995 can be seen in figures 12 and 13, with the reduced milksolid production, both per hectare and per cow for the *affected* farmers, and even though the *unaffected* farmers are *affected* by the conditions to some extent, the production curves still maintain a similar shape to previous years.

Probably an important reason for the increase in the incidence of pugging damage on the *affected* farms was the failure to back fencing in grazing, either in the winter or the spring. Most *unaffected* farmers visited said they back fenced grazing stock, reducing pasture damage, compared to most *affected* farmers visited having not used back fencing during the winter and/or spring. Without a back fence stock are able to tread over previously grazed pasture, damaging pastures and the soil, reducing future growth rates (Thomson *et al*, 1993).

Farmers have noted several "carry over" effects from the 1995 spring to the 1996 spring. Farmers that had farms damaged by pugging either in the winter or spring period of 1995, have notice a reduced pasture growth rates in the following 1996 year. This has been particularly noticeable in the areas where pugging damage was severe, and farmers that had all of their farm damaged, have noticed reduced pasture growth over the entire farm. This longer term effect of reduced pasture growth agrees with the results of Mackay *et al,* (1996), where pugging damage reduced future pasture growth rates, and if pugging had occurred in 1994, may be the cumulative effect of soil damage (Greenwood *et al*, 1992). Due to the pastures being opened up from the pugging, there has also been an increase in weeds present in the pasture, which reduces the quality of the pasture offered to cows. Farmers are also having to cultivate the paddocks pugged in the 1995 winter and spring. These paddocks have an uneven contour, the soil surface is compacted, and this has an effect on drainage capacities and pasture production (Greenwood *et al*, 1992).

Another probable carry over effect from wet 1995 into 1996 was the effect on the herd's calving dates with consequent effects on milksolid production. Farmers from both groups had a poor or good mating in 1995. The reasons given by the farmers who experienced a poor mating in 1995, were the weather conditions, lack of feed, and cows in low body condition.

Additional costs incurred by the two groups of farmers due to the winter and spring conditions were for similar expenses. There was an increased fertiliser applied in the spring, and increased supplements fed during the winter/spring period of 1995. There was also additional expenditure on breeding, particularly for the purchase of CIDR's, to get cows in oestrous. The size of the differences in the additional expenses between the two groups of farmers was not known.

There are a number of reasons for these differences between the two groups of farmers. The first, and possibly the most important difference, is in terms of goals and objectives of farming. This difference between the two groups can initially be seen in

Table 29, which shows that more *unaffected* farmers had calving targets than *affected* farmers. The *affected* farmers that were visited, when asked what their goals were said they were trying to achieve a comfortable management system, and lifestyle. These farmers had more personal goals and objectives, rather than striving to maximise milksolid production, and this is how they managed their farms. The *unaffected* farmers had goals and objectives focused more clearly on making a return on the farm and its inputs, and of high production levels. This is reflected in five farms producing over 1000 kgMS/ha at least once during the three years studied and the higher production both per hectare and per cow compared to the *affected* farmers production levels (Table 19). The *affected* farmers visited were generally older than the *unaffected* farmers visited, and this difference relates to a change in goals and objectives as a business develops and life cycle changes, with emphasis changing from profit and production to more personal goals (Poole, 1989).

All *unaffected* farms visited said that their aim was to maximise total milksolid production up to the end of December. During early lactation they ensure that high production is maintained, with constant farm monitoring and with changes to management when required. Ensuring high production in early lactation, these farmers are utilising the cows efficiency of converting pasture into milk (Table 3), and setting the prerequisite for high total production (Bryant *et al*, 1986). Additional milksolid production in the autumn period above the normal was described as "a bonus", and with a majority of the seasons production achieved before January the risk of a poor autumn is reduced. It also provides the opportunity to take advantage of good autumn conditions, and to increase the total seasons production, as can be seen in Table 22, with the *unaffected* farmers significantly increasing the totals season production after maintaining production to the end of December.

The *unaffected* farmers management practices reduced the risk of milksolid yield variability. Firstly, these farmers are high producing farmers, who are targeting high milksolid production. They achieve high levels of pasture cover and have sufficient supplements available, which provides for short term flexibility in management to adapt to changing circumstances (Martin, 1996). Secondly, these farmers are maximising milksolid production to the end of December, which is a qualifying factor for high production and reduces the risk of a poor autumn greatly affecting the total milksolids produced.

