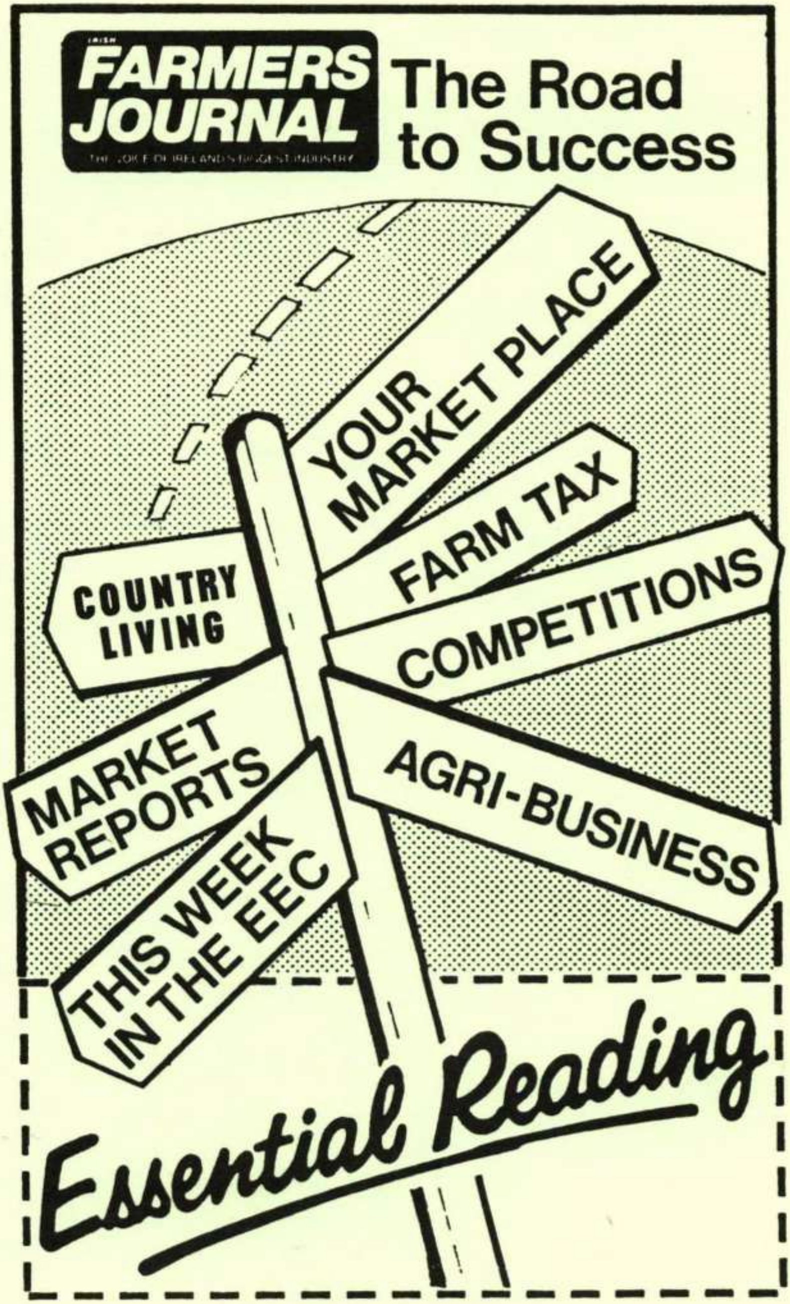
Irish Grassland & Animal Production Association Journal 1993


FARMERS JOURNAL
The Road to Success
YOUR MARKET PLACE
FARM TAX
COUNTRY LIVING
COMPETITIONS
MARKET REPORTS
AGRI-BUSINESS
THIS WEEK IN THE EEC
Essential Reading

Irish Grassland and Animal Production Association

JOURNAL

Vol. 27 1993

Edited by
SEAN FLANAGAN

ISSN 0332-0588

Printed by Wicklow Press Ltd., Wicklow

CONTENTS

COUNCIL 1992/93

Milk Production Systems – Management and Economic Considerations

S. CROSSE and P. DILLON
Teagasc, Moorepark Research Centre, Fermoy, Co. Cork.

The long-term viability of the dairy industry is dependent both upon the milk producer receiving sufficient return for his inputs of labour, capital, and the consumer being offered a quality product at a price which is realistic enough to ensure an adequate demand. For the dairy farmer this implies making lhe maximum use of grass in the system of milk production since it is a cheap source of high quality feed.

This paper will deal with 4 main topics which have a large influence on the viability of the dairy farm. These include (i) quota size and quota management, (ii) milk price, (iii) calving date, (iv) stocking rate, and (v) milk yield per cow.

In order to discuss these topics, a model farm will be used as illustrated in Table 1.

Table 1
Farm Profile

Farm size	(ac)	80
Farm milk quota	(gallons)	50,000
Milk yield/cow	(gallons)	1,100
Farm liabilities	(£)	40,000
Farm/Family drawings		20,000

The farm enterprises will include dairying and beef. The discussion will mainly focus on the opportunity to increase the farm margin. In order to pursue any of these options at farm level, a more detailed analysis is required.

(1) Milk quota and quota management

Since the introduction of milk quotas, the size of quota on the farm is a major determinant of farm income. The data in Table 2 show the effect of quota size on farm gross margin.

Table 2
Effect of quota size on farm gross margin

Quota Size Gallons	Farm Gross Margin
40,000	37,547
50,000	44,934
60,000	52,321
70,000	59,707

If the farm quota could be increased from 50,000 to 70,000 gallons, this would result in an increase in farm gross margin from £44,934 to £59,707. This represents an increase of £14,773 or £7,400 for an additional 10,000 of quota. Quota management is also important. Many dairy farmers have too many cows for the quota on the farm. In the early years after the introduction of quotas, it was possible to avail of "flexi" milk. But in recent years, this policy has proved to result in high risk farming. Many farmers now have to dry off cows early and reduce feeding especially in the early spring period. This is resulting in reduced farm profit. It should also be recognised that the quota size per holding in Ireland is relatively small as can be seen from Table 3.

Table 3
Distribution of dairy cows by size of herd - December 1989

Herd Size	Dairy Cows			
	Holdings		Animals	
	('000)	(%)	('000)	%
1-2	6.0	10.6	7.8	0.6
3-9	7.8	13.6	48.9	3.5
10-19	15.5	27.1	213.7	15.3
20-39	16.9	29.6	457.8	32.7
40-59	6.5	11.5	304.0	21.7
60-99	3.6	6.4	259.6	18.5
100+	0.8	1.3	108.2	7.7

Source: Irish Agriculture in Figures

The additional gross margin return per gallon of milk quota as influenced by milk yield per cow and milk price is shown in Table 4.

Table 4
The effect of milk yield per cow and milk price on the additional gross margin return per gallon of milk quota

Yield Level (Gals/cow)	Milk Price (p/gallon)	Gross Margin (p/gallon)
1100	90	74
1100	70	53
900	90	57
900	70	41

It is evident from these data that the value of an additional gallon of milk quota is very much dependent on the yield level of the herd and the prevailing milk price at the time. This must be considered if additional milk quota is to be leased.

Milk price

The relatively high income from dairying in Ireland in recent years is due to a large extent to a high milk price. The effect of milk price on farm gross margin and net margin is shown in Table 5.

Table 5
The effect of milk price on farm gross margin and net margin

Milk Price pence/gallon	Farm Gross Margin	Farm Net Margin
70	34,698	-302
80	39,841	4,841
90	44,934	9,934
100	50,075	15,075

The farm gross margin for a milk price of 70, 80, 90 and 100 p/gallon is £34,698, £39,841, £44,934 and £50,075 respectively. When fixed costs and living expenses are considered the net margin is -£302, £4,841, £9,934 and £15,075 respectively. If milk price drops to 70p/gallon then there will be very little surplus cash available. This emphasises the extent to which farms with a small milk quota are dependent on milk price.

Calving date

The effect of calving month on the cost of milk production/cow and on margin/cow is shown in Table 6.

Table 6
Effect of calving month on the cost of milk production/cow and on farm margin/cow

Calving Month	Addition to Costs/Cow	Addition to Margin/Cow
January	44	- 23
March	0	0
October	114	- 57 (63)*

* if winter bonuses are paid (20 p/gallon)

Calving date has a large influence on the seasonality of milk supply, on the cost of milk production and on farm profit. The spread of calvings is also important. If no milk bonus payments are available then the calving date (compact calving essential) should be concentrated just prior to the start of the grazing season (early March in the south of Ireland). Calving in January will add £44/cow to costs and calving in October will add £114/cow to costs. January calving will reduce margin by £23/cow while October calving will reduce margin per cow by £57 (if no milk bonus is paid). Systems of milk production based on March calving result in a highly seasonal milk supply pattern. This is not suitable for the full range of product mix in Ireland. Some autumn calving is consequently necessary and winter milk bonuses are paid to encourage farmers to produce out of season milk. Winter milk schemes can best be exploited by concentrating the majority of calving to the start of the grazing season and then calving the remainder of the herd in late September/early October. Generally, a ratio of 60% spring and 40% autumn calving results in profitable systems of milk production where up to 35% of total milk supply is required by the processor in the period from October to February. All the advantages of the extra bonus can easily be eroded by a scattered calving pattern. The milk processor might best be advised to encourage 100% autumn calving using selected farms and then combine the milk from the total pool of milk in the factory.

Stocking rate

Traditionally milk production systems in Ireland were driven by high output per acre even if this resulted in a depression in milk yield per cow. Since the advent of milk quota, this situation has changed. The farm quota is now generally more limiting than the land area. There is now no need to have very high stocking rates for the dairy cows especially since the return from allocating excess land to other enterprises is low. Performance per cow has now assumed more importance than performance per acre.

The effect of calving month and stocking rate on cost of milk production/cow and on margin/cow is shown in Table 7.

Table 7

Effect of calving month and stocking rate on cost of milk production/cow and on margin/cow

Calving Month	Stocking Rate (ac/cow)	Addition to Costs/Cow	Addition to Margin/Cow
January	0.85	44	- 23
March	0.85	0	0
March	0.95	- 7	49

A reduction in stocking rate from 0.85 ac/cow to 0.95 ac/cow for March calving cows reduces costs by £7/cow but it increases the margin/cow by £49. This is due mainly to extra performance by allocating more grass to the cow. It is possible now to have a plentiful supply of high quality grass available to the dairy cow and this can be easily achieved by reducing the stocking rate. The benefits are mainly seen from mid season onwards. Lowering the stocking rates, however, presents many challenges to the farmer in order to maintain quality grass to the cow at all times.

Milk yield/cow

High genetic merit cows are very important for profitable dairying. The continued improvement of the genetic merit of the herd is achieved by breeding the cows to the best sires available. It is important that the genetic potential of these animals is fully exploited by having them well fed and with a major portion of the feed coming from grazed grass. There are indications now that dairy farmers are neglecting milk yield per cow with a consequent loss in farm income. This is due in part to poor quota management (too many cows for the quota available) and an over-emphasis on reducing the variable cost of milk production which can result in a loss in milk receipts. When considering milk yield per cow, cognizance must be taken of its effect on the numbers of cows to fill the quota, the capital investment in livestock and buildings, the opportunity cost of this capital as well as the land, labour, etc.

The effect of milk yield/cow on farm profitability is shown in Table 8. The milk yield per cow is allowed to vary without a change in variable costs per cow (better management).

Table 8
Effect of milk yield/cow on farm profitability

Milk Yield /Cow (Gal.)	Opportunity* Cost/Cow	Farm Net Margin	Addition to Farm Margin
900	- 96	33718	- 5602
1000	- 68	35758	- 3562
1100	- 41	37366	- 1954
1200	- 15	38697	- 623
1250	0	39320	0

* Opportunity cost is a measure of the money foregone by replacing one unit of the optimum system (ie 1200 gallon herd) with one unit of the alternatives.

The effect of milk yield/cow on farm margin and on dairy variable costs (p/gallon) is shown in Table 9.

Table 9
Effect of milk yield/cow on farm margin and on dairy variable costs (p/gallon)

Milk Yield /Cow(Gal.)	Farm Margin /Gallon of Quota	Addition to Farm Margin/Gal.	Dairy Variable Costs
900	67.4	-11.2	30.1
1000	71.5	- 7.1	26.9
1100	74.7	- 3.9	24.3
1200	77.4	- 1.2	22.3
1250	78.6	0	21.3

Farm income can be increased by up to £3,000 or 6 p/gallon of quota by having a 1,200 gallon herd vs a 1000 gallon herd. The variable costs for the dairy enterprise can be reduced by up to 5 p/gallon by having a 1200 gallon herd vs a 1000 gallon herd. The exploitation of the potential of a herd should also result in the following additional benefits: 1) Sale of surplus cows releases capital, 2) Lower labour requirement, 3) Less demand for additional dairy facilities, 4) Opportunity to use the released land to reduce further the cost of milk production.

It is not clear if it will be profitable for Irish dairy farmers to continue to breed their cows to the best sires available in the world. Our low cost systems of milk production based on grass and silage may not be adequate for these animals. They may have the effect of pulling in high cost systems. This is an issue which needs to be researched.

Summary

Traditionally milk production systems in Ireland (pre-quota) were driven by the achievement of high output/acre and generally resulted in a highly seasonal milk supply pattern. With the introduction of milk quotas, the decision-making process to devise the optimum system on dairy farms became more complex. There is less emphasis now on very high stocking rates. To achieve the maximum return from the milk quota available on the farm, the dairy farmer has to consider the milk supply and milk quality requirement of the food industry. High margins can be achieved by maximising the receipts from the farm as well as controlling costs. Milk yield/cow, milk price and a high price for calves and cull cows are of critical importance. Costs (variable, fixed and depreciation costs) are also very important and need to be continuously reviewed. Care must be taken in the drive to reduce costs so as not to reduce the receipts/cow on the farm too much. The goal should be to maximise net margin from the farm. Losses due to reproductive wastage, animal health, etc. need to be controlled. The milk production system will need to be sustainable economically and in terms of its impact on the environment and on the quality of life for the farm family.

Achieving High Performance from Dairy Cows on Grazed Pastures

G. STAKELUM
Teagasc, Moorepark Research Centre, Fermoy, Co. Cork.

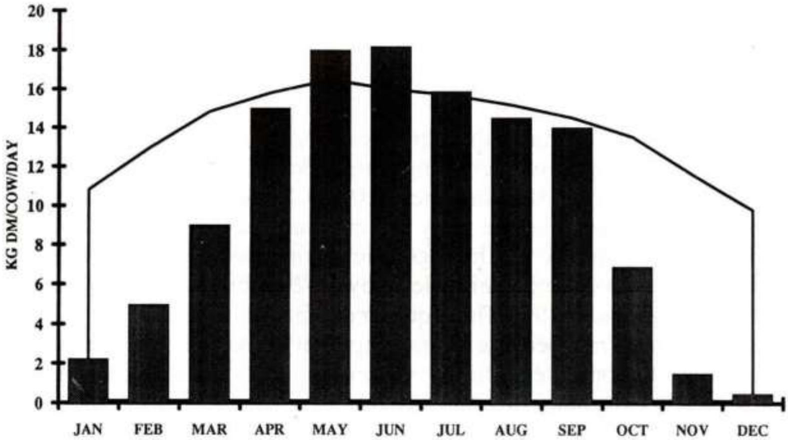
Before the introduction of milk quotas in Ireland, profitable dairying was driven by the objective of increasing farm sales of milk. This was mainly dependent on using high stocking rates (3.0 to 3.5 cows/ha), medium levels of N (300 kg/ha), 2 cuts of silage, early and compact calving 6-8 weeks prior to turn-out to spring pasture and high genetic merit cows. The use of such high stocking rates depressed cow milk yields by 10-20% but maximised the yields of milk/ha by around 8-10%. The requirement for winter feed as silage placed a limit on stocking rate because as stocking rates increased it became increasingly difficult to conserve sufficient winter feed from the available hectares. Approximately 6-7 tonnes of silage per cow were required on dry land farms. An extra 2 tonnes of silage was required on wet land farms and therefore the optimum stocking was some 20% lower. The adequate feeding of the cow on grazed grass is now of central importance. The constraints to intake at pasture, feed requirement of the cow, feed supply at pasture, supplementary feeding and the digestion of grass as well as nutrient supply to the small intestine from grass are major issues with regard to potential milk production from pasture. The research programme of the Dairy Husbandry Department since the quotas has reflected this change of objectives.

Potential production from grazed pasture

Many factors are well known to affect production of grazing cows. The most important sward factors are the quantity and quality of grass available for grazing and the daily herbage allowance (stocking rate) as well as the provision of supplementary feeds. In addition, cow factors play a major role. Cows have different milk production potentials (based on genetic indices). Individual cow intake studies at Moorepark have shown that for each extra 1 kg of FC milk production at pasture, the cow will consume 0.4 kg of extra pasture dry matter under *ad libitum* feeding conditions (Stakelum and Connolly, 1987). Genetic selection for milk yield will produce cows of high intake potential as well as higher efficiency. To fully exploit the extra feed demand, these cows need to be better fed at pasture.

Farmers often ask "What yields of milk will pastures support if I do everything right and control quality and quantity of herbage throughout the lactation?" Experiments at Moorepark in 1985 with early February calving cows established, when daily herbage allowance was twice the daily intake level with high digestibility pastures (regrowths of 4 weeks after cutting) throughout the lactation, that yields of 204 and 183 kg of milk fat and protein respectively could be achieved per cow (Stakelum, 1991). Higher intakes caused no further increases in milk fat or protein yields but resulted in increases in cow liveweights.

Figure 1: Feed demand and grass supply for late January calving cows stocked at 3 per hectare



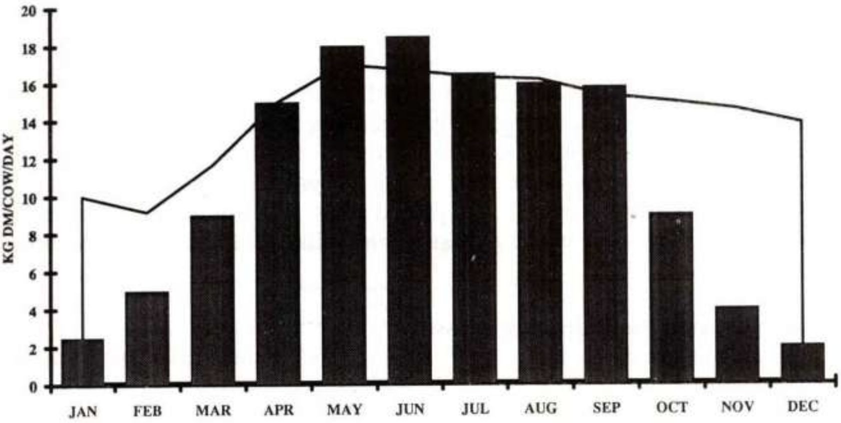
The results indicated that the herds were being fed on pasture to produce milk at or near their potential. Higher genetic material would be needed to further increase milk production from pasture under these conditions. It is not intended to deal with this subject here but to describe the recent advances in our knowledge of pasture feeding of cows under rotational grazing.

Grass supply and cow demand during grazing

The traditional system of seasonal milk production from pasture was based on high stocking rates and compact calving 6-8 weeks prior to turn-out to spring pasture. The concentrate input in this system was around 0.5 tonnes. This system was capable of producing 70% of the milk from grazed pasture with the remaining coming from silage and concentrate. The figure of 70% refers to the intake of a lactating cow from calving to drying off. In this system (see Figure 1) grass supply is not sufficient to meet the feed requirement of the cow in January to March or from October through to December. There is a small deficiency of grass in April and September. Some concentrate feeding at pasture was necessitated in early April to sustain yields immediately after turn-out to pasture. This feeding usually ceased by mid-April. The first grazing cycle lasted up to 10 April (normal grass growth pattern) and at this time current grass growth rate was sufficient to feed the cows when 45% of the farm was closed up for silage. The May/June period usually produced an oversupply of grass in those months and this factor was responsible for poor on pasture performance later in the season.

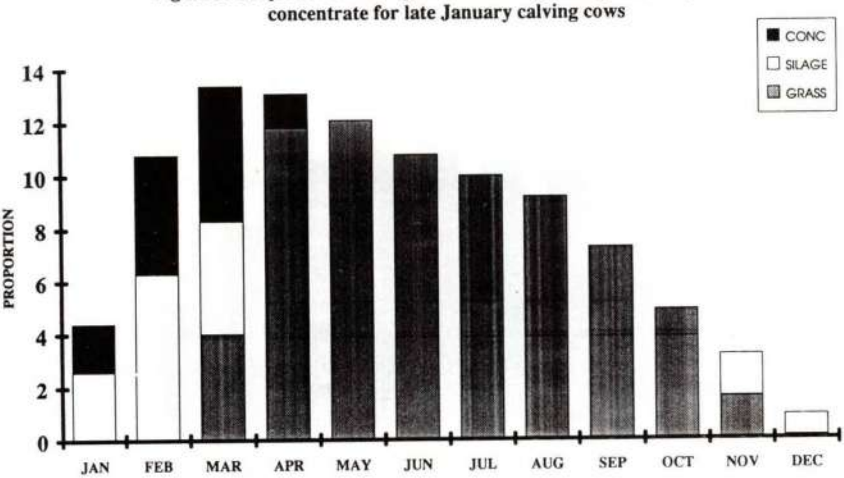
The experiments run at Curtins farm since 1990 (Dillon and Crosse, 1992) have examined two major factors controlling this supply and demand relationship, namely, calving date and stocking rate. Altering the calving date changes the seasonal demand pattern for grass and reducing stocking rate increases the

Figure 2: Feed demand and grass supply for early march calving cows stocked at 2.6 per hectare



feed supply from grazed grass. Figure 2 outlines the supply and demand relationship for a situation where cows calve 6-8 weeks later (ie. much closer to the commencement of grass growth at a 10% reduced stocking rate). It is now apparent that the April and September deficits are eliminated and the March and October deficits are reduced substantially. The feed demand in the January-April period is reduced because there are less cows in milk but the demand is higher in September to November because of lactation stage. With this system, 85% of the milk is produced from grazed grass compared to the traditional

Figure 3: Proportion of milk produced from grazed grass, silage and concentrate for late January calving cows



system described above. This means that during lactation more grazed grass was fed to the cows and less of silage and concentrate. The problem with the May/June surplus continues to exist in this system. Figures 3 and 4 show the proportions of milk produced from the three feed sources for the traditional early calving and the later March calving cows.

The later calving system at 2.6 cows/ha produced 215 and 195 kg of milk fat and protein/cow, respectively, in 5600 L of milk. To achieve this level of production some important targets with regard to cow and grazing management need to be attained. Compact calving of cows at the desired date is essential. Grassland management is now more critical as a greater proportion of the cows diet during lactation is coming from grazed grass. Some of the more important factors controlling feed intake at pasture and milk yield of cows will now be considered.

Herbage quality and grazing pressure

Grazing experiments during 1986-1990 (Stakelum and Dillon, 1991) using post-grazing sward surface height as a measure of grazing severity under rotational grazing, established the importance of herbage digestibility on milk production per cow. The overall result from these experiments was that the response of dairy cows for the second half of lactation to an extra 1 kg of DMI of pasture was the production of 1 kg of extra milk. This is at least the best response possible from feeding concentrates at pasture under normal conditions. This extra DMI from pasture is achieved by controlling grazing conditions in order to produce dense leafy pastures for the cows. The financial cost associated with this amounts to zero because it is not associated with the purchase of extra feed or the conservation of forage on the farm. In fact the benefits are greater than the extra per cow production achieved because pastures which are not either

Figure 4: Proportion of milk produced from grazed grass, silage and concentrate for early March calving cows

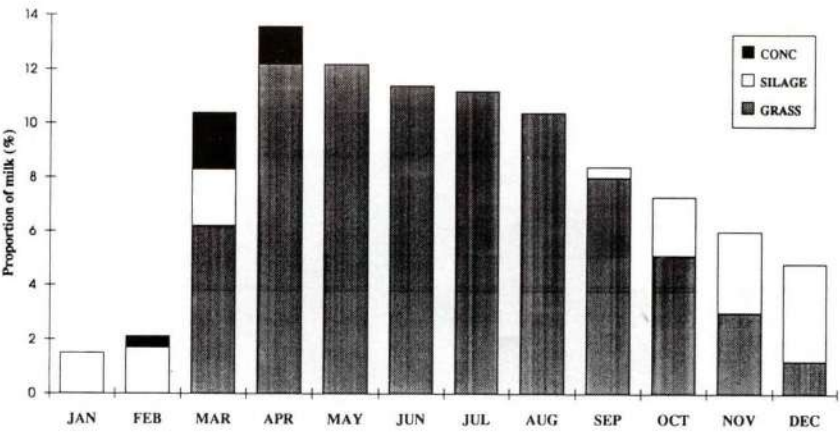
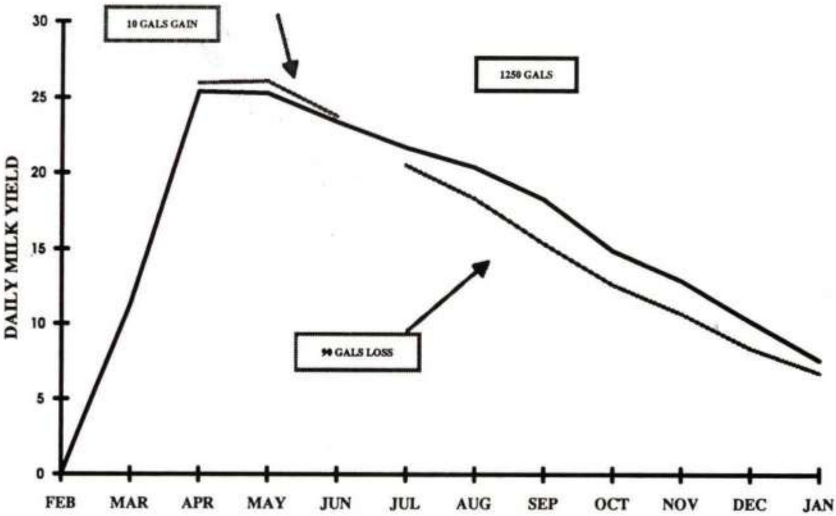


Figure 5: Effect of poor grass quality from July onwards



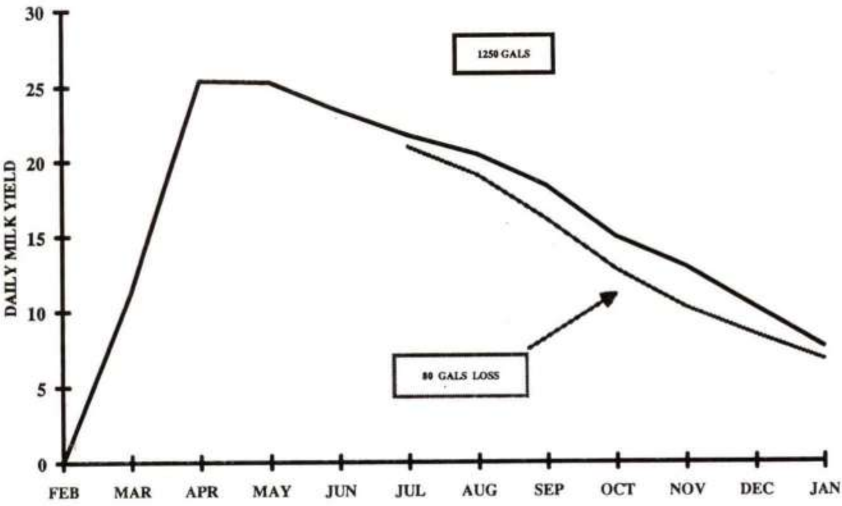
over or under grazed grow much better and achieve higher spring growth rates in subsequent years. Additionally, there are also benefits to be derived in silage making costs as a greater proportion of total silage can now be harvested from the first cut in May.

One of the main influences on pasture digestibility is the proportion of stem and dead material present. When pastures are under-grazed during April and May in a mistaken effort by farmers to increase intake, stem elongation occurs and the sward achieves a high rate of gross herbage production. However, the rate of pasture senescence also increases dramatically and the digestibility of the pasture declines.

Figure 5 outlines the effect of reduced pasture digestibility on milk yield per cow. The results are an overall summary of 5 separate whole season grazing experiments where different pasture digestibilities were evaluated at a number of grazing pressures. Cows produced about an extra 50 kg (10 gals) milk during April-May when post-grazing height is at 8 cm or greater compared to tighter grazing. However, at equal grazing pressure later, cows lose 450 kg of milk (approx. 100 gals) due to the lower pasture digestibility. This highlights the importance of grazing relatively tightly (to 6 cm) in the period of very active grass growth (April-June). The cows, because of the early stage of lactation and the very high nutritive value of the herbage, are well able to buffer the effects of the high grazing pressure.

Figure 6 outlines what happens where grazing pressure is pitched too high from late June onwards. This means grazing below 8 cm. Cows lose on average 375 kg of milk (80 gals). This happens whether pasture digestibility is high or low. Too high a grazing pressure is being applied on some dairy farms in Ireland from July onwards in an effort to lengthen the rotation in order to push grass

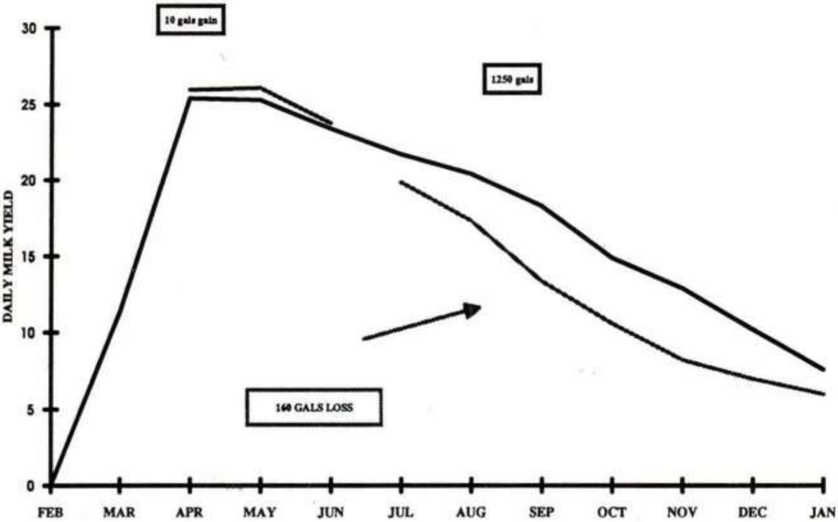
Figure 6: Effect of too high a stocking rate from July onwards



ahead of the cows into the September-October period. Milk production per cow will suffer as a result. The logical way to reduce the autumn deficit is to use the correct overall stocking rate and graze the cows in such a way as to avoid depressing their milk production by large amounts. This means reducing the grazing pressure from July onwards (post-grazing height of 8 cm). The higher post-grazing herbage masses will respond by higher growth rates in the recovery period. The rotation length in the late summer/early autumn period can only be lengthened if grass supply is high enough to allow for it. Otherwise it will only be achieved by low post-grazing pasture height (or mass) and a consequent reduction in cow performance.

Figure 7 shows what happens if grazing pressure is lenient in early season (>8 cm) and this reduced quality pasture is subsequently grazed out by having a fairly high grazing pressure later on. This is not an uncommon situation on many dairy farms where a buildup of pasture mass occurs in mid-summer and this is eventually grazed out by the following November/December. In this situation cows can lose up to 750 kg of milk (160 gals). The DMI is reduced by up to 4-5 kg mainly because of changes in the ingestive behaviour of the cow. Prehension of herbage becomes increasingly difficult for the cows on the long grass due to the presence of stem and dead material mixed through the green leaf canopy. The digestibility of the selected material falls (not as large as the depression in the sward digestibility). Figure 8 shows the milk production per cow profile for 4 farms in the Cork area from pasture from March to August. These farms have similar calving dates, stocking rates, N input and cow genetic merit and yet by August there is a difference in milk production of 7 kg/cow/day between the farms. One succeeded in achieving high production throughout the whole period. The significant point illustrated here is that, by applying the

Figure 7: Effect of too high a stocking rate and poor grass quality from July onwards



principles outlined of correct grazing height during the April/May period and from July onwards, per cow performance levels from pasture similar to the Curtins farm can be achieved.

Topping of pastures

Where pastures are undergrazed by choice in the April to June period because of an unwillingness of the farmer to do so or because it is physically too difficult

Figure 8: Performance for four farms from pasture

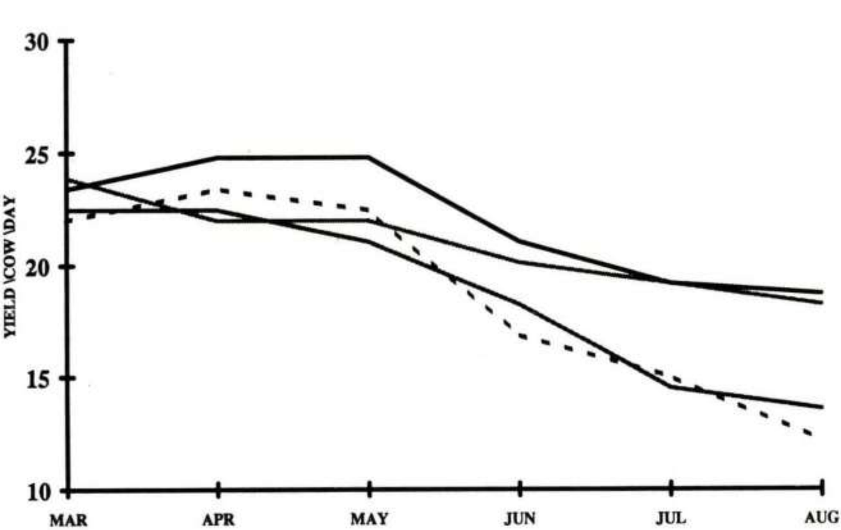
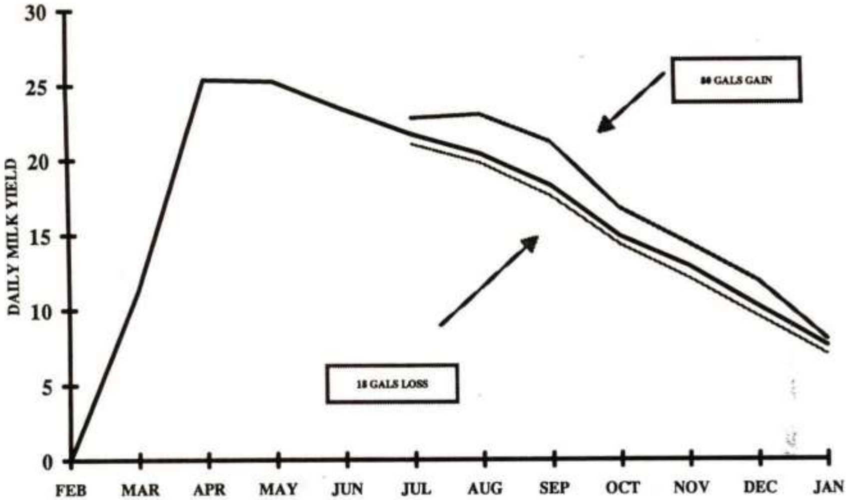


Figure 9: Effect of very high grass quality on milk yield



to do so because of ground conditions and late turn-out, topping pastures to 6 cm can have a role in maintaining pasture digestibility. Figure 9 outlines the results of recent Moorepark experiments on this subject. Very high digestibility can be maintained in the pastures by mechanical topping during stem extension. It is vitally important, however, to graze these pastures at the correct intensity later on. Because the tall grass in close proximity to the faecal deposits has been defoliated by topping there will be less herbage mass available for grazing. If previously topped swards are grazed at 8 cm from July onwards an extra 375 kg of milk (80 gals) per cow can be produced compared to the standard milk production profile of the spring calver. Cows grazing these swards however are more sensitive to grazing pressure because of the lower available herbage. If grazing is at 6 cm, cows will lose about 84 kg of milk (18 gals). The technique is most suitable on farms which have below optimum stocking rates and produce big surpluses of grass in May. The toppings can usefully be grazed in situ by other stock on the farm.

Summary

Since the introduction of milk quotas the emphasis has now shifted to achieving higher performance from cows and doing this through grazed grass. Results from the present experiment at Curtins has shown that by a better match of the feed demand curve to the grass supply curve, a higher proportion of the milk can be produced during the grazing season with much reduced concentrate inputs. This means calving the cows closer to the start of the grazing season in March. Also, by giving the cows more land (10%), the extra grass can be successfully used to increase performance of the cows.

The most important factors which affect milk yield at pasture (intake and

digestibility of the sward), therefore, need to be considered. High intakes at pasture will occur if the grazing pressure is very low. But because of the nature of grass growth, very lenient grazing pressures will cause large declines in the digestibility of the sward with consequent depressions in intake and performance of cows. Moorepark grazing experiments over the last 7 years have established the following important biological responses:

1. Poor sward digestibility from July onwards will cause a loss of 90-100 gallons of milk per cow.
2. Too high a grazing pressure from July onwards will cause a loss of 80 gallons of milk per cow.
3. Imposing too high a grazing pressure on poorer quality swards will cause a loss of 160 gallons of milk per cow.
4. Creating very high digestibility swards by mechanical topping will give an extra 80 gallons per cow from July onwards if those swards are grazed leniently (>8 cm). If they are grazed too tightly (<8 cm) a loss of 20 gallons per cow will result.
5. Grazing paddocks to the correct height from April to June will create high quality pastures for the remainder of the grazing season. A penalty of 10 gallons per cow results from this compared to leniently grazing those pastures at that time.

It is, therefore, a central issue in grazing management for milk production, to graze pastures at the correct severity during the first half and the second half of the grazing season. This can be done by using feed budgeting. This means making decisions on the overall stocking rate firstly. Then the silage conservation programme is decided. These two decisions will determine the effective stocking rate during the major periods of the grazing season. During the season, day to day decisions are made on the basis of herbage amount or height in the paddock after grazing. Keeping cows longer or shorter in the paddock to achieve this optimum grazing severity is the corner stone of feed budgeting. A knowledge of grass supply ahead of the cows is important in order to anticipate the onset of large surpluses or deficits. This is got by a visual assessment of the amount of grass, current grass growth rate bulletins from Teagasc and the experience of the farmer himself.

The current recommendation from Moorepark to increase the amount of grass eaten by cows and increase their milk production is to allocate more land to cows, ie. drop stocking rate by 10% from 3.0 to 2.6 ha/cow and continue to use 350 kg of N/ha to support this. The post-grazing severity should be 6 cm up to end of June and 8 cm later. The extra land will allow the grazing season to be significantly extended. For seasonal milk production, the cows should now be calved closer to grass. This also allows for an earlier start to the grazing season because of the lower feed demand (less cows now in milk in early March) in early spring.

The challenge is to get the parameters which adequately describe grazing severity (height of tall and short grass and proportion of each in the paddock) communicated clearly at farm level so that farmers can put these very important grazing principles into practice and increase the productivity of their cows on pasture and therefore the returns from dairying.

References

Dillon, P. and Crosse, S. (1992). Optimising herd calving patterns - Dairy Herd Management. Irish Grassland and Animal Production Association Journal, 26: 132-140.

Stakelum, G. (1991). The production and utilisation of grass for grazing and silage. The 11th Edward Richards Orpen Memorial Lecture presented to the Dairy Conference of Irish Grassland Association. Irish Grassland and Animal Production Association Journal, 25: 3-37.

Stakelum, G. and Connolly, J. (1987). The effect of body size and milk yield on daily herbage intake by dairy cows. Irish Journal of Agricultural Research, 26: 9-22.

Stakelum, G. and Dillon, P. (1991). Influence of sward structure and digestibility on the intake and performance of lactating and growing cattle. BGS Occasional Symposium (Ed. C. S. Mayne) 'Management Issues for the Grassland Farmer in the 1990's'. pp. 30-42.

The Effects of Ensiling on Dry Matter Intake and Animal Performance

T. W. J. KEADY and J. J. MURPHY
Teagasc, Moorepark Research Centre, Fermoy, Co. Cork.

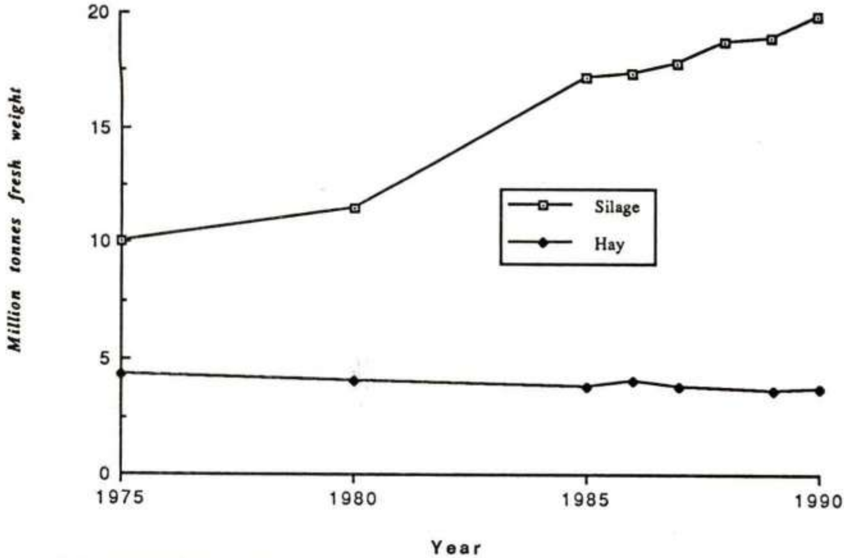
The maximum profitability from Irish dairying in a quota situation will occur from the economical production of each litre of quota. Therefore in the mild Irish temperate climate which is favourable to grass production, maximum utilisation of grazed grass and conserved forage will be important to achieve maximum profitability. Even with indications of reductions in cereal prices, home produced forage will still be competitive. Fitzgerald (1992) valued concentrates and silage on a metabolisable energy (M.E.) basis. He concluded that relative to high quality silage (DMD = 750 g/kg and M.E. = 10.8 mj/kg DM), for concentrates to be competitive on a per unit M.E. basis, prices would have to be in the region of £71 or £99/tonne depending on whether a land charge was included or not. Today on most intensive dairy and calf-to-beef farms silage accounts for 25-35% of the annual feed dry matter intake while grazed grass and concentrates represent approximately 55-70% and 5-10% respectively. These proportions may change in the future due to an extended grazing season, lower stocking rates, animals of higher genetic merit, cheaper substitutes or milk price reductions. However, conserved forage is always likely to be a major part of Irish livestock production systems bridging a feeding period from 2-4 months on southerly dry soils to 6 plus months on wet drumlin soil in the northern half of the country.

