A STUDY OF WINTER MILK PRODUCTION AND A COMPARISON OF TOWN MILK AND SEASONAL SUPPLY DAIRY FARMS IN THE MANAWATU

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ABSTRACT

The literature review commences with a brief description of the past and present town milk industry and reviews the consequences of recent legislative changes which have already wrought substantial change to the town milk industry.

This is followed by a review of factors affecting milk production per cow (feed intake, level of supplementation, cow quality, breed, stage of lactation, calving date) and factors affecting milk production per hectare (stocking rate) on pastoral dairy farms. The likely effects of these factors on the productivity of town milk and seasonal supply farms is also discussed.

There were two major objectives to the present study. The first was to measure the productivity of town milk farms over the winter period. The second was to compare the overall annual productivity of town milk farms with that of seasonal supply farms in the same district. To achieve these objectives, a survey of 58 Manawatu dairy farms (both town milk and seasonal supply) was carried out during the 1988 winter.

Average daily milk production per cow on town milk farms during winter was 12.6 litres/cow/day and ranged from 8 to 19 litres/cow/day. Mean pasture cover and mean cow condition score decreased slightly over the winter period. Average daily production per cow of milkfat, protein and total solids fluctuated during winter, but showed a universal downward trend. The percentage of fat, protein and total solids in milk all decreased over the winter period. Average daily milk production per cow in winter was positively correlated with a number of other variables measured including cow condition score and pasture cover in May, annual milkfat production per cow and per hectare, and digestibility of supplement eaten.

Daily production per cow was negatively correlated with milkfat % and somatic cell count. Farmers who practiced an "all autumn" calving policy to provide winter lactating cows had significantly higher winter milk production than those farmers who continued to milk late spring / summer calved cows through the winter.

On an annual basis, town milk farms produced considerably less milkfat per cow and per hectare than seasonal supply farms although stocking rate on the two farm types was similar. As a consequence of a high winter feed demand, town milk farmers made, brought in and fed more hay and silage supplement than seasonal supply farmers. Town milk farmers grew more forage crops, fed more concentrates and made more extensive use of irrigation and nitrogen fertilizer to boost pasture growth at strategic times of the year than seasonal supply farmers. No significant differences in youngstock grazing policy was observed between farm types. Both seasonal supply and town milk farms were assumed to grow similar amounts of feed per hectare, but town milk farms fed more per hectare when brought in supplements were considered. However feed consumption per hectare was estimated to be significantly higher on seasonal supply farms due to their higher milkfat production per hectare. This resulted in seasonal supply farms having a significantly higher annual feed utilisation efficiency (95 %) compared with town milk farms.

Hay and silage quality in terms of DM Digestibility, protein % and DM % was measured on all farms. Mean digestibility of DM was 56.1 % and 64.5 % for hay and silage respectively.

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LIST OF ABBREVIATIONS

Common abbreviations used in this thesis are as follows:

-	=	minus
*	=	multiplied by
/	=	divided by
+	=	plus
^	=	to the power of
AA	=	All Autumn calving winter milkers
cowADM	=	Milk production (litres per cow per day)
DM	=	Dry matter
Ha	=	Hectare
Kg	=	Kilogram
ME	=	Metabolisable Energy
MF	=	Milkfat
MJ	=	Megajoule
OM	=	Organic matter
Prob	=	Probability
SOM CELL	=	Somatic cell
SS	=	Some spring calving winter milkers
STD DEV	=	Standard deviation

CHAPTER ONE
Review of Literature

1.1 Town milk and seasonal supply farms in New Zealand.

Dairy farms in New Zealand can be classified into two groups - seasonal supply and town milk farms. A summary of farm and cow numbers for the two farm types during the 1987/88 season is presented in Table 1.1.

Table 1.1 Number of farms, cows and average herd size on New Zealand town milk and seasonal supply dairy farms.

	Seasonal	Town	Total
No. of farms (% of total)	13772 (93)	1046 (7)	14838
No. of cows (% of total)	2105637 (94)	130653 (6)	2236290
Average herd size	158	143	

Source: NZDB 1988

Seasonal supply farms are characterized by a spring concentrated calving pattern. This pattern is part of a system which involves maximum utilisation of pasture "in situ" with limited use of pasture conservation, cropping or high energy supplements (MacMillan et al 1984). Seasonal supply farms provide milk for bulk processing into products such as butter, cheese, casein and milk powders for export.

Town milk farms are responsible for producing a year round supply of fresh liquid milk for the production of bottled/cartoned milk, cream and cultured food products. Historically and still predominately today, town milk farms have operated under a "quota" system of production which requires production of a set minimum volume of milk for 365 days of the year. In order to achieve this, the cows are mated so as to calve not only in springtime, but also at other times, in particular late summer or autumn (Holmes and Wilson 1984).

An autumn calving pattern such as occurs on town milk farms is not associated with maximum "in situ" pasture utilisation. Stewart (1988) estimates wastage of "in situ" pasture for June/July/August milking cows at 25, 40 and 55 % for light , medium and heavy soils respectively. Town milk farms also feed considerably more crop, hay and silage dry matter than seasonal supply farms (Brookes and Holmes 1988). However a higher price is paid for town milk than seasonal milk to compensate farmers for higher production costs incurred in producing milk under difficult conditions where grazed pasture cannot supply the full ration (Bryden 1988).

Historically, the New Zealand town milk industry has been highly regulated with the New Zealand Milk Board as its organisational and regulatory head. However legislation passed through parliament during 1987 resulted in the abolition of the New Zealand Milk Board and deregulation of the town milk industry (NZMB 1987). One major ramification of the deregulation is that town milk producers have lost their exclusive right to supply milk on a year round basis and other dairy farmers can now supply winter milk (NZMB 1987).

This major legislative change has coincided with predictions of increased fresh milk sales in the medium term (Bryden 1988) and a huge increase in the manufacture of short shelf life products for export (Stewart 1988). Both of these trends indicate an increasing demand for winter milk. This has lead to claims such as "Winter milking within seasonal supply dairying will be common within ten years" (NZDE 1987) and "Winter milk production from autumn calving is permanently with us on a scale much larger than in the past with our town milk industry" (Stewart 1988). In the South Auckland area, at least two dairy companies have winter milk schemes for seasonal supply farmers. The chairman of the New Zealand Co-operative Dairy Company (New Zealand's largest dairy company) has stated that his company is making a long term commitment to "out of season" producers of milk for specialist products (NZDE 1987).

In light of these developments, more detailed investigations into the effects of winter milk production on whole farm systems such as attempted in the present study are easily justified and probably well overdue.

1.2 Factors affecting milk production per cow.

1.2.1 Feed intake

It is a well established fact that the level of feed intake per cow is directly related to milk production at all stages of lactation (Mitchell 1985, King et al 1980, Grainger et al 1982, Holmes et al 1985). Factors which affect feed intake therefore indirectly affect milk production per cow. Factors which affect the voluntary feed intake of ruminants can be broadly classified into three groups (Meijs 1981). These are:

ANIMAL FACTORS
PLANT FACTORS
ENVIRONMENTAL FACTORS

1.2.1.1 Animal factors

The upper limit of nutrient intake is set by the rate at which metabolites can be removed from circulation - this will reflect the energy demand of the animal as affected by its potential at the time for lactation, tissue deposition and maintenance requirement (Hodgson 1977). An animal attempts to maintain a constant energy balance by changing food intake in proportion to its altered physiological and environmental circumstances (Baile and Forbes 1974).

The maintenance of a constant energy balance can be mediated by physical means such as:

a) Distension of the reticulorumen (Forbes 1986).
b) Changing digesta outflow rate from the reticulorumen (Campling 1970).

Constant energy balance may also be maintained by chemical means:

a) Rumen volatile fatty acid concentration (Baile and Mayer 1970)
b) Ratio of Insulin/Glucagon in blood circulation (Forbes 1986)

Other less important physiological factors influencing feed intake include lipostatic mechanisms which attempt to balance fat depots (Freer 1981) and central nervous system control via the hypothalmus (Forbes 1986).

1.2.1.2 Plant factors

A useful framework for considering the effects of various pasture and plant factors on feed intake is the following equation given by Allden and Whittaker (1970).

$$I = IB * RB * GT$$

where I = Herbage intake
IB = Intake per bite
RB = Rate of biting
GT = Grazing time

Hodgson (1985) considers this equation to be somewhat mechanistic, but points out that it has provided the basis for most subsequent investigations of the influence of behavioural responses on the relationship between sward characteristics and herbage intake. A number of plant factors have been isolated as being important determinants of intake via their effects on grazing time, rate of biting or intake per bite.

(i) Herbage allowance.
Considerable research in New Zealand has shown the relationship between herbage allowance allowance and feed intake to be positive and curvilinear (Rattray and Jagusch 1978, Trigg and Marsh 1979, Bryant 1980, Glassey et al 1980, Holmes 1987). Several Australian experiments (Grainger et al 1982, Stockdale 1985) have however indicated a much more linear relationship. Stockdale (1985) suggested that a cow will consume a maximum of 0.27 kgDM per additional kg of herbage DM offered to her.

In more general terms, Holmes and Wilson (1984) state that grazing stock must be offered quantities of pasture which are about 2 - 4 times greater than the quantity that they are able to eat to ensure that they eat to their maximum capacity.

(ii) Sward height.
At a certain lower level of pasture height, intake will be reduced even at a high allowance because intake per bite will be reduced. Le Du et al (1981) reported that reducing pasture height from 9 to 7 cm had little effect on intake, but a further reduction from 7 to 5 cm resulted in significant depressions in feed intake and milk production.

(iii) Pasture Mass.

Holmes (1987) states that the DM intake is not affected by variation in pre grazing pasture mass in the range 2 - 4 tonne DM/Ha. Although there is no supporting data, it is possible that at a lower pre grazing pasture mass (e.g 1.5 tonne DM per Ha), feed intake may be reduced particularly if the associated pasture height falls below 7 cm (Le Du et al 1981). Depression of DM intake has also been observed at very high pre grazing pasture masses of 5000 kgDM/Ha (Combellas and Hodgson 1979). Pasture quality is an important plant factor which has the potential to affect intake and milk production either via its effects on the individual components of the intake equation I = IB * RB * GT or by affecting the process of digestion.

(iv) Pasture Quality.

The botanical composition of herbage and the quantity and digestibility of the leaf, stem, inflorescence and dead components have a major effect on pasture quality and intake (Poppi et al 1987). Smetham (1977) states that the first and foremost significant measure of pasture quality for the ruminant is digestibility. Digestibility has been defined as follows

$$\text{DIGESTIBILITY OF DRY MATTER} = \frac{\text{DM INTAKE PER DAY} - \text{FAECAL OUTPUT PER DAY}}{\text{DM INTAKE PER DAY}}$$

(Poppi 1983)

Hodgson (1977) collated the results of a number of different experiments and showed a linear and constant rate of increase in herbage intake over a range of digestibilities up to OM digestibilities of 83% for grazing animals. The following further components of pasture quality are most likely to affect pasture quality via their effects on herbage digestibility.

a) Dead matter content.

The very high spring herbage growth rates recorded on many dairy farms as plants go through a reproductive growth surge often results in an undesirable accumulation of dead material which lowers pasture quality over the summer lactation period (Goold et al 1985). The dead matter content of pasture is negatively correlated with digestibility (Rattray 1978) and milkfat production (Thomson et al 1984).

b) Botanical composition.

The quality of pasture can be altered by changes in the species comprising the sward (Holmes and Wilson 1984). Generally, legumes are of higher digestibility than grasses resulting in higher DM intake and milk yield per cow (Rogers et al 1982). When grazed on a mixed sward, dairy cows are able to select herbage of a higher average digestibility than that on offer. The extent to which this occurs is dependant on the amount of feed on offer and the botanical composition (Leaver 1985). It has been reported that selected herbage may be 3 - 10 % higher in digestibility than the average of that on offer (Le Du et al 1981, Taylor and Deriaz 1963).

c) Leaf/stem ratios.

At a leafy or vegetative state of growth, the grass species in a pasture contain relatively large amounts of digestible cell contents (Osbourn 1980, Waghorn and Barry 1987). However as a plant matures, the proportion of leaf to stem decreases and this is associated with a decrease in digestibility (Bryant 1981a, Terry and Tilley 1964). Associated with this decrease in digestibility is a decrease in voluntary intake by grazing ruminants (Minson et al 1964).

Having discussed pasture allowance and pasture quality as separate issues, it is important to understand the negative relationship that exists between the two variables over time. The trials of Hoogendoorn (1986) show that high allowances of pasture in spring to achieve high feed intake increases the risk of subsequent deterioration of pasture quality and lower milk yield in summer. Conversely, restriction of cows (low pasture allowance) in spring to maintain sward quality may result in an immediate decrease in per cow performance.

1.2.1.3 Environmental factors

(a) Extremes of temperature are known to affect animal intake. Below the critical temperature an animal has by definition to increase its rate of heat production and therefore intake in order to maintain body temperature (Forbes 1986). Very high temperatures depress intake and prolonged exposure to radiation may affect cattle deleteriously (Weston 1982). However, most experimental work investigating temperature/feed intake/milk production relationships has been undertaken overseas. There is no evidence that extremes of temperature have any influence on feed intake and milk production in the major dairying areas of New Zealand.

(b) Social facilitation of feeding is known to occur in both sheep and cattle (Forbes 1986). Coppock et al (1972) found that lactating cows ate 7% more feed when grouped than when fed separately. However social interactions do not necessarily facilitate feeding if animals are in a confined space (Forbes 1986).

1.2.2 Feeding of supplements.

Supplements are offered to grazing dairy cows to alleviate shortfalls in herbage intake. Supplement usage is a particularly important aspect of winter milk production and town milk farms may require 2 - 3 times as much hay, silage or forage crops than seasonal farms (Brookes and Holmes 1987). The milk yield response to supplementary feeding has been estimated at 0.5, 0.32, and 0.4 kg milk/kg supplement DM consumed by Bryant and Trigg (1982), Leaver et al (1968) and Journet and Demarquilly (1979) respectively. The variation in such responses can be attributed to differences in supplement and pasture quantity and quality (which determine total intake and level of substitution) and the stage of lactation, level of production and condition score of cows (Rogers 1985).

1.2.2.1 Substitution

When offered supplement, animals seldom continue to eat the same quantity of pasture as well as the supplement - they often reduce consumption of the pasture and consume an increasing amount of supplement (Wright et al 1980). The effect of such substitution on total intake and milk yield has been the subject of extensive reseach. Substitution is known to occur where the supplement being fed is a concentrate (Suksombat 1988), hay (Wills and Holmes 1988) or silage (Philips and Leaver 1985b). Regardless of the type of supplement, the substitution rate (kg pasture substituted per kg supplement fed) is decreased with decreasing herbage allowance. Meijs and Hoekstra (1984) feeding concentrate supplements to grazing cows found that the substitution rate decreased from 0.5 kg pasture/kg supplement at a high allowance to 0.11 kg/kg at a low herbage allowance. This observation may indicate that only negligible substitution effects occur under New Zealand conditions because herbage allowances are generally low coinciding with low winter pasture growth rates. However, substitution rate may depend on total level of feeding. Rogers and Robinson (1985) found that pastures and supplements were used more efficiently (low substitution rate) for milk production when the supplement was fed in conjunction with a fast rotation/high allowance grazing management policy.

1.2.2.2 Quality of supplement

The quality of supplements is known to be positively correlated with milk production for concentrates (Meijs 1986), hay (S. Sangsritavong, pers. comm.) and silage (Gordon 1980). In all these cases however, quality was also positively related to intake so how much of the extra milk response was due to quantitative or qualitative effects of the supplements remains unclear.

1.2.2.3 Stage of lactation and level of production.

Milk yield response to supplementation may decline as lactation advances (Broster and Thomas 1981) because more energy is partitioned towards liveweight and less toward milk with advancing lactation. Philips and Leaver (1985b) and King and Stockdale (1981) also reported decreased milk yield per kgDM supplement eaten as lactation advanced.

Higher yielding cows show a greater response to supplements than low yielding (Philips and Leaver 1985a). Coulon et al (1987) reported a marginal response of 0.6, 1.2, and 1.6 kg milk/kg supplement for cows yielding <26, 26 - 29, > 29 kg milk per cow per day respectively.

1.2.2.4 Body condition

Supplementation of dairy cows in early lactation either reduces the rate of liveweight loss or increases the rate of liveweight gain (Bryant and Trigg 1982). The liveweight response to supplementation has been measured by Bryant (1978/79) and by Stockdale et al (1981). The mean response in these two trials was 145 gm liveweight per kg DM supplement eaten. However any positive effect of supplementation on liveweight change is likely to reduce the milk response of supplementation because energy partitioning between milk and liveweight is negatively correlated. This is particularly marked in later lactation when cows direct proportionally more of their consumed energy into body tissue rather than milk production (Rogers 1985).

1.2.3 Cow quality

Research at both Ruakura and Massey has highlighted the importance of cow quality. (Bryant 1982, Grainger 1982, Davey et al 1983, Holmes et al 1985). In New Zealand, the most important measure of a cows quality is her breeding index (BI) which can be calculated using the method described by Wickham and Stichbury (1980). High BI cows are known to differ from low BI cows for a number of important parameters.

1.2.3.1 Milk and milkfat production.

During the 1982/83 season, Ngarmsak (1984) found mean milk yield to be 4385 and 3761 litres per cow and milkfat yield to be 213 and 167 kg milkfat per cow for high and low BI cows respectively. The higher production of high BI cows is in agreement with other studies (Bryant 1982, Grainger 1982).

1.2.3.2 Liveweight and liveweight change.

Massey University experiments (Grainger et al 1985a, b) showed high BI cows did not differ significantly in liveweight or condition at calving, but they gained less liveweight and condition score throughout lactation than low BI cows. Similarly, at Ruakura one trial reported by Bryant and Trigg (1981) showed that high BI cows gained less liveweight (14 kg) than low BI cows (31 kg) during lactation.

1.2.3.3 Feed intake

It is generally reported that intake per unit of metabolic liveweight ($LW^{0.75}$) for lactating cows is higher for high BI cows than low BI cows. This has been shown by both stall feeding and grazing trials (Bryant 1981b, Grainger et al 1985a, b). Also Bryant (1982) showed that at a given herbage allowance, dry high BI cows grazed more severely than dry low BI cows. As a consequence, high BI cows achieve higher intake and liveweight gain during the dry period than low BI cows.

1.2.3.4 Grazing behaviour.

Arave and Kilgour (1982) observed that there were no significant differences in grazing, lying or standing times between high and low BI cows during early or mid lactation. High BI cows did however graze significantly longer during late lactation when pasture was less readily available. This suggests a greater persistence or drive to achieve high feed intakes in high BI cows compared with low BI cows.

1.2.3.5 Feed conversion efficiency.

The higher milkfat production of high BI cows is due to the higher feed intake and higher feed conversion efficiency (kg MF produced/kg DM eaten) of high BI cows (Bryant 1981b, Grainger et al 1985a, b). The higher feed conversion efficiency has been attributed to the fact that high BI cows partition a greater proportion of total ME intake towards milk production and less towards liveweight gain than low BI cows. Also, maintenance requirement expressed as a proportion of total intake is less for high BI cows due to their higher intake.

1.2.4 Breed

An estimate of the relative popularity of the various dairy cattle breeds in New Zealand can be derived from Livestock Improvement Corporation data for artificial insemination (G. Ahlborn-Breier pers. comm.). The most popular breed in New Zealand with 73.8 % of total inseminations in 1987/88 is the Holstein - Friesian followed by the Jersey (25.1 %) and then the Ayrshire (1.1 %). There is unanimous agreement among researchers that Friesian cows produce more milk and milkfat per cow per year, but have a considerably lower fat % in their milk than Jersey cows (Quartermain and Carter 1969, NZDB 1983, Bryant et al 1985, L'Huillier et al 1988). This higher milk production per cow of Friesian cows has resulted in their use on all town milk farms in New Zealand as town milk farmers are paid on a milk volume basis irrespective of milkfat %. There appears to be conflicting evidence as to whether the higher milk and milkfat per cow for Friesians is due to a higher intake or a higher feed conversion efficiency. Bryant et al (1985) estimated total dry matter intake per year at 4203 and 4333 kg and measured milkfat per cow at 192 and 180 kg for Friesians and Jerseys respectively. This resulted in a feed requirement of 22.2 kg DM/kg milkfat (Friesians)and 24.4 kg DM/kg milkfat (Jerseys). Bryant et al (1985) concluded that Friesian cows produce more due to their higher feed conversion efficiency. This conclusion should be treated with caution as the cows in the trial of Bryant et al (1985) were on different farms and there was not much of difference in liveweight between the breeds.

However L'Huillier et al (1988) conducted a comparative trial for Jerseys and Fresians in early - mid lactation and showed that Friesians had higher DM intakes per cow per day than Jersey cows over a wide range of herbage allowances (10, 20, 30, 40 kg DM/cow/day). The feed conversion efficiency of the two breeds showed the reverse trend of the trial of Bryant et al (1985) i.e. Jerseys were superior at 14.9 kg DM/kg MF compared with Friesians at 16.3 kg DM/kg MF. L'Huillier et al (1988) concluded that the higher milkfat production of Friesians was due to their higher DM intake compared with Jerseys.

1.2.5 Stage of lactation

The pattern of milk yield in dairy cows over a lactation has been studied since the earliest stages of dairy research. Sanders (1930) states that the yields of individual cows rise to a maximum in a few weeks and then fall away slowly until secretion stops. It is therefore logical to analyze a cows lactation curve in terms of

a) The height to which the yield rises and
b) The rate at which it falls off from this maximum

(Sanders 1930)

In an experiment with first calving Friesian heifers, Broster et al (1969) reported a mean value of 35 ± 10 days from calving to peak yield. Following peak yield, daily output gradually falls away over about 270 days before milking is stopped to allow for a dry period before the next parturition (Broster 1972). The expected milk production at any particular stage of lactation (i.e. the shape of the lactation curve) is influenced by a number of inherent cow characteristics such as:

a) Breed. (Wood 1980)
b) Age. (Blau 1961) cited by Wood (1969)
c) Fertility. (Gerdemann 1964) cited by Wood (1969)
d) Body size and conformation. (Johansson 1964)

The shape of the curve however can also be influenced by environmental factors under the direct control of farmers namely:

(i) Season and time of calving (Wood 1969)
(ii) The level of feeding during lactation (Broster 1972)

Despite this large number of factors influencing milk production at any given stage of lactation, the universal trends (i.e. a short rise to a peak yield followed by a long decline to termination) remain constant. This has prompted several authors (e.g. Wood 1967) to mathematically describe the lactation curve.

Wood (1967) proposed that

$Y_n = an^b \exp(-cn)$ where
Y_n = average daily milk yield in the nth week and a, b, c are constants

This equation is fairly precise and Wood (1967) used it to calculate average daily milk production for a single Friesian lactation with accuracy of ± 8.6%.

The response to level of feeding at different stages of lactation is an area of study which is particularly relevant to New Zealand town milk farms. The trial of Broster et al (1969) showed a response of 1.92 kg milk/kg of extra feed DM in early lactation (weeks 1 - 9), but only 1.05 kg milk/kg DM in mid lactation and even less in late lactation. Town milk farmers can therefore expect to much more efficiently utilise scarce winter feed by feeding it to freshly calved cows rather than "stale" cows in their ninth or tenth month of lactation.

1.2.6 Calving date.

1.2.6.1 Seasonal supply farms.

The choice of calving date is a decision which through its effects on level of feeding in early lactation and on length of lactation, is of considerable importance in relation to farm productivity (Holmes and MacMillan 1982). In simple terms the quantity of milk produced by a cow during a lactation is determined by two factors (Holmes 1986).

a) The total length of lactation.
b) The average daily milk production during the lactation.

In a seasonal supply system where drying off date is the same for all cows, late calving cows (e.g. September) clearly have shorter lactations than July or August calving cows, but may achieve a higher level of milk production per cow per day than early calving cows (Hutton 1968, Bryant 1982). However this higher daily production may be insufficient to offset the shorter lactation so September/ October calvers produce less total milkfat than July or August calvers (NZDB 1951).

On the other hand, very early calvers (June), although they have long lactations, they may have lower average daily production per cow and total kg milkfat per cow per annum than August calvers (NZDB 1951). This is very likely the result of underfeeding in early lactation (Holmes 1986). In deciding a calving date, the principle is to achieve the best match of feed demand and supply (Simmonds 1985). While feed supply is dependant on district pasture growth rates, feed demand will depend on two things (Simmonds 1985);

a) Cow feed requirements when cows are dry or lactating. According to Holmes and Wilson (1984), the daily feed requirements of a cow increase by 50 to 100% as soon as it calves.

b) The pattern of calving which is variable between herds due to differences in rates of submission and conception (MacMillan and Curnow, 1976).

Calving dates which result in an accurate match of feed supply and feed demand will ensure that cows are not lactating during periods of low pasture growth (resulting in underfeeding) while maximising lactation length to allow the cow to achieve a satisfactory total lactation yield (Holmes 1986). In this way, the direct use of grazed pastures by lactating cows will be maximised and the need to conserve and waste pasture will be minimised.

1.2.6.2 Town supply calving dates.

Town milk farmers need to calve cows at different times of the year in order to meet a daily quota of "town supply" milk. The numbers of cows which must be calved at different times of the year will depend mainly on the size of the farms quota (litres per hectare per day) and also on any special feed supply problems which may exist on the farm (Holmes 1986). The higher the proportion of total annual production that is required to meet quota, then the more spread and regular the calving pattern must be through the year (Eede 1981).

Generally, quotas of up to 15 litres per hectare can be met by calving a proportion of the herd in spring and a proportion in autumn (Holmes 1986). However, very high quotas (up to 30 litres per hectare) can be met by calving an equal number of cows in each month of the year (Holmes 1986, Eede 1981). It is generally accepted that calving the whole or any proportion of the herd in autumn is associated with a decrease in milk/milkfat production per cow. The trial of Fulkerson et al (1987) showed that cows in autumn calving herds produced 157 kg MF/cow/year compared with cows in spring calving herds at 164 kg MF/cow/year. The reasons suggested by Fulkerson et al (1987) for the reduced performance of autumn calving herds related primarily to a reduced feed supply available to autumn calving cows. The following factors were among those considered important;

* Wastage of total feed available due to high conservation losses.
* Reduced pasture regrowth due to high pasture damage in winter and hard grazing/high conservation in spring.
* Low utilization of winter pasture due to lax grazing cows in full lactation during winter.

There is however no evidence to suggest that if autumn calvers are offered the same quantity and quality of feed throughout lactation as spring calvers, that they should produce any less milkfat over a lactation. One study (Thomas et al 1985) showed that autumn calvers fed large quantities of supplement and concentrates produced more milkfat than predominately pasture fed spring calvers.

1.3 Factors affecting milk production per hectare.

1.3.1 Introduction to Stocking Rate.

Without doubt, the most important factor affecting milk and milkfat production per hectare is the stocking rate (cows / hectare). The positive correlation of stocking rate with production per hectare has been described by many authors both in New Zealand (Riddet 1954, McMeekan and Walshe 1963, Pringle and Wright 1983, Holmes and McMillan 1982) and overseas (King and Stockdale 1980, Gordon 1973, 1976, Jones and Sandland 1974). For the purposes of the present review, stocking rate will be defined as the number of cows grazing per effective hectare of the farm. Animals per unit area seems to be the most common expression of stocking rate used in the literature. However Holmes and Wilson (1984) point out that this definition is unsatisfactory on two separate counts;

a) It takes no account of vast differences in amounts of feed grown per hectare due to soil type, climate and fertility differences.

b) It also takes no account of feed requirements per cow which may vary across different breeds and levels of cow genetic merit.

In addition to this , when making stocking rate comparisons between farms, one must consider whether milking cows consume "bought in" feed (Riddet 1954) and the likely feed consumption of any dry or young stock carried on the specified area of land.

1.3.2 The production per hectare - stocking rate relationship.

Jones and Sandland (1974) proposed that production per hectare (in the context of liveweight gain per hectare for beef cattle) increased curvilinearly with increasing stocking rate up to a maximum stocking rate = Smax. Further increases in stocking rate beyond Smax saw production per hectare begin to decrease again in a curvilinear fashion. Jones and Sandland (1974) described the the shape of this quadratic curve with the equation

$$Y = aS - bS^2$$

where Y = Production per hectare

S = Stocking rate (animals per hectare)

a, b = constants

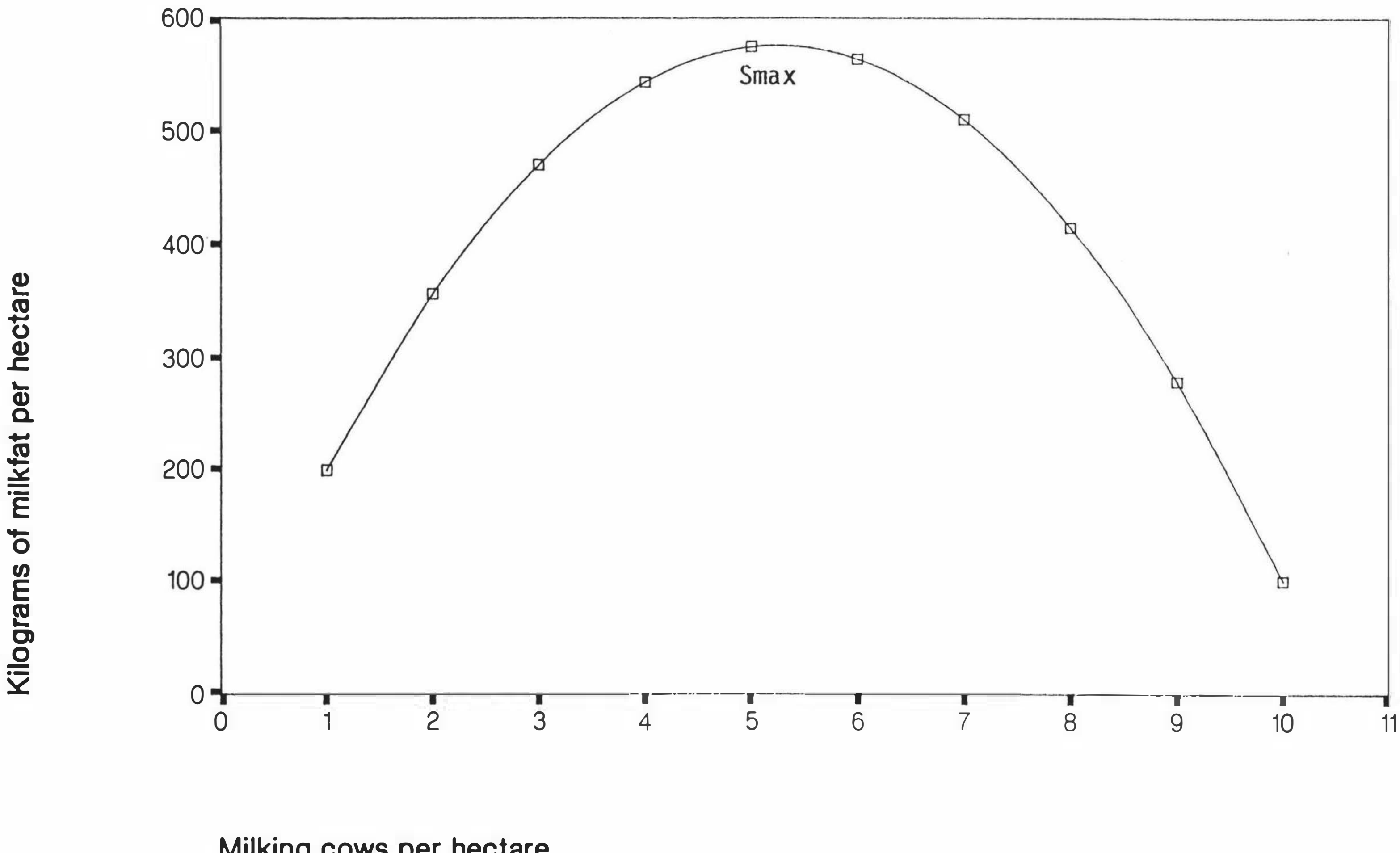
In the context of milkfat production per hectare, Holmes and MacMillan (1982) attempted to estimate values for the constants a and b by pooling the results of 14 different New Zealand stocking rate trials where approximately 12 - 15 tonnes of dry matter per hectare were grown. Their estimates were

$a = 220$,

$b = 21$.

Using values of S from 1 to 10 and the constants of Holmes and MacMillan (1982), it is possible to derive a profile of theoretical milkfat per hectare performances over the range of stocking rates from 1 to 10 cows per hectare (Figure 1.1)

Figure 1.1 Theoretical milkfat production at different stocking rates



Smax can be calculated by setting the first derivative of $Y = aS - bS^2$ as equal to zero i.e.

$$Y = aS - bS^2$$
$$Y' = a - 2bS$$
$$a - 2bS = 0$$
$$a = 2bS$$
$$a/2bS = Smax$$

Smax = 220/(2*21) = 220/42 = 5.24 cows per hectare

Maximum milkfat per hectare can now be calculated by inserting the stocking rate of 5.24 cows per hectare in the original equation of $Y = aS - bS^2$ i.e.

Maximum milkfat per hectare = 220 * 5.24 - 21(5.24^2)
= 1152.8 - 576.6
= 576.2 kg milkfat per hectare

These theoretical estimates of the shape and direction of the stocking rate - milkfat per hectare relationship have been backed up with survey work on commercial farms. Crabbe (1983) showed the milkfat per hectare - stocking rate relationship between farms to be positive and curvilinear for three separate counties surveyed in New Zealand.

However because no commercial farms or experiments have attempted to run the very high stocking rates required to observe a decrease in milkfat per hectare with increasing stocking rate (i.e. the second half of the curve in Figure 1.1), this relationship remains theory only.