On the farm visits, the farmers were questioned as to whether they thought that their management was flexible. Most farmers believed their management was flexible, and that they were able to, and would change their management when required. However, the group of *unaffected* farmers had responsive management. They monitored the farm situation throughout the winter period and early spring period, and when the conditions required a change in management, it happened when required. This was mentioned by two *affected* farmers who noted that they should have implemented on-off grazing before they did, to avoid the pugging damage that occurred. Two *unaffected* farmers said that they were able to change their management very quickly, for example they had enough supplementary feed in reserve so when conditions required more feed input to the cows in spring of 1995, they were able to respond immediately. Another *unaffected* farmer believed that part of the reason for his success in the early part of lactation of 1995 season and during the winter period was due to the correct and critical decisions being made at the right time. The *unaffected* farmers had flexible management, in that they were able to and did change their management when required, through constant monitoring of the farm, and with clear defined goals.

An *unaffected* farmer believed that the differences between the farmers such as himself, unaffected, and farmers affected by the winter and early spring, was not the result of one decision or failure to do something specific, but the result of many decisions and actions which accumulated into one effect. This statement is true with all *unaffected* farmers not having one individual management practice that "saved " them. The results from the management survey show no major differences in the farm management used by both groups of farmers. The success of the *unaffected* farmers is due to an accumulated effort of doing the right things at the right time to suit the conditions, with the survey results showing more *unaffected* farmers applied fertiliser, grazed stock off, used on-off grazing, had more drainage, and had a higher pasture cover at calving.

The difference between the two groups is partly due to the style or method of management, with *unaffected* farmers having targets for milksolid production and doing more farm monitoring to achieve this target, the first and third functions of management respectively (Boehlje, 1989). *Unaffected* farmers used preliminary and concurrent control in their management (Boehlje, 1993), with corrections made to any deviations from their plan of high production milksolid production. The *affected* farmers tended to use feedback control, in that after the event they recognised that they would be able to handle the situation better in the future (Boehlje, 1993). However due to the lack of clear production goals and with more focus on personal goals they were unaware or unwilling to change management to overcome the conditions in the winter and spring of 1995 quickly enough to be effective.

5.4 Evaluation of the Materials and Methods used in the present study; and Future Research.

Methods and Materials Evaluation:

The aims of the present study were to:

(i) Measure the cost of a wet winter on the milksolid production

(ii) Evaluate the management methods and other differences between "*affected*" farms and "*unaffected*" farms after a wet winter.

The final results are of course dependent on the validity of the initial data, the source and analysis. The outcome of the present study must be considered in the context of a number of limiting features about the data. Firstly the measurement of the effect of a wet winter (MS/ha in 1993 - MS/ha in 1994 and 1995) assumes no other changes on the farms between the years studied. This is unlikely to be true, but such changes between the years were minimised by selecting only those farms which had minimal changes in hectares and cows, and the stocking rate (cows/hectare), between the three years.

The selection of suitable farms was a trade off between the number of farms used and the changes in cow numbers and in effective area between years. The final selection criteria of a 20% variation in the stocking rate could have been reduced to 15% or 10% variation, however this would have reduced the number of farm numbers in the study. The variation allowed lead to average effective areas of 58 hectares and 147 cows milked being the same in each of the 1993, 1994 and 1995 years.

The second part of the study involving the selection of specific farms. At this point of the study the stocking rate differences were an issue. The criteria used to select farms could have been changed to avoid differences in stocking rates between years. The initial selection of "*affected*" and "*unaffected*" farms resulted in soil differences between the two groups. To avoid any possible bias in farm management practices due to the soil differences, suitable farms were replaced with less suitable farms so that all soil groups were represented equally. This resulted in a difference in the stocking rates between the two groups and a change in stocking rates for each group throughout the three years studied.

