Farm business analysis

Lincoln College
Department of Farm Management and Rural Valuation

The Management of Christchurch Milk Supply Farms

P. L. Nuthall

Farm Management Studies 1

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THE MANAGEMENT OF CHRISTCHURCH MILK SUPPLY FARMS

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J.D. Stewart,
Professor of Farm Management

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INTRODUCTION

The number of town milk producing farms in the Christchurch region is relatively small compared with other classes of farms. It is partly for this reason that a comprehensive farm management study of town milk dairy farming has not been carried out in the past. Work presented in this bulletin attempts to make a contribution towards meeting this gap. It is based on research carried out during the period 1965-67, part of which involved an analysis of the profitability of different management systems on a particular farm. It is this section, together with supporting information, that is presented.

The farm chosen was carefully selected so that it would have similar attributes to as many other farms as possible, the selection being based on information obtained from a postal survey sent to all town milk producers in 1965.

The bulletin consists of six sections. The first section defines the area in which milk is produced and discusses its soils and climate. In section two the major management decisions which must be made by a town supply farmer are discussed and some of the factors which should influence these decisions are outlined. In section three descriptive information obtained about farms in the area from the postal survey and the method used in selecting the case farm from this information is presented. In section four the method used to determine the optimum management systems for the case farm is briefly discussed while in section five the results of this analysis are given. Finally a summary of recommendations is given in section six.

In order to widen the applicability of the results the analysis compared management systems for different quota levels. No claim can be made that the results can be directly applied to other farms. The most that can be claimed is that the method of selecting the case-form gives some confidence in making recommendations based on these results.

Over four years have elapsed since the postal survey was conducted. In the interim some of the statistics used in selecting the case farm will have changed but it is believed that these changes will not have significantly affected the results. Statistics such as the area of farms and the number of labour units employed do not change much where a large number of farms is considered. Similarly, as the prices and costs existing at the end of 1967 were used in the analysis some of the optimum plans could change slightly if the analysis was based on current prices. In the original analysis the effect of price changes was explored and this indicated that the optimum management systems determined were quite stable in relation to price variations. It is therefore considered that the major conclusion of this analysis apply. Minor changes considered possible are outlined in the results section.

1. THE SUPPLY AREA

To minimise transport costs, town milk supply dairy farms are not more than 20 miles from the centre of Christchurch. The supply area is roughly a rectangle with boundaries of the coast line, the Ashley River, a line drawn through the townships of Fernside and Rolleston, and the Selwyn River and Lake Ellesmere. The topography of the farms in the area is flat, except for a small number of farms on Banks Peninsula.

Rainfall and temperature figures indicate that the climate experienced throughout the area, except for Banks Peninsula, is similar. Average seasonal rainfall figures for meteorological stations situated throughout the area are given in Table 1.1.

Table 1.1
Seasonal Five Year Average Rainfall Figures for 1960-64 (in inches)**

Station	Spring (Sept.-Nov. inc.)	Summer (Dec.-Feb. inc.)	Autumn (Mar.-May inc.)	Winter (June-Aug. inc.)	Total
Rangiora High S.	4.39*	6.67*	7.15*	8.77*	26.99*
Woodend	3.77*	5.54*	6.12	7.70*	24.41*
Chch. Airport	4.13	5.26	6.16	7.62	23.81
Waimakariri Bridge	3.65	5.36	6.07	6.86	21.94
Lincoln	4.51	6.50	6.91	7.93	25.84
Greenpark	4.03	5.65	5.79	7.07	22.54
Lake Ellesmere	3.45*	4.88*	4.71*	N.A.	N.A.
Seasonal Average	4.0	5.58	6.00	7.64	23.64

* indicates that the average is for less than five years.

** Source - "Meteorological Observations for the years 1960, 61, 62, 63 and 64." New Zealand Meteorological Service.

An indication of air temperature throughout the area is given in Table 1.2.

Table 1.2
Seasonal Five Year Average Air Temperatures $(\frac{max + min}{2})$
for 1960–64 (in ^{o}F.)

Station	Spring (Sept.-Nov.)	Summer (Dec.-Feb.)	Autumn (Mar.-May)	Winter (June-Aug.)	Year
Chch. Airport	53.2	61.6	52.7	43.2	52.7
Lincoln	52.0	60.7	52.1	42.9	51.9
Seasonal Average	52.6	61.1	52.4	43.0	52.3

Thirteen soils series are found within the area. By superimposing the location of farm dairies on a soil map an indication of the relative importance of the different soils can be obtained. Table 1.3 shows the percentage of all town supply farms' dairies found on each major soil series.

Table 1.3
The Location of Farm Dairies by Soil Series

Soil Type	Percentage of farms
Tai Tapu Loams	33.8
Temuka Loams	28.8
Kaiapoi Loams	12.4
Waimakariri Loams	6.2
Motukarara Loams	5.0
Other (each less than 5%)	13.8
	100.0

This information may be misleading as the soil series upon which the farm dairy is located may not be the major soil series of the whole farm, but nevertheless it is probably a reasonable indication of the relative importance of these soils.

These soils are all derived from greywacke alluvium. They are poorly drained, except for the Waimakariri series, the Tai Tapu and Temuka soils being gleyed, indicating they have been formed under poor drainage. The Tai Tapu, Temuka and Kaiapoi loams are all naturally fertile. The Waimakariri series vary from high to medium natural fertility depending on the depth of soil and the degree of stoniness. The Motukarara soils vary from saline low fertility, to medium-high fertility areas.

Because of the large number of different soils found within the supply area any analysis must take into account these variations. Clearly, results applicable to one type of farm will not necessarily hold for another.

II THE MANAGEMENT OF TOWN SUPPLY DAIRY FARMS

In all systems of farming there are a number of major factors which a farmer must consider when formulating a management plan. In town supply dairying the most important of these is probably the size of the milk quota. If the quota is large in relation to the size of the farm the producer must be mainly involved in decisions relating to methods of milk production, as available resources will be fully utilised in milk production. If the quota is small the farmer has alternative products he can produce, and therefore the decision field will be wider.

