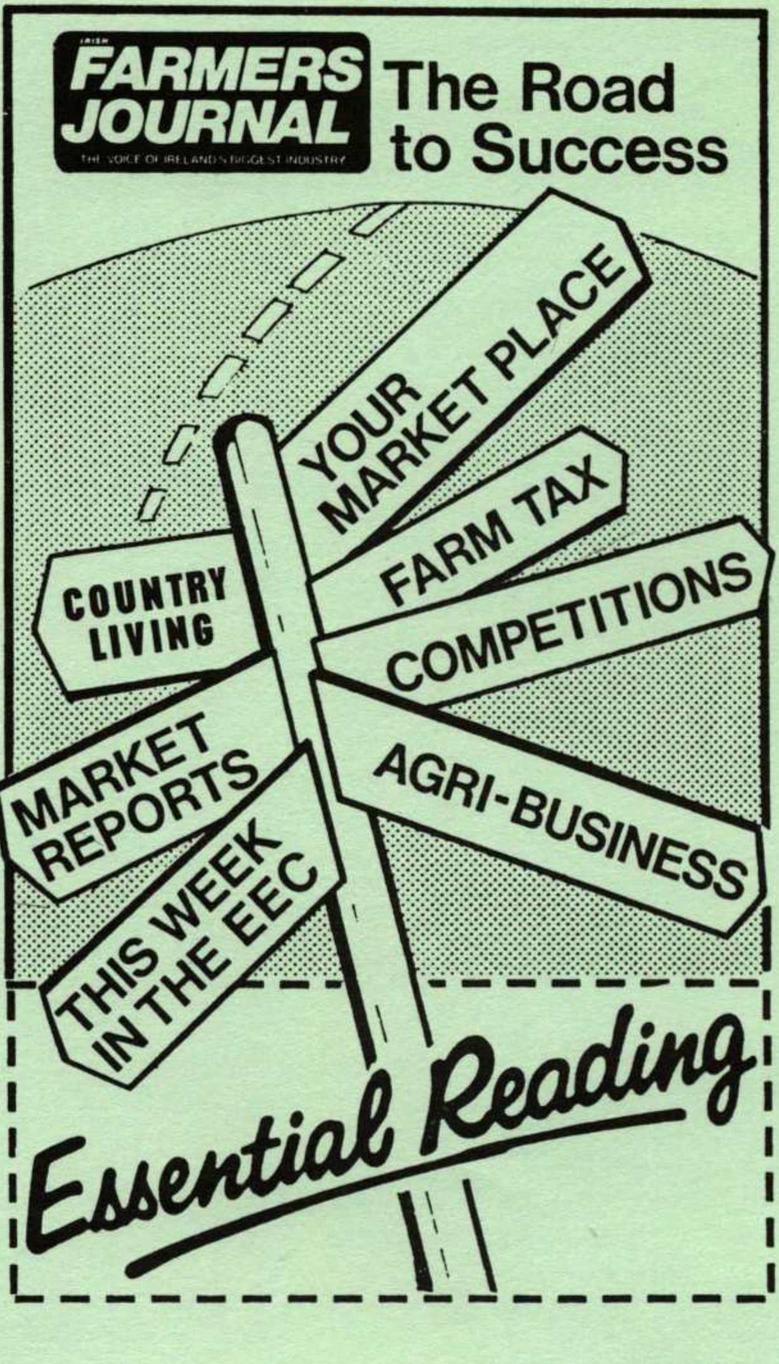
Irish Grassland & Animal Production Association Journal 1992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Irish Grassland and Animal Production Association

JOURNAL

Vol. 25 1992

Edited by
SEAN FLANAGAN

Printed by Wicklow Press Ltd., Wicklow

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COUNCIL 1991/92

Altering the Composition of Milk Fat by Dietary Means

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Introduction

Recent experiments on feeding whole oilseeds to dairy cows have resulted in milk fat containing increased levels of oleic acid (McGuffey and Schingoethe, 1982; De Peters et al., 1985; Murphy and McNeill, 1988 and Murphy et al., 1990). Oilseeds contain between 20 and 40% lipid and a high proportion of the fatty acids are unsaturated and contain 18 carbon atoms. The accepted mechanism whereby this alters the milk fatty acid composition is as follows. The polyunsaturated 18 carbon fatty acids are hydrogenated in the rumen to stearic acid. This is then absorbed from the intestine and it is converted to oleic acid in the mammary gland by an intramammary stearic acid desaturase, the presence of which has been demonstrated by Kinsella (1972). Thus, increasing the supply of stearic acid to the gland results in an increased level of oleic acid in the milk fat.