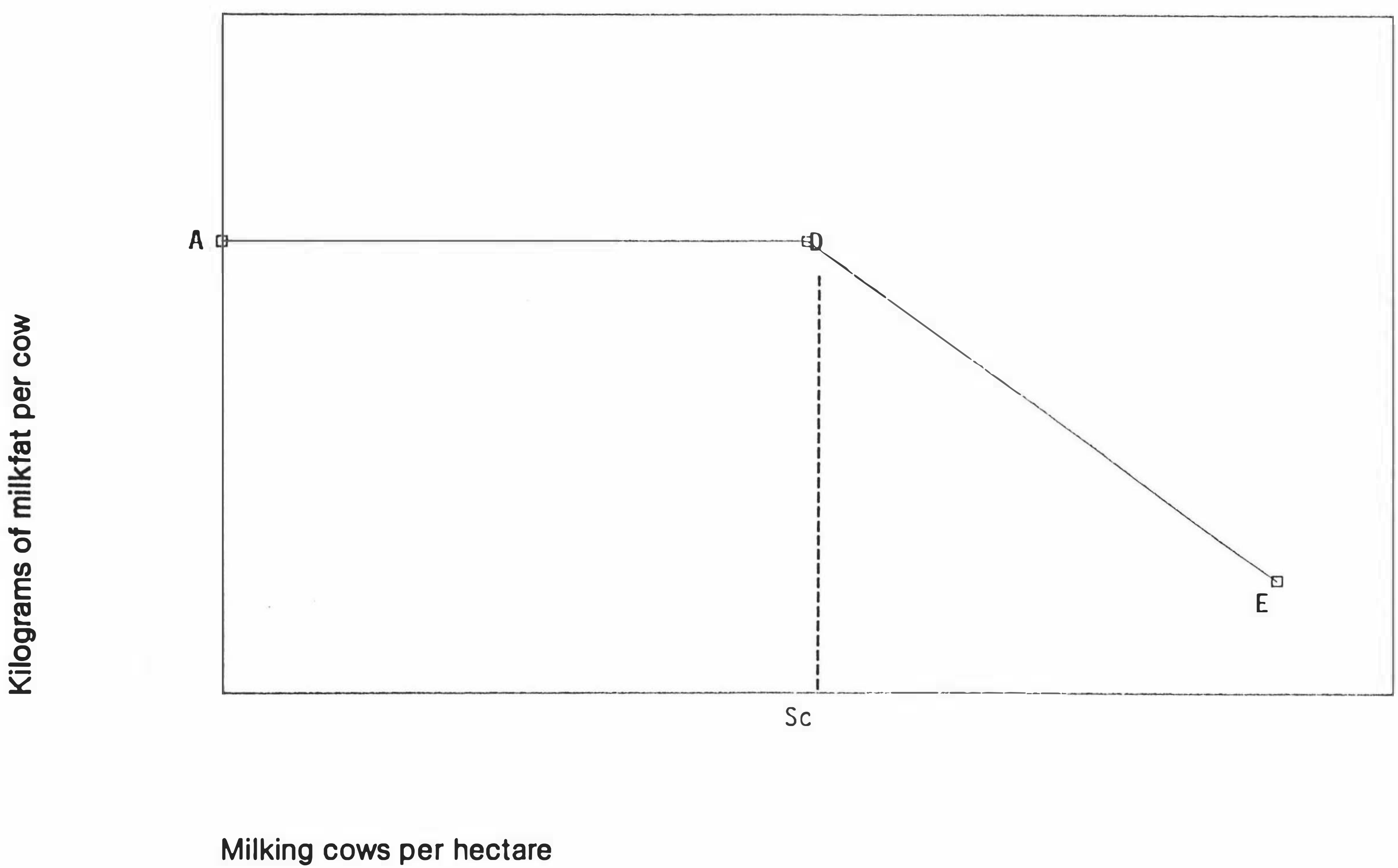
It is clear from the literature that changes in stocking rate influence total milk production per hectare via their effects on the following 4 parameters.

a) Level of feeding and milk production per cow.
b) Annual feed utilisation efficiency
c) Quantity of pasture produced per hectare
d) Quality of pasture produced.

1.3.3 Level of feeding and milk production per cow

A rise in stocking rate will clearly result in a larger number of mouths to feed per unit of feed grown and thus less available pasture per cow. The resulting lower level of feeding per cow is the most likely explanation for the negative relationship between stocking rate and milkfat production per cow observed by McMeekan (1956), Hancock (1958), Gordon (1973), (1976), King and Stockdale (1980). Some researchers (e.g. Freer 1960, Coleman and Holder 1968) observed no decrease in per cow performance with increased stocking rates. Generally, it is agreed that production per animal is unaffected over a range of low stocking rates because animals have unrestricted intake (Conniffe et al 1970). The graph of Wright and Pringle (1983) (Figure 1.2) helps visualize this.

Figure 1.2 Theoretical milkfat production per cow as stocking rate increases



Source: Wright and Pringle (1983)

Milkfat per cow is unaffected in the range of low stocking rates up to Sc. Above Sc, milkfat production per cow declines in a linear fashion. Mathematical descriptions of lines AD and DE have been given by Jones and Sandland (1974).

AD = K for $S \leq Sc$
DE = a - bS for $S \geq Sc$

where K = constant.
a, b = constants in a linear equation.
S = stocking rate (animals per hectare).

Although there is still some debate as to the mathematical form of the milkfat per cow line above Sc (i.e. line DE), King and Stockdale (1980) state that a linear relationship is likely to be a good approximation. There have however not been enough dairy trials to validate the model or the shape of the decline above Sc (Wright and Pringle 1983). Overall it is clear that the extra milk production achieved from running extra cows is more than enough to offset a drop in per cow production as stocking rate increases up to the point Smax. This can be explained in terms of the effects that stocking rate has on pasture quantity, quality and annual utilisation efficiency.

1.3.4 Pasture Utilisation

The term "utilisation" has been used to express both the efficiency with which an individual paddock is grazed (i.e. pasture consumed at each defoliation as a proportion of pasture mass originally present) and the overall efficiency of a grazing system (i.e. pasture consumed over a season or year as a proportion of pasture accumulation over the same time period)(Korte et al 1987). Stocking rate is known to affect pasture utilisation both in the context of an individual grazing and over a whole season.

Greenhalgh (1970) derived estimates of pasture utilisation at different stocking rates by averaging the results of a number of individual grazings. It was shown that herbage utilisation increased from 58 % at 5.4 cows per hectare to 95% at 6.8 cows per hectare. Stockdale and King (1980) reported increases in pasture utilisation and decreases in cow intake for individual grazings as stocking rate increased. This trend was consistent for both spring and summer pastures.

Care must be taken when estimating pasture utilisation over a season because pasture consumed and pasture accumulated are essentially the same (Korte et al 1987). Several studies have measured pasture growth and animal intake by unrelated methods and have shown that up to 50 - 70 % of new growth was harvested (Bircham and Hodgson 1983, Parsons et al 1983). The remainder was lost through decay.

On an annual basis, an increase in stocking rate will often result in an increase in the proportion of new growth that is eaten by animals (e.g. Jagusch et al 1978) because losses from decay are reduced from increaased stocking. Hancock (1958) estimated pasture wastage on a seasonal supply dairy farm over 3 seasons at 35% (i.e. utilisation = 65%). It was concluded that utilisation could be increased by increasing stocking rate. Holmes and Wilson (1984) estimate the range in annual pasture utilisation to be from 50% for low stocked farms up to 90% for highly stocked and efficient dairy farms in New Zealand.

However, very high stocking rates which result in high utilisation per grazing through the whole year may not be sustainable without the input of fertilizer nutrients because of poor nutrient cycling (Field and Ball 1982).

1.3.5 Total net pasture production.

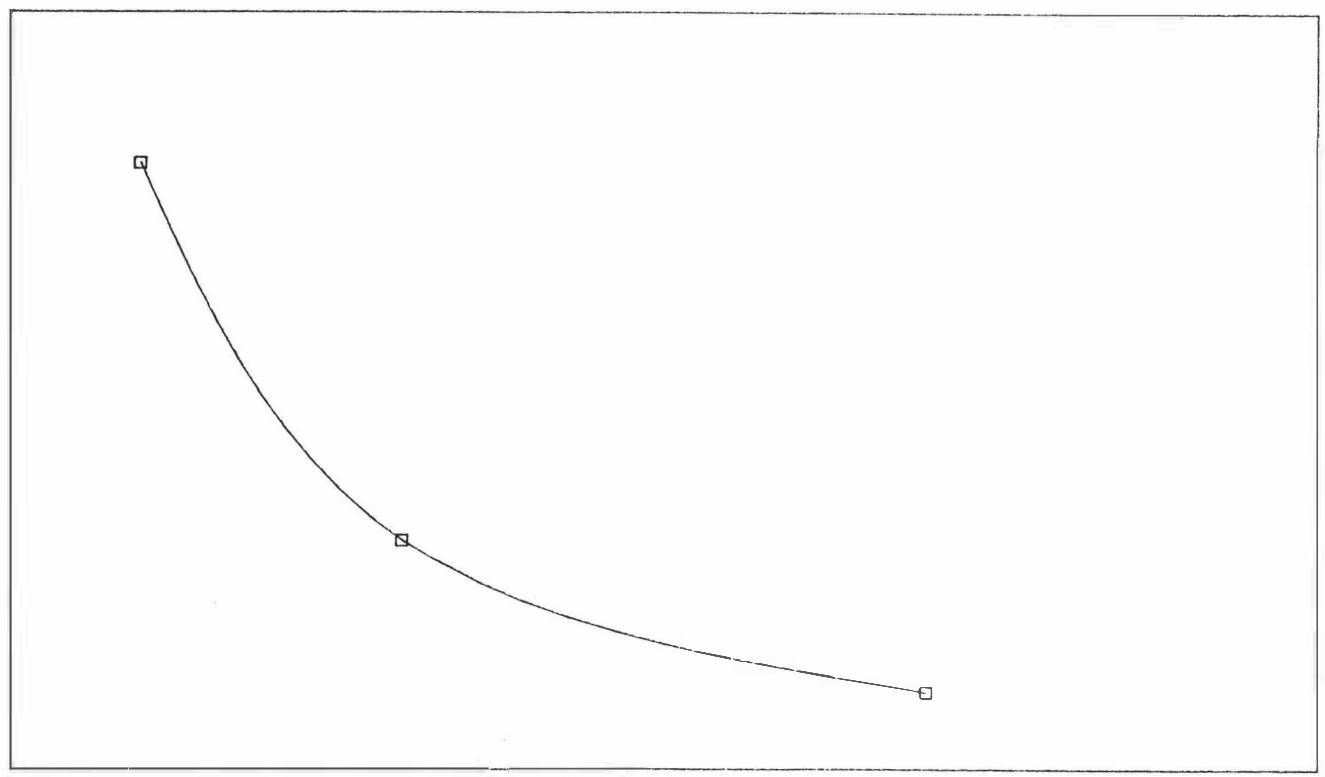
Several authors have reported that annual net herbage accumulation decreases with increasing stocking rate. O'Sullivan (1984) reported that high stocking rate treatments produced around 7 % less dry matter per hectare per annum than low stocking rate treatments. This difference was consistent across continuous and rotational grazing systems. Stockdale and King (1980) derived a regression relationship which predicted dry matter accumulation to decrease by 394 kg DM/Ha/year for every 1 cow/Ha increase in stocking rate.

However conflicting evidence was reported by Greenhalgh (1970) with the following result

Stocking rate (cows/hectare)	6.8	5.8	5.4
Kg DM/Ha/year accumulation	11350	11110	10860

Assuming that net pasture accumulation does decrease with increasing stocking rate (O'Sullivan 1984, Stockdale and King 1980), it is most likely explained by the fact that closer grazing and more frequent defoliation may occur at higher stocking rates. McGowan (1978) showed residual feed to be negatively correlated with stocking rate as shown in Figure 1.3.

Figure 1.3 Theoretical residual herbage mass as stocking rate increases



Source: McGowan (1978)

Lower levels of residual feed associated with increased severity of defoliation reduces the photosynthetic area of the plant which in turn can reduce the pasture growth rate (Stockdale and King 1980).

1.3.6 Pasture quality.

There is general agreement in the literature that increasing stocking rate will have a beneficial effect on both the composition and overall quality of pasture swards. These benefits are a direct result of more intense grazing of pasture (Holmes and Wilson 1984) and include the following specific aspects of pasture quality

a) A decrease in the amount of dead and dying material in the pasture (Campbell 1966). The experiment of Campbell (1966) showed a dramatic build up of dead material in late summer for a low stocking rate compared with a high stocking rate treatment. Given that dead matter is considerably less digestible than green matter (Waghorn and Barry 1987), a high dead matter content in the sward will reduce digestibility and therefore quality.

b) An increase in the proportion of clover can result from increased stocking rate (Stockdale and King 1980). High stocking rates increase the clover/ryegrass ratio because cows eat the growing points of erect grasses and leave those of prostrate clovers open and exposed to light (Brougham et al 1978). There is also some evidence that that high stocking rates will decrease the weed % of rundown weedy pasture (Holmes and Wilson 1984).

c) An increase in the digestibility of herbage on offer. This increase in digestibility can be attributed to the combined results of less dead matter (Campbell 1966), more clover in the sward (Stockdale and King 1980) and in particular, the reduced incidence of reproductive growth associated with the increased grazing intensity at higher stocking rates (Korte et al 1984, Hoogendoorn 1986). Grazing intensity increases and residual herbage mass decreases as stocking rate increases (McGowan 1978, Stockdale and King 1980). Intense grazing removes reproductive herbage resulting in subsequent regrowths being vegetative (Korte et al 1984). Given that vegetative leafy matter is considerably more digestible than reproductive growth (Waghorn and Barry 1987), it can be logically concluded that increased stocking rate will improve pasture quality.

1.4 Effects of these factors on the productivity of town milk farms compared with seasonal supply farms.

The Tasmanian trial of Fulkerson et al (1987) showed reduced productivity per cow and per hectare for autumn compared with spring calving farmlets. Although conditions on New Zealand town milk farms are not strictly comparable (i.e. there are both autumn and spring calving cows on a New Zealand town milk farm), it is logical to suggest that the autumn calving cows on town milk farms will cause a reduction in total productivity per cow and per hectare for many of the same reasons suggested by Fulkerson et al (1987).

1.4.1 Annual milkfat production per cow.

Milkfat production per cow is likely to be lower on town milk farms than seasonal supply farms for the following reasons.

(i) Lower ME and DM intake per cow.
It has been established that;

a) Town milk farms use considerably more supplementary/conserved feed than seasonal supply farms (Brookes and Holmes 1988). This would suggest that a supplements form a larger part of total annual feed intake per cow on town milk farms.

b) Conserved feeds such as hay and silage have a lower digestibility and ME concentration than pasture (Ulyatt et al 1980). Given the negative correlation between feed digestibility and intake (Hodgson 1977), it is clear that cows with a higher proportion of supplement in their diet are likely to achieve a lower feed DM intake on a daily or annual basis.

The fact that on average each unit of DM eaten is likely to have a lower ME concentration for town milk herds (due to high supplementation) will result in a further reduction in ME intake per cow relative to seasonal supply herds.

(ii) Increased proportion of feed required for maintenance.
A lactating cow requires the same amount of feed for maintenance whether she produces at a high or a low level (Holmes and Wilson 1984). Assuming that feed intake per cow per year is lower on town milk farms (as in (i)), it is clear that a greater proportion of feed eaten per cow on town milk farms will be required for maintenance. This will result in a reduction in available feed for milk synthesis with reduced per cow production as a consequence.

1.4.2 Annual milkfat production per hectare

Milkfat production per hectare is likely to be lower on town milk farms than seasonal supply farms for the following reasons.

(i) Lower stocking rate

Moffitt (1986) compared seasonal supply and town milk farms in the South Auckland region and found that stocking rate was 33% lower on town milk farms than on seasonal supply farms (1.4 cows per hectare c.f. 2.1 cows per hectare). This is almost certainly due to the high winter feed demand on town milk farms. Given the well documented positive relationship between stocking rate and milk production per hectare (1.3.2), it is clearly predictable that town milk farms will produce less milkfat per hectare.

(ii) Higher wastage of feed.

The conservation of herbage as silage or hay is a very costly process in terms of dry matter loss (Thomson 1984). In addition to this, the feeding out of silage and hay onto existing pasture in wet winter months is associated with pasture damage and loss (Fulkerson et al 1987). Although some farmers may go to considerable lengths to minimise supplement wastage (e.g. storage of silage in bunkers, feeding out on concrete pads), it is clear that the larger amounts of supplements used on town milk farms (Brookes and Holmes 1988) will inevitably result in higher wastage of feed per hectare. This wastage of feed is likely to be reflected in a reduced production per hectare.

(iii) Reduced pasture growth rates.

Although there is no available data, there is reason to suspect that town milk farms in the same locality and district may grow less feed than their seasonal supply neighbours. This may be due to;

a) The reduced regrowth of pasture associated with the need to graze pasture harder in spring in order to conserve more supplement (Fulkerson et al 1987).

b) Pasture damage from winter feeding out of supplements.

c) A shorter winter rotation length to achieve a high pasture allowance for lactating cows

This will further reduce the availability of feed relative to a seasonal supply system and depress milkfat production per hectare.

(iv) Lower average milk response per unit of feed eaten.

The requirement to meet quota on town milk farms means that there is considerably less flexibility with regard to drying off date. Where feed supplies become scarce, a seasonal supply will dry off late lactation cows producing at a low level. Town milk farmers however may be reluctant to dry off late lactation cows at critical times of the year if it means they will produce under quota. This may result in a larger proportion of total available feed being fed to "stale" cows on town milk farms. Given the lower milk response per unit of feed eaten for late vs early lactation cows (1.2.5), this could also be a contributing factor to the lower milkfat production per hectare expected on town milk farms.

CHAPTER TWO
Objectives and methods

2.1 Objectives of the study.

A survey of 58 Manawatu dairy farms was undertaken in May, June and July of 1988. The survey had two principal objectives.

(1) To make a detailed study of winter milk production on town milk farms during the 1988 winter (1st May to 31st July).

(2) To compare town milk and seasonal supply farms with respect to their overall annual productivity and efficiency

2.2 Selection and surveying of farms.

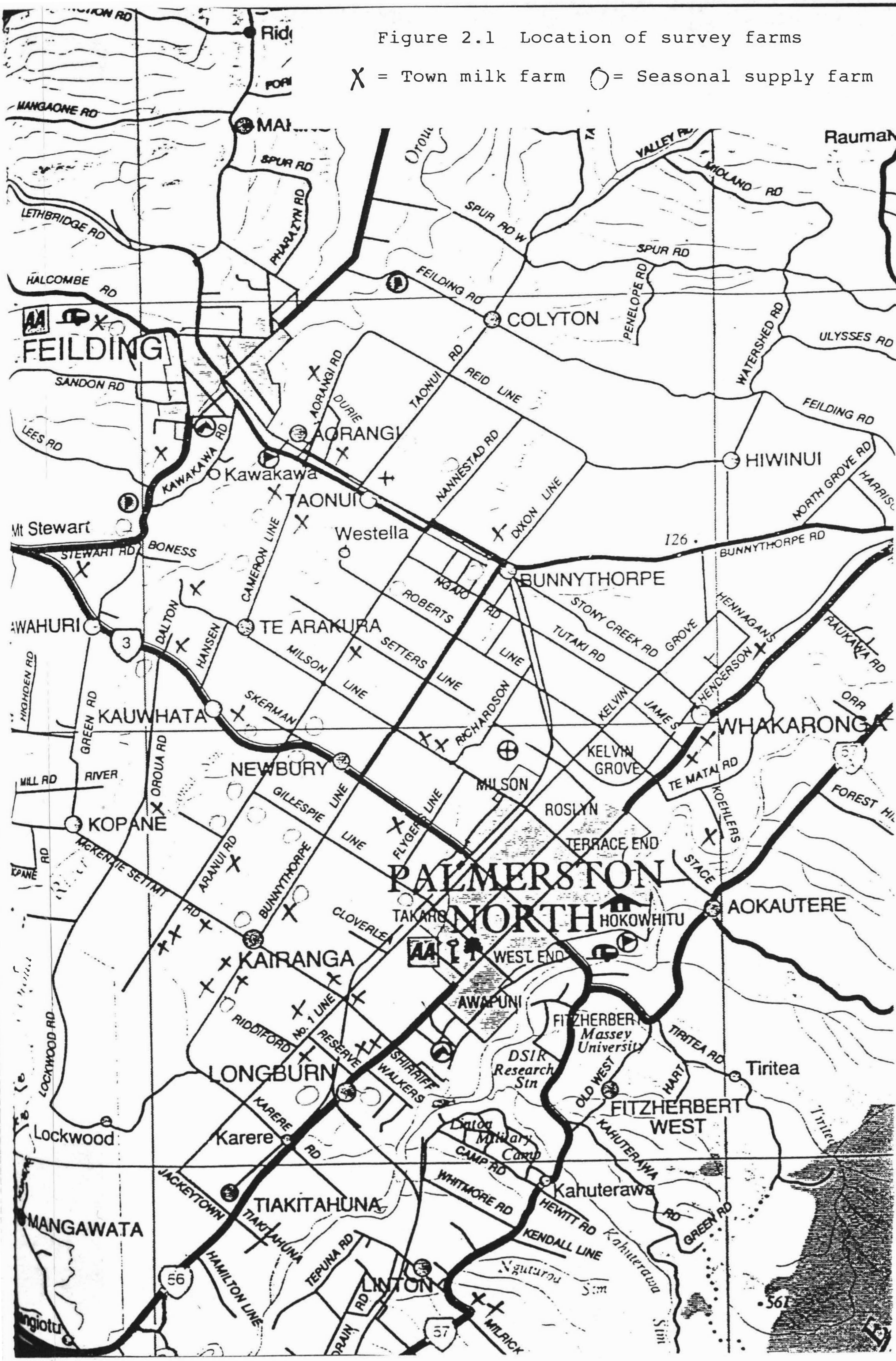
All survey farms were suppliers to the Manawatu Cooperative Dairy Company Ltd. Permission to survey its suppliers was granted by the Company who also supplied names and addresses of all town milk suppliers in the Palmerston North district (42 in total). Letters requesting participation in the survey were sent to all town milk farmers and a follow up telephone call revealed that 36 farmers (86 % of the total) were willing to be visited and provide information. Subsequently, 25 seasonal supply farms were selected for surveying on the basis of their geographic proximity to individual town milk farms or groups of town milk farms (see Figure 2.1), in order to ensure that climatic and soil type differences between the two farm types were minimised. 22 of the 25 farms were able to participate, giving a total of 58 survey farms (36 town milk, 22 seasonal supply). Surveying of town milk farms consisted of 2 visits of approximately 1 hour per visit to each farm. The first round of visits was completed between the 13/5/88 and 1/6/88 while the second visit occured between 22/7/88 and 8/8/88. Seasonal supply farms were visited only once during July between 5/7/88 and 20/7/88.

2.3 Location of farms/Soil types

The location of individual survey farms on a Manawatu district map is shown in Figure 2.1. Town milk farms are all located within a 26 km radius of Palmerston North with notable concentrations around Longburn and Kairanga. There were also a number of farms near Fielding, 2 at Linton and 4 at Whakarongo. The majority of farms were located on Kairanga or Te Arakura series soils - in particular Kairanga silt loam and Te Arakura silt loam. These soils are both described as alluvial low lying river flats ranging from 9 to 75 metres above

Figure 2.1 Location of survey farms

X = Town milk farm ◯= Seasonal supply farm



sea level (Cowie et al 1972). They tend to be poorly drained with a mottled gley horizon beneath the topsoil. Several farms located near the Oroua or Manawatu rivers were located on the much freer draining Manawatu series soils which were much more suited to wintering lactating cows than the wetter soils. Mean annual rainfall for the Palmerston North district is 995 mm ranging from 793 to 1298 mm (NZMS 1980)

2.4 Information collected.

2.4.1 Town milk farms only.

2.4.1.1 Average daily milk production per cow during winter.

During the first farm visit, each farmer was given a shed chart and asked to record the average number of cows being milked on the farm each week and the amount of wholemilk being fed to calves per day. On the second visit, these charts were collected together with the daily milk weight copied from the farmers own records or statements of milk supplied from Manawatu Cooperative Dairy Company. Average daily milk production per cow was calculated on a weekly basis using the following equation

cowADM = (((m1+m2+m3+m4+m5+m6+m7) + (cfm 7)) / 7) / avcow
where
cowADM = litres per cow per day
m1 to m7 = litres of milk in vat each day of the week
cfm = wholemilk fed to calves (total litres per day)
avcow = average number of cows milking each week

Estimates of the milkfat %, protein % and solids % was taken from "ten day sheets" issued to farmers by Manawatu Cooperative Dairy Company Limited. The estimates are not completely accurate because not all farmers retained a full set of ten day sheets for the winter period. Production per cow per day of milkfat, protein and total solids was calculated by multiplying the percentage of each component with the average value for litres/cow/day in each ten day period.

2.4.1.2 Condition score

A sample of approximately 20 autumn calving cows per herd were condition scored during the first visit and another sample were condition scored during the second visit. Change in condition score over the winter was calculated by subtracting the mean condition score on visit one from the mean condition score on visit two. The scoring system used has been described by Holmes and Wilson (1984) - the following adjectives give an idea of the relative scores given to cows.

Score	Description
3	Very skinny
4	Light
5	Target calving condition
6	Fat
7	Very fat

2.4.1.3 Pasture cover.

On both visits, farmers were asked to identify the shortest and longest paddocks on their farm. In most cases this corresponded to the paddock grazed on the previous day and and the paddock planned to be grazed on the next day. The mean pasture height of these two paddocks was measured using a rising plate meter (Earle and McGowan 1979, Michell 1982). This reading was converted to kgDM/Ha using the equation

$$\text{Pasture cover} = (\text{Height (cm)} * 150) + 110$$

Mean pasture cover on each farm was calculated as the mean of the shortest and longest paddocks. Change in farm cover was calculated by subtracting the farm cover estimate on the first visit from the estimate on the second visit.

2.4.1.4 Other town milk information

Other information specific to the town milk industry which was collected on the first farm visit included

a) Quota size (litres/day)

b) Distribution of calving. Where two distinct herds were run, farmers were asked the appropriate numbers of spring and autumn calving cows. Where an all year round calving policy existed, the appropriate number of cows calving per month was recorded.

2.4.2 Town milk and seasonal supply farms

Farmers were asked to supply the following information about their farms for the 1987/88 season.

(i) Effective milking area (Hectares).
(ii) Number of cows milked (total)
(iii) Nitrogen usage (kg/year).
(iv) Feed conserved from the milking area as hay or silage.
(v) Feed brought in from elsewhere (hay, silage, concentrates).
(vi) Total supplements fed (i.e. supplements made + brought in - supplements remaining at the end of the winter).
(vii) Types and amounts of crops planted.
(viii) Extent of any irrigation used.
(ix) Numbers and ages of any youngstock grazing on the milking area.
(x) Numbers of calves reared on wholemilk.
(xi) Milkfat production at factory for 1987/88 season.

A small (1 - 2 kg) sample of hay and / or silage was collected from each farm. These samples were then later subject to analyses of in vitro digestibility and concentration of protein at the nutrition laboratory of the Faculty of Agricultural and Horticultural Science, Massey University. In vitro digestibility was determined by the method described by Roughan and Holland (1977) while protein (nitrogen) was determined using a Kjeltic auto-analyser (Kjeldahl method). A number of detailed feed calculations were carried out based on the feeding information given by farmers. These are further described in Appendix 2.

To calculate the "digestibility of supplement" variable used in Figure 3.26, it was assumed that cows would be eating silage during winter where both hay and silage were available. This is because many farmers who made both supplement types reserved hay for dry cows and young stock, preferring to feed silage to milkers. Thus the only data points representing digestibility of hay in Figure 3.26 are for farms where hay was the only supplement made.

2.5 Statistical procedures

The survey data obtained was analysed using the statistical package SPSSX driven by Massey University Prime mainframe computer. All raw data was keyed into data files together with the dairy company supply number appropriate to each farm. Each variable was then named, labelled and read into an SPSSX system file which considerably simplified the application of statistical procedures. The largest data matrix contained daily milk production and number of milking cow data for each town milk farm for the 13 week period from 1/5 to 31/7 1988. This was then used to calculate average daily milk production per cow. By using the AGGREGATE command in SPSSX, it was possible to generate mean and range information for daily milk production per cow for

a) each week of winter across all farms (Figure 3.17) and

b) each farm in the survey across all weeks of the winter (Appendix 1).

Differences between means of the same variable on town milk and seasonal supply farms were tested for statistical significance by use of the students t test (Steel and Torrie 1981). Students t test was also used to test for significance of differences between early winter and late winter cow condition and pasture cover on town milk farms. The strength of the relationship between two variables was examined using linear regression (Steel and Torrie 1981). Graphs drawn in this thesis were generated by the SPSSGRAF graphics package and plotted on the Hewlett Packard plotter at the Massey University Computer Centre.

CHAPTER THREE
Results

3.1 Town milk farms

3.1.1 Summary Information for town milk farms.

3.1.1.1 Area, Stocking Rate and Milkfat Production

A wide range of farm sizes and production levels were observed on the 36 Manawatu Town Milk farms surveyed. Farm area, herd size and Milkfat production (at factory) for survey farms in the 1987/88 season is summarized in Table 3.1. Data for individual farms is given in Appendix 1.

Table 3.1 Summary Statistics for Town milk farms

VARIABLE	MEAN	STD DEV	MINIMUM	MAXIMUM
Area in Hectares	65.9	23.6	28	125
Number of cows	182	77.8	70	400
Milking cows / Ha	2.74	0.54	1.6	4.1
Total MF prod. (kg)	27576	14635	10562	74437
MF Production (kg/Ha)	412	119	197	760
MF Production (kg/cow)	150	30	85	241

Distribution graphs for each of these variables across all town milk farms are shown in Figures 3.1 to 3.6. The relationship between MF production per hectare and Stocking rate, total production, herd size was examined using regression. Milkfat production per hectare was positively correlated with stocking rate (Figure 3.7), Total Production (Figure 3.8) and herd size (Figure 3.9).