The other factors the farmer must consider in determining the farm plan are:-

(i) The stocking rate per acre and the cow calving pattern (i.e. the percentage of the herd calving in each month),
(ii) the herd replacement policy,
(iii) stock feeding methods, and
(iv) the production of alternative products (e.g. cash crops).

These management factors are inter-related. Decisions relating to the calving pattern, for example, cannot be made without reference to the cost of feed production in different periods of the year, the quota, the price of milk, and the return from the production of alternative products. In the following sub-sections each of the above factors is discussed in order to give a fairly comprehensive outline of the influence of other related factors.

2.1 The Stocking Rate and Calving Pattern

In general there is a close relationship between stocking rate, production per cow and production per acre. Compared with seasonal dairy farming this relationship is complicated by the need to organise a feed and calving pattern capable of maintaining the quota. The principle to be applied in estimating the optimum stocking rate, however, must still consist of determining whether the cost of producing, say, an extra ten gallons per acre from an increase in the stocking rate is less than the increase in revenue. With the information available it is not possible to draw conclusions about the optimum stocking rate in the supply area. In the analysis it was assumed that a cow produced approximately 900 gallons per lactation (this varied according to the month of calving) and was fed in order to achieve this.

Decisions relating to the calving pattern are dependent upon the quota per acre and on the milk production per acre achieved. A farmer with a high quota per acre, say two gallons, will be concerned with arranging an even pattern so that the quota will be fulfilled throughout the year. A farmer with a low quota per acre, say 0.5 gallons, has scope to arrange calving dates in order to achieve a pattern of milk production which maximises profit. His decisions would be dependent on the competitiveness of alternative products with surplus milk. Expectations of quota increases should also influence decisions about the calving pattern.

The pattern must also allow flexibility. Milk production must be sufficiently above quota to allow for fluctuations caused by day to day weather and feed, and it is also necessary to allow for mating failures. If the payout and quota allocation systems are frequently changed a flexible calving pattern enables a more rapid adjustment.

2.2 The Herd Replacement Policy

Replacement stock may be either bred or purchased. Breeding and rearing implies carrying a smaller number of milking cows, or the purchase of supplementary feed, or the reduction of other forms of production.

Rearing of replacement stock may be carried out in a number of ways. These include:-

Calves	(i)	bucket rearing,
	(ii)	nurse cow rearing, and
	(iii)	reared on another farm.
Weaning to calving	(i)	home reared,
	(ii)	reared on another farm, and
	(iii)	a combination of (i) and (ii).

One of the major advantages of breeding is that the farmer has some direct control over the genetic potential of stock through the use of high producing cows as dams, and proven bulls, and therefore the general genetic quality of the herd can be improved. High producing cows reduce overhead and labour costs per gallon, as well as more efficiently converting available feed. Home rearing also ensures control over the growth and development of stock, and adequate precautions enable replacement stock to be disease-free. Besides these factors many farmers obtain considerable satisfaction from breeding and rearing their own stock and for this reason alone will breed rather than buy.

Buying replacement stock, depending on the type of stock purchased, may eliminate labour and feed requirements for rearing, but the disadvantages are that the stock's genetic quality is dependent upon the seller, as are their development and disease carrying potential. There is no way of estimating potential production, and success in buying depends to a large extent upon the purchaser's intrinsic knowledge of stock and his access to the breeders' records. Also, unless arrangements are made will in advance, stock may be unavailable when required.

2.3 Stock Feeding Methods

The natural pasture growth pattern in the area means that fodder must be conserved in the spring-summer (September-December inclusive) for use in the summer-autumn (January-April inclusive) and the winter (May-August inclusive) to give an even supply. Alternatively feed can be purchased.

Summer-autumn pasture can be supplemented with green feed crops, mainly maize or recently developed tropical grasses, hay or silage. Concentrates (e.g. barley meal), hay and silage can also be purchased. Grass and clover species included in the pasture mixtures, due to their different growth patterns, will influence the degree of supplementation required.

Irrigation augments spring-summer pasture production, and can be used for fodder and cash crop production. The contour of farm and the water supply available dictate whether spray or flood irrigation can be used. In general, spray irrigation is most suited to the area. The capital cost of spray irrigation plants varies from $10 to $100 per acre depending on the acerage irrigated and its physical characteristics. Associated with this cost may be investment in extra stock, subdivision, hay making equipment and so on, depending on how the increased pasture production is utilised.

The increased pasture growth resulting from irrigation can be utilised in the following ways:-

- (i) grazed "in situ",
- (ii) made into pasture hay and/or silage, and
- (iii) saved for winter use (autumn saved pasture).

There is very little research evidence on the effect of irrigation on grass production in the area. Work at Lincoln College in 1955/56, however, gives a guideline. This trial showed that the application of 17" of effective water to a Short Rotation Ryegrass/Timothy pasture in eleven irrigations produced a significant increase in production. Results from this trial are given in Table 2.1.

Table 2.1
Spray Irrigation Trial
(Temuka Soils, Lincoln College)
1955/56*

	lbs. dry matter production	
	lbs. per acre 1.11.55 – 5.4.56	lbs. per acre per day
Irrigated	5420	35.0
Unirrigated	2373	15.3
Increase	3047	19.7 (128% increase)

(* Rainfall for period 8.82")

This result was substantiated by records of cow-grazing-days, which increased by 138%.

Pasture irrigation reduces the risk and uncertainty associated with pasture yields. Plans can be made with greater assurance. Having control over soil water also increases the useful life of a pasture through the reduction of weed invasion resulting from dense swards. The profitability of irrigation is dependent however on a number of variables particular to each farm. These include the quota per acre; the physical nature of the farm, and thus the per acre overhead and running costs; the increase in pasture yields obtained; and labour availability.