Over 20 million tonnes of fresh herbage is ensiled annually in the Republic of Ireland (Fig. 1). Grass accounts for over 99% of forage ensiled, the remainder being made up of crops such as maize, whole crop fodder beet and whole crop cereals. The feeding value of silage varies depending on factors such as digestibility, initial rate of fermentation, final fermentation quality, etc., which ultimately affects its intake characteristics.

Grazed grass v silage

Intake by dairy cattle grazing grass during a 21 day rotation can be as high as 15-17 kg DM while that for silage is only 9-13 kg DM supporting milk yields of up to 26 and 16 kg/hd/day respectively. However, such a simple comparison is not scientifically valid because animal, feed and management factors (Table 1) are not standard. In a grazing situation animals have the opportunity to select fresh leaf and reject stem, dead material, and growth around dung pads. However when offered precision chopped silage, which is usually lower in digestibility than grass, the animal is not able to select leaf from stem and may eat pieces from the total botanical mass, i.e. leaf, stem, dead material, weed species, etc. in one mouthfull.

During the ensiling process herbage is changed from its fresh state to a pickled one resulting in many changes in its chemical composition (Table 2). Two main



(Source: Wilkinson and Stark, 1992)

Figure 1 – Changes in forage production in Ireland 1975-1990

changes occur in the chemical composition of the herbage during the ensiling process. Firstly the water soluble carbohydrates are broken down to lactic acid and volatile fatty acids. Secondly the true protein concentration is reduced from approximately 80% of the crude protein in the parent material to approximately 59% in silage. These changes may have big effects on the intake and animal performance potential of the resultant silage. Feed value of any forage is affected firstly by its voluntary intake and secondly by its efficiency of utilisation.

As silage is a fermented feed containing quantities of volatile fatty acids and alcohols, dry matter can be underestimated by oven drying at high temperatures

Table 1
Factors potentially affecting forage intake by the dairy cow

Factor		
Animal	**Feed**	**Management**
Liveweight	Concentrate supplementation	Feeding frequency
Condition score	Dry matter concentration	Feeding space
Milk yield	Digestibility	
Stage of lactation	Fermentation products	
Parity		
Pregnancy		
Breed		

Table 2
Chemical compositional changes which occur during the ensiling process (mean of 6 experiments)

	Grass	Silage	
		Untreated	Formic
Dry matter(g/kg)	150	178	189
pH	—	4.2	3.8
Composition of DM (g/kg)			
Crude protein	196	179	176
True Protein (g/kg nitrogen)	790	553	627
NH_3/N (g/kg nitrogen)	—	107	67
Water soluble carbohydrate	95	8	17
Modified acid detergent fibre	316	307	307
Lactate	—	90	88

(Source: Keady, 1991).

due to loss of volatile components. In order to account for losses in volatile fatty acids and alcohols the determination of dry matter of the silages should be estimated using a toluene distillation technique, e.g. that proposed by Dewar and McDonald (1961), corrected for losses of alcohols. The difference in dry matter concentration between oven drying and toluene distillation varies depending on many factors including fermentation quality of the silage, dry matter concentration, additive used, etc. Keady (1991 - unpublished data) noted that the dry matter concentration of 20 silages varied from 6.1 to 14.3% higher when estimated using the toluene distillation method of Dewar and McDonald (1961) relative to oven drying at 85°C for 24 hours.

Ensiling and its effect on intake

Sheep

Most of the initial work carried out examining the effects of ensiling per-se on forage dry matter intake was carried out using sheep. Data from 65 comparisons in which the intakes of the parent herbage and the resultant silages were compared are presented in Table 3. Intake of silage dry matter by sheep varied from as low as 38% (Harris and Raymond, 1963) to as high as 84% (Demarquilly and Dulphy, 1977) of that of the parent herbage. From the mean of 24 comparisons in which the silages were well preserved, as measured by pH being less than 4.2, ensiling per-se decreased forage dry matter intake of sheep by 30%. However when the silages were poorly preserved from the mean of 41 comparisons ensiling per-se decreased dry matter intake of sheep by 41%. Ensiling had little effect on dry matter digestibility increasing it by 1% and decreasing it by 2%, for well and poorly preserved silages respectively.

However these data need to be interpreted cautiously when using them to

Table 3
The effects of ensiling per-se on forage dry matter intake by sheep

Source	Number of comparisons	Silage pH	Silage Ammonia Nitrogen (g/kg nitrogen)	Silage (as a % of fresh herbage) Dry Matter Digestibility	Organic Matter Digestibility	Dry Matter Intake
Silages well preserved (pH <4.2)						
Donaldson and Edwards (1976)	1	3.94	-	101	102	76
Lancaster (1975)	1	3.93	87	104	-	75
Bryant and Lancaster (1970)	1	3.70	48	-	109	81
	1	3.70	108	-	102	81
Dermarquilly and Dulphy (1977)	4	3.88	57	-	-	84
Michalet (1975)	3	3.99	73	-	-	79
Dermarquilly (1973)	13	3.80	62	-	98.5	61
Harris and Raymond (1963)	6	4.00	-	100	-	
Mean		***3.87***	***65***	***101***	***100***	***70***
Silages poorly preserved (pH ≥4.2)						
Lancaster (1975)	1	4.72	174	94	-	83
Bryant and Lancaster (1970)	1	5.40	224	-	99	65
Dermarquilly and Dulphy (1977)	4	4.49	112	-	-	73
Michalet (1975)	3	4.23	99	-	-	41
Dermarquilly (1973)	21	4.50	112	-	98	61
	7	4.20	68	-	98	62
Harris and Raymond (1963)	4	4.98	-	104	-	38
	4	4.58	-	97	-	-
Mean		***4.51***	***107***	***100***	***96***	***59***

draw conclusions on the effect of ensiling on intake. Some of the comparisons were confounded firstly by poor fermentation quality of the resultant silages and secondly by the method of determination of the dry matter concentration of the silage. Also, sheep are more sensitive than cattle to factors such as silage fermentation quality, dry matter concentration, chop length, etc. Michalet (1975) reported that relative to the fresh herbage sheep ingested 59 and 20% less dry matter when offered the resultant flail cut and precision chop silages respectively. Possible positive effects of the shorter chop length on intake are firstly improvements in silage fermentation quality, secondly increased rates of passage of the forage through the intestine and thirdly decreases in the time between the end of eating and the beginning of rumination.

Sheep relative to cattle

Data from seven comparisons in which the same parent herbage and resultant silages were fed to both sheep and heifers are presented in Table 4. These data, in which the silages were of a good fermentation quality and precision chopped, illustrate two important points. Firstly, heifers consumed approximately the same quantity of dry matter when the parent herbage was offered in the fresh

Table 4
The effects of type of animal and ensiling per-se on forage dry matter intake

Source	Number of comparisons	pH	Silage Ammonia Nitrogen (g/kg nitrogen)	Dry Matter Intake (as a % of fresh herbage) Heifer	Sheep
Demarquilly and Dulphy (1977)	4	3.88	57	92	84
Dulphy and Michalet (1975)	3	3.99	73	106	79
Mean		***3.93***	***64***	***98***	***82***

or ensiled form. Secondly, using the same forages sheep consumed 18% less forage dry matter in the ensiled relative to the fresh state. Therefore it is clear from the data presented in Table 4 that the sheep is a poor indicator of the intake characteristics of the mature bovine in a production system based on silage feeding.

Growing and finishing cattle

The data from 12 comparisons in which the effects of ensiling per-se on forage dry matter intake and animal performance was investigated are presented in Table 5. All silages were well preserved as measured by ammonia nitrogen concentrations. It should be noted that one of the silages reported by Flynn (1978) which had a pH of 4.6 was wilted prior to ensiling. Ensiling tended to reduce forage dry matter intake by 6% relative to that of the parent herbage. Other than the trial of Noller *et al.* (1963) who reported a decrease in dry matter intake of 29% due to ensiling, the 11 other comparisons reported variations in intake from -11% to +6%. From the data of the six comparisons in which animal performance was measured as daily liveweight gain, ensiling per-se reduced daily liveweight gain by 25%, varying from -35% (Wilkinson *et al.*, 1976) to -11% (O'Kiely and Flynn, 1982). However in the four comparisons in which carcass gain was measured ensiling reduced animal performance by 8%, ranging from -15% (Flynn, 1978) to an increase of 1% (Flynn, 1978).

Current research at Moorepark

There are little data available in the literature on the effects of ensiling on forage intake and animal performance of lactating dairy cattle. Therefore as part of an ongoing series of studies at Moorepark investigating intake and performance on grass silage diets an experiment was initiated using dairy cows to examine the effects of ensiling per se on

(1) forage dry matter intake
(2) efficiency of utilisation of forage for milk production, and
(3) digestibility of forages.

During April and May 1992 herbage from a silage sward which had not been grazed since the previous autumn was zero grazed by cows in late lactation indoors. During the same time similar herbage was harvested with a precision

Table 5

The effect of ensiling per-se on forage dry matter intake and animal performance of heifers (H) and finishing beef cattle (S)

Source	Number of comparisons	Animal Type	pH	Silage Ammonium Nitrogen (g/kg nitrogen)	Silage as % of Fresh Herbage Dry Matter Digestibility	Silage as % of Fresh Herbage Dry Matter Intake	Animal Performance (as % of fresh herbage) Daily L'weight Gain	Animal Performance (as % of fresh herbage) Carcass Gain
Dulphy and Michalet (1975)	3	H	3.99	73	–	106	–	–
Demarquilly and Dulphy (1977)	4	H	3.88	57	–	92	–	–
Dinius et al. (1968)+	1	H	–	–	–	89	–	–
Noller et al. (1963)+	1	H	–	–	–	72	66	–
Wilkinson et al. (1976)+	1	S	4.23	61	101	94	66	–
Flynn (1978)	1	S	4.4	57	101	93	81	101
	1	S	4.6	63	101	96	71	85
O'Kiely and Flynn (1982)	1	S	–	–	–	–	89	97
	1	S	–	–	–	–	90	87
Mean			***4.07***	***63***	***101***	***94***	***75***	***92***

+ Green and ensile maize used

chop harvester. Alternative loads were ensiled unwilted, using good ensiling techniques in 100 t unwalled clamps either untreated or treated with formic acid at 2.5 l/t. Eight weeks after ensiling the silages were fed as the sole diet to cows of equal parity, liveweight, at a similar milk yield level and stage of lactation as those fed the parent herbage previously.

At ensiling the grass was of moderate ensilability having dry matter, water soluble carbohydrate and nitrate concentrations and buffering capacity of 163 g/kg, 154 g/kg DM, 1000 mg/kg juice and 590 mEq/kg D.M. respectively. The chemical composition of the diets at feeding are presented in Table 6. The untreated and formic acid treated silages were well preserved, having pH's of 3.94 and 3.93 and ammonia nitrogen concentrations of 95 and 75 g/kg total nitrogen respectively. Both silage treatments tended to have higher concentrations of dry matter, modified acid detergent fibre and crude fibre, and lower concentrations of neutral detergent fibre compared to the parent herbage.

The effects of ensiling on forage dry matter intake and animal performance are presented in Table 7. Compared to the parent herbage, the untreated silage significantly decreased forage dry matter intake by 9% whereas the decrease of 5% with formic acid treatment was not significant. The decrease in intake of the formic acid treated silage is in accordance with the data reported in Table 5; from the mean of 12 comparisons silage dry matter intake was decreased by 6%. Relative to the parent herbage the untreated and formic acid treatments significantly decreased milk yield by 22% and 20%; milk protein concentration by 9.1% and 8.8%; fat and protein yield by 28% and 24%; and the yield of fat plus protein per kg dry matter intake by 25 and 25% respectively. The decrease in animal performance due to ensiling is probably due to two factors. Firstly, silage only diets result in a lower microbial nitrogen flow from the rumen. ARC

Table 6

Chemical composition of the grass and silages at feeding (g/kg DM unless otherwise stated)

	Treatment		
	Parent Herbage	Untreated Silage	Formic Acid Silage
Dry matter (oven) (g/kg)	173	–	–
Drymatter (alcohol corr. tol.) (g/kg)	–	186	189
pH	–	3.94	3.93
Composition of DM			
Crude protein	167	163	174
Ammonia nitrogen (g/kg nitrogen)	–	95	75
Ash	85	79	77
Neutral detergent fibre	568	480	500
Modified acid detergent fibre	267	282	289
Crude fibre	248	255	263
Lactate	–	167	117
Acetate	–	27.8	17.8
Propionate	–	1.8	0.6
Butyrate	–	0.7	0.4
Alcohol	–	7.4	29.6

(Source: Keady and Murphy, 1993)

Table 7

The effects of ensiling "per-se" on forage dry matter intake and animal performance of lactating dairy cows

	Treatment			
	Parent Herbage	Untreated Silage	Formic Acid Silage	Av SE diff
Forage dry matter intake (kg/day)	12.70[b]	11.51[a]	12.07[ab]	0.458
(kg/100 kg LW/day)	2.47[b]	2.26[a]	2.35[ab]	0.077
Milk yield (kg/day)	12.79[b]	10.01[a]	10.18[a]	0.346
Milk fat (g/kg)	39.8[b]	33.7[a]	36.7[ab]	1.74
Milk protein (g/kg)	32.9[b]	29.9[a]	30.0[a]	0.83
Milk lactose (g/kg)	44.2[b]	43.5[ab]	42.5[a]	0.74
Fat yield (kg/day)	0.491[b]	0.344[a]	0.375[a]	0.016
Protein yield (kg/day)	0.411[b]	0.305[a]	0.306[a]	0.012
Lactose yield (kg/day)	0.563[b]	0.432[a]	0.440[a]	0.016
Fat and protein yield (kg/day)	0.900[b]	0.649[a]	0.682[a]	0.026
Fat and protein yield (kg/kg DMI)	0.073[b]	0.055[a]	0.055[a]	0.003
Mean liveweight (kg)	529[b]	502[a]	508[a]	4.06
Dry matter digestibility	0.719[a]	0.757[b]	0.743[a]b	0.0142

(Source: Keady and Murphy, 1993)

(1984) reported microbial nitrogen flows in sheep of 1.43, 0.71 and 1.15 g nitrogen incorporated to microbial nitrogen per MJ metabolisable energy in diets consisting of grass, silage and silage plus concentrates respectively. Secondly, apparently ensiling results in a lower efficiency of utilisation of metabolisable energy for animal production. Similarly the decreases in animal performance of the dairy cow recorded in the present study are in line with the data from six comparisons reported in Table 5 in which the performance of beef cattle was measured as daily liveweight gain.

At present, in Moorepark, there is on-going research into verifying the effects of ensiling per-se on forage dry matter intake and animal performance. An understanding of the factors affecting silage intake may in the future result in the development of technology to increase animal product output from conserved forage. Also, work is ongoing evaluating possible ways of reducing the difference in animal performance obtained when the parent herbage is offered in the fresh or ensiled state.

Conclusions

A large proportion of the previous work comparing grass and silage used sheep as the experimental animal. Sheep are more sensitive than cattle to the effects of ensiling on forage intake, being sensitive to factors such as chop length, dry matter concentration, volatile fatty acid concentrations, digestibility, etc. and have now been shown not to be reliable indicators of intake in the bovine. Some comparisons with beef cattle reported effects on intake due to ensiling of -29 to 6% and on liveweight gain of -35 to -11%. From the current work at Moorepark ensiling reduces the efficiency of utilisation of forage for milk production. The Moorepark experiment reported has shown that with lactating dairy cattle a well preserved formic acid treated silage compared to the parent herbage did not significantly reduce dry matter intake but reduced fat and protein yield by 24 percent. Further work is ongoing to identify ways of improving animal product output from silage. Strategies employed could involve different types of supplements, better management of the grass crop for ensiling and on the day of harvesting and the use of particular additives at ensiling. Some bacterial inoculants have given improvements in animal performance through increases in forage intake (Gordon, 1989; Mayne, 1990; Keady and Steen, 1993b), digestibility (Keady et al., 1993; Keady and Steen, 1993b) and in efficiency of utilisation of digestible energy (Keady and Steen, 1993a).

References

Agricultural Research Council (1984). The nutrient requirements of ruminant livestock. Supplement No. 1. Commonwealth Agricultural Bureaux.

Bryant, A. M. and Lancaster, R. J. (1970). The effect of storage time on the voluntary intake of silage by sheep. Proceedings of the New Zealand Society of Animal Production, 30: 77-89.

Dewar, A. R. and McDonald, P. (1961). Determination of dry matter in silage by distillation with toluene. Journal of the Science of Food and Agriculture, 12: 790-795.

Demarquilly, C. (1973). Composition chimique, caractéristiques fermentaires, digestibilité et quantité ingeréé des ensilages de fourrages: modifications par rapport au fourrage vert initial. Annales de Zootechnic, 22 (1): 1-35.

Demarquilly, C. and Dulphy, J. P. (1977). Effect of ensiling on feed intake and animal performance. International meeting on animal production from temperate grassland, Dublin, 53-61.

Dinus, D. A., Hill, D. L. and Noller, C. H. (1968). Influence of supplemental acetate feeding on the voluntary intake of cattle fed green corn and corn silage. Journal of Dairy Science 51(9): 1505-1507.

Donaldson, E. and Edwards, R. A. (1976). Feeding value of silage: Silages made from freshly cut grass, wilted grass and formic acid treated wilted grass. Journal of the Science of Food and Agriculture, 27: 536-544.

Dulphy, J. P. and Michalet Brigette (1975). Influence compareé de la machine de récolte sur les quantités d'ensilage ingéréés par des génisses et des moutons. Annales de Zootechnie, 24 (4): 757-763.

Fitzgerald, S. (1992). Effect of a reduction in concentrate price on feed cost and its implication for grass silage in the diet of lactating dairy cows. Proceedings of the Irish Grassland and Animal Production Association 18th Annual Research Meeting, Dublin, 59-60.

Flynn, A. V. (1978). The relative importance of different factors in determining the beef production potential of silage. Ph.D. Thesis, National University of Ireland, Dublin.

Gordon, F. J. (1989). An evaluation through lactating cattle of a bacterial inoculant as an additive for grass silage. Grass and Forage Science, 44: 169-179.

Harris, C. E. and Raymond, W. F. (1963). The effect of ensiling on crop digestibiity. Journal of the British Grassland Society, 18: 204-212.

Keady, T. W. J. (1991). Studies of the mode of action of a bacterial inoculant as a silage additive and an evaluation of its efficiency. Ph.D. Thesis, Queen's University, Belfast.

Keady, T. W. J. and Murphy, J. J. (1993). The effects of ensiling on the intake of herbage and milk production by lactating dairy cows. Proceedings of the British Society of Animal Production Winter Meeting, p.20.

Keady, T. W. J. and Steen, R. W. J. (1993a). The effects of treating low dry matter grass with a bacterial inoculant on the intake and performance of beef cattle and studies on its mode of action. Grass and Forage Science (in Press).

Keady, T. W. J. and Steen, R. W. J. (1993b). A further study on the effects of treatment of difficult-to-ensile herbage with a bacterial inoculant on the intake and performance of beef cattle, and studies on its mode of action. Grass and Forage Science (in Press).

Keady, T. W. J., Steen, R. W. J., Kirkpatrick, D. J. and Mayne, C. S. (1993). Effects of inoculant treatment on silage fermentation, digestibility and intake by growing cattle. Grass and Forage Science (in Press).

Lancaster, R. J. (1975). Storage time and fermentation temperature of grass silage as factors affecting its voluntary consumption by sheep. New Zealand Journal of Experimental Agriculture, 3: 199-202.

Mayne, C. S. (1990). An evaluation of an inoculant of lactobacillus plantarum as an additive for grass silage for dairy cattle. Animal Production, 51: 1-13.

Michalet, Brigitte (1975). Recherches sur les causes des variations des quantités d'ensilage d'herbe ingéréés par les ruminants. Thése Doct. Ing. Universite de Nancy.

Noller, C. H., Warner, J. E., Rumsey, T. S. and Hill, D. L. (1963). Comparative digestibilities and intakes of green corn and corn silages with advancing maturity. Journal of Animal Science, 22: 1135.

O'Kiely, P. and Flynn, A. V. (1982). Effect of ensilage on feed value of grass. An Foras Taluntais, Animal Production Research Report, 23-24.

Wilkinson, J. M. and Stark, B. A. (1992). Silage in Western Europe - a survey of 17 countries. Chalcombe Publications, Bucks., U.K.

Wilkinson, J. M., Huber, J. T. and Henderson, H. E. (1976). Acidity and proteolysis as factors affecting the nutritive value of corn silage. Journal of Animal Science, 42 (1): 208-218.

Trace Element Deficiency in Irish Dairy Herds

J. F. MEE[1], K. O'FARRELL[1], P. A. M. ROGERS[2]
[1]*Teagasc, Moorepark Research Centre, Fermoy, Co. Cork.*
[2]*Teagasc, Grange Research Centre, Dunsany, Co. Meath.*

'The sheep and cattle are just not doing well, even though they seem to be getting plenty of feed. Do you think it could be a mineral deficiency?' Although this quote is from New Zealand (Clark and Towers, 1983) it could easily be attributed to an Irish farmer. While nutritional disorders, including deficiencies, are of more significant consequence than are infectious diseases in developing countries (McDowell, 1987), their economic significance in developed countries is contested. Kitwood (1991) stated that the understanding of the importance of adequate trace element status and the availability of trace element supplements is such that deficiencies seldom occur on British dairy farms. However, Howie (1992) observed that management changes in recent years in the U.K. have seen much greater utilization of home-grown feed, more specialized pasture grasses and fertilizer regimes, more purchase of supplementary feed in "straight" form, more use of maize silage and significant changes in calving patterns, with more cows calving in late summer without receiving concentrate feeding during the dry period. All of these factors may predispose to mineral deficiencies in dairy herds.

The national averages for trace-element composition (mg/kg DM) of Irish herbages indicate that, in general, Irish herbages are low in copper (6.9), iodine (0.19) and selenium (0.095) and high in molybdenum (2.1), (Rogers, Fleming and Gately, 1989). Assuming 90 to 95 per cent of the feed intake of dairy cows consists of grazed or conserved herbage then the trace element status of dairy cows is dependent primarily on forage trace element status. This is particularly important during the latter part of the grazing season and during the dry period when supplementation is generally not practised.

According to Rogers et al. (1989) the most important trace element deficiencies affecting Irish cattle are those of copper, selenium, iodine and cobalt. Three surveys of blood vitamin B 12 status (inferential cobalt status) of Irish cattle have shown that between 7 and 12 per cent of herds had a very low (< 100 pg/ml) B12 status, (Poole, O'Connor and Rogers, 1983; Poole, Rogers and O'Connor, 1984; Rogers and Poole, 1984). However, Rogers and Poole (1984) stated that there are technical problems in cattle plasma vitamin B12 analysis which restrict its value as a confirmatory test of cobalt deficiency. In the only study of the plasma inorganic iodine status of Irish herds, Rogers (1992) found that 19 per cent of 158 herds had a very low (<l00 ng/ml) iodine status (Table 1). These data were compiled from routine analyses conducted on samples received from veterinary practitioners and, as such, may not be representative of normal herds not under veterinary investigation.

All of the Irish base-line surveys of cattle blood selenium status (glutathione

Table 1
Surveys of Irish cattle blood trace element status

Trace elements	No. of herds	Survey period	Survey region	Grand mean	Percentage of herds High/Norm.	Marg./Low	V. Low	Reference
Iodine	216	1992	Ireland	–	60[b]	25[b]	15[b]	Langley (1992)
(ng/ml)	400[a]	1991-92	Ireland	52[b]	–	–	–	Britton (1992)
	158	1991	Ireland	74.9	23	58	19	Rogers (1992)
Selenium	232	1992	Ireland	–	63	12	25	Langley (1992)
(iu GPX/	400[a]	1991-92	Ireland	72	–	–	–	Britton (1992)
g Hb)	2984[a]	1989	Ireland	–		35[c]		Anon (1989)
	8348[a]	1988	Ireland	–		44[c]		Anon (1988)
	112-191	1984-87	Ireland	58-78	34-54	34-57	4-14	Poole & Rogers (1987[a])
	41	1987	N. Leinster	130	–	–	–	Poole & Rogers (1987[b])
	253	1982-83	Co. Clare, Limerick	21.2	1	23	76	Poole et al. (1984)
	197	1979-81	Co. Limerick	67.2	40	25	35	Poole & Rogers (1984)
	993	1980-82	Co. Kerry	42.0	22	42	36	Poole et al. (1983)
	177[d]	1979	N. Ireland	21.5	15	85		McMurry & Rice (1982)
Copper	225	1992	Ireland	–	84	11	5	Langley (19923)
(ug/ml)	200[a]	1990-91	Ireland	0.89	–	–	–	Britton (1992)
	1823[a]	1989	Ireland	–		29[c]		Ann (1989)
	6016[a]	1988	Ireland	–		30[c]		Anon (1988)
	112-191	1984-87	Ireland	0.71-0.78	35-64	35-64	1-2	Poole & Rogers (1987[a])
	412	1982-83	Co. Clare, Limerick & Kerry	0.60	15	74	11	Poole et al. (1984)
	197	1979-81	Co. Limerick	0.54	11	63	26	Rogers & Poole (1984)
	967	1980-82	& Kerry	0.62	19	71	10	Poole et al. (1983)
	672[d]	–	N. Ireland	0.72	–	–	11	McMurray (1980)
	491[d]	1977	N. Ireland	0.59	–	–	–	Anon (1978)
	3458[a]	1977	N. Ireland	–	–	9		Anon (1978)
	302	1975	Co. Clare	–	9	80	11	Rogers & Poole (1975)

[a]No. samples, not herds; [b]Thyroxine (n mol/L); cAbnormal values (Se = approx. 50% toxic; 50% deficient; Cu = primarly deficient); [d]Suckler herds.

peroxidase activity) have shown that the majority of herds had a suboptimal selenium status (Table 1). In contradistinction, selenium toxicity is rare in Irish cattle (Rogers, Arora, Fleming, Crinion and McLaughlin, 1990). Results from routine analysis on samples collected by veterinary practitioners between 1984 and 1987 indicate no consistent trend or change over time in cattle blood selenium status (Poole and Rogers, 1987a).

While the base-line surveys of cattle blood copper status (copper or ceruloplasmin) conducted in the Republic of Ireland showed that the majority of herds have a suboptimal copper status (Table 1), studies conducted in Northern Ireland found a much lower prevalence of copper deficiency (Table 1).

Results from routine analysis of samples from veterinary practitioners between 1984 and 1987 in Grange Research Centre show no consistent changes over time in cattle blood copper status (Poole and Rogers, 1987a).

This review of the available published data on the blood trace elements status of Irish cattle shows that no base-line survey of Irish cattle plasma inorganic iodine status has been conducted and the most recent base line surveys of Irish cattle blood copper and selenium status were conducted ten years ago. The objective of this project was to establish the iodine, copper and selenium status of dairy herds in the South of Ireland during the spring and autumn of 1991.

Materials and methods

Herd selection: The 50 dairy herds sampled were selected because they were participating in a computerized management information system (DAIRYMIS), (Crosse, 1986). As this was a base-line study, a farm history of clinical problems or trace element deficiency was not used as a selection criterion. Farms were located in counties Cork (n=26), Tipperary (n=20), Waterford (n=3) and Clare (n=1). These are predominantly spring-calving (December to May) herds varying in size from 33 to 293 cows. The physical performance, grassland management and calving and fertility records of these farms in 1991 are shown in Tables 2, 3, 4 and 5.

Sample collection: Samples were collected during the spring of 1991 from dry cows only, and during the autumn of 1991 from lactating cows only. Approximately ten cows per herd were sampled in the spring and ten cows or ten per cent of the herd, which ever was the greater, was sampled in the autumn (Tables 6 and 7). The farmer was asked to present cows of different ages, excluding maiden heifers.

All samples were collected during the morning (8.00 - 13.00 hrs) by coccygeal venepuncture into vacutainer tubes containing lithium heparin.

Laboratory analyses : All samples were analyzed at Grange Research Centre. The copper concentration of whole blood samples was determined by atomic absorption spectrophotometry (Spillane, 1966; Hilliard, 1979). The

Table 2
Physical performance cumulative records of the dairy herds during 1991

Variable	Mean (SD)	Minimum	Maximum
1. Herd size (cows)	89.90 (49.95)	33	293
2. Farm size (ha)	53.46 (27.95)	12.36	152.17
3. First calvers (%)	18.68 (6.37)	0.4	36.70
4. Mean calving date	7th Feb (16 days)	1.1	5.3
5. Ration fed (kg/cow)	625.50 (264.50)	255	1385
6. Milk production, April-Sept. (%)	66.72 (6.24)	52	77
7. Milk yield (kg/cow)	5009.71 (711.08)	2873.52	6037.20
8. Culling (%)	16.38 (6.66)	2.6	33.3

Table 3
Grassland management cumulative records of the dairy herds during 1991

Variable	Mean (SD)	Minimum	Maximum
1. Stocking rate (LU/ha)	2.82 (0.49)	1.04	4.10
2. Nitrogen (kg/ha)	308.33 (63.16)	171.25	426.25
3. Phosphate (kg/ha)	16.56 (10.63)	0	41.25
4. Potash (kg/ha)	55.63 (35.35)	0	136.25
5. Silage (1st cut) Date	30th May (19 days)	11th May	29th July
6. pH	4.08 (0.35)	3.6	5.2
7. D.M. (%)	23.42 (4.24)	18	34
8. D.M.D. (%)	71.62 (4.57)	62	78

Table 4
Calving cumulative records for the dairy herds during 1991

Variable	Mean	Minimum	Maximum	Target	Herds off target (%)
1. Abortion (%)	1.38	0	8.10	<2	34.1
2. Dystocia (%)	4.76	0	20.41	< 10	11.4
3. Stillbirths (%)	3.00	0	8.47	< 3.5	38.6
4. Perinatal calf[a] loss (%)	4.49	0	11.86	<5	43.2
5. Retained placenta (%)	1.44	0	15.85	<5	10.3

[a]Includes calf deaths at calving (stillbirths) and up to two days after calving

Table 5
Fertility cumulative records for the dairy herds during 1991

Variable	Mean (SD)	Minimum	Maximum	Target range	Herds off target (%)
1. Services/conception (N)[a]	1.63 (0.32)	1.14	2.65	1.4-2.0	18.6
2. Normal repeats (%)	51.0 (15.3)	20.0	100.0	60-65	72.1
3. Submission rate (%)[b]	48.5 (22.8)	2.0	80.0	60-80	62.8
4 Conception rate (%)[c]	61.3 (11.7)	34.0	86.1	50-65	18.6
5. Calving to service (days)	70.3 (7.1)	55.7	94.4	60-70	53.5
6. Calving to conception (days)	85.5 (9.6)	67.2	110.5	80-85	55.8
7. Non detected oestrous (%)	26.4 (24.7)	3.0	100.0	10-20	39.5
8. Fertility index[d]	51.7 (8.1)	35.0	73.0	50-100	44.2

[a]served cows; [b]first 3 weeks of breeding season; [c]first service; [d]weighted mean fertility value

Table 6

Proportion of dry cows from which blood samples were collected during the spring (06.02.91 - 14.03.91) of 1991

Population sample	DAIRYMIS group				TOTAL
	Fermoy	Tipperary	Bandon	Research	
Blood samples (No.)	264	124	54	99	541
Herds (No.)	26	13	5	6	50
Cows (No.)	2,693	1,05I	360	734	4,839
Cows sampled (%)	9.80	11.80	15.00	13.49	11.18

Table 7

Proportion of lactating cows from which blood samples were collected during the autumn (01.09.91 - 20.09.91) of 1991

Population sample	DAIRYMIS group				TOTAL
	Fermoy	Tipperary	Bandon	Research	
Blood samples (No.)	311	138	52	126	627
Herds (No.)	26	13	5	6	50
Cows (No.)	2,561	1,005	346	799	4,711
Cows sampled (%)	12.14	13.73	15.03	15.77	13.31

activity of erythrocyte glutathione peroxidase was measured by spectrophotometry based on the method of Paglia and Valentine (1967). Plasma inorganic iodine was determined by a chromatographic and colorimetric technique developed by Aumont (1986). The method used for haemoglobin measurement (Anon, 1969) was based on the cyanmethaemoglobin procedure.

Herd classification: The trace element status of each herd was classified based on the mean value of the individual sample results into one of six categories (Table 8). These are the same break-points used by the Teagasc laboratory at Grange Research Centre to classify the status of samples routinely submitted by veterinary practitioners.

Results

The mean (SD), minimum and maximum individual animal blood trace element values in spring and autumn 1991 are shown in Table 9. The data in Table 10 show that only three of the herds had a low copper status in the spring while none had a very low copper status. Almost half (n=24) of all herds had a normal copper status during the spring. The copper status of herds in Tipperary was better (16/20 herds normal) than that of herds in Cork (5/26 herds normal). Over one third of herds had a very low selenium status in the spring (Table 10) with a further 18 per cent classified as low selenium status. The selenium status of herds in Tipperary was better (9/20 herds normal) than that of herds in Cork

(5/26 herds normal). Approximately three-quarters (72%) of herds had a low or very low iodine status in the spring (Table 10). The iodine status of herds in Tipperary was better (7/20 herds normal or high) than that of herds in Cork (4/26 herds normal).

Two of the low copper status herds in the spring also had very low selenium and iodine status while the third low copper status herd had also had very low selenium status. Eight of the very low selenium status herds in the spring did not have very low copper or iodine status and ten had very low iodine status also. Nine of the very low iodine herds did not have a very low copper or selenium status. Thus, over half (54%) of all herds were classified as very low in one or more trace elements in the spring.

Table 8

Break-points used to classify herd trace element status based on the mean value of approximately ten blood samples per herd

Herd status	Copper (ug/ml)	GPX (iu/g Hb)	Iodine (ng/ml)	Haemoglobin (g/dl)
1. Very high	>1.61	>237	>380	>15.87
2. High	1.24-1.61	184-237	286-380	14.17-15.87
3. Normal	0.69-1.23	64-183	105-285	11.13-14.16
4. Marginal	0.57-0.68	45-63	51-104	9.40-11.12
5. Low	0.44-0.56	35-44	25-50	8.50-9.39
6. Very low	<0.44	<35	<25	<8.50

Table 9

Mean (standard deviation), minimum and maximum individual animal blood trace element values in spring and autumn 1991

Spring (06.02.91 - 14.03.91) 1991					
Variable	Units	N	Mean (SD)	Minimum	Maximum
Copper	(ug/ml)	532	0.69 (0.11)	0.30	1.30
GPX	(iu/g Hb)	541	47.60 (20.42)	5.00	105.00
Iodine	(ng/ml)	531	58.10 (73.50)	3.00	300.00
Haemoglobin	(g/dl)	541	12.21 (1.30)	7.10	20.00
Autumn (01.09.91 - 20.09.91) 1991					
Variable	Units	N	Mean (SD)	Minimum	Maximum
Copper	(ug/ml)	627	0.65 (0.09)	0.40	1.00
GPX	(iu/g Hb)	597	50.10 (21.57)	15.00	116.00
Iodine	(ng/ml)	598	28.73 (34.24)	1.00	225.00
Haemoglobin	(g/dl)	597	12.44 (1.16)	7.90	17.20

Table 10

Herd mean blood trace element status during spring 1991 on 50 dairy farms in four southern counties

Trace element	Herd status	Co. Cork (n=26)	Co. Tipperary (n=20)	Co. Waterford (n=3)	Co. Clare (n=1)	Total (n=50) N	%
Copper	Normal	5	16	3	0	24	48.0
	Marginal	19	4	0	0	23	46.0
	Low	2	0	0	1	3	6.0
Selenium	Normal	5	9	1	0	15	30.0
	Marginal	4	3	1	0	8	16.0
	Low	2	6	1	0	9	18.0
	Very low	15	2	0	1	18	36.0
Iodine	High	0	1	0	0	1	2.0
	Normal	4	6	0	0	10	20.0
	Marginal	1	2	0	0	3	6.0
	Low	7	6	3	1	17	34.0
	Very low	14	5	0	0	19	38.0

Table 11

Herd mean blood trace element status during autumn 1991 on 50 dairy farms in four southern counties

Trace element	Herd status	Co. Cork (n=26)	Co. Tipperary (n=20)	Co. Waterford (n=3)	Co. Clare (n=1)	Total (n=50) N	%
Copper	Normal	10	4	0	0	14	28.8
	Marginal	15	15	3	1	34	68.0
	Low	1	1	0	0	2	4.0
Selenium	Normal	4	11	1	0	16	32.0
	Marginal	7	2	0	0	9	18.0
	Low	4	5	1	0	10	20.0
	Very low	11	2	1	1	10	30.0
Iodine	Normal	1	0	0	0	1	2.0
	Marginal	3	3	0	0	6	12.0
	Low	3	5	0	0	8	16.0
	Very low	19	12	3	1	35	70.0

The results from the blood sampling survey conducted in autumn 1991 are shown in Table 11. None of the farms had a very low copper status and only two farms had a low blood copper status. The copper status of herds in Cork was better (10/16 herds normal) than that of herds in Tipperary (4/20 herds normal). Half of all herds had a low or very low selenium status in the autumn (Table 11). The selenium status of herds in Tipperary was better (11/20 herds normal) than that of herds in Cork (4/26 herds normal). Almost ninety per cent (86%) of herds had a low or very low blood iodine status in the autumn (Table 11). The percentage of herds with low or very low blood iodine status did not differ greatly between counties.

One of the low copper status herds in the autumn also had very low iodine status and the other also had very low selenium status. Three of the very low selenium status herds in the autumn did not have very low copper or iodine status and twelve also had very low iodine status. Twenty three of the very low iodine status herds in the autumn did not have a very low copper or selenium status. Thus, over three-quarters (76%) of all herds were classified as very low in one or more trace elements in the autumn.

The distribution of herds in the autumn which were classified as normal, marginal, low or very low trace elements status in the spring is shown in Table 12. While the majority (96%) of herds classified as normal or marginal copper status in the spring were again classified as normal or marginal copper status in the autumn, none of the three herds classified as low copper status in the spring had a low copper status in the autumn (Table 12). Approximately three-quarters

Table 12

Distribution of herd trace element status in autumn 1991 of 50 herds classified as high/normal, marginal, low and very low in spring 1991

Trace element	Herd status Spring 1991	No. of herds	Herd status in Autumn 1991			
			Normal	Marginal	Low	Very low
Copper	Normal	24	8	15	1	0
	Marginal	23	5	17	1	0
	Low	3	1	2	0	0
		50	14	34	2	0
Selenium	Normal	15	10	3	2	0
	Marginal	8	2	2	2	2
	Low	9	2	1	2	4
	Very low	18	1	2	5	10
		50	15	8	11	16
Iodine	High/Normal	11	1	0	4	6
	Marginal	3	0	1	0	2
	Low	17	0	3	2	12
	Very low	19	0	2	3	14
		50	1	6	9	34

(74%) of herds classified as normal or marginal selenium status in the spring had a similar status in the autumn (Table 12). Likewise, 77% of herds classified as low or very low selenium status in the spring were classified in the same categories in the autumn. While only 14 per cent of herds classified as normal or marginal iodine status in the spring had a similar autumn status, eighty six per cent of herds classified as low or very low iodine status in the spring had a similar autumn status (Table 12).

Discussion

The data presented on the physical performance and grassland management of the farms sampled (Tables 2, 3, 4 and 5) show that these farms are representative of intensive progressive dairy farming in the south of Ireland, which is the main dairying area of Ireland. Their farming performance is comparable with the top twenty five per cent (ranked on margin over feed and fertilizer per 1000 gallons) of all farm data recorded on the DAIRYMIS management information system (Cliffe, 1990).

The proportion of herds with a low or marginal copper status (0.44-0.68 ug/ml) in both the spring and autumn in this study (52-72%) is similar to the proportion of herds (35-80%) with a marginal or low copper status (0.40-0.75 ug/ml) reported in previous Irish studies (Table 1). However, the absence of very low copper status herds (<0.44 ug/ml) in this study is in contrast with all of the earlier Irish studies which found that between 10 and 26 per cent of herds had a very low copper status (Table 1). The data reported here are similar to more recent Irish data which showed that only one to two per cent of herds had a very low copper status (Poole and Rogers, 1987a). Differences between this and previous studies reflect differences in survey location, sample collection procedures and possibly increased awareness of hypocuprosis.

The proportion of herds with a very low inferential selenium status (<35 iu GPX/g HB) in both the spring and autumn in this study (30-36%) is similar to that reported by Poole *et al.* (1983) and Rogers and Poole (1984) for very low selenium status (<25 iu GPX/g Hb) herds. Both Poole *et al.* (1984) and McMurray and Rice (1982) found a much higher proportion of herds with a very low selenium status, 76% and 85%, respectively, in mainly dairy farms around the Shannon estuary and suckler farms in the North of Ireland. These differences reflect differences in geographical location, animal type and management practices.

While there are no comparable data available on the plasma inorganic iodine status of Irish dairy herds, Rogers (1992) stated that over a two year period between 33% and 70% of herds from twelve counties had a low or very low iodine status. Previously, Rogers and Poole (1989) had confirmed severe iodine deficiency (<20 PII ug/ml) in eight counties. The prevalence of goitre and thyroid hyperplasia in cases of bovine perinatal mortality reported by Mee (1991a and 1991b) provide additional evidence of iodine deficiency in Irish dairy herds.

In all herds where a low copper status was detected there was a concurrent very low iodine or very low selenium status. This reflects the high prevalence of very low iodine and very low selenium herds in the survey. While combined very low selenium and iodine herd status occurred twice as frequently as very low selenium status alone, 22 and 11 herds respectively, very low iodine status alone (32 herds) was more frequently detected than combined very low iodine and selenium (22 herds). This reflects the greater prevalence of very low iodine than very low iodine and selenium status herds in this study. While Rogers et al. (1989) stated that deficiencies of trace elements may arise singly or in combination, there are no published data on the combined deficiencies detected here in Irish herds.