Figure 3.1 Distribution of farm size on town milk farms

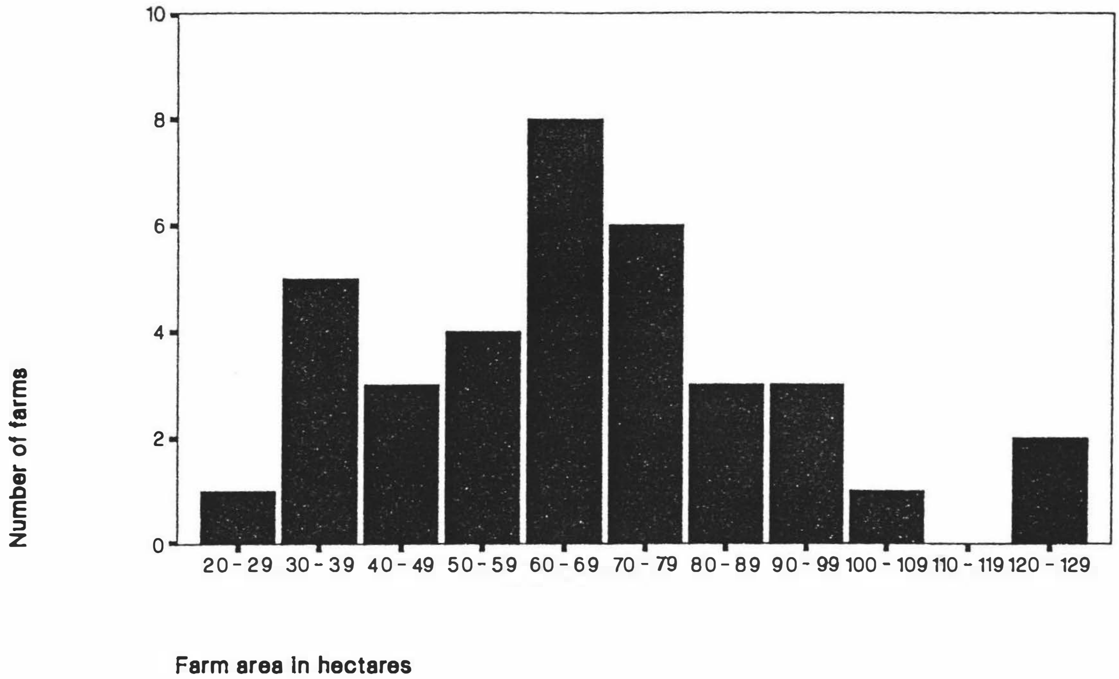


Figure 3.2 Distribution of herd size on town milk farms

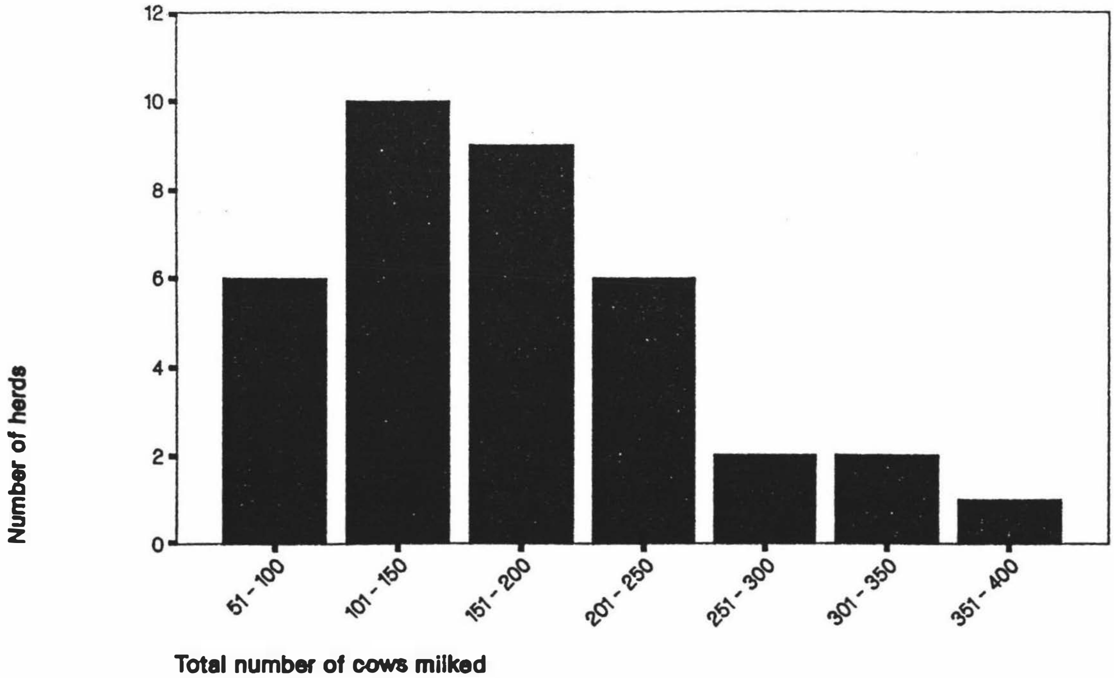


Figure 3.3 Distribution of stocking rate on town milk farms

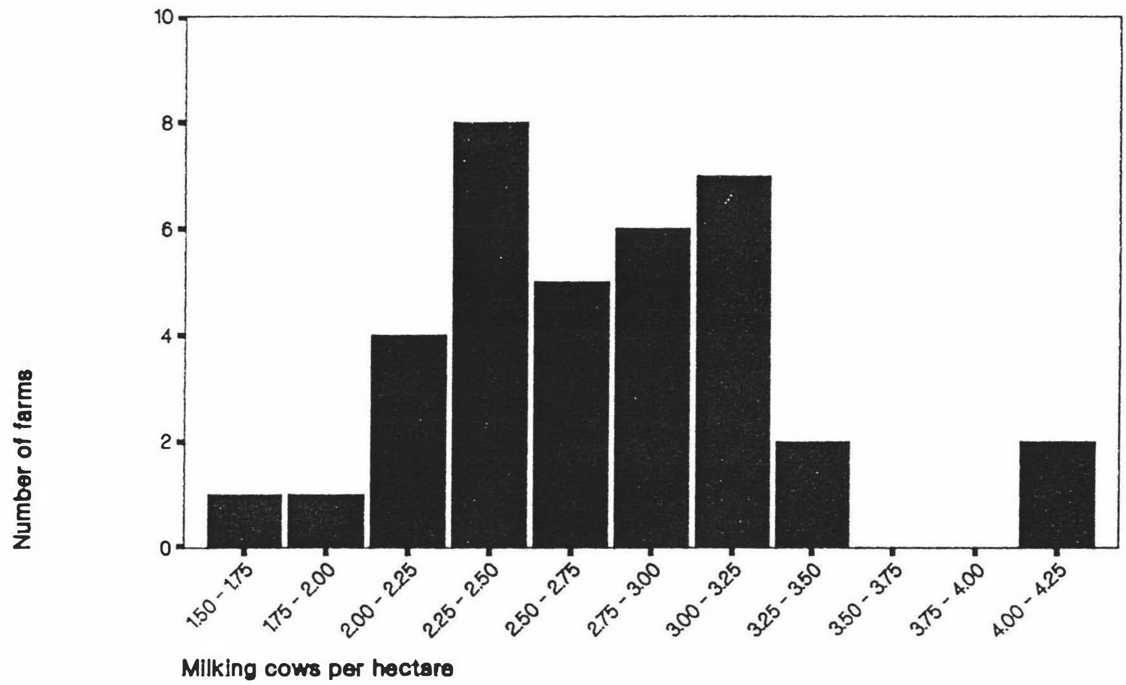


Figure 3.4 Distribution of 1987/88 milkfat production on town milk farms

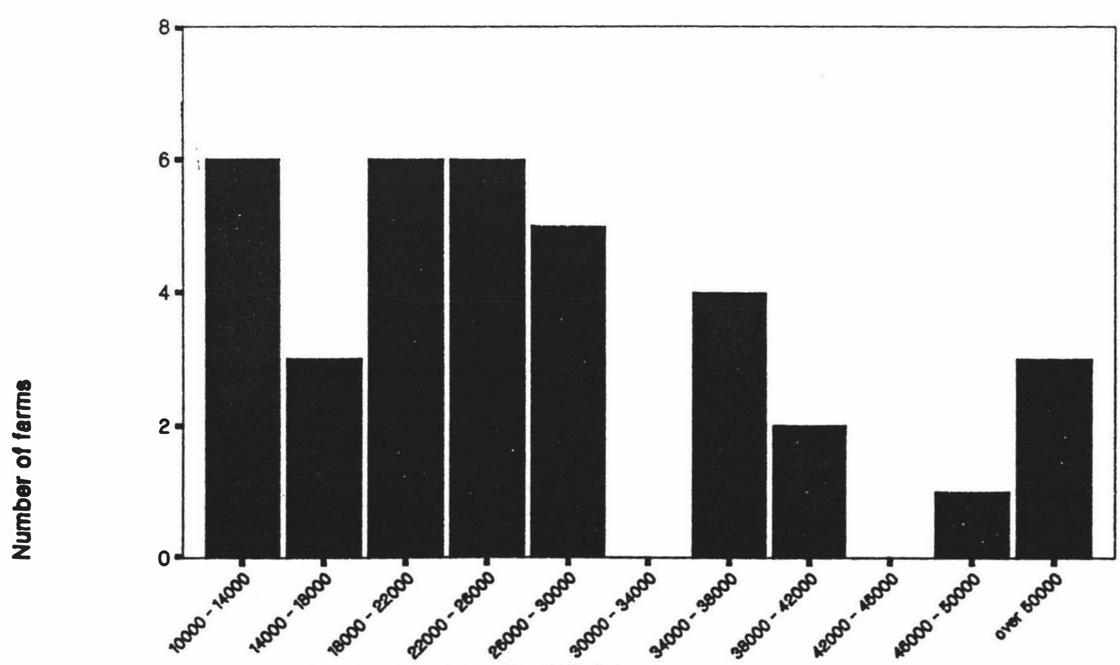


Figure 3.5 Distribution of milkfat production per hectare on town milk farms

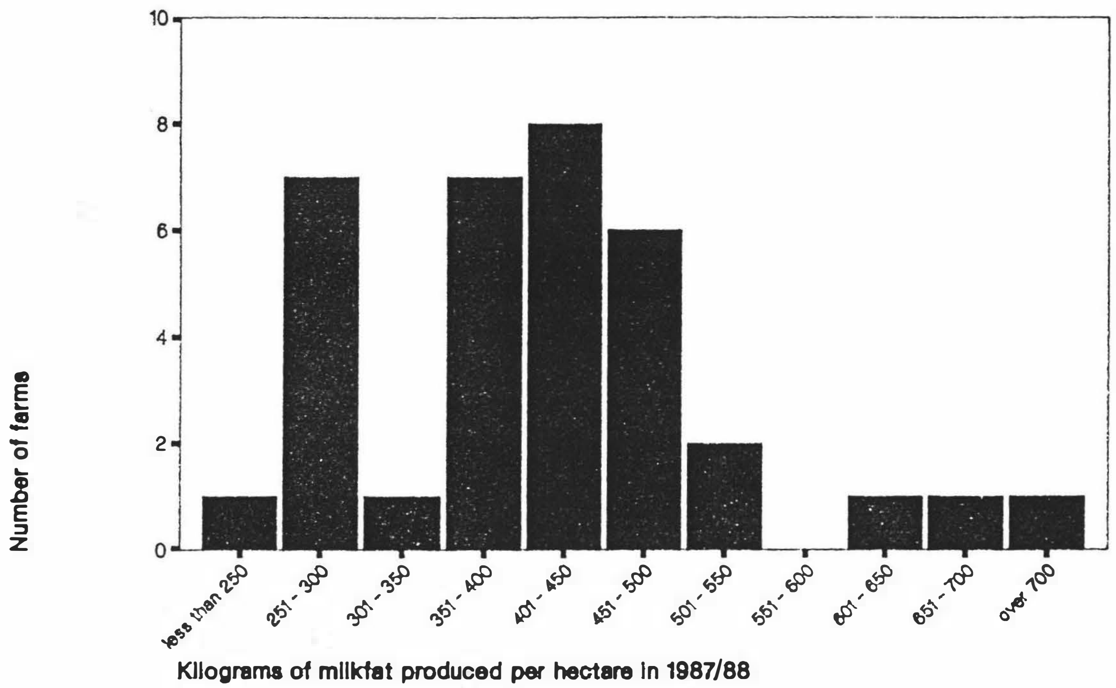


Figure 3.6 Distribution of milkfat production per cow on town milk farms

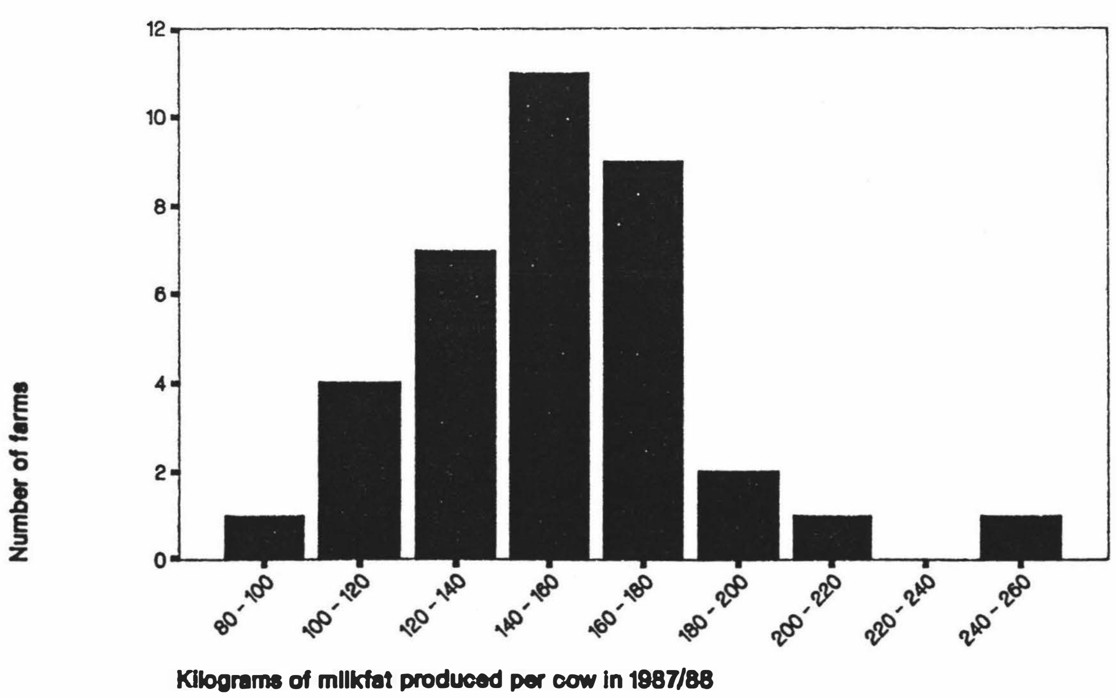
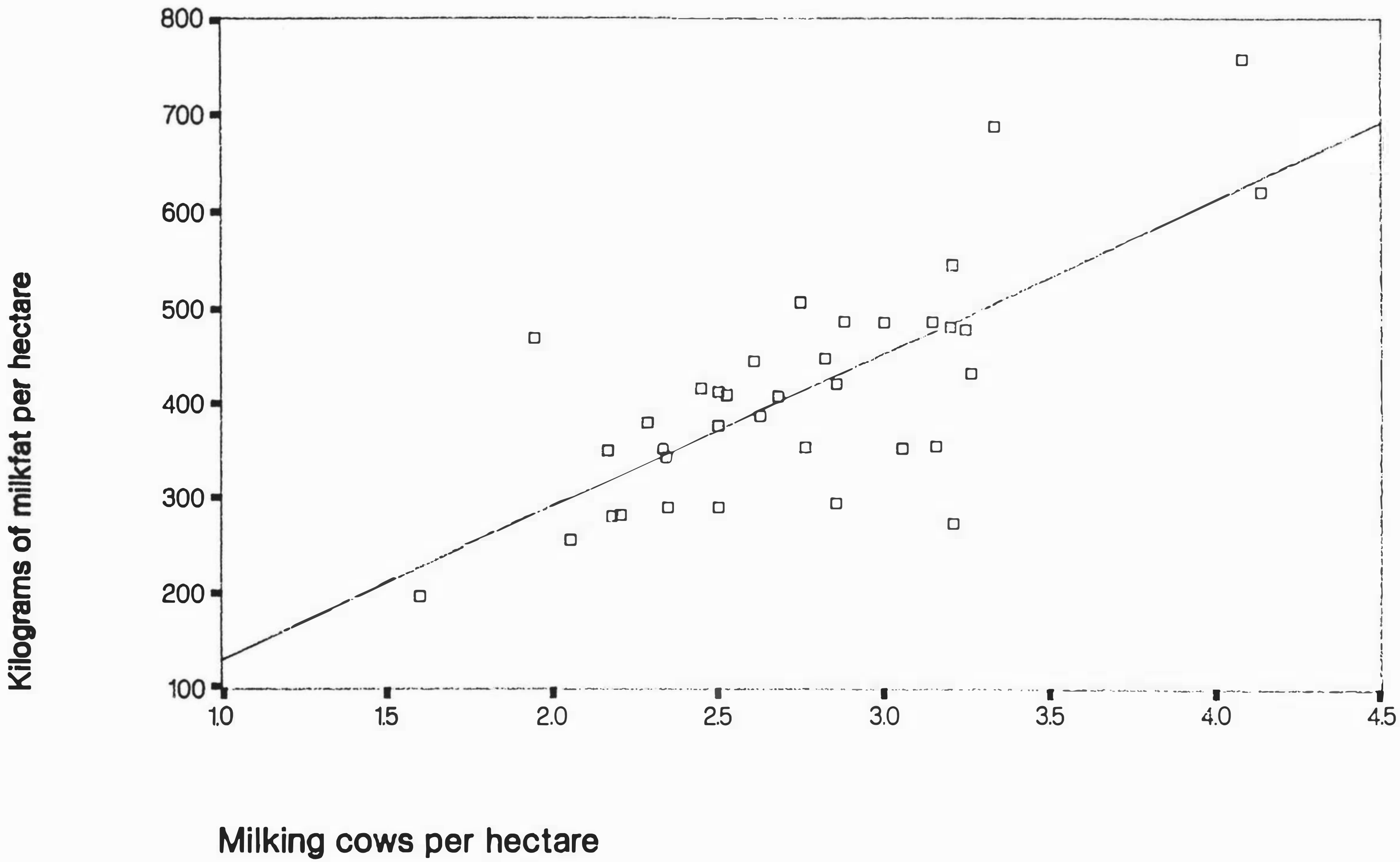
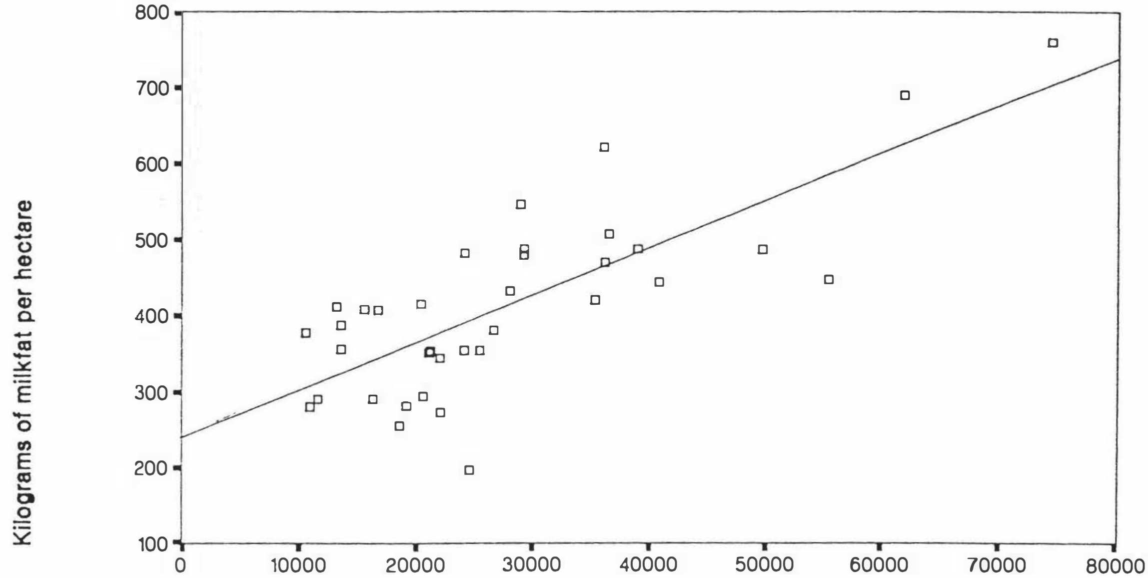


Figure 3.7 Relationship between milkfat production per hectare and stocking rate on town milk farms



Correlation = 0.73 R squared = 0.54

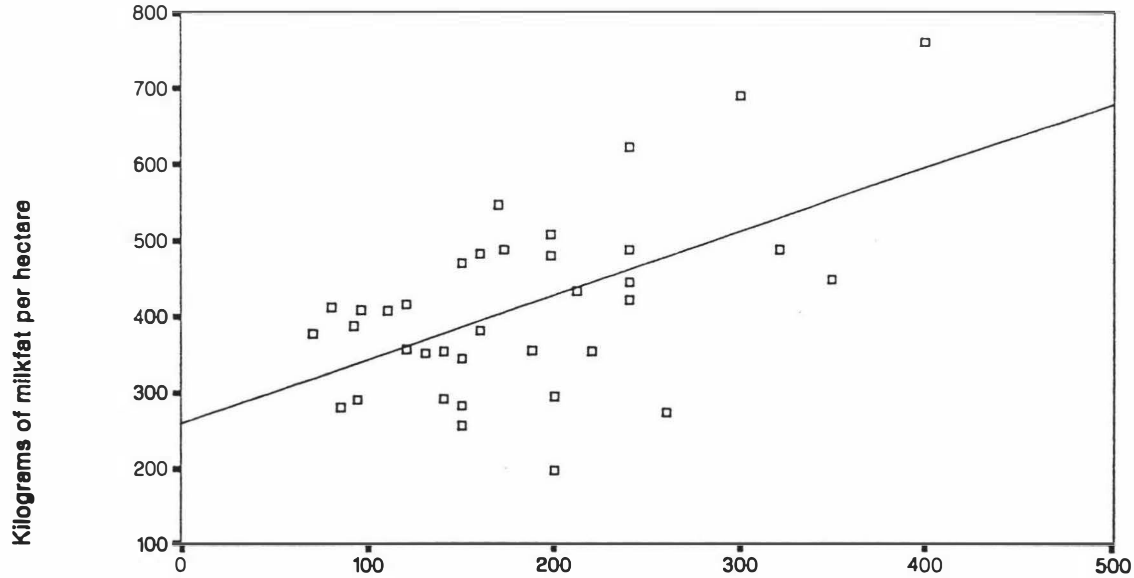
Figure 3.8 Relationship between milkfat production per hectare and total milkfat production on town milk farms



Kilograms of milkfat produced in 1987/88

Correlation = 0.77 R squared = 0.59
Slope (S.E.) = 0.006 (0.0009) 2 - tailed significance = 0.00

Figure 3.9 Relationship between milkfat production per hectare and herd size on town milk farms



Total number of cows milked

Correlation = 0.55 R squared = 0.30
Slope (S.E.) = 0.84 (0.22) 2 - tailed significance = 0.0005

3.1.1.2 Quota levels

A farms quota is defined as the minimum daily milk production (averaged over one month) that the farm is required to produce. Quota level and its relationship with farm size, total production and number of winter milking cows is summarized in Table 3.2. and distribution graphs for quota and quota per hectare are given in Figures 3.10 and 3.11. Individual farm data is presented in Appendix 1. The estimate of required litres per cow per day to meet quota has been calculated by dividing the quota by the mean number of winter milking cows.

Table 3.2 Summary of Town milk farm quotas

VARIABLE	MEAN	STD DEV	MINIMUM	MAXIMUM
Total Quota in litres/day	1027	504	360	2180
Litres of quota per Ha.	15.5	4.6	8.9	27.4
Milk sold as "Quota" (% of total)	61	14.7	24	89.6
Required l/cow/day to meet quota	9.9	2.0	6.4	14.7
Winter milking cows per hectare	1.5	0.4	0.8	1.4

Farms with a larger Quota per hectare sold a larger proportion of total production as "quota milk" (Figure 3.12). Quota per hectare was also positively correlated with the number of winter milking cows per Hectare (Figure 3.13) and the required litres per cow per day to meet quota (Figure 3.14)

Figure 3.10 Distribution of quota on town milk farms

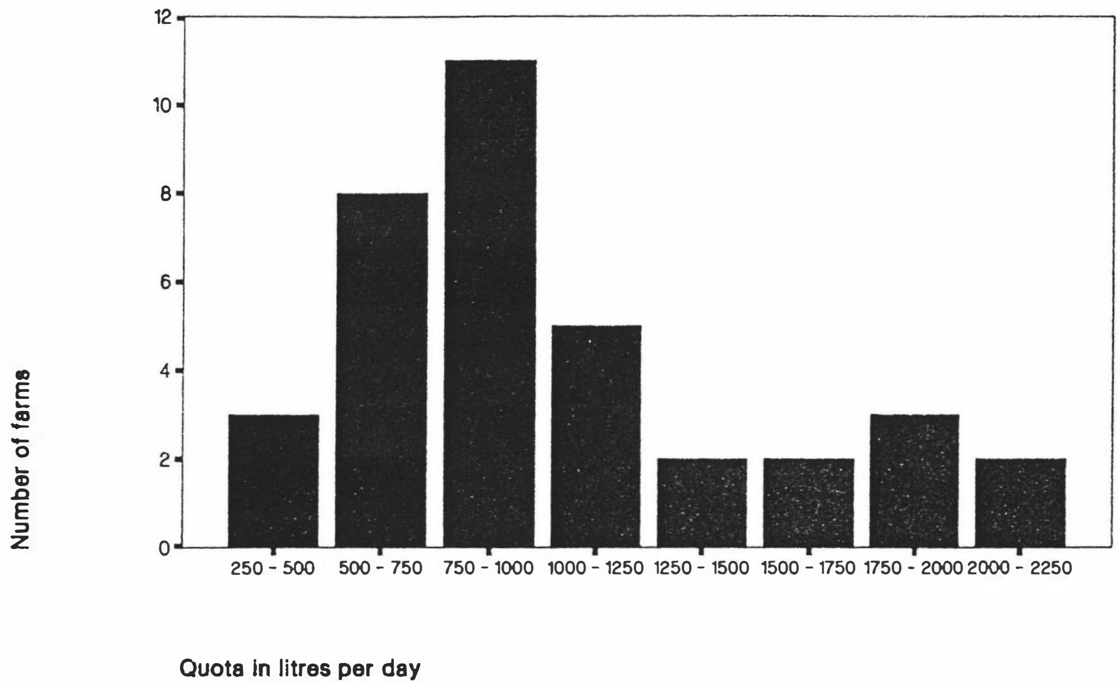


Figure 3.11 Distribution of quota per hectare on town milk farms

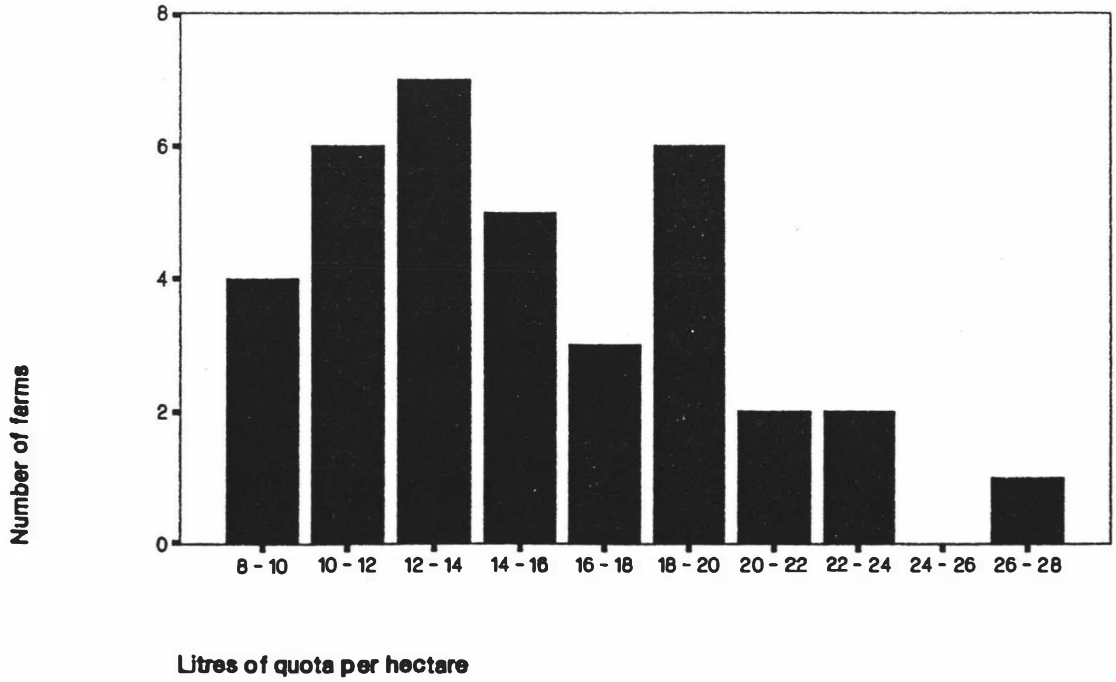
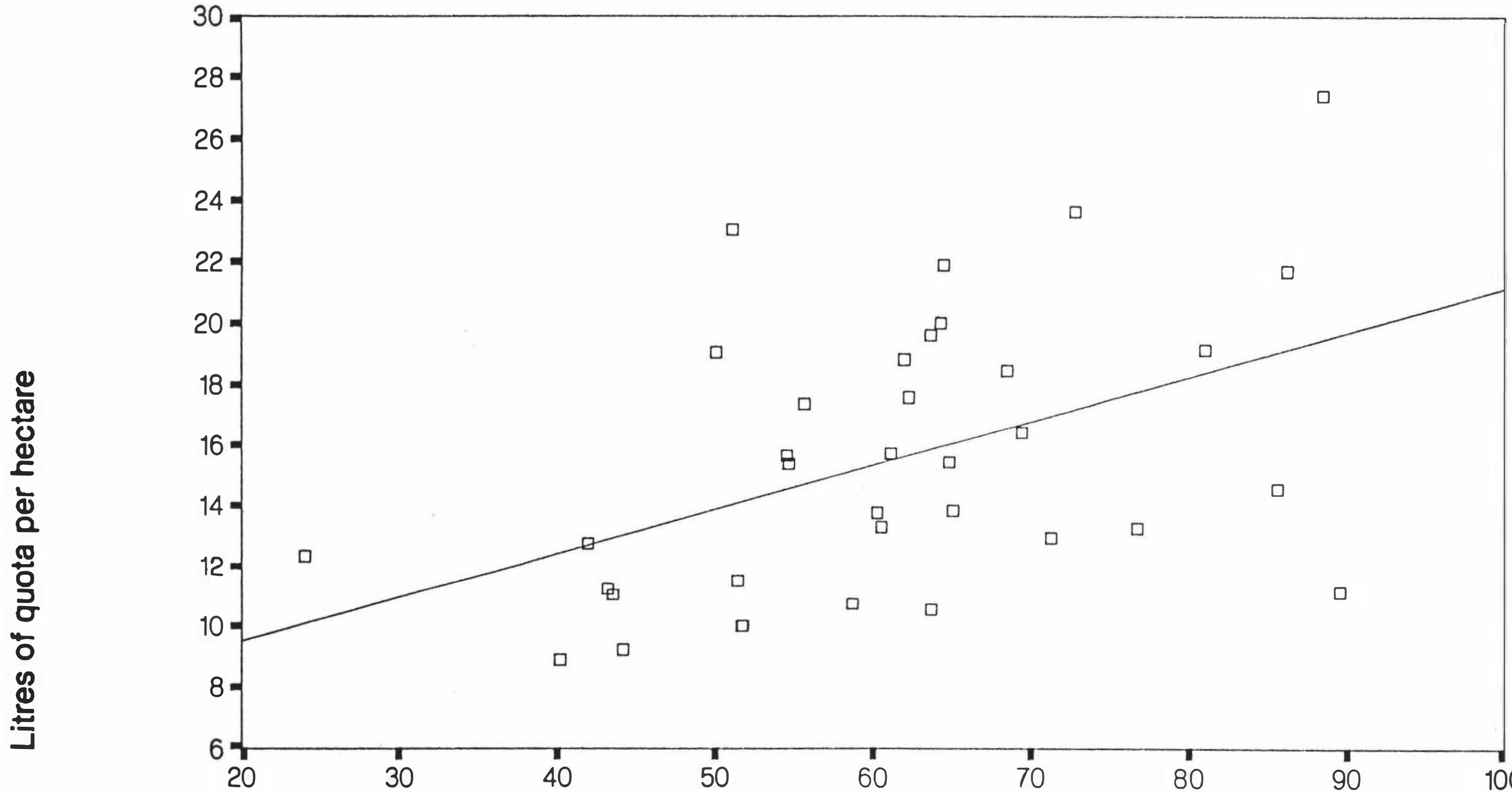


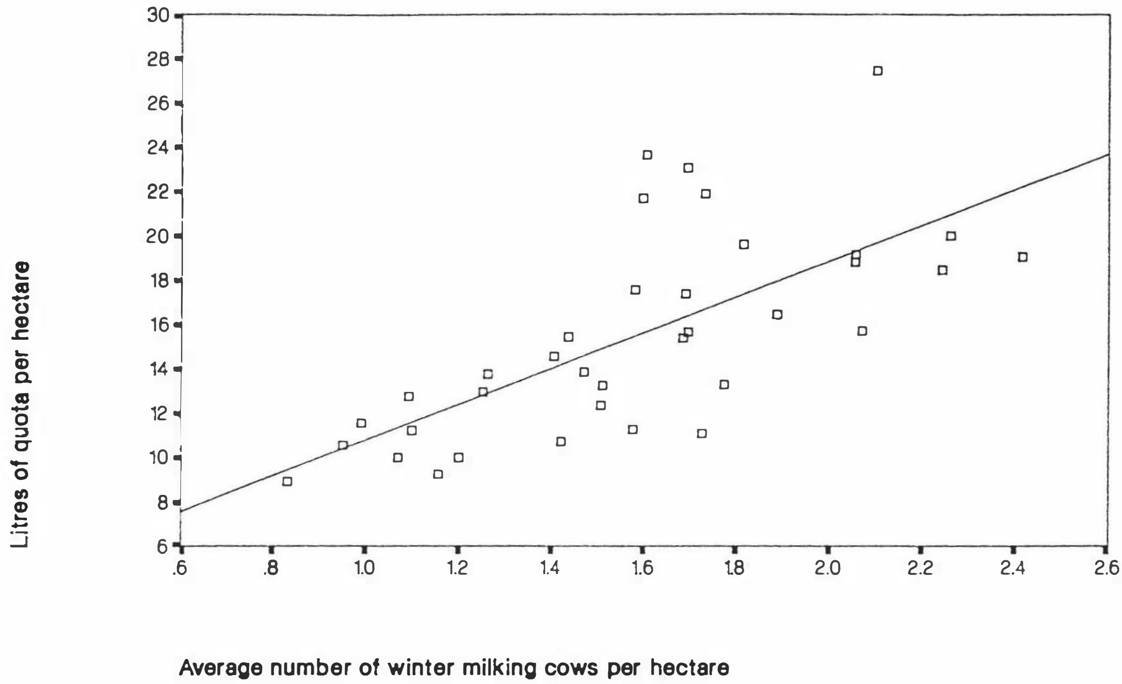
Figure 3.12 Relationship between quota per hectare and the proportion of milk sold as "quota" milk



Percentage of total production sold as quota milk

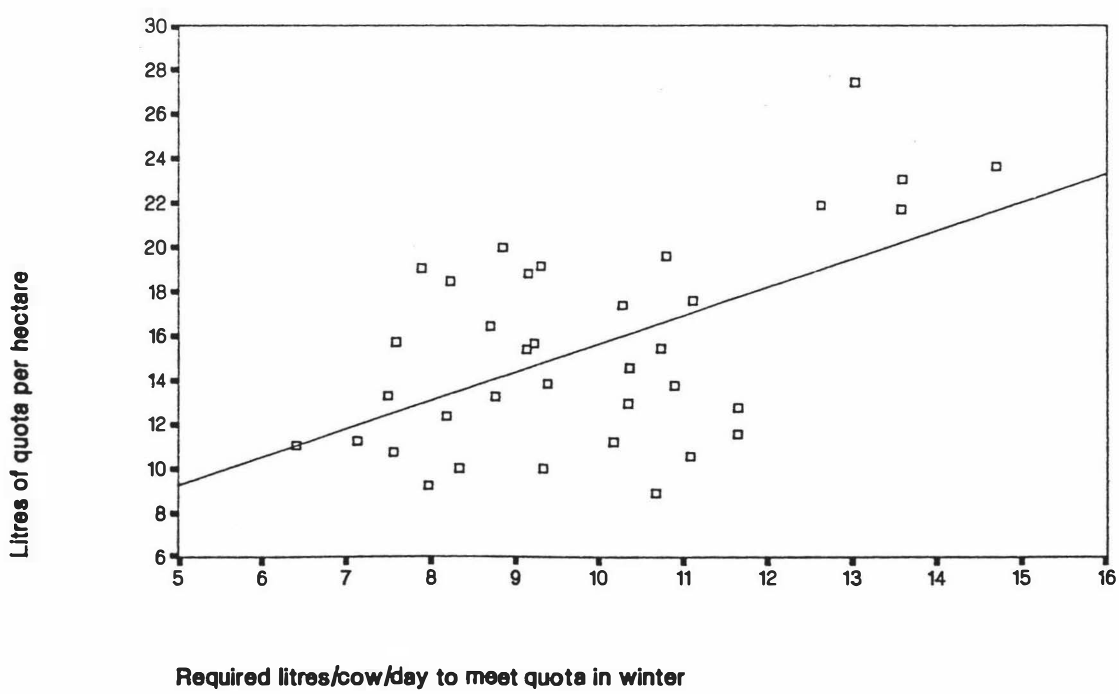
Correlation = 0.47 R squared = 0.21
Slope (S.E) = 0.15 (0.05) 2 - tailed significance = 0.0041

Figure 3.13 Relationship between quota per hectare and winter milking cows per hectare



Correlation = 0.7 R - squared = 0.48
Slope (S.E) = 8.1 (1.4) 2 - tailed significance = 0.00

Figure 3.14 Relationship between quota per hectare and the required daily milk production per winter milking cow to meet quota



Correlation = 0.55 R - squared = 0.30
Slope (S.E) = 1.3 (0.33) 2 - tailed significance = 0.00

3.1.2 Changes in Pasture cover and cow condition score over winter

3.1.2.1 Farm average pasture cover

Average Pasture cover (kgDM/Ha) was measured in early May and again in late July of 1988. Pasture cover data is summarized in Table 3.3 and given for individual farms in Appendix 1.