The profitability of investing in an irrigation plant on the case study farm was investigated in the original analysis. This showed that, where the Lincoln College results were used as the basis for increased pasture yield, this investment was profitable at all quota levels. This farm, however, was most suitable for spray irrigation. The cost of the plant necessary to irrigate 7/10ths of the area was only $2200 and the running costs per acre were $7.84.

During winter, pasture growth is usually no more than 6-7 lbs of dry matter per acre per day. Required supplementation can be obtained from fodder crops. These include mangolds, chou moellier and fodder beet. Fodder beet is the most productive in terms of starch equivalent, yields of 7000 lbs of starch equivalent per acre being obtainable. In the past the labour requirement in weeding and thinning fodder beet has limited the acreage. Recently there has been an upsurge of interest in fodder beet as a result of research at Lincoln into the use of new weedicides and specialised machinery.

Pasture and lucerne hay, both bought and home produced are other alternatives. Silage, though not commonly used, may have its place, especially where self feeding is practised. Purchased and home grown concentrates are other alternatives.

Another alternative is the use of autumn grown greenfeed. Grass greenfeeds, both fallow sown and overdrilled into pastures, are important high quality feeds. Cereal greenfeeds produce bulk but the feed is of lower quality. Autumn saved pasture is another commonly used high quality feed. The use of artificial nitrogen with these crops can give high yields.

When planning winter feed supplies the cow's appetite must be considered in relation to the dry matter, starch and protein contents of the alternative feed sources. A high producing cow will not be able to obtain sufficient nutrients to reach potential production if fed solely on low quality silage or hay. Dry stock can, however, obtain maintenance requirements from poorer quality feed.

Winter pugging of pastures due to stock treading is a related problem affecting pasture yields. The soils in the Christchurch area are prone to pugging damage. Stock treading causes mechanical damage to plants and compacts the soil as cows exert a contact pressure of 40-50 lbs per square inch over 14 square inches. This pressure is applied 8-10,000 times per day. The degree of pugging is influenced by the soil type, rainfall, presence of field drainage, density of sward, length of grass and stocking rate.

Pugging reduces pasture yields as a result of the mechanical damage to plants (in part dependent upon the species) and the disruption of soil structure and air spaces affecting the soil water holding capacity and plant growth. Soil pans may also be formed impeding plant growth. Weed infestation may also result due to the opening of pastures following pugging. The time required for pasture and soil recovery depends on the degree of pugging and probably lasts for twelve months in extreme cases. (1).

The methods of reducing pugging applicable to town supply farming are:-

- (i) use of a run off,
- (ii) use of sacrifice paddocks,
- (iii) use of holding yards and sheds, and
- (iv) zero grazing (holding the cows in sheds and bringing all feed to them).

A run off enables only dry stock to be removed from susceptible soils, assuming it is some distance from the milking shed. The reduction in pugging will be proportional to the quantity of feed produced on the home farm and fed on the run off, and to the purchased feed which would otherwise be fed on the home farm. In many cases the reduction of pugging where a run off is used will be small. Where this is the case the profitability of a run off depends mainly on the cost of the land in relation to the feed it produces.

A sacrifice paddock is used for holding stock all winter except when they are utilising feed crops and grass; thus pugging can be almost eliminated on the rest of the farm. Milking cows, however, become mud covered, foot and other injuries can occur, and foot and udder diseases spread rapidly. The other disadvantages are that the paddock will usually require ploughing in the spring and possible pan formation may affect future drainage.

Zero grazing completely eliminates stock pugging but has heavy labour and capital requirements for machinery and buildings. At the time of writing there is insufficient evidence to comment on the feasibility of the system.

The use of a yard, barn, or a combination of these to hold stock while they are not grazing reduces pugging. Other effects are that supplementary feed losses are reduced if feeding racks are used in conjunction with the holding system and stock maintenance requirements and milk yield fluctuations can be reduced if the system provides suitable shelter.

(1) See Appendix A for a list of references which discuss pugging and from which most of the information presented was obtained.

Estimates in the reduction in supplementary feed required (mainly hay) as a result of using feeding racks in conjunction with a holding yard and barn, vary from 20%[2] to 30%[3]. Research work on the effect of environment shows that similar temperature variations to those experienced in Christchurch do not affect milk production. Wind velocity can, however, affect milk production and it is probable that winds experienced in Christchurch (av. May–August velocity at Lincoln College during 1957-61 was 7.2 miles per hour) are sufficiently high to have this effect.[4] If cattle are housed in a well sheltered yard and open barn, the effect of wind could be almost eliminated.

If the holding yard and barn are well designed, labour requirements for feeding out can be reduced compared with paddock feeding. Labour is required, however, for cleaning out the system so that the net effect on labour requirement may be small.

Where no pugging device is used, good management can reduce its incidence considerably. After heavy rain cattle could be held in races for short periods if fed good hay. The wetter paddocks should also be avoided in winter and plans made around this assumption where possible.

The limited information available on the effect of pugging on pasture yields precludes a full economic appraisal of the alternative systems. However, preliminary analysis using data from some of Edmond's work at Palmerston North indicated that where it was assumed a holding yard and shed system had a capital cost of $25 per head, this was a profitable investment at all quota levels, on the case study farm.

(2) Doutre J. and Van Zeller C. (1964) "Planning a Feeding Platform". New Zealand Journal of Agriculture, Volume 108, page 146.

(3) "Winter Pastures Saved from Hoof Damage". New Zealand Farmer, Volume 83, page 2, (1962).

(4) (i) Blaxter K.L. et al. (1963) "Effect of Air velocity on the Heat Production of Sheep and Cattle". Nature, Volume 198, page 1115.

(ii) Hancock J. (1954) "The Direct Influence of Climate on Milk Production". Dairy Science Abstracts, Volume 16, page 89.