Herd copper status did not vary greatly between spring and autumn (Table 12). This reflects the fact that at both sampling periods cows were generally not fed concentrate ration. Poole *et al.* (1983) found that while herd copper status declined during the summer, with higher values from January to June, they noted that these data referred to different farms and different locations in Kerry for each monthly mean value. O'Farrell, MacCarthy, Crinion and Sherington (1986) reported that blood copper concentration declined from a peak in May to a trough in November in a single dairy herd monitored over a year and a half. Although there was considerable variation in selenium status of herds between spring and autumn in this study (Table 12) normal/marginal herds in the spring tended to remain so in the autumn and low/very low herds in the spring tended to have a similar status in the autumn. Poole et al. (1983) showed that selenium status tended to be relatively high and rising in spring and declined over the summer to a trough in August or September. There was a trend in the present data towards a lower iodine status in the autumn compared to the spring (Table 12). This may be due to differences in iodine intake, seasonal effects and physiological status.

The finding that over half of all herds in the spring and over three -quarters of all herds in the autumn were classified as very low in one or more trace elements is perhaps surprising considering the levels of physical, calving and fertility performance achieved on these farms (Tables 2, 3, 4 and 5). However, healthy herds often show abnormal blood or feed tests (Rogers *et al.*, 1989), hence, blood tests alone will not identify deficient herds. Diagnosis of trace element responsive-disorders should be based on the presence of clinical or subclinical signs together with low or very low mineral status in blood and on the response to specific mineral supplementation.

Acknowledgements

The authors gratefully acknowledge the skilled technical assistance of Mr. T. Condon and Mr. J. Larkin. This project was financed by Irish dairy farmers through the Dairy Levy.

References

ANON (1969). Clinical Chemical Procedures No. 0008. Gilford Instrument Laboratories, Oberon, Ohio.

ANON (1988). Biochemistry - metabolic, nutritional, diagnostic analyses. Report of the

Veterinary Research Laboratory, 1987-88. Department of Agriculture and Food. Dublin pp 18-19.

ANON (1989). Biochemistry Section - metabolic, nutritional, diagnostic analyses. Annual Report of the Veterinary Laboratory Service, 1989. Department of Agriculture and Food. Dublin. pp 11-12.

ANON (1977). Common metabolic and toxicological diseases during 1977. Annual Report on Research and Technical Work. Veterinary Research Laboratories, Northern Ireland. 190.

ANON (1978). Trace metal survey 1977. Annual Report on Research and Technical Work. Veterinary Research Laboratories, Northern Ireland. pp 1 72-173.

Aumont, G. (1986). L'Alimentation en Iode des Ruminants. These, L'Ecole Nationale Superieure Agronomique de Montpellier.

Britton, J. (1992). Personal communication. Independant Analytical Services Ltd., Bagenalstown, Co. Carlow.

Clark, R. G. and Towers, N. R. (1983). Introduction. In: The mineral requirements of grazing ruminants. New Zealand Society of Animal Production. Occasional Publication No. 9. Editor N. D. Grace. pp 9-12.

Cliffe, D. (1990). DAIRYMIS II, Comparison of 1988 with 1989. Teagasc, Moorepark Research Centre, Fermoy, Co. Cork. 61.

Crosse, J. G. (1986). The Development and Implementation of Computerized Management Information Systems for Irish Dairy Farmers. Ph.D. Thesis, National University of Ireland.

Hilliard, E. P. (1979). Determination of trace elements in serum, plasma and whole blood. Animal Production Research Report. Dublin. An Foras Taluntais. 38.

Howie, N. M. (1992). Feeding and fertility. Proceedings of the British Cattle Veterinary Association Summer Meeting. Wye College. pp 111-119.

Kitwood, S. E. (1991). Trace element status. In: Nutrition and fertility in the dairy cow. Technical Report No. 8, Dairy Research Unit, School of Agricultural and Forest Sciences. pp 74-75.

Langley, O. H. (1992). Personal communication. Anitest Ltd., Thurles, Co. Tipperary.

McDowell, L. R. (1987). Assessment of mineral status of grazing ruminants. World Review of Animal Production 23: 19-32.

McMurray, C. H. and Rice, D. A. (1982). Vitamin E and selenium deficiency diseases. Irish Veterinary Journal 36: 57-67.

McMurray, C. H., (1980). Copper deficency in ruminants. Biological roles of copper. Ciba foundation 79 (new series). pp 183-207.

Mee, J. F. (199la). Perinatal calf mortality - recent findings. Irish Veterinary Journal 44: 80-83.

Mee, J. F. (199lb). Perinatal calf mortality. Veterinary Record 129: 202-203.

O'Farrell, K. J., MacCarthy, D. D., Crinion, R. A. P. and Sherington, J. (1986). Metabolic profiles of dairy cows. 1. The effects of season, nitrogen level and stocking rate. Irish Veterinary Journal 40: 42-52.

Paglia, D. E. and Valentine, W. N. (1967). Studies on the quantitative and qualitative characterization of erythrocyte glutathione peroxidase. Journal of Laboratory Clinical Medicine 70: 158-169.

Poole, D. B. R. and Rogers, P. A .M. (1987a). A survey of the copper and glutathione peroxidase status of Irish cattle. Animal Production Research Report. Dublin. An Foras Taluntais. pp 38-39.

Poole, D. B. R. and Rogers, P. A. M. (1987b). Mineral levels in silage and blood samples from dairy farms. Animal Production Research Report. Dublin. An Foras Taluntais. pp 40-41.

Poole, D. B. R., O'Connor, C. M. and Rogers, P. A. M. (1983). Survey of blood trace mineral status of cattle in Co. Kerry. Dublin. An Foras Taluntais. 68.

Poole, D. B. R., Rogers, P. A. M. and O'Connor, C. M. (1984). Moneypoint Power Station. Environmental impact study and the consequences for agriculture. Dublin. An Foras Taluntais. pp 98-146.

Rogers, P. A. M. (1992). Iodine deficiency in cattle. Proceedings of the British Cattle Veterinary Association for 1991-92. pp 201-209.

Rogers, P. A. M. and Poole, D. B. R. (1984). Baseline survey in the vicinity of Aughinish Island - Animal Productivity. Dublin. An Foras Taluntais. 110.

Rogers, P. A. M. and Poole, D. B. R. (1989). A survey of the mineral status in the blood of Irish cattle. Animal Production Research Report. Dublin. Teagasc. 111 .

Rogers, P. A. M., Arora, S. P., Fleming, G. A., Crinion, R. A. P. and McLaughlin, J. G. (1990). Selenium toxicity in farm animals: Treatment and prevention. Irish Veterinary Journal 43: 151-153.

Rogers, P. A. M., Fleming, G. A. and Gately, T. F. (1989). Mineral imbalances and mineral supplementation in cattle. Dublin. Teagasc. 15.

Spillane, T. A. (1966). Copper in biological material. Animal Production Research Report. Dublin. An Foras Taluntais. pp 118-119.

Systems of Beef Production Using Continental Cross Cattle from the Suckler Herd

M. J. DRENNAN

Teagasc, Grange Research Centre, Dunsany, Co. Meath

Where clearly demonstrated financial benefits are shown, beef farmers have responded by making the necessary changes. One such example in recent years has been the change to continental breeds. Estimates made in the late seventies showed that only 6 to 8% of the national calf crop were continental crosses which increased to 17% in 1985 and 48% in 1993 (Figure 1). In fact, recent estimates (Drennan and Power, 1993) show that 84% of mature suckler cows and 50% of suckler replacement heifers are bred to continental sire breeds. This major change in breeding policy was due to the high growth potential of the continentals and the higher prices for the better quality carcasses, i.e., leaner and of good conformation (Keane, 1992). The introduction of milk quotas in 1984 resulted in decreased calf supplies from the dairy herd resulting in increased calf prices which lead to an increase in suckler cow numbers. This increase subsequently gained momentum following improved suckler cow premiums. As a result, suckler cow numbers have increased from 0.44 million in 1984 to 0.98 million in 1993 (Table 1).

While financial benefits could be clearly shown for increasing the use of continental sire breeds and increasing suckler cow numbers the financial gain to the individual producer as a result of opting for a specific production system were not as clear. The main reason was the uncertainty and variation in beef prices throughout the year. A further complication at present is eligibility for cattle premiums which is influenced by stocking rate requirements, quotas in the case of suckler cow numbers, a maximum of 90 animals in the case of beef premia and for the slaughter premium period of slaughter (January 1 to April 30). In this paper, it is attempted to provide guidelines for non-disadvantaged areas of optimum production systems for suckler herds within which the progeny are taken to slaughter or where male progeny are purchased at weaning and taken to slaughter.

Table 1
Cow numbers (million)

	Dairy	Suckler	Total	Suckler %
1984	1.64	0.44	2.08	21
1993	1.28	0.98	2.26	43
Change	-0.36	+0.54	+0.18	
% change	-22	+123	+8.7	

Source: CSO

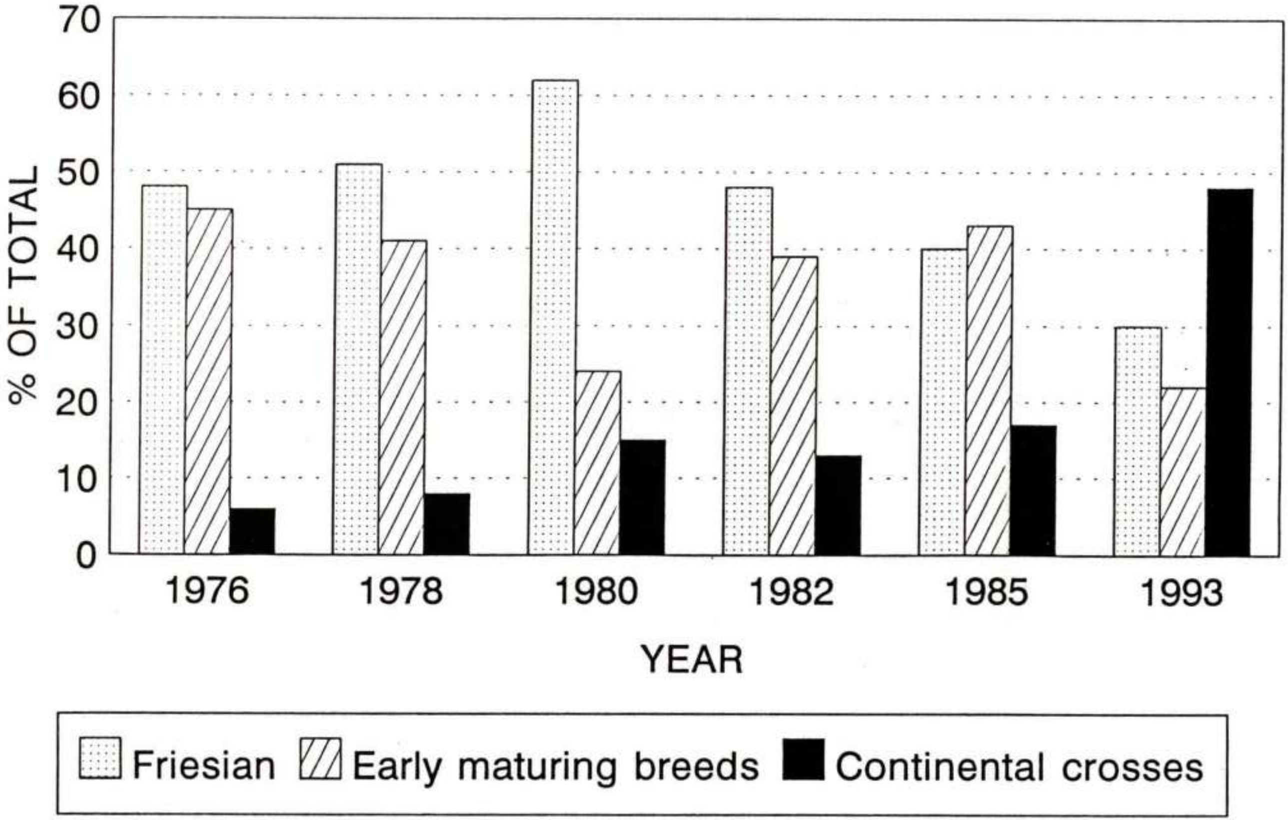


Fig. 1 – Estimated breed composition (%) – National Calf Crop

Distribution of slaughterings

Before discussing details of systems it is necessary to briefly discuss the impact of the Common Agricultural Policy Reforms (1992). These reforms will involve a reduction in intervention purchases and lower intervention prices. This will be offset by increased payments directly to farmers in the form of the various premia. Because of the high proportion of Irish beef which must be exported and the distance from the main markets of Europe, Ireland has relied heavily on intervention in the past. In the future, a greater proportion of beef will have to be marketed directly rather than through intervention. For orderly marketing a relatively even supply of beef throughout the year is important. While heifer and cow slaughterings at meat export premises have been relatively evenly spread throughout the year there has been a pronounced seasonality in steer slaughterings with a larger proportion in autumn (Figure 2). In fact the position has deteriorated over the years in that 32% were slaughtered in the October/December period in the years 1973 to 1978, while the corresponding figures were 37% for the years 1979 to 1984, 47% for 1985 to 1990 and 41% for 1991 and 1992. Economic factors were the major reasons for this change. Intervention, aids to private storage (APS) and export refunds in recent years ensured a satisfactory price for finished animals in autumn and resulted in an escalation in store prices thereby reducing the economic returns from winter finishing. The slaughter premium payable on steers slaughtered during the first four months of the year should improve the distribution of steer slaughterings but if removed there is the danger of a return to the original position.

Suckler cow systems

The systems examined are based on Grange data using Limousin x Friesian cows. Sires of the larger continental breeds (Charolais) are used on mature cows and easy calving Limousin sires on heifers. High quality silage (ensiled May 20 to 27, DMD 74%) is fed to the progeny in winter while cows receive lower quality material (ensiled late July, DMD 64%). Cows are fed a mineral/vitamin supplement with silage in winter.

Three spring calving systems are compared and high animal performance is assumed. In each system heifers are taken to slaughter at 20 months of age. The systems involve different slaughter ages for the male progeny.

The systems are:

A. (Steers 24 m) : steers slaughtered at 24 months, 1.9 acres (0.77 ha) of grassland per cow unit

B. (Steers 29 m) : steers slaughtered at 29 months, 2.2 acres (0.89 ha) of grassland per cow unit

C. (Bulls 16 m) : bulls slaughtered at 16 months, 1.6 acres (0.65 ha) of grassland per cow unit

All systems are at a similar stocking density and the total input of nitrogenous fertiliser is approximately 95 kg per acre (235 kg per ha). In system A, steers are finished at the end of their second winter, whereas in system B, steers are put to grass for a third grazing season. In system C, young bulls are slaughtered

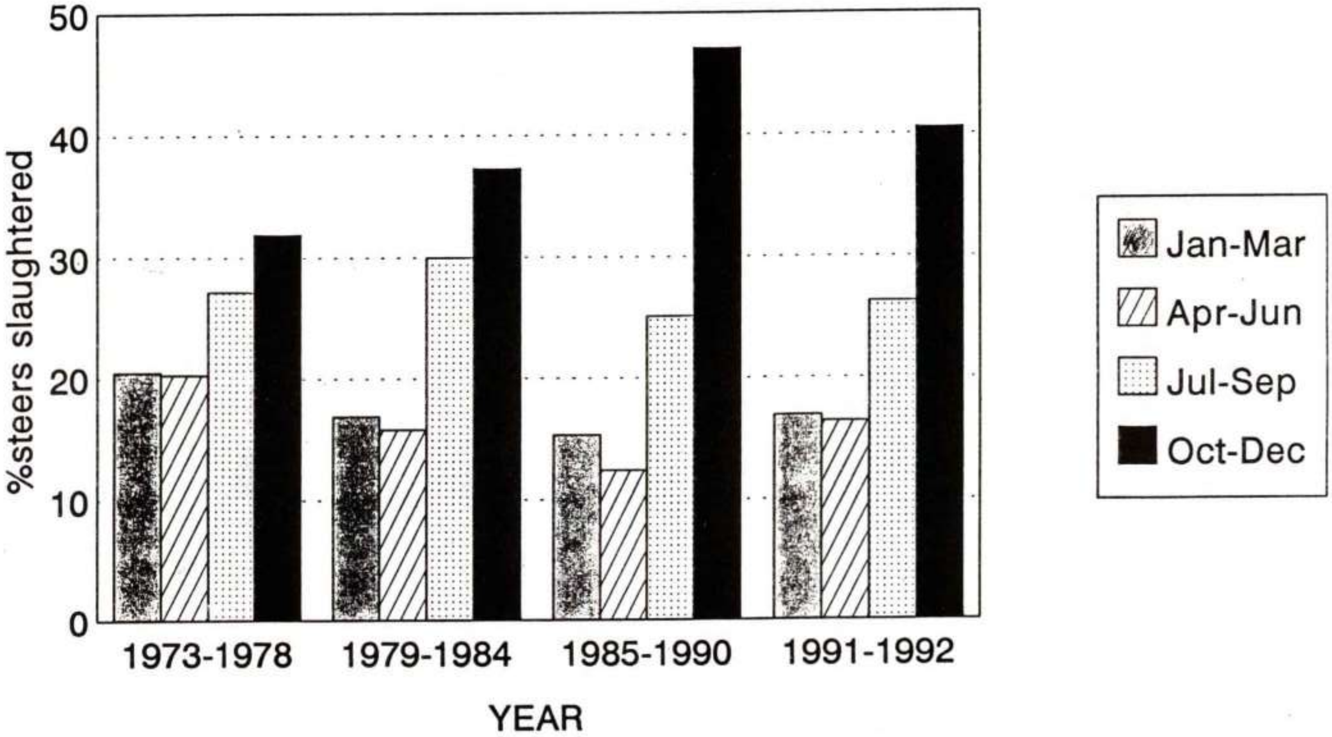


Fig. 2 – Quarterly Steer Slaughterings (%) at Meat Export Premises (1973-92)

following an extended winter feeding period of 8 months. Daily concentrate feeding levels are: 1 kg for weanlings (steers and heifers), 4.5 kg for young bulls, 4 kg for finishing steers and 3 kg for finishing heifers. Where steers are let to pasture for a third grazing season (system B) no concentrates are fed during the second winter period.

Carcass weight (kg) of males for systems A, B and C are 390, 420 and 350 kg, respectively. Heifers in all systems have carcass weights of 300 kg. Carcass prices are 229.3 and 220.5 p/kg for males and heifers, respectively. This assumes that young bulls obtain a similar price to steers and that there is no effect of time of year when slaughtered on price obtained.

The premia payable for each system are those applicable in 1994 and amount to £113, £84 and £93 per acre for systems A, B and C, respectively (Table 2). In addition to the suckler cow premium, system A receives the beef premium for males at 10 and 22 months of age and the slaughter premium, system B receives the beef premium at 10 and 22 months while system C (bulls) receives only the beef premium at 10 months. The extensification premium is not included for any system. As actual grass acreage is used, it is reasonable to assume that on most farms this amounts to about 90% of map acres. Using this adjustment the stocking rates for all three systems are below the 0.81 livestock units (L.U.) per acre (2 L.U. per ha) necessary for premia in the final (1996) eligibility specifications. It is noticeable that with inclusion of replacements the stocking rate of system B would approach eligibility for the extensification premium. It is assumed that the premia shown are actually obtained and in this respect there is very little freedom regarding the 22 month beef premium and the slaughter premium when animals are slaughtered at 2 years (System A).

Interest is charged on all working capital but no charge for housing or labour is included in the calculations. Inclusion of the slaughter premium for steers

Table 2
Premia (£) and livestock units (LU) per suckler cow unit - 1994

Premia	A (Steers 24 m)	B (Steers 29 m)	C (Bulls 16 m)
Suckler cow	112	112	112
[1]Special beef 10 month	37	37	37
[1]Special beef 22 month	37	37	...
[1]Slaughter	29	...	...
Total/cow	215	186	149
Total/acre	113	84	93
[2]LU	1.6	1.6	1.3
[3]LU/ac	0.77	0.66	0.74

[1]Half the progeny are heifers
[2]LU : cows and steers over 2 years = 1
: steers 6 months to 2 years = 0.6
[3]Adjusted acres (actual increased by 10%)

Table 3
Incomes (£) from suckling calf to beef systems : 1994 premia

	Per cow unit (£)			Per acre (£)		
	A (Steers 24)	B (Steers 29)	C (Bulls 16)	A (Steers 24)	B (Steers 29)	C (Bulls 16)
1. Animal sales	778	812	732	409	369	458
2. Premia	215	186	149	113	84	93
3. Total receipts (1+2)	993	998	881	522	453	551
4. Variable costs	360	338	358	189	154	224
5. Interest & overhead costs	311	338	295	164	154	185
6. Total costs (4+5)	670	676	654	353	307	408
Gross margin (3-4)	633	660	523	333	300	327
Income (3-6)	322	322	227	170	146	142

slaughtered at 24 months results in similar incomes per cow unit for the two steer systems, but higher income per acre (£170 v £146) from the 24 month than from the 29 month steer system (Table 3). The outcome would be similar in the absence of the slaughter premium if there was a price differential of 15 p/kg of carcass for steers slaughtered in March above that for steers slaughtered in the July/September period. The bull system (C) had a considerably lower income per cow than the other two systems and an income per acre of £142. However, with a fixed cow quota and assuming that land is not limiting then the bull system would result in reduced premia (no 22 month beef premium or slaughter premium) and lower total income on a farm basis.

Total costs per kg of liveweight and carcass weight produced are shown in Table 4. Due to differences in killing-out percentage, carcass weight provides a better assessment than liveweight. The system (B) producing steers at 29 months of age produced beef at lower cost per kg than the other two systems. This is expected as concentrate inputs (and costs) were lower for this system although interest on animals were higher as animals were retained for a longer period. The higher premia for the 24 month system (received the slaughter premium) resulted in higher incomes from the spring system (System A). Therefore, while grass finishing systems with lower variable costs result in lower costs per kg of carcass produced cattle prices and premia also have a major effect on incomes and in this instance more than offset the higher production costs.

Table 4
Total costs (£) per kg weight gain

	A	B	C
Liveweight	1.07	1.03	1.14
Carcass weight	1.94	1.88	2.01

Weaning to slaughter systems for steers or bulls

Many producers purchase suckled weanlings and take them through to slaughter. Assuming similar slaughter ages, weights and prices as shown for systems A, B and C the grassland area required for systems A1 (steers 24 months), B1 (steers 29 months) and C1 (bulls 16 months) from weaning at 8 months of age to slaughter are 1.0 (0.40), 1.6 (0.65) and 0.27 (0.11) acres (ha), respectively. While both steer systems qualify for the total premia in 1994 at both the 10 and 22 months only 60% of bulls qualify for the 10 month premium (1.21 livestock units per acre) assuming no other animals are available on the farm and actual rather than adjusted acres are used. It is assumed that steers and bulls are purchased at 300 kg liveweight at a cost of £480 per head.

The incomes per acre are £174, £107 and £141 for steers slaughtered at 24 months (A1), steers slaughtered at 29 months (B1) and bulls slaughtered at 16 months (C1), respectively (Table 5). The results again indicate the better

Table 5
Incomes (£) from weaning to beef systems: 1994 premia and stocking rates

	Per animal (£)			Per acre (£)		
	A1	B1	C1	A1	B1	C1
1. Animal sales	894	963	803	894	602	2972
2. Premia	205	146	44	205	92	163
3. Total receipts (1+2)	1099	1109	847	1099	694	3135
4. Variable costs	726	682	713	726	426	2641
5. Interest and overhead costs	199	257	95	199	160	353
6. Total costs (4+5)	925	938	809	925	586	2994
Gross margin (3-4)	373	428	133	373	268	494
Income (3-6)	174	172	38	174	107	141
Effect of ± 10 p/kg carcass	±39	±42	±35	±39	±26	±130

incomes from the steers slaughtered at 24 months which receive the slaughter premium. However, it should be noted that only one purchase price and one sale price is used both of which have a substantial effect on comparable incomes. Changing the sale price by 10 p/kg of carcass changes incomes per acre by £39, £26 and £130 from weanling to beef systems A1, B1 and C1, respectively. Likewise, changing purchase price would have a far greater effect on incomes per acre from the bull system than from the two steer systems.

Total costs per kg of carcass gain is £1.98, £1.80 and £1.78 for systems A1, B1 and C1, respectively (Table 6). This again shows that production costs are

Table 6
Total costs per kg weight gain : weaning to slaughter

	A1	B1	C1
Liveweight	1.11	1.00	1.09
Carcass weight	1.99	1.80	1.78

Table 7
Effect of premia on incomes (£) from weaning to beef systems

	Per animal (£)			Per acre (£)		
Premia	Al	B1	C1	A1	Bl	Cl
1994 (1.21 LU/ac)	205	146	44	205	92	163
1996 (0.81 LU/ac)	189	176	35	189	110	130
Income						
1994	174	172	38	174	107	141
1996	158	201	29	158	126	108

only one factor in determining income as despite the higher cost per kg gain steers slaughtered at 24 months give a considerably higher income per acre than the other two systems.

In 1996, the special beef premium will be increased to £87.9 per head on each occasion and stocking rate requirements will be 0.81 LU per acre. An examination of incomes for the three weanling to beef systems for 1996 shows that 74% of the animals in the 24 month steer system and only 40% of the bulls would qualify. In these circumstances, the 24 month old steer system would still provide the highest income per acre while the difference between systems would be reduced (Table 7). The bull system would give the lowest income per acre. As an indication of the importance of the beef premium and its effects on system comparisons the total premia per acre from the weanling to beef systems in 1996 amounts to £189, £110 and £130 for systems A1, Bl and Cl when only 74% of the animals in system Al and 40% in system Cl qualified for premia due to stocking rate limitations. However, if all animals were eligible for premia then the corresponding total premia for 1996 would be £234, £110 and £326. The higher premia payments could be achieved if there were animals produced on the farm which are not eligible for premia (and are thus not included in the LU calculations) such as heifers.

Conclusions

1. The various beef premia have a major effect on beef incomes.
2. In both suckling to beef and weaning to beef systems, inclusion of the winter slaughter premium (for animals slaughtered between January 1 and April 30) results in higher incomes from the 24 month steer system.
3. Higher sale prices (or cheaper weanlings) have a far greater effect on incomes from the young bull system than from the two steer systems.
4. In both suckling to beef systems and weanling to beef systems the cost per kg of carcass was lower for the 29 month than for the 24 month system, although incomes were higher for the latter. This shows that in addition to production costs animal prices and premia are important determinants of profitability.

5. The spring slaughter premium improves the profitability of winter finishing and as a result leads to a better distribution of slaughterings throughout the year. Higher cattle prices in spring than later in the year would have similar effects.

References

Drennan, M. and Power, R. 1993. Breed composition of the national cattle herd. Farm and Food 3 No. 1: 27-30.

Keane, M.G. 1990. Productivity of different steer breed types for beef production. Irish Grassland and Animal Production Association Journal 24: 78-87.

My Farming System and Cattle Breeding Policy

M. LYNCH, *Ennis, Co. Clare*
and J. KEANE, *Teagasc*

Farm profile

The farm consists of 500 acres (300 adjusted) in four divisions. Herding the four divisions involves a round trip of twenty four miles. Of the 250 acres in the home farm only 55 acres can be cut. This is cut twice; 30 acres are also cut twice on one of the outside farms. Due to the limited amount of land suitable for cutting it is important to graze extra cattle in summertime. This is one of the reasons for opting for a 2.5 year old cattle system.

Livestock

	1987	1993
Cows	30	90
Calves	50	90
1-2 yrs.	50	60
Beef Cattle	110	105
Ewes	30	125

A slatted house was built on the farm in 1978. A slatted house for cows on the home farm and a slatted cattle house on an outside farm were completed by 1988. All cattle are now housed on slats.

Over 100 acres of the home farm have been drained and developed over the years.

Clare Leader now proposes to fund a pilot project proposed by Clare Marts to improve the quality of cows and bulls in suckler herds.

I believe that beef now has to be produced for the real markets and that intervention specification should not influence anyone when planning their longterm breeding programme. We have already seen Intervention become less attractive to factories and I expect we will have little or no meat going to this outlet in a few years time. My programme is planned to produce very large lean animals that will give carcase weights of 440 - 500 kg and Grade U.

Niche Market

With the very high price of top quality calves and weanlings it makes sense to carry them to high weights provided they have the potential to do this without getting too fat. I have got a premium for this type of animal over the last few years. The market for heavy U Grade carcases is a niche market and will probably remain so but I believe that there will be a market for animals that produce large quantities of good quality uniform lean meat.

Seasonality

Due to my farm structure much of my production is geared towards autumn slaughtering. This has been very satisfactory in the past when intervention was open ended and provided an outlet for all the beef that came on the market. I now think that I will have to plan to spread my slaughtering over the year or at least move it away from the autumn glut.

Development of suckler enterprise

In the mid-eighties I had 30 suckler cows; mainly Hereford X with a few Angus X and Continental X. These were crossed with a Simmental bull. I also reared 30 calves and bought in about 100 stores each year. At that stage the calves were Hereford X, Friesian and Continental X. These were satisfactory but the declining quality and high prices of the calves available and the demand for higher quality in the market place pushed me into breeding more of my own cattle.

The numbers were increased by buying in some Angus heifer calves and Angus breeding heifers. These were crossed with a good Simmental bull (except for first calvers). The best heifers from this herd were kept for breeding.

Two herds

I now have two herds. The old Hereford X and Angus X herd now produces replacements for the main herd. This herd is grazed on a wet peaty area of the farm.

The main herd consists almost completely of Simmental X cows bred on the farm. These are crossed with a large muscular Charolais bull specially selected to breed large fast growing cattle with good conformation. This herd is still being expanded.

Calving difficulty

In spring of 1992 the first Charolais calves were born. The cows had been on high quality silage with little or no rationing. The calves were very large and we had many difficult calvings with five losses.

In 1993 silage quality was poorer and some moderate quality hay was also fed. The feed was also rationed. The result was that only one calf was lost at calving from 50 calvings.

Plans for the future

The final size of the cow herd will depend on the price of store cattle over the next few years. I would not rule out buying quota to keep extra cows. More buildings will be required if the cow herd is increased.

There is also more reclamation to be carried out.

I expect to get the bullocks now coming from the Charolais bull to reach 850 kg at 2.5 years and the heifers up to 650 kg at 2 years.

Managing and Marketing Suckled Calves in Scotland

B. G. LOWMAN

Genetics and Behavioural Sciences Department, SAC, Bush Estate, Penicuik, Midlothian EH26 0QE.

Introduction

Beef from the suckler herd accounts for two-thirds of overall Scottish beef production, unlike the UK where suckler herds account for only one-third of beef supplies. The importance of the suckler herd in Scotland may partly explain the reputation Scotch beef has developed as a quality product in overseas markets. Certainly the export of prime Scottish beef plays a significant part in maintaining higher prices for finished cattle in Scotland compared with the rest of the UK. In addition, the recent increase in exports has revived competitiveness in the Scottish beef market which previously was increasingly being dominated by the five main UK supermarkets.

Two aspects have been important in successfully marketing Scottish beef. First its perceived high eating quality – beef with excellent eating quality is never expensive whatever it costs. The second has been the "naturalness and wholesomeness" of Scottish beef – suckled calf production being based in the scenic Scottish hills and uplands and recently reinforced with the introduction of a Scottish Farm Assured Scheme – FASL.

The general specification for Scotch beef exports is :

* steers or heifers
* under 30 months of age
* 280-340 kg carcass weight
* carcass conformation R or better
* fat class 4L

The overall philosophy in exporting Scotch beef has been to provide a unique, labelled, top quality product which cannot be provided elsewhere, rather than the conventional approach of exporting a product which other countries already produce themselves.

To meet these specifications, particularly in terms of high eating quality and good conformation, even well bred suckled calves must remain healthy throughout their life. For the suckled calf the most common cause of ill health occurs post weaning, particularly infectious diseases such as pneumonia.

Trials monitoring the effect of pneumonia in an intensive bull beef system show that as well as reducing lifetime performance, i.e. growth rate and food conversion, pneumonia has an equally expensive effect in reducing eventual carcass conformation.

The weaning check

After birth, weaning is the next most traumatic day in the life of the suckled calf. In many cases all aspects of the calf's life changes completely in a few short hours – its diet, its environment and its social contacts! As a consequence most calves, if they are lucky , lose 1-2 months performance and the ones who are unlucky get pneumonia! Fortunately, careful management around weaning can minimise the weaning check, maintain calf performance and minimse the risk of pneumonia with benefits in the eventual quality of the carcass they produce.

As with any disease, the two important aspects to consider with pneumonia are the resistance of the animal and the level of infection to which it is exposed. Effectively, this simply means minimising the weaning check. Important management points to consider are:

1. ***Age at weaning.*** The older/heavier the calf is at weaning the less the weaning check will be.
   For example, for calves growing at 1 kg/head/day, at 3 months of age the calf might be drinking 9 kg of milk/day which would represent 65% of its total energy intake. In comparison a 9 month old calf might only be receiving 4 kg of milk/day equivalent to only 20% of its total daily energy intake. As a general rule of thumb calves should NOT be weaned until they are over 5 months old or over 200 kg liveweight.
2. ***The importance of milk.*** Milk is a unique feed for the calf, going directly into its own "special stomach" the abomasum. All other feed goes into the main stomach – the rumen. Hence the more milk calves are drinking pre weaning, the less normal feed (grass, concentrates, etc.) they have to eat to maintain liveweight gains of around 1 kg/day and the smaller their rumen capacity. As a consequence the day after the calf is weaned its feed intake is limited by its restricted rumen capacity so that in many cases energy intakes are only sufficient to maintain the calf with no energy available for growth. Research shows that in general it can take up to about 2 months for the rumen to expand sufficiently for weaned calves to have normal dry matter intakes.
   The way to overcome the initial low intake of weaned suckled calves is to feed a ration with a high energy concentration immediately post weaning. As a general rule of thumb, for weaned spring born calves wintered on silage rations, a minimum of 2½ kg of concentrates/head/day should be fed post weaning.
   As the dry matter intake of the calf increases during the 3 months after weaning the energy concentration of the ration can gradually be reduced, e.g. concentrate supplementation gradually reduced to around only 1 kg/head/day and still maintain liveweight gain. In many situations this high/low level of concentrate feeding results in similar overall concentrate intakes over the winter but can improve total winter gains by around 30 kg/head.
3. ***Creep feeding pre weaning.*** Abrupt weaning and housing of spring born suckled calves means a complete change in their diet – pre weaning they will be receiving milk and grass and post weaning silage and possibly some concentrates. This abrupt change is a major stress to the calf - it has to

find where the new feed is "hidden", has to get accustomed to eating the new feeds as do the bugs in its rumen which research work has shown will take 2 to 3 weeks to adjust fully to the new diet. This stress is made worse with calves likely to be short of feed (grass) pre weaning.
Trials investigating creep feeding spring born calves shows that introducing supplementary concentrates approximately 2 months pre weaning increases calf weaning weights by around 25 kg/head and improves overall performance during the following winter with the calves having been acclimatised to at least one of their subsequent winter feeds. Creep feeding is therefore the basis of a successful weaning programme for spring born calves.
It also has the advantage that calves will regulate their intake of creep depending on grass supplies - if adequate grass (a target grass height of 9 cm) is available calves will graze rather than eat creep.

4. ***Clipping the backs of weaned calves.*** In the autumn cattle begin to grow their winter coat, yet the majority of weaned calves will be housed indoors over the winter. In this situation the biggest problem facing cattle is keeping cool, not keeping warm!
Cattle like humans, control their body temperature by sweating, particularly along their back. However with a full winter coat it is difficult for sweat to evaporate so that body temperatures rise, again stressing the animal. Simply clipping the back of weaned calves at housing enables them to sweat freely and hence maintain a more constant body temperature, helping to minimise the risk of pneumonia.
Trials in the north of Scotland showed that simply clipping the backs of weaned calves increased overall winter gains by 7 kg/head.

Reducing the infection to which the weaned calf is exposed

1. ***Reducing relative humidity***

Most of the pneumonia-causing organisms are airborne so that animals become infected by breathing in the organisms. Hence how long these organisms survive in the air will determine the level of infection animals breathe in. The moisture content of the air is critical to the survival of these organisms. Research work has shown that in damp air (relative humidity above 75%) their life-span is many hours whereas in a dry atmosphere (below 75% relative humidity) their life-span is much shorter, in terms of minutes rather than hours. This is why pneumonia is a major problem in damp, muggy weather.
To minimise the risk of pneumonia it is therefore essential that buildings are kept as dry as possible and this is the main function of good ventilation. It is probably true to say that the majority, if not all, cattle buildings are under-ventilated. The principle to successfully ventilating cattle buildings is to get as much air change as possible over the heads of the cattle without draughts occurring amongst the cattle. One method for improving the ventilation of existing buildings which has been successfully used in Scotland over recent years has been slotting of roofs.

2. ***Frequent bedding***
   One way of helping to reduce moisture levels in buildings soon after cattle are housed is to bed them frequently. Hence, most Scottish producers housing cattle in straw yards now bed weaned calves daily for the first one to 2 weeks after they are weaned. Producers in Northern Ireland have taken this a step further and actually bed slatted pens for weaned calves for the first 2 to 3 weeks of the winter.

3. ***Stocking rates***
   The level of infection an animal faces depends on how much infection is being produced around about it. An animal housed by itself is most unlikely to suffer from pneumonia whereas animals heavily stocked are most at risk. Ideally therefore newly weaned calves should be housed at as low a stocking rate as possible – stocking rates can gradually be increased once the calves are fully settled down and have got over the worst of the weaning check. In slatted buildings this could be reasonably easily achieved by initially only stocking every other pen and utilising other sheds, e.g. buildings which will eventually house dry cows.

It is not only the level of infection but also the type of infection to which weaned calves are exposed which influence the risk of pneumonia.

Pneumonia organisms are commonly found in all situations so that during the suckling period calves will have developed some resistance to the organisms they have come in contact with. However should they be faced with new organisms to which they have no resistance when they are being stressed, i.e. post weaning, then there is a real risk of pneumonia occurring. To avoid this occurring :

1. ***Don't mix stock in the same building.*** Ideally newly weaned suckled calves should be housed by themselves in a separate building. The exception to this would be housing weaned calves alongside the mature cows who, in general, are reasonably resistant to pneumonia and do not produce large levels of infection. The common problem on many farms is to house newly weaned calves in the same shed as the "tail end" calves from the previous year. Often these tail end calves also had pneumonia earlier in their life and hence are an ideal source of infection to this year's crop of weaned calves.
2. ***Don't mix with purchased stock.*** The other major risk is mixing newly weaned homebred calves with purchased stock. In this situation it will almost be essential to vaccinate both purchased animals and homebred calves. To ensure the homebred calves have developed full resistance before they are challenged, it is essential that the vaccination programme is carried out pre weaning at grass.

Conclusions

To successfully market beef it is essential that it has high eating quality to give maximum consumer satisfaction. An important component in achieving this objective is to maintain a high health status throughout the animal's lifetime.

Careful planning the weaning programme can:

* ensure that the major cause of ill health in suckled calves is avoided, with considerable benefits, both to the efficiency and hence profitability of the system.
* ensuring a high value carcass which can compete in terms of eating quality with the wide range of other foods available to the modern consumer.

Increasing Reproductive Efficiency in Suckler Herds

M. G. DISKIN

Teagasc, Belclare Research Centre, Tuam, Co. Galway.

Both the biological and economic efficiency of suckler herds depend on calving the cows at the optimum time each year, on the cow's reproductive rate, one calf per cow per year and on the rate of gain of the calf. Reproductive efficiency is, clearly, very important.

In terms of reproduction suckler cows are distinctly different to dairy cows in a number of important aspects. Firstly, the interval from calving to the resumption of cycles or first heat averages about 60 days for suckler cows as opposed to about 30 days for dairy cows. This long interval from calving to resumption of cyclicity has serious implications for maintaining a 365 day calving interval. Secondly, because of the suckling effect of the calf and indeed the presence of the calves, suckler cows display less intense signs of behaviourial heat thus making heat detection very difficult for farmers who use A.I. These and other factors that affect herd reproductive performance are discussed.

Reproductive targets

The reproductive targets for a suckler herd are: 1) 90% of the cows should calve in 80 days, 2) less than 5% of cows should be culled for reproductive failure and, 3) the calving-to-calving interval should not exceed 365 days. Good management is required in order to achieve these targets.

Areas for improving reproductive efficiency

In suckler herds there are 3 potential areas to improve reproductive efficiency viz., shortening the interval from calving to first heat, 2) improving heat detection efficiency and 3) improving cow conception rate.

Interval between calving and resumption of cycles

The interval from calving to first heat (post-partum interval) largely determines the likelihood of cows becoming pregnant during a compact breeding season. There are a number of key physiological factors resulting from the suckling effect of the calf and from interactions between the cow and her calf that affect herd reproductive efficiency. A better understanding of how these factors operate is being obtained from experiments at Belclare. The results of experiments on cows in poor body condition at calving and on different levels of post-calving nutrition, suckling restriction and cow-calf interaction are presented in Table 1. In these indoor experiments suckling restriction (once daily) and/or cow-calf isolation were started 30 days after calving. The experimental cows were allowed to be suckled once per day starting 30 days after calving. When cyclicity was resumed calves were returned to full-time access.

Table 1
Effect of suckling restriction and calf isolation on days to first heat after calving

	SUCKLING FREQUENCY			OVERALL
	Ad lib	Restricted Adjacent	Restricted Isolated	
Low (80 M.J. M.E./Cow)	83	70	55	66
High (120 M.J. M.E./Cow)	73	60	53	60
Overall	78	63	54	63

Restricting suckling frequency while the cows were adjacent to the other cows and calves shortened the post partum interval by 15 days (from 78 to 63 days). The combination of restricting suckling frequency and of isolating the cows from their calves shortened the post-partum interval by 24 days. In a further experiment with cows in different body condition scores at calving, restricted suckling combined with calf isolation also significantly shortened the post-partum interval (see Table 2) with the greatest effect seen in cows that were in poor body score (1.75) at calving.

Table 2
Effect of body condition score (BCS) at calving and suckling restriction on days to first heat after calving

	SUCKLING FREQUENCY		
BCS	Ad lib	Restricted Suckling	Overall
1.75	71	50	57
2.50	59	49	53
3.50	55	45	48
Overall	62	48	52

It is clear irrespective of factors such as feeding level or body condition score at calving that the suckling process itself contributes significantly to the delay in resumption of cylicity in suckler cows. Furthermore, there appears to be two components to the suckling effects 1) the direct stimulus of the teat or udder when the calf suckles the cow and 2) non-tactile stimulation (visual, auditory or olfactory cues) from the calf, or indeed other calves or other adjacent cows being suckled.