Table 3.3 Summary of pre and post grazing herbage masses and changes in pasture cover over winter on town milk farms.

VARIABLE	MEAN	STD DEV	MIN	MAX
Pre-grazing herbage mass (May)	1991	468	1175	3020
Post-grazing herbage mass (May)	1113	183	785	1535
Farm cover (kgDM/Ha) (May)	1551	259	1107	2072
Pre-grazing herbage mass (July)	1713	384	1160	2750
Post-grazing herbage mass (July)	961	224	560	1505
Farm cover (kgDM/Ha) (July)	1337	263	957	1978
Change in cover (kgDM/Ha)	-215	263	-803	319

The majority of farms (75%) showed a decline in Average Pasture cover while a smaller number (25%) of farms showed an increase in cover. Mean farm cover at the end of July (1337 kgDM/Ha) was significantly lower ($P<0.05$) than the May measurement of 1551 kgDM/Ha.

3.1.2.2 Average Cow condition score.

A random sample of approximately 20 cows per herd were condition scored in early May and another sample was scored in late July of 1988. Cow condition score data is summarized in Table 3.4 and given for individual herds in Appendix 1.

Table 3.4 Summary of condition score changes for autumn calving cows on town milk farms

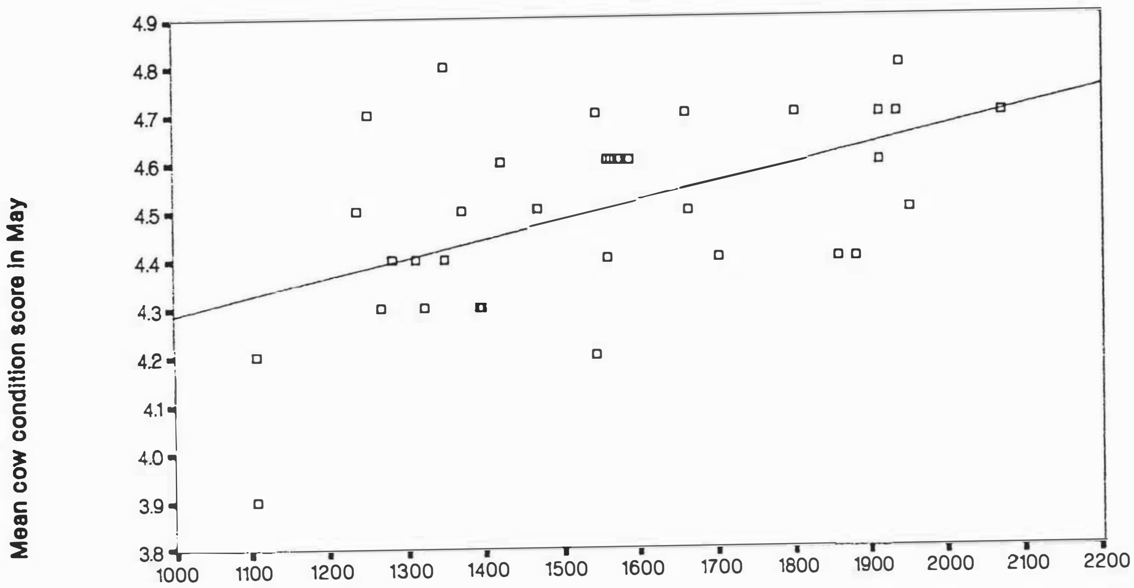
VARIABLE	MEAN	STD DEV	MINIMUM	MAXIMUM
Condition score in May	4.5	0.19	3.9	4.8
Condition score in July	4.4	0.21	3.8	4.7
Change in condition score	-0.1	0.20	-0.7	0.3

61% of herds showed decreases in average cow condition score while 22% of herds showed increases in condition score over winter. 17% of herds showed no change in condition score at all. Mean cow condition score of 4.4 in late July was significantly lower ($P<0.05$) than the May estimate of 4.5.

3.1.2.3 Relationship between condition score and average farm cover.

The relationship between cow condition score and average farm cover in both May and July was examined using regression. The results (shown in Figures 3.15 and 3.16) show positive correlations in both months although the relationship was stronger (higher R squared value) in May compared with July.

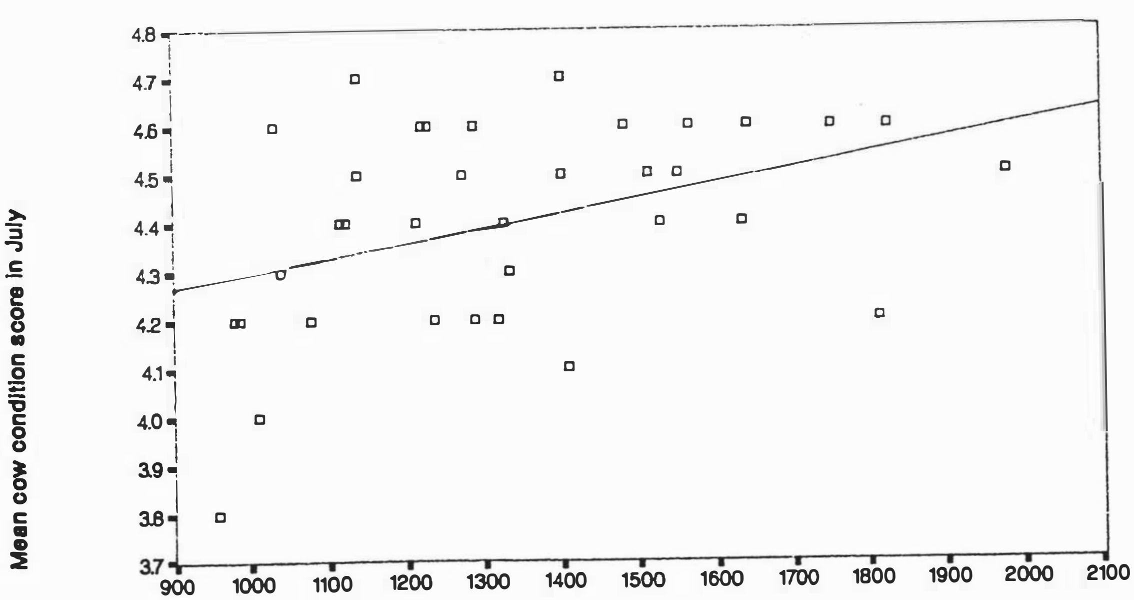
Figure 3.15 Relationship between mean cow condition score and average farm cover in may



Average farm cover in May (kgDM/Ha)

Correlation = 0.52 R - squared = 0.27
Slope (S.E.) = 0.0039 (0.0011) 2 - tailed significance = 0.001

Figure 3.16 Relationship between mean cow condition score and average farm cover in July



Average farm cover in July (kgDM/Ha)

Correlation = 0.38 R - squared = 0.15
Slope (S.E.) = 0.0031 (0.0013) 2 - tailed significance = 0.020

3.1.3 Production levels per cow achieved on Town milk farms during Winter 1988

3.1.3.1 Daily volumetric milk production.

Average daily milk production per cow for all farms has been calculated on a weekly basis for the time period 1 May to 31 July 1988. This information is summarized in Table 3.5 and illustrated in Figure 3.17. Average daily milk production per cow was highest in early May and then decreased from 14.2 to 12.4 litres/cow/day in late May. Production then gradually increased through June and July before decreasing to 13.0 litres/cow/day at the end of July. Mean production for the 13 week period for all farms was 12.63 litres/cow/day and ranged from under 8 litres (lowest farm) to 19 litres (highest farm). A distribution graph for the level of daily production per cow is given in Figure 3.18.

Table 3.5 District Average Daily milk production per cow by week.

WEEK	DISAV	MAX	MIN
1	14.5	20.3	9.0
2	14.3	20.0	8.6
3	14.2	19.2	7.2
4	12.4	18.4	6.8
5	12.9	19.0	7.0
6	13.4	18.5	6.6
7	13.7	23.1	7.2
8	13.2	19.5	6.9
9	13.6	20.5	6.5
10	13.6	20.2	6.8
11	13.8	20.2	7.7
12	13.6	17.4	8.6
13	13.0	16.9	8.7

Max - Milk production (litres per cow per day) for the herd which achieved the highest value within each week.
Min = Milk production (litres per cow per day) for the herd which achieved the lowest value within each week.
Disav = Average litres per cow per day for all cows in the district during each week in the winter.

The maximum for week 7 (23.1 litres per cow per day) is a particularly high result which may have come about from an error in recording the exact date of drying off of a proportion of the herd on the farm concerned. If they were recorded as being dried off a few days earlier than they actually were, herd size would have dropped while milk production remained constant resulting in an inflated estimate of per cow production.

Figure 3.17 (a) Mean milk yield per cow per day across all farms during winter

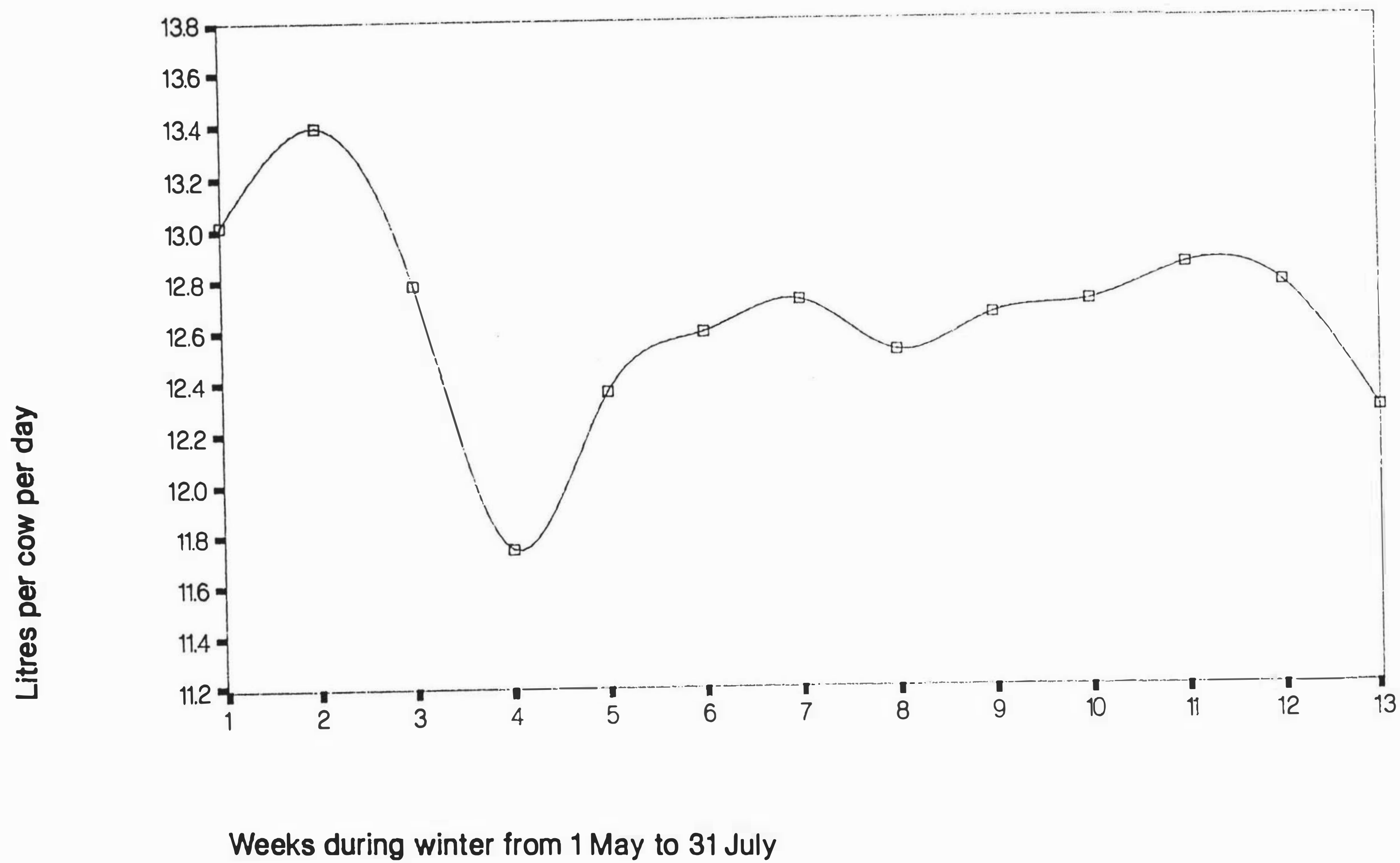
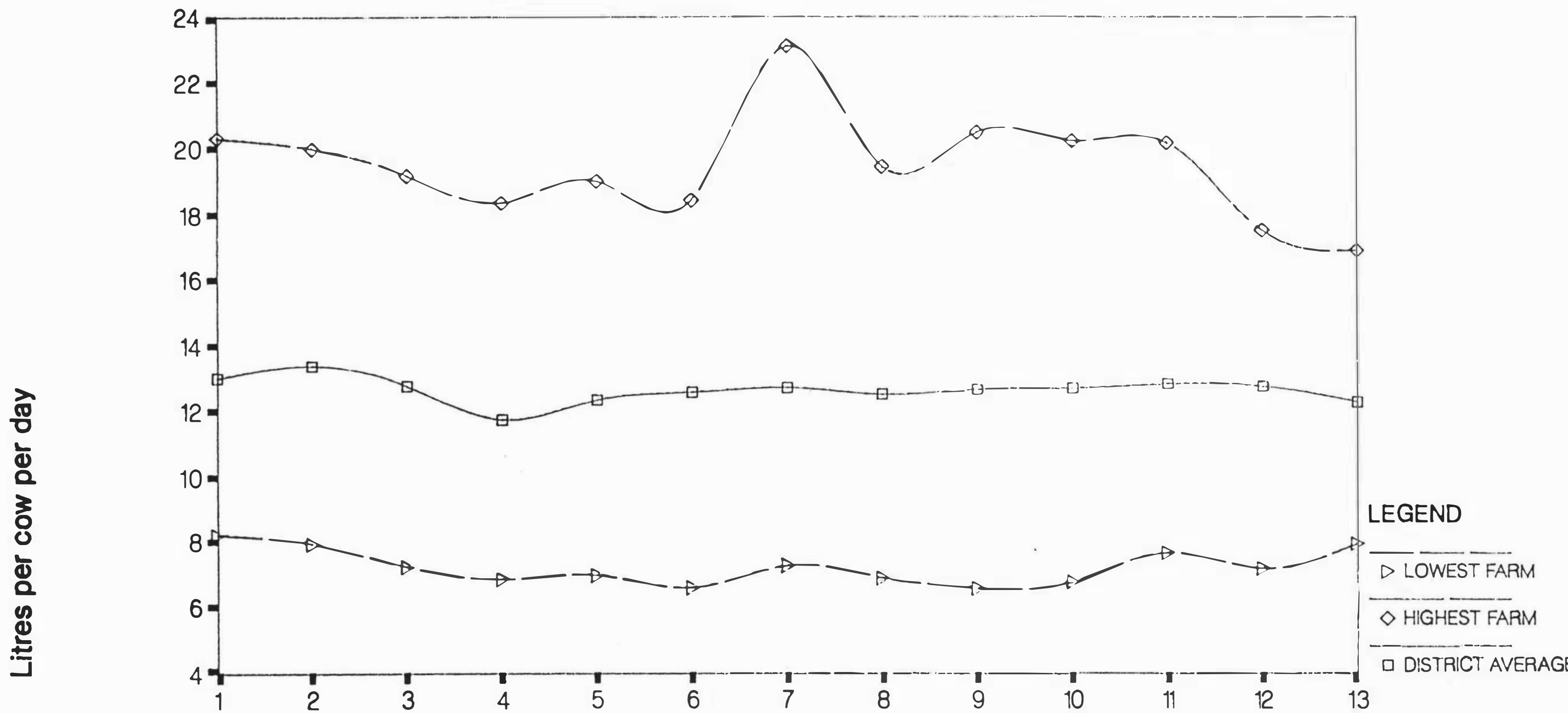
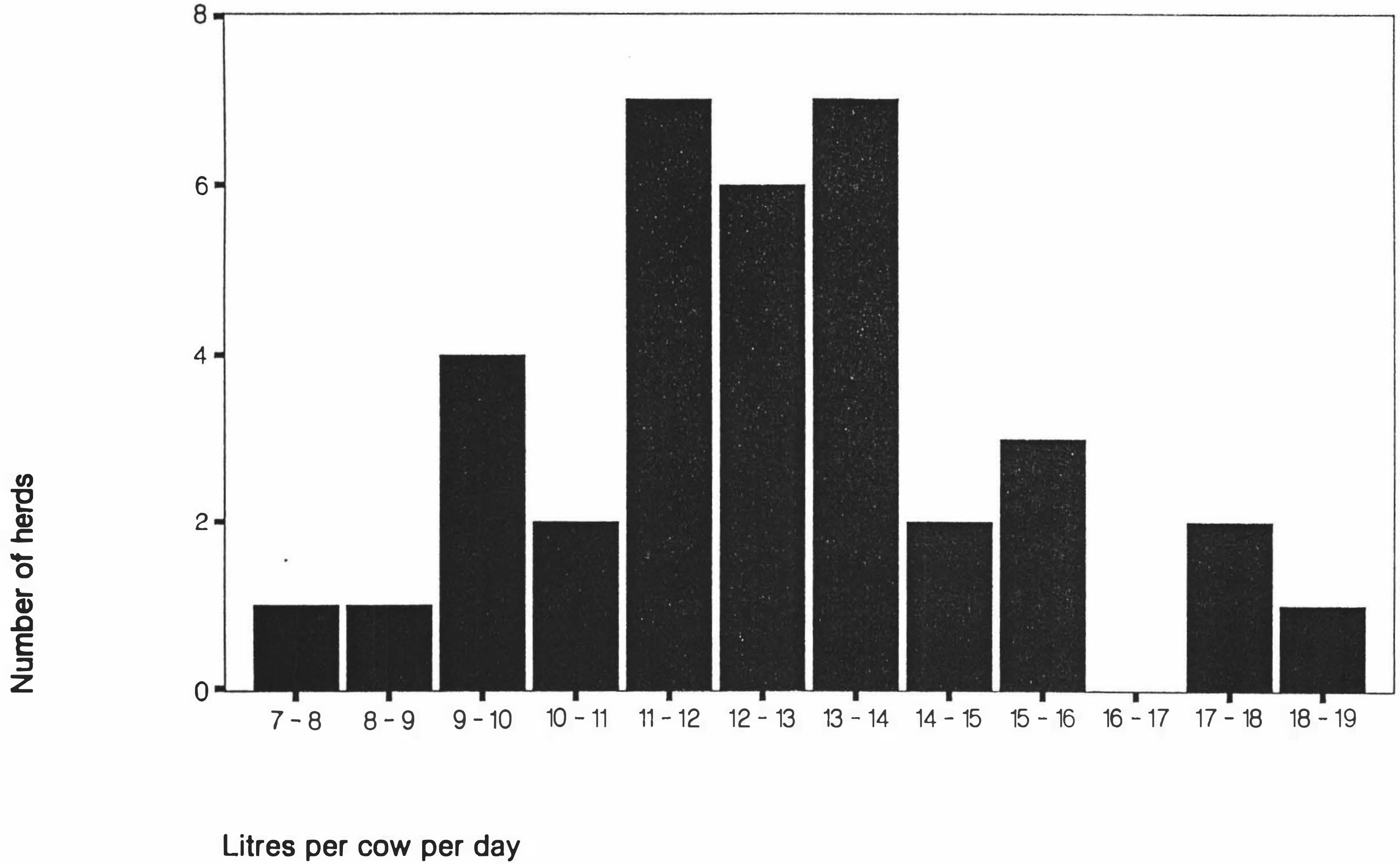


Figure 3.17 (b) Mean milk yield per cow per day with maximum and minimum values shown



Weeks during winter from 1 May to 31 July

Figure 3.18 Distribution of average daily milk production per cow during winter on town milk farms



3.1.3.2 Average daily production of Milkfat, Protein, and Total solids.

Milkfat, protein and Total solids production (kg/cow/day) have been calculated on a 10-day period basis for the 92 day period from 1 May to 31 July. Production of the three components is summarized in Table 3.6 and illustrated in Figures 3.19, 3.20 and 3.21. Per cow production of Milkfat, Protein and Total solids all declined over the winter period. The largest percentage drop from the beginning to the end of the survey period was for protein (17%) followed by milkfat (15%) and Total solids (14%). The pattern of production is similar for all three components over winter. There is a sharp decrease in early May followed by 2 peaks in June and July (Figures 3.19, 3.20, 3.21).

Table 3.6 Average daily production of Milkfat, Protein and Total solids (kg/cow/day) by ten day period.

TDAY	FCD	PCD	TSCD
1		.63	.49 1.90
2		.60	.45 1.78
3		.57	.42 1.69
4		.58	.44 1.89
5		.57	.45 1.63
6		.57	.43 1.66
7		.58	.44 1.74
8		.56	.43 1.70
9		.55	.42 1.66

FCD = Kg milkfat / cow / day
PCD = Kg protein / cow / day
TSCD = Kg total solids / cow / day
TDAY = Ten day period during winter

Figure 3.19 Mean milkfat yield per cow per day across all farms during winter

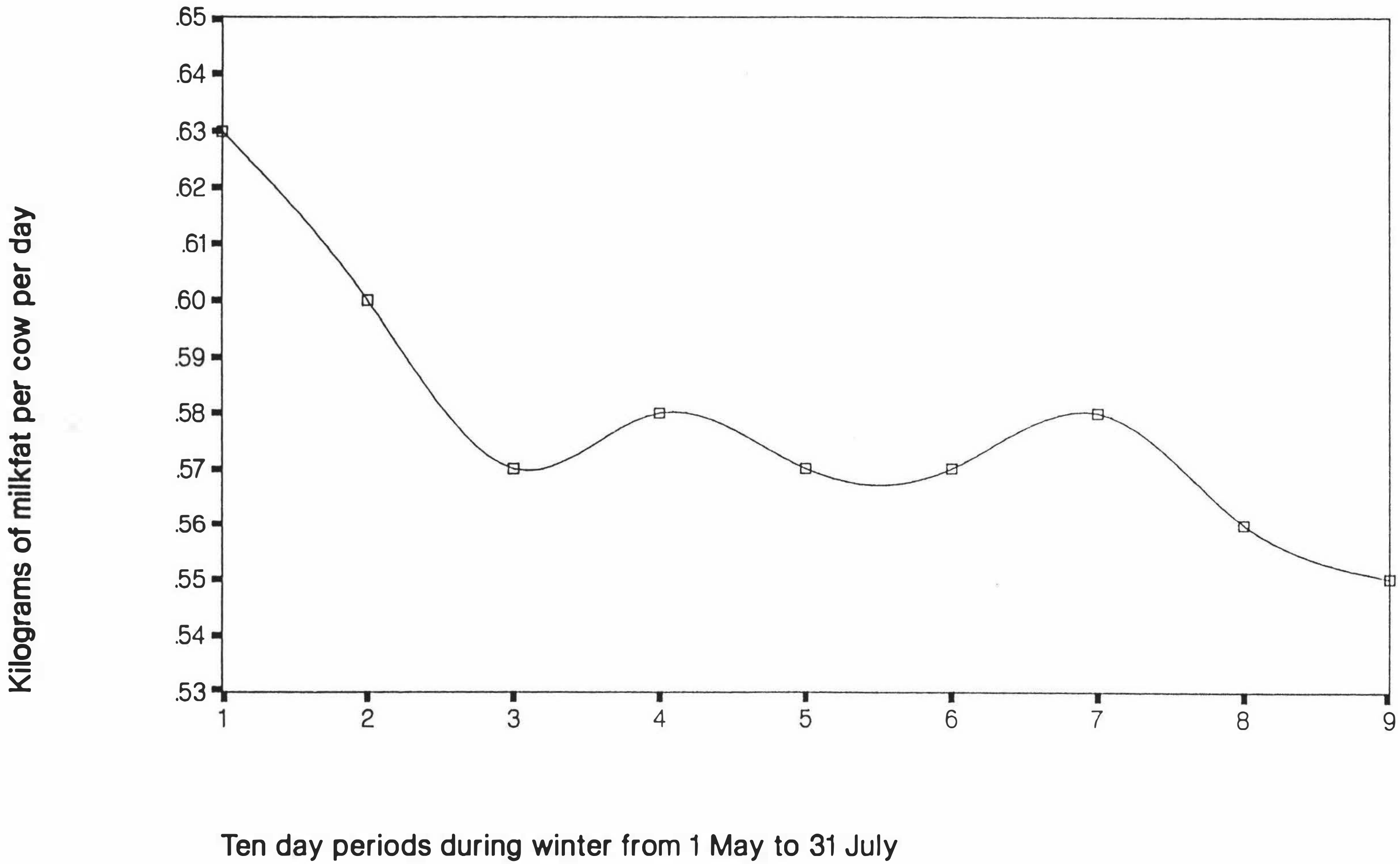


Figure 3.20 Mean protein yield per cow per day across all farms during winter

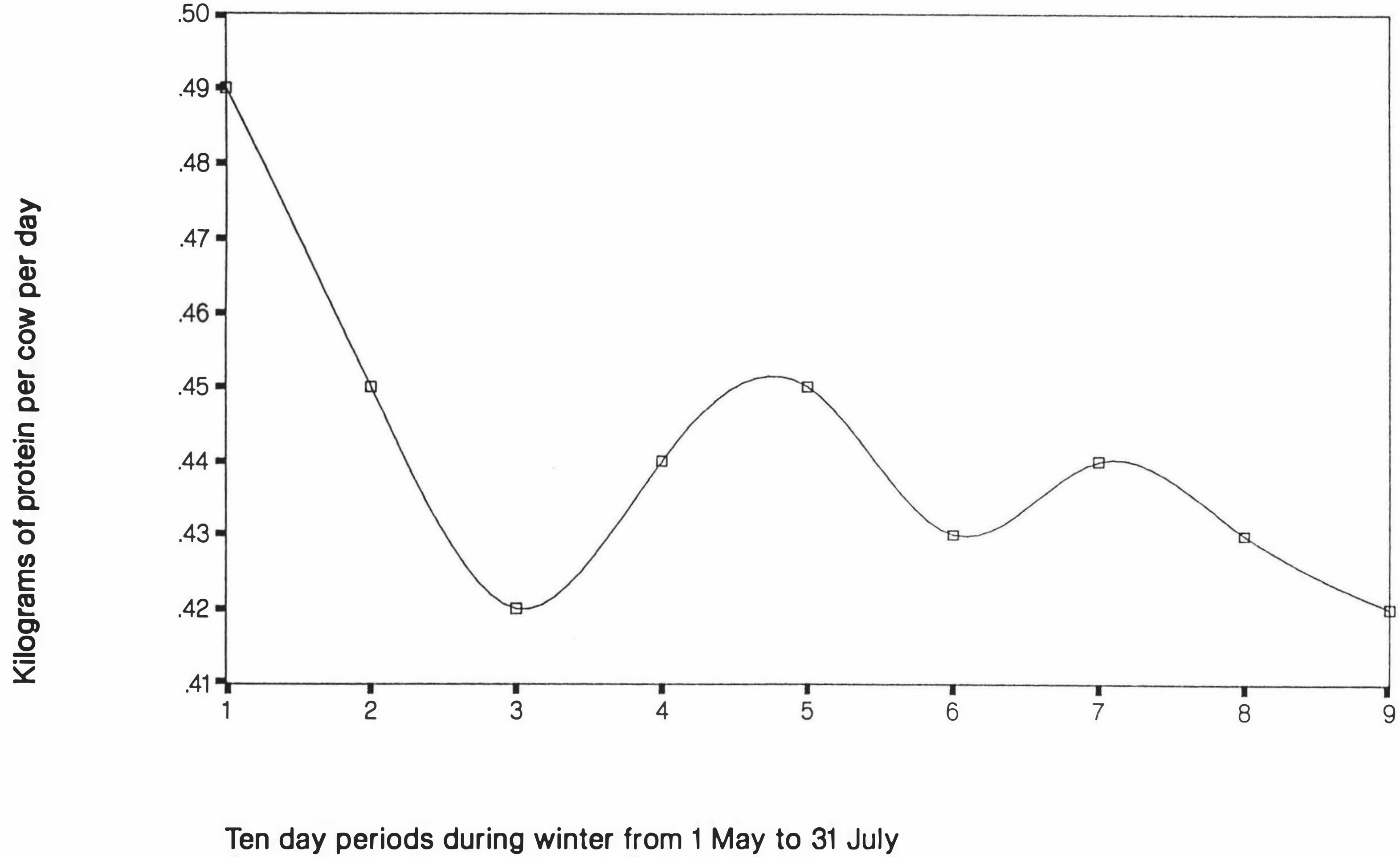
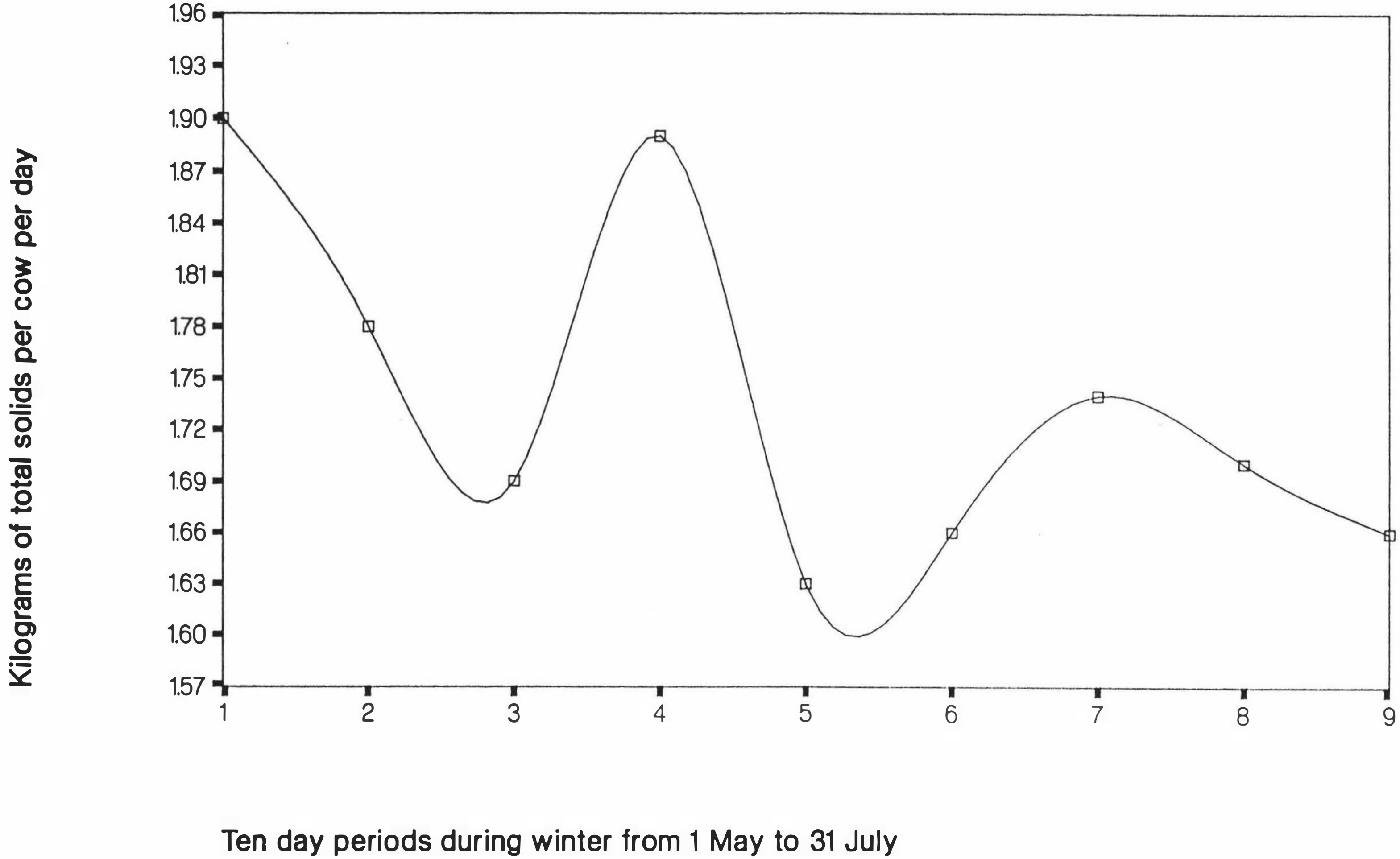


Figure 3.21 Mean yield of total solids per cow per day across all farms in winter



Mean and range information for individual milk component production for the whole 92 day period for all farms is summarized in Table 3.7

Table 3.7 Summary of milk component production over winter. (kilograms component per cow per day)

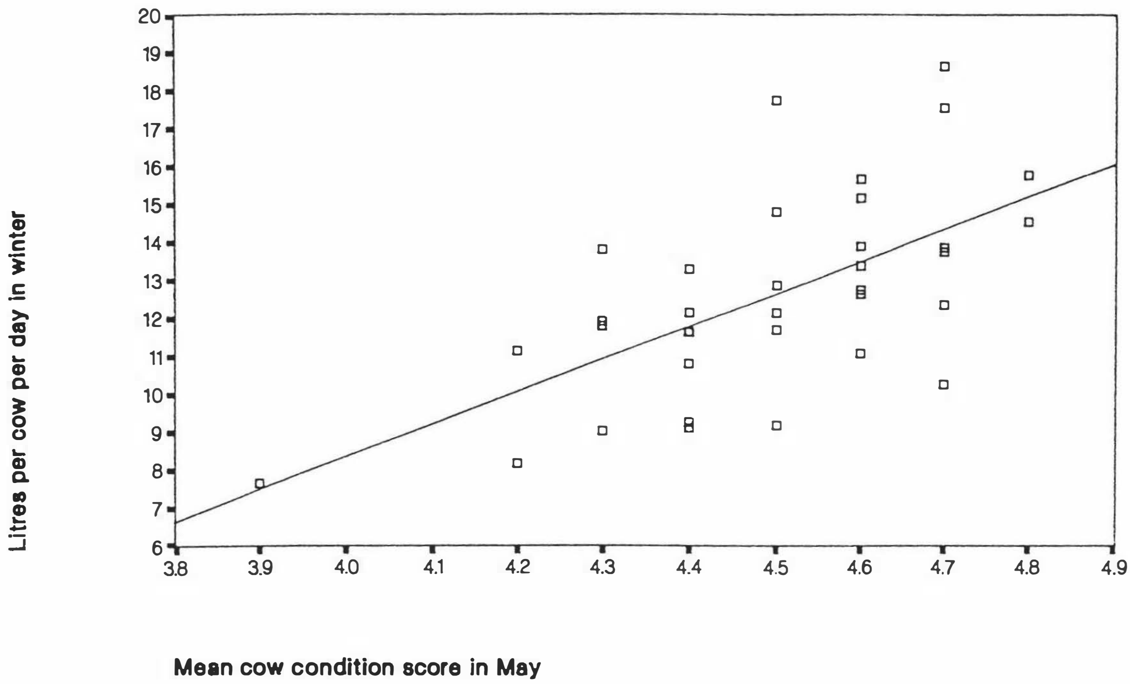
VARIABLE	MEAN	STD DEV	MINIMUM	MAXIMUM
Average fat/cow/day in winter	0.564	0.110	0.36	0.76
Average protein/cow/day in winter	0.429	0.090	0.26	0.61
Average tot sol/cow/day in winter	1.684	0.357	1.04	2.40

3.1.4 The association between Average daily milk production per cow over winter and other variables as shown by regression.