2.4 The Alternative Products

Once the farmer has made plans to fulfil the milk contract the farm may have resources available for allocation to other products, this being largely dependent on the quota per acre.

An important consideration in these decisions is the labour requirement of the alternative products and in particular the seasonal distribution of these requirements. As milking demands a large labour input, the production of less labour demanding products may be more profitable than surplus milk. The farmer's ability to organise different forms of production and his preference for these products must also be taken into account.

The feasible alternative products are:-

(i) Surplus milk production.

(ii) Cash crops. The fertility of the soils enables a wide range of crops to be grown. Yields are high. Potatoes, vining, garden and field peas, wheat, and barley can be grown. Poor drainage may limit the area of autumn sown wheat possible. A wide range of grass seeds can be grown. The grazing habits of cattle, however, make the saving of clover seeds difficult. Specialist seed crops such as chou moellier can be taken but the low altitude of the area provides certification difficulties. The closeness of the area to Christchurch city means vegetable and fruit production is feasible. In general, however, farmers lack the required technical knowledge to implement this alternative.

(iii) Stock. Dairy replacement stock can be reared and sold, the main alternatives being yearing heifers and springing heifers. As buyers will be town milk producers the size of the stock replacement market is very small. Dairy beef can be reared and sold at varying stages in their development. The more common sheep alternatives are the fattening of store lambs, the sale of ewes and lambs "all-counted," and the running of a one year flying flock. Technical knowledge, fences and access to a shearing shed are problems associated with sheep and many dairy farms.

(iv) Production of fodder for sale. Hay, silage, mangolds, fodder beet, and grazing can be sold.

III. THE POSTAL SURVEY AND THE SELECTION OF THE CASE STUDY FARM.

There is a wide variation in the town supply dairy farms of the area so that care must be taken in generalising about management policy. There are groups of farms, however, where the differences between individual units are small. A study of one farm in such a group may give results largely applicable to the other units in the group. It is for this reason that a postal survey was conducted. Information obtained was used to group farms so that the case farm could be selected from the largest group.

The farm was selected on the basis of soil class, farm size and efficiency of management as reflected by cows per acre. As the climate throughout the major part of the area is similar, location was not considered important. Size of quota was not considered important as this could be varied in the analysis. Labour imput was not used as a selection factor, although reference was made to this variable to ensure that the case farm was reasonably similar.

A questionnaire was sent to the 254 suppliers in February 1965. There were 180 replies and the respondents were well distributed throughout the area. Area bias of the results was unlikely. The response rate of 70.87% also indicates that the non-response bias was probably small.

3.1 Attributes of Survey Farms

3.1.1 Soil Class and Size of Farm

Each farm was classified on the basis of its major soil class and the existence or not of a run off. (Each farmer was asked to state whether each of his blocks consisted of heavy, medium, sandy or light soil.) Farms falling in a particular soil group were put in size of farm groups, the groups being in multiples of fifty acres. Table 3.1 gives the number of farms in each category.

Table 3.1
Soil Class and Size of Farms
Replying to the Postal Survey

Area (acres)	Number of Farms							
	Heavy Soils		Medium Soils					
	with run off	without run off	with run off	without run off	Sandy Soils	Light Soils	Total	% of Total
0 – 49	1	13	-	1	-	-	15	8
50 – 99	8	33	4	5	2	-	52	29
100 – 149	11	16	4	7	2	1	41	23
150 – 199	2	7	1	12	-	3	25	14
200 – 249	5	3	4	2	2	2	18	10
250 – 299	3	2	2	2	1	2	12	7
300 – 349	2	-	2	2	-	-	6	3
350+	-	-	3	3	-	4	10	6
Total	32	74	20	34	7	12	179	100
% of Total	18	41	11	19	4	7	100	

The greatest number of farms were on heavy soils, 59% of the total. The majority of these, 41% of the total, did not operate with a run off. Twenty-nine per cent of all farms had some form of run off. The total area distribution tended to relatively small farms as sixty per cent of all farms were between 0 and 149 acres and 52% of all farms fell in the 50-149 acre cells. The cell with the largest number of farms was the 50-99 acres, heavy soil, without run-off, group. Thirty-three farms (18% of the total) were in this cell.

3.1.2 The Management Factor

A single measure of managerial performance is particularly difficult to establish without a much more elaborate survey than the present one. It was necessary, however, to establish some criterion to ensure reasonable representativeness in the case farm. There is reasonable evidence that stocking rate is highly correlated with managerial performance, so that this, measured as "cows per available grazing and fodder acre" was chosen as the criterion. Table 3.2 sets out the relevant information.

Table 3.2
Soil Class and Stocking Rate
(Cow nos. as for June 1964)

(i)

Cows per Available Acre	Number of Farms							
	Heavy Soils		Medium Soils		Sandy Soils	Light Soils	Total	% of Total
	with run off	without run off	with run off	without run off				
0 – 0.19	-	-	1	2	-	1	4	2
0.2 – 0.39	9	4	10	10	5	6	44	25
0.4 – 0.59	16	41	6	16	2	4	85	47
0.6 – 0.79	6	23	2	4	-	1	36	20
0.8 +	1	6	1	2	-	-	10	6
Total	32	74	20	34	7	12	179	100

Cow Stocking Rate for 50–149 acre Farms in
the Soil Class – Heavy Without Run-Off

(ii)

Cows per Available Acre	Number of Farms
0 – 0.19	-
0.2 – 0.39	1
0.4 – 0.59	31
0.6 – 0.79	14
0.8 +	3
Total	49

Note: - The major breed in 95% of the herds was Friesian. 80% of farms bred replacements (Farms buying replacements were generally smaller than 100 acres).

Almost half the farms (47%) were carrying between 0.4 and 0.59 cows per acre. A further break up into size groups and replacement policy showed that small farms and those buying replacements tended to have a heavier stocking rate. Table 3.2 (ii) gives the stocking rate distribution for 50-149 acre farms in the heavy-without run off soil class. Sixty-three per cent of these farms carried 0.4-0.59 cows per acre.