Milk fat high in oleic acid has two positive characteristics. Firstly, recent evidence suggests that oleic acid has a protective effect against the risk of coronary heart disease (CHD) in humans. A diet high in oleic acid reduced low density lipoprotein (LDL) cholesterol while leaving high density lipoprotein (HDL) cholesterol unchanged (Mattson and Grundy, 1985). The former is strongly associated with CHD while the latter is considered protective against it. Secondly, because the level of oleic acid is increased in the milkfat and simultaneously, the level of palmitic acid is reduced, the milk fat is significantly softer than usual. This permits the manufacture of butter with much improved spreadability characteristics. Such a butter, high in oleic acid and spreadable at refrigeration temperature, has been produced in a Moorepark study from the milk fat of full fat rapeseed (FFR) supplemented cows (Murphy et *al.*, 1991).

The purpose of this paper is to briefly review some of the results obtained at our Research Centre in this area of work.

Oilseed rape

Oilseed rape is an oilseed which is grown widely within the E.C. and approximately six million tonnes were grown in 1990. Generally the seed is processed to remove the oil which is used in margarine manufacture and the remaining rapeseed meal is used as an animal foodstuff. Almost all of the oilseed rape now grown is of the double zero type, which means it has low concentrations of both the anti-nutritional compounds, erucic acid and glucosinolates. The whole oilseed which will be referred to as full fat rapeseed (FFR) is high in feeding value, being high in both energy (21 MJ/kg DM) and crude protein (212g/kg DM). The oil content of FFR is over 400g/kg and the principal fatty

Table 1
The fatty acid composition of the milk fat produced on the diffferent concentrates indoors

	[1]Concentrate Mixture			
	Control	Low FFR	Med.FFR	High FFR
C4-C14	24.7	23.9	23.8	20.5
C16:0	30.7	29.5	26.1	24.3
C18:0	9.5	10.9	11.9	13.6
C18:1	23 .9	25.3	28.6	31.6

[1] Control 0g/kg FFR
Low FFR 80g/kg FFR
Med.FFR 140 g/kg FFR
High FFR 200 g/kg FFR

acids present are oleic acid (C18:1), 54g/lOOg fatty acids; linoleic acid (C18:2), 24g/lOOg fatty acids and linolenic acid (C18:3),. 13g/lOOg fatty acids. Thus, over 90 percent of the fatty acids present in oilseed rape are 18-carbon fatty acids. In order to obtain the best effect on fat composition the whole seed has to be processed so that the hard seed coat is broken (Murphy et al., 1991).

Feeding FFR indoors

An experiment was carried out where three different levels of FFR were fed to cows indoors on a grass-silage based diet (Murphy and Connolly 1989). The concentrate feeding level was 8 kg/cow/day. The concentrates contained 0, 80, 140 and 200 g/kg of FFR which corresponded to a FFR and rape oil intake of O kg and 0 g, 0.64 kg and 270 g, 1.12kg and 470 g and 1.6 kg and 670 g respectively. Four herds, of 16 cows each, were fed the respective concentrates for a 7 week period. Neither milk yield, milk constituent yield or milk composition were significantly different between concentrate treatments. The short to medium chain length fatty acids (C4:0-C16) in the milk fat were reduced whereas the C18:0 and C18:1 levels were increased with increased FFR feeding (Table 1). This change in fatty acid profile resulted in a softening of the milk fat, which was reflected in the reduced percent solid fat at 10°C in the milk fat. The values were 44.8, 42.9, 37.4 and 32.2 for milk fat produced on the control, low FFR, medium FFR and high FFR concentrates respectively. The latter value corresponds to the levels of solid fat at 10°C found in products (dairy spreads) spreadable at refrigeration temperatures.

Feeding FFR on pasture

Milk fat produced on pasture normally, has a higher content of C 18 :1 and is softer than that produced indoors due to the intake of 1 8-carbon fatty acids from grass. However, the fat is not spreadable at refrigeration temperatures.