Average daily milk production per cow was found to be positively correlated with cow condition score and pasture cover in May (Figure 3.22, 3.23). Farms with high per cow production levels in winter also had high levels of total annual production per cow and per hectare (Figure 3.24. 3.25). Although not statistically significant, average daily milk production per cow was also positively correlated with digestibility of supplement (silage or hay). This trend (illustrated in Figure 3.26) showed an increase of 0.13 litre of milk per cow daily for each increase of 1% in digestibility of supplement.

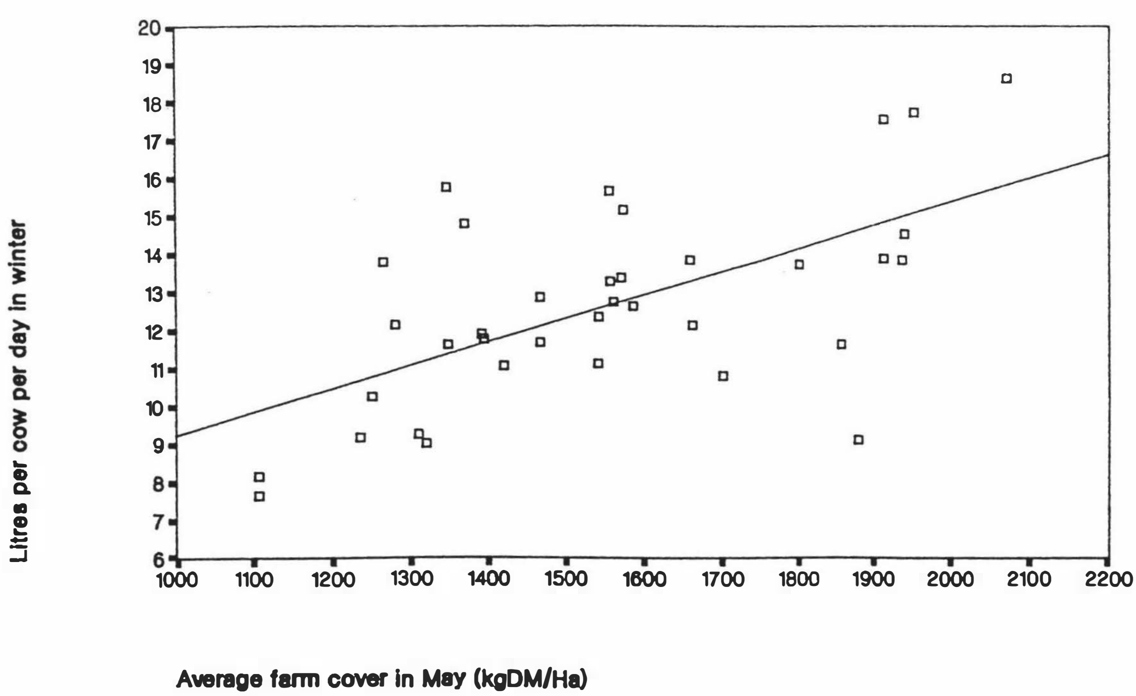
Average daily milk production per cow was negatively correlated with average fat% and average somatic cell count measured over the same winter period. Significant ($p<0.05$) regression lines for per cow production on Fat% and somatic cell count are shown in Figures 3.27, 3.28. The regression analysis clearly shows that milk from the high producing herds had a lower concentration of milkfat. High producing herds also had considerably lower somatic cell counts which may reflect a lower incidence of mastitis infection in these herds.

Figure 3.22 Relationship between average daily milk production per cow during winter and mean cow condition score in May



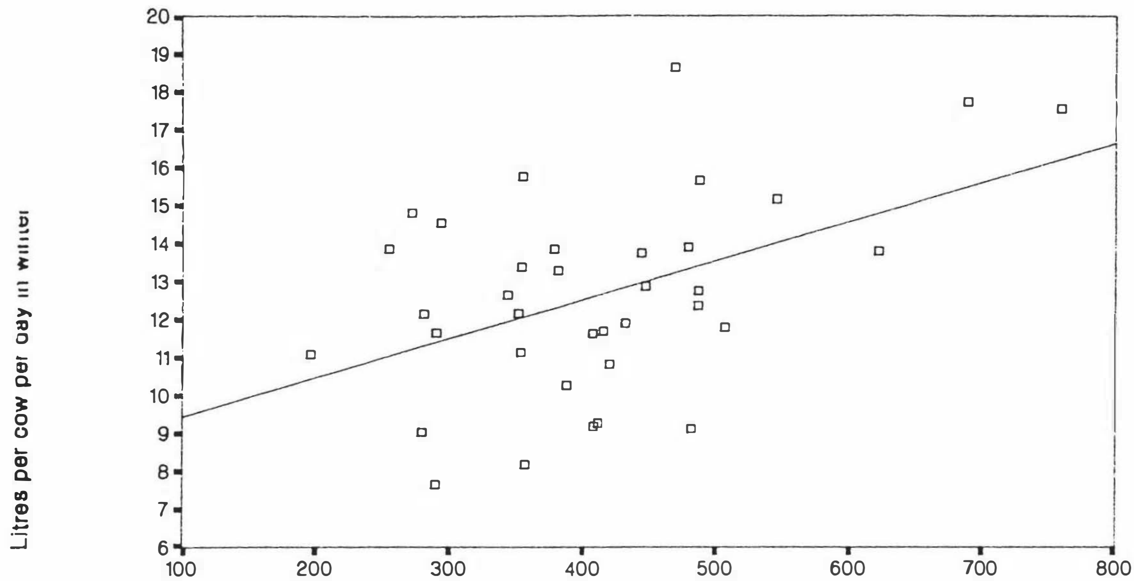
Correlation = 0.63   R - squared = 0.40
Slope (S.E.) = 0.86 (0.02)   2 - tailed significance = 0.00

Figure 3.23 Relationship between average daily milk production per cow during winter and average farm cover in May



Correlation = 0.61   R - squared = 0.37
Slope (S.E.) = 0.0062 (0.0014)   2 - tailed significance = 0.0001

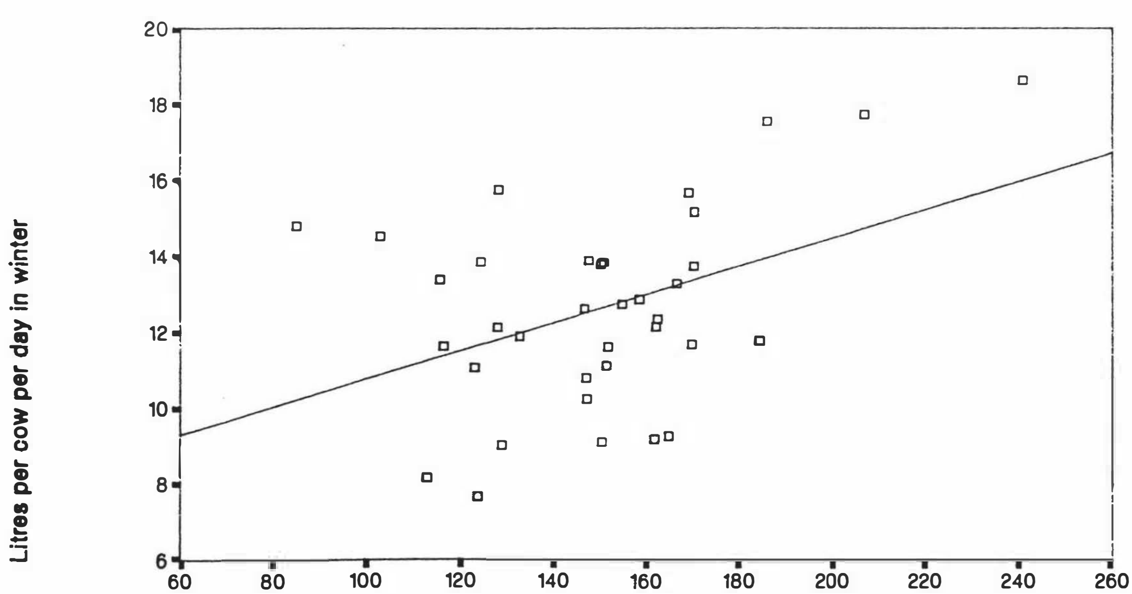
Figure 3.24 Relationship between average daily milk production per cow during winter and milkfat per hectare in the 1987/88 season



Kilograms of milkfat produced per hectare in 1987/88

Correlation = 0.47 R - squared = 0.22
Slope (S.E.) = 0.010 (0.003) 2 - tailed significance = 0.0041

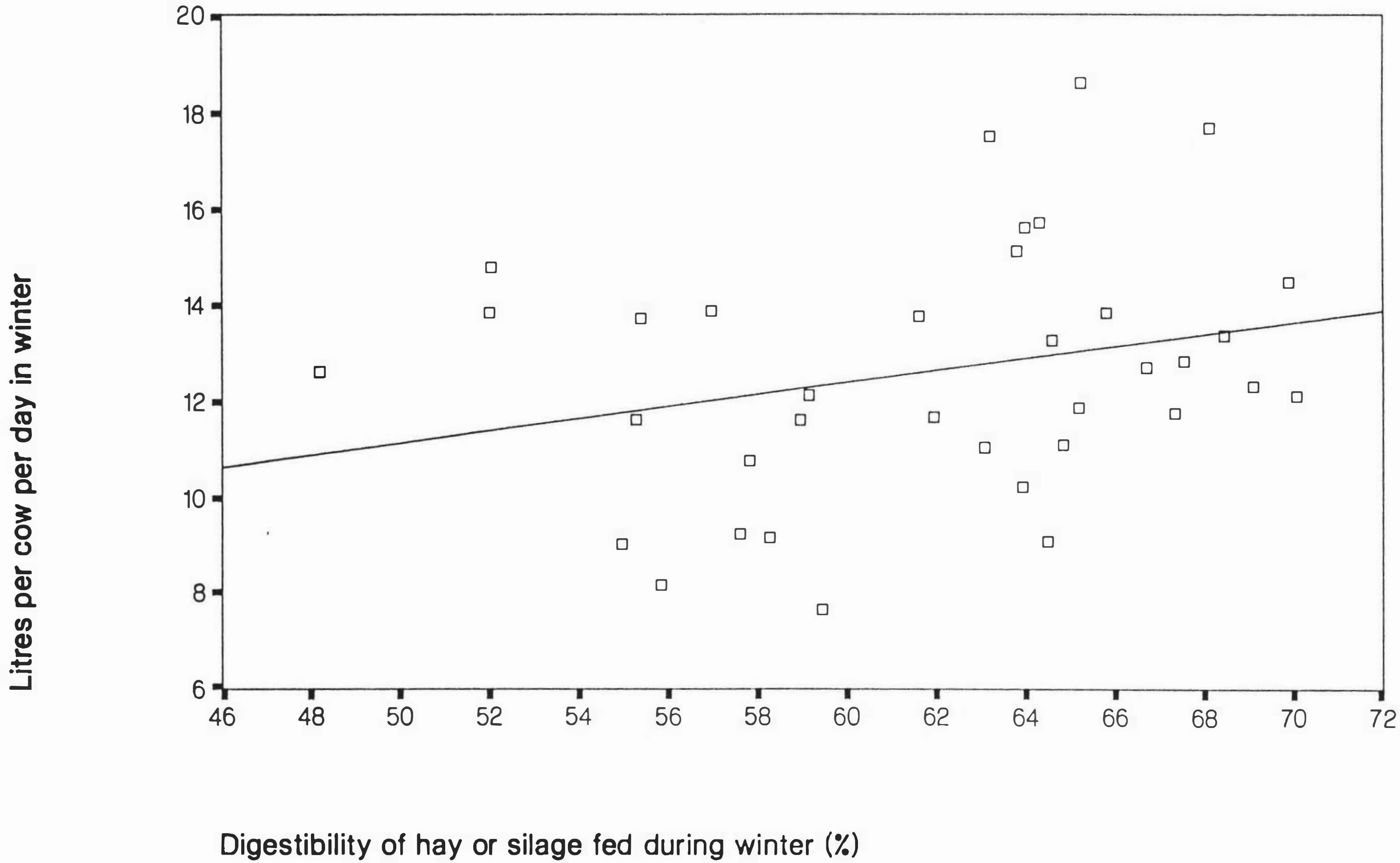
Figure 3.25 Relationship between average daily milk production per cow in winter and total milkfat produced per cow in 1987/88 season



Kilograms of milkfat produced per cow in 1987/88

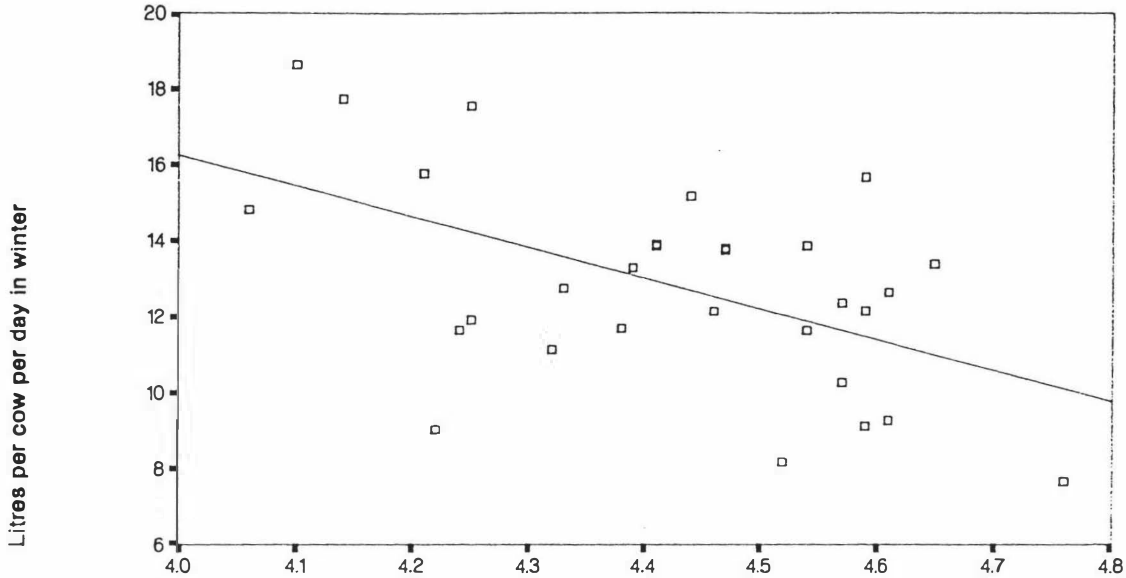
Correlation = 0.42 R - squared = 0.18
Slope (S.E.) = 0.037 (0.014) 2 - tailed significance = 0.011

Figure 3.26 Relationship between average daily milk production per cow in winter and digestibility of hay or silage fed



Correlation = 0.26 R - squared = 0.07
Slope (S.E) = 0.13 (0.08) 2 - tailed significance = 0.12

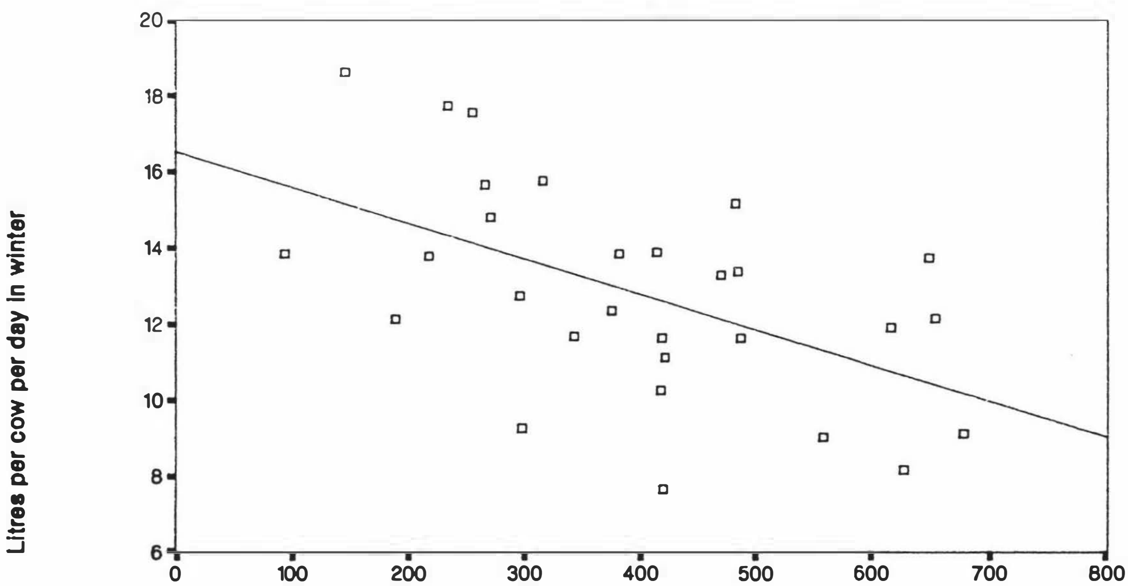
Figure 3.27 Relationship between average daily milk production per cow in winter and average fat percentage in milk



Average milkfat % during winter

Correlation = -0.53 R - squared = 0.28
Slope (S.E.) = -8.11 (2.46) 2 - tailed significance = 0.0027

Figure 3.28 Relationship between average daily milk production per cow in winter and average somatic cell count in milk



Average somatic cell count during winter (1000/ml)

Correlation = -0.53 R - squared = 0.29
Slope (S.E) = -0.0094 (0.0028) 2 - tailed significance = 0.0028

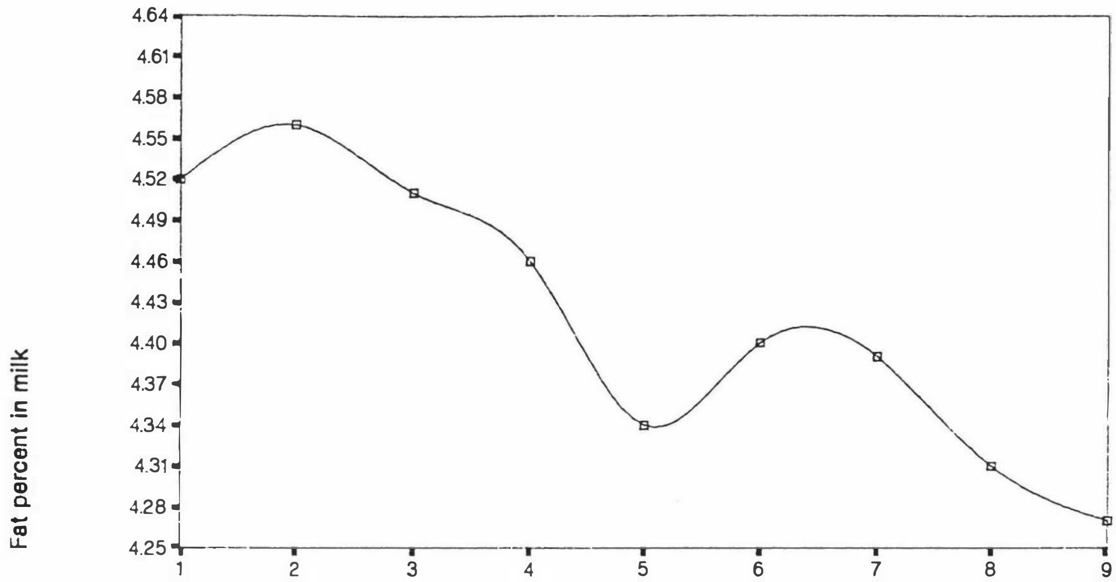
3.1.5 Trends in milk composition over winter.

The percentage of Milkfat, Protein, Total solids and the somatic cell count for milk produced from 1 May to 31 July has been calculated on a 10-day average basis. Changes in milk composition are summarized in Table 3.8 and illustrated in Figures 3.29, 3.30, 3.31, 3.32. The proportion of the 4 composition variables measured in milk fluctuated throughout the winter although all showed a downward trend.

Table 3.8 Changes in milk composition over winter by ten day periods.

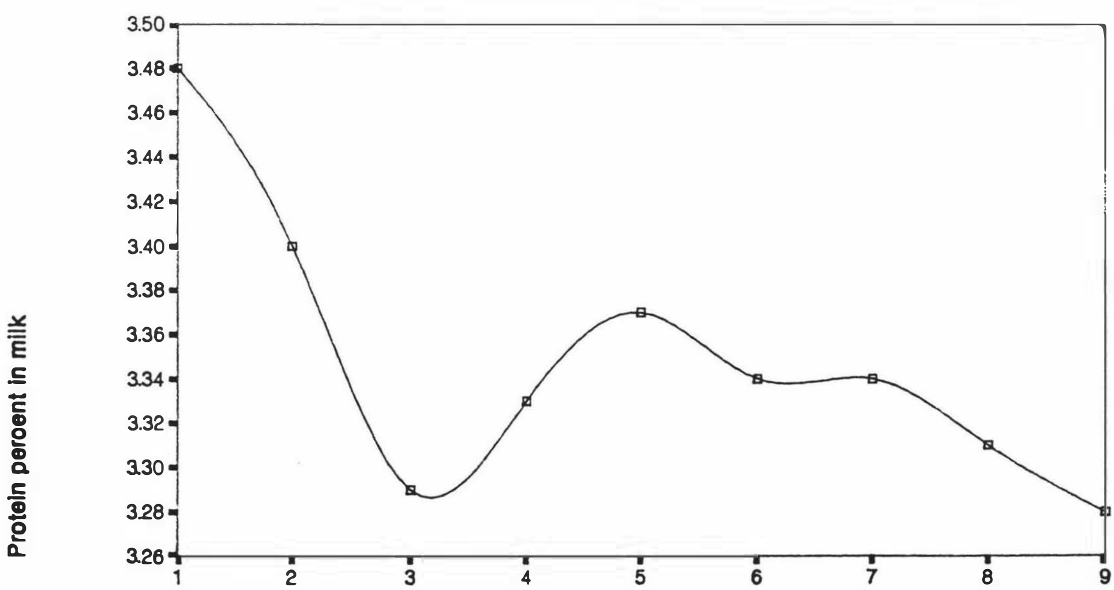
TDAY	FAT%	PRO%	TOTS%	SOMCELL/ML * 1000
1	4.52	3.48	13.36	429
2	4.56	3.40	13.31	458
3	4.51	3.29	13.19	358
4	4.46	3.33	13.34	382
5	4.34	3.37	13.27	443
6	4.40	3.34	13.08	395
7	4.39	3.34	13.09	387
8	4.31	3.31	13.09	321
9	4.27	3.28	12.81	315

Figure 3.29 Mean milkfat % across all farms during winter



Ten day periods during winter from 1 May to 31 July

Figure 3.30 Mean protein % across all farms during winter



Ten day periods during winter from 1 May to 31 July

Figure 3.31 Mean total solids % across all farms during winter

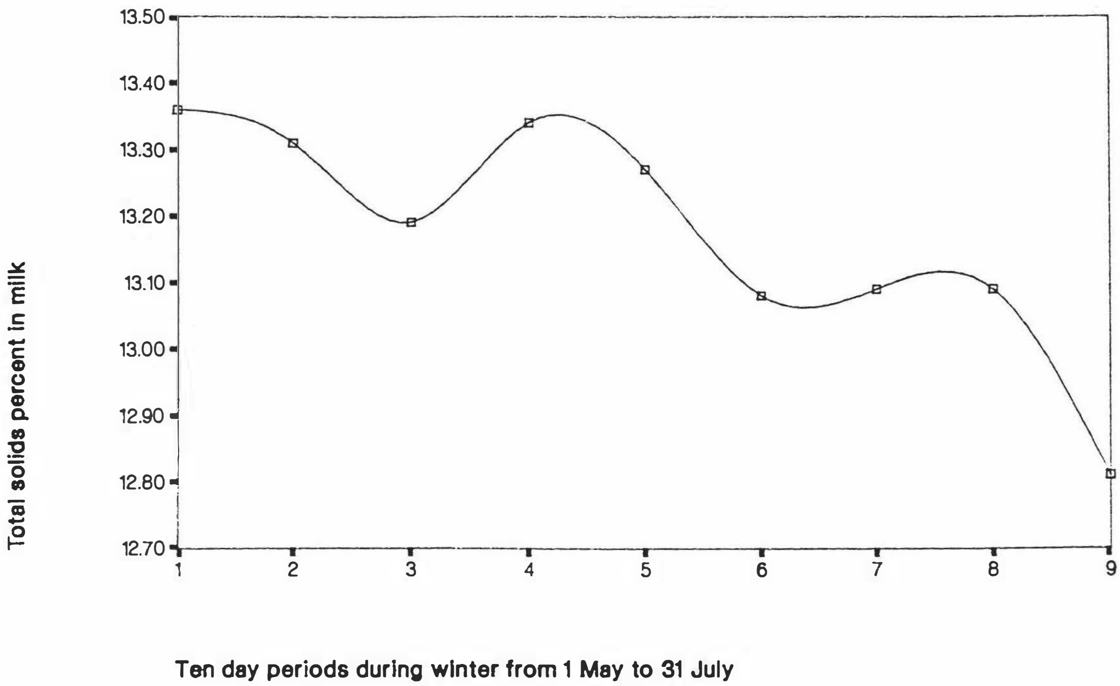
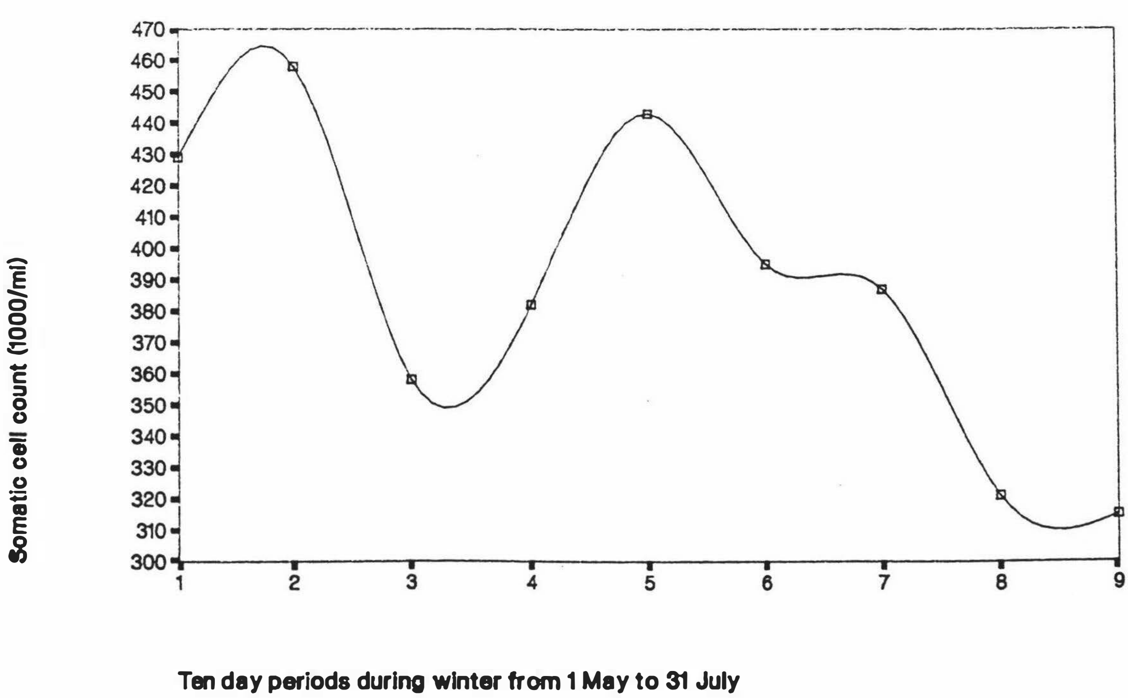


Figure 3.32 Mean somatic cell count across all farms during winter



Mean and range information for milk composition for the whole 13 week period for all farms is summarized in Table 3.9

Table 3.9 Summary of Milk composition over winter.

VARIABLE	MEAN	STD DEV	MINIMUM	MAXIMUM
District Av. fat %	4.4	0.101	4.27	4.56
District Av. protein %	3.3	0.061	3.28	3.48
District Av. tot solids %	13.2	0.173	12.81	13.36
Dis. Av. som cell count.	388	50.6	315.6	458.7

3.1.6 Comparison of town milk farmers who calved all winter milking cows in Autumn and farmers who retained some spring calvers through winter.

11 of the 36 farms surveyed (31%) were identified as having all autumn calving cows in their winter milking herds. The remaining 25 farms (69%) milked varying proportions of late lactation cows (typically October, November, December calving cows) during winter. A comparison of farm and production statistics for these two groups is presented in Table 3.10.

The All Autumn cow herds ("AA") were milked on significantly larger farms ($P<0.05$) than the herds with Some Spring cows ("SS") where farm size is measured by total MF production, total herd size or quota size for 1987/88. AA farms had higher levels of total MF production per hectare and per cow than SS farms (not significant). AA herds had a slightly higher condition score in May and a significantly higher condition score in July than SS herds. AA herds had significantly higher winter milk production than SS herds for all parameters measured which were total litres, milkfat, protein and total solids per cow per day. There were however no significant differences in milk composition between the two groups.

Table 3.10 Comparison of winter milking herds with all autumn or some spring calving cows.

VARIABLE	MEAN SS	MEAN AA	SIGNIFICANCE (2 Tail Prob.)
Area in Hectares	61.8	82.6	0.074
Herd size	153.3	246.7	0.000
Stocking rate	2.6	2.9	0.134
Milkfat production (kg) for 1987/88	22305	39555	0.001
Total production per hectare (kgMF/Ha/yr	385.0	465.1	0.072
Average per cow production (kgMF/cow/yr)	147.0	155.9	0.411
Average number of cows over winter	94.5	121.5	0.081
Total Quota in litres	913	1287	0.038
Litres of quota per hectare	15.4	15.1	0.871
Proportion of milk sold as "Quota" milk	64.1	54.0	0.055
Required l/cow/day to meet quota	9.5	10.6	0.131
Average farm cover May	1523	1616	0.327
Average farm cover July	1297	1427	0.175
Condition score May	44.7	45.6	0.193
Condition score July	43.4	45.2	0.013
Average litres/cow/day in winter	11.9	14.2	0.012
Average fat per cow per day in winter	.53	.63	0.022
Average protein/cow per day in winter	.40	.48	0.017
Average tot. sol./cow per day in winter	1.58	1.90	0.018
Average milkfat % over winter	4.45	4.37	0.296
Average protein % over winter	3.35	3.35	0.663
Average total solids % over winter	13.13	13.19	0.664
Average somatic cell count (1000/ml)	405	377	0.663

3.2 A comparison of Town Milk and Seasonal Supply milk production for the 1987/88 season.

3.2.1 Comparison of farm areas, cow numbers and production

A summary of area, cow numbers and production on the two farm types is presented in Table 3.11. Individual farm data is presented in Appendix 1.