3.1.3 Size of Quota in Relation to Size of Farm

Size of quota is likely to affect the optimum plan on any one farm. If the analysis on the case study farm was restricted to the existing milk contract, the extent to which the results could be applied would be limited. For this reason information on quota variation was important. Table 3.3 gives the distribution of quota per acre $\left(\frac{\text{quota gallons}}{\text{total farm area}}\right)$ by size and soil class.

Table 3.3
Quota per Acre (1964/65 quota)

Number of Farms

Quota per acre (gallons)	Heavy Soils						Medium Soils						Sandy Soils	Light Soils	Total	Per Cent
	without run off			with run off			without run off			with run off			Area* 1, 2, & 3	Area* 1, 2, & 3		
	Area* 1	2	3	Area* 1	2	3	Area* 1	2	3	Area* 1	2	3				
0 –0.59	1	5	4	0	2	8	0	9	5	0	0	9	4	11	58	32
0.6–1.19	22	14	1	6	10	1	5	9	4	3	5	1	3	1	85	48
1.2+	23	4	0	3	1	1	1	1	0	1	0	1	0	0	36	20
Total	46	23	5	9	13	10	6	19	9	4	5	11	7	12	179	100

* Area Classification 1 0 – 99 acres
2 100 – 200 acres
3 201 + acres

Quota per Acre for 50-149 acre Farms in the Soil Class – Heavy without Run Off

(ii)

Quota per acre groups	**Number of Farms**
0.3 – 0.59	3
0.6 – 0.89	17
0.9 – 1.19	15
1.2 – 1.49	13
1.5 +	1
Total	49

Though the 0.6–1.19 gallons per acre group was the largest (48% of all farms) the number of farms involved was not much greater than for the other groups. Smaller farms tend to have a higher quota per acre. Table 3.3 (ii) gives the number of 50-149 acre, Heavy (without run-off) soil class farms in quota per acre groups that have a smaller range. Most of the farms have a quota per acre between 0.6 and 1.49 gallons and are evenly distributed within this range.

3.1.4 Labour

Size of herd is the major factor affecting the labour requirement. As it is difficult to employ casual labour for milking, it is usual to rely on full time labour so that large variations in per cow labour are to be expected due to indivisibility. Other factors which affect the employment of labour are the farmer's objectives (profits or leisure?), the level of other enterprises, the standard and type of equipment used, and the farm layout.

The 1964 labour used – permanent, casual and family – on respondent farms was calculated and compared with the 1964 herd size. Information on contract work was not available so that some of the figures may be midleading. Table 3.4 (i) gives the number of farms in size of herd – labour input cells for farms with less than 10% of their area utilised by alternative enterprises. Table 3.4 (ii) presents the same information for farms with greater than 10% of their area utilised by alternative enterprises. No attempt was made to sub-classify for other factors.

Table 3.4

Size of Herd and Labour Input for 1964 – Number of Farms

(i) For Farms with less than 10% of area utilized by alternative enterprises.

Size of herd - cows June 1964	Equivalent Man Units 1 – 1.5	1.6 – 2	2.1 – 2.5	2.6 – 3	Over 3
Up to 30	23	1	-	-	-
31 – 50	33	6	-	3	-
51 – 70	7	13	8	2	-
71 – 90	1	4	2	4	3
Over 90	1	1	2	3	5
Total	65	25	12	12	8
					Total 122

(ii) For Farms with greater than 10% of area utilized by alternative enterprises.

Size of herd - cows June 1964	Equivalent Man Units 1 – 1.5	1.6 – 2	2.1 – 2.5	2.6 – 3	Over 3
Up to 30	6	2	-	-	-
31 – 50	8	3	1	-	-
51 – 70	6	5	7	-	-
71 – 90	1	-	1	2	7
Over 90	-	-	2	3	3
Total	21	10	11	5	10
					Total 57

The majority of farms with a labour force of less than 1.5 equivalent men units carried up to 50 cows and the majority with an input of 1.6-2.5 man units carried up to 70 cows. A comparison of farms having less than and greater than 10% of their area in alternative enterprises suggests the size of herd is 'the major' factor affecting labour input, except for the greater than 3 man units category. This suggestion does not take into account, however, the absolute level of alternative enterprises and is based on the small number of farms in Table 3.4 (ii).

3.2 Selection of the Case Study Farm

The group containing the largest number of farms had heavy soils with no run-off, was in the 50-149 acres area range, and was stocked at 0.4-0.59 cows per acre. The case study farm was selected from this group. Table 3.5 summarises the classification and gives the number of farms in each category.

Table 3.5
The Basis of the Case Study Farm Selection

Soil Class	No. of Farms
Light	12
Sandy	7
Medium – with run off	20
Medium – without run off	34
Heavy with run off	32
Heavy without run off	74

Heavy – Without Run Off Group (74 Farms)

Area (acres)	No. of Farms	Cows per acre	No. of Farms
0 – 49	13	0.2 – 0.39	1
50 – 99	33	0.4 – 0.59	31*
100 – 149	16	0.6 – 0.79	14
150 – 199	7	0.8 +	3
200 – 249	3		
250 – 299	2		

* farm selected from within this group

The farm selected had an effective area of 104 acres and carried 0.45 cows per acre. It had similar characteristics to 31 other units, but the selection procedure does not permit any stronger claims as to representativeness as this.

The farm is on the boundaries of Tai Tapu silt loam and Kaiapoi silt loam and is well drained with open and a small number of tile drains. The labour force consisted of the farmer plus a single man. Milk production was the major policy, but there was a limited area of cash crops. Replacements were mainly bred and reared on the farm. There was a full range of cultivation and hay making equipment, including a baler. All heading was done by contract. Fences and buildings were in reasonable condition. The milking shed was a conventional walk-through unit with eight stands, capable of milking 100 cows in reasonable time. There was a small irrigation plant.