Table 2
The fatty acid composition of the milk fat produced on the concentrate supplements at pasture

	[1]Concentrate Mixture		
	Control	Low FFR	High FFR
C4-C14	23.8	19.2	14.5
C16:0	23.7	19.8	18.1
C18:0	12.0	12.6	12.1
C18:1	29.0	36.3	42.7

[1]Control 0g/kg FFR
Low FFR 275g/kg FFR
High FFR 550g/kg FFR

Therefore, supplements containing 275 and 550 g/kg of FFR were fed at 3 kg/cow/day for an 8 week period between July and August. This corresponded to FFR and rape oil intakes of 0.83 kg and 340g and 1.65kg and 680g, per cow per day respectively. These two treatments were compared with a control group where no supplementation was given (Murphy and Connolly, 1991).

Both groups of cows receiving FFR supplements produced significantly higher milk, protein and lactose yields than the unsupplemented group. Milk fat concentration was significantly lower on the supplemented groups while milk fat yield and milk protein concentration were similar on all three groups. The changes in the fatty acid composition of the milk fat were in the same direction as those observed in the indoor experiment (Table 2). The changes were greatest in the group supplemented with the high FFR (550g/kg) where C16:0 was reduced to 18.1g/lOOg fatty acids and C18:1 was increased to 42.7g/lOOg fatty acids. Again, these changes were reflected in a reduction in the percent solid fat at l0°C from 40.1 in the control to 35.6 and 34.1 in the low FFR and high FFR treatments, respectively.

Butter manufacture and consumer acceptability study

A herd of 82 cows was fed 3.0 kg per head/day of a supplement containing 550g/kg of FFR, on pasture between mid-April and mid-May. Butter was manufactured by a batch churn process on two occasions from the milk fat produced by this herd and a batch of butter was also produced from a control unsupplemented herd. The C18:1 content of the control and treatment butters was 29 and 40g/lOOg fatty acids, respectively, with corresponding percent solid fat values at 10°C of 42.6 and 34.

The treatment butter was evaluated in a consumer acceptability study (Murphy *et al.*, 1991; Cowan and McIntyre, 1991). This was based on a structured selfreport questionnaire received as a result of in-home placement of the treatment butter, distributed to a judgemental sample of 135 Dublin households

Table 3

The response of consumers already using butter or full fat spreads to the treatment butter compared to their existing product

Existing Product	Butter	Full Fat Spread
Colour		
much better/better	16	50
same	77	40
Taste		
much better/better	23	53
same	57	34
Spreadability		
much better/better	70	21
same	27	45
General Acceptability		
much better/better	44	47
same	39	36

in the ABC[1]socio-economic group. Only one summary table is shown here (Table 3). This shows the response of consumers, whose usual product was butter or full fat spreads (dairy spreads, margarine), to the treatment butter under the heading of colour, taste, spreadability and general acceptability. The majority of butter users found the colour and taste of the treatment butter to be the same, but 70 percent of them found it to have superior spreadability characteristics. Of the full fat spread users 50 percent or more found the treatment butter to be superior in terms of colour and taste whereas only 21 percent found it superior in terms of spreadability. Overall, in terms of general acceptability 44 percent of butter users and 47 percent of full fat spread users found the treatment butter to be better or much better than their usual product. Fifty eight percent of butter users and 60 percent of full fat spread users said that they would be willing to change to the treatment product.

The results of this survey show that butter produced from the milk fat of FFR fed cows is a very acceptable product with superior spreadability characteristics than existing butter. The extra cost of producing this product in the peak milk production months of April, May and June, due to the additional supplementation, would be about 14p per 545g (Ib) of butter. This is equivalent to an extra 1.2p per litre of milk produced during this three-month period .

Conclusions

Milk fat high in monounsaturated fatty acids (C18:1) and spreadable at refrigeration temperatures is produced by the cow when given a supplement containing 1.65kg of FFR per day. Other studies have shown that similar milk fat can be obtained from the cow if full fat soya, whole sunflower seed or maize distillers grains are fed at the appropriate level. Butter and cheese have been manufactured from this milk and consumer acceptability studies with the butter, in both Ireland and Germany, have given very positive results.

References

Cowan, C. and McIntyre, B. 1991. Consumers' views on monounsaturated butter. Farm and Food, July/September, 1: 6-7.

De Peters, E. J., Taylor, S.J., Franke, A. A. and Aguirre, A. 1985. Effects of feeding whole cottonseed on composition of milk. *Journal of Dairy Science 68:* 897-902.

Kinsella, J. E. 1972. Stearyl-CoA as a precursor of oleic acid and glycerolipids in mammary microsomes from lactating bovine: possible regulatory step in milk triglyceride synthesis. Lipids 7: 349-355.