Town milk farms were significantly larger and milked more cows on average than seasonal supply farms ($P<0.05$). Town milk farms also produced 22% more total milkfat in the 1987/88 year than seasonal supply farms (not significant). Seasonal supply farms however had significantly higher production per hectare and higher production per cow (not significant) than town milk farms. Stocking rate was marginally higher on seasonal supply farms (not significant).

Table 3.11 Comparison of area, cow numbers and production

GROUP 1 = Town milk farms

GROUP 2 = Seasonal supply farms

VARIABLE		NUMBER OF CASES	MEAN	STANDARD ERROR	POOLED VARIANCE ESTIMATE T VALUE	POOLED VARIANCE ESTIMATE 2-TAIL PROB.
AREA	Area in Hectares					
	GROUP 1	36	66	3.9	2.76	0.008
	GROUP 2	22	49	4.7		
COWNO	Total herd size					
	GROUP 1	36	182	13.0	2.36	0.022
	GROUP 2	22	136	13.1		
SR	Stocking rate (Milking cows/Hectare)					
	GROUP 1	36	2.75	0.09	-0.70	0.484
	GROUP 2	22	2.85	0.12		
PROD	Milkfat production (kg) for 1987/88					
	GROUP 1	36	27576	2439	1.41	0.163
	GROUP 2	21	22436	2262		
PRODHA	Total prod. per hectare (kgMF/Ha/yr)					
	GROUP 1	36	412	19.8	-2.03	0.047
	GROUP 2	21	474	21.5		
PRODCOW	Average per cow prod. (kgMF/cow/yr)					
	GROUP 1	36	150	4.9	-1.86	0.068
	GROUP 2	21	163	4.2		

3.2.2 Comparison of town milk and seasonal supply farms for feeding policy.

3.2.2.1 Hay and silage

The quantities of Hay and silage conserved and fed on the two farm types is summarized in Table 3.12(a) and given in Appendix 1.

During 1987/88, town milk farmers made and fed significantly more silage and total supplements than seasonal supply farmers. Town milk farmers also made more hay (not significant) and fed more hay (significant) than seasonal supply farmers. Town milk farmers also brought in 45% more supplement DM per cow from elsewhere although this difference was not significant (Table 3.12b).

Table 3.12 (a) Comparison of supplements made and fed

GROUP 1 = Town milk farms

GROUP 2 = Seasonal supply farms

VARIABLE		NUMBER OF CASES	MEAN	STANDARD ERROR	POOLED VARIANCE ESTIMATE T VALUE	POOLED VARIANCE ESTIMATE 2-TAIL PROB.
HMC	Hay made (kgDM/cow/year)					
	GROUP 1	36	213	40.1	1.32	0.191
	GROUP 2	22	136	36.7		
SMC	Silage made (kgDM/cow/year)					
	GROUP 1	36	297	46.4	2.52	0.015
	GROUP 2	22	133	32.9		
TSMC	Total supplements made (kgDM/cow)					
	GROUP 1	36	510	61.6	2.73	0.009
	GROUP 2	22	269	51.3		
HFC	Hay fed (kgDM/cow/year)					
	GROUP 1	36	385	46.5	2.34	0.023
	GROUP 2	22	230	36.0		
SFC	Silage fed (kgDM/cow/year)					
	GROUP 1	36	357	47.9	2.43	0.018
	GROUP 2	22	190	39.3		
TSFC	Total supplements fed (kgDM/cow/year)					
	GROUP 1	36	741	362.7	3.56	0.001
	GROUP 2	22	420	52.3		

Table 3.12 **(b) Comparison of supplements bought**

GROUP 1 = Town milk farms

GROUP 2 = Seasonal supply farms

VARIABLE		NUMBER OF CASES	MEAN	STANDARD ERROR	POOLED VARIANCE ESTIMATE T VALUE	POOLED VARIANCE ESTIMATE 2-TAIL PROB.
HBC	Hay brought in (kgDM/cow/year)					
	GROUP 1	36	229	43.5	1.76	0.084
	GROUP 2	22	121	31.3		
SBC	Silage brought in (kgDM/cow/year)					
	GROUP 1	36	85	25.2	0.17	0.866
	GROUP 2	22	78	34.5		
TSBC	Total supp. bought (kgDM/cow/year)					
	GROUP 1	36	314	48.2	1.62	0.110
	GROUP 2	22	199	43.7		

3.2.2.2 Cropping

The main crop planted on the survey farms was maize. Other crops planted included kale (choumoullier), greenfeed oats, Wairoa brassica and ryecorn. The level of crop usage on the two farm types is summarized in Table 3.13 and given in Appendix 1. There were no significant differences in the amounts of crop planted or harvested between Town milk and seasonal supply farms although some interesting trends were observed. Town milk farms had on average a higher percentage of their total milking area planted in crop and grew 75% more crop DM/cow than seasonal supply farmers.

Table 3.13 Comparison of cropping regime.

GROUP 1 = Town milk farms

GROUP 2 = Seasonal Supply farms

VARIABLE		NUMBER OF CASES	MEAN	STANDARD ERROR	POOLED VARIANCE ESTIMATE T VALUE	POOLED VARIANCE ESTIMATE 2-TAIL PROB.
PFC	Proportion of farm in crop (%)					
	GROUP 1	36	4.2	0.56	1.51	0.136
	GROUP 2	22	2.9	0.61		
CDMC	DM grown as crop (kgDM/cow/year)					
	GROUP 1	36	133	19.6	1.98	0.053
	GROUP 2	22	76	18.3		

3.2.2.3 Nitrogen, concentrate feed and irrigation usage.

A summary of Nitrogen, concentrate feeding and irrigation usage is presented in Table 3.14 and individual farm data is presented in Appendix 1. Concentrate feeding and irrigation were practiced almost exclusively by town milk farmers. However usage of these two high cost inputs on town milk farms was not significantly different from seasonal supply farms due to the small number of farmers feeding concentrate (6 of 36 town milk farms) and irrigating (9 town milk farms, 1 seasonal farm). Nitrogen application/hectare/year was 32% higher on Town milk farms (not significant).

Table 3.14 Comparison of nitrogen usage, concentrate feeding and irrigation.

GROUP 1 = Town milk farms
GROUP 2 = Seasonal Supply farms

VARIABLE		NUMBER OF CASES	MEAN	STANDARD ERROR	POOLED VARIANCE ESTIMATE T VALUE	POOLED VARIANCE ESTIMATE 2-TAIL PROB.
CONCOW	Concentrates fed (kg/cow/year)					
	GROUP 1	36	55	31.6	1.35	0.183
	GROUP 2	22	0.00	0.00		
PFI	Proportion of farm irrigated (%)					
	GROUP 1	36	12.0	4.1	1.17	0.245
	GROUP 2	22	4.5	4.5		
NH	Nitrogen usage (kg/Ha/year)					
	GROUP 1	36	18.9	6.2	0.43	0.666
	GROUP 2	22	14.2	9.0		

3.2.3 Comparison of Town milk and seasonal supply farms for stocking policy.

A summary of the extent to which youngstock and dry cows are grazed off/on the farm milking area is presented in Table 3.15. Individual farm data is presented in Appendix 1. No significant differences in stocking policy existed between the two farm types and no clear trends in either youngstock or dry cow grazing emerge from the data. It is of interest to note that Town milk farmers reared 55 calves per 100 cows calved on wholemilk whereas seasonal supply farmers only reared 46 calves per 100 cows calved.

Table 3.15 Comparison of stocking policy

GROUP 1 = Town milk farms

GROUP 2 = Seasonal supply farms

VARIABLE		NUMBER OF CASES	MEAN	STANDARD ERROR	POOLED VARIANCE ESTIMATE: T VALUE	POOLED VARIANCE ESTIMATE: 2-TAIL PROB.
CF	Calves reared per 100 cows calved					
	GROUP 1	36	55	4.8	1.29	0.203
	GROUP 2	22	46	5.2		
PHO	Prop. of herd grazed off when dry (%)					
	GROUP 1	36	27.1	6.2	-0.57	0.574
	GROUP 2	22	33.2	9.5		
OFF	Time cows off (days)					
	GROUP 1	36	35	7.4	0.83	0.413
	GROUP 2	22	26	7.1		
R1H	No of R1 heifers carried/Ha					
	GROUP 1	36	0.26	0.052	-1.34	0.186
	GROUP 2	22	0.37	0.073		
R2H	No of R2 heifers carried/Ha					
	GROUP 1	36	0.13	0.035	0.17	0.868
	GROUP 2	22	0.12	0.049		
TR1	Time R1 heifers on farm (days/year)					
	GROUP 1	36	139	24.3	-0.74	0.461
	GROUP 2	22	168	31.1		
TR2	Time R2 heifers on farm (days/year)					
	GROUP 1	36	122	29.0	1.50	0.139
	GROUP 2	22	58	25.4		

3.2.4 Comparison of town milk and seasonal supply farms for feed utilisation efficiency

Estimates of total feed grown, fed and consumed per hectare were calculated as described in Appendix 2. A summary of these calculated variables and estimates of feed utilization efficiency on the two farm types is given in Table 3.16. Individual farm data is presented in Appendix 1.

Town milk farms grew slightly more feed/hectare and bought in slightly more hay and silage supplement per hectare (not significant) than seasonal supply farms. However significantly more feed/hectare was consumed on seasonal supply farms relative to town milk farms. The fact that more feed/hectare was fed, yet less was consumed on town milk farms resulted in a significantly lower feed utilisation efficiency (83%) on the town milk farms compared with seasonal supply farms (95%).

Table 3.16 Comparison of feed demand, supply and utilisation.

GROUP 1 = Town supply farms

GROUP 2 = Seasonal supply farms

VARIABLE		NUMBER OF CASES	MEAN	STANDARD ERROR	POOLED VARIANCE ESTIMATE T VALUE	POOLED VARIANCE ESTIMATE 2-TAIL PROB.
TFG	Total feed grown (kgDM/Ha/yr)					
	GROUP 1	36	12660	125	0.81	0.420
	GROUP 2	22	12490	166		
TSB	Total supp. brought in (kgDM/Ha/yr)					
	GROUP 1	36	878	134	1.28	0.206
	GROUP 2	22	613	148		
TFF	Total feed fed (kgDM/Ha/yr)					
	GROUP 1	36	13470	257	1.45	0.152
	GROUP 2	22	12950	184		
TFC	Total feed consumed (kgDM/Ha/yr					
	GROUP 1	36	11140	354	-2.10	0.040
	GROUP 2	21	12340	434		
FUE	Feed Utilisation efficiency (%)					
	GROUP 1	36	83.1	2.49	-3.03	0.004
	GROUP 2	21	95.0	2.84		

3.2.5 Supplement quality.

Data for the composition of hay and silage for the two farm types is summarized in Table 3.17 and given in Appendix 1. The significant difference in silage DM% is due to the fact that 2 of 6 seasonal supply farmers who made silage used baled silage of a very high DM%. Other small and non significant differences were observed for the quality and composition variables of hay and silage between farms. A distribution graph for silage and hay digestibility is given in Figures 3.33 and 3.34.

Figure 3.33 Distribution of silage digestibility for all survey farms

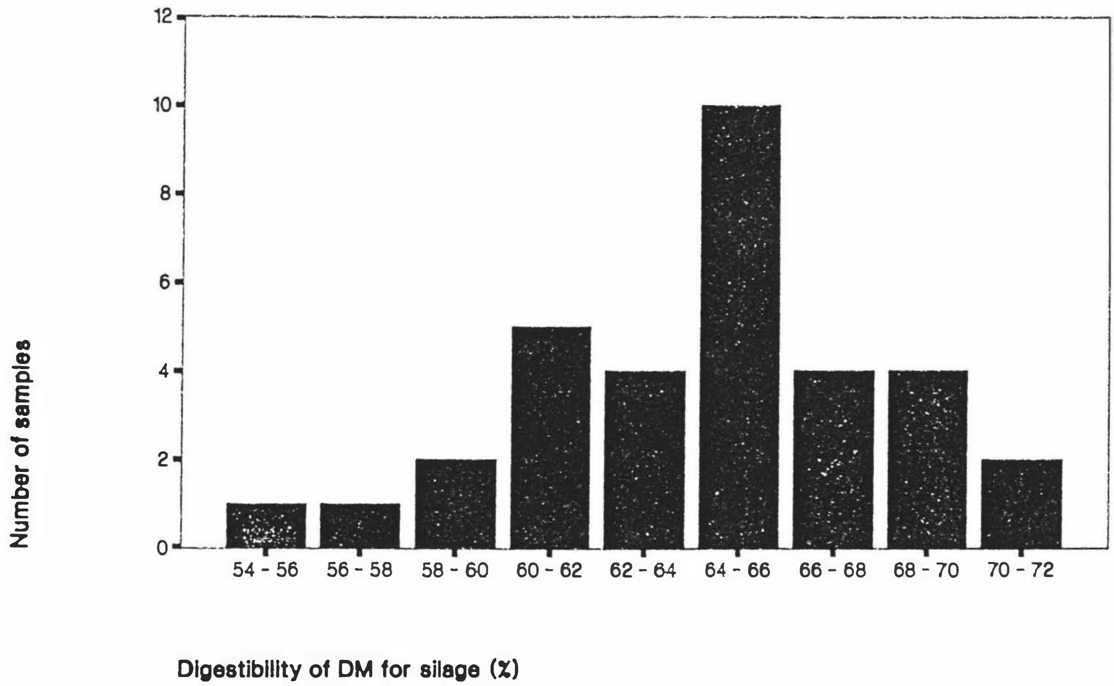


Figure 3.34 Distribution of hay digestibility for all survey farms

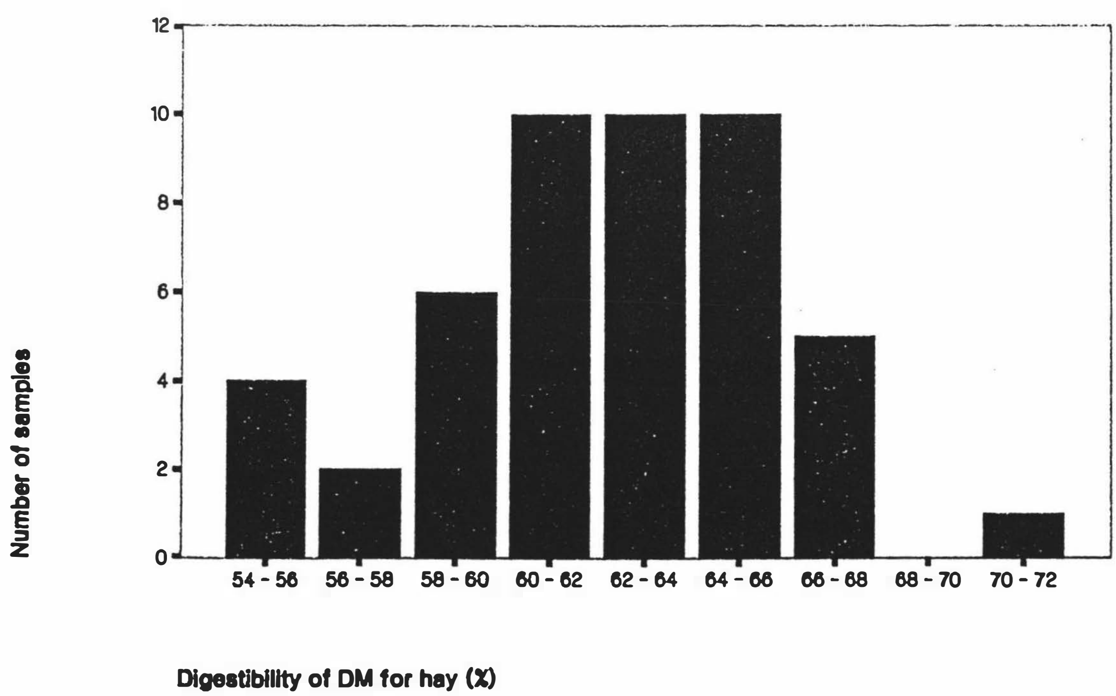


Table 3.17 Comparison of supplement quality.

GROUP 1 = Town milk farms

GROUP 2 = Seasonal supply farms

VARIABLE		NUMBER OF CASES	MEAN	STANDARD ERROR	POOLED VARIANCE ESTIMATE T VALUE	POOLED VARIANCE ESTIMATE 2-TAIL PROB.
HDIG	Digestibility of DM for hay (%)					
	GROUP 1	31	55.8	0.63	-0.54	0.592
	GROUP 2	17	56.4	0.92		
HPRO	Protein % of hay					
	GROUP 1	31	9.2	0.38	-1.98	0.053
	GROUP 2	17	10.5	0.65		
HDM	Dry Matter % of hay					
	GROUP 1	31	85.1	0.31	-3.07	0.004
	GROUP 2	17	86.8	0.51		
SDIG	Digestibility of DM for silage (%)					
	GROUP 1	25	64.4	0.75	-0.30	0.765
	GROUP 2	8	64.9	1.13		
SPRO	Protein % of silage					
	GROUP 1	25	13.7	0.56	-0.33	0.742
	GROUP 2	8	14.1	1.36		
SDM	Dry Matter % of silage					
	GROUP 1	25	26.0	1.11	-4.09	0.000
	GROUP 2	8	39.1	4.64		

3.2.6 Comparison of production and feeding for the top five (on a milkfat per hectare basis) town milk and the top five seasonal supply farms.

The top 5 farms in each group for MF/Hectare/year were selected and separate comparisons were carried out. The results of these comparisons are presented in Table 3.18. Because of the greatly reduced sample size (only 5 cases from each group), any differences between group means are much less likely to be significant. It is however of interest to note that several of the trends observed with all farms are reversed when only the top 5 farms in each group are considered. Production per hectare and per cow are higher on the top 5 town milk farms compared with the top 5 seasonal supply farms. This is the reverse of the district results with all 58 farms which clearly showed seasonal supply farms to have higher production per cow and per hectare. The top 5 town milk farms grew slightly less feed than the top 5 seasonal supply farms (district results showed town milk farms to grow slightly more feed than seasonal supply farms). The top 5 seasonal supply farms still had a higher feed utilisation efficiency than the top 5 town milk farmers although the difference of 7 percentage points in their favour was considerably less than the difference of 12 percentage points observed across all farms.

Table 3.18 Comparison of production and feeding on the top 5 town milk and seasonal supply farms

RIABLE	TOWN MILK MEAN TOP 5	TOWN MILK MEAN ALL	SEASONAL SUPPLY MEAN TOP 5	SEASONAL SUPPLY MEAN ALL	2-TAIL PROBABILI FOR TOP 5 FARM
ocking rate (Milking cows/Hectare)	3.5	2.7	3.5	2.8	0.867
lkfat production (kg) for 1987/88	47601	27576	19563	22435	0.021
tal production per hectare (kgMF/Ha/yr	624	411	604	474	0.692
erage per cow production (kgMF/cow/yr)	179	149	170	163	0.359
tal feed grown (kgDM/Ha/yr)	13132	12707	13243	12509	0.900
tal supplements brought in (kgDM/Ha)	1006	878	938	613	0.902
tal feed fed (kgDM/Ha/yr)	14767	13947	13913	13181	0.487
tal feed consumed (kgDM/Ha/yr)	12778	10215	13005	11353	0.849
ed Utilisation efficiency	87.1	73.5	94.1	85.8	0.446
ncentrates fed (kg/cow/year)	174	55	0	0	0.267
oportion of farm irrigated (%)	19.8	12.0	10.2	4.5	0.501
trogen fertiliser (kg/Ha/year)	26	18	54	14	0.475
sing 1 year heifers carried / Ha	0.17	0.26	0.37	0.37	0.504
sing 2 year heifers carried / Ha	0.00	0.13	0.00	0.12	1.00
ops fed (kgDM/cow/year)	11.3	133	42.3	76	0.312
oportion of farm cropped (%)	0.6	4.2	1.9	2.9	0.359

CHAPTER FOUR
Discussion

4.1 Farm size and milk production on town milk farms.

4.1.1 Comparison of surveys

A number of the variables measured in this study were also measured in a nationwide survey of town milk farms undertaken in the 1985/86 season by Lincoln College (Moffitt 1987). A comparison of observations in the present study with the national average results from the Lincoln study is given in Table 4.2. Care should be taken when comparing the two studies as seasonal effects may explain a certain amount of variation. Consideration of national production data for seasonal supply farms (NZDB 1986,1988) shows however that 1985/86 and 1987/88 were fairly similar seasons in terms of milkfat per cow and milkfat per hectare (Table 4.1)

Table 4.1 Comparison of national milkfat production on seasonal supply farms in two seasons.

	kgMF/farm	kgMF/cow	kgMF/hectare
1985/86	24541	157	382
1987/88	24448	154	381

Source:NZDB 1986, 1988.

Table 4.2 Comparison of the present study with observations in a Lincoln College study.

	The present study (Manawatu 1987/88)	Lincoln (New Zealand 1985/86)
No. of farms surveyed	36	152
Average milking area (Ha)	68.2	81.0
Total Herd size	182	110
Stocking Rate (cows/hectare)	2.7	1.4
Quota size (litres)	1028	774
Quota/hectare	15.4	9.5
Milk sold at quota prices (%)	61	61
Total milkfat production (kg)	27576	21574
Milkfat/hectare	410	266
Milkfat/cow	149	196

N.B. Lincoln estimates of total herd size, stocking rate and milkfat per cow based on the number of December milking cows.

It is of interest to note that although Manawatu town milk farms were smaller in area, they had larger herd sizes due to a stocking rate almost twice the national average. This higher stocking rate was probably the most important factor enabling Manawatu farmers to service a considerably higher quota per hectare and to produce 54 % more milkfat per hectare than the national average. Production per cow however was considerably lower than the national average - presumably also a consequence of the higher stocking rate. Overall though, it is clear that the Manawatu survey farms are of a much higher productive capacity than the average New Zealand town milk farm. This may be attributed to a number of factors including ;

* Cow genetic merit.
* Management skill of farmers.
* Stocking rate
* Amount of total feed grown

There is no logical reason for assuming that cow genetic merit or farm management skill is different in the Manawatu from other areas. It would appear therefore that the high stocking rate and possibly a higher level of pasture growth due to the favourable soil and climate conditions of the Kairanga-Fielding district are the most likely factors contributing to the high milkfat per hectare performance of the Manawatu survey farms. Factory supply farms in the Kairanga county have consistently produced more milkfat per hectare than the New Zealand average (NZDB 1986, 1987, 1988) as shown in Table 4.3.

Table 4.3 Comparison of milkfat production (kg/hectare) on Kairanga factory supply farms with the New Zealand average.

	NZ average	Kairanga average	%Difference
1985/86	382	433	+13%
1986/87	334	369	+10%
1987/88	381	398	+4%
MEAN	366	400	+9%

Source : NZDB 1986, 1987, 1988

4.1.2 Production and quotas on Manawatu town milk farms.

The positive correlation of stocking rate with milkfat production per hectare (Figure 3.7) is in agreement with numerous other studies (e.g. Holmes and McMillan 1982, Crabbe 1983). These authors state the shape of the milkfat per hectare - stocking rate line to be curvilinear. The scatter of individual data points in Figure 3.7 however does not indicate a curvilinear relationship to be appropriate and thus a linear regression line has been fitted instead. The regression coefficient of 161 (i.e. an increase of 161 kgMF/Ha for a rise of one milking cow per hectare in stocking rate) is considerably higher than the mean figure of 69 kgMF/Ha per S.R. unit derived from 14 experiments by Holmes and McMillan 1982. The positive correlation of production per hectare with herd size and total production (Figures 3.8, 3.9) is also of interest. Although no other data for town milk farms is available, this trend is in agreement with data from the Dairy Board (NZDB 1986b) for factory supply farms. Bradford (1968) also conducted a survey of East coast factory supply dairy farms and found that large herds produced 345 kgMF/Ha compared with small herds that produced 329 kgMF/Ha. One likely reason for this difference is the difference in management skill between large and small herd operators. During the farm visits, it became noticeable that large herd operators had better presented and well organised farms. Large herd operators also tended to be much more conversant with their past and present production levels and grazing management practices than small herd operators. However management skill cannot be clearly quantified and many other factors may have contributed to this result.

As far as quota levels are concerned, Figure 3.12 shows predictably that a rise in quota per hectare is associated with an increased proportion of total milk which is sold as quota milk. Litres of quota per hectare is also positively correlated with the number of winter milking cows per hectare (Figure 3.13) These two graphs have both positive and negative financial implications for farmers. Extra income will result from selling a larger proportion of milk at quota prices. However there may be extra feed costs associated with feeding a larger number of winter milking cows. Figure 3.14 shows that the rise in winter milking cows per hectare (Figure 3.13) was not in itself sufficient to meet the higher quota per hectare - farmers were anticipating increased per cow performance. Every 1.3 litre increase in quota per hectare was associated with a one litre increase in the required litres per cow per day production level if quota was to be met from the number of cows being milked (Figure 3.14). This has 3 important implications for farmers with a high level of quota per hectare. To achieve the high litre/cow/day performance, these farmers may require

a) A higher quantity and/or quality of feed available per cow.
b) Cows of a higher genetic merit at an earlier stage of lactation.
c) A higher level of grazing management and herd husbandry skills.

4.2 Pasture cover and cow condition score changes

4.2.1 Pasture cover

The mean decrease in pasture cover of 214 kgDM/Ha from early May to late July (Table 3.3) clearly shows that animal feed demand/Ha on the town milk farms was greater than the combined total of pasture growth per hectare and supplements fed per hectare. During winter, the cows therefore ate into the bank of feed available in late autumn. The mean cover in May of 1551 kgDM/Ha is possibly more than would be expected in an "average" year given the favourable pasture growth conditions that occured during the 1988 Autumn (Table 4.4).

Table 4.4 Comparison of Autumn/Winter pasture growth rates for 1988 with 8 year averages measured by MAF on Manawatu "downland" sites

Units = kilograms of dry matter per hectare per day

	Average	1988	% Difference
March	37	49	+32
April	24	29	+21
May	21	26	+24
June	16	16	0
July	17	16	-6

Source: MAFTech 1988. Unpublished data.

The fact that 25% of farms went against the trend and increased in farm cover shows that a decrease in farm cover over winter is by no means inevitable. The different grazing management practices on the various farms is the most logical explanation for the range in pasture cover changes.

4.2.2 Cow condition score

The decrease of 0.1 (approximately 3 kg liveweight) in mean cow condition score (Table 3.4) although statistically significant is fairly small given the approximate 80 day interval between scoring days. It indicates that feeding levels were approximately equal to or slightly below the herds maintenance and lactation requirements. It is possible that cows mobilised a small amount of body reserve over the winter period.

The wide range of condition score change observations (-0.7 to +0.3 condition scores in Table 3.4) clearly shows condition score to be under the management control of farmers. Rogers (1985) states that for any given level of feeding, milk production is directly related to condition score. This can be logically rephrased to suggest that for any given level of milk production, change in condition score is directly related to the level of feeding. The changes in condition score over the winter would have almost certainly been influenced by herd feeding levels as well as the level of milk production which determines the metabolic demand for precursors for milk synthesis.

4.2.3 Interaction of condition score and pasture cover.

The positive correlation of average farm cover with condition score (Figures 3.15, 3.16) is an interesting trend for which there is no comparable data. The reverse trend would have been easier to explain i.e. farms with high cow condition may have fed their cows liberally at the expense of pasture cover. Likewise, farms with a low cow condition score may have been using restricted pasture allowance in an effort to increase pasture cover. The fact that many farms had both high condition score and cover or low condition score and cover can again only be attributed to the different management and feeding policies on each farm. A number of factors are likely to affect the relationship between cow condition and pasture cover -- likely to be of particular importance is calving date, drying off date and level of supplementary feeding during winter (Holmes and Wilson 1984).

4.3 Average daily milk production per cow over winter.

An estimate of the range in per cow average daily milk production (hereinafter "cowADM") achieved during winter was one of the prime objectives of the study. Throughout the winter there was consistently a 2.5 to 3 fold difference between the highest and lowest producing farms (Table 3.5, Figure 3.17b). The level of cowADM is important because it has profound implications for the number of winter milkers and amount of feed required to meet quota.

Consider the following calculations;

ASSUMPTIONS

* Quota (Q) level = 1000 litres
* cowADM (C) for lowest farm = 8 litres/cow/day
* cowADM (C) for highest farm = 19 litres/cow/day
* Liveweight (LW) of Friesian cows = 450 kg
* Cow maintenance requirement (CMR) = 0.60 MJME/kgLW^0.75 (Holmes & Wilson 1984)
* Milk synthesis requirement (MSR) = 5.7 MJME/litre (Holmes & Wilson 1984)
* Average energy concentration (MD) of intake = 10.5 MJME/kgDM

The feed required to produce one litre of quota milk can be calculated by the following equation where

* = multiplication
/ = division
^ = to the power of

Feed/litre = ((((Q / C) * LW^0.75 * CMR) + (MSR * Q)) / MD) / Q

For the lowest farm therefore, feed requirement =
((((1000/8) * 450^0.75 * 0.6) + (5.7 * 1000)) / 10.5) / 1000
= 1.24 kgDM / litre of quota milk

For the highest farm feed requirement =

((((1000/19) * 450^0.75 * 0.6) + (5.7 * 1000)) / 10.5) / 1000
= 0.84 kgDM / litre of quota milk

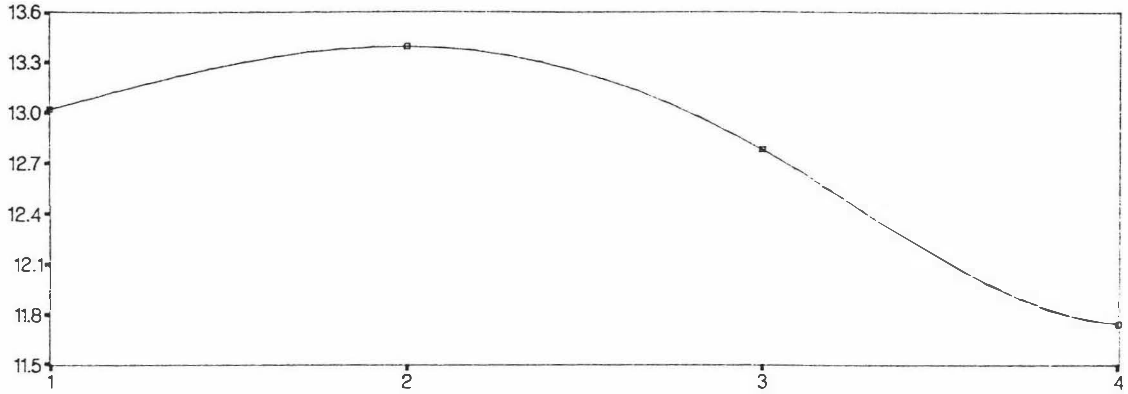
SUMMARY TABLE

	Lowest farm	Highest farm
cowADM (litres/cow/day	8	19
Quota	1000	1000
Required cows to meet quota	125	53
Feed required/litre quota	1.24	0.84
Total feed per day (kgDM)	1240	840

The farm with the highest cowADM therefore saved 400 kgDM/day (48%) to meet the same 1000 litre quota as the farm with the lowest cowADM. This saving resulted solely from the dilution of maintenance effect associated with carrying a smaller number of cows each of which produced at a higher level. The advantages of a high cowADM during winter are now self evident. Not only is the efficiency of milk production improved via reduced feed requirement per litre of milk produced, but financial performance may be improved due to a reduction in animal health, mating and herd testing costs associated with milking fewer cows over winter.

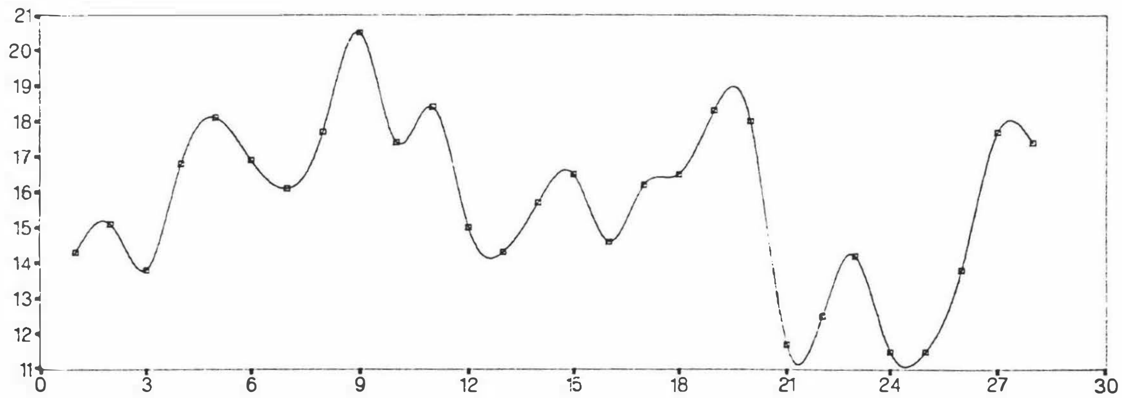
As far as the overall trend in cowADM is concerned, the sharp decrease during the fourth week of May (Figure 3.17 a) may be partially explained by the weather. Figure 4.1 shows cowADM for the first 4 weeks of May plotted together with the maximum air temperature observed by the DSIR in Palmerston North. The period of cold temperatures during the fourth week of May was accompanied by low sunshine hours and periods of rain. Although it is probable that temperature is not limiting to milk production under New Zealand conditions, it is widely believed among farmers that cold wet weather will cause an immediate short term drop in milk production.