The changes in stocking rates between years could have been reduced by reducing the permissible variation in stocking rate, to minimise the changes throughout the years studied. Alternatively, only those farms within a selected range of stocking rates might have been selected so each group had a similar stocking rate. Another possible change to the method would have been to survey all farms, probably with a mail survey. This has several advantages over the method used. Firstly it would have avoided the problems associated with the stocking rate changes. Secondly, if done in the year of concern i.e. for this study 1995, it would have allowed for an in depth questionnaire and avoided the problem of farmers ceasing supply, and farmers and sharemilkers moving properties. From here follow up visits could have been done to selected farmers, or they could have been used as case studies. If farms had been identified before the start of calving or possibly at drying off, this would have allowed for the quantification of the farm situation and provided for more questioning on management decisions as they happened.

Future Research:

Case study research could be done on selected farms, whether they are *affected* or *unaffected*. This would allow for the changes and the level of inputs to be measured and then compared with the associated benefits and disadvantages accurately. Following this, or using results obtained in this study, the actual costs of implementing similar management as that practised by *unaffected* farmers. The associated milksolid benefits given the risks of variable weather conditions could also be studied using a farm model from which a number of possible outcomes can be generated.

Another area of research that could prove valuable is in grazing management, particularly with on-off grazing both in the winter and early lactation using different options such as sacrifice paddocks versus a feed pad. The effect of pugging damage both in the short and long term on milksolid production and the effect on pastures should also be studied, together with the benefits from effective methods of prevention.

Chapter 6: Conclusion.

- The wet winters caused a significant loss in milksolid production to the end of December for both wet years studied . In 1994 the reduction in milksolids was 26 kgMS/ha and 9 kgMS/cow and in 1995 the reduction was 66 kgMS/ha and 24 kgMS/cow, compared to 1993 production. The effect of reduced milksolid production for 1994 and 1995 was an accumulated effect of a wet winter and a wet spring. The cost of the wet winters on the total seasons milksolid production were not significant, with the 1994 year having an increase in the total yield per cow. The effect of the wet winter/spring was to decrease the early season milksolid production, with a lower peak milk production. However with longer lactation lengths for the two wet years, there was an increase in the off peak milksolid production for the two years, giving the opportunity to regain production lost earlier in the season.

- The reasons for the lost early season production in the 1994 and 1995 was probably due to a lower pasture cover at calving and the effects of pugging damage that occurred in the winter or the spring period. This reduced the pasture growth rates and the amount of feed available for cows, thereby increasing the period of underfeeding and affecting the milksolids produced. The "lost" pasture was 0.2tDM/ha in 1994, and 0.5tDM/ha in 1995.

- There was no one single management strategy used by the unaffected farmers during the winter period that affected farmers did not implement to avoid early lactation milksolids losses. Instead it was a combination of more off farm grazing, on-off grazing, and farm drainage used by the unaffected farmers that reduced the risk of pugging damage in winter or spring. A benefit of the increased off farm grazing is to reduce the risk of pugging damage occurring on the farm during the winter, and it allowed for greater pasture cover on the farm at the start of calving, further reducing the risk of a decrease in milksolid production. On-off grazing also reduced pugging damage, and was used effectively by some farmers during early lactation to reduce pugging damage. In addition, more unaffected farmers used back fences to prevent regrazing of previously grazed areas. The unaffected farmers also had a high level of pasture cover at calving (2350 kgDM/ha), which gave them the associated benefits of higher pasture growth rates and reduced risk of underfeeding stock and pugging damage in early lactation.

-There was a difference between the affected and unaffected farmers in terms of their goals. Unaffected farmers had goals of high early season production and implemented changes to management when required. The targets for winter management were specific calving targets, with a high pasture cover target. Achieving the calving targets reduced the risk of weather conditions reducing milksolid production in early lactation and provided the ability for flexible management. Unaffected farmers monitored their farms towards their production goals, with constant farm monitoring during the winter and spring periods, minimising the effects of the wetness on milksolid production.

- Farmers that were visited also noted some carry over effects from the winter and spring of 1995 into the start of the 1996 lactation. These included reduced pasture growth rates in 1996, and paddock damage with an increase of weeds present, a result from the pugging damage that was incurred in 1995. In addition some herds experienced mating difficulties in 1995, which delayed the mean calving date in 1996.

- The effects of the wet winter or spring can be minimised with management towards clearly defined targets, whether they are pasture cover, cow condition, or milksolid production, and close monitoring of actual conditions. By having targets the system can be monitored and assessed correctly, and thus the risk of deviation from the target due to events such as a wet winter can be reduced.