IV. THE METHOD OF ANALYSIS

The objective of the analysis has been to determine the farm plans which maximise short term profits for different quota levels, subject to the maintenance of the assets, and constrained by the managerial ability of the farmer. It was assumed that working capital, plant and machinery were adequate for any plan otherwise feasible.

For the purpose of this analysis, short term profits are analagous with "gross margins." This is the margin of gross revenue per unit of an enterprise over direct costs, defined as those costs which vary with the level of the enterprise. Hence fixed costs are omitted from the analysis although they may be taken into account subsequently if this is necessary.

The actual comparisons of all the alternative farm plans possible was carried out by linear programming. Comparative budgeting of alternative programmes could have been used, but the range of possibilities, and the complexity of the inter-relationships between activities was such that programming was justified. The technique selects from the range of alternative activities considered, that combination which is feasible in terms of the defined constraints, and which maximises profits.

A summary of the different activities considered is given below. Their gross margins are given in Appendix B. It will be seen that activities which do not enter directly into production will have negative gross margins.

Stock Activities

1. Cows calving in alternative months.
2. Alternative stock replacement policies.
3. The rearing and selling of dairy beef as 2 year olds.
4. The rearing and selling of yearling heifers.
5. The rearing and selling of springing heifers.
6. Fattening of store lambs.
7. Ewes and lambs "all counted".
8. Fat lamb flock (1 year ewes).

Feed Activities

1. Making different types of hay.
2. Purchasing different types of hay.
3. Buying barley for feeding at different times of the year.
4. Autumn saving pasture.
5. Making silage.
6. Buying off-farm winter grazing (including hay to make up a maintenance ration).
7. Irrigating pasture.

Rotation Activities

1. Old Pasture — Fodder Beet — Summer Fallow — New Pasture — 18 years Grazing
2. Old Pasture — Chou Moellier — Summer Fallow — New Pasture — 18 years Grazing
3. Old Pasture — Chou Moellier — Summer Fallow — New Pasture — 5 years Grazing
4. Old Pasture — Maize — Green Feed Oats — Summer Fallow — New Pasture — 18 years Grazing
5. Old Pasture — Maize — Green Feed Oats — Summer Fallow — New Pasture — 5 years Grazing
6. Old Pasture — Fodder Beet — Maize — Green Feed Oats — Summer Fallow — New Pasture — 17 years Grazing
7. Old Pasture — Chou Moellier — Maize — Green Feed Oats — Summer Fallow — New Pasture — 17 years Grazing
8. Old Pasture — Chou Moellier — Maize — Green Feed Oats — Summer Fallow — New Pasture — 4 years Grazing
9. Old Pasture — Summer Fallow — New Pasture — 19 years Grazing
10. Old Pasture — Green Feed Italian Ryegrass — Green Feed Italian Ryegrass — Summer Fallow — New Pasture — 17 years Grazing
11. Same as (10) except 4 years grazing.
12. Old Pasture — Garden Peas — Wheat — Wheat — Green Feed Oats — Summer Fallow — New Pasture — Ryegrass Seed — 4 years Grazing
13. Old Pasture — Garden Peas — Barley — Barley — Green Feed Oats — Summer Fallow — New Pasture — Ryegrass Seed — 4 years Grazing

14. Old Pasture — Short Summer Fallow and Winter Fallow — New Lucerne — 7 years Haying

The constraints which defined the bounds within which a plan could be selected are summarized below:

1. Constraints requiring that 105% of quota is produced at all times and which limit the surplus milk sold above quota, but at quota prices, to the allowed percentages of quota in April, May, June, July and August.
2. Feed constraints. Maximum and minimum levels of hay and barley feeding, conforming to accepted feeding standards.
3. Limits on the amount of off-farm grazing available.
4. Limits on sheep numbers.
5. Limits on sales of certain classes of stock for technical or marketing reasons.
6. Limits on hay buying to conform to availability and storage.
7. Limit on area irrigable.

The strategy of producing surplus milk to influence quota increases was not considered. Due to the abolition of the school milk scheme, increases in the nominated quantity and thus individual producer's quotas are unlikely before the 1970/71 season. Any changes that will occur will be due to producers withdrawing from town milk and to suppliers producing below their quotas. Due to recent reshuffling of quotas for underproduction it is unlikely there will be significant underproduction in the next 2 years. Therefore, any quota changes that will occur over the next two years will probably only be marginal and for this reason the possibility for surplus milk production to give quota increases has been ignored in this study. For long term planning, however, this factor cannot be ignored as it takes several years to radically alter a calving pattern.

In comparing alternative systems, labour availability and the cost of hiring additional labour is usually a vital consideration. The case study farm had a married couple's house and facilities for a single man. Therefore, in comparing alternative systems, the labour force was also varied so that the optimum labour force could be determined for each level of quota. It was assumed that only full time labour was satisfactory for milking cows due to the problems of casual labour availability at milking time.

V. THE RESULTS

Plans which maximized short run profit on the case farm using 1967/68 season prices, were calculated for quota levels of 50, 100, 150, and 200 gallons, (respectively 0.5, 1.0, 1.5 and 2.0 gallons per acre). This range covers most situations found (see Table 3.3). The programmed optimum plans for each quota level are summarised in Tables 5.1, 5.2 and 5.3 In comparing these plans with a plan currently being carried out on a farm, the difference in profitability must be considered in relation to changes in the farmer's work load and to variations in risk. The total net revenue for each plan has had labour costs deducted from the total gross margin. After deducting fixed costs (other than labour) this is the return to the farmer's labour and management as well as to the capital invested.

5.1 The Calving Pattern and Milk Production

The optimum calving patterns and the resultant milk production are presented in Table 5.1 The total net revenue for each plan is also given.