The other major factor that effects resumption of cyclicity is nutrition and is currently the major focus of the Belclare programme. Nutrition, particularly pre-partum, has important implications when cows resume cyclicity after calving (see Table 2). In the *ad libitum* group, the cows in the lowest body condition at calving had the long intervals (71 days) compared with cows in moderate (59 days) and good (55 days) body condition score. These and other experiments clearly indicate that cows should calve in a moderate body condition score and post-calving weight losses should be minimised. Suckler cows should be body condition scored on a regular basis before calving and cows in poor condition or losing body condition should be selected out for additional feeding.

Heat detection

Nearly half of all suckler cows are now bred by A.I. the success of which is dependent on achieving both high and accurate heat detection rates. Because the average duration of standing heat is short, at about 9 hours, and because the signs of heat are less intense, heat detection is more difficult in suckler cows than in either dairy cows or heifers. Successful heat detection requires firstly that the farmer clearly recognises the signs of heat, and secondly has a definite commitment to at least 3 heat checks daily for the duration of the breeding period. These cheeks must be carried out early morning and late evening because these are the times of greatest heat activity.

Signs of heat

1. ***Standing to be mounted*** by herd mate or bull is the most definite sign.
2. ***Discharge of clear mucus:*** this originates in the uterus and is a good indication of imminent heat.
3. ***Restlessness and mounting behaviour:*** signs of restlessness are characteristic of individual cows that are either approaching or are in heat.
4. ***Swelling of vulva:*** hormonal changes associated with heat cause an increased blood supply to the reproductive organs which in turn causes swelling and reddening of the vulva.
5. ***Hair loss and dirt marks:*** as a result of continuous mounting by herd mates, the hair on the tailhead is usually removed and the skin on either side of the tail-head is often scarred and dirty.
6. ***Blood stains on the tail or vulval area*** are indicative of a recent heat.

Techniques which may be of assistance to improve heat detection efficiency

Tail-painting: This works well in dairy cows but is more variable in suckler cows. Due to the lower intensity of heat activity there is less complete removal of paint.

Teaser: Active, vasectomized or teaser bulls can be useful in identifying cows either coming into or on heat. However, there is considerable variation in libido among bulls and they require the same management as full bulls without any of the advantages.

Steers: Steers, particularly if recently castrated, can be useful in identifying cows coming into or on heat.

Calf removal: The presence of the calf reduces the intensity of heat as well as delaying the onset of cycles. Restricting suckling frequency to either once or twice per day for a period of 14 to 20 days may be an option to both initiate cyclicity and increase the signs of heat activity thus facilitating detection and the A.I. of a higher proportion of cows early in the season. This may not be readily practical but in acute situations for example with late calving cows, young cows or with cows in poor body condition at calving this may be an option worth considering. Where this approach is contemplated, to either hasten the onset of cyclicity or to improve the behavioral signs of heat, cows should be separated not only from their own calves but also from other cows and their calves.

Heat synchronisation

Control of the cycle, or synchronisation as it is popularly known, combined with fixed time A.I. can reduce the amount of heat checking, allow A.I. at a preplanned time and induce earlier resumption of cycles after calving. There are two categories of synchronisation treatment.

1) ***Prostaglandins:*** These are only effective in cyclic cows and are incapable of inducing cyclicity. Because a high proportion of suckler cows are likely to be non-cyclic prostaglandin treatment is not recommended.
2) ***Progestagens:*** PRIDs (Sanofi) and Crestar ear implants (Intervet)) are capable of inducing cyclicity in a proportion of cows as well as synchronising heat and are the treatments of choice for suckler cows.

Advantages of synchronisation in breeding management

Synchronisation has certain benefits in terms of shortening the calving-to-conception interval, achieving more compact calving, reducing the amount of heat detection and facilitating A.I. thus giving access to proven sires.

Shortening the calving-to-conception interval: In herds with a seasonal calving pattern late calving cows do not have sufficient time and opportunity to become pregnant within a restricted breeding season. Because of this, more late calving than early calving cows are culled for infertility. Treating individual late calving cows with a progestagen (PRID or Crestar Implant) can induce ovarian cyclicity and reduce the calving-to-service and conception intervals. Late calvers can be treated with a PRID or Crestar implant from Day 30 after calving to allow A.I. from 41 days after calving. While the conception rate at this early stage post-partum is low, nevertheless it still leaves 2 further repeat opportunities for successful A.I. within an 83-day period, the time required for the cow to calve within 12 months. This would reduce the culling rate for apparent infertility. In herds already using A.I. individual cows not observed in heat, due to missed heat or true anoestrum, may be treated with either a PRID or Crestar implant.

Compact calving: One of the potential benefits envisaged initially was synchronisation of groups of cows, particularly in herds with a scattered calving pattern. Because cows should be calved 35 days before treatment the proportion of cows available on any given day is restricted necessitating the treatment of groups of cows at intervals. Thus, where the requirement is greatest, the role for synchronisation is least effective.

Reducing the amount of heat detection: Inability to accurately detect a high proportion of cows in heat leads to disappointing conception rates and to the use of A.I. for a longer period than should be necessary. If efficient heat detection is not possible an alternative strategy would be to synchronise all cows calved at least 35 days at the start of the breeding period which would allow fixed-time A.I. without reference to heat. Most of the repeat heats would fall over a confined period, facilitating heat detection. However, as already indicated, if detection of repeats is poor any advantage will be easily lost. An alternative strategy would be to introduce a bull to cover late and repeat heats. However, for a small number of cows the economics of such a system would be doubtful.

Disadvantages of synchronisation

1) It is important to realise that treatment for oestrous cycle control necessitates assembly of animals up to four times, viz., for progestagen insertion and removal or for two prostaglandin injections and again for two fixed-time A.I.s. This requires good basic cattle handling facilities.

2) Both Crestar ear implants and PRIDs cost approximately £8-10 per cow treated plus a veterinary call fee. The actual cost may depend on the number of cows to be synchronised.

3) Where reproductive efficiency is already low because of underlying causes such as poor nutrition, synchronisation treatments will not improve fertility until the underlying causes are corrected. Synchronisation treatments are only successful when used with good management. They must always be considered as an aid and never as a substitute for good breeding management.

Factors affecting conception rate

Even when heat detection and A.I. are properly carried out, a significant amount of reproductive wastage still occurs. On average only 55%-60% of inseminations (natural or artificial) result in the birth of a calf. This low calving rate is seldom caused by fertilisation, rather is due to death of the embryo at a later stage. When embryo death occurs before the time of maternal recognition of pregnancy at days 16-17 after breeding the cow repeats at between 18 and 24 days after breeding. However, when death of the embryo occurs later than 16 or 17 days after breeding, repeat occur at long and irregular intervals. Between days 50 days and 8 months after breeding the incidence of foetal loss is about 5-8%.

A number of factors are known to affect calving rate including calving-to-service interval, accuracy of heat detection, level of nutrition and many others.

Calving-to-service interval: Calving rate reaches a normal 60% in cows bred at 60 or more days after calving. When cows are bred at 40 days or less after calving or indeed at their first post-calving heat conception rate is as low as 20-40%. Clearly, it is essential that cows return to cyclicity as quickly as possible after calving in order to be inseminated at their second or subsequent insemination.

Heat detection accuracy: Unless the cow submitted for A.I. is in "true" heat there is no chance of conception. Accuracy of heat detection is a problem in herds. Even in some dairy herds up to 20% of cows submitted for A.I. are not in "true" heat.

Timing of A.I: Calving rate is highest following A.I. at 12-18 hours after heat onset but not greatly reduced following early A.I. However, A.I. (e.g., 24 hours after onset of standing heat) should be avoided.

Calving difficulty: Besides its effects on cow and calf mortality calving difficulty also decreases rebreeding performance. As the severity of calving difficulty increases conception rate decreases. This reduction in conception rate is due to abnormalities arising from calving difficulty, including delayed uterine involution and increased infection, damage to the tract and the development of uterine and ovarian adhesions. Therefore, calving difficulty should be minimised. Two factors that greatly affect the incidence of calving difficulty are cow's age and calf sire. The incidence of calving difficulty is 4-8 times higher in first calvers than in mature cows and about twice as high in second calvers than in mature cows. Breed of sire and indeed sire within a breed should be carefully selected for use on heifers and young cows. Cows with a uterine infection should be treated at an early stage.

Minerals: Mineral deficiencies and imbalances are frequently implicated as a likely cause of low conception rate. However, scientific data to substantiate this claim is lacking. Because of the low cost of mineral supplements it is best to supplement cows during the dry period by feeding a pre-calving mineral supplement and after calving a post-calving mineral supplement. Any further supplementation should be based on blood, herbage/feed and soil analysis.

Season: A drop of conception is frequently seen in dairy herds and in a proportion of suckler herds following turn-out in spring. This may be related to excessive intakes of rumen-degradable protein, the level of which is high in spring grass. On-going Teagasc experiments at Belclare suggest that the feeding of 0.75 kg of fishmeal, to cows on spring pasture, improves conception rate.

Cow age: While heifers acquire the ability to reproduce once they reach puberty, calving rate is as low as 20-30% following breeding at the first or second heats and only reaches a normal level (60%) at the third and subsequent heats. Replacement heifers should be well grown and regularly cyclic before the start of the breeding season. Between 5 and 15% of heifers may have genetic or anatomical abnormalities which prevent conception.

When heifers calve as 2-year olds their post-calving conception rates are lower compared with mature cows. This is a reflection of the increased demands on the young cow at this time to support maintenance, lactation, growth and reproduction; hence the need to have replacements well grown at the time of first calving. Similarly, old cows nearing the end of their productive life tend to have a lower level of fertility.

A.I. vs natural service: If heat is accurate and A.I. timed and carried out correctly, conception rate is similar following A.I. or natural service.

Bull fertility: Natural service bulls can have a major impact on pregnancy rate and calving spread. Unfortunately, a bull's infertility is not usually discovered until at least one repeat interval has elapsed since joining the herd. In Ireland there is no documented information on the fertility of bulls in natural service but U.K and American data indicate that 3-5% of bulls are completely infertile and a further 30% are "unsatisfactory" in terms of semen quality, abnormalities of the penis and libido.

A veterinary examination combined with a semen evaluation one month before the start of the breeding season identifies the majority of infertile bulls though not sub-fertile bulls. A bull may not remain fertile throughout all of his working life or indeed throughout a single breeding season.

During the breeding season the farmer should check cows regularly for repeats and also to check bulls periodically for serving ability. Where a bull is expected to serve a large herd of cows (>50) it is important that the bull is active and has a high libido. Because bulls vary in libido, semen production and mating ability, it is difficult to be precise about cow to bull ratio. However, a mature bull will generally cover up to 40 cows and a yearling bull up to 25 cows.

Herd replacements

To avoid delayed resumption of cycles after first their first calving, replacements should be 350+ kg at mating and 550 kg at calving. Heifers should be bred to an easy calving sire, and should be bred to calve early in the season. Late calving heifers will on average be late calving cows.

Relative Tissue Growth Patterns and Carcass Composition in Beef Cattle

M. G. KEANE
Teagasc, Grange Research Centre, Dunsany, Co. Meath.

The main objective of the beef breed evaluation programme which has been carried out at Grange Research Centre over the past number of years has been to evaluate all the common breed types under Irish condition. The programme was designed primarily to provide information on the productive characteristics of the different beef crosses out of Friesian cows but in the course of the work much additional information was also acquired on growth patterns of body parts and tissues and how they determine body composition.

Cattle can be categorised into 3 main breed types: (1) early maturing types such as the Angus and Hereford and their crosses, (2) dairy types such as the Friesian, Holstein and Meuse-Rhine Issel (MRI), and (3) late maturing or continental breed types such as Limousin, Blonde D'Aquitaine, Charolais and their crosses. Throughout this paper the results from an experiment which compared Friesians (dairy type), Hereford x Friesians (early maturing type) and Charolais x Friesians (late maturing type) will be used to indicate or represent the differences between these three categories. The subject matter will be discussed under the following headings: (1) non-carcass parts and kill-out, (2) carcass physical composition, (3) muscle chemical composition, (4) sex type and dairy breed type in relation to carcass composition and classification, and (5) carcass classification as an indicator of carcass composition.

Non-carcass parts and kill-out

The non-carcass parts of beef cattle are sources of food and industrial raw materials in their own right, but the main interest in them by beef producers is in how they influence killing out proportion since this determines carcass weight on which payment is based. The mean weights and proportions of the non-carcass parts for Friesian, Hereford x Friesian and Charolais x Friesian steers are shown in Table 1. Taken together, transport weight loss and weight of rumen contents ranged from 99 g/kg for the Charolais crosses to 110 g/kg for the Friesians. The higher value for the Friesians over the beef crosses was due to their greater feed intake and consequently their greater weight of rumen and intestinal contents. Thus, as a proportion of full liveweight, empty liveweight ranged from 890 g/kg for the Friesians to 901 g/kg for the Charolais crosses. Gastro intestinal tract (rumen, reticulum and abomasum empty plus omasum and intestines with contents) as a proportion of empty bodyweight ranged from 99 g/kg for the Hereford crosses to 110 g/kg for the Friesians, the higher value for Friesians being again a function of their higher intake capacity. Hide, head and feet combined, ranged from 124 g/kg for Friesians to 139 g/kg for Hereford crosses, the higher value for Herefords being due to their greater hide proportion. Red offal (lungs, heart, liver, kidneys, blood, trim and miscellaneous) amounted

Table 1

Weights (kg) and proportions (g/kg) of non-carcass parts in three breed types

Sire breed[a]	Friesian		Hereford		Charolais	
	kg	g/kg	kg	g/kg	kg	g/kg
Slaughter weight	570	1000	561	1000	586	1000
Transport loss	23	40	22	40	23	39
Rumen contents	40	70	36	63	35	60
Empty body	507	890	503	897	528	901
g/kg Empty Bodyweight						
Gastro intestinal tract	56	110	50	99	56	106
Hide	35	69	42	84	38	72
Head	17	34	17	34	18	34
Feet	11	21	11	21	12	23
Lungs + Heart	10	20	9	18	9	17
Liver + Kidneys	8	17	8	16	7	14
Kidney + Channel fat	17	34	15	30	14	27
Caul Fat	13	25	12	24	11	21
Trim	5	10	6	12	6	11
Blood + Misc	26	52	24	48	28	53
Cod + Topside fats	5	9	4	8	4	7
Chill Loss	6	11	6	12	7	13
Total Parts	209	412	204	406	210	398
Cold Carcass	298	533[b]	299	543[b]	318	553[b]
Cold Carcass (g/kg EBW)[C]		588		594		602

[a]Mated to Friesian cows
[b]g/kg Slaughter Weight
[c]g/kg Empty Bodyweight

to 99 g/kg for Friesians, 94 g/kg for Hereford crosses and 95 g/kg for Charolais crosses. The higher value for the Friesians reflects the potential of this dairy breed for higher metabolic turnover. Trimmed fats (kidney, channel, caul, cod and topside) amounted to 68 g/kg for Friesians, 62 g/kg for Hereford crosses and 55 g/kg for Charolais crosses. The higher value for the Friesians is in agreement with the known greater deposition of internal fats in dairy than in beef breeds and the higher value for Hereford than Charolais crosses is in line with the generally greater fatness of the Hereford than the Charolais breed.

As proportions of empty bodyweight, all the non-carcass parts (plus chill weight loss) amounted to 412 g/kg for Friesians, 406 g/kg for Hereford crosses and 398 g/kg for Charolais crosses. This left carcass weight (cold) at 588, 594 and 602 g/kg for the three breed types, respectively. Based on slaughter weight, the conventional kill-out proportions were 533, 543 and 553 g/kg for the Friesians; Hereford and Charolais crosses, respectively. Thus, at approximately the same liveweight (570 kg), the cold carcass weights for Friesian, Hereford and Charolais crosses would be 304, 310 and 315 kg, respectively.

Table 2
Killing-out proportion by breed type and weight

Sire Breed[a]	Friesian			Hereford			Charolais		
Slaughter weight (kg)	565	670	775	560	665	770	560	665	770
Empty bodyweight	500	600	700	500	600	700	500	600	700
Carcass weight (kg)	297	359	422	301	365	430	305	370	435
Kill-out (full)[b]	526	536	545	538	549	558	545	556	565
Kill-out (empty)[c]	594	598	603	602	608	614	610	616	621

[a]Mated to Friesian cows [b]g/kg slaughter weight [c]g/kg empty bodyweight

The data in Table 1 were used for the detailed comparison of the three breed types because slaughter weights were similar. In practice, however, these breed types would be slaughtered at different weights and slaughter weight affects the proportions of non-carcass parts and consequently kill-out proportion. Thus, carcass weights and kill-out proportions were calculated for three different slaughter weights for each of the breed types (Table 2). The three weights chosen were 500, 600 and 700 kg, empty bodyweight. These gave slaughter weights which were similar for the Hereford and Charolais crosses, but which were somewhat higher for Friesians because of their greater gastro-intestinal tract contents. Over the range 500 to 700 kg empty bodyweight, kill-out proportion increased by about 20 g/kg for all three breed types. At a slaughter weight of about 670 kg, carcass weights were 359, 368 and 373 kg for the Friesians, Hereford and Charolais crosses, respectively. Corresponding carcass weights at slaughter weights of about 770 kg were 420, 430 and 435 kg, respectively. In brief, the kill-out proportion of Hereford crosses was about 10 g/kg higher than that of Friesians and the kill-out proportion of Charolais crosses was about 10 g/kg higher than that of Hereford crosses. Kill-out increased by about 10 g/kg for each 100 kg increase in slaughter weight and this was reasonably similar for the different breed types.

Carcass composition

Carcass composition is defined as the proportions of fat, muscle, bone and other tissue in the carcass. Other tissue includes tendons, ligaments, fascia, glands and large blood vessels and is generally included with bone in the presentation of compositional data. Fat is generally partitioned into the subcutaneous and intermuscular depots. Subcutaneous fat is that which is visible and overlies the muscle on the surface of the carcass. Intermuscular fat comprises the seams of separable fat lying beneath and between the muscles. It should not be confused with intramuscular fat or marbling fat which is the fat between the muscle fibres within the muscle. This can only be quantified by chemical analysis and is then defined as lipid.

Carcass composition changes continuously with increasing weight. Consequently a single point estimate of composition at a particular carcass weight is of little value because it gives no information on what composition would be at a different carcass weight. Therefore, what is required is measurement of the growth rates of the different tissues. This then permits estimation of the weights (and hence the proportions) of the different tissues at any carcass weight. Based on such tissue growth measurements, the proportions of subcutaneous fat, intermuscular fat, bone (including "other tissue") and muscle were estimated for all the common breed types at 280, 340 and 400 kg carcass weight. The results are shown in Table 3. At 280 kg carcass weight, Friesians had about 18% fat, 20% bone and 62% muscle. Corresponding proportions were 20%, 19% and 61% for Hereford crosses, 15%, 19% and 66% for Limousin crosses, 14%, 19% and 67% for Charolais crosses and 13%, 19% and 68% for Belgian Blue crosses. Thus, at the same carcass weight, muscle proportion ranged from 61% for Herefords to 68% for Belgian Blue crosses. As carcass weight increased, proportions of fat increased and proportions of muscle and bone decreased. Compared with at 280 kg, at 400 kg carcass weight, fat had increased by 9% and bone and muscle had decreased by 3% and 6%, respectively in Friesians. Corresponding changes were 11%, 3% and 8% for Hereford crosses, 7%, 3% and 4% for Charolais crosses and 7%, 4% and 3% for Belgian Blue crosses.

The changes in fat and muscle proportions per 10 kg change in carcass weight are shown in Table 4. Rates of fat change varied from 8.2 g per 10 kg carcass weight for Hereford crosses to 5.5 g per 10 kg carcass weight for Belgian Blue crosses. Rates of muscle change were lower and varied from -6.3 for Hereford crosses to -2.4 for Belgian Blue crosses. Weights at similar total carcass fatness (210 g/kg) ranged from 286 kg for Hereford crosses to 427 kg for Belgian Blue crosses. Compared with Friesians, Hereford crosses were about 30 kg carcass lighter and MRI, Limousin, Simmental, Charolais, Blonde d'Aquitaine and Belgian Blue crosses were about 10, 40, 60, 90, 100 and 110 kg heavier, respectively at the same carcass fat proportion. Muscle proportion at constant fatness was similar for Friesians, Hereford and MRI crosses, and was

Table 3
Carcass composition (g/kg) of different breed types by weight

Carcass Weight (kg)	280				340				400			
Sire Breed[a]	Sub.Fat[b]	IM.Fat[c]	Bone	Muscle	Sub.Fat[b]	IM.Fat[c]	Bone	Muscle	Sub.Fat[b]	IM.Fat[c]	Bone	Muscle
Friesian	77	104	199	620	102	123	183	592	130	138	168	564
Hereford	91	114	188	607	121	134	175	570	155	150	164	531
MRI	76	102	199	623	98	120	180	602	123	135	165	577
Limousin	65	90	188	657	86	109	169	636	109	126	150	615
Blonde	53	74	199	674	72	90	183	655	92	105	167	636
Simmental	61	87	197	655	82	104	181	633	105	119	167	609
B. Blue	53	76	189	682	71	91	170	668	89	106	152	653
Charolais	55	80	191	674	74	96	173	657	95	110	155	640

[a]Mated to Friesian cows [b]Subcutaneous fat [c]Intermuscular fat

Table 4
Rates of change in proportions of fat and muscle, and carcass weights at constant fat proportion (210 g/kg)

Sire Breed[a]	Rates of change (g/10 kg carcass weight) Fat	Muscle	Carcass weight (kg) at 210 g/kg fat	Muscle (g/kg) at 210 g/kg fat
Friesian	7.25	-4.67	320	601
Hereford	8.33	-6.33	286	603
MRY	6.67	-3.83	328	605
Limousin	6.67	-3.50	363	628
Blonde	5.83	-3.17	422	629
Simmental	6.33	-3.83	378	618
B. Blue	5.50	-2.42	427	646
Charolais	5.83	-2.83	409	638

[a]Mated to Friesian cows

approximately 20, 30, 30, 40 and 50 g/kg higher for Simmental, Limousin, Blonde d'Aquitaine, Charolais and Belgian Blue crosses, respectively. Thus, even at constant carcass fatness the continental crosses had a higher proportion of muscle.

As well as differing in the proportions of tissues in the carcass, breeds also differ in the distribution of tissues across the carcass, and this distribution changes with changes in carcass weight. The distribution of muscle in the main carcass joints for the three contrasting breed types (Friesians, Hereford x Friesians and Charolais x Friesians) at three muscle weights is shown in Table 5. The carcass weights at which these muscle weights occurred are also shown. At any muscle weight, Hereford crosses had a lower proportion of muscle in the hind limb and higher proportions in the flank and ribs than Friesians. Charolais crosses had a higher proportion of muscle in the hind limb and thorax and lower proportions in the flank and fore limb than both Friesians and Hereford crosses. Overall, the breeds did not differ greatly in the proportions of muscle in the fore- and hindquarters. There were some differences in the proportions of muscle in the higher value joints with the Charolais crosses having more muscle than Herefords which had "good" conformation. Of course the Charolais crosses which also had "good" conformation did have a higher proportion of higher value muscle. On average the proportion of higher value muscle decreased by 2.67 g per 10 kg increase in muscle weight. Again, conformation improved with increasing (muscle) weight, but as already shown, the proportion of higher value muscle declined. In brief therefore, there were differences between breeds in muscle distribution although such differences were small. Continental type cattle had more high value muscle than Friesians which in turn had more high value muscle than early maturing breed types. Proportions of muscle in the higher value joints and in the hindquarter decreased with increasing carcass and muscle weight.

Table 5

Distribution of muscle (g/kg) across the carcass by breed type and muscle weight

Muscle Weight (kg)	180			210			240		
Sire Breed[a]	FR	HF	CH	FR	HF	CH	FR	HF	CH
Hind limb	307	302	311	299	294	302	292	288	296
Loin	61	62	61	60	61	61	60	60	60
Flank	55	58	51	56	59	53	57	60	54
Ribs	52	55	52	54	57	54	55	59	55
Thorax	390	389	394	397	396	401	403	402	407
Fore limb	135	134	131	134	133	129	133	131	128
Hindquarter	423	422	423	415	414	416	409	408	410
Forequarter	577	578	577	585	586	584	591	592	590
High value[b]	368	364	372	359	355	363	352	348	356
Carcass weight (kg)[c]	290	297	267	355	368	320	425	452	375

[a]Mated to Friesian cows [b]Muscle in hind limb + loin [c]At which the respective muscle weights occur

FR = Friesian, HF = Hereford x Friesian, CH = Charolais x Friesian

Chemical composition of muscle

The chemical constituents of muscle are moisture, protein, lipid (intramuscular fat) and ash. Ash usually amounts to only about 10 g/kg and is smaller than the error involved in determining the other constituents. Consequently, it is generally not measured and is assumed at 10 g/kg. The mean composition of muscle is about 720 g/kg moisture, 220 g/kg protein, 50 g/kg lipid and 10 g/kg ash. However, as shown in Table 6, the chemical composition of muscle is not constant but varies between joints across the carcass. In general, protein proportion remains reasonably constant but lipid and moisture proportions vary inversely with each other.

As is clear from Table 6, the hind limb and *l. dorsi* had the lowest lipid concentrations followed by the fore limb and loin. The flank and thorax had lipid values almost double those in the hind limb and *l. dorsi* and the ribs had the highest lipid concentration. The latter high value may reflect the fact that complete separation of the muscle and intermuscular fat is almost impossible in the ribs. Consequently, the high lipid value for the ribs may be due to some separable fat remaining attached to the muscle. In brief, it is clear that muscle lipid concentration can vary from being very low to being quite high.

As with physical composition, chemical composition also varies with weight and breed type. The estimated mean chemical composition of the *l. dorsi* at three carcass weights is shown in Table 7 for the main breed types. Lipid

Table 6
Mean chemical composition (g/kg) of muscle from different joints

Joint	Moisture	Protein	Lipid
Hind limb	728	225	37
Loin	721	223	46
L. dorsi	726	228	36
Fore limb	726	222	42
Flank	710	218	62
Thorax	712	214	64
Ribs	686	207	97

concentration varied from as low as 16 g/kg for Blonde d'Aquitaine, Belgian Blue and Charolais steers at 280 kg carcass weight to as high as 77 g/kg for Hereford x Friesian steers at 400 kg carcass weight. Some continental crosses had similar lipid concentrations at 340 kg carcass weight to Hereford crosses at 280 kg carcass weight. Similarly, Charolais and Belgian Blue (or Blonde) crosses at 400 kg carcass weight had similar lipid concentrations to Friesians and Limousin crosses, respectively, at 340 kg carcass weight. When compared with data in Tables 3 and 4, it is clear that the differences in carcass weight between breeds at similar muscle lipid concentration are less than at similar carcass fat proportion. In brief the Hereford crosses had the highest lipid concentration at any weight followed by the MRI crosses and then the Friesians. The Limousin crosses had the highest lipid concentration of the continentals followed by the Simmental, Charolais, Blonde d'Aquitaine and Belgian Blue crosses.

Table 7
Mean chemical composition (g/kg) of *l. dorsi* by breed and weight

Carcass Weight (kg)	280			340			400		
Sire Breed[a]	Moisture	Protein	Lipid	Moisture	Protein	Lipid	Moisture	Protein	Lipid
Friesian	745	223	22	728	221	43	707	215	67
Hereford	743	221	26	722	218	50	703	210	77
MRI	745	223	22	724	220	46	704	213	73
Limousin	746	224	20	734	221	35	719	218	53
Blonde	748	226	16	742	223	25	734	219	37
Simmental	747	225	18	738	222	30	727	218	45
B. Blue	748	226	16	742	223	25	734	219	37
Charolais	748	226	16	740	222	28	729	218	43

[a]Mated to Friesian cows

Sex type and dairy breed type in relation to composition and carcass classification

Steers and heifers

Surprisingly, there are few reported comparisons of carcass composition in heifers and steers. Heifers are generally considered to be inferior to steers in carcass composition and consequently are often discounted in price per unit carcass weight. In Ireland the reasons for differences in price between heifers and steers has little to do with their respective real value. The price of steers is determined by market supports such as intervention and export refunds and by the prices prevailing on export markets. There are no market supports for heifers and their price is determined largely by conditions in the domestic market. Therefore, it cannot be concluded, that because steers are priced higher than heifers they are of superior carcass composition and of greater real value. Nevertheless, heifer carcasses do grade poorer (higher fat score and/or poorer conformation score) than steer carcasses from similar breed types at the same age or weight and because of this there is the perception that they are of poor quality and lower value overall.

The data in Table 8 are from a comparison of Hereford x Friesian steers and heifers which were reared together from calfhood to slaughter. The heifers were serially slaughtered to ensure that they covered the range of fatness of the steers. Slaughter groups of heifers were then picked which had approximately the same carcass composition as the steers. The steers were about 60 kg carcass weight heavier than the heifers. The heifers were about one half class poorer in carcass conformation than the steers and there was little difference in carcass fat score. Overall, composition between the two sexes was very similar with the heifers having slightly more bone and muscle and less fat than the steers. The heifers also had more high value muscle than the steers. In brief, therefore, early maturing type heifers and steers have similar proportions of carcass fat when the heifers are about 50 kg carcass weight lighter than the steers (the 59 kg

Table 8
Carcass composition of steers and heifers

	Steers	Heifers
Carcass weight (kg)	326	267
Conformation	3.1	2.7
Fat score	3.8	3.7
g/kg carcass		
Bone	164	169
Muscle	623	627
Fat	213	204
High value muscle[a]	382	392

[a]g/kg muscle

difference here was excessive because fat proportion was lower for the heifers (204 g/kg) than for the steers (213 g/kg)). The poorer carcass conformation of heifers was accompanied by a slightly higher muscle proportion and a considerably higher proportion of higher value muscle.

Dairy breeds

There has been much criticism from beef interests of the move towards Holsteins by dairy farmers. This is mainly because the Holsteins have inferior carcass grades. As an alternative to the Friesian-Holstein, the MRI has been proposed as a suitable dual purpose or dairy breed because it has good carcass conformation. Both the Holstein (Holstein x (Holstein x Friesian) and the MRI (MRI x Friesian) have been evaluated at Grange (Table 9). In agreement with much published work worldwide, the Grange experiments showed that even though Holsteins had considerably poorer conformation than Friesians, there was very little difference in carcass composition between the two strains. However, the Holsteins did have a slightly lower proportion of higher value muscle.

In the comparison between the Friesians and MRIs, the MRIs had much superior carcass conformation (0.4 class) but there were no differences in the proportions of muscle or of higher value muscle. It is clear therefore that in the dairy breeds compared here there was little relationship between carcass conformation score and the main components of carcass composition.

Table 9
Carcass traits of Friesian, Holstein and MRI steers

Sire Breed	Friesian	Holstein[a]	MRI[b]
Slaughter weight (kg)	590	595	603
Carcass weight (kg)	311	310	327
Kill-out (g/kg)	527	521	542
Conformation	2.21	1.97	2.61
Fat score	3.39	3.23	3.46
Carcass Composition			
Fat (g/kg)	200	195	195
Muscle (g/kg)	600	598	604
High value muscle[c]	395	389	396

[a]Holstein x (Holstein x Friesian) [b]MRI x Friesian [c]g/kg muscle

Carcass classification and composition

The main purposes of a carcass classification scheme are (a) to serve as a common language for the visual description of carcasses, (b) to facilitate the administration of various schemes (i.e. intervention), and (c) to provide a basis for differential pricing of carcasses. Proponents and administrators of carcass classification schemes do not claim that such schemes necessarily discriminate between carcasses of different muscle proportions and muscle distribution. The classification schemes are provided to describe traits which those involved in trading and marketing of beef carcasses believe need to be described. However, many producers and many of those involved in the provision of technical information and services to the cattle and beef industry believe that beef carcass classification does discriminate between carcasses on the basis of real quality and value.

When the original Irish carcass classification was established a large number of carcasses were boned out and fat trimmed to determine the meat yields for each cell of the classification grid. Later when the common EC scheme (EUROP) was adopted, the data for the Irish scheme were converted to the EC scale. These are shown in Table 10. Very few carcasses occurred in conformation class E or in fat class l, so these classes have been omitted. Averaged across the four fat classes (2 to 5), mean meat proportion declined from 712 to 662 g/kg or a mean decrease of 16.7 g/kg per class increase in fatness. There was a trend towards a greater difference in meat proportion between fat class as conformation improved. Averaged across the four conformation classes (U to P) meat yield declined from 698 to 681 g/kg or a mean decrease of 5.7 g/kg per conformation class. When examined more closely it is clear that there was virtually no difference in meat yield between conformation class "R" and "O" and over 75% of all Irish steer carcasses fall into these two conformation classes. In brief, therefore, the Irish data relating carcass classification to composition showed that fat score was three times as important as conformation score in determining the meat yield of a carcass and for the majority of Irish carcasses (conformation classes "R" and "O") conformation had no significant influence on meat yield.

From research in Great Britain by the Meat and Livestock Commission (MLC) and also at Grange it has become clear that any relationship between conformation and composition depends on the mix of breed types involved. Some breed types have both good conformation and high meat yields while others have both poor conformation and low meat yields. In cattle populations where only these two distinct types occur, then conformation is closely asso-

Table 10
Meat yields (g/kg) by carcass class

Fat	Conformation				
Class	U	R	O	P	Mean
2	736	710	705	696	712
3	703	700	697	690	698
4	684	677	678	657	674
5	670	660	656	----	662
Mean	698	687	684	681	

Coleman, 1984 (personal communication)

Table 11
Proportions of muscle and higher value muscle by conformation class and breed type

Conformation class	R		O	
Breed Type	B. Blue	MRI	MRI	Friesian
No. carcasses	26	16	13	24
Muscle (g/kg carcass)	648	604	589	593
High value muscle[a]	404	398	390	394

[a]g/kg muscle

ciated with meat yield. In practice however, cattle populations are comprised of a wide range of breed types. In addition to the two distinct types mentioned above there are also breed types which have reasonably good conformation but have rather low meat yields and there are breed types which have relatively poor conformation but have fairly high meat yields. Thus, any relationship between conformation and meat yield depends on the relative proportions of these different breed types in the population. This is evident from some recent results from a Grange experiment which compared Friesians with Belgian Blue x Friesians and MRI x Friesians.

The data in Table 11 show the comparison by conformation class and breed type. Belgian Blue crosses were predominantly "R" while Friesians were predominantly "O". Muscle proportions for the two breed types/conformation classes were 648 and 593 g/kg, respectively while high value muscle proportions were 404 and 394 g/kg, respectively. Thus, on the basis of this comparison between the Belgian Blue crosses ("R") and the Friesians ("O") it would be concluded that there was a big difference between the two conformation classes ("R" and "O") in muscle proportion and in high value muscle.

Unlike the Belgian Blue crosses and Friesians where each breed type fell into a different conformation class, the MRI crosses fell almost half and half into the same two classes. Including the MRI crosses helps to establish whether the differences in composition between the Belgian Blue crosses and the Friesians was due to breed type or to conformation class. There was essentially no difference between the "R" and "O" MRIs in muscle proportion and while there was some difference in high value muscle proportion it seems to have been largely due to chance because the value for the Friesians was midway between the two MRI values. In brief, if there had only been Belgian Blue crosses and Friesians then there would have been big differences in composition between the "R" and "O" conformation classes, whereas if there had only been MRIs, there would have been little or no difference. Thus, the differences in carcass composition between the conformation classes was a function of the mix of breed types involved and independent of breed type, conformation is a poor if not worthless indicator of carcass composition, muscle distribution or real carcass value.

Table 12
Proportions of muscle and higher value muscle by fat class and breed type

Fat class	3			4L		
Breed Type	B. Blue	MRI	Friesian	B. Blue	MRI	Friesian
No. carcasses	20	15	17	7	14	11
Muscle (g/kg)	652	610	601	626	584	578
High value muscle[a]	405	395	395	400	393	395

[a]g/kg muscle

The proportions of muscle and higher value muscle as affected by fat class (for fat classes 3 and 4) are shown in Table 12. On average the difference between the two fat classes were 25 g/kg muscle and 2 g/kg higher value muscle. The proportion of higher value muscle would not be expected to be influenced by fat class. As with conformation, there was a breed effect. There was little difference in composition between the MRI crosses and the Friesians in either fat class, but the Belgian Blue crosses had 46 g/kg more muscle and 10 g/kg more high value muscle in fat class 3 than the mean of the MRI crosses and Friesians. The corresponding values for fat class 4L were 45 g/kg more muscle and 6 g/kg more high value muscle. In brief, there was an effect of fat class on muscle proportion but the difference between breeds within a fat class was greater than the difference between fat classes.

The mean proportions of muscle and higher value muscle together with the ranges around these means for the four most important classification cells (03, 04L, R3, R4L) are shown in Table 13. As would be expected from the foregoing discussion, the differences between the means were not very large but the ranges around the means were very large and overlapped considerably. For example, the muscle proportion in R4L ranged from 525 to 656 g/kg. This covered the entire range found in 03 (555-621), practically the entire range found in 04L (521-632) and most of the range in R3 (596-682). Therefore, classification did not really discriminate between carcasses on the basis of muscle proportion. There was also a very large range in proportion of higher value muscle. Again the range found in class R4L (371-428) covered the entire ranges found in R3 (378-420) and 04L (373-421) and most of the range found in 03 (359-424). In brief, it is concluded that carcass classification is a very poor indicator of muscle proportion and higher value muscle proportion.

While the foregoing tables and discussion clearly show that carcass classification is an unreliable indicator of carcass composition, it is nevertheless necessary to give statistical expression to this. Consequently, the relevant elements of composition were regressed on fat score and on conformation score separately (Table 14). Both fat proportion and muscle proportion were significantly related to fat score. On average fat proportion increased by 31 g/kg and muscle proportion decreased by 25 g/kg per unit increase in fat class.

However, while these relationships were statistically significant, fat score

Table 13
Proportions of muscle and high value muscle by conformation and fat class

Conformation class	O		R	
Fat class	3	4L	3	4L
No. carcasses	26	12	26	20
Muscle (g/kg) - mean	596	581	625	597
- range	555-621	521-632	596-682	525-656
High value muscle - mean	393	392	405	397
- range	359-424	373-421	378-420	371-428

explained only one-third of the variance in fat proportion and only one-half in muscle proportion.

Conformation score was not significantly related to fat proportion, muscle proportion, high value muscle proportion or muscle size (*l. dorsi* area). The only element of composition significantly related to conformation score was bone proportion which decreased by 10 g/kg per unit improvement in conformation. In brief, it is concluded that fat score was significantly related to fat and muscle proportions but accounted for only one-third to one-half of the variance. Conformation score was not significantly related to any carcass trait except bone proportion which declined with improving conformation.

Conclusions

1. Carcass weight as a proportion of empty bodyweight was 588, 594 and 602 g/kg for Friesians, Hereford x Friesians and Charolais x Friesians, respectively. Corresponding kill-out proportions (cold carcass weights as a proportion of unfasted final farm weight) were 533, 543 and 553 g/kg. Kill-out proportion increased by about 10 g/kg per 100 kg increase in slaughter weight.

2. As carcass weight increased, the proportions of bone and muscle decreased and the proportion of fat increased, but the rates of these changes differed between breed types.

Table 14
Regressions of compositional variables on fat score and on conformation score

	Fat score				Conformation score			
Variable	b[a]	s.e.	Sig	Var[b]	b[a]	s.e.	Sig	Var[b]
Fat (g/kg)	30.7	9.35	***	0.33	8.0	10.50	NS	0.18
Muscle (g/kg)	-25.2	7.19	***	0.54	2.1	8.26	NS	0.37
Bone (g/kg)					-10.2	3.68	**	0.15
High value muscle					3.2	3.20	NS	0.07
L. dorsi area (cm^2)					46.2	23.2	NS	0.32

[a]Linear regression coefficient   [b]Proportion of variance accounted for

3. Compared with Friesians at 320 kg carcass weight, Hereford crosses were about 30 kg carcass weight lighter at the same carcass fat proportion. Corresponding differentials for MRI, Limousin, Simmental, Charolais, Blonde d'Aquitaine and Belgian Blue crosses were 10, 40, 60, 90, 100 and 110 kg carcass weight heavier.

4. Breed types differed in muscle distribution across the carcass. Continental type cattle had a higher proportion of higher value muscle than Friesians and early maturing breed types, while Friesians had a higher proportion than the early maturing types notwithstanding the fact that the latter had better conformation.

5. Mean muscle chemical composition was about 720 g/kg moisture, 220 g/kg protein, 50 g/kg lipid and 10 g/kg ash. Chemical composition varied between joints of the carcass, lipid concentration was lowest for the *l. dorsi*, hind limb and fore limb and was highest for the flank, thorax and ribs.

6. At any carcass weight, Hereford crosses had the highest muscle lipid concentration followed by MRI crosses, Friesians, Limousin, Simmental, Charolais, Blonde d'Aquitaine and Belgian Blue crosses. The differences in carcass weight between breeds at similar muscle lipid concentration were less than at similar carcass fat proportion.

7. Early maturing breed type steers and heifers had similar proportions of carcass fat when the heifers were about 50 kg carcass weight lighter than the steers. Despite being about one half class poorer in conformation, heifers had a slightly higher muscle proportion and a considerably higher proportion of higher value muscle than steers. Despite big differences in carcass conformation there was little difference in carcass composition between Friesians, Holsteins and MRI crosses.

8. In the Irish cattle population, fat score is three times as important as conformation in indicating muscle proportion but both are poor indicators of same. Any relationship between conformation and muscle proportion depends on the breed mix involved but generally there is no such relationship.

9. The range in muscle proportion for classes O3, O4L, R3 and R4L was 555 to 621, 521 to 632, 596 to 682 and 525 to 656 g/kg, respectively. Clearly classification grade is a poor indicator of muscle proportion.

10. Fat score was significantly related to both fat proportion and muscle proportion but accounted for only one third to one half of the variance in these.

Conformation score was not significantly related to muscle proportion, fat proportion, high value muscle proportion or muscle size. Its only statistical relationship was with bone proportion.