Figure 4.1 (a) Milk production during May



Weeks during May

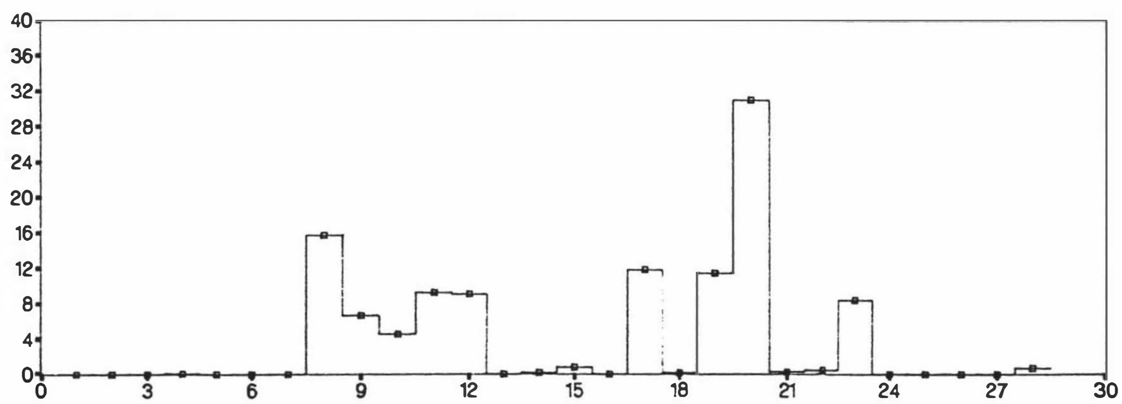
Figure 4.1 (b) Maximum temperature in Palmerston North during May



Date in May 1988

Source: DSIR Meteorological records

Figure 4.1 (c) Rainfall in Palmerston North during May



Date in May 1988

Source: DSIR Meteorological records

4.4 Trends in per cow production of milkfat, protein and total solids and milk composition over winter.

Two contributing factors determine a cows average daily production of any particular milk component; cowADM and the percentage of the component in the milk. Comparison of Figure 3.17a with Figures 3.19, 3.20, 3.21 shows the pattern of cowADM change over winter to be remarkably similar to the pattern of milkfat, protein and total solids production. This suggests that the composition of milk did not show marked variation during the winter. This can be confirmed by calculation of coefficients of variation for the 3 milk composition variables measured. Table 4.4 shows a comparison of the coefficient of variation for cowADM with the coefficients of variation for milkfat %, protein % and total solids %.

Table 4.5 Coefficients of variation for cowADM, MF%, Prot%, Total solids%

	MEAN	ST DEV	C.V.
Milkfat %	4.42	0.18	4.1%
Protein %	3.35	0.11	3.3%
Total solids %	13.15	0.32	2.4%
cowADM	12.63	2.62	20.7%

The value of 20.7% for cowADM is considerably larger than the average C.V. for percentage concentrations of milkfat, protein and total solids (3.3%). This shows that cowADM is much more variable and will therefore be much more likely to cause changes in individual milk component production per cow than the percentage of each component in the milk. Although the variation in milkfat, protein and total solids percent was considerably less than the variation in cowADM, it should not be overlooked as some trends with time were established. Table 3.8 and Figures 3.29, 3.30, 3.31 show that milkfat %, protein % and total solids % all decreased during the 13 week period of study. This downward trend would have been very likely mediated by some feed factor i.e. quantity or quality of feed offered.

Holmes and Wilson (1984) state that a restriction of intake usually results in an increase in milkfat % and a decrease in protein %. The drop in protein % in the present study is in agreement with this statement and may therefore indicate a reduced level of feeding on town milk farms toward the end of winter. The accompanying decrease in fat % is however the reverse of the claim of Holmes and Wilson (1984). This makes predictions about the level of feeding based on changing milk composition much more difficult. Mitchell (1985) showed that the negative correlation of milkfat % on level of feeding may not hold for longer periods of underfeeding as cows eventually exhaust supplies of body fat to mobilise for milk production and fat % reverts to a level similar to what would be expected under "fully fed" conditions. This may well have been happening on survey farms with a low level of cow condition score and pasture cover (Figure 3.15, 3.16). The drop in somatic cell count over winter (Figure 3.32) may be due to a number of factors. A major contributor though is likely to be the drying off of stale (i.e. October, November calving cows) during the winter. Holdaway (1989) showed that cows in late lactation tend to have considerably higher somatic cell counts. Given that 69 % of survey farms still had 1987 calved cows in their herds in May 1988 (start of winter), it is almost certain that these "stale" cows contributed to the high somatic cell counts during the early winter.

4.5 Regression relationships of cowADM on other variables.

4.5.1 Condition score.

The positive correlation of cowADM with condition score (Figure 3.22) is in agreement with several other studies (e.g. MacMillan et al 1984, Holmes et al 1985) which showed positive correlations of total milkfat per cow with condition score at calving. The relationship arises from the fact that fatter cows have more body reserve available to mobilise for milk synthesis in early lactation. The practical implications of this on town milk farms is that farmers who ensure that their autumn cows calve in good condition should achieve better winter lactation performances. This will reduce the chance of going below quota and may mean that slighty fewer winter milkers are required to meet quota. The strength of the condition score - cowADM relationship in Figure 3.22 may have been influenced by the higher pasture cover on farms with high cow condition score (Fig 3.15, 3.16).

4.5.2 Pasture cover

Figure 3.23 shows herds with a high cowADM tended to be on farms with high average pasture cover (and presumably high cow condition score - Fig 3.15, 3.16). The explanation for this lies very likely with the fact that these herds had a higher level of metabolisable energy intake (MEI) per cow. A higher MEI per cow on farms with high pasture cover is likely for two reasons;

1. Higher allowance.
   By definition, for any given rotation length, increases in pasture cover must result in increases in herbage allowance per cow. Increased herbage allowance

results in increased voluntary intake (Rattray & Jagusch 1978, Holmes 1987) and subsequently higher milk production.

2. Higher average M/D values per kgDM eaten due to reduced supplementation. Farms with larger amounts of pasture on hand during winter are likely to feed more pasture and less supplement per cow. Given that winter pasture is of higher ME concentration (11.2 MJME/kgDM) than hay (9 MJME/kgDM) or silage (10 MJME/kgDM) (Ulyatt et al 1980), it follows that cows with a higher proportion of pasture in their diet will have a higher metabolisable energy intake. To summarize, farms with higher pasture cover can probably feed cows a higher quantity and quality of feed during winter and therefore can expect a higher cowADM performance.

4.5.3 Production per hectare

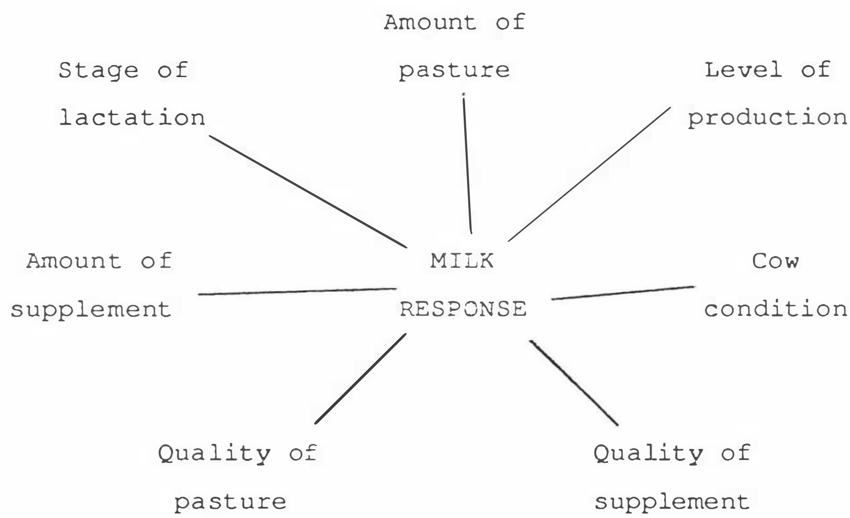
The positive correlation of cowADM with production per hectare (Figure 3.24) shows that farmers achieving a high level of annual MF production per hectare were not necessarily sacrificing individual cow performance in winter. Given the relatively small range in stocking rate (Coefficient of variation = 22%, 81% of farms fall in the range 2.3 to 3.3 cows / Ha) and assuming that lactation lengths are fairly similar, it follows that farms with high levels of total production per hectare would require high levels of cowADM to achieve their high per hectare performance. The positive correlation in Figure 3.24 supports this statement.

4.5.4 Annual milkfat production per cow.

The fact that cowADM positively correlates with total annual milkfat production per cow (Figure 3.25) shows that the performance of winter milkers may have a significant effect on overall per cow performance. It is a fairly predictable result as it is doubtful that herds with low cowADM performance for 3 months of their lactation (i.e. in winter) would be able to show sufficient compensation in the remaining 9 months to achieve a high level of total annual milkfat per cow.

4.5.5 Digestibility of supplement.

No firm statements about the effects of digestibility of supplement on cowADM can be made based on Figure 3.26 given the very low R-squared value (0.07) and low significance ($P<0.12$). The reason that no significant relationship has been derived is probably due to the large number of factors which affect cows response to supplements. These factors have been summarized by Rogers (1985)



However the positive trend established in Figure 3.26 is in agreement with other experiments measuring the effects of quality of supplement intake on milk production (e.g. S. Sangsritavong pers comm, Castle et al 1980, Gordon 1980). Gordon 1980 found milk production to be significantly higher for cows consuming 77.5% digestible silage compared with cows consuming 65.5% digestible silage Linear interpolation of the unwilted silage results (treatments 5 & 9) of Gordon (1980) show each 1% rise in digestibility to result in a 0.24 litre/cow/day rise in cowADM - nearly double the coefficient derived in the present study = 0.125 litre/cow/day. A greater response would be expected though in the trial of Gordon (1980) given that the cows were producing at a higher level (>20 litres/cow/day) vs 12.6 litres/cow/day in the present study.

4.5.6 Milkfat %

The negative correlation of cow ADM on milkfat % (Figure 3.27) clearly indicates that the higher yielding herds had lower fat %. This very likely reflects the stage of lactation of the high yielding herds - i.e. they were fresher cows. Holmes and Wilson (1984) state that milkfat concentration decreases towards its lowest concentration as peak yield is approached. Herds with all autumn calvers (i.e. March to May calvers) would be expected to reach peak yield during the winter and therefore reach lowest milkfat % during this time. Lower yielding herds would be more likely to have "stale" spring calvers with a higher fat %. Table 3.10 supports this assumption - i.e. "SS" herds had a higher fat % than "AA" herds. Although a lower milkfat % reduces the kg milkfat/cow/day production, it is of little concern to town milk farmers. Quota milk is paid for at one price provided milkfat level is > 3.5%.

4.5.7 Somatic cell count.

The negative association between somatic cell count and milk production is well known to most farmers. The negative correlation established in the present study (Figure 3.28) is in agreement with Gill (1977) who also measured somatic cell counts in Manawatu town milk herds. Gill (1977) found that every 100000 cell/ml increase in somatic cell count resulted in a decrease of 0.14 litres/cow/day. This is considerably lower than the present study which showed a 0.93 litre/cow/day drop per 100000 cell/ml increase. A possible reason for the steeper line in the present study is the stage of lactation effect for individual herds plotted on Figure 3.28. Holdaway (1989) showed a clear positive correlation between somatic cell count and stage of lactation. Thus high cowADM herds in Figure 3.28 are likely to be freshly calved "all autumn" herds with correspondingly low somatic cell counts. Low cowADM herds may have had high proportions of "stale" cows with correspondingly high somatic cell counts. This assumption is supported by the somatic cell count figures presented for "SS" and "AA" herds in Table 3.10.

4.6 Comparison of all autumn calved vs some spring calved winter herds.

The comparison presented in Table 3.10 clearly shows that a policy of all autumn calving to supply winter lactating cows was practiced on the larger (area, herd size, quota size) and more efficient (milkfat/Ha, milkfat/cow) farms in the group. Whether this policy contributed to the higher efficiency or not is unclear. It is likely however that many of the "AA" herds are managed by large herd operators with a higher level of management skill than small herd operators as referred to in 4.1.2. Consider Table 4.6.

Table 4.6 Comparison of level of "over quota" milk production for "AA" and "SS" farms

	SSmean (S.E.)	AAmean (S.E.)	2-tail prob.
Quota size	913 (88)	1288 (168)	0.38
Av. total prod/day	1150 (111)	1717 (218)	0.015
Percent over quota	27 (5.7)	35 (7.8)	0.471

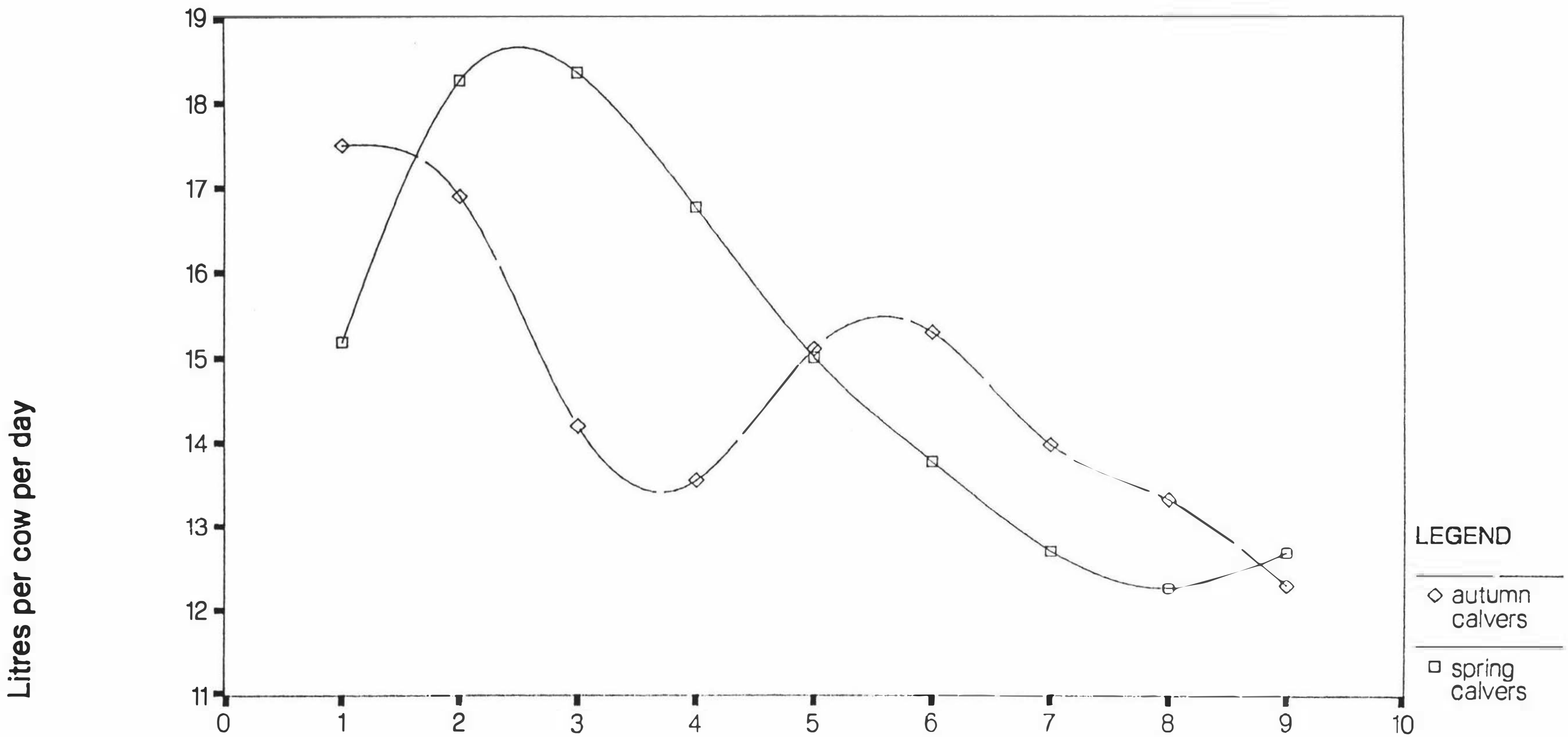
The fact that "AA" farmers produced considerably more "over-quota" milk in winter suggests that they were producing their current quotas with ease and may have been trying to gain more quota. (Manawatu Cooperative Dairy Company rules require at least 110 % quota production in winter to be eligible for an increase in quota). The fact that the "SS" farmers produced less over quota milk and that they retained some spring calvers in the winter milking herd suggests that they were content with their present quotas or in some cases struggling to meet them. Many of the "SS" farmers stated that they had intended to meet all winter milk production requirements from autumn calving cows, but had not calved enough autumn cows to meet quota - hence the continued milking of spring cows. This may suggest mating management difficulties on "SS" farms.

Given that all condition scoring was done on autumn calving cows (see chapter 2), the fact that autumn cows in "SS" herds were in lighter condition in May and July and lost more condition (0.17 condition scores) than autumn cows in "AA" herds could be explained in two ways.

1. Feeding levels on "SS" farms were lower resulting in greater mobilisation of body reserves in autumn calving cows.
2. There was a negative interaction effect on autumn cows in "SS" herds due to the presence of stale spring cows in the herds.

The significantly higher winter milk production per cow per day of "AA" herds shown in Table 3.10 is logical and explainable by looking at any set of lactation curves (e.g.Figure 4.2)

Figure 4.2 Lactation curves for spring and autumn calving cows



Month of lactation

Source: Massey University No. 1 dairy farm records

Clearly milk production for both spring and autumn calvers is higher in early lactation. For "SS" herds in winter, the high average daily milk production of autumn calvers is offset by the low average daily milk production of spring cows resulting in a lower overall cowADM.

4.7 Town milk and seasonal supply farms in the Manawatu district.

A number of the comparisons made in the present study (Table 3.11) were also made in a Lincoln College survey of town milk and seasonal supply farmers in the South Auckland district during the 1985/86 season (Moffitt 1986). A comparison of the two studies is given in Table 4.7. As with the comparison made in 4.1.1, some of the variation between farm types may be due to the fact that the two studies were made in different (1985/86 and 1987/88) yet similarly productive seasons (Table 4.1).

Table 4.7 Comparison of two separate studies of town milk and seasonal supply farms in the Manawatu and South Auckland.

	The present study Manawatu 1987/88			Lincoln study South Auckland 1985/86		
	T	S	DIFF	T	S	DIFF
No. of farms in survey	36	22	0.61	26	31	1.19
Farm area	66	49	0.74	74	66	0.89
Total herd size	182	136	0.75	104	136	1.31
Stocking rate	2.7	2.8	1.04	1.4	2.1	1.50
Total milkfat/year	27580	22440	0.81	23080	21800	0.94
Milkfat per hectare	412	474	1.15	314	330	1.05
Milkfat per cow	150	163	1.09	222	160	0.72

Source: Moffitt 1987

N.B. Total herd size in Lincoln study derived from an estimate of the number of "December milking cows"

T = Town milk farms

S = Seasonal supply farms

DIFF = (S/T)

Trends of interest to be observed from this table are;

* In South Auckland, town milk farms had much lower stocking rates than Manawatu farms. This resulted in the difference in stocking rate in favour of seasonal supply farms being considerably larger in South Auckland (50%) than Manawatu (4%).
* Total milkfat production and milkfat production per hectare were higher on Manawatu town milk and seasonal supply farms compared with Auckland farms. This points to the Manawatu being a more productive dairying region regardless of the system of production (town milk or seasonal supply).
* Seasonal supply farmers outperformed town milk farmers for production per hectare by a higher margin (15%) in the Manawatu compared with South Auckland (5%)
* Production per cow on South Auckland Town milk farms was very high. Possible reasons for this include a high per cow voluntary feed intake and/or long lactation lengths. Whatever the explanation, there was a reversal of the trend in the Manawatu where seasonal supply production per cow was higher than town supply production per cow.

4.8 Feeding policy on town milk and seasonal supply dairy farms

Table 3.12 confirms and quantifies the well known fact that town milk farmers have a greater requirement for supplementary feed. The reason for this is the larger deficit between animal demand and pasture growth which occurs on town milk farms during winter. Consider the following calculations for a town milk and a seasonal supply farm of the same size and stocking rate.

ASSUMPTIONS

1. Farm size = 40 hectares
2. Herd size = 110 cows
3. Stocking rate = 2.75 cows/hectare
4. Seasonal supply farm has 110 cows dry in winter (May, June, July)
5. Town supply farm has 55 cows dry in winter
6. Town supply farm has 55 cows milking in winter
7. Cow maintenance requirement (dry cow) = 0.55 MJME/kgLW^0.75
8. Cow maintenance requirement (milker) = 0.60 MJME/kgLW^0.75
9. Cow liveweight = 450 kilograms
10. Energy concentration of intake = 10.5 MJME/kgDM
11. Milk synthesis requirement = 5.7 MJME/litre
12. Winter milkers average 12.6 litres/cow/day
13. Mean pasture growth in winter = 18 kgDM/Ha/day (Maftech. Unpublished data)

Assumptions 7,8,12 from Holmes & Wilson (1984)

Therefore feed demand on town milk farm =

(((55*0.55*450^0.75)+(55*0.60*450^0.75)+(12.6*55*5.7))/10.5)/40
= 24 kgDM/Ha/day

Feed demand on seasonal supply farm =

((110*0.55*450^0.75)/10.5)/40
= 14 kgDM/Ha/day

Mean pasture growth rate on both farms is 18 kgDM/Ha/day.

On the town milk farm therefore there will be a feed deficit of
18 - 24 = -6 kgDM/Ha/day

On the seasonal supply farm there will be a surplus of
18 - 14 = 4 kgDM/Ha/day

This simplified calculation clearly shows feed demand on town milk farms to be higher in winter and thus helps explain the greater usage of supplements. In reality, the feed deficit may be higher than indicated due to;

* Requirements of youngstock
* Cow pregnancy requirements
* Relatively low utilisation of pasture in wet puggy conditions.

The practical implications of higher supplement usage on town milk farms are self evident. Either extra spring feed must be harvested (with reduced milk production in spring as a consequence) or extra supplement must be purchased. Either of these alternatives represents a financial cost and the higher price paid for winter milk has been historically justified on the basis of compensating town milk farmers for supplement and other (e.g. extra labour) costs.

As shown in Table 3.13, cropping did not play a large role on either town milk or seasonal supply farms - although town milk farmers used more cropping than seasonal supply farmers. As with silage and hay, this reflects town milk farmers greater requirement for Autumn/Winter feed. Many of the well established town milk farmers commented that they had made a lot more use of crops in the past, but were now relying much more on silage and/or hay. This probably reflects the high cost of cultivation and high pasture production losses associated with planting a greenfeed crop.

Larger quantities of high cost inputs (nitrogen, concentrate feeding, irrigation) were utilised by town milk farmers (Table 3.14). This is not surprising given that town milk farmers are committed to supplying a minimum quota and therefore need to be able to manipulate feed supply during periods of natural shortfall. Town milk farmers are able to financially justify their usage of these inputs by the higher price recieved for quota milk. Four farms (3 town milk and 1 seasonal) irrigated their farms with industrial effluent from Manawatu Dairy Company or Fielding freezing works. The high temperature (30 - 40 degrees) and presence of nitrogen in this effluent may have further enhanced the pasture growth rate response to irrigation. Seven out of thirty six town milk farmers used concentrates - either barley based or Brewers grain. Among non users, the most common reasons cited for non use were the prohibitive cost of concentrates and a lack of cowshed facilities to feed them. Nitrogen use was predominately in the form of urea. Both town milk and seasonal farmers used Autumn and spring dressings depending on their individual feed supply situations.

4.9 Stocking policy

The comparisons made in Table 3.15 should be treated with caution as a number of "near as possible" estimates had to be made in the raw data. Farmers do not keep accurate records about the movement of youngstock and only approximate estimates of stock numbers grazed on/off were gained. Both groups of farmers carried fewer R2 heifers than R1 heifers which is logical given the higher feed requirements of R2 heifers. Seasonal supply farmers appeared to graze R2 heifers off for longer periods of the year and thus would have saved larger amounts of feed per hectare which could be utilised by milkers. This may be a reflection of the smaller size of seasonal farms that need to achieve a much higher production per hectare to get the same income as a larger farm. New Zealand Dairy Board surveys (e.g.NZDB 1986) have established that the grazing off of youngstock generally results in higher production per hectare. Seasonal farmers also grazed on average a larger proportion of their dry cows off the farm but for a shorter time period than town milk farmers. The higher number of calves reared on town milk farms reflects the widespread practice of Autumn bull calf rearing. Autumn bull calves attract considerable premiums at spring weaner sales and it is thus profitable for town milk farmers (who have the only source of such calves) to rear and sell them. NZDB (1988) published survey results for all New Zealand dairy farms and showed that seasonal supply farmers on average rear only 32 bull calves / 100 cows compared with town milk farmers who rear 48 calves per 100 cows. The NZDB (1988) survey also showed that a higher number of heifer calves are reared on town milk farms (27/100 cows) compared with 23/100 cows on seasonal supply farms.

4.10 Feed utilisation efficiency.

Attention is drawn to the large number of assumptions made in the calculation of feed utilisation efficiency (see Appendix 2). For this reason, the derived estimates should not be regarded as absolutely accurate. However assuming that base pasture growth rates are the same on both farm types, the larger amount of total feed grown on town milk farms (Table 3.16) can be explained by the higher inputs of nitrogen and irrigation. The larger amount of total feed fed (TFF) is due partly to the larger amount of total feed grown and the extra usage of bought in supplements. Total feed consumed (TFC) was calculated backwards from farm production levels using tabulated values of animal feed requirements for maintenance, pregnancy, growth and milk production. The higher level of total feed consumption on seasonal farms was due to the slightly higher stocking rate (hence greater maintenance requirements) and the significantly higher milk production per hectare of seasonal supply farms. The resulting estimates of feed utilisation efficiency (i.e.(TFC/TFF)*100) presented in Table 3.16 clearly indicate a significantly larger wastage / non utilisation of feed on town milk farms. Possible explanations for this higher wastage of feed include:-

* Supplementation. Given the high wastage associated with supplements (42 % for silage, 24% for hay - Thomson 1985), it follows that a higher level of supplementation results in a high level of wastage
* Pugging and trampling of pasture is likely to be higher on town milk farms given the higher level of supplements fed on paddocks. Michell and Fulkerson (1987) suggested further reasons for the low performance of Autumn calving herds during a four year trial in Tasmania.
* There is reduced regrowth of pasture associated with the need to graze blocks harder in spring in order to conserve more supplement.
* The inability to utilize pasture fully in autumn/winter because cows in full lactation cannot graze as hard as late lactation or dry spring calving cows.

In general terms, the fact that the feed demand curve on seasonal supply farms can be fairly easily manipulated to accurately match the feed supply curve (Simmonds 1985) suggests that feed harvesting will chronologically coincide with feed growth. This will reduce the need for the carrying forward of feed in whatever form (standing or conserved) and result in reduced senescence and/or wastage of pasture. Hence a higher feed utilisation efficiency on seasonal supply farms.

4.11 Supplement quality

Because supplements are used extensively on town milk farms, one of the main objectives of the present study was to derive estimates of the quality as well as the quantity of supplements used. There is no reason for expecting a difference between town milk and seasonal supply farms for supplement quality - Table 3.17 confirms this. The quality of supplement is more likely to have an effect on milk production on town milk farms because supplements are mostly fed to lactating cows - seasonal farmers tend to feed their supplements to dry pregnant cows. Several studies have shown a strong relationship between the quality of pasture ensiled and silage quality (e.g. Demarquilly & Jarridge 1970) and between the quality of pasture ensiled and milk production from cows fed the resultant silage (Castle et al 1980, Gordon 1980). Preliminary results from a recent Massey University experiment indicate that a similar relationship exists for hay (S. Sangsritavong, pers. comm.). Given these trends, town milk farmers in particular would be advised to try and increase supplement quality in order to gain extra milk production in winter. One limiting factor to increasing supplement quality is the inevitable reduction in yield associated with harvesting leafy, vegetative swards. Clearly , more research is required to establish whether increases in supplement quality result in sufficient milk production response to offset the reduced yield and/or higher cost (if purchased) associated with higher quality supplements.

4.12 The "top five" town milk and seasonal supply farms.

The results of the analysis of the "top five farms" presented in Table 3.18 shows that a system of town milk production is no absolute barrier to achieving high levels of milkfat production per hectare or per cow. Although the level of concentrate feeding and irrigation on town milk farms must have influenced the higher level of production per hectare and per cow, the reversal of the trends established across all farms is of considerable interest. It shows that there are some well managed town milk farms that achieve higher levels of annual production/Ha and per cow than comparable top seasonal supply farmers despite split calving, winter milk production and the other extra physical demands placed on town milk farms. It is also of interest that the top 5 farms in both groups used considerably less crops and grazed no rising 2 year heifers on their home milking area compared with the entire group averages shown in Table 3.18. Both of these trends would increase the availability of pasture to milking cows and thus contribute to the high production performances of both farm groups.

4.13 General considerations

The town milk industry in New Zealand has undergone some extensive structural changes in the past 2 - 3 years (NZMB 1987). While the demand for winter milk is changing only slightly, extensive changes are currently being suggested for the way in which it is produced and paid for (Bryden 1988). This study has highlighted and quantified a number of the fundamental physical production issues which need to be considered when designing or attempting to improve winter milk production systems. All year round milk production is likely to result in lower feed utilisation efficiency and thus lower annual production per hectare compared with seasonal milk production. This relationship is however sensitive to the management skill of individual farmers. The "best" town milk farmers in the current study were able to incorporate winter milk production into their farming system and achieve as good or better overall annual performance as their seasonal supply neighbours (Table 3.18). A number of components of management skill on town milk farms were indirectly examined in this study. One of the best measures of farm management skill to emerge from the present study is the average daily milk production per cow in winter (cowADM). Farmers who achieved high levels of cowADM tended to have:-

* High pasture cover in winter (Figure 3.23).
* Higher cow condition score (Figure 3.22).
* Autumn calving winter milkers (Table 3.10).
* Higher quality supplements (Figure 3.26)

The management skill of individual farmers together with the quality of a farms land, pasture and animal resources will determine the total annual milk production on both town milk and seasonal supply farms. The average price recieved per litre of milk less the average costs incurred will then determine the profitability. If the present rapidly rising seasonal supply milkfat prices cause a reduction in the price differential between quota and seasonal milk, it is logical to suggest that the less efficient town milk farmers (i.e. those whose quota production is achieved at considerable expense in terms of total annual production) will find that there is no longer sufficient incentive to produce winter milk. Should these farmers then decide to leave the town milk industry, future winter milk production would be in the hands of fewer, larger farms - a trend that may well have started already. This study has been a broad general examination of a number of factors which influence winter milk production and the differences between town milk and seasonal supply farms. More detailed research is required to define optimal calving dates, milk production patterns, winter milking cow stocking rates and other factors. Many of the factors established in the present study as being important determinants of efficiency in winter milk production need to be ranked according to the magnitude of their effects so advisors and farmers know what the "critical" issues are and can concentrate on improving them.