Mattson, F. H. and Grundy, S.M. 1985. A comparison of effects of dietary saturated, monounsaturated and polyunsaturated fatty acids on plasma lipids and lipoproteins in man. *Journal of Lipid Research 26 :* 194-202.

McGuffey, R. K. and Schingoethe, D.J. 1982. Whole sunflower seeds for high producing dairy cows. *Journal of Dairy Science 65:* 1479-1483.

Murphy, J. and McNeill, G. 1988. Altering the diet of the cow to produce a softer and nutritionally acceptable milk fat. Proceedings of a Symposium on Food and Industrial Uses of Fat including Milkfat at Moorepark (Nov. 1988) pp 92-1 1 1.

Murphy, J. J. and Connolly, J. F. 1989. Oil rich diets for dairy cows - their effects on production and the composition and hardness of milk fat. 40th Annual EAAP Meeting, Dublin, paper N3.40.

Murphy, J. J. and Connolly, J. F. 1991. Supplementing cows with full fat rapeseed at pasture - effects on production and the chemical and physical properties of milk fat. 42nd Annual EAAP Meeting, Berlin, paper C2.15.

Murphy, J. J., Connolly, J. F., Keogh, K. and Cowan, C. 1991. Increasing butter consumption by the production of a softer and nutritionally improved product. Final Report on Co-Responsibility Project No. 663/88 29 pages.

Murphy, J. J., McNeill, G.P., Connolly, J.F. and Gleeson, P.A. 1990. Effect on cow performance and milk fat composition of including full fat soyabeans and rapeseeds in the concentrate mixture for lactating dairy cows. *Journal of Dairy Research 57:* 295-306.

Factors Affecting Milk Protein Concentration

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In recent years, milk payment schemes have involved milk protein concentration as one of the elements which determine milk price. Because of the declining value of milk fat, protein is now more important than fat in price determination in many payment schemes.

Irish milk protein concentrations

Irish milk protein concentrations for the last ten years are shown in Figure 1. There has been a decline from levels around 33g/kg in the early 1980's to approximately 32g/kg, where they appear to have stabilised now. Average EC levels in 1990 were 32.4g/kg, ranging from 29.9g/kg in Italy to 34.5g/kg in the Netherlands.

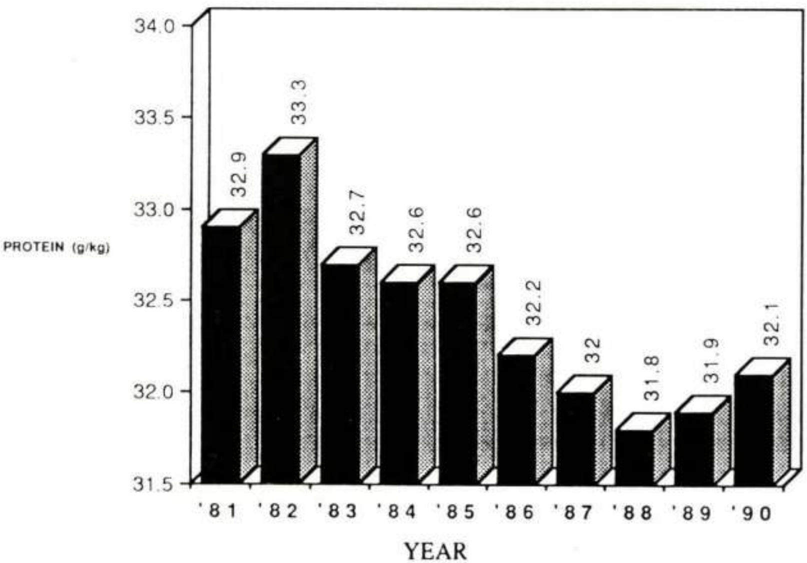

Figure 1 – Irish Annual Milk Protein Levels

Figure 2 shows that there is much variation from month to month within these annual figures with values from under 29g/kg for some years during March to above 36g/kg in October.