Exploitation of Beef Breed Differences

M. G. KEANE
Teagasc, Grange Research Centre, Dunsany, Co. Meath.

The reformed Common Agricultural Policy has introduced a quota on suckler cow and male cattle numbers for premia payments and has set maximum stocking densities for premia eligible animals. Therefore, the best opportunity for further increases in productivity and efficiency in beef production lies in the full exploitation of the range of beef breeds available. The main productivity differences between the various beef breeds have been described previously (Keane, 1990). The purpose of this paper is to quantify these differences in greater detail, and to include additional information on carcass composition and quality differences. The topics discussed here are (1) trends in sire breed usage, (2) calving traits by sire breed, (3) relative productivity of progeny from different sire breeds, (4) ranking of approved bulls across breeds, (5) carcass composition and quality, and (6) carcass classification.

Trends in sire breed usage

The distribution of inseminations by sire breed since 1985 is shown in Table 1. With the exceptions of 1987 and 1991, when they fell to 32%, Friesian inseminations have remained constant at 37% to 39%. Aberdeen Angus inseminations have also remained constant at 9% to 10%. The consistent trend has been the substitution of the continental breeds for the Hereford. Hereford inseminations declined from 32% in 1985 to 8% in 1992 while in the same period continental inseminations increased from 19% to 42%. Within the continentals there have also been changes. In the mid 1980s, the proportions of Charolais, Simmental and Limousin inseminations were similar. Since then, Simmental inseminations have remained constant at about 10%, Limousin inseminations have increased slightly to about 12% while Charolais inseminations have more

Table 1
Distribution of inseminations by sire breed for years 1985-1992

Sire Breed	1985	1986	1987⁺	1988	1989	1990	1991	1992
Friesian	38	37	32	39	37	38	32	39
Angus	9	9	9	10	10	10	9	9
Hereford	32	28	25	18	18	15	14	8
Charolais	7	7	10	10	11	13	17	17
Simmental	7	8	9	9	9	10	11	9
Limousin	5	9	12	11	11	10	12	12
B. Blue	-	-	1	1	2	2	3	4
Other	2	2	2	2	2	2	2	2

⁺For 9 months to September 30

Table 2
Distribution of inseminations by breed type for Ireland and Great Britain for years 1986 and 1992

Area	Rep. Ireland		N. Ireland		Scotland		Eng.+Wales	
Year	86	92	86⁺	92⁺⁺	86⁺	92⁺⁺	86⁺	92⁺⁺
Friesian	37	39	27	32	49	52	48	56
Angus	9	9	6	5	4	3	3	3
Hereford	28	8	4	2	3	1	10	3
Charolais	7	17	7	15	7	11	9	9
Simmental	8	9	26	20	6	8	3	5
Limousin	9	12	20	7	15	12	18	10
B. Blue	-	4	-	5	6	3	4	7
Blonde	-	-	-	9	1	2	1	2
Other	2	2	10	5	9	8	4	5

⁺86/87 ⁺⁺91/92

than doubled to 17%. Belgian Blue inseminations have increased from 0 to 4%. Friesian inseminations are determined by the need to provide replacement heifers for the dairy herd, and Angus inseminations appear to be determined by the suitability of the breed for use on heifers. Thus, the only real opportunity for change is substitution amongst the beef breeds, and there has been large scale substitution of continentals for Hereford in recent years.

In addition to the national trend it is also of interest to examine the trends for neighbouring regions and countries (Table 2). Both England plus Wales and Scotland have a higher proportion of Friesian inseminations than Ireland (Republic and North). Despite the decline mentioned above, the Hereford is still more widely used here (8%) than in England plus Wales (3%), Scotland (1%) and Northern Ireland (2%). The Angus is still more widely used here also (9%) than in Northern Ireland or Britain (3%-5%). Thus, early maturing breed inseminations have fallen to 7% in Northern Ireland, 6% in England plus Wales and to 4% in Scotland compared with 17% here. Amongst the continentals, Limousin inseminations are fairly consistent between regions but there are big differences in Simmental usage which ranges from 5% in England plus Wales to 20% in Northern Ireland. Northern Ireland has 15% of Charolais inseminations compared with 9% in England plus Wales and 11% in Scotland. Northern Ireland is also the only region where the Blonde d'Aquitaine is fairly widely used (9%). To date all regions have similar usage of Belgian Blue (4%-7%).

Since inseminations account for only 50%-60% of total matings and since more dairy cows are bred by artificial insemination (AI) than suckler cows, the distribution of inseminations does not necessarily reflect the distribution of total matings. Unlike AI, there is no national record of natural matings and the only way an estimate of natural matings can be obtained is by survey. Such a survey was undertaken recently (Drennan and Power, 1992) and the distribution of AI

Table 3

Comparison of sire breed distribution in AI matings alone and total matings for 1992

Sire Breed	AI	Total
Friesian	39	28
Angus	9	6
Hereford	8	15
Charolais	17	20
Simmental	9	11
Limousin	12	13
B. Blue	4	2
Other	2	5

and total matings is shown in Table 3. Friesian and Angus constitute smaller proportions of total matings than of total inseminations, and the remaining breeds constitute proportionately more. Amongst the latter, the Hereford shows the greatest difference between AI (8%) and total matings (15%). The three main continental breeds follow the same trend in AI and total matings (17%, 9% and 12%, and 20%, 11% and 13% for Charolais, Simmental and Limousin, respectively). Practically all Belgian Blue matings appear to have been by AI.

From the breed distribution of total matings, the breed composition of the national calf crop for 1993 was predicted and compared with previous years (Table 4). Prior to 1985 Friesians and Herefords tended to substitute for each other (i.e. when Friesians decreased Herefords increased and vice versa). Since then however, continentals have substituted for both Friesians and Herefords. From 1985 to 1993 Friesian, Angus and Hereford combined decreased from 82% to 49%, while continentals (including "other") increased from 18% to 51%. Thus, the national calf crop for 1993 consists approximately of 30% Friesians, 20% early maturing breed types and 50% continental breed types with the Charolais constituting 20% of the latter.

Table 4

Estimated breed composition of the national calf crop for 1980, 1985 and 1993

Sire Breed	1980	1985	1993
Friesian	62	40	28
Angus	1	6	6
Hereford	20	36	15
Charolais	5	7	20
Simmental	4	6	11
Limousin	2	3	13
Other	6	2	7

Calving traits by sire breed

Factors which have a major influence on the breed of bull used particularly in dairy herds are the incidence of calving difficulty, calf mortality and gestation length. These are shown in Table 5 for the different sire breeds. In brief, there is little difference in these traits between the Friesian, Angus and Hereford breeds. For these the mean serious calving difficulty percentage is 2.1, the mean calf mortality percentage is 1.6 and the mean gestation length is 281 days. In contrast, the continentals have mean calving difficulty, calf mortality and gestation length values of 4.9%, 2.3% and 285 days, respectively. There are some differences in these traits amongst the continental breeds but they are not very large–Charolais has the highest (5.6%) and Limousin has the lowest (4.4%) calving difficulty incidence, Belgian Blue has the highest (3.0%) and Blonde d'Aquitaine has the lowest (1.2%) calf mortality and Belgian Blue has the shortest (283 days) and Blonde d'Aquitaine has the longest (287 days) gestation length.

Table 5
Incidence of calving difficulty, calf mortality and gestation length for different sire breeds

Sire Breed	Calving Difficulty (%)$^{+}$	Calf Mortality^{++}	Gestation Length
Friesian	1.7	1.7	281
Angus	2.4	1.4	281
Hereford	2.3	1.8	282
Charolais	5.6	2.4	285
Simmental	4.6	2.3	285
Limousin	4.4	2.5	286
Blonde	4.7	1.2	287
B. Blue	5.0	3.0	283

$^{+}$Serious $^{++}$Within 48 hrs

Relative productivity of progeny from different sire breeds

In Ireland, data on the productivity of the different breed crosses for beef production are available from two sources - the Breed Characterisation Research Programme at Grange Research Centre and the Beef Progeny Test Programme at the Department of Agriculture and Food. The Breed Characterisation Research Programme provides data on a range of traits from feed intake to muscle chemical composition, whereas the Performance Test data are confined to carcass gain and carcass grades. Where both programmes generate data on the same traits these data should be similar and the combined results from both programmes should be more accurate for these traits than the individual results. The data from the two programmes for carcass gain, carcass conformation and carcass fat score are shown in Table 6. Because the Breed Characterisation Programme has not included the Angus and the Progeny Test Programme has no data yet on the MRI and Belgian Blue, there is no comparison for these breeds.

Table 6
Comparision of relative breed (FR=100) performance in the breed characterisation and progeny test programmes

Trait	Carcass Gain		Conformation		Fat Score	
	Br. Char.⁺	Prog. Test⁺⁺	Br. Char.	Prog. Test	Br. Char.	Prog. Test
Friesian	100	100	100	100	100	100
Angus	-	99	-	127	-	119
Hereford	104	104	123	127	125	125
MRI	105	-	118	-	102	-
Limousin	104	105	136	146	103	100
Blonde	107	109	132	132	91	84
Simmental	109	107	140	146	103	100
B. Blue	109	-	138	-	91	-
Charolais	111	111	143	141	94	97

⁺Beef Breed Characterisation Research Programme at Grange
⁺⁺Department of Agriculture and Food Beef Progeny Test Programme (Source Approved AI Beef Bull List, 1993).

Otherwise, all comparisons for carcass gain show remarkably good agreement and are within two percentage points. The only difference of any consequence is the change in ranking of the Simmental and Blonde d'Aquitaine between the two programmes. There is also very good agreement between the two programmes in the ranking for carcass conformation and fat score.

The different sire breeds are ranked for various traits in Table 7. The carcass weight for age ranking is the mean of the Breed Characterisation Programme

Table 7
Ranking of progeny from different sire breeds and Friesian cows

Sire Breed	Sl. Wt./ Age	K.O.	Car. Wt./ Age⁺	Muscle Wt./ Age	Muscle Size	Higher Value Muscle
Friesian	100	100	100	100	100	100
Angus	96	102	99	94	100	100
Hereford	102	102	104	100	102	100
MRI	102	103	105	106	107	100
Limousin	99	105	105	111	118	103
Blonde	102	105	108	117	119	103
Simmental	106	103	108	115	118	102
B. Blue	104	105	109	119	122	102
Charolais	107	104	111	118	123	103

⁺Mean of Breed Characterisation and Progeny Test Programmes. All other traits are from Breed Characterisation Programme only.
Sl. Wt. = Slaughter Weight; K.O. = Killing-out Proportion; Car. Wt. = Carcass Weight.

and the Progeny Test Programme but all other trait rankings are from the Breed Characterisation Programme only, as these traits are not reported for the Progeny Test Programme. Other than the Angus progeny which had a lower value, there was little difference in slaughter weight for age between the Friesian, Hereford, MRI, Limousin and Blonde d'Aquitaine progeny while the Simmental, Belgian Blue and Charolais progeny were 4% to 7% superior to these. All beef crosses had higher kill-out values than Friesians with the continentals having higher values than the traditional beef breeds. Carcass weight for age differed little between the Friesian and Angus progeny. Hereford, MRI and Limousin progeny were 4%-5% superior while the Blonde d'Aquitaine, Simmental, Belgian Blue and Charolais progeny were 8%-11% superior.

Some carcass quality traits are also shown in Table 7. At the same age, Angus progeny produced 6% less muscle than Friesian and Hereford progeny produced only the same quantity of muscle even though they had 4% greater carcass weight. MRI progeny produced 6% more muscle in line with their 5% superior carcass weight, indicating essentially no difference in carcass composition between the Friesians and MRI crosses. All continentals produced 11%-19% more muscle than Friesian and Hereford progeny, with the Limousin progeny at the lower end of this range and the Belgian Blue and Charolais progeny at the upper end. Muscle size paralleled muscle weight for age. There was no difference between the Friesian, Angus, Hereford and MRI progeny in the proportion of higher value muscle. The continentals had 2%-3% more of their muscle as higher value muscle.

Table 8

Ranking of approved bulls across breeds for growth rate

Breed	Bull Code	RBV+	ABV++	Carcass weight (kg)+++
Angus	COO	104	104	306
	MLI	113	113	320
Hereford	UKF	101	109	314
	GSE	117	127	341
Limousin	SKZ	103	114	321
	PEB	119	131	347
Simmental	SMR	106	121	330
	SUE	118	136	354
Charolais	TFY	102	125	338
	IC27	115	141	362
Friesian	DGM	94	95	293
	DDB	106	107	311

+Relative Breeding Value as shown on the Approved Bull List (1993)

++Adjusted Breeding Value based on mean of Angus breed = 100

+++Assuming a carcass weight of 300 kg for mean of Angus breed progeny out of Friesian cows

Ranking of approved bulls across breeds

The Approved A.I. Beef Bull List (1993) compiled by the Department of Agriculture and Food shows the breeding value of bulls relative to the mean of their own breed (RBV). In addition, breed means from the Beef Progeny Test Programme are also published. From these two sources a ranking of all the approved bulls can be compiled across breeds. This is shown for selected bulls (generally the best and poorest for growth rate within a breed) in Table 8. To generate such a ranking some base must be assumed. For the present purposes the base taken was the mean of the Angus breed. Thus, the ranking of the two Angus bulls selected (COO and MLI) did not change. To calculate the differences in carcass weight between the progeny of the various bulls, it was also assumed that the progeny of Friesian cows mated to Angus bulls of the breed mean value for growth rate, would have a carcass weight of 300 kg when slaughtered at around two years of age. The carcass weights of the progeny of the other bulls were calculated relative to this. (It should be kept in mind that only half of the difference in breeding value of a bull is passed on to his progeny).

While the ranking of the Angus bulls did not change (because the baseline taken was the mean of the Angus breed), the breeding values of the bulls of all the other breeds did change when expressed relative to the mean of the Angus breed. For example, Hereford GSE which has an RBV of 117 relative to its own breed mean has an adjusted breeding value (ABV) of 127 relative to the mean of the Angus breed. Similarly, Limousin PEB and Charolais IC27 which have RBVs of 119 and 115, respectively, have ABVs of 131 and 141 relative to the mean of the Angus breed. Translated into differences in carcass weight at a constant age, GSE is +41 kg, PEB is +47 kg and IC27 is +62 kg. These values indicate the enormous potential in productivity that exists both between and within breeds.

Carcass composition and quality

In the foregoing discussion, it was assumed that all breed types were slaughtered at a constant age of about two years. This was necessary to emphasise the magnitude of the differences between breeds and between bulls within a breed. In practice however, animals of the different breed types are generally slaughtered at different ages and weights, although, there is an acceptable range in composition, generally defined in terms of fatness, within which carcasses must fall. It is widely believed that some breed types are leaner or fatter than others. This is so only when expressed on an age or weight constant basis. The reason for such age or weight constant differences in composition is that the three main carcass tissues (muscle, fat and bone) have different relative growth rates in the different breed types. Thus, at any constant end point there are differences in composition, but if the end point is allowed vary with breed type then all breed types can have similar composition or at least can have similar proportions of carcass fat. This is illustrated in Table 9 where the proportions of carcass fat at 280, 340 and 400 kg carcass weight is shown for the progeny of the different sire breeds and Friesian cows. With increasing weight, the proportion of fat in the carcass increased for all breed types but it increased more rapidly for some breed types than for others. For example, over the carcass weight range 280 to 400 kg the fat concentration of Hereford cross carcasses increased by 100 g/kg, compared with 70 g/kg for Charolais crosses. Examination of the data shows that Hereford and Charolais crosses had similar carcass fatness at carcass weights of 280 and 400 kg, respectively. Similarly, Friesians and Simmental crosses had similar carcass fatness at carcass weights of 340 and 400 kg, respectively as did Limousin and Belgian Blue crosses. It can be calculated that Friesians of 320 kg carcass weight had similar carcass fatness (205 g/kg) to Hereford crosses at 280 kg and Charolais crosses at 400 kg. Clearly therefore, all breed types can be of similar fatness if slaughtered at the appropriate carcass weight. In the context of exploiting the potential of the different breed types, substitution of the Hereford by the Limousin, Charolais and Belgian Blue would permit increases in carcass output at constant carcass fatness of proportionately 0.27, 0.43 and 0.50, respectively. With quotas on cattle numbers, this is a means through which producers can increase output and productivity.

With regard to the proposed 340 kg carcass weight intervention limit, it is worth noting that the intermediate weight in Table 9 is 340 kg. Where carcass composition or fatness is important, a single carcass weight limit is not appropriate to a beef industry which was a range of breed types. At 340 kg, carcass fat proportion ranged from 162 g/kg for Belgian Blue crosses to 255 g/kg for Hereford crosses. There is no suggestion in the data that any of the breed types had insufficient fat for general market purposes at 340 kg carcass weight.

After the composition of the carcass, the next most important quality issue is the chemical composition of the muscle. The mean chemical composition of beef muscle from the *L. dorsi* is approximately 720 g/kg moisture, 220 g/kg protein, 10 g/kg ash and 50 g/kg lipid (fat). (The term lipid is used here to describe the fat which is chemically extracted from the muscle and to differentiate between this chemically determined fat and the separable fat of the carcass). The lipid concentration of *L. dorsi* muscle at 280, 340 and 400 kg carcass weight

Table 9

Carcass fat proportion (g/kg) by breed type⁺ and carcass weight

Carcass weight (kg)	280	340	400
<u>Sire Breed</u>			
Friesian	181	225	268
Hereford	205	255	305
MRI	178	218	258
Limousin	155	195	235
Blonde	127	162	197
Simmental	148	186	224
B. Blue	129	162	195
Charolais	135	170	205

⁺Friesian dams

Table 10
***L. Dorsi* lipid concentration (g/kg) for different carcass weights and breed types**

Carcass weight (kg)	280	340	400
Sire Breed			
Friesian	22	43	67
Hereford	26	50	77
MRI	22	46	73
Limousin	20	35	53
Blonde	16	25	37
Simmental	18	30	45
B. Blue	16	25	37
Charolais	16	28	43

⁺Friesian dams

is shown for the various breed types in Table 10. As with separable fat proportion, lipid proportion increased with increasing carcass weight and did so more rapidly for some breeds than for others. For example, over the carcass weight range 280 to 400 kg, lipid concentration increased by 51 g/kg for Hereford progeny compared with an increase of only 21 g/kg for Belgian Blue progeny. The difference between breed types in carcass weight at similar *L. dorsi* lipid concentration was less than the difference at similar carcass fat proportion. For example, Hereford and Charolais crosses had similar muscle lipid concentration at carcass weights of 280 and 340 kg, respectively compared with carcass weights of 280 and 400 kg for similar carcass fat proportion. Similarly, Friesians and Charolais crosses had similar muscle lipid concentrations at 340 and 400 kg, respectively compared with carcass weights of 320 and 400 kg for similar carcass fat proportion. In the context of the 340 kg carcass weight limit for intervention, it is again apparent that there were very large differences between breeds in muscle lipid concentration at this carcass weight. For example, the lipid concentration of Hereford progeny muscle was double that of Blonde d'Aquitaine and Belgian Blue progeny muscle.

Carcass classification

Carcass classification is a widely discussed topic in beef production, but there is some confusion on what its real purpose is. The most commonly cited purpose is to serve as a common language amongst the various sectors of the beef industry (producers, processors, wholesalers, butchers, etc.), but what such a common language is supposed to describe has not been defined. There is a widespread belief that the classification score indicates the real quality and true value of a carcass but this is not necessarily so. Two carcasses with similar classification scores could be very different in quality and value while two carcasses of similar quality and value could have very different classification scores. Attempts to evaluate the usefulness of classification are hampered by the fact that the grading is subjective, and there are no objectively measurable parameters which correspond to the subjective grades.

Intuitively, carcass fat score would be considered a predictor of the proportion of fat in the carcass. Furthermore, it would be expected that the interval between one class and the next would be the same for all classes and thus, that changing fat score would represent a constant rate of change in carcass fat proportion. While it is generally believed that increasing fat score does indicate increasing carcass fatness, there is nothing to indicate what proportion (or range in proportions) of carcass fat is indicated by any particular fat score or what a change in fat score represents in terms of changing carcass fat proportion.

The relevance of conformation score is even more obscure than that of fat score. One or more of the following traits are generally believed to be indicated by conformation - muscle proportion, muscle and fat proportion, bone proportion, muscle/bone ratio, muscle size and muscle distribution (e.g. proportion of muscle in the hind-quarter or in the higher value joints). Because cattle are generally slaughtered within a fairly narrow range of fatness and conformation, it is difficult to find a data set where both carcass classification and carcass composition were measured over a usefully wide range. However, a recent data set from Grange does have both composition and classification measured on 96 carcasses varying in fatness and conformation.

The relationships between fat class and the proportions of fat and muscle in the carcass are shown in Table 11. Total fat proportion increased by 31 g/kg per unit increase in fat class. While these changes were statistically significant, the proportions of variance explained by the regressions were quite low indicating that while fat score was related to carcass fat proportion, it was nevertheless a poor indicator of carcass fat proportion.

In contrast to fat score, which although poorly related, was nevertheless related to compositional traits, conformation was related to bone proportion only and even then it explained only 15% of the variation in bone proportion (Table 12). Conformation was not significantly related to muscle proportion, fat proportion, muscle size or the proportion of muscle in the higher value joints. For all practical purposes therefore, conformation had no relationship with actual carcass composition or real carcass value.

Table 11

Regressions of carcass composition (g/kg) on carcass fat score

	b value	Significance	% Variation[+]
Subcutaneous fat	18.3	***	32
Intermuscular fat	12.4	*	27
Total fat	30.7	**	33
Muscle	-25.2	***	54
Lipid in *L. dorsi*	10.6	*	17

[+]Explained by regression model

Table 12
Regressions of carcass composition (g/kg) on conformation score

	b value	Significance	% Variation+++
Muscle	2.1	NS	37
Bone	-10.2	**	15
Fat	8.0	NS	18
L. dorsi area+	4.6	NS	32
L. dorsi area++	-0.005	NS	14
High value muscle	3.2	NS	7

+cm^2 ++cm^2/kg carcass +++Explained by regression model

The reason why classification score is a poor indicator of composition and value is evident from the data in Table 13 which shows the range in fat and muscle proportions and proportion of higher value muscle for the classes 04L, 03, R4L and R3. For R4L, fat proportion ranged from 161 to 305 g/kg. This range covered all of the 03 range and most of the R3 and 04L ranges. For 04L, muscle proportion ranged from 521 to 632 g/kg, for 03, it ranged from 555 to 621 g/kg, for R4L, it ranged from 525 to 656 g/kg, and for R3, it ranged from 596 to 682 g/kg. Therefore, except for the upper end of the R3 range, all the carcasses could have fitted within the R4L muscle range. Similarly, for the proportion of higher value muscle, except for the upper end of R4L, all carcasses could have fitted within the 03 higher value muscle range. These data demonstrate that classification did not reasonably differentiate between carcasses on the basis of either fat proportion, muscle proportion or proportion of muscle in the higher value joints.

As the carcasses in question came from 3 breed types - Friesians (FR), MRI x Friesians (MR) and Belgian Blue x Friesians (BB), it was of interest to examine the relationship between fat score and carcass fat proportion within breed type

Table 13
Fat, muscle and higher value muscle proportions (g/kg) by class

Class	O4L	O3	R4L	R3
No. carcasses	12	26	20	26
Fat	208	206	217	163
Range	150-294	164-255	161-305	127-221
Muscle	581	596	597	625
Range	521-632	555-621	525-656	596-682
High value muscle	392	393	397	405
Range	373-421	359-424	371-428	378-420

Table 14
Fat proportion (g/kg) by fat class and breed type

Fat class	3			4L		
Breed type+	FR	MR	BB	FR	MR	BB
No. carcasses	17	15	20	11	14	7
Fat (g/kg)	205	188	157	228	210	198
Range	164-255	150-251	127-242	150-305	161-289	164 233

+FR = Friesian, MR = MRI x Friesian, BB = Belgian Blue x Friesian

(Table 14). At both fat classes 3 and 4L, FR had a higher proportion of fat than MR which in turn had a higher proportion of fat than BB. There is no obvious explanation why the relationship between fat class and carcass fat proportion should vary with breed type. Muscle proportion varied also with breed type at constant fat class, but the differences between FR and MR in muscle proportion and proportion of higher value muscle were quite small, whereas the differences between these two and BB were quite large at any particular fat class.

As well as differing at constant fat class, breeds also differed at constant conformation class (Table 15). Since there were few BB animals in conformation class O and few FR animals in conformation class R, the comparison at each conformation class involves only two breed types. At conformation class O there was little difference between FR and MR but at conformation class R, BB had 36 g/kg less fat and 44 g/kg more muscle than MR. Thus, there was a much greater difference between breeds within a single conformation class than between the means for different conformation classes.

There are many reasons why fat class might not be a good predictor of carcass fat proportion (differences between graders, variations in grading with prevailing levels of fat and type of cattle, disturbance of fat by the operation of the hide puller), but obvious reasons are that less than 50% of the total fat is

Table 15
Fat, muscle and higher value muscle proportions (g/kg) by conformation class and breed type

Conformation class	O		R	
Breed Type+	FR	MR	MR	BB
No. carcasses	24	13	16	26
Fat	211	196	201	165
Muscle	593	586	604	648
Higher value muscle	394	390	398	404

+FR = Friesian, MR = MRI x Friesian, BB = Belgian Blue x Friesian

Table 16
Subcutaneous fat as a proportion (g/kg) of total carcass fat by breed type+ and carcass weight

Carcass Weight (kg)	280	340	400
Friesian	424	454	484
Hereford	445	476	507
MRI	424	450	476
Limousin	418	441	464
Blonde	416	442	468
Simmental	410	439	468
B. Blue	414	436	458
Charolais	406	435	464

+Friesian dams

subcutaneous fat which is visible to the grader and also that subcutaneous fat is not a constant proportion of total fat. Variation in subcutaneous fat with breed type and carcass weight is shown in Table 16. At a carcass weight of 280 kg subcutaneous fat as a proportion of total fat ranged from 406 g/kg for Charolais crosses to 445 g/kg for Hereford crosses. With increasing carcass weight, subcutaneous fat as a proportion of total carcass fat increased until at 400 kg carcass weight it ranged from 458 g/kg for Belgian Blue crosses to 507 g/kg for Herefords. These variations suggest that the carcasses of early maturing breed types and heavy carcasses appear fatter than they actually are (because more of their total fat is visible) relative to carcasses of late maturing breed types and heavy carcasses.

References

Keane, M. G. (1990). Productivity of different steer breed types for beef production. Irish Grassland and Animal Production Association Journal, 24: 78-87.

Drennan, M. J. and Power, R. (1993). Breed composition of the National Catle Herd. Farm and Food, 3: 27-30.

Department of Agriculture, Food and Forestry (1993). Approved A.I. Beef Bull List. Published by Department of Agriculture, Food and Forestry.

Lambs from Grass

BARTLE and BRENDAN FLYNN
Mountnugent, Co. Cavan.

Land

Our farm is an all-grass farm of 86 map acres, adjusted to 70 acres and 10 acres are rented. Ten acres are fenced off for deer which leaves 70 acres for sheep. This land consists of a wet peaty soil on the flat and heavy soil on the hills. Thirteen acres were reclaimed from cut-away bog which floods during winter and in wet summers. As a result some constraints arise: early grass is difficult to produce on this farm; flock turnout in spring is delayed until late March and all sheep must be returned to the sheds before Christmas.

It is very good land for producing grass in dry summers. Last summer was difficult due to the wet, cold conditions.

Winter feeding

Ewes are housed on straw and meal feeding commences 8 weeks prior to lambing with 120 g per head per day increasing to 700 g for the last 3 weeks pre-lambing. From lambing to turnout nearly 1 kg per ewe per day is fed. The ration consists of a barley/beet pulp/soyabean mix (18% crude protein) and sheep minerals.

Lambing date

Lambing is from March 7 to mid-April during which there is 24 hour supervision. Fostering lambs on the ewes with single lambs is part of the system. Lambs are 2 weeks old when the flock is moved to grass. No meals are fed at grass post lambing or during the summer. Meals are introduced to light lambs remaining in late October but intakes are low until mid November.

GRASS SYSTEM

No. ewes:	Mature		353
	Ewe lambs		104
No. acres (adj)			70
S. Rate, no. ewes/acre			6.7
Litter size:	Mature ewes		2.27
	Ewe lambs		1.37
Lambs reared/ewe joined:		Mature	1.9
		Ewe lambs	0.9
Breeds: Ewes			Belclare cross
Rams			2 Belclare, 2 Vendeen, 9 Texel

Ram lambs

All ram lambs are left entire until October 1 and then all remaining ram lambs are castrated.

Sale dates

In 1993 we commenced selling lambs 2 weeks later than other years due to difficult weather conditions.

LAMB SALES

		No. lambs	Carcass wt. (kg)	Grades
1.	Mar./Apr.	116	–	Pet lambs
2.	Aug.	110 30	40 kg LWT 19.8	Breeding Premium
3.	Sept.	114	19.9	Premium
4.	Oct.	111	19.8	Premium
5	Nov.	126	19.9	123 Premium/3 fat
6.	Dec.	86	19. 5	84 Pemium/2 fat
7.	Jan.	65	–	To be sold in Jan.

GROSS MARGIN

Income per ewe		
1.9 lambs/ewe + 0.9 lambs/ewe lamb	57	
Wool	1	
Premium	20	
Headage on hoggets	2	80
Direct costs per ewe		
1. Fertilizers	4.66	
2. Silage	1.90	
3. Meals: 46 kg per ewe 955 kg for finishing light lambs	9.00 2.30 4.37	
4. Vet/medicine	5.50	
5. Depreciation	3.75	
6. Other: 5 straw bales, hay, sprays	0.70	32
Gross margin per ewe =	**£48**	
Gross margin per acre =	**£311**	

Our pattern of lamb sales is usually 2 weeks behind most sheep farmers: This is caused by several factors. Firstly, we have a coccidiosis problem. All our lambs are affected by it between 4 and 8 weeks of age. Mortality is negligible but growth rates are adversely affected. Secondly, we ensure that all our ewes are suckling 2 lambs if they have two sound teats. So, we have no 'single' lambs. Thirdly, we have a high percentage of triplets and quads which are slower to mature than singles or twins.

Buffer feed

Owing to our high stocking rate we are vulnerable to severe weather conditions. Hence, we always keep a full year's supply of silage on reserve to act as a buffer in these conditions.

Deer

Present Red Deer stock consists of 36 hinds, 16 calves and 1 stag.

Future

We feel that the carcass quality of our lambs is satisfactory. Last autumn we introduced a Suffolk and a Charollais ram into the flock for breeding purposes.

We intend to continue improving the milking ability of our ewes.

Systems of Early Lamb Production

S. FLANAGAN
Teagasc, Belclare Research Centre, Tuam, Co. Galway.

One of the principal difficulties in managing a high output grass-based system of early lamb production is the lack of grass growth during winter and early spring. This, in particular, limits the stock carrying capacity of permanent pastures. In the search for a resolution of this problem, two alternative systems have been developed at the Teagasc Sheep Farm, Knockbeg, Carlow based either on autumn sown Italian ryegrass or on fodder beet grown as a main crop. Both crops produce high quality feed at relatively low cost.

It will be shown in this report that these crops have a high feeding capacity for early lambing ewes and that, when properly supplemented with concentrates, the resulting lamb growth rates were sufficiently high to meet target sale dates for early marketing. Both systems were examined by using the farmlet system approach. Inputs and outputs were recorded in order to provide guidelines for feed budgeting and planned production. It is considered that the growing of I. ryegrass provides a useful option for all-grass farms which carry early lamb enterprises and which require silage conservation for livestock. Production of fodder beet is confined mainly to sugar beet growing areas where the technology for growing, harvesting and feeding the crop mechanically is well developed.

(1) ALL-GRASS SYSTEM

The research at Knockbeg involved grazing by flocks lambing in January 1988 and 1989. In preparation for this, Italian ryegrass (cv. Lemtal) was sown by direct reseeding in August 1987 at the rate of 40 kg per ha. Compound fertiliser (10:10:20) was applied at 250 kg per ha at time of sowing.

Ewes were housed in early December and fed silage *ad libitum* with concentrate supplements, commencing at the rate of 0.25 kg per ewe per day and increasing to 0.70 kg in the final two weeks before lambing. After lambing in 1988 the turnout of ewes and lambs to the I. ryegrass was delayed for three weeks due to unfavourable weather. During this time the ewes were fed silage *ad libitum* plus 1.6 kg concentrates per head per day. Lambs were introduced to creep feed at 1 week old. The turnout date was January 14. In 1989 ewes and lambs were turned out three weeks earlier, i.e. January 24. The number of lambs per ewe grazing was 1.33 in 1988 and 1.55 in 1989.

Pasture management

Ewes and lambs were turned out to the I. ryegrass in early February. The I. ryegrass was sub-divided into temporary paddocks using portable electric fencing. The aims of grazing management were to offer the pasture for grazing on an unrestricted basis and to optimise the conditions for achieving high lamb growth rates. Hence, ewes and lambs were moved to a new paddock whenever supplies in the paddock being grazed were considered limiting, i.e. when the sward height was grazed down to about 4 cm. This meant in practice that each paddock was grazed for 5-6 days. Concentrate supplements were trough fed at the rate of 0.5 kg per ewe per day for 5-6 weeks. Lambs were creep fed until they reached slaughter weight.

In both years, the first grazing of I. ryegrass was completed after 4 to 5 weeks, i.e. early March. The flock was then transferred to permanent pastures, mainly perennial ryegrass, which had been rested for the winter and dressed with 34 kg N fertiliser per ha on about February 1. The stocking rate on the permanent pasture in 1988 was high, 24 ewes per ha. However, this stocking rate was not supported solely on the permanent pasture, as whenever the I. ryegrass had recovered sufficiently, second and third grazings were taken. In order to provide for summer cuts of silage, the I. ryegrass pasture was closed in early April. From then until July, the flock was grazed exclusively on the permanent pasture, with the stocking rate declining regularly as lambs were drafted for slaughter during April and May.

Lambs were weighed and drafted at a standard body finish as assessed by handling for light-to-medium fat cover on the loin, rump and tail. They were weaned in mid-April and grazed selectively thereafter, while the ewes were mob stocked at 50 ewes per ha. Following silage cutting during summer, grazing of I. ryegrass was resumed in late July when ewes were flushed for a new production cycle.

Two years' results

Lamb performance and details of concentrate inputs are shown in Table 1. Lamb growth rates in early lactation, 315g/day in 1988 and 300g/day in 1989, met the requirements of early marketing as shown by the average age at slaughter, 92 days and 102 days in 1988 and 1989 respectively.

The amounts of I. ryegrass pasture on offer for grazing at turnout, as estimated by clips taken at ground level, were 1200 kg DM per ha in 1988, and 1600 kg in 1989.

Under the grazing conditions described above, the realised stocking rate was 16.8 ewes per ha when averaged over the two years. These results confirm the advantage of I. ryegrass for short-term grazing as a means of overcoming seasonal constraints in the supplies of permanent pasture, as occur in early spring.

Lamb growth rates from 5 weeks of age to slaughter were high, 346g and 334g/day in 1988 and 1989 respectively, and as a result, finished liveweights for slaughter were achieved at a young age, viz., 13 weeks on average in 1988. In 1989 it was decided to retain lambs for extended grazing in order to increase carcass weights. As a result, average carcass weight in 1989 was over 2kg heavier than in 1988 but the lambs were 10 days older at slaughter. In relation to maximising the financial returns from early lamb production, management must strike a delicate balance in this matter as the trade is characterised by falling prices following the initial peak in April.

Almost all lambs reached finished liveweights by June 1, the date around which mid-season supplies arrive on the market and the price falls by about 20 per cent.

The concentrate inputs shown in Table 1 provide guidelines for drawing up feed budgets for the production of early-season lambs under grazing conditions. Concentrate inputs for ewes were similar for both years but lambs consumed 45% more creep in 1989 than in 1988, due to being retained longer at grass before drafting.

Table 1

Lamb performance and concentrate inputs

	1988	1989
Period 1: 0-5 weeks	Italian ryegrass	
Grazing commenced	Feb. 14	Jan. 24
No. lambs	146	113
No. ewes per ha	17.3	16.3
Lamb birth weight, kg	4.1	4.5
Lamb growth rate, g/day	315	300
Period 2: 5 weeks to slaughter	Permanent pasture (plus some Italian grazings)	
Grazing commenced	Mar. 15	Feb. 20
No. ewes per ha	24.0	15.8
Lamb growth rate, g/day	346	335
Carcass wt., kg	16.3	18.5
Age at slaughter, days	92	102
% Lambs finished June 1	96.6	98.1
Concentrate supplements		
Pre-Lambing, kg/ewe	19	20
Post-Lambing, kg/ewe	43	49
Creep feed, kg/lamb	22	32

Conclusion

These results were recorded at Knockbeg using a farmlet system approach, and they can be interpreted for planning early lamb production on all-grass farms.

Autumn sown I. ryegrass provides strategic grazing for January lambing ewes at a time of year when permanent pasture supplies are scarce. For short-term grazing, it can be stocked at 16 to 17 ewes per ha when concentrate supplements are fed as described.

During the finishing period in April and May permanent pasture, which has been suitably managed during winter, can be stocked at 16 to 24 ewes per ha depending on grazing date, declining as lambs are drafted. During the summer the dry flock can be stocked at 50 ewes per ha while the I. ryegrass is used for 2 to 3 cuts of silage.

The period of flushing, hormone treatment and post-mating management, including repeat matings in October, extends from late July to late November. Fertilised pastures at Knockbeg were stocked at 25 ewes per ha during this period. In October this was reduced to 15 ewes per ha, when repeat breeders were removed and managed separately for spring lambing. Thus, stocking rate varies widely during the extended grazing season, depending on the requirements of the flock.

(2) FODDER BEET/GRASS SYSTEM

In the previous system ewes were lambed down in mid January, managed indoor for one to three weeks and turned out to early grass when the risk of weather hazards had receded. Flocks that are lambed down in December and turned out to forage crops and grass after lambing are subject to unfavourable weather conditions which may result in management difficulties. In the period 1990-91 an indoor feeding system for managing ewes and lambs for 5-6 weeks post-lambing was developed. This was followed by pasture grazing for late lactation and for finishing the lambs. It will be shown in this report that early lambing ewes can be managed very effectively indoor on a diet of chopped roots. As a result, flock management at this critical phase of the production cycle can proceed unhindered by adverse weather. However, it will also be shown that lamb growth rates in late lactation, when lambs were turned out to pasture, can vary from year to year.

Fodder beet diet

Ewes lambing in early January were housed in late November, fed silage *ad libitum* and concentrate supplements at the rate of 0.25kg per ewe per day initially, increasing to 0.70kg in the final two weeks before lambing.

After lambing, the flock was group penned in a straw bedded shed at 20 ewes plus their lambs per pen, stocked at 1.9 sq. m per ewe. Chopped fodder beet (cv. Kyros) was fed *ad libitum* and hay was fed as a source of fibre at the rate of 0.35 kg/ewe/day.

Initially, a protein supplement was fed at the rate of 500 g soyabean meal/ewe/day. However, the intake of fodder beet by the ewes increased rapidly and after about 2 weeks reached 2000 g DM/head/day. This was higher than expected and the level of protein supplementation was increased to 700 g soyabean meal in order to achieve a ratio of about 14 g crude protein per MJ of ME in the diet. Minerals/vitamins were fed at the rate of 50 g/ewe/day. Lambs were creep fed from one week of age.

Management approach

Although it was planned to move ewes and lambs to early grass after 5-6 weeks, unfavourable weather in both years delayed turnout until 8 weeks post-lambing, i.e. early March. The early grass consisted mainly of perennial ryegrass and some Italian ryegrass rested since October and dressed with fertiliser N at the rate of 45kg N per ha on about February 1. The basic approach to grazing management was to optimise the conditions for high lamb growth rates. The flock was grazed rotationally by using portable electric fencing and was moved to a new paddock whenever the pasture was grazed down to a sward height of about 4cm. The lambs were creep fed until slaughter.

Lambs were drafted for slaughter from early April onwards as soon as they reached finished liveweights. This was assessed by weighing and handling the lambs for light to medium fat cover on the loin, rump and tail. Weaning was carried out in mid-April; the lambs were grazed selectively while the ewes were mob stocked at 50 ewes per ha.

Lamb growth rate

Lamb performance results and concentrate inputs are summarised in Table 2. Average lamb growth rate from birth to 5 weeks of age was 288g/day in 1990 and 257g/day in 1991. The reasons for the lower growth rate in 1991 are not clear as the management system was similar in both years and there were no apparent disease problems; it may have been associated with a relatively high proportion of old ewes in the flock in 1991.

Table 2
Lamb performance and concentrate inputs on a fodder beet/grass system

Period 1: 0-5 weeks: Fodder beet diet	1990	1991
No. ewes lambing	185	177
No. lambs	293	290
Lamb growth rate, g/day	288	257
Period 2: 5 weeks to slaughter: Grazed pasture		
No. ewes per ha	12.3	12.4
Lamb growth rate, g/day	323	261
Carcass wt. kg	17.3	17.5
Killing out %	48.3	46.3
Age at slaughter, days	104	132
% Lambs finished by April 26	70	25
% Lambs finished by June 1	100	89
Concentrate supplements		
Pre-lambing, kg/ewe	25	32
Post-lambing, kg/ewe	26	32
Creep feed, kg/lamb	15	34

Although flock turnout was delayed until lambs were 8 weeks of age, there were no flock health problems during the extended feeding period indoor. Special attention was devoted to bedding the pens daily with straw and to cleaning the feed troughs and drinkers. Ewes become accustomed quickly to fodder beet after lambing by introducing a small amount of it in the last week of pregnancy e.g. about 1 kg per head per day.

In 1990 lamb growth rate during the finishing period on pasture was 323g/day and 70% of lambs were drafted at finished liveweights during April, the month in which peak prices prevail. All lambs were drafted by June 1.

Lamb growth rate was considerably lower in 1991 than in 1990. As a result, the 1991 lambs were on average 28 days older than in 1990 when drafted for slaughter. The reduced growth rate in 1991 was associated with very high rainfall in April resulting in waterlogged ground conditions which made grazing difficult. The contrasting conditions for lamb thrive on spring pasture in 1990 and 1991 may be gauged from the rainfall recordings at Oakpark Research Centre as follows:

	Rainfall (mm)
	April
1990	20.9
1991	92.3
1981-91 Average	49.4

Although there is no evidence that wet weather affects pasture dry matter intake by lambs, it is considered that prolonged heavy rain is stressful and may reduce lamb growth rate. The rate at which lambs were drafted in 1991 was slow, 25% during April compared with 70% in 1990 (Table 1). In the context of falling prices as the early season progresses, it is clearly desirable that the majority of lambs should reach finished liveweights during April and early May.