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Appendix:1

Farm Survey For Winter Management (1995 Winter Period).

1. Herd BI (BW):_____

2. Drying Off- What were your reasons for drying off in 1995-

-Cow condition at the time Y/N

-Pasture cover at the time Y/N

-Milk flow Y/N

-Somatic cell count Y/N

Other____

3. During the 1995 winter period did you use-

-Application(s) of fertiliser Y/N

What type __________

When was it applied __________________

-Supplementary feeding Y/N

What type __________________________

How long was it fed for ________________

-Off farm grazing Y/N

All or part of the herd _________________

How long for ________________________

-On/off grazing Y/N

Did this use a feed or loafing pad Y/N

-Other

____

____

4. Is your farm drained by -tiles Y/N

-moles Y/N

-open drains Y/N

5. Do you believe that you did have a winter wetness problem in 1995? Y/N

6. Did you adopt special management to prevent pasture damage in 1995? Y/N

-What was it?____

____

____

____

-How did you judge when to implement it?

____

____

____

____

-Was it effective in reducing pasture damage and achieving calving targets?

____

____

7. Do you have calving targets you aim to achieve -

- Pasture Cover -Y/N Target - __________

- Cow Condition -Y/N Target- __________

8. Early Spring Management-Were supplements fed in early lactation in 1995?

Y/N

Were cow intakes held back in the early part of lactation, or were they fully fed from the start of calving in

1995?____

____

____

9. Are there any changes that you have made to your winter management for the winter of 1995 compared to the 1994/93

winters?____

____

____

____

____

Appendix 2.

Production Data Correlation Coefficients.

(Soil groups were the same as by the dairy factory, with the three groups Manawatu clays, sands or silts, numerically coded as 1, 2 and 3 respectively).

Correlation coefficients between Soil groups, Stocking Rate and per hectare and per cow milksolid production up to the end of December.

	/ha 93	/ha 94	/ha 95	/cow 93	/cow 94	/cow 95
Soil Group	0.005 NS	0.071 NS	0.161 NS	-0.064 NS	0.003 NS	0.105 NS
Average SR	0.728***	0.807***	0.698***	0.129 NS	0.263 **	0.056 NS

P<1%***   P<5%**

P>5% NS

Correlation coefficients between Soil groups, Stocking Rate and Milk Production differences per hectare & per cow between dry and wet winters (up to the end of December & for the whole season).

	Up to 31st Dec. Differences/ha		Total Season Differences/ha		Up to 31st Dec. Differences/cow		Total Season Differences/cow	
	93/94	93/95	93/94	93/95	93/94	93/95	93/94	93/95
Soil Group	-0.186 NS	-0.271 **	-0186 NS	-0.089 NS	-0.124 NS	-0.239 **	-0.138 NS	-0.036 NS
Average SR	-0.182 NS	0.162 NS	-0.231 **	-0.230 **	-0.201 NS	0.110 NS	-0.099 NS	0.161 NS

P<1%***   P<5%**

P>5% NS

Appendix 3.

Calculations Of Pasture Losses For The Years 1994 & 1995.

1994

Early lactation milksolid loss = 26 kgMS/ha

(@ 1 kgMS = 46 MJ net energy) 26 kgMS/ha = 1196 MJ net energy/ha

(@ utilisation of ME 0.65) MJME intake req. = 1196/0.65

= 1840 MJME/ha

(@ pasture utilisation 85%) MJME/ha lost = 1840/0.85

= 2165 MJME/ha

(@ 1kgDM = 11 MJME) KgDM/ha lost = 2165/11

= 197 kgDM/ha

= 0.2 tDM/ha

1995

Early lactation milksolid loss = 66 kgMS/ha

(@ 1 KgMS = 46 MJ net energy) 66 kgMS/ha = 3036 MJ net energy/ha

(@ utilisation of ME 0.65) MJME intake req. = 3036/0.65

= 4671 MJME/ha

(@ pasture utilisation 85%) MJME/ha lost = 4671/0.85

= 5495 MJME/ha

(@ 1kgDM = 11 MJME) kgDM/ha lost = 5495/11

= 500 kgDM/ha

= 0.5 tDM/ha