Table 5.1
Calving Patterns and Milk Production

Quota (gallons)	50	100	150	200
Calving Pattern				
Cows coming into milk on the first day of:				
October	-	5	6	11
November	14	11	14	24
January	-	2	4	6
February	29	17	19	38
April	-	3	14	-
May	-	4	4	8
June	-	6	9	11
July	-	2	-	1
Total	43	50	70	99

Milk Sales – Gallons Per Day at Various Quota Levels

	50 gal. Quota		100 gal. Quota		150 gal. Quota		200 gal. Quota	
	Quota Price gals.	Surplus Price gals.	Quota Price gals.	Surplus Price gals.	Quota Price gals.	Surplus Price gals.	Quota Price gals.	Surplus Price gals.
September	52.5	58.5	105.0	83.0	157.5	132.5	210.0	162.0
October	52.5	-	105.0	-	157.5	-	210.0	-
November	52.5	68.5	105.0	48.0	157.5	55.5	210.0	103.0
December	52.5	-	105.0	-	157.5	-	210.0	-
January	52.5	-	105.0	-	157.5	-	210.0	-
February	157.0	-	149.0	-	180.0	-	326.0	-
March	155.0	-	137.0	-	167.0	-	302.0	-
April	60.0	75.0	120.0	-	180.0	-	240.0	-
May	60.0	58.0	120.0	-	180.0	-	240.0	-
June	62.5	40.5	125.0	-	187.5	-	250.0	-
July	62.5	22.5	116.0	-	173.5	-	234.0	-
August	60.0	41.0	120.0	-	180.0	-	240.0	-
Total Net Revenue ($)	10,600		13,100		13,480		13,310	

In all cases the calving pattern is arranged so that sufficient milk is produced in each month to fulfil the quota and to enable the maximum amount possible of surplus milk to be sold at quota prices where the payout system provides for this. To achieve this a simple calving pattern is used in the 50 gallons case, but in the other cases calvings must be spread over the year.

Surplus milk production that is sold at surplus price is not a dominating feature of the plans. In the 50 gallons quota plan significant amounts are produced but nothing like what could be produced if cow numbers were increased to the maximum possible (i.e. 100 cows). In the other plans only a limited amount is produced and this is restricted to the spring period.

These plans are optimal where all February and March milk is paid for at quota prices. Currently this quality is limited to 115% of quota, but the effect of this is offset somewhat with the higher surplus milk price in these months. Under this system it is considered that a small amount of the February–March surplus milk production should be transferred to the spring period so that the number of February calving cows should be reduced in favour of spring calving. But, this change should only be marginal. Where a farmer is attempting to increase his quota the milk production pattern in Table 5.1 should be followed and, if anything, winter milk production increased.

The total net revenue for each plan increases as the quota increases up to the 150 gallons plan. The subsequent decline is due to the need to employ extra labour and the increase in the average cost of feed supplies (considerable feed purchasing is carried out). If a 200 gallons quota could be handled with a total of two men the profit would increase by the cost of the third labour unit.

5.2 Land Utilisation and Feed Organisation

The optimum feed supply plans are given in Table 5.2

Table 5.2
Optimum Plans
Land Utilisation and Feed Organisation

Quota (gallons)	50	100	150	200
Cows	43	50	70	99
Land Utilisation (acres)				
Pasture	58	64	75	89
Lucerne	11	12	5	-
Chou Moellier	10	6	4	-
Fodder Beet	1	3	4	5
Maize-Green Feed Oats	11	9	8	5
Summer Fallow – New Pasture	13	10	8	5
Total	104	104	104	104
Winter Feed Supplements				
Made Lucerne Hay (bales)	1950	2170	820	-
Purchased Lucerne Hay (bales)	-	-	950	-
Purchased Grazing (weeks)	-	-	340	-
Spring-Summer Feed Supplements				
Purchased Feed Barley (bushels)	-	-	-	1120
Summer-Autumn Feed Supplements				
Purchased Feed Barley (bushels)	-	-	-	2340
Irrigation (acres)	25	25	25	25
Total Net Revenue ($)	10,600	13,100	13,480	13,310

Considering the 50 gallons quota plan, feed is mainly supplied by fodder crops and pasture. The high acreages of chou moellier and maize are a feature of the plan. Clearly, hay should not be the basis of the winter feed plan, though for nutritional reasons a small quantity is probably necessary. As the quota increases this same principle has been implemented as far as possible but fodder beet, with its higher per acre production (but more costly), has replaced some of the chou moellier. However, as the herd size increases it is necessary to increase the area of pasture for spring-summer grazing (and autumn) so that the area of fodder cropping must decline. At the 200 gallons quota level winter feed (and some for other periods) must be mainly purchased in the form of lucerne hay, barley and off-farm grazing. Irrigation is a feature of all plans.

Cash cropping is not included in any of the plans, though the results showed that the total net revenue would only decrease slightly if a small amount of wheat was grown in the 50 and 100 gallons quota plans. In the other two plans cash cropping would decrease profit considerably.

5.3 Stock Replacement, Production of Alternatives, and Labour

Preliminary budgets revealed that a replacement policy based on purchasing rather than breeding tended to marginally favour purchasing. However, there were some assumptions in this analysis which were not strongly based, the major one being that per-cow performance would be similar. When other non-measurable factors such as farmer's preferences and disease risk were taken into account it appeared clear that a breeding and rearing policy would be the most realistic on which to base the stock programmes.

Other details of the stock programmes and labour used are given in Table 5.3.

Table 5.3
Optimum Plans
Stock Numbers and Labour

Quota (gallons)	50	100	150	200
Stock Numbers				
(i) Cows	43	50	70	99
(ii) Replacements				
Rear calves to Autumn calvers	6	7	11	14
Rear calves to spring calvers	3	4	5	8
(iii) Other Cattle				
Sell bobby calves	13	15	45	63
Buy spring born Steer bobby calves (for beef)	43	23	-	-
Rear spring steer calves to 2yr. beef	50	31	-	-
Sell autumn born heifer yearlings	7	8	-	-
Sell spring born heifer yearlings	3	4	5	9
Labour				
Labour units (men– including owner)	1	1	2	3
Total Net Revenue ($)	10,600	13,100	13,480	13,310

In the 50 and 100 gallons cases the programmes are implemented by the owner-operator. It is not profitable to employ additional labour to allow the production of surplus milk. Feed not used for milk production is used for dairy beef and in the rearing of heifers for sale. It was not profitable to use this feed for sheep production.