The concentrate inputs shown in Table 2 provide guidelines for drawing up feed budgets for the production of early season lambs on fodder beet diets fed indoor during early lactation, followed by finishing on grazed pasture. Concentrate supplements fed to ewes were higher in 1991 than in 1990 due to a shortage of silage arising from summer drought and a longer indoor feeding period post-lambing.

The consumption of creep feed by lambs up to 6 weeks of age was low, 4 to 5kg per head; intake increased subsequently. In the two years under review, lambs consumed over twice as much creep feed in 1991 compared with 1990 as shown in Table 1. It is likely that this effect was due to the unsatisfactory conditions for grazing in 1991, as described above, which in turn resulted in an extended finishing period.

The realised stocking rate on early grass during March was 12.3 ewes per ha in 1990 and 12.4 ewes per ha in 1991.

Advantages of fodder beet

The main advantages of fodder beet as feed for sheep are:

* Both ewes and lambs have high potential intakes of fodder beets when chopped, equivalent to over 3% of bodyweight. Despite their bulky nature, sheep consume as much dry matter in the form of pulped roots as they can on all-concentrate diets.
* Fodder beet can be produced at about one-third of the cost of concentrates.
* Developments in the design of harvesters, fodder feeders and diet wagons have overcome the technical problems of handling fodder beet roots.

Conclusion

By housing early lambing flocks for 5 to 6 weeks after lambing, the weather hazards associated with turning out ewes with their young lambs to pasture or root crops in January are avoided. Housing facilitates control over the management system, adequate intakes of high quality feed are assured, lamb growth rates are predictable and labour efficiency in feeding and supervision are enhanced. Good housing facilities and suitable machinery for feeding roots are essential. In occasional years heavy rain in spring may cause difficult grazing conditions; temporary transfer of the flock to a dry paddock elsewhere and extra supplementation may be necessary.

Grazing Management for Sheep

E. J. GRENNAN
Teagasc, Belclare Research Centre, Tuam, Co. Galway.

The growth rate of lambs on pasture can vary greatly, depending on the type of pasture being grazed. Sward height and method of grazing (set stocking, paddocks, creep grazing) may affect lamb growth rate. The requirement for and response to meal supplementation at pasture will also be affected by pasture supply. The aim of this paper is to outline the effects of grazing management and meal supplementation on lamb growth rate pre and post weaning.

Pasture height

This has been used in grazing trials at Belclare to study the effect of grazing management on lamb growth rate. In general sward height is a useful guide to the quantity of herbage available and its suitability for sheep grazing. The rising plate pasture meter used gives a reliable measurement particularly when pasture is in the vegetative (leafy) state. Caution is needed with height measurements taken in late May and June when pastures may be getting stemmy if undergrazed at this time. Stemmy pasture can give high readings for sward height but these are a poor indicator of the suitability of the pasture for sheep.

Lamb growth pre-weaning

Set stocking: The first priority is to have enough grass to meet the high feed demands of ewes after lambing. Table 1 shows the effect of sward height on the growth rate of lambs set stocked from birth to weaning at 14 weeks of age in late June (1). Results show that a sward height of about 6 cm is near optimum until late May when lambs are about 10 weeks of age. Tight grazing at 4 cm reduces lamb growth rate. However, lax grazing at 9 cm, which requires a lower stocking rate, gives little increase in lamb growth. This lax grazing, especially in May, results in selective grazing by sheep and the pasture becoming quite stemmy in June. This is more obvious on old permanent pastures where unpalatable grasses such as red fescue are rejected, resulting in the pasture developing a patch-work appearance of tightly grazed areas and rejected high-grass areas. Table 1 also shows that lamb growth rate in June (10-14 weeks) is lower than in April-May (0-10 weeks) at all sward heights and some adjustment in grazing management is required to maintain high lamb growth rates in June.

Table 1
Effect of sward height on lamb growth rate (g/day) under set stocking

	Pasture height (cm)		
	3.6	5.8	8.7
0 to 10 wks	267	306	315
10 to 14 wks	245	245	258

Table 2
Effect of post-grazing height (cm) on lamb liveweight (kg) under rotational grazing

Sward height	Lamb age (weeks) 5	10	14
3.0	12.5	21.2	26.3
4.5	12.5	21.4	27.0
6.0	13.2	22.7	29.2

Rotational grazing: If paddock grazing is used, the question arises as to how tightly they should be grazed before moving sheep to the next paddock and what effect this will have on lamb growth. Results in Table 2 with a ewe lamb flock show that weaning weights were highest when paddocks were grazed down to about 6 cm (2). Very tight grazing to 3 cm for the 14 weeks depressed lamb weaning weight significantly. Closer examination of these and other results from grazing trials at Belclare suggests that a post-grazing height of 6 cm may not be appropriate for April, May and June. Grazing to 4 or 6 cm in April had little effect on the 5 week weight of lambs. The effect is more significant when tight grazing is continued in May and June. This may be explained by the fact that in April grass is very leafy and high quality and so sheep can graze tightly without restricting their performance. Later in May/June the base of the sward becomes more stemmy as the flowering stems rise. Tight grazing at this time forces lambs to eat herbage of lower digestibility, thereby reducing their performance. As a general guide, post grazing height of 4, 5 and 6 cm may be more appropriate for April, May and June respectively. For the same reasons sward heights of 5 and 6 cm may be adequate in April and May respectively for set stocking.

Lamb growth in June

Records from many experiments indicate that the growth rate of March born lambs from 10 to 14 weeks is often much lower than in the period up to 10 weeks of age. This reduced growth rate occurs in late May and June when ewe milk supply is decreasing and lambs are becoming increasingly dependent on pasture. This pasture may either be getting stemmy if undergrazed in May or it may be too short due to drought or too high stocking rate. A reduction of 35 g/day in growth rate during this time means a loss of 1 kg in weaning weight. Records suggest that the potential loss in weaning weight ranges from 1 to 3 kg. Since it requires about 1 week gazing on good pasture for weaned lambs to gain 1 kg liveweight, it follows that the reduced growth rate pre-weaning can delay sale date of finished lambs by 1 to 3 weeks.

Results at Belclare over 3 years indicate that with some adjustments in grazing management it is possible to keep lamb growth at a high rate in June. The objective is to offer lambs leafy grass of a high quality similar to that normally available in April and May. Three different pastures were grazed by ewes and

Table 3
Effect of sward height and type on lamb growth rate (g/day) in June

Grazed pasture		Aftergrass
5-6 cm	6-8 cm	8-9 cm
224	263	286

lambs from 10 to 14 weeks of age: Pasture A was set stocked at 5-6 cm height up to 10 weeks and grazed at the same height in June: Pasture B was similarly grazed up to late May and at 6-8 cm height in June: Pasture C was aftergrass (silage cut mid-May) and grazed at 8-9 cm in June. Results in Table 3 show that lamb growth rate was affected by the pasture being grazed. Increasing the height from 5-6 cm to 6-8 cm improved growth rates considerably, with highest growth rates on aftergrass available *ad lib.* It is concluded that while a sward height of about 6 cm is adequate up to about the end of May for set stocking, an increase in height is necessary in June in order to maintain high lamb growth rates. Tight grazing in May prevents seed-heads developing while the increased height in June allows for the growth of new leafy material. This increased height in June may be achieved by applying nitrogen in late May or by increasing the grazing area, by, for example including a paddock cut for silage in mid-May. The provision of aftergrass for weaned lambs is generally desirable but few sheep farmers would be in a position to have adequate aftergrass available for ewes and lambs in June. In some situations it might be possible to allow the lambs to forward creep graze on the aftergrass while the ewes are setstocked. Lambs would have access to high quality pasture and the area of aftergrass required would be much smaller.

Creep feeding and creep grazing

The response of ewes or lambs to meal feeding in spring will depend on the supply of grass available. Results from England suggest that there is little response to feeding meals to ewes after lambing unless sward height falls below about 4 cm for set stocking (3). At Belclare O'Riordan found no response, in ewes or lambs, to feeding 250 g/day to ewe lambs for 5 weeks after lambing when grazing down to 3.0, 4.5 or 6 cm in a rotational grazing system (1). When the same level of creep was fed to the lambs from 5 to 14 weeks there was a response to creep with tight grazing to 3 cm but not with lax grazing to 6 cm.

In separate experiments the effect of creep feeding and creep grazing was investigated over two seasons at Belclare. Pastures were rotationally grazed down to either 4 or 6 cm using a ewe lamb flock in Year 1 and mature ewes in Year 2. Creep feed was fed at the 4 cm height only from 5 to 14 weeks at 250 g/day. The facility to creep graze was available at both heights and availed of by lambs increasingly from about seven weeks of age. Results in Table 4 show that tight grazing to 4 cm in May-June restricted lamb growth more than lax grazing to 6 cm. Lamb growth rates were improved by creep feeding or creep

Table 4
Effect of post-grazing height, creep feeding (CF) and creep grazing (CG) on lamb growth rate from 5-14 weeks

	Post grazing height				
	4 cm	4 cm + CF	4 cm + CG	6 cm	6 cm + CG
Yearling ewes	155	212	197	221	246
Mature ewes	221	289	271	232	261

grazing. The average response to creep grazing was 2.9 kg at 4 cm and 1.7 kg at 6 cm, while the response to creep feeding averaged 3.9 kg at the 4 cm height.

These results, taken in conjunction with the previous trials at Belclare show that the response to meal feeding or creep grazing will depend on sward height. While very tight grazing in May/June is beneficial in preventing the pasture becoming stemmy it does reduce lamb growth rate, but this can be counteracted by creep feeding or creep grazing. The latter option may be most feasible where a paddock grazing system is in use. The response to either creep feeding or creep grazing will be small where high quality pasture is available *ad lib.*

Lamb growth post weaning

The growth rate of lambs on pasture post weaning can vary greatly and reports of poor growth rates on farms are frequent. Growth rates under controlled conditions in research flocks can range from under 100 to over 200 g/day depending on the pasture being grazed. Pasture height, clover content, previous grazing management and "clean pasture" can all affect the rate of lamb growth. In some farm situations mineral deficiencies, such as cobalt, or inadequate dosing practices are blamed.

Set stocking

Table 5 shows the typical effect of pasture height on lamb growth on pastures of low clover content and grazed by sheep pre-weaning. A height of about 9 cm gives highest growth rates in contrast to about 6 cm in April/May. Tight

Table 5
Effect of sward height on growth rate of weaned lambs set stocked on pasture from July to September

	Sward height (cm)		
	5.0	7.0	8.5
Liveweight gain (g/day)	115	141	162

Table 6
Effect of post grazing height on growth rate (g/day) of weaned lambs under rotational grazing

	Post grazing height (cm)		
Pasture type	4	5	6
Old pasture	99	141	159
Ryegrass pasture	90	139	153
Ryegrass/clover	117	173	222

grazing on summer pasture forces lambs to graze down into a layer of poor quality herbage at the base of the sward resulting in poor lamb growth rates.

Rotational grazing

Table 6 shows the general effect of grazing down to different heights in rotational grazing, and also the effect of different pastures. Highest growth rates are associated with leafy pasture, rich in clover. Growth rates up to 200 g/day can also be obtained on aftergrass. The lower parasite levels on this pasture may account for the higher lamb growth rates. It is difficult to get growth rates higher than 150 to 170 g/day on pasture grazed by ewes/lambs up to weaning (no matter how intensive the dosing routine). Grazing down below about 6 cm in paddocks also reduces growth rate as lambs are forced to eat poor quality herbage. A system of leader/follower grazing would be beneficial (where paddocks are available) with lambs grazing ahead of ewes, keeping in mind the need to restrict the diet of ewes post weaning and allow a build up of grass for autumn flushing.

Effect of grazing management pre-weaning

As indicated earlier, tight grazing in May/June results in a more leafy pasture post weaning. This can affect lamb growth if weaned lambs grazed the same area postweaning. Results in Table 7 illustrate this effect at Belclare: when

Table 7
Effect of sward height pre and post weaning on growth rate (g/day) of weaned lambs under set stocking

	Stocking rate (lambs/ha)			
	Mean sward height (cm)			
Residual sward height pre-weaning (cm)	4.5	6.0	7.5	9.0
3.0	107	120	150	159
4.5	87	113	134	167
6.0	81	107	123	160

weaned lambs were highly stocked (at pasture heights up to 7.5 cm) growth rates were highest on pasture grazed down to 3 cm pre-weaning. However when weaned lambs were grazed on pasture at about 9 cm lambs growth rate was not affected by grazing height pre-weaning. It appears that at low stocking rate (9 cm) lambs could select a similar diet from all pastures but at high stocking rate and shorter grass the penalty for lax grazing pre-weaning is evident. The highest growth rates were about 160 g/day on these pastures grazed by ewes/lambs pre-weaning.

Feeding concentrates at pasture

As in spring-time the response to feeding concentrates to weaned lambs on pasture will depend on the quantity and quality of the pasture being grazed. The response will be small where pasture alone supports a high growth rate. Conversely the response will be greater where pasture alone supports a low growth rate. Results in Table 8 show the response of lambs to feeding meals on pasture in autumn at Belclare. There is a response to meals especially where grass is short. The extra carcass gain due to meal feeding would cover the cost of the meals. It does allow lambs to be finished that would not finish on pasture alone in autumn and may otherwise have to be sold as stores. It also allows lambs to be finished earlier and this may be important if lamb prices are falling at that time.

Table 8

Effect of sward height and concentrates on lamb performance

	High grass (8.5cm)		Low grass (6.2cm)		
	Concentrates (g/head/day)				
	0	500	0	500	s.e.
Growth rate (g/d)	185	214	158	199	
Pre-slaughter wt.	44.0	45.6	42.6	44.8	0.45
Carcass wt.	19.0	20.3	18.5	20.7	0.25
Killing out %	43.2	44.6	43.5	46.4	0.46
F.C.R. (carcass)	20		12		

Mixed grazing

Lamb growth rate to weaning is generally higher in mixed cattle/sheep than in all sheep grazing systems. Weaning weights are about 2 kg higher with mixed grazing (4). The higher growth rates may be attributed to several factors such as more grass available to sheep, including high grass areas around dung-pats, more nutritious grass near dung pats, more clover in mixed-grazed pastures and lower parasite levels.

At Belclare a similar 2 kg advantage in weaning weight was obtained when ewes/lambs grazed pasture not grazed by sheep in the previous year. Due to the limited amount of silage required in all-sheep systems it is difficult to plan to have "clean grazing" for lambs in spring. Clean grazing is mainly required

Table 9

A guide to sward heights (cm) for set stocking and post-grazing heights for rotational grazing by sheep

	April	May	June	Post weaning
Set stocking	5-6	6	6-8	8-9
Rotational grazing	4	5	6	6

when lambs are eating an appreciable quantity of grass after 4-5 weeks of age. It would be useful for nematodirus control to have "clean pasture" available from mid-April to the end of May.

Dosing lambs

In all sheep systems at Belclare the routine dosing of spring born lambs is at 5 wks, 10 wks and 14 wks (weaning). More intensive dosing at $7^{1}/_{2}$ and 12 weeks gave no growth-rate response up to weaning. A similar result was obtained with a ewe lamb flock grazing the same area in two successive years.

Post-weaning, lambs should be grazed on "clean pasture" if available. Dosing requirements will depend on where the lambs are grazing. On clean pasture one dose about 3 weeks post-weaning may be enough. If no clean grazing is available we dose lambs at about 3 week intervals in grazing trials to minimise the effect of parasites. More intensive dosing in this situation (every $1^{1}/_{2}$ weeks) did not improve lambs growth compared with dosing at 3 week intervals and may only increase the risk of worms developing resistance to the drugs used.

A guide to pasture heights for sheep

Table 9 gives a guide to pasture heights for all sheep grazing for set stocking and post-grazing heights for rotational grazing to achieve high lamb growth rates throughout the season.

References

1. Grennan, E. J. (1990). Lamb growth rate on pasture. Irish Grassland and Animal Production Association Journal, 24: 100-104.
2. O'Riordan, E. G. (1992). Effect of sward height on the growth rate of progeny of yearling ewes. Irish Grassland and Animal Production Association, 18th Annual Research Meeting, 1991/92.
3. Treacher, T. T. (1990). Grazing management and supplementation for the lowland sheep flock. In: New developments in sheep production, occasional publication No. 14 - British Society of Animal Production. Edited by C. F. R. Slade and T. L. J. Lawrence, 45-54.
4. Nolan, T. and McNamara, N. (1992). New suckler cow and sheep mixed grazing systems. Farm and Food, January-March, Teagasc, 23-24.

Beef Production from New Zealand Grasslands

E. G. O'RIORDAN
Teagasc, Grange Research Centre, Dunsany, Co. Meath.

Agriculture is an important component of the New Zealand economy where it accounts for over 50% of export receipts. Grassland based farming, producing animal products from dairying, sheep and beef account for 36%, 30% and 20% of agricultural export receipts respectively. Many comparisons of agricultural production in both Ireland and New Zealand have been made which suggest that they are similar. However, closer examination of geography, climate and farming systems shows that differences do exist and that systems of farming have developed to cope with the local constraints. The main aims of the present paper are firstly to generally describe agriculture in New Zealand, secondly to describe weather and grass growth in the main livestock producing regions and thirdly to describe beef production which is mainly based on grazed grass.

1. Agriculture in New Zealand

Some general statistics which compare New Zealand and Ireland are given in Table 1. It can be seen that New Zealand's land mass is nearly four times the size of Ireland. New Zealand comprises two main Islands, with the North Island accounting for 43% of the land area (Figure 1). Both New Zealand and Ireland have a similar proportion of their areas classified as mountainous. Again, both countries have a similar sized population with rural/urban balances that are quite alike. The one big difference between the two countries is in average farm size, which in New Zealand is 220 hectares (540 acres) compared with 25 hectares (60 acres) in Ireland.

Table 1
General statistics for New Zealand and Ireland

	New Zealand	Ireland
Location	34-47°S	51-56°N
Land Area (million hectares)	26.5	6.9
Utilised Land (million hectares)		
– Pasture	13.7	4.2
– Arable crops	0.2	0.4
% Mountainous	33	33
Farm size (hectares)	220	25
Human population (million)	3.4	3.5
% Rural	16	13

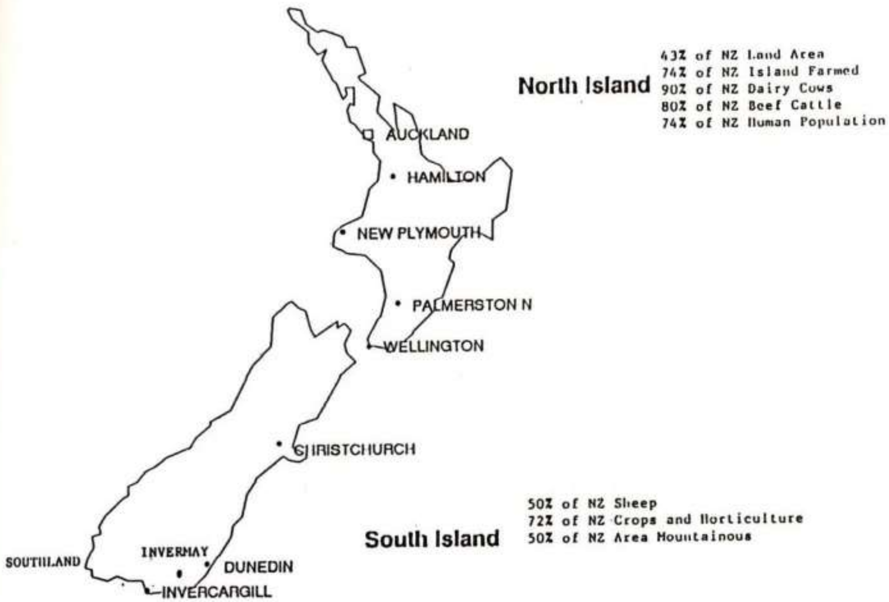


Fig 1 – New Zealand and Agricultural Distribution

The North Island is the most intensively populated and farmed part of New Zealand (Table 2). The majority of New Zealand's dairy cattle (90%), almost 80% of the beef cattle and 50% of the sheep numbers are farmed on the North Island. Three quarters of New Zealand people live on the North Island.

There are approximately 4.5 million beef cattle in New Zealand of which 1.4 million are breeding cows and heifers. Angus, Hereford and their crosses account for 70% of beef cow breeds (Table 3). Very few farmers devote themselves exclusively to beef production. In general, the raising and finishing of beef is carried on in conjunction with sheep farming. The dairy sector has a major part to play in the New Zealand beef industry. Presently, 50% of beef is of dairy origin. Calving in the beef cow herd is planned to coincide with spring grass growth. Grazed grass is the main diet throughout the year and while some limited amounts of hay or silage may be offered, no meal supplements are fed. Winter housing of animals is virtually non-existent in New Zealand.

Virtually all animal production systems in New Zealand are based on grassland, either grazed or to a much lesser extent conserved as hay or silage. Clover is the sward component that plays a important role in grassland productivity. Clovers are present in nearly all swards and the use of fertiliser nitrogen is limited. However, there is a renewed interest in nitrogen use in autumn and spring to overcome the sometimes unreliable productivity of clovers at these times of the year. While grass growth patterns vary with the season, although

Table 2
Statistics for North and South Island

	South Island	North Island	% of total on North Island
Area (million hectares)	15.0	11.5	43
Areas Farmed (million hectares)	9.1	8.5	48
% Farmed	61	74	
Area in Sown Pasture (million hectares)	7.5	6.2	45
Dairy Cattle Nos. (millions)	0.3	3.0	90
Beef Cattle Nos. (millions)	0.9	3.6	79
Sheep Nos. (millions)	30.4	30.1	50
Human population (millions)	0.9	2.5	74

Table 3
Breed composition of the New Zealand beef cow herd

Breed	% of Beef Cows
Angus	28
Hereford	16
Angus x Hereford	22
Friesian	13
Other Crosses	21

not to the same degree as in Ireland, is has resulted in quite seasonal animal production patterns.

2. Weather and grass growth in New Zealand

New Zealand may simply be described as a "long narrow" country situated between latitude 34° and 47° South of the equator and.at approximately 165-180° East longitude. For comparison purposes, its position relative to Ireland has been simplified in Figure 2, where New Zealand has been moved and placed at the same co-ordinates North (of the equator) as it occupies South of the equator. From this figure, it can be seen that the "North Island" coincides mainly with central and Southern Spain. The Auckland region would be situated close to Gibraltar with some lands stretching as far South as Morocco in North Africa. New Zealand's capital city, Wellington which is located on the Southern end of the North Island would now approximate to Spains capital, Madrid. The "South Island" would stretch from the North Spain/Portugal border over the Bay of Biscay into the Atlantic Ocean. but would not come as far North as Brittany/ Normandy in France. The nearest regions of New Zealand would be some 200-250 miles South of the Irish South Coast. Because of its location closer to the

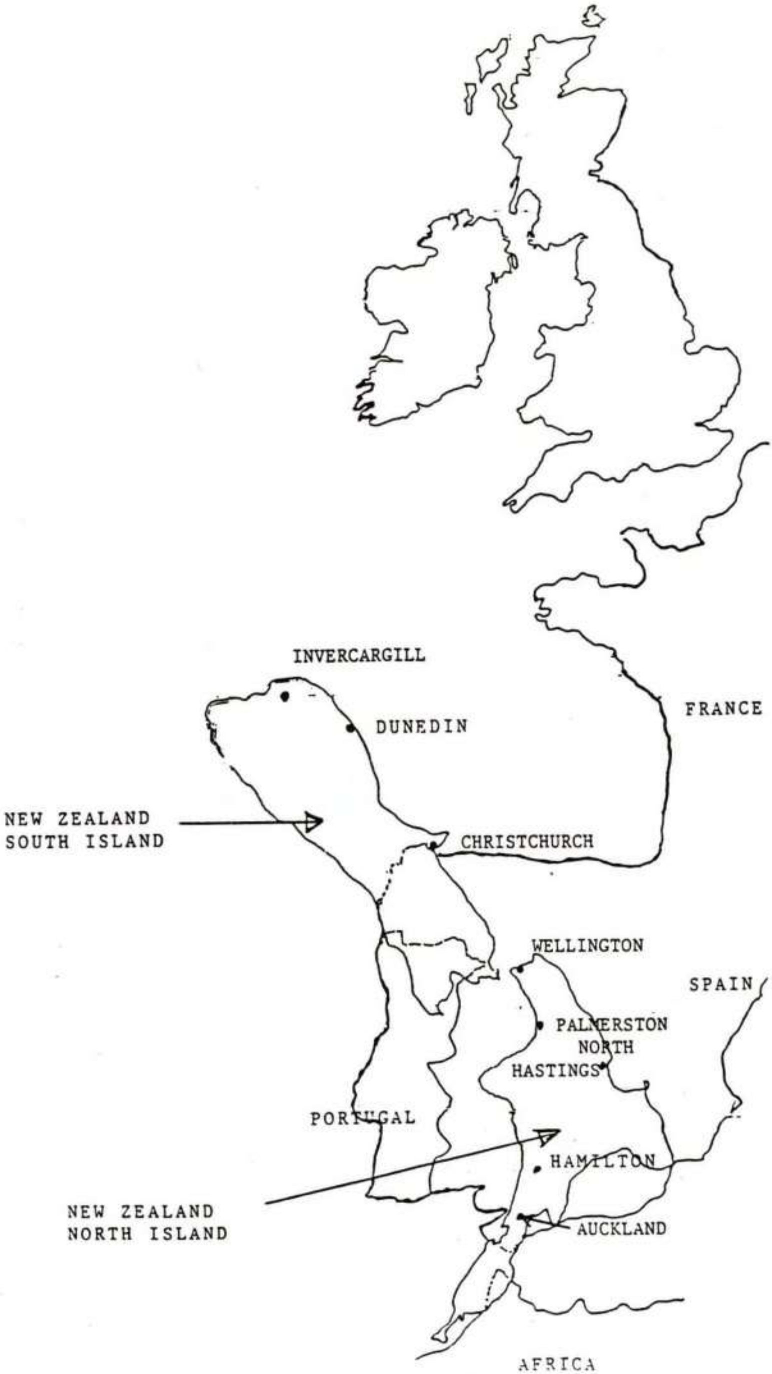


Fig. 2 – New Zealand location relative to Europe

equator, the sun is more directly overhead than in Ireland. This means that solar radiation is higher. This is critical for grass growth.

Because New Zealand is a "narrow" shaped country, its climate is to a large extent influenced by the seas that surround it. As a large proportion (approximately 50%) of the South Island is covered by mountains (Southern Alps), this greatly modifies the climate. The tall mountain ranges that run the entire length of the South Island have a large influence on both rainfall and temperature. These influences, as well as the fact that Ireland is warmed by the Gulf stream, makes the expected differences in climate less than their relative locations in Figure 2 might suggest.

North Island

Grass growth data for the North Island are shown in Figures 3 and 4. Meteorological data are shown in Figures 6 and 7. For comparisons the grass growth curve for Moorepark is shown and this site may be seen as one of the most favourable locations in Ireland for grass production. Seasonal distribution of grass growth is shown in Figure 8.

In general, compared with Ireland, grass growth rates on New Zealand's North Island are lower in summer and higher in winter, thus, giving a more uniform seasonal grass supply. In the Hamilton region, average winter grass growth rates are approximately 14 kg DM/ha/day. Grass growth is at a minimum in June/ July (winter) and increases gradually during late July to reach a peak of 50-60 kg DM/ha/day in September/October/November. Growth rates decrease in January (summer), but seldom fall below 20 kg DM/ha/day until mid winter. Approximately 1/3 of the annual grass production takes place in winter and autumn (Figure 8). Rainfall is relatively high and well distributed throughout the year. Average winter temperatures (June/July/August) are approximately 9°C (Figure 6).

In the Palmerston North region (Figure 4), winter, summer and autumn growth rates are similar at 20-24 kg DM/ha/day, representing over half of the season's grass growth. Grass growth reaches a maximum of approximately 70 kg DM/ha/day in October/ November. Due to drought effects and the approach of autumn, growth rates can drop to less than 20 kg DM/ha/day, but increase again during the winter. Winter temperatures average 8°C and rainfall is generally well distributed throughout the year.

Grass growth occurs in New Zealand's North Island throughout the year. Winter temperatures (December, January and February) at Moorepark and Grange average 5.2 °C and 4.4°C, respectively. Corresponding winter (June, July and August) temperature in the Hamilton region is 9.2°C and at Palmerston North is 7.8°C. Soil temperatures closely reflect these differences, and there is generally no grass growth at soil temperatures less than 5 to 6°C. These differences in temperatures result in a more even supply of grass throughout the year in New Zealand. It can be clearly seen in Figures 3 and 4 that New Zealand have an advantage in terms of grass supply in early spring when growth rates can be at least double those of Ireland. During the autumn, New Zealand again has the advantage. It is only during the summer months that Ireland

GRASS GROWTH

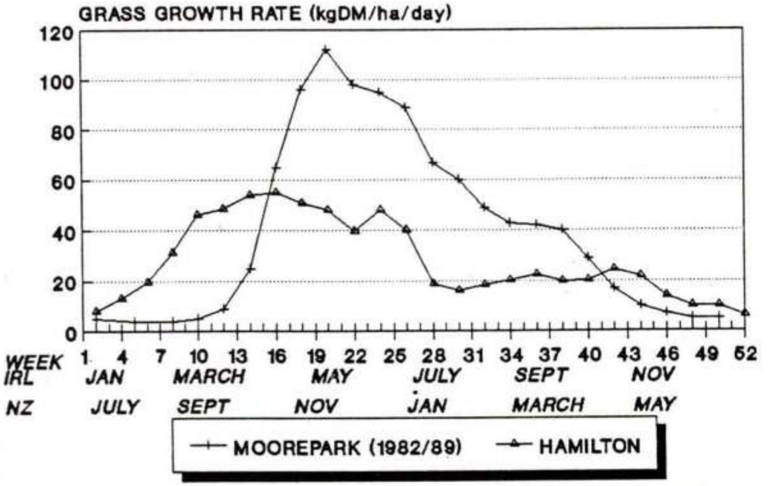


FIG.3 GRASS GROWTH AT MOOREPARK AND HAMILTON

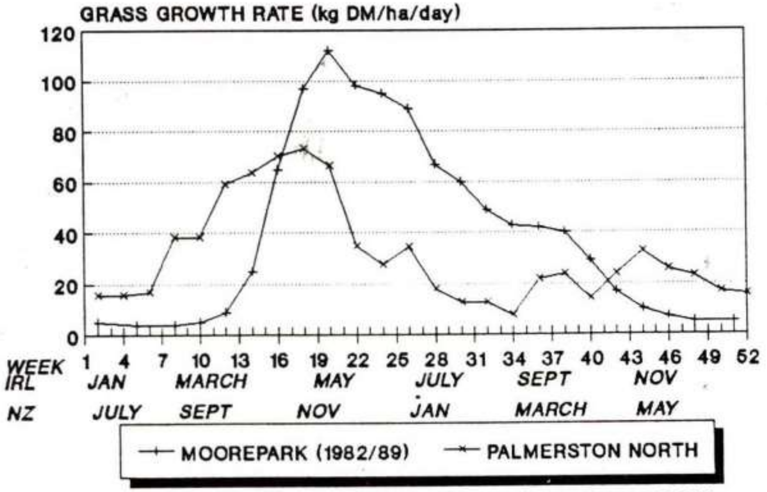


FIG.4 MOOREPARK COMPARED WITH PALMERSTON NORTH

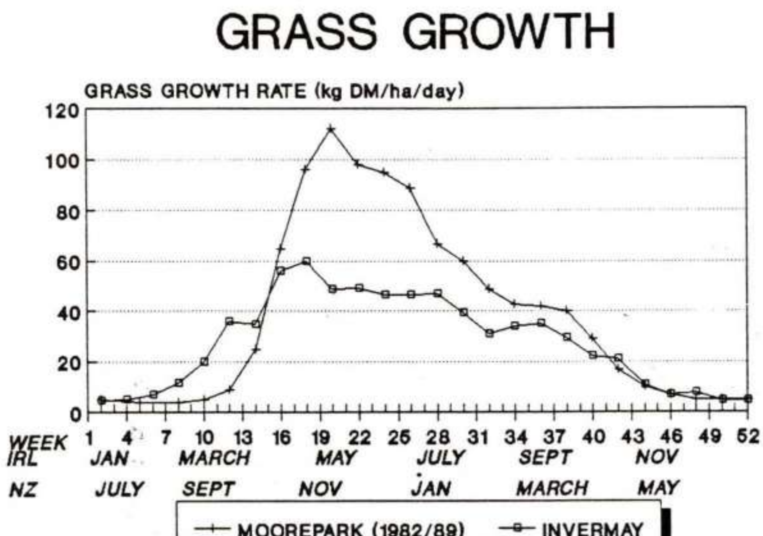


FIG.5 MOOREPARK COMPARED WITH INVERMAY

produces more grass. It is under these conditions, favourable to pastoral farming, that most of New Zealand's cattle are farmed.

South Island

The main grassland based farming region of the South Island is Southland, which supports a large proportion of New Zealand sheep population. A typical grass growth pattern over the season (Figure 5) shows the growth curve for the Invermay Research Centre. Grass growth rates during June/July (winter) are typically less than 10 kg DM/ha/day. During August, growth rates increase to reach a peak in October of about 60 kg DM/ha/day. Growth rates fall off gradually during November through to April when they reach approximately 20 kg DM/ha/day. Growth rates during May are typically 10 kg DM/ha/day. One third of the annual grass growth take place in autumn and winter. The remaining seasons production in the spring and summer accounts for 23 and 47% of seasonal growth (Figure 8).

Temperatures on the southerly regions of the South Island (Southland) are more like those of Ireland than of the North Island. The January equivalent in Southland has similar temperatures to Irish Southern regions. but is one degree centigrade warmer than for example Grange. During the equivalent month of February in New Zealand, Southland is l-2°C warmer than Ireland. When this difference means temperatures of 4 or 5°C in Ireland compared with 6°C in New Zealand, it is of major significance for grass growth. It in effect means the

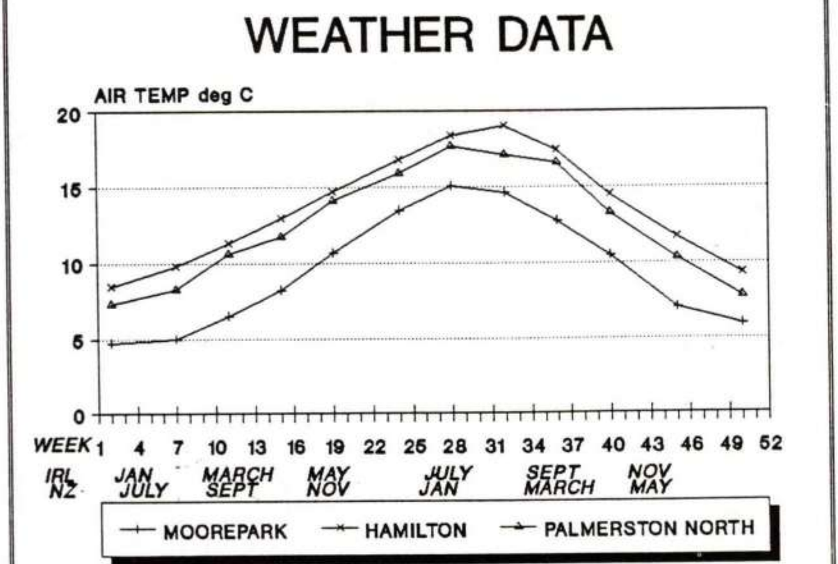


FIG.6 TEMPERATURES IN IRELAND AND NEW ZEALAND

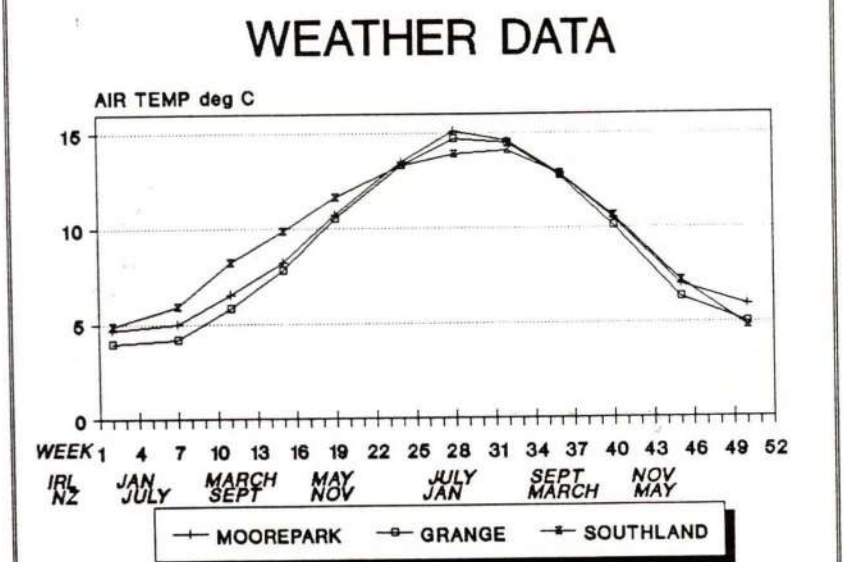
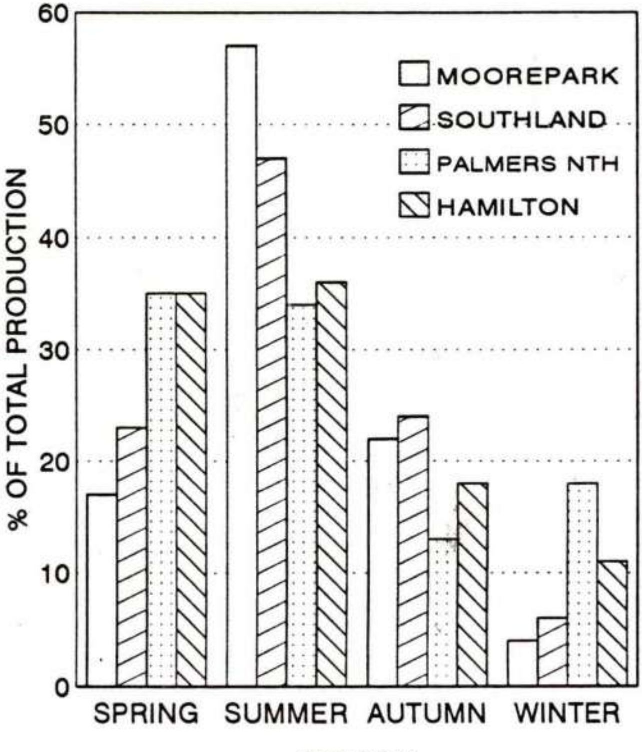


FIG.7 TEMPERATURES IN IRELAND AND NEW ZEALAND

difference between grass growth and no growth. This is probably best understood if these differences are put into context. February 1993 remains clear in most peoples minds as being a remarkably mild month. The average air temperature during February 1993 at Grange was 6°C compared with the more normal 4°C. This exceptional Irish February is the normal average temperature in Southland (which in turn is inferior to the North Island of New Zealand). Probably in most farmers' minds if February 1993 was the normal, then much more use would be made of grazed grass.

During spring (March and April), the differences in temperature between Ireland and New Zealand become greater. The importance of these temperature differences cannot be overstated, as growth of grass is very sensitive to temperature changes at this time of the year. For the remainder of the year, Southland temperatures are similar to those of the Southern part of Ireland. However, grass



SPRING	SUMMER	AUTUMN	WINTER	
Feb-Apr	May-Jul	Aug-Oct	Nov-Jan	IRELAND
Aug-Oct	Nov-Jan	Feb-Apr	May-Jul	NEW ZEALAND

Fig 8 – Seasonal grass growth distribution

growth in the autumn is better in Southland, reflecting the longer days and higher solar radiation due to its closer proximity to the equator than Ireland.

3. Beef production in New Zealand

There are approximately 30,000 beef and sheep farmers in New Zealand that have more than 250 sheep or 50 beef cattle. Less than 6,000 farmers derive their income solely from beef production. Therefore, in nearly all situations, beef cattle and sheep are farmed as joint enterprises. On the more extensive North Island Hill country, cattle may account for 25-30% of the livestock units on the farm, on better lands cattle may make up 30-35% of the stock. While, on average, beef cattle make up 30% of livestock units on the North Island, the corresponding figure for the South Island is 5-15%. While the overall average farm size in New Zealand is 220 ha (540 acres), those engaged in drystock farming occupy holdings that average 490 ha (1,200 acres). Such a farm employs 1.6 labour units (including the farmer) who manage on average 2,600 sheep and 180 cattle. A "typical" drystock farm may comprise 25% flat land, 25% rolling country and 50% steep hill. These farms produce lamb and beef carcases of 14 kg and 250 kg, respectively.

The New Zealand beef industry obtains its raw materials from two sources, the suckler herd which comprises approximately 1.4 million cows and the dairy herd which comprises 2.2 million cows of mainly Friesian and Friesian x Jersey breeds. Beef produced from the dairy herd is almost exclusively raised as 15-22 month bull beef, while steers are produced from the suckler herd.

Beef cow breeds are the traditional Angus (30%), Hereford (15%) and their crosses (25%) (Table 3). Hereford and Angus sires are the most commonly used bulls in beef production. Calves from the dairy herd, mainly males, make a major contribution to the beef industry (Table 4). The predominant breeds of cow in the dairy industry are Friesian (66%) and Jersey (26%), with Friesian (and Jersey) sires widely used. Many of the Jersey male calves are slaughtered shortly after birth.

The ratio of cattle to sheep, the time of selling and animal weights are very

Table 4
Sources of animals for New Zealand beef industry

	Herd	
	Suckler	Dairy
Cow Nos. (millions)	1.4	2.2
Progeny Nos. (millions)	1.2	2.0
To beef industry (millions)		
– steers	0.6	—
– bulls	—	0.6
– heifers	0.3	0.1
– cull cows	0.3	0.5

much dependent on the type of land and the proportions of flat and easily managed lowlands to steep hill country. Production systems thus vary, and depending on price and herbage supply selling dates may vary widely between years.