APPENDIX

1.0 Data collected off town milk and seasonal supply farms.

1.1 Quotas, pasture cover and cow condition score on town milk farms.

FARM	QUOTA	QHA	PROP	QWC	WCH
1	1000	20.00	64.25	8.84	2.26
2	1505	18.81	61.93	9.15	2.06
3	505	12.95	71.24	10.34	1.25
4	870	10.74	58.65	7.55	1.42
5	1400	11.20	89.57	10.17	1.10
6	670	19.14	81.00	9.31	2.06
7	765	12.75	41.93	11.65	1.09
8	2180	17.58	62.25	11.11	1.58
9	1975	27.43	88.54	13.03	2.10
10	2000	19.61	63.62	10.79	1.82
11	1440	15.65	54.49	9.22	1.70
12	1550	18.45	68.45	8.22	2.24
13	590	9.22	44.15	7.96	1.16
14	770	15.71	61.12	7.58	2.07
15	825	13.75	60.24	10.89	1.26
16	1080	15.43	64.81	10.73	1.44
17	420	11.05	43.51	6.40	1.73
18	1820	23.64	72.80	14.70	1.61
19	460	16.43	69.41	8.69	1.89
20	830	13.83	65.04	9.39	1.47
21	700	10.00	51.74	9.33	1.07
22	640	8.89	40.17	10.67	.83
23	990	14.56	85.60	10.35	1.41
24	770	10.55	63.66	11.08	.95
25	890	21.71	86.21	13.58	1.60
26	1160	21.89	64.44	12.63	1.73
27	785	11.54	51.40	11.64	.99
28	505	13.29	60.49	7.49	1.77
29	530	13.25	76.69	8.75	1.51
30	1105	19.05	50.04	7.88	2.42
31	1000	15.38	54.63	9.13	1.69
32	1060	17.38	55.62	10.27	1.69
33	560	10.00	51.67	8.32	1.20
34	2075	23.06	51.07	13.59	1.70
35	360	11.25	43.18	7.13	1.58
36	1210	12.35	24.03	8.18	1.51

QUOTA = Quota per farm in litres per day
QHA = Litres of quota per hectare per day
PROP = Proportion of total production sold as quota milk
QWC = Quota / average number of winter milking cows
WCH = Winter milking cows per hectare

FARM	PRECO1	POSTCO1	GRAV1	PRECO2	POSTCO2	GRAV2	CINCO
1	2300	1460	1880	1685	980	1332	-547.50
2	1930	1155	1543	1700	875	1287	-255.50
3	1790	850	1320	1490	965	1227	-92.50
4	1760	980	1370	1610	1025	1317	-52.50
5	1950	890	1420	1490	755	1122	-297.50
6	1495	1005	1250	1580	965	1272	22.50
7	1970	1145	1557	1535	905	1220	-337.00
8	1850	1085	1467	1760	1370	1565	98.00
9	1600	1190	1395	1385	575	980	-415.00
10	2195	930	1562	1505	770	1137	-424.50
11	2550	1045	1800	1460	770	1115	-685.00
12	1868	1535	1701	2360	1265	1812	111.50
13	2015	1160	1587	1460	965	1212	-374.50
14	1940	895	1467	1190	785	987	-479.50
15	1820	1265	1542	1640	935	1287	-254.50
16	1820	1265	1558	2240	1025	1632	74.50
17	1400	1070	1235	1160	755	957	-277.50
18	2760	1385	2072	2660	995	1827	-244.50
19	2720	1265	1937	1940	1115	1527	-409.50
20	1415	1145	1280	1460	1010	1235	-45.00
21	2765	1115	1940	1340	935	1137	-802.50
22	1715	1430	1572	1655	995	1325	-247.00
23	2105	1220	1662	2000	1505	1752	90.50
24	2395	925	1659	2750	1205	1977	318.50
25	1580	1115	1348	1235	845	1040	-308.00
26	2250	900	1575	1610	1055	1332	-242.50
27	1565	1130	1347	1865	935	1400	53.00
28	1470	785	1107	1400	755	1077	-29.50
29	1175	1040	1107	1460	560	1010	-97.00
30	1475	1055	1265	2165	935	1550	285.00
31	1730	1055	1392	2030	995	1512	120.50
32	2575	1250	1913	1685	1280	1482	-430.50
33	2315	1400	1857	1985	830	1407	-449.50
34	3020	885	1952	1775	1505	1640	-312.00
35	1610	1010	1310	1295	770	1032	-277.50
36	2780	1046	1913	2105	695	1400	-513.00

All units are Kilograms of dry matter per hectare
PRECO1 = Pre-grazing pasture cover in May
POSTCO1 = Post-grazing pasture cover in May
GRAV1 = Average farm cover in May
PRECO2 = Pre-grazing pasture cover in July
POSTCO2 = Post-grazing pasture cover in July
GRAV2 = Average farm cover in July
CINCO = Change in cover over winter

FARM	CONMAY	CONJUL	CHINCS	MLK
1	4.40	4.30	-.10	9
2	4.70	4.60	-.10	12
3	4.30	4.60	.30	9
4	4.50	4.20	-.30	15
5	4.60	4.40	-.20	11
6	4.70	4.50	-.20	10
7	4.60	4.60	.00	16
8	4.50	4.60	.10	13
9	4.30	4.20	-.10	12
10	4.60	4.50	-.10	13
11	4.70	4.40	-.30	14
12	4.40	4.20	-.20	11
13	4.60	4.40	-.20	13
14	4.50	4.20	-.30	12
15	4.20	4.20	.00	11
16	4.40	4.40	.00	13
17	4.50	3.80	-.70	9
18	4.70	4.60	-.10	19
19	4.70	4.40	-.30	14
20	4.40	4.20	-.20	12
21	4.80	4.70	-.10	15
22	4.60	4.40	-.20	13
23	4.50	4.60	.10	12
24	4.70	4.50	-.20	14
25	4.40	4.30	-.10	12
26	4.60	4.30	-.30	15
27	4.80	4.50	-.30	15
28	4.20	4.20	.00	8
29	3.90	4.00	.10	8
30	4.30	4.50	.20	14
31	4.30	4.50	.20	12
32	4.60	4.60	.00	14
33	4.40	4.10	-.30	12
34	4.50	4.60	.10	18
35	4.40	4.60	.20	9
36	4.70	4.70	.00	18

CONMAY = Mean cow condition score in May

CONJUL = Mean cow condition score in July

CHINCS = Change in condition score over winter

MLK = Litres per cow per day in winter

1.2 General data from both town milk and seasonal farms

The following is a guide to the variable abbreviations used in the next 8 pages

Page 104
AREA = Effective farm area in hectares
COWNO = Total number of cows milked
SR = Stocking rate (cows per hectare)
PROD = Total milkfat production for 1987/88 (kg)
PRODHA = Milkfat production per hectare (kg/Ha)
PRODCOW = Milkfat production per cow (kg/cow)

Page 105/6 All units are kilograms of dry matter per cow for 1987/88
HMC = Hay made on farm
SMC = Silage made on farm
TSMC = Total supplements made on farm
HFC = Hay fed on farm
SFC = Silage fed on farm
TSFC = Total supplements fed on farm
HBC = Hay brought in
SBC = Silage brought in
TSBC = Total supplements bought in

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PFC = Proportion of farm cropped (%)
CDMC = Crop dry matter grown (kg/cow)
CONCOW = Concentrates fed (kg/cow)
PFI = Proportion of farm irrigated (%)
NH = Nitrogen applied (kg/hectare)

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CF = Calves reared on whole milk per 100 cows calved
PHO = Proportion of herd grazed when dry (%)
OFF = Time cows grazed off when dry (days)_
R1H = Rising 1 year heifers grazed per hectare
R2H = Rising 2 year heifers grazed per hectare
TR1 = Time rising one year heifers grazed on farm (days)
TR2 = Time rising two year heifers grazed on farm (days)

Page 109
TFG = Total feed grown (kg DM/Ha)
TSBH = Total supplements brought in (kg DM/Ha)
TFF = Total feed fed (kg DM/Ha)
TFC = Total feed consumed (kg DM/Ha)
FUE = Feed utilisation efficiency (%)

Page 110 All units in percent (%)
HDIG = Hay DM digestibility
HPRO = Hay protein concentration
HDM = Hay dry matter level
SDIG = Silage DM digestibility
SPRO = Silage protein concentration
SDM = Silage dry matter level

TM = Town Milk Supply Farm
SS = Seasonal Supply Farm

FARM	AREA	COWNO	SR	PROD	PRODHA	PRODCOW
TM1	50	160	3.20	24101	482.02	150.63
TM2	80	240	3.00	38950	486.88	162.29
TM3	39	85	2.18	10932	280.31	128.61
TM4	81	260	3.21	22085	272.65	84.94
TM5	125	200	1.60	24573	196.58	122.86
TM6	35	92	2.63	13551	387.17	147.29
TM7	60	173	2.88	29250	487.50	169.08
TM8	124	350	2.82	55460	447.26	158.46
TM9	72	198	2.75	36522	507.25	184.45
TM10	102	321	3.15	49681	487.07	154.77
TM11	92	240	2.61	40847	443.99	170.20
TM12	84	240	2.86	35308	420.33	147.12
TM13	64	150	2.34	22002	343.78	146.68
TM14	49	120	2.45	20362	415.55	169.68
TM15	60	140	2.33	21194	353.23	151.39
TM16	70	160	2.29	26631	380.44	166.44
TM17	38	96	2.53	15518	408.37	161.65
TM18	77	150	1.95	36141	469.36	240.94
TM19	28	70	2.50	10562	377.21	150.89
TM20	60	130	2.17	21057	350.95	161.98
TM21	70	200	2.86	20594	294.20	102.97
TM22	72	220	3.06	25434	353.25	115.61
TM23	68	150	2.21	19153	281.66	127.69
TM24	73	150	2.05	18642	255.37	124.28
TM25	41	110	2.68	16695	407.20	151.77
TM26	53	170	3.21	28954	546.30	170.32
TM27	68	188	2.76	24090	354.26	128.14
TM28	38	120	3.16	13535	356.18	112.79
TM29	40	94	2.35	11609	290.22	123.50
TM30	58	240	4.14	36068	621.86	150.28
TM31	65	212	3.26	28095	432.23	132.52
TM32	61	198	3.25	29233	479.23	147.64
TM33	56	140	2.50	16279	290.70	116.28
TM34	90	300	3.33	62028	689.20	206.76
TM35	32	80	2.50	13176	411.75	164.70
TM36	98	400	4.08	74437	759.56	186.09
SS1	35	140	4.00	23000	657.14	164.29
SS2	56	140	2.50	16000	285.71	114.29
SS3	70	170	2.43	27000	385.71	158.82
SS4	45	106	2.36	18600	413.33	175.47
SS5	45	112	2.49	18300	406.67	163.39
SS6	65	150	2.31	25500	392.31	170.00
SS7	28	63	2.25	9000	321.43	142.86
SS8	128	350	2.73	58300	455.47	166.57
SS9	52	89	1.71	.	.	.
SS10	15	54	3.60	9504	633.60	176.00
SS11	40	115	2.88	20213	505.33	175.77
SS12	49	160	3.27	23200	473.47	145.00
SS13	54	160	2.96	30100	557.41	188.13
SS14	37	95	2.57	15000	405.41	157.89
SS15	55	194	3.53	24800	450.91	127.84
SS16	40	104	2.60	16300	407.50	156.73
SS17	50	139	2.78	22522	450.44	162.03
SS18	48	120	2.50	24500	510.42	204.17
SS19	47	144	3.06	24000	510.64	166.67
SS20	44	147	3.34	25228	573.36	171.62
SS21	51	180	3.53	30585	599.71	169.92
SS22	17	56	3.29	9500	558.82	169.64

FARM	HMC	SMC	TSMC	HFC	SFC	TSFC
TM1	137.50	312.50	450.00	575.00	312.50	887.50
TM2	333.33	691.67	1025.00	333.33	833.33	1166.67
TM3	517.65	.00	517.65	517.65	.00	517.65
TM4	446.15	.00	446.15	446.15	.00	446.15
TM5	160.00	420.00	580.00	160.00	420.00	580.00
TM6	326.09	826.09	1152.17	652.17	826.09	1478.26
TM7	.00	202.31	202.31	.00	173.41	173.41
TM8	28.57	337.14	365.71	342.86	337.14	680.00
TM9	202.02	1010.10	1212.12	202.02	1010.10	1212.12
TM10	.00	311.53	311.53	.00	679.13	679.13
TM11	.00	558.33	558.33	416.67	558.33	975.00
TM12	83.33	175.00	258.33	225.00	229.17	454.17
TM13	.00	473.33	473.33	666.67	366.67	1033.33
TM14	1000.00	291.67	1291.67	1000.00	291.67	1291.67
TM15	142.86	357.14	500.00	357.14	357.14	714.29
TM16	450.00	631.25	1081.25	637.50	631.25	1268.75
TM17	354.17	.00	354.17	322.92	.00	322.92
TM18	400.00	513.33	913.33	600.00	513.33	1113.33
TM19	285.71	.00	285.71	428.57	.00	428.57
TM20	307.69	307.69	615.38	769.23	307.69	1076.92
TM21	750.00	335.00	1085.00	750.00	335.00	1085.00
TM22	136.36	95.45	231.82	136.36	277.27	413.64
TM23	.00	786.67	786.67	.00	786.67	786.67
TM24	200.00	786.67	986.67	333.33	786.67	1120.00
TM25	118.18	309.09	427.27	236.36	854.55	1090.91
TM26	.00	.00	.00	117.65	.00	117.65
TM27	.00	265.96	265.96	372.34	265.96	638.30
TM28	.00	208.33	208.33	833.33	208.33	1041.67
TM29	638.30	.00	638.30	425.53	.00	425.53
TM30	.00	66.67	66.67	.00	329.17	329.17
TM31	141.51	198.11	339.62	141.51	198.11	339.62
TM32	222.22	191.92	414.14	151.52	.00	151.52
TM33	.00	.00	.00	785.71	300.00	1085.71
TM34	.00	.00	.00	3.33	260.00	263.33
TM35	300.00	.00	300.00	800.00	.00	800.00
TM36	.00	20.00	20.00	105.00	397.50	502.50
SS1	.00	85.71	85.71	.00	385.71	385.71
SS2	285.71	.00	285.71	285.71	.00	285.71
SS3	294.12	.00	294.12	411.76	.00	411.76
SS4	188.68	.00	188.68	377.36	.00	377.36
SS5	178.57	321.43	500.00	357.14	321.43	678.57
SS6	360.00	226.67	586.67	266.67	226.67	493.33
SS7	.00	.00	.00	380.95	47.62	428.57
SS8	.00	.00	.00	114.29	385.71	500.00
SS9	.00	.00	.00	.00	.00	.00
SS10	370.37	.00	370.37	370.37	555.56	925.93
SS11	556.52	452.17	1008.70	521.74	391.30	913.04
SS12	.00	231.25	231.25	312.50	231.25	543.75
SS13	.00	231.25	231.25	225.00	231.25	456.25
SS14	157.89	.00	157.89	157.89	.00	157.89
SS15	206.19	257.73	463.92	309.28	231.96	541.24
SS16	384.62	.00	384.62	480.77	.00	480.77
SS17	.00	431.65	431.65	57.55	489.21	546.76
SS18	.00	283.33	283.33	166.67	283.33	450.00
SS19	.00	208.33	208.33	.00	326.39	326.39
SS20	.00	204.08	204.08	272.11	68.03	340.14
SS21	.00	.00	.00	.00	.00	.00
SS22	.00	.00	.00	.00	.00	.00

FARM	HBC	SBC	TSBC
TM1	687.50	.00	687.50
TM2	.00	141.67	141.67
TM3	.00	.00	.00
TM4	.00	.00	.00
TM5	.00	.00	.00
TM6	326.09	.00	326.09
TM7	115.61	144.51	260.12
TM8	342.86	.00	342.86
TM9	.00	.00	.00
TM10	.00	367.60	367.60
TM11	500.00	279.17	779.17
TM12	250.00	279.17	529.17
TM13	800.00	.00	800.00
TM14	.00	.00	.00
TM15	357.14	.00	357.14
TM16	187.50	.00	187.50
TM17	.00	.00	.00
TM18	200.00	.00	200.00
TM19	571.43	.00	571.43
TM20	461.54	.00	461.54
TM21	.00	.00	.00
TM22	.00	.00	.00
TM23	.00	.00	.00
TM24	213.33	.00	213.33
TM25	118.18	545.45	663.64
TM26	235.29	.00	235.29
TM27	372.34	.00	372.34
TM28	833.33	.00	833.33
TM29	.00	.00	.00
TM30	.00	262.50	262.50
TM31	188.68	.00	188.68
TM32	80.81	.00	80.81
TM33	785.71	300.00	1085.71
TM34	3.33	363.33	366.67
TM35	500.00	.00	500.00
TM36	105.00	377.50	482.50
SS1	.00	300.00	300.00
SS2	.00	.00	.00
SS3	117.65	.00	117.65
SS4	188.68	.00	188.68
SS5	178.57	.00	178.57
SS6	.00	.00	.00
SS7	380.95	47.62	428.57
SS8	114.29	385.71	500.00
SS9	.00	.00	.00
SS10	.00	629.63	629.63
SS11	.00	.00	.00
SS12	312.50	.00	312.50
SS13	225.00	.00	225.00
SS14	.00	.00	.00
SS15	463.92	175.26	639.18
SS16	96.15	.00	96.15
SS17	57.55	57.55	115.11
SS18	166.67	.00	166.67
SS19	.00	118.06	118.06
SS20	367.35	.00	367.35
SS21	.00	.00	.00
SS22	.00	.00	.00

FARM	PFC	CDMC	CONCOW	PFI	NH
TM1	4.00	75.00	.00	45.00	156.00
TM2	.00	.00	.00	.00	.00
TM3	10.77	444.71	.00	.00	.00
TM4	7.41	230.77	61.54	.00	.00
TM5	4.80	135.00	90.00	.00	.00
TM6	4.57	104.35	.00	30.00	154.29
TM7	.00	.00	.00	.00	38.33
TM8	4.19	148.57	.00	.00	.00
TM9	.00	.00	.00	.00	.00
TM10	7.84	249.22	.00	33.00	56.86
TM11	.00	.00	.00	.00	.00
TM12	3.33	116.67	.00	.00	23.81
TM13	3.91	166.67	.00	.00	.00
TM14	.00	.00	66.67	.00	.00
TM15	6.67	285.71	.00	.00	8.33
TM16	2.29	60.00	.00	.00	.00
TM17	6.32	175.00	.00	.00	.00
TM18	6.23	240.00	880.00	40.00	.00
TM19	6.43	205.71	.00	.00	17.86
TM20	6.67	184.62	.00	.00	33.33
TM21	5.71	200.00	.00	.00	.00
TM22	.00	.00	.00	.00	.00
TM23	2.94	80.00	.00	.00	.00
TM24	9.86	417.60	.00	.00	34.25
TM25	4.88	181.82	.00	.00	.00
TM26	3.02	56.47	.00	.00	18.87
TM27	8.82	239.36	.00	12.00	14.71
TM28	5.79	183.33	.00	.00	.00
TM29	10.00	170.21	.00	.00	12.50
TM30	.00	.00	.00	.00	17.24
TM31	6.15	150.94	.00	.00	.00
TM32	1.97	48.48	.00	13.00	.00
TM33	.00	.00	.00	15.00	.00
TM34	.00	.00	120.00	50.00	63.33
TM35	7.50	240.00	.00	.00	.00
TM36	.00	.00	750.00	49.00	30.61
SS1	.00	.00	.00	.00	42.86
SS2	3.57	85.71	.00	.00	.00
SS3	.00	.00	.00	.00	.00
SS4	5.33	226.42	.00	.00	.00
SS5	.00	.00	.00	.00	11.11
SS6	6.15	213.33	.00	.00	.00
SS7	7.14	190.48	.00	.00	.00
SS8	5.94	21.71	.00	.00	7.81
SS9	2.31	80.90	.00	.00	.00
SS10	5.33	88.89	.00	.00	33.33
SS11	.00	.00	.00	.00	.00
SS12	.00	.00	.00	.00	.00
SS13	6.67	157.50	.00	.00	.00
SS14	3.24	75.79	.00	.00	.00
SS15	.00	.00	.00	.00	.00
SS16	3.50	80.77	.00	.00	.00
SS17	2.80	60.43	.00	.00	.00
SS18	8.33	266.67	.00	.00	22.92
SS19	.00	.00	.00	.00	.00
SS20	4.09	122.45	.00	.00	.00
SS21	.00	.00	.00	51.00	196.06
SS22	.00	.00	.00	.00	.00

FARM	CF	PHO	OFF	R1H	R2H	TR1	TR2
TM1	38.75	.00	0	.74	.00	300	0
TM2	50.00	.00	0	.00	.00	0	0
TM3	47.06	.00	0	.51	.51	300	365
TM4	55.77	.00	0	1.23	.37	300	365
TM5	90.00	.00	0	.40	.40	300	365
TM6	38.04	.00	0	.60	.00	100	0
TM7	80.92	.00	0	.47	.00	200	0
TM8	17.14	85.71	90	.00	.00	0	0
TM9	95.96	.00	0	.00	.00	0	0
TM10	18.69	93.46	90	.49	.00	300	0
TM11	23.33	.00	0	.00	.00	0	0
TM12	91.67	50.00	90	.36	.00	300	0
TM13	93.33	.00	0	.00	.00	0	0
TM14	100.00	100.00	90	.00	.00	0	0
TM15	28.57	.00	0	.00	.00	0	0
TM16	75.00	.00	0	.63	.59	300	365
TM17	.00	.00	0	.42	.42	300	365
TM18	106.67	66.67	90	.26	.26	300	365
TM19	28.57	.00	0	.00	.00	0	0
TM20	34.62	.00	0	.20	.17	300	365
TM21	55.00	.00	0	.43	.43	300	365
TM22	18.18	.00	0	.28	.28	300	365
TM23	33.33	.00	0	.00	.00	0	0
TM24	93.33	86.67	90	.00	.00	0	0
TM25	63.64	90.91	90	.00	.00	0	0
TM26	11.76	94.12	90	.85	.00	200	0
TM27	37.23	26.60	90	.66	.66	300	365
TM28	66.67	.00	0	.00	.00	0	0
TM29	31.91	.00	0	.50	.50	300	365
TM30	91.67	41.67	90	.00	.00	0	0
TM31	47.17	47.17	90	.00	.00	0	0
TM32	50.51	.00	0	.16	.16	300	365
TM33	92.86	.00	0	.00	.00	0	0
TM34	50.00	66.67	90	.00	.00	0	0
TM35	43.75	50.00	90	.00	.00	0	0
TM36	95.00	75.00	90	.00	.00	0	0
SS1	25.00	.00	0	.00	.00	0	0
SS2	26.43	85.71	60	.54	.00	300	0
SS3	47.06	.00	0	.00	.00	0	0
SS4	47.17	.00	0	.44	.00	300	0
SS5	71.43	100.00	60	.56	.00	300	0
SS6	28.67	.00	0	.57	.57	300	250
SS7	26.98	.00	0	.50	.50	300	365
SS8	28.57	.00	0	.00	.00	0	0
SS9	89.89	.00	0	.54	.54	300	365
SS10	92.59	100.00	60	.00	.00	0	0
SS11	60.87	.00	0	.00	.00	0	0
SS12	25.00	.00	0	.82	.00	300	0
SS13	28.13	15.63	75	.00	.00	0	0
SS14	94.74	100.00	90	.00	.00	0	0
SS15	72.16	51.55	60	.00	.00	0	0
SS16	24.04	.00	0	.60	.00	300	0
SS17	32.37	.00	0	.76	.62	300	150
SS18	47.50	.00	0	.46	.46	200	150
SS19	33.33	.00	0	.60	.00	300	0
SS20	20.41	78.23	30	.95	.00	300	0
SS21	27.78	100.00	60	.88	.00	200	0
SS22	64.29	100.00	75	.00	.00	0	0

FARM	TFG	TSB	TFF	TFC	FUE
TM1	15139	2200	16539	13613	82.3
TM2	12471	425	12896	12743	98.8
TM3	12097		12097	9687	80.0
TM4	12287		12485	12406	99.3
TM5	12088		12232	7069	57.7
TM6	15001	857	15858	10777	67.9
TM7	12725	750	12642	12541	99.2
TM8	12367	967	13254	10476	79.0
TM9	12471		12471	12130	97.2
TM10	13334	1156	14491	11920	82.2
TM11	12471	2032	13557	11044	81.4
TM12	12546	1511	13106	11073	84.4
TM13	12374	1875	13686	9317	68.0
TM14	12471		12634	9311	73.7
TM15	12361	833	12861	9440	73.4
TM16	12323	428	12751	11363	89.1
TM17	12125		12046	11730	97.3
TM18	13252	389	15355	10022	65.2
TM19	12302	1428	12659	10063	79.5
TM20	12261	1000	13261	9516	71.7
TM21	12329		12329	11148	90.4
TM22	12471		13026	11837	90.8
TM23	12280		12280	8290	67.5
TM24	12326	438	12600	6822	54.1
TM25	12350	1780	14130	9726	68.8
TM26	12401	754	12778	12793	100.1
TM27	12500	1029	13530	11961	88.4
TM28	12327	2631	14959	11352	75.8
TM29	11707		11207	10202	91.0
TM30	12585	1086	13671	15819	15.7
TM31	12195	615	12195	11703	95.9
TM32	12830	262	11978	13425	12.0
TM33	13033	2714	15747	9074	57.6
TM34	14058	1222	15336	14494	94.5
TM35	12135	1250	13385	9873	73.7
TM36	13724	1969	18755	16627	88.6
SS1	12756	1200	13956	16714	119.7
SS2	12239		12239	9575	78.2
SS3	12471	285	12756	9983	78.2
SS4	12339	444	12783	10618	83.0
SS5	12544	444	12989	10194	78.4
SS6	12195		11980	11097	92.6
SS7	12008	964	12973	10376	79.9
SS8	11841	1367	13209	11481	86.9
SS9	12321		12321		.
SS10	12347	2266	14347	14591	101.7
SS11	12471		12196	12409	101.7
SS12	12471	1020	13491	13742	101.8
SS13	12106	666	12772	12999	101.7
SS14	12261		12261	9395	76.6
SS15	12471	2254	12743	12682	99.5
SS16	12244	250	12494	11277	90.2
SS17	12289	320	12609	13545	107.4
SS18	12250	416	12667	12261	96.8
SS19	12471	361	12832	14376	112.0
SS20	12369	1227	12824	14805	115.4
SS21	15874		15874	14467	91.1
SS22	12471		12471	12727	102.0

FARM	HDIG	HPRO	HDM	SDIG	SPRO	SDM
TM1	53	8	82	65	13	19
TM2	60	10	87	69	16	22
TM3	55	7	85	.	.	.
TM4	52	10	83	.	.	.
TM5	60	9	85	63	13	25
TM6	56	8	84	64	13	25
TM7	50	8	88	64	14	25
TM8	58	12	87	68	9	26
TM9	.	.	.	67	15	25
TM10	57	7	86	67	16	30
TM11	56	8	85	55	10	19
TM12	55	10	86	58	9	24
TM13	48	7	84	.	.	.
TM14	54	8	85	62	14	22
TM15	58	9	88	65	10	20
TM16	58	12	85	65	12	38
TM17	58	9	84	.	.	.
TM18	53	7	86	65	12	30
TM19	52	9	85	.	.	.
TM20	56	10	85	70	18	24
TM21	56	11	83	70	18	29
TM22	49	7	84	68	13	26
TM23	.	.	.	59	12	29
TM24	53	7	86	66	18	21
TM25	.	.	.	59	12	38
TM26	58	8	86	.	.	.
TM27	56	6	88	64	13	26
TM28	56	10	88	.	.	.
TM29	59	11	84	.	.	.
TM30	.	.	.	62	16	15
TM31	56	8	84	65	18	27
TM32	61	11	85	.	.	.
TM33	55	11	84	.	.	.
TM34	64	16	87	68	17	31
TM35	58	9	83	.	.	.
TM36	.	.	.	63	13	33
SS1	59	13	88	.	.	.
SS2	54	7	85	.	.	.
SS3	57	10	86	.	.	.
SS4	55	10	85	.	.	.
SS5	.	.	.	.	.	.
SS6	54	8	84	66	13	37
SS7	55	10	85	.	.	.
SS8	.	.	.	.	.	.
SS9	.	.	.	.	.	.
SS10	60	11	87	62	11	39
SS11	58	10	88	62	13	56
SS12	51	5	85	65	18	60
SS13	58	10	92	.	.	.
SS14	62	14	86	.	.	.
SS15	61	15	88	.	.	.
SS16	55	8	87	.	.	.
SS17	58	12	88	.	.	.
SS18	54	12	89	67	12	34
SS19	.	.	.	66	20	28
SS20	49	11	89	71	17	21
SS21	61	14	85	.	.	.
SS22	.	.	.	61	9	38

2.0 Feed calculations

2.1 Supplements made and fed in 1987/88

The following two equations were used to derive estimates of total supplements made and fed on each farm.

tsm = ((haym * 20) + (sim * 1000)

tsf = ((hayf * 20) + (sif * 1000)

where

tsm = Total supplements conserved from milking area (kgDM/year)

haym = Number of haybales made on farm

sim = Tonnes of silage DM made on farm

tsf = Total supplements fed on the milking area including any bought in hay or silage (kgDM/year)

hayf = Number of haybales fed on farm (i.e.hay made + bought - any leftover at the end of the winter

sif = Tonnes of silage DM fed on farm (i.e.silage made + bought - leftover)

Haybales were assumed to contain 20 kgDM per bale (23 kg per bale * 86% DM - Maftech 1987). Where the area of silage conserved on the farm was the only quantitative parameter known by the farmer, a yield of 4200 kgDM/Ha was assumed to convert silage to a tonnes of dry matter basis. This was based on a mean yield of 16800 kg of wilted silage per hectare at a DM% of 25 (Maftech 1987). Estimates of hay made, brought in and left at the end of the season were all derived from the farmers records or head knowledge. No attempt was made to physically assess amounts of supplement on farms

2.2 Total feed grown.

The following equation was used to estimate total feed grown on each farm during the 1987/88 season

$$tfg = (((12471 * (area - crp)) + (crp * yld * 1000) + (2100 * ir) + (Nuse * 6.65)) / area$$

where

tfg = Total feed grown on farm (kgDM/Ha/year)
area = Milking area (Ha)
crp = area of farm planted in crop (Ha)
yld = yield of crop (tonnes of DM/Ha)
Assume Maize = 10, choumoullier = 8, wairoa brassica = 7.5, turnips = 6, ryecorn = 4.5 (Douglas 1980).
ir = area of farm under irrigation (Ha)
Nuse = kilograms of nitrogen applied to the farm 1987/88

Pasture growth on all farms was assumed to be 12471 kgDM/Ha/year. This was the mean pasture growth of a number of "downland Manawatu" sites measured by Maftech during the 1987/88 season (1/6/87 - 31/5/88) (Maftech 1988 unpublished data). Pasture growth response to irrigation was estimated using the "GROW" model developed by the Massey University Agronomy Department (B.M. Butler unpublished). The model has been proven to be accurate in predicting pasture growth for a number of Massey University trials and was used to verify the pasture growth rate data presented by Gray et al (1987).

Irrigation was assumed to apply an extra 93 mm of water for the three months of summer. The calculation of 93 mm of water was based on effluent outflow rates from Manawatu Cooperative Dairy Company to three of the survey farms being irrigated. The net pasture growth response to irrigation estimated by the "GROW" model was an increase in feed grown of 2100 kgDM per irrigated hectare per year. Response to nitrogen application (in irrigation water or as urea) was 6.65 kgDM/kg N applied which was the mean response to nitrogen observed in 6 spring and autumn trials in the Manawatu (O'Connor 1982).

2.3 Total feed fed.

The following equation was used to estimate total feed available for animal consumption.

tff = tfg - tsm + tsf + (con * 1000)

where

tff = total feed fed (kgDM/Ha/year)

tfg = total feed grown (Appendix 2.2)

tsm/tsf = total supplements made and fed (Appendix 2.1)

con = tonnes of concentrate DM fed per year

2.4 Feed consumption

Annual consumption of feed (tfc) was estimated from known feed requirements per unit of animal production, maintenance, growth etc. The following equation was used

tfc = (((cowno * 57.5 * 365)	---maintenance
+ (120 * prod)	---production
+ (cowno * 1790)	---pregnancy
+ (cowno * 1071)	---liveweight change
+ (nr1 * tr1 * 35.6)	---R1 heifer maintenance and growth
+ (nr2 * tr2 * 53.8)	---R2 heifer maintenance and growth
+ (os * 60 * 365)	---other stock maintenance
- (nco * off * 53.7))	---dry cows grazed off
/ 10.5) / area	---convert to kgDM/Ha basis

Essentially, the equation seeks to add up the metabolisable energy requirements of each class of livestock on each farm and then convert this to a kgDM/Ha basis on the assumption that mean pasture ME concentration is 10.5 MJME/kgDM (Ulyatt et al 1980). ME requirements are all based on chapter 13 of Holmes and Wilson (1984). Individual components of the equation have been calculated as follows

(a) Maintenance

Average liveweight of cows during the season = 450 kg

Average lactation length = 280 days

Maintenance requirement for a lactating cow = 0.6 MJME/kgLW^0.75

Maintenance requirement for a non lactating cow = 0.55 MJME/kgLW^0.75

Therefore average maintenance requirement =

((0.6 * 450^0.75 * 280) + (0.55 * 450^0.75 * 85)) / 365
= 57.5 MJME/cow/day

cowno = herd size

(b) Production

Net Energy in milk = 78 MJNE/kg milkfat (Friesian cow)

Kl (efficiency with which ME is utilised for lactation) = 0.65

Therefore ME requirements for milk production are

78 / 0.65 = 120 MJME/kg milkfat

prod = total milkfat production at factory for 1987/88 season (kg)

(c) Pregnancy

Mean ME requirements for the last three 4-week periods of pregnancy are 11, 19 and 34 MJME/cow/day respectively

Therefore total pregnancy requirements are (11 + 19 + 34) * 28 days = 1790 MJME/cow/pregnancy

(d) Liveweight change

Assume each cow loses and gains 1 condition score per cow per year (i.e approximately 30 kg liveweight)

Also assume that all catabolised liveweight is used for milk production

Catabolism of 1 kg LW contributes 25 MJNE to milk production

Therefore total contribution = 25 * 30 = 750 MJNE if cow loses 1 condition score

If the efficiency of NE (from liveweight loss) usage for milk production (Kg - l) is 0.83), then NE in milk contributed from LW loss

= 750 * 0.83 = 622 MJNE

If this NE in milk had to be supplied from feed consumption, the cow would have to eat 622 / 0.65 (Kl) = 957 MJME. Therefore contribution to milk production from liveweight loss is 957 MJME.

However, liveweight lost must be replaced, probably during dry period ME cost to replace lost liveweight =

30kg * 67.6 MJME/kgLW/cow = 2078 MJME/cow/year

Therefore net cost of liveweight change during the season is

2078 - 957 = 1071 MJME/cow/year

(e) Rising one year heifer maintenance and growth

Assume a rising one year heifer grows from 80 to 220 kg LW in 310 days from weaning to one year of age (i.e weaned at 55 days)

Therefore average liveweight during season = (80 + 220) / 2 = 150 kg

Maintenance requirement = 0.55 MJME/kgLW^0.75/day * 150^0.75 = 23.6 MJME/hfr/day

ME requirements for gain = (26.7 MJME/kg gain * 140 kg) / 310 = 12.1 MJME/hfr/day

Total ME requirements = 23.6 + 12.1 = 35.7 MJME/hfr/day

nr1 = number of R1 heifers grazed on milking area

tr1 = number of days per year R1 heifers are grazed on milking area

(f) Rising two year heifer maintenance and growth

Assume a rising one year heifer grows from 220 to 400 kg LW in a year

Therefore average liveweight during season = (220 + 400)) / 2 = 310 kg

Maintenance requirement = 0.55 * 310^0.75 = 40.6 MJME/hfr/day

ME requirements for gain = (26.7 MJME/kg gain * 180 kg) / 365 = 13.2 MJME/hfr/day

Total ME requirements = 40.6 + 13.7 = 53.8 MJME/hfr/day

nr2 = number of R2 heifers grazed on milking area

tr2 = number of days per year R2 heifers are grazed on milking area

(g) Other stock maintenance

This refers to any other cattle carried on the milking area for the year

Assume any breeding bulls or fattening steers weigh 520 kg

Therefore maintenance requirement = 0.55 * 520^0.75 = 60 MJME/animal/day

(h) Dry cows grazed off

nco = number of (dry) cows grazed off the milking area

off = number of days these cows spend off the milking area

Therefore feed saved on milking area = maintenance requirement of each cow

= 0.55 * 450^0.75 = 53.7 MJME/cow/day

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