Additional labour is employed in the 150 and 200 gallons plans. This is necessary to enable the herd to be increased so that the quota and related percentages can be met throughout the year. In these plans the small amount of surplus feed is used in rearing a few heifers for sale. In the 150 gallons plan it does not pay to employ a second labour unit thus enabling more surplus milk to be produced (this would also require the purchase of feed, as in the 200 gallons plan).

If more cows could be milked per labour unit (it was assumed that number of cows that could be milked with 1 man was 50, 2 men 70, and 3 men 100), perhaps by using a herringbone shed or by working longer hours, it is probable that more surplus milk should be produced in the 100 gallons plan and therefore less dairy beef and saleable heifers.

5.4 Price Variations

Optimum plans were determined for a number of different price regimes (the highest and lowest since 1960 for both supply associations) but it was found that only marginal changes occurred in a few of the plans. It was, therefore, concluded that the major features of the presented plans would remain valid given prices that have occurred since 1960.

The milk prices and payout system assumed in the analysis was that used by the larger of the two supply associations. As the major difference in the systems used was one of price, the results of the price variation analysis indicate the major conclusions made apply to both systems.

VI SUMMARY

Management plans that maximised short run profit were determined for a case study farm. The case farm was selected on the basis of information obtained from a postal survey. The general conclusions that can be made from the optimum plans are:-

(i) The calving pattern should be organised so that sufficient milk is produced to meet the quota and the percentages of quota for which quota prices are paid.

(ii) The employment of additional labour is profitable if this increases milk production that is sold at quota prices, provided this production is not based solely on purchased feed.

(iii) Production sold at surplus milk prices is not profitable if labour has to be employed to achieve this.

(iv) Where surplus milk production is possible with the existing labour force it should be supplied during the autumn–winter period and to a limited extent in the spring.

(v) Stock replacements should be home bred and reared unless such a policy is unacceptable to the farmer.

(vi) Feed not used for milk production should be used for the production of dairy beef and the rearing of yearling heifers for sale.

(vii) Feed plans should be based on a policy of pasture and fodder crops together with a small amount of home produced lucerne hay. At higher quota levels, due to the increased requirement for pasture grazing, feed supplied by fodder crops must be partly replaced with purchased feed. This should consist of lucerne hay, barley and off-farm grazing (but it is not profitable to purchase feed for surplus milk production).

APPENDIX A
References which Discuss Pugging

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APPENDIX B

Gross Margins of the Activities Compared in the Analysis

		$
1.	An Autumn calving cow (also produces milk for sale)	- 7.40
2.	A spring calving cow (also produces milk for sale)	- 6.14
3.	Rear an autumn calving cow	- 14.16
4.	Rear a spring calving cow	- 10.60
5.	Sell an autumn born heifer as 2 yr. beef	56.40
6.	Sell a spring born heifer as 2 yr. beef	63.10
7.	Sell an autumn born steer as 2 yr. beef	64.00
8.	Sell a spring born steer as 2 yr. beef	72.00
9.	Rear and sell an autumn born heifer yearling	35.40
10.	Rear and sell a spring born heifer yearling	29.00
11.	Fatten a store lamb	1.20
12.	Fatten ewe and lamb "all counted"	1.00
13.	Run a one year ewe	4.20
14.	Rot. 1 (refer to main text for details of each rotation) - one acre	- 3.80
15.	Rot. 2 - one acre	- 3.63
16.	Rot. 3 - one acre	- 4.50

17.	Rot. 4 - one acre	-	4.30
18.	Rot. 5 - one acre	-	6.50
19.	Rot. 6 - one acre	-	4.63
20.	Rot. 7 - one acre	-	4.50
21.	Rot. 8 - one acre	-	7.20
22.	Rot. 9 - one acre	-	3.40
23.	Rot. 10 - one acre	-	3.80
24.	Rot. 11 - one acre	-	4.30
25.	Rot. 12 - one acre (doesn't include sale of barley)		1.73
26.	Rot. 13 - one acre		21.44
27.	Rot. 14 - one acre	-	24.00 (includes cost of haymaking)
28.	Make 12 bales of straw	-	1.20
29.	Make 1 acre of pasture hay (spring)	-	10.20
30.	Make 1 acre of pasture hay (autumn)	-	6.60
31.	Make 1 acre of silage	-	6.50
32.	Buy barley (1 bushel)	-	1.00
33.	Buy 12 bales of straw	-	3.10
34.	Buy 6 bales of pasture hay	-	2.80
35.	Buy 3 bales of lucerne hay	-	2.20

36.	Hire 1 week of grazing (including hay)	- 1.10
37.	Buy bobby calf for fattening	- 7.00
38.	Buy one autumn calving heifer	- 101.50
39.	Buy one spring calving heifer	- 81.50
40.	Sell one bobby calf	- 6.00
41.	Sell one autumn calving heifer	- 94.00
42.	Sell one spring calving heifer	- 74.00
43.	Irrigate one acre	- 7.85

Note (1) An autumn calving cow has been defined as one calving during the period January–June. A spring calving cow has been defined as one calving during July–December.

(2) The majority of these activities are not complete entities – for example an autumn calving cow has a negative gross margin and also requires feed from the various sources but produces milk for sale so that when combined with a rotation and the milk is sold the complete entity would have a positive gross margin.

Hence these activity gross margins cannot be studied individually. They have been presented, mainly, so that stock prices assumed can be studied.

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