High hill country: Most cows are mated to Hereford or Angus sires; terminal sires such as the Charolais or Simmental would account for less than 10% of matings. Very few farmers would mate all cows to terminal sires. Selling patterns vary widely. Some or all of the weanlings may be sold before winter where the buyer is normally farming on better lowlands. Some producers carry their progeny over the winter and may sell in spring when prices are normally highest yet others may wait until late spring/summer and sell at heavier weights. Generally, animals are not finished on the high hill country. Suckler cow herd size on the hill country is typically 70-90 cows.

Easier (gently rolling) hill country: Suckler cows, again, with sheep are farmed on these more easily managed hills and are often managed with another drystock enterprise. These drystock may be steers or surplus females from the high hill country or may be bulls bought from the dairy industry. Heifers are finished at 15-18 months of age while bulls are sold at 18-22 months with carcase weights of approximately 280 kg.

Good flatlands: While sheep are again farmed, the beef enterprise tends to be specialised. Producing bull beef or finishing steers purchased from the hill country is common.

Some typical cow weights during the year are shown in Table 5 and are lower than those on most Irish farrns. At weaning time a bodyweight of 450 kg for Angus or Hereford cows is common. Between weaning and mid/late winter cows may lose up to 10-15% of their bodyweight. On many farms cows at this stage of the production cycle are used as pasture cleaners where they are offered whatever herbage is remaining after the ewe flock, especially during the mating season. During the winter pregnant ewes and cows are seen as the least sensitive animals to changes in herbage supply as growing stock (lambs/hoggets and weanlings/yearlings) are offered first choice of pasture. Weight losses of the

Table 5
Target seasonal cow bodyweights (kg) and condition scores

Production Stage Cow Type	Weaning	Mid-Winter	Pre-Calving	Mating
Angus	450	410	440	440
Medium size crossbred cow	500	450	480	480
Heavy size crossbred cow	550	490	530	530
Body condition scores	3-3.5	2.5	2-2.5	2.5-3.0

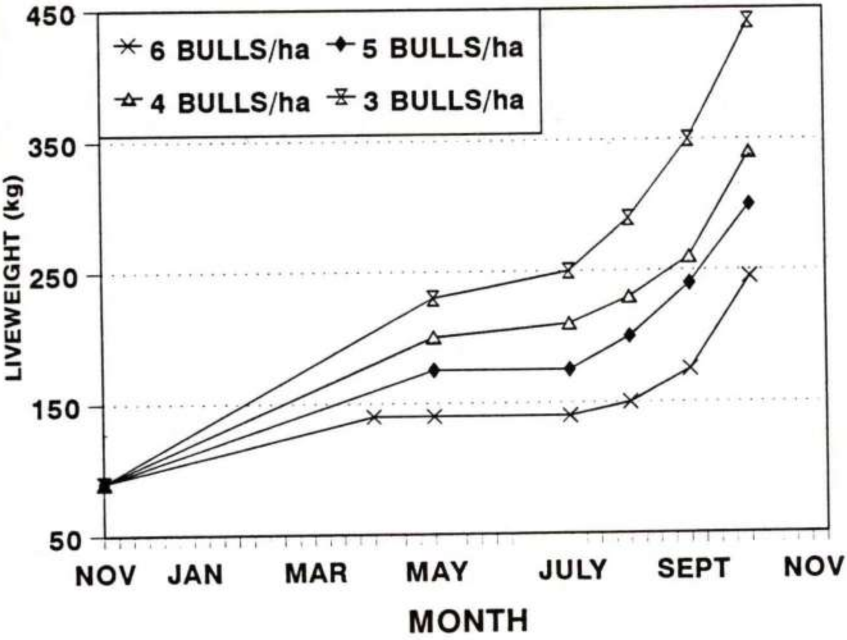


Fig 9 – Effect of stocking rate on liveweight

order of 10-15% are seen as reasonable provided it takes place before 4 weeks pre calving. Bodyweights at calving for the Angus and Hereford type cows are normally in the range 440-480 kg. After calving cows are gradually introduced to spring grass and over the first 4 weeks of lactation cow bodyweights may be reduced to 400 kg. As grass growth improves (spring-September to November) bodyweight recovers and will reach a peak in December/January. Mating takes place during November/December when the cows are on an increasing plane of nutrition. Weaning takes place in February/March. Both cows and ewes are normally set stocked during spring/summer. Calf weights at weaning are in the range 200-250 kg.

Bull beef production

Of all the beef production systems practised in New Zealand, finishing bull calves from the dairy herd is the most clearly defined and managed system. Production of steer beef, from the suckler herd, is less well defined and somewhat like Ireland involves a fair degree of animal movement between farms during the animals lifetime. The bull beef system involves raising bulls (Friesian) purchased in October (spring) at weights ranging from 85 to 100 kg and feeding outdoors on grass until they are 15-22 months old, producing carcases in the weight range 230-280 kg. Bulls are managed in groups of 20-40 and are generally set stocked during summer and rotationally grazed during winter. Management problems in relation to animal behaviour are not seen as an important issue. Animal stocking rates on these bull beef systems are usually less than 3 to 4 bull/ha (1.5/acre). Performance is closely associated with grass supply and on bull finishing units regular assessments of pasture cover/mass are made.

The effect of stocking rate on liveweight gain is shown in Figure 9. Stocking bulls at 5 to 6/ha over the year resulted in little gain during the winter month (April-September) when animals were 150-200 kg at the beginning of winter. At 6 bulls/ha animals maintained liveweight and at 5 bulls/ha gained approximately 25 kg. During the winter period bulls stocked at 4/ha gained 0.2 kg/head/day while those stocked at 3/ha achieved a gain of 0.5 kg/head/day. To achieve satisfactory lifetime gains bulls are therefore stocked at 3/ha or less. An example of a typical bull beef unit is the 105 ha (260 acres) farm at Massey University. The unit is made up of 31 paddocks ranging in size from 1.3 to 6.1 ha (3 to 15 acres) based on a permanent ryegrass/white clover mixture. Rainfall is about 1000 mm (40 inches) and is evenly spread throughout the year. Nitrogen may be used in the autumn (April) and in 1990 it represented 20 kg N/ha in the form of urea. In autumn 1991, 40 kg N/ha was applied with a further 22 kg N/ha in July (late winter). Friesian bull calves are purchased during October/November (Table 6), and prices have ranged from $120 to $303 (£60-£150). Bulls are sold during December to March at 15-20 months of age (Table 7). The disposal pattern for the 1991/92 production season is shown in Table 8. During the years 1983/84 to 1987/88 where bulls were stocked at 3/ha average carcase weight was 223 kg. But when stocking rates were reduced to 2.5 bulls/ha during the years 1988/89 to 1991/92 average carcase weight increased to 254 kg and has been increasing yearly. During the corresponding periods carcase output had declined from 723 to 670 kg/ha, but price per head had increased from NZ$444 to NZ$692.

Table 6
Friesian bull calves purchased during October/November at Massey University

Year	No.	Price (NZ$)
1982	377	120
1983	330	135
1984	340	179
1985	355	180
1986	360	195
1987	280	190
1988	280	209
1989	280	284
1990	280	295
1991	285	303

Table 7
Bull sales, carcase weight (kg) and returns (NZ$)

Year	No.	Net price per head	Average carcass wt (kg)	Carcase Wt per ha (kg)	Net Return/ha
1983/84	369	353	205	720	781
1984/85	324	610	231	713	1356
1985/86	327	445	237	738	841
1986/87	342	411	208	677	727
1987/88	346	399	233	768	739
1988/89	276	538	231	607	828
1989/90	278	749	247	656	1219
1990/91	275	694	263	687	1040
1991/92	277	787	276	728	1261

Table 8
Bull sale pattern for 1991/92 season

Date	No. sold (to factory)	Carcass Weight (kg)	Net price/head NZ$
26/9/91	1	101	264
18/11	37	246	752
15/1	30	278	779
28/1/92	30	273	748
30/1	31	280	819
4/2	40	279	814
9/2	25	265	753
18/2	16	269	766
18/2	8	270	771
19/2	29	265	753
1/4	30	336	934
Average		276	787

Herbage supply has a major influence on the growth rate of bulls within the system as can be seen from Figures 9, 10 and 11. The production year 1986/87 (Table 7) was characterised by a low herbage mass which for most of the year was less than 1,400 kg DM/ha (Figure 10). Animal performance was poor (Figure 10 and Table 7) and carcase weights averaged 208 kg. The following year (1987/88) the weather pattern resulted in herbage production that was improved and pasture mass was seldom less than 1,400 kg DM/ha. Animal performance was greatly improved and carcase weights were increased by 25 kg/head.

Fig.10 Pasture cover on bull unit

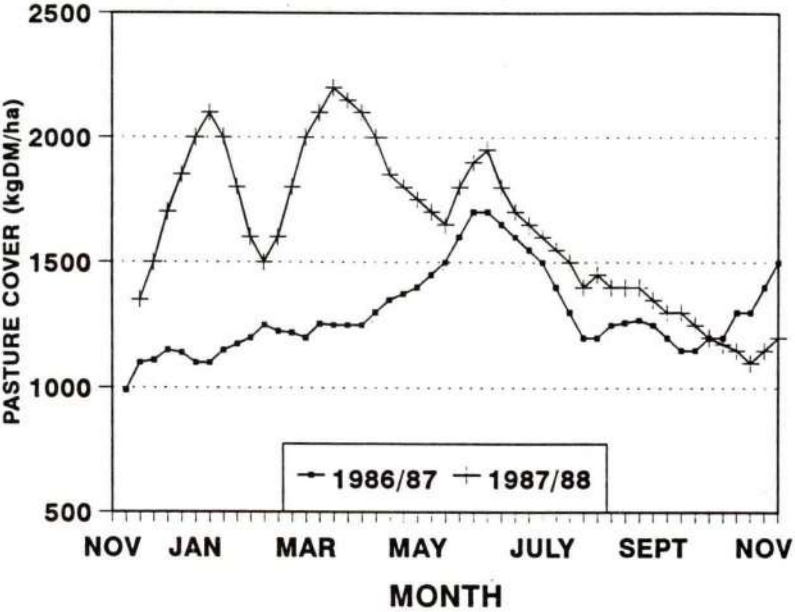
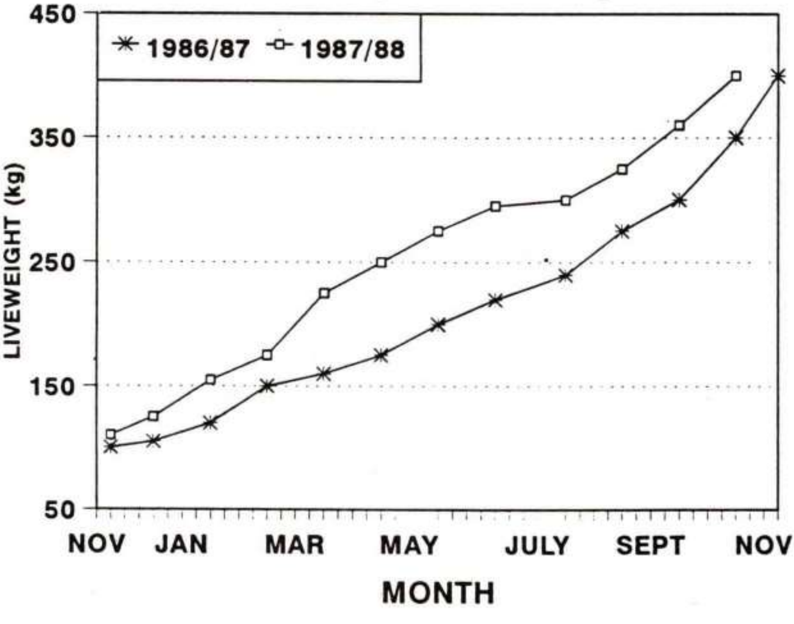


Fig.11 Effect of year on liveweight



Seasonality of production

Although grassland is grazed throughout the year, there is nevertheless a clear seasonality to beef production. The slaughtering at export plants over the year is shown in Figure 12. Data for Ireland are shown for comparison. A smaller proportion of the New Zealand kill of steers and heifers takes place in winter than in Ireland. Peak killing takes place in late summer and autumn. The ratio between the minimum and maximum kill is at least as wide as observed in Ireland. The seasonality of production is to a large extent a reflection of (a) the seasonality of calving where virtually all beef cows calf in spring at the beginning of the grass growth period and (b) the production of beef from grazed grass.

Conclusions

There are similarities between Ireland and New Zealand in factors such as the importance of grassland for animal production, the contribution of the dairy

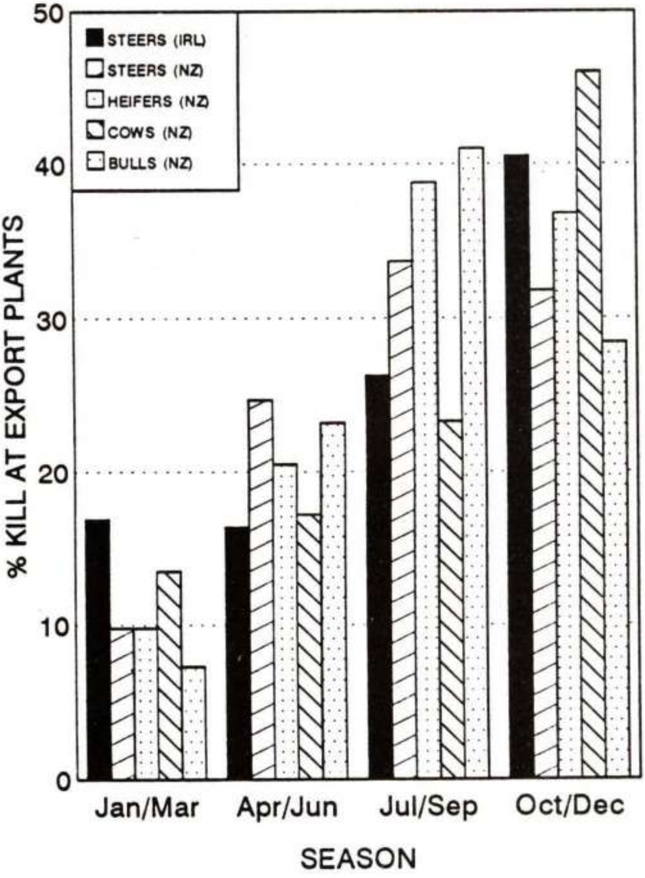


Fig 12 – Seasonality of beef production

industry to beef production and the fact that agricultural production in general is seasonal. There are however, differences that make direct extrapolation of New Zealand production practices to Ireland more difficult. Chiefly among those is climate. The North Island of New Zealand where 90% of the dairy cows and almost 80% of beef animals are farmed does have a warmer climate than Ireland. Grass growth does take place all year round with winter growth rates generally greater than 10-15 kg DM/ha/day.

Average farm and herd size in New Zealand is much larger than in Ireland. Dairy herds approximate to 170 cows/farm, likewise, suckler herd size is 60-100 cows on North Island hill country. Clearly economics of scale are important when comparing those enterprise between Ireland and New Zealand.

Soil on the New Zealand hills are quite different from those of Ireland. North Island soils are largely influenced by volanic activity and many of these soils where adequately fertilised are quite productive. In an Irish context, such hill soil would be seen as good mineral soils.

Beef production is derived from two sources, the national suckler herd and the male progeny of the dairy herd. Steer beef is produced from the suckler herd while bull beef slaughtered at 15-22 months of age is almost exclusively from the dairy herd.

Acknowledgements

The author gratefully acknowledges the financial contribution made by The Irish Grassland and Animal Production Association, The Irish Farmers' Journal and Teagasc, in relation to the study tour in New Zealand.

Sheep Production from New Zealand Grasslands

S. FLANAGAN
Teagasc, Belclare Research Centre, Tuam, Co. Galway.

E. G. O'RIORDAN
Teagasc, Grange Research Centre, Dunsany, Co. Meath.

Animal production in New Zealand involving dairying, sheep and beef on grazed grass accounts for 85% of agricultural receipts. Many comparisons have been made of agricultural production in both Ireland and New Zealand which suggest that they are similar. However, closer examination of geography, climate and farming systems reveal differences and show that systems of farming have developed independently to cope with local constraints.

The present report presents information on a number of areas relating to sheep production in NZ. Firstly, reference is made to grass growth. Secondly, sheep production which is totally grass based is described. Thirdly, some research developments of relevance to current practices in Ireland are outlined.

Grass growth and weather

New Zealands location south of the equator approximates to Spain's position north of the equator. However, because of New Zealand's location in the south seas and its own geography, climate is modified and varies with location. The North Island has average temperatures that are 3 to 5°C warmer than Ireland and soil temperature in the main grassland regions seldom falls below 6 to 8°C. The threshold temperature for grass growth is 6°C. Thus grass grows all year round and on the North Island grass growth seldom falls below 10 kg DM/hectare/day.

Details on the characteristics of grass growth in NZ are described separately by E. G. O'Riordan in this Journal (see Beef Production From New Zealand Grasslands). Grass growth rates throughout the year do not show the large fluctuations as observed in Ireland. While the climate on the southern end of the South Island is more similar to Ireland it nevertheless has more favourable grass growth in spring and autumn/winter.

Drop in sheep numbers

NZ's land area is nearly 4 times the size of Ireland. Of a total area of 26 million ha, about 13m ha is in pastoral land with two-thirds of the livestock units carried on lowland or rolling terrain, one-third in the hill country and 1%-2% on the high country. About 40% of land is classed as hill.

The total sheep population in 1992 was 52.5 million, with a decline of 18% since 1987. Relatively poor returns from sheepmeat, wool and skins are contributing to the decline in sheep numbers. In the South Island there have been sheep farm conversions to dairying. Herd owners and share milkers have moved down from the North Island to develop and establish large dairy farm enterprises

Table 1
Schedule prices to farmers 1992-93 (IR£)

	Lamb	
	Meat 12-16 kg £/kg	Skin + 1 kg Wool Pull £/head
July	0.60	1.81
August	0.64	1.72
September	0.68	1.68
October	0.76	1.88
November	0.76	1.99
December	0.78	2.40
January	0.78	2.44
February	0.74	2.56
March	0.72	2.48
April	0.72	2.40
May	0.78	2.30
June	0.82	2.25

(300-500 cows). This pattern has been stimulated by lower land prices on the South Is., by the profit margins in milk and by confidence in a secure market. There were 300 dairy farm conversions up to 1993 with a further 140 planned at the time.

Lamb prices

Table 1 shows the schedule prices for lamb. Carcass weights are typically from 12.5 kg to 16 kg at 14-18 weeks of age. Lamb prices in 1992/93 averaged IR£13 per head with the tops making IR£17.

Sheep and goat meat production is 585,000 tonnes carcass weight equivalent of which 460,000 tonnes are exported.

Labour

Table 2 shows the number of flocks classified by size. Labour units per farm are often 1.5 to 2.0 on the larger hill farms but it is common for many owners/ operators to manage 3500 stock units on their own (one stock unit = one 55 kg breeding ewe), with the use of a motor cycle and dogs for mustering and family assistance for seasonal work.

On the majority of NZ farms, sheep and beef production take place together. Traditionally, in relation to drystock, NZ is a sheep producing country. On most North Island farms beef cattle (suckler cows) account for less than 35% of the livestock units. Very few farms have beef as the only enterprise. The proportions of sheep and cows, in conjunction with the age and weight of cattle at sale, are largely influenced by the amount of good lowland, easily managed hill and steep hills on the farms.

Table 2
Size of sheep flocks

Flock size	1991
1-99	11,960
100-199	2,588
200-499	3,884
500-999	3,884
1000-1999	6,135
2000-4999	8,198
5000-9999	1,581
10,000 and over	439
Total no. flocks	**38,080**
Average flock size	**1,449**

Low costs

Primary production of meat and wool is the mainstay of the NZ sheep industry. Production per ha remains a basic principle for maximising whole farm profitability. Low cost sheep grazing systems were developed to enable NZ farmers to survive on returns from the international market place. The efficient matching of pasture feed supply with seasonal feed demand using proven techniques of grazing management and control of internal parasites is a key management principle. These principles contribute significantly to the management of long term production and profit and to the management of long term risk.

Low cost is a key principle and sheep systems are essentially low input. The concept of grazed grass as the sole diet together with economy of scale predominates. Typically the main inputs are aimed at labour efficiency. (1) A 4-wheeled motor bike; (2) Trained dogs; (3) Fencing; (4) Easy care ewes that receive no attention at lambing; (5) Wool shed and handling pens. Without these inputs it would be impossible to farm much of the land. Machinery and farm buildings are noticeable by their absence. Fertilizer N is not used.

Lamb finishing farms

These farms are often in the 100-300 ha range and carry stocking rates of 16 to 18 stock units per ha in the very fertile areas of the North Is. and 10 to 20 stock units per ha in Southland, one of the most densely populated sheep areas in NZ. Sources of supply for stock in the North Is. are the hill country for young or cast for age Romney ewes and weaner steers and dairy farms for Friesian and cross-bred bulls.

A typical South Is. intensive meat and wool producing farm is about 200 ha in size, of undulating topography and responsive to lime and fertilisers containing molybdenum, phosphorus and sulphur. Stock consists of about 2000 ewes, 650 ewe hoggets, 40 rams and 50 to 70 beef cattle. Hence, with a total of about 2900 stock units, the farm is stocked at the rate of 14 stock units per ha.

Lambing percentage is 125%. The flock is set stocked until weaning; weaning weight is 25 kg. After weaning, lambs are divided into forward, medium and light groups and grazed on hay or silage aftermaths or chicory, a specially sown crop which is resistant to drought. Lamb growth rate is 200 g/day. Lambs are drafted at 3-week intervals at 35-40 kg liveweight. Average carcass weight is 16 kg.

Clover

White clover has traditionally been the king pin of NZ grazing systems. Its high digestibility characteristics combined with a high protein content ensures better lamb growth rates than all-grass swards, i.e. 320 g/day and 275 g/day respectively according to results at Lincoln College, Canterbury. Moreover, there are relatively large differences in gut fill and killing-out percentage in favour of lambs finished off clover swards. A new variety "Demand" has been developed which produces significant growth in the NZ winter.

Direct drilling has proved to be an effective method for replacing clover in existing pastures which have deteriorated over time. Special inverted T drill openers have been developed. The critical points of management for the success of the technique are:

1. Remove competition from grasses by overall or band spraying depending on the condition of the existing pasture.
2. Control the depth of sowing; 1-1½ cm is ideal.
3. Do not sow clover at less than 10°C
4. Control pests and grubs with insecticides and slug pellets.
5. Graze regularly during the first 6 months to prevent clover suppression from tall grass.

Grass budgeting

Otago-Southland at the southern end of the South Is. is one of the most densely populated sheep areas of NZ producing about 40% of NZ's export lamb. The region is characterised by long cold winters and cool moist summers. The traditional winter feeding systems based on hay and basic crops have been replaced during the past 20 years by grazed grass. An all-grass farming concept was developed from research investigation into rotation lengths, autumn saved pasture and the effects of trampling. Grass feed rationing, increased stocking rates and lambing percentages using grass budgeting and electric fencing have benefited farmers through lower winter feed costs. Over a 95 day winter, sheep are grazed at the rate of 250 ewes per ha in daily shifts.

Hill country

Some 8000 of the 21,300 sheep/beef farms with over 750 stock units are classified as hill country. About 85% of them are situated in the North Is., 400-700 ha in size and carry 8 to 10 stock units per ha. Cattle ratios are generally

1 beast to 10 sheep. It is common for an owner/operator to run 3500 stock units on his own. Electric fencing is widely used and many 400 ha farms have increased the number of paddocks from 30 to 60, giving better control and utilisation of pasture.

South Island hill country farms are larger, up to 1700 ha. Fine wool sheep breeds are run at 3-4 stock units per ha.

High country farms

These are situated at higher altitudes in the South Is. with extensive tussock grassland grazing and are subject to severe weather hazards. They occupy 15% of NZ farmland; average size is 11,000 ha and flock size is 8000 sheep. Rainfall varies from 250 mm in Otago to 10,000 mm in the Main Divide. Wool provides 60-70% of the income with store stock sold. Stocking rates vary from 1 sheep per 1.5 ha to 1 sheep per 4 ha.

Easy care ewes

The most popular breed is the Romney, an English breed, but further developed in NZ as a dual purpose breed for both meat and wool production. It has been cross-bred with the coarser wooled Border Leicester from which the Coopworth has been developed for higher fertility, meat and wool production. Research and development on this breed at Lincoln College, Canterbury includes a sire reference scheme using A.I. and laparoscopy and 30 cooperating breeders. Selection pressure is intense for fertility, growth rate and clean fleece weight; only 2 sires are selected from a recorded pool of 350-400 sires.

Easy care means that ewes lamb down unassisted - there is no intervention by the stockman. Selection for this trait has been on-going for many years and has resulted in improvements in mothering ability. The Coopworth is an example.

The Perindale (Romney x Cheviot) is another crossbred type developed to suit local conditions. It is hardier than the Romney, bred for survival in the high country and has 'easy care' attributes.

Most flocks are self-contained with up to 50% of the ewes being mated with sires of their own breed and the remainder with terminal sires such as Suffolk, Hampshire Down or Texel.

Responses to removal of subsidies

The removal of subsidies in the mid 80's forced farmers to change their management policies in order to maintain farm viability. All non-production costs were terminated e.g. chemical sprays ('some jobs just were not done'). Fixed costs and machinery expenditure were severely curtailed. Hired labour was terminated.

Some farms had insufficient units of production, hectares of land or stock numbers to maintain profitability under the existing cost structure; some farms were over capitalised. As a result there has been considerable restructuring in terms of farm size. It is now considered that an economically viable hill farm for one labour unit is 400 ha compared with 100 ha 20 years ago.

There was also a sharp re-focus on choice of expenditure for the best financial returns. Policy changes on the farm involved: (i) reduction in sheep numbers in order to improve the quality of the remainder; (2) increase in cattle numbers and a greater proportion of young stock finished on the farm; (3) introduction of a bull beef enterprise on some farms to increase whole farm profitability; (4) diversification into forestry, deer or fruit enterprises.

Lean meat growth-measurement service

The meat processing industry in NZ requires heavier, leaner lamb. Farmers have used husbandry and management methods to partially meet the market requirements but presently well designed breeding programmes will provide superior rams to lamb producers. The result of this research is an index which incorporates liveweight, fat depth and muscle depth. An index value is calculated for each animal. The index values of individual animals together with fat and muscle depths are returned to breeders in a ranking list to assist with selection and sale. By using the animals with the highest values within the breeder's flock, the breeder makes genetic progress for lean meat growth.

Resistance to anthelmintics

The desire to eliminate worm drenching in NZ flocks arises, not because of the cost but because of the emergence of resistance to anthelmintics. Moreover there is increasing consumer concern regarding chemical residues in food.

Regular drenching at 3-week intervals post-weaning is considered in NZ to be a strong contributory factor to the development of resistance in worm parasites. Similar trends have been observed in the U.K. New Zealand researchers are attempting to develop new sheep production systems aimed at eliminating the need for drenching by: (1) using sheep that are genetically selected for worm parasite resistance and, (2) using grazing methods that minimise worm larvae ingestion.

This twin pronged approach embraces both breeding and management strategies. The sheep breeding trials involve progeny testing and selection of Romney breeding stock for low faecal egg output of Haemonchus, Ostertagia, Trichostrongyloids and Nematodirus species. Faecal samples from the progeny of rams selected for resistance or non-resistance are examined on a monthly basis. The resistant sheep have relatively low faecal egg output. The heritability of worm resistance has been estimated at 33%.

But without suitable grazing management the worm challenge is still high. Incompatibility between sheep and cattle nematodes is being exploited by introducing cattle to the grazing rotation in order to reduce larval ingestion by sheep. In this way, it is considered that the worm parasite cycle for sheep can be broken. From lambing until weaning at 12 weeks of age, cattle are grazed on part of the farm, with the ewes plus lambs grazing behind them in a leader/follower fashion. After weaning, the lambs are transferred to fresh pasture on the remainder of the farm.

Fig. 1 shows the results of a trial in which equal numbers of lambs sired by resistant and non-resistant rams were managed together in the same grazing

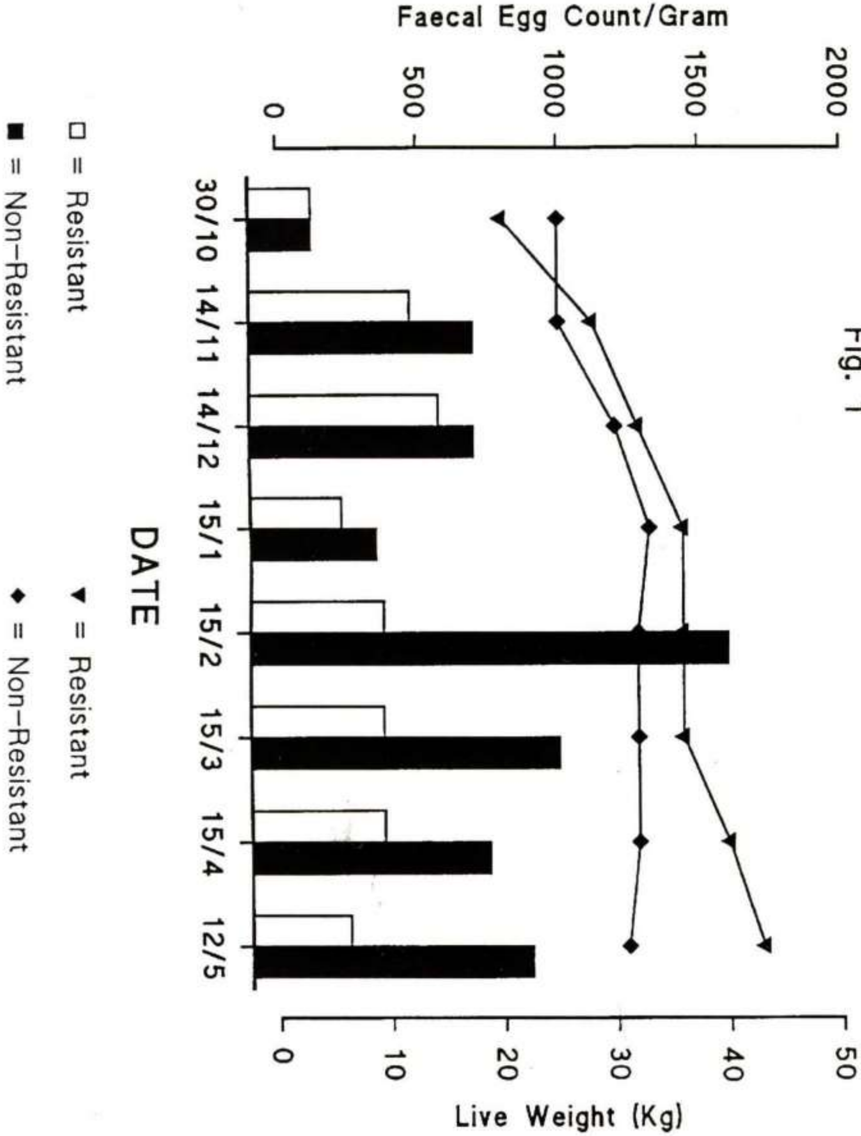

Faecal Egg Count/Gram
0
500
1000
1500
2000
30/10
14/11
14/12
15/1
15/2
15/3
15/4
12/5
DATE
0
10
20
30
40
50
Live Weight (Kg)
□ = Resistant
■ = Non-Resistant
▼ = Resistant
◆ = Non-Resistant

Fig. 1

system. In the early part of the sheep production year there was little difference between the two categories of lambs either in faecal egg count or in liveweight gain, because the pasture was relatively clean. After weaning in February, however, non-resistant lambs had up to 2000 eggs per gram compared with under 500 eggs in resistant lambs. As a result, the liveweight gains of non-resistant lambs declined whereas resistant lambs continued to thrive. The non-resistant lambs were eventually drenched for welfare reasons.

As there are no new types of worm drenches on the horizon this research will be watched with interest.

Acknowledgements

I wish to acknowledge and to express thanks for financial assistance from the Irish Grassland and Animal Production Association, Teagasc and Farm Business Developments for attending the XVII International Grassland Congress in New Zealand/Queensland.

Milk Production in New Zealand

S. FITZGERALD
Teagasc, Moorepark, Fermoy, Co. Cork.

Introduction

The purpose of my visit to New Zealand in February 1993 was threefold:-

(1) To attend the XVII International Grassland Congress which was held at Massey University, Palmerston North and subsequently at Hamilton.

(2) To visit research organisations and university faculties engaged in research on grassland and animal production, particularly dairying.

(3) To visit dairy farms in the North and South Islands and observe New Zealand grassland farming in practice.

International Grassland Congress

There was a large attendance (1400) at the Congress from all over the world. The main theme of the Congress was sustainable animal production from the grasslands of the world. The grassland systems discussed varied widely in nature, e.g. intensive temperate grassland, arid/semi-arid zones, distinct wet/dry zones, humid subtropical/tropical zones, winter cold temperate rangelands. Separate sessions dealt with various aspects of grassland production and utilisation, e.g. plant growth and physiology, plant breeding, nutrition, pests and diseases, nutritive value of forages, grassland management, utilisation and animal production systems. In the underdeveloped countries the main concern was to sustain viable systems of grassland farming against a background of an expansion in population and climatic changes. In the developed countries where intensive production is practised concern was focussed on the detrimental effects on the environment and the high reliance of inputs from outside the system, e.g. nitrogen fertiliser, fossil fuel, imported feeds and irrigation to sustain high levels of production in an era when many of these countries are more than self-sufficient in the main products of grassland, i.e. dairy produce, meat and fibre.

Animal production from most grassland systems in the world is low due to the extensive systems of grazing adopted to maintain the systems and the high cost or impracticability of using inputs, e.g. fertiliser or supplementary feed. High levels of production from grassland are mainly associated with the temperate or continental grassland zones of the developed world, e.g. North West Europe, South East Australia, New Zealand, East Coast and Mid-West of U.S.A. However, much of this production is dependent on feeds other than grass, e.g. maize, sorghum, cereal grains, lucerne and fodder crops, often constituting more than half of the animal's diet. Ireland and New Zealand are the only two countries where intensive animal production systems are largely based on grassland. Intensive animal production mainly from grassland is the exception rather than the rule on a worldwide scale.

Weather and grass growth in New Zealand

New Zealand is located about 1600 km east of Southern Australia between 34-47° south of the equator and is therefore much more favourably located than Ireland (51-56°N) in terms of solar radiation and winter temperature. Aspects of weather and grass growth in New Zealand are dealt with in detail in another paper in this proceedings (E. G. O'Riordan, Grange) and only will be outlined briefly in this paper. The total sunshine hours/annum range from 1600-2100 hrs in New Zealand (Southlands - Auckland) compared with a range of 1200-1500 hrs in Ireland. Mean daily air temperature in the North Island (Hamilton and Palmerston North) range from 8-9°C in winter (June-August) to 17-19°C in summer (Dec.-Feb.) compared with 5°C in winter (Dec.-Feb.) and 14°C in summer (June-Aug.) at Moorepark. In the Southlands, i.e. the southern part of the South Island, which most resembles Ireland climatically, temperatures in spring and early summer are 1-2°C higher than at Moorepark and consequently is more favourable for early spring grass growth. During late summer, autumn and early winter temperatures at Southland are similar to Moorepark but the duration of sunshine is significantly higher at Southland (Fig. 1).

The distribution of rainfall in New Zealand is very much influenced by the mountainy terrain in the centre of the North Island and the Southern Alps running along the entire length of the South Island. Rain-bearing South westerly winds blowing in from the Tasman sea provide a good distribution of rain, i.e. 1000-1200 mm (40-50 ins) in the western part of the North Island, except in mid-summer in inland areas, whereas the eastern areas (Hawkes Bay) receive 500-700 mm (20-30 ins) and are very dry in summer. In the South Island rainfall is extremely variable between the west and east coast. The west coast area (Westland) receives a very high rainfall of 2500-4000 mm (100-150 ins) whereas the east coast (Canterbury and Otago) which are sheltered by the Alps receive very little, particularly in inland areas, i.e. 400-800 mm (15-30 ins) and is usually subject to a prolonged summer drought. The Southlands area which is not sheltered by the Alps receives a higher rainfall of about 1000 mm (40 ins), similar to the South of Ireland.

Due to the higher temperature and solar radiation the pattern of grass growth in New Zealand is much more uniform than in Ireland. In the North Island grass growth in winter is in the range of 15-20 kg DM/ha and rises gradually to a peak of 50-70 kg DM/ha by early summer (October/November). Grass growth often declines to 20-30 kg DM/ha due to midsummer drought and rises again in autumn to 30 kg DM/ha. This pattern is in marked contrast to the pattern of grass growth in Ireland, e.g. Moorepark which is characterised by little growth in winter (5 kg DM/ha) until early March, followed by rapid growth to a peak of 100-120 kg DM/ha in May and a steady decline thereafter to less than 20 kg DM/ha in October/November (See Figs. 3-4 in E. O'Riordan's paper). In terms of animal feed requirements there is therefore far less need or scope for grass conservation as hay or silage in late spring/early summer in the North Island of New Zealand and less need for winter feed compared with Ireland. In the south of the South Island the pattern of grass growth at Invermay (near Dunedin) is slower in spring, rising to a peak of 60 kg DM/ha in October, declines steadily to about 20 kg DM/

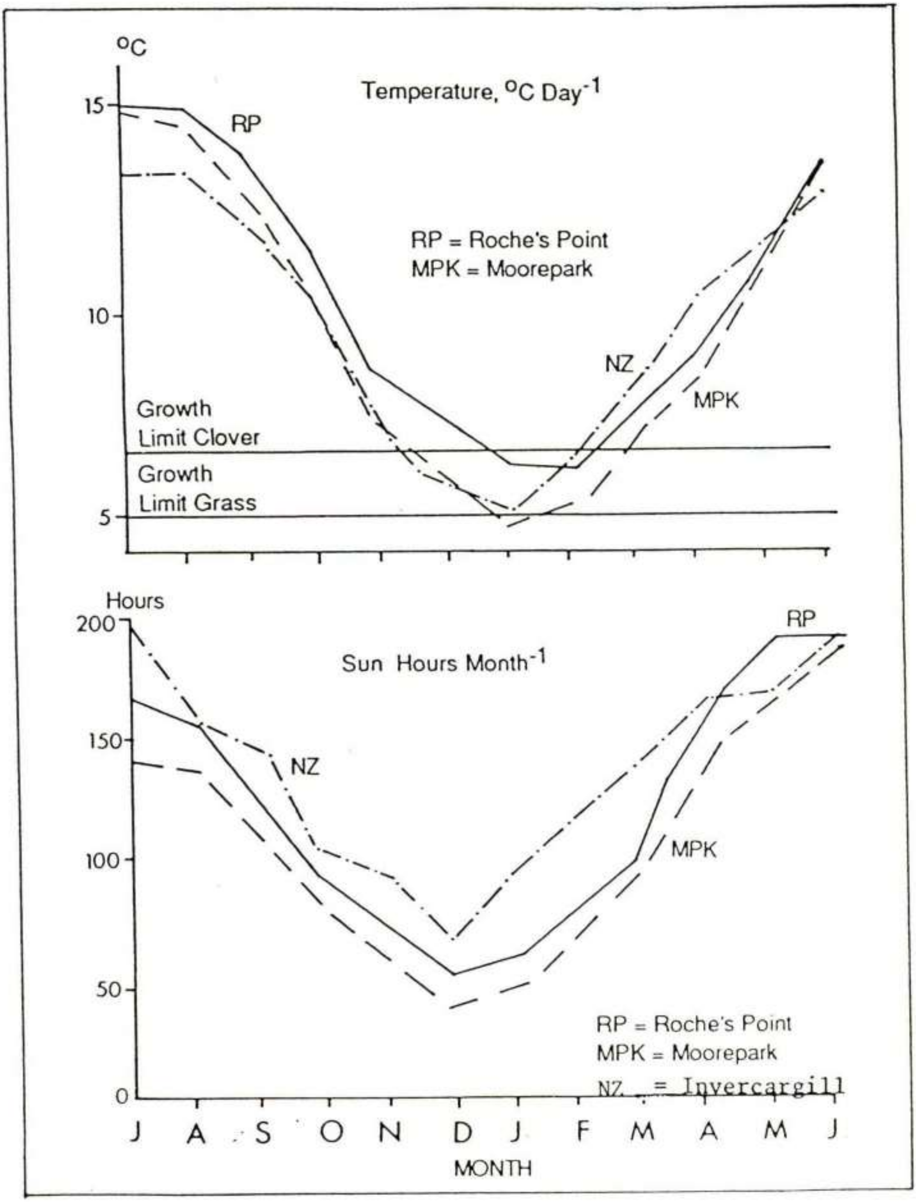


Fig. 1 – Climatic comparisons between South of Ireland and Southland, New Zealand. (Brereton, 1991)

ha in autumn (April) and to less than 10 kg DM/ha in winter. Thus grass growth in the South Island is fairly similar to Moorepark in winter but is much earlier in spring and doesn't produce as much growth in summer (See Fig. 5 in E. O'Riordan's paper). There is considerable variation in the amount and pattern of grass growth in New Zealand due to location and the wide variation in rainfall (Fig. 2). Sustained levels of grass growth are achieved from September to April in areas which receive adequate rainfall in summer, e.g. Northlands and Southlands whereas in the dry areas, e.g. Canterbury and Otago summer growth can be poor and variable. Irrigation is practised on many dairy farms in the Canterbury area to ensure grass growth. Conserved grass in the form of hay/silage or bought-in feed is used as much to supplement poor pasture growth in mid summer in the drier areas as it is for supplementing winter pasture.

Milk production in New Zealand

Most of the livestock in New Zealand are located in the North Island, i.e. 90% of the dairy cattle, 80% of the beef cattle and 50% of the sheep. Three-quarters of the people also live there. Consequently, from an agricultural and economic perspective the North Island is by far the most important. There are 14,500 dairy farms in New Zealand and three-quarters (77%) of those are located on the western side of the North Island, i.e. Northlands, Waikato and Tarinaki. The biggest concentration of dairy farmers (6,300 - 45%) occur in the Waikato area. There are only 1,200 dairy farms (9%) in the South Island. These are located in three main areas, i.e. Westland/Nelson area (620), Canterbury (280) and Southland (300). However, the number of dairy farmers in the South Island is growing as more dairy farmers and sharemilkers move south to either start up or expand their operation with larger herds, due to the cheaper price of land.

The number of dairy farms has declined from 18,500 in 1974/75 while cow numbers have increased from 2.08 to 2.44 million (Table 1) resulting in an increase of 43% in the amount of milk delivered for processing. This represents 96% of all milk produced. The average herd size is 170 cows, producing 157 kg milk fat/cow (=930 gls at 3.6% fat) at a stocking rate of 2.4 cows/ha. Herd size and milk fat production per cow and per hectare have increased progressively over the last 20 years (Table 2). There is considerable emphasis on milk recording and currently 60% of herds involving 66% of all cows are milk-

Table 1
Trends in cow numbers and milk supply in New Zealand

Season	Herds (1,000)	Cows (million)	Factory Supply Milk (million l)	Factory Supply Fat million kg)
1974/75	18.5	2.08	5222	244
1984/85	15.9	2.28	6965	332
1991/92	14.5	2.44	7441	363

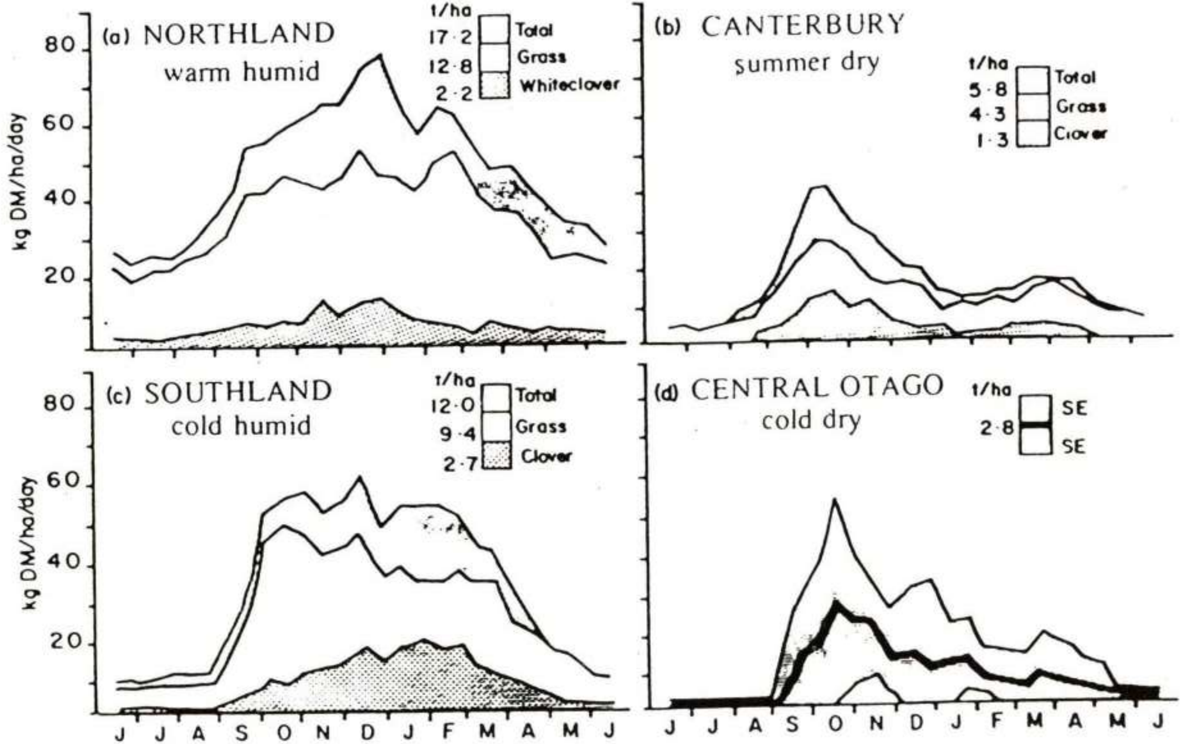


Fig. 2 – Typical seasonal patterns of pasture production in New Zealand, showing the daily accumulation rates (kg DM/ha/d) for clover, grass and the total pasture. Mean annual production is also given (t DM/ha) (Source, 2.54.57.58).

Source: Livestock Feeding on Pasture. NZSAP Publ. No. 10.

Table 2
Trends in average herd size and milk production per farm

Season	Herd Size (No.)	Milk Fat Production Per Farm Kg	Per Cow Kg	Farm Size Ha	Stocking Rate Cows/Ha	Milkfat /ha Kg
1974/75	113	14,400	128	-	-	-
1981/82	133	19,090	144	63	2.1	310
1986/87	151	20,885	138	65	2.4	331
1991/92	170	26,567	157	70	2.4	377

LIC Data, 1991/92.

Table 3
Trends in milk yield and composition in recorded herds in New Zealand

Season	Cows Tested %	Milk l/cow	Fat Kg/cow	Fat %	Protein Kg/cow	Protein %
1970/71	32	2809	134	4.77	-	-
1980/81	45	3331	160	4.80	-	-
1991/92	66	3361	162	4.83	124	3.70

recorded. This level has increased progressively over the years except for a period in the late 80's. Milk production per cow in recorded herds has increased from 1970/71 but only to a small extent since 1980/81 (Table 3). This may be a reflection of a dilution effect by the increasing numbers of herds of average or below average production which are now being tested. Milk fat composition is quite high (4.8%) and has changed little over the years, possibly due to a change in breeding policy from Jerseys to Friesians. Milk protein content is high at 3.7%.

Over half of the recorded cows are Friesian (53%) while Jerseys (21%), crossbred Friesian x Jersey cows (12%) and other breeds, mainly Ayrshire and Shorthorn (14%) represent the main breed types (Table 4). The highest concen-

Table 4
Breed type of dairy cows in recorded herds (1991/92)

Breed Type (%)	New Zealand	Taranaki	South Island
Holstein/Friesian	53	35	66
Jersey	21	32	16
Fr. x Jy.	12	16	8
Others	14	17	10

LIC Data, 1991/92

Table 5
Milk production by breed type in recorded herds (1991/92)

Breed	Days in Milk	Milk Yield (l)	Milk Fat		Protein	
			Kg/cow	%	Kg/cow	%
Holst./Friesian	222	3595	161	4.50	127	3.53
Jersey	227	2742	161	5.87	116	4.22
Fr. x Jy.	226	3364	169	5.06	127	3.79
Ayrshire	228	3415	150	4.39	124	3.64

LIC Data, 1991/92

tration of Jersey cows and crossbreds (48%) are found in the Taranaki area, while the highest concentration of Friesians occur in the South Island. In these herds the average lactation length is similar for the different breeds (226 days). The Friesians produce more milk than the Jerseys but of a lower fat and protein content while the crossbred cows are intermediate (Table 5). However, the three breed types produce a similar yield of milk fat while protein yield is less for the Jerseys. The fat and protein composition of the Friesian cows is quite high by Irish standards and may be a reflection of a Jersey ancestry coupled with a breeding policy to improve fat content over the past 30 years. Milk protein content is becoming of increasing importance and in that regard the fat to protein ratio of milk is better for Friesians (0.78) than for Jerseys (0.72) or the crossbred cows (0.75).

Milk processing for export

The pattern of milk production is even more seasonal in New Zealand than in Ireland. Virtually no milk is produced in the winter months of June/July other than for the liquid trade. Milk processing rises to a peak in October/November, i.e. 50 million kg milk fat/month and declines gradually thereafter. Milk is processed by 16 co-operatives, 5 large and 11 small cooperatives, 9 of which are located in the South Island. Over 7 million tonnes of milk is processed annually. The main dairy products are butter, milk powder, cheese, casein and food ingredients. About 80% of dairy products are exported exclusively through the New Zealand Dairy Board which has a number of subsidiary companies located around the world. New Zealand accounts for only a small proportion (1.5%) of total world milk production. Nevertheless its exports of dairy produce, which represent only 1.2% of world milk production, accounts for about 25% of the world market trade, which is dominated by the European Union and U.S.A. International trade in dairy produce accounts for only a small fraction (5%) of world milk production.

The New Zealand Dairy Board, which is farmer owned, controls all exports of dairy produce, co-ordinates the type of product required for foreign markets and determines the direction of research and development into new products for these markets. A subsidiary company, the Livestock Improvement Corporation

(LIC) is responsible for on-farm developments such as dairy herd recording, breeding, selection and progeny testing of bulls, A.I., special advisory service to farmers via the Consulting Officers, processing of farm data and providing farm management information.

Main features of dairy farming in New Zealand

There are a number of features which characterise the type of dairy farming and system of milk production which has developed in New Zealand.

(1) Low cost system of milk production

The milk price paid to farmers is dependent solely on world market prices. There are no subsidies or price supports since the mid-eighties. Milk prices at farm level have fluctuated from NZ$ 4-6/kg milk fat (= 24-38 IRp/gallon) in recent years. The cost of milk production, based on a recent survey of 200 dairy farms, ranged from NZ$2.46 to 4.46/kg milk fat, equivalent to 15-27 IRp/gallon from the top 25% to the bottom 25% of the sample, based on profitability. The net profit margin or economic farm surplus ranged from NZ$1.70-3.87/kg milk fat, equivalent to 10-23 IR p/gallon (Deane, 1993).

(2) Grass/clover based systems of milk production

Most of the milk is produced during the active grass-growing season. Cows start to calve 6-8 weeks ahead of the point where grass growth equals feed demand. Calving starts in mid-late July in the North Island and mid-August in the South Island. These cows graze on pasture built up in the previous autumn/ early winter. Most cows will be calved by the time grass growth takes off. Generally no concentrates are fed and conserved hay, silage or maize is fed during periods of feed deficit, e.g. during a summer drought, early winter or in a late spring. Nitrogen is applied (25-50 kg N/ha) on most dairy farms to boost grass growth in early spring and in autumn. White clover is relied on to supply nitrogen during most of the season but fertiliser nitrogen is being increasingly used on intensive dairy farms in recent years.

(3) Large herd size - high output per labour unit

By Irish standards dairy herds are quite large. A typical herd contains 150-200 cows, managed by one family unit. Only 20% of herds are less than 100 cows. Herd sizes are increasing and a number of very large herds (400-800 cows) exist. There is a considerable emphasis on a high throughput of cows through the milking parlour, e.g. 150 cows per labour unit in 1.5 hours.

(4) Compact calving

To maximise milk production from grass considerable emphasis is placed on compact calving so that the bulk of the herd have calved down before grass growth takes off in spring. Tailpainting before and during the breeding season is widely practised to achieve a high submission rate (90%). A.I. is widely used during the first 6 weeks followed by natural service for the next 6 weeks. Over 70% of cows calve in the first 4 weeks. Late calving cows are induced to calve prematurely in many herds to shorten the calving season. These cows represent

0-20% of cows in a herd. Heifers, late calvers and cows not detected in heat are synchronised to induce oestrus in many herds.

(5) High genetic merit herds

A high proportion of cows (66%) are milk-recorded. Dairy herd replacements are generally bred from the top 50% of cows on a genetic breeding index basis. High genetic merit bulls are widely used. These are selected from 150 bulls submitted annually for performance and progeny testing. The top herds may breed all cows to dairy bulls to produce surplus heifers for sale. Herd replacement rates are 20-25%, resulting in fairly rapid genetic progress.

(6) Off-wintering of dry cows on drystock farms

Off-wintering of dry cows is practised by many intensive dairy farmers. This practice permits higher stocking rates on the home farm, reduces conserved feed requirements, allows for a longer lactation and the whole farm is rested until calving. Heifers are also contract-reared on outside farms.

(7) Capital investment priorities

The main capital investment in New Zealand dairy farms, apart from cows, is in providing a good milking facility, collection yard, roads and fencing. Investment in other types of housing and machinery is minimal. Usually a hay barn is used for storing hay, rearing calves, storing machinery, etc. On some farms there may be a feeding pad for feeding cows off the pasture. Machinery usually consists of a low HP tractor, fertiliser spreader, silage feeding wagon, sprayer, pick-up truck and motor bike. The main emphasis is to obtain a good return on investment and to increase the net worth of the farm.

(8) Share milking system

A very successful share milking system has operated for many years and has facilitated the entry of new blood from many sources into dairy farming. Various schemes exist, e.g. 29-50% arrangements, whereby the share milker owns part or all of the herd, the land and facilities are supplied by the owner, and the expenses and profits are divided on an agreed basis. In due course sharemilkers move onto bigger farms and eventually purchase their own farms. This system builds up a highly skilled and motivated labour force, enables older established farmers to phase out of active farming and ensures mobility and expansion in the industry. However, the high cost of land is limiting the opportunity for sharemilkers to purchase their own farms.

Year-round grassland management on New Zealand dairy farms

Despite the wide variation in soil type and rainfall in New Zealand, the system of grassland management on most dairy farms follow a general pattern, with some local variations. The main objective on all farms is to convert grazed grass into milk with the minimum of supplementary feeding and to winter the cows during the dry period as cheaply as possible. During the dry period (May/July) on farms where cows are wintered on the home farm, cows are grazed restrictedly on winter pasture and supplemented with hay/silage to maintain them in moderate condition until calving. Pasture cover is built up in the autumn as cows are dried off or culled and restricted grazing begins, following an application of

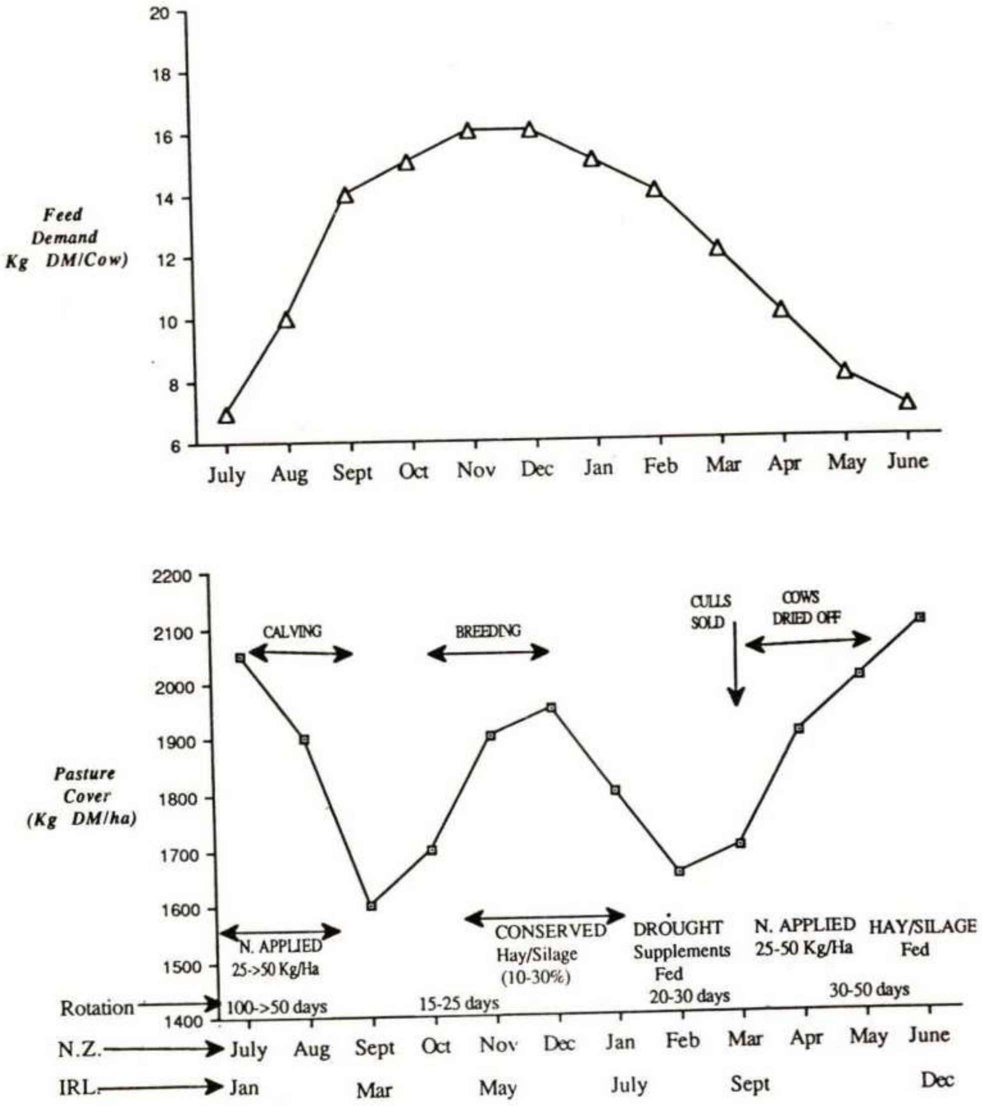


Fig. 3 – Grassland management and pasture cover to meet feed demand on a New Zealand dairy farm.

nitrogen (30-50 kg/ha) to provide an average cover of 2000 kg DM/ha over the whole farm at the start of calving (Fig. 3). The cows are strip grazed using back fences in a long rotation over the winter (90-120 days). Supplementary feed, e.g. hay/silage or other crops, tend to be fed in early winter until the required pasture cover is reached, usually on the grazed area, but in some cases in specially constructed feeding areas. Wintering pads are provided on some farms in wetter areas or heavy soils to which cows are moved after grazing. When cows calve down in spring (July/August in North Island) the pasture allocation is increased to provide 16 kg DM/cow/day to the milking cows and the pasture cover on the farm is gradually reduced to about 1500 kg DMlha by September. Hay or silage supplements are fed during this period if grass cover is not adequate to sustain milk production. Nitrogen is applied (25-50 kg N/ha) to boost grass growth in the grazed area. From mid-September onwards grass growth is usually adequate in the North Island to meet the level of feed required at peak lactation. Cows are rotationally grazed (16-24 day rotation) during October/November to achieve maximum milk production from grass and to ensure a high intake during the breeding season. Pasture cover gradually increases to 1800-2000 kg DM/ha. Surplus grass (usually 10-30% of the farm) is conserved as hay or silage but preference is given to the cows and on some farms no grass is conserved. Maize is grown on some farms as a green feed during summer drought. In summer (December/February) grass growth is often poor (10-30 kg DM/ha) due to a moisture deficit and supplementary feeds, e.g. hay, silage or green maize are fed to maintain milk production. Deferred pasture accumulated from spring is strip grazed in certain areas, e.g. Tarinaki. Irrigation is practised in dry areas, e.g. Canterbury.

In autumn (March/April) there is usually a flush of growth as the moisture deficit is reduced. However, the emphasis is switched from maintaining milk production to building up grass reserves for the winter, even at the expense of the current yield. Grazing is restricted to extend the rotation (30-50 days). Feed demand is reduced by selling off cull cows, drying off low yielding cows and heifers and grass growth is boosted by applying nitrogen fertiliser (25-50 kg N/ha). Cow body condition is improved to achieve a moderate score of 5 (=2.5 Irish score). In early winter (May) the remaining cows are dried off and the pasture is rationed and grazed tightly down to less than 1000 kg DM/ha over the winter months in a long rotation. On many dairy farms the cows are off-wintered on other farms, e.g. sheep farms for all or part of the winter. Replacement heifers are usually reared off the dairy farm, i.e. contract reared by other farmers or on an out-farm, or "run off" area and join the herd prior to calving. Monitoring of pasture cover going into the winter is an important aspect of feed budgeting since conserved feed, e.g. hay/silage usually represents only a small part (30-50%) of the total winter feed requirements. In a recent survey about half of the dairy farmers who responded aimed for a target pasture cover at calving either by regular assessment or extended rotation. Assessment was done mainly by eye appraisal (90%), while relatively few used plate meters (9%), or pasture probes (3%). Only 22% of farmers formally prepared a feed budget (Parker et al., 1993).

Dairy farming in the Southlands

The Southlands, i.e. the southern part of the South Island, is climatically closest to Ireland. There, the cows calve later, e.g. August/September, due to the longer winter and later growth in spring compared with the North Island. The requirements for winter feed are also much greater. Dairy herds can be classified into two categories, i.e. "self-contained" or "milking platforms" (Ms. Gail Wylie, LIC Consulting Officer, personal communication). On the self-contained farms all winter feed is made on the farm and replacement stock are reared on the farm. The stocking rates are usually 1.6-2.4 cows/ha producing 270-440 kg milkfat/ha. Winter feed requirements are 9-10 kg DM/cow, since cows are generally larger (mainly Friesian) and weather is colder than in the North Island. Conserved feed requirements are in the region of 1000-1100 kg DM/cow. This includes an average of 600 kg DM/cow as hay or silage and 200 kg DM/cow as crops, e.g. kale or swedes for feeding during the winter. About 250 kg DM/cow of hay or silage is fed to milking cows in autumn and spring. About 10-20% of winter feed requirements is obtained from grazed pasture when soil conditions allow. Thus total conserved feed requirements for self-contained herds in Southland are equivalent to 5-6 tonnes silage (20% DM), fairly similar to the requirements in the South of Ireland. About half of the dairy farms in Southland are described as milking platforms, i.e. milking cows only are carried on the farm during the grazing season. Replacement stock are reared off the farm until prior to calving. Cows are off-wintered either on another farm, e.g. a sheep farm or on a "run off" area which is separate from the dairy farm where they are fed hay/ silage plus brassica crops or they are wintered on a stand-off feed pad and fed mainly on purchased hay or silage.

On these farms the stocking rates are higher, e.g. 2.4-3.5 cows/ha and consequently milk production is higher (400-700 kg milkfat/ha) and they are generally more profitable. Conserved feed made on the dairy farm is of the order of 200-300 kg DM/cow to supplement pasture in autumn and to provide for a wet spring. The pasture on these farms is rested over the winter and is grazed only by in-calf heifers which are brought home for a month before calving starts.

Limitations and weaknesses in New Zealand dairying

New Zealand dairy farming is often held up as a model which Irish dairy farmers should follow. The system of dairy farming in New Zealand has evolved over the years to suit the climate, pattern of grass growth, scale of farming and distance from its main market outlets. While there are some similarities there are also differences between the two countries which must be taken into account. There are many progressive and highly motivated dairy farmers in New Zealand. However, the dairy industry there has its own limitations and weaknesses which must be recognised.

(1) Under-feeding of dairy cows and heifers

By Irish or European standards, New Zealand dairy cows are quite light and generally are in poorer condition. Jersey cows average about 350 kg while Friesians average about 450 kg, except in Southland (500 kg). Cows are calved down in moderate condition (BCS = 2.5) and are stocked heavily on intensive dairy farms with little supplementation. Cows with a high breeding index are seldom given an opportunity to realise their potential. Heifers are generally light at mating (280 kg) and calve down at light weights (380-400 kg). They have to compete with the other cows on intensively stocked farms and consequently about 25% of heifers are culled annually. There is a growing awareness of the need to feed cows better.

(2) Extremely seasonal pattern of milk production

The concentrated pattern of calving and limited supplementary feeding during early or late lactation results in a very high seasonal milk production peak in Oct./Nov. This results in a high investment in processing capacity which is severely stretched during the peak period and is poorly utilized during the remainder of the season. The current expansion in milk production will put even more pressure on the existing processing capacity. The short lactation length (220-230 days) of most dairy herds contributes to this problem. Better feeding, particularly in mid/late lactation would help to round out the seasonal pattern of milk production. Winter milk production is never likely to be economical in New Zealand apart from domestic liquid milk requirements.

(3) Variation in pasture production and quality

Apart from seasonal and regional variation in grass growth, many of the swards are very open, presumably due to repeated hard grazing in winter and during summer drought. Ingress of weeds are a problem, i.e. dandelion, docks and ragworth in the South Island. In dry areas perennial ryegrass performs poorly and other more drought-resistant species are being introduced, e.g. tall fescue, cocksfoot, paspalum. The white clover content of many swards is often less than expected (0-20%) and in many cases makes only a small contribution to sward fertility and productivity. Many dairy farmers are increasingly using fertiliser nitrogen throughout the season to overcome their dependence on clover. The use of nitrogen fertilizers has increased four-fold in recent years.

(4) Pasture pests and animal diseases

The roots of grass and clover are susceptible to attack from "grass grub" in the North Island, resulting in reduced productivity. The base of grass plants are subject to attack by Argentinian stem weevil. This problem can be overcome by sowing ryegrass varieties containing an endophyte (a fungus) which makes the plant resistant to attack from stem weevil. However the endophyte contains a toxin which gives rise to a neuromuscular disorder in cattle and sheep known as grass staggers. Cows are also susceptible to other disorders, e.g. grass tetany in spring, bloat on high clover swards and facial eczema. Preventative measures usually involve continuous drenching in the milking parlour during the periods of susceptibility.

(5) A conservative approach to dairying

Most dairy farmers have become accustomed to the "all grass" system of milk production which has evolved over the years with its emphasis on low cost milk production. They are reluctant to make changes in that system and there is a strong resistance to feeding supplements especially concentrates, which might increase feed costs. However, this attitude is beginning to change and given a period of stable or rising world market prices for dairy products, better feeding regimes, including more supplementation, are likely to be adopted.

(6) High priced land

In the intensive dairying regions of the North Island farmland suitable for dairying is becoming very expensive. Existing dairy farms are sold on the basis of current levels of production, i.e. NZ$30-40/kg milkfat which is equivalent to IR£1,500-2,000/acre, due to competition between dairy farmers, other land users, e.g. stud farmers, horticulturists and "hobby farmers" near towns and cities. This results in a high level of borrowings for new entrants, e.g. sharemilkers and is beginning to limit their numbers. As a result there is a movement by such people to the South Island and other less traditional areas to start up dairying in areas where land is cheaper and larger farms can be established.

Milk production on New Zealand dairy farms

Recent trials carried out at one of the Dairy Research Corporation farms at Ruakura have shown that high levels of milk production, e.g. 700 kg milkfat/ha and 500 kg milk protein/ha can be achieved when cows are intensively stocked at levels where milk production per cow was reduced when no supplements were fed during lactation. The maximum production of milk solids and income/ha was achieved at stocking rates of 3.0 Friesian cows/ha and 3.8-4.0 Jersey cows/ha. Higher levels of milkfat production/ha were achieved with Jersey cows than with Friesian cows as milk production/cow was depressed to a lesser extent at high stocking rates with Jersey cows compared with Friesians.

A recent survey of milk production costs and profitability from a representative sample of 198 dairy farmers throughout New Zealand has been carried out in the 1991/92 season by the Livestock Improvement Corporation (Deane, 1993). The farms involved represented a wide range in farming conditions, levels of production and farming ability. There was a strong linear relationship between stocking rate and milk fat production/ha (Fig. 4). The stocking rate ranged from 1-4 cows/ha (2.5-0.6 acs/cow) and milk fat production ranged from <100 to 750

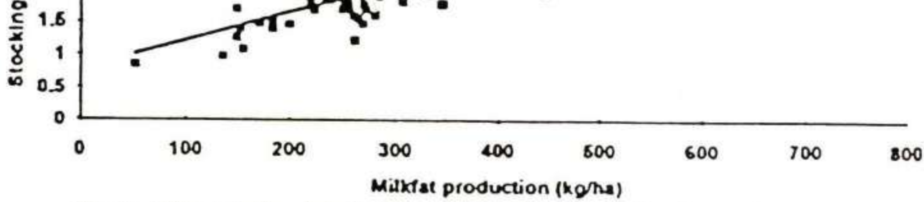


Fig 4 – The relationship between milk fat production/ha and stocking rate (R^2=0.79, m=0.0042, c=0.79).

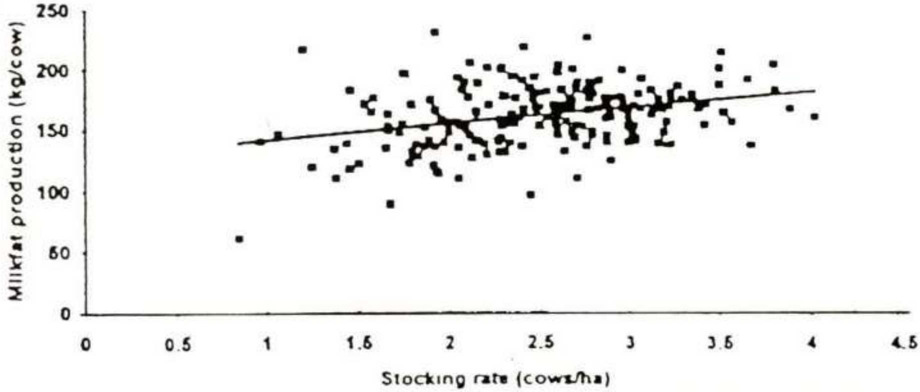


Fig 5 – The relationship between stocking rate and milk fat production/ cow (R^2=0.092, m=13.2, c=129.2).

(Deane, 1993)

kg milkfat/ha equivalent to a range of <240 to 1,800 gallons of milk/acre at 3.6% butterfat. There was no indication, over the wide range of farming conditions, cow potential and managerial ability involved, that milk yield per cow was depressed as stocking rate was reduced (Fig. 5). It may be surprising to many that such a wide range in stocking rate and production exists in New Zealand dairying. Farm receipts (income) per hectare were highly related to milk fat production/ha but farm expenses and overhead costs also increased (Fig. 6). The economic farm surplus or net profit margin/ha (i.e. money available to service debt, personal drawings, tax and reinvestment) also increased with increased milkfat production/ha but the relationship was weak, indicating that the same level of income was achieved at vastly different levels of production (Fig. 7).

When the data were classified into four quartiles based on the net profit margin/ha (Table 6) milk fat production per cow, per ha and stocking rate all

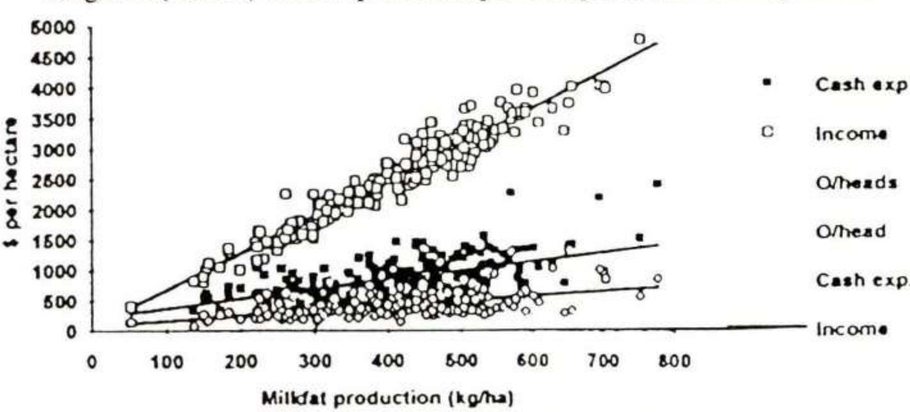


Fig 6 – The relationship between milkfat production/ha and income, cash expenses and overheads/ha (for income (R^2=0.93, m=6.02, c=75, for cash exp. R^2=0.31, m=1.55, c=222, for o/heads R^2=0.29, m=0.83, c=83).

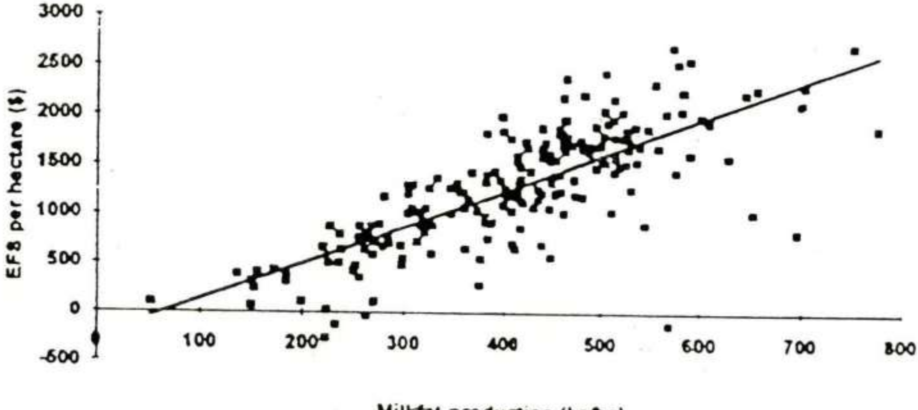


Fig 7 – The relationship between milk fat/ha and EFS/ha (R^2=0.58, m=3.65, c=–230).

(Deane, 1993)

increased going from the bottom 25% to the top 25%. Receipts (expressed as IR£/ac) almost doubled while total farm expenses increased slightly, resulting in an almost four-fold difference in profit margin/acre (£66 v 285/ac) between the bottom 25% and top 25%. When expressed on a gallonage basis, receipts were similar for all farms (averaging 36.6 p/gal) but expenses per gallon were considerably lower on the more profitable farms resulting in a much higher profit margin per gallon (22.9 v 10.0 p/gal). These results indicate the wide range in production and profitability which exist among New Zealand dairy farmers.

Table 6
Production and financial characteristics of New Zealand dairy farms based on profit margin/ha (1991/92)

Quartile		Q4 Bottom 25%	Q3 3rd 25%	Q2 2nd 25%	Ql Top 25%	Average
Milkfat	(kg/ha)	279	384	460	525	412
	(gl/ac)*	(662)	(912)	(1092)	(1246)	(978)
Milkfat	(kg/cow)	142	157	172	177	162
	(gl/cow)*	(843)	(932)	(1021)	(1050)	(962)
Stocking rate	(cows/ha)	1.9	2.5	2.7	3.0	2.53
	(ac/cow)	(1.3)	(1.0)	(0.9)	(0.8)	(1.0)
Receipts	£/ac.	241	328	400	466	359
Expenses	£/ac.	175	177	187	181	180
Net Profit	£/ac.	66	157	213	285	179
Receipts	p/gl.	36.4	36.0	36.6	37.4	36.6
Expenses	p/gl.	26.4	19.4	17.1	14.5	19.4
Net Profit	p/gl.	10.0	16.6	19.5	22.9	17.2

(Deane, 1993) * Based on 3.6% fat

Table 7
Variation in milk solids production/ha (Kg fat + protein) between dairy farms within different districts

District Potential	1 Moderate		2 Good		3 High	
	Prod./ha (Kg F+P)	Rel. to Top 10%	Prod./ha (Kg F+P)	Rel. to Top 10%	Prod./ha (Kg F+P)	Rel. to Top 10%
Group						
Top 10%	656		956		1019	
District Avg.	486	-35%	708	-35%	814	-25%
Bottom 25%	354	-85%	515	-86%	634	-61%

Source: Deane (1992).

The wide variation in milk production/ha between farms is not due solely to differences in soil type, climate and location. Within districts of different potential in terms of milk production the top 10% of milk producers produce 25-35% more milkfat + protein/ha than the district average while they produce 61-86% more than the bottom 25% (Table 7). These differences are likely to be due to a number of factors, e.g. higher stocking rates, differences in breed type or genetic potential of the cows, whether replacements are reared on or off the farm, off-wintering of dry cows, and differences in managerial ability, stockmanship and ambitions of the individual farmers.

The main factors determining a high output of milk solids/ha have been established from research at Ruakura and other centres. These are (1) stocking rate, (2) calving date and spread, (3) cow quality and (4) drying-off decisions in relation to feed supply. Other factors, including the management of feed supply are of minor importance compared with those listed above (Bryant, 1993).

Agricultural research in New Zealand

Government funding for "public good" research is channelled through an agency called the Foundation for Research, Science and Technology (FRST). The funds are administered through ten Crown Research Institutes which are responsible for the various research organisations involved in agriculture, industry, environment, etc. The research organisations most relevant to grassland, animal production and dairying are as follows:

Ag Research - NZ Pastoral Agricultural Research Institute.

It is responsible for all aspects of grassland and animal production research, other than dairying. It is divided into five main divisions located at different centres in New Zealand.

(1) Ruakura Research Centre (Hamilton) – animal production, physiology, nutrition

(2) AgResearch Grasslands (Palmerston North) – forage production, plant breeding, pastorial systems

(3) Animal Health & Disease Control (Wellington) – infectious diseases and parasites, reproduction

(4) AgResearch, Lincoln (near Christchurch) – environmental agriculture, plant protection, dryland agriculture

(5) Invermay Research Centre (Dunedin) – sheep and deer research, genetics, wool science.

Each of these centres have a large team of research personnel, extensive laboratory and farm facilities at the main campus. There are also a number of research stations attached to these centres, located in strategic soil type/climatic areas with a team of research and technical staff at each station to develop animal production systems suited to those areas.

Dairy Research Corporation (DRC)

This organisation is a joint venture between the New Zealand Dairy Board and the Ministry of Agriculture. It is responsible for all dairy farm production research. The staff and facilities include those formerly involved in dairy production research at the Ruakura Research Centre, Tarinaki Agricultural Research Station and the Lactation Physiology Dept. based at Ruakura Research Centre. Its main goal is to promote innovation in New Zealand dairy farm production and to enhance its competitiveness by increased production from existing systems (1750 kg milk solids/ha) through improved pasture production, better cow nutrition by strategic supplementation, control of metabolic diseases. reproduction and breeding, increasing the efficiency of milking and understanding the factors which control milk secretion. The research programme of DRC is funded by dairy farmers via the N.Z. Dairy Board and by contract research through FRST.

Dairy Research Institute (DRI)

This institute, which is based at Palmerston North, is responsible for research into milk processing and product development. It is mainly funded by the New Zealand Dairy Board (90%) and the research programme is driven by the requirements of the export market. It is involved in the development of a wide range of products and processes, e.g. casein products, milk powders, milk fat products, cheese technology, food ingredients, starters, whey products, flavours, protein chemistry, etc.

Massey University and Lincoln University

These two universities provide degree and diploma courses in agriculture. Post-graduate degree courses (M.Sc.) are also provided at Massey. Massey University has extensive land and animal facilities for educational and research purposes in dairying, beef, sheep and deer production. Lincoln University has more limited facilities. Prospective young farmers can undertake certificate courses in farming and farm business management at Community Colleges and Polytechnical Colleges throughout the country.

Advisory Service

The MAF advisory service, which was formerly available free to farmers, has been considerably reduced from 320 to 125 staff currently and is now available on a fee paying basis only. Management and financial advice is also provided by commercial consultants (90), company advisers and the Consulting Officers (33) of the Livestock Improvement Corporation. These have to provide a service to 56,000 livestock and crop farmers and 9,000 horticulturists.

Dairy Research and Development Funding

Funding for dairy production and processing research and development in New Zealand is largely paid for by the dairy industry and amounts to NZ$40 million, equivalent to IR£14 million per annum. This represents an average contribution of £1,000 per farmer or £6 per cow, or 0.8p per gallon of milk compared with the Dairy Research Levy in Ireland of 0.lp per gallon. The total investment in agricultural research in New Zealand, despite recent cutbacks, would be at least 3-4 times greater than in Ireland. This gives New Zealand a considerable advantage to expand their production, develop new products and gain access to world markets at the expense of Irish and other producers.

Conclusions

There are some similarities between the Irish and New Zealand dairy industries in that both are largely based on grassland, are seasonal producers and are largely export oriented. However, the North Island of New Zealand, where most of the dairy farming occurs, does have a climatic advantage in terms of temperature and sunshine. Grass production is more evenly distributed (except in mid-summer) and grass growth in winter is far higher in New Zealand, thereby considerably reducing the need for expensive winter feed. The ability to out-winter cows results in a considerable saving in terms of housing, slurry storage and disposal. This saving in winter feed and housing coupled with a much larger herd size enables New Zealand dairy farmers to produce milk at an extremely low price and survive at low world market prices. In the Southlands, the climate is more similar to that along the south coast of Ireland, but temperatures in early spring are higher in Southland, resulting in earlier grass growth. The amount of sunshine is also higher in Southland throughout the winter and this helps to dry out the soil as well as favouring grass growth. Self-contained dairy farms in Southland produce a lot of winter feed, approximately similar to dairy farms in the South of Ireland.

While there are these differences in climate, pattern of grass growth and the scale of operation between Irish and New Zealand dairy farming, there are, nevertheless, certain aspects of New Zealand dairy farming which are quite relevant to Irish dairy farmers. These are (1) the ability to match the overall stocking rate to the grass production potential of the farm so as to maximise production per hectare, where quota constraints do not operate, (2) calving the cows in a compact manner about a month ahead of the point where grass growth is expected to take off (i.e. February/March), (3) manage the pasture so as to maximise milk production through the main growing season, (4) extend the grazing season, where the stocking rate and soil type allows, by building up grass cover in autumn for grazing in early winter (November/December) and early spring (February/March), (5) milk recording of more herds, to identify the better cows for breeding and use of high RBI bulls to improve the genetic quality of the herd, (6) manage the farming operation as a business so as to maximise the farm net income and increase the net worth of the farm, (7) greater mobility into and out of dairy farming, which is a regular feature of New Zealand dairying, and the inflow of young blood via farm apprenticeship or sharemilking arrangements. The right to build up entitlement to a reasonable sized quota and transfer it onto their own farm ultimately would be essential if such a system is to operate successfully.

Acknowledgements

The author wishes to thank the Irish Grassland and Animal Production Association and Teagasc for the financial support to attend the International Grassland Congress and the subsequent study tour in New Zealand.

Sources

(1) Dairy Statistics 1991/92. Livestock Improvement, New Zealand Dairy Board.

(2) Deane, T. H. (1993). The relationship between milkfat production per hectare and economic farm surplus on New Zealand dairy farms. Proceedings of New Zealand Society of Animal Production. 53: 51-53.

(3) Deane, T. H. (1992). What should be measured on dairy farms? 44th Ruakura Farmers' Conference. pp. 102-107.

(4) Livestock Feeding on Pasture (Ed. A. M. Nicol). New Zealand Society of Animal Production Occasional Publication No. 10 (1987).

(5) Parker, W. J., Gray, D. I., Lockhart, J. C., Lynch, G. A. and Todd, E. A. G. (1993). Drying off management and the use of management aids on seasonal supply dairy farms. New Zealand Society of Animal Production 53rd Annual Conference. University of Waikato. Abstract 25.

(6) Bryant, A. M. (1993). Dairy farming in New Zealand. XVII International Grassland Congress. Hamilton.

(7) Brereton, A. J. (1991). Milk production systems in New Zealand and Ireland. Farm and Food. Teagasc. July/Sept. 1(3): 13-15.

(8) Wylie, G. Consulting Officer, Livestock Improvement Corporation, Invercargill (personal communication).

(9) O'Riordan, E. G. (1994). Beef production from New Zealand Grasslands. Irish