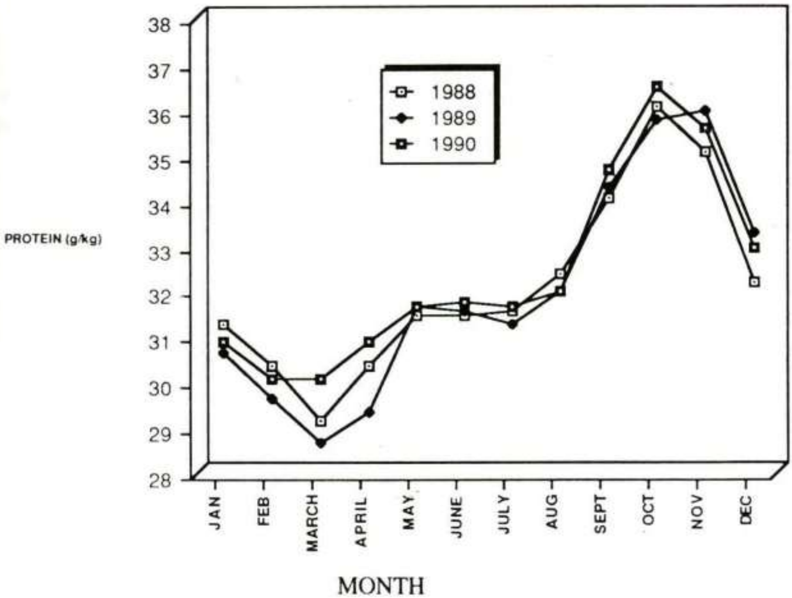

Figure 2 – Irish Monthly Milk Protein Levels

Most of this variation is due to lactational effects: cows reach a minimum in protein concentration 6-8 weeks post calving. Most Irish cows calve in early spring and most, therefore, reach a lactational minimum in March which coincides with the minimum level recorded in March. Inadequate nutrition before turnout at this period of high yields will further depress the level measured in March. Milk protein concentration rises rapidly when cows go to grass and this is the reason for the rapid rise during April-May. After that, levels are relatively constant for the rest of the summer but they start to rise again in autumn as cows enter late lactation. The fall in November and December is due to early lactation, low protein milk from autumn calving cows making up a substantial portion of the total milk supply during this period.

Calving cows late in spring and thus turning them out to grass earlier in their lactation means that they get the lift in protein from grass sooner and the very low levels 6-8 weeks after calving are avoided. Dillon and Crosse (1992) reported higher lactation milk protein concentrations for late spring calving herds compared to an early spring calving herd.

Increasing milk protein concentration

Apart from changing calving date, there are two strategies towards increasing milk protein concentration, namely breeding and nutrition. This paper is confined to nutritional aspects but breeding should not be ignored. Increased milk protein concentration through breeding requires the use of bulls with high PD82's for protein percentage for breeding replacements (and even where this is done progress will be slow).

Nutritional effects on milk protein concentration

1. *Concentrate feeding level*

Table 1 shows the results of an experiment carried out at Moorepark over two years. Milk protein concentration was increased significantly as concentrate feeding level increased.

Table 1. Effect of concentrate feeding level on milk yield and milk protein concentration

		Concentrate feeding level (kg/day)		
		3.0	5.5	8.0
Milk yield	Year 1	100	115	120
	Year 2	100	119	128
Protein concentration	Year 1	100	103	110
	Year 2	100	104	111

Source: Butler, Gleeson and Morgan, 1983.

However, while a very strong positive relationship exists, feeding levels are usually predetermined by considerations of silage quality, milk and feed price, and quota restrictions, not by considerations of milk protein concentration. Thus, while concentrate feeding level is not an economic means of increasing milk protein the composition of the concentrate can be altered. The effects of alterations on milk protein concentration are examined in the next section.

2 . *Protein ingredients in concentrates*

Protein concentration in concentrates has little effect on milk protein concentration (Butler, Gleeson and Morgan, 1983). However, it is often argued that sources of protein high in undegradable protein (UDP) would be beneficial for milk yield and milk protein concentration. Fishmeal and maize distillers are the only two conventional protein sources with higher UDP levels than soyabean meal.

Fishmeal supplementation at levels in the concentrate from 8 to 13.8% (giving feeding levels of 450-966 g/day) has given an average response of 10% in milk protein yield in trials at Moorepark. The effect on milk protein concentration has been small and variable but generally positive. However, with current prices for fishmeal and milk, the economics of its use are marginal.

Maize distillers grains is a cheaper and more widely used protein source. Table 2 shows the results of an experiment where a barley/soyabean concentrate was compared to a barley maize distillers one.

Maize distillers grains decreased protein concentration and while protein yield was not affected in this experiment, where maize distillers were fed at higher levels in the concentrate, milk protein concentration was so depressed that milk protein yield was also decreased.

Table 2. Maize distillers and milk composition

Concentrate type		Barley/soya	Barley/m. distillers
Fat concentration	(g/kg)	36.9	35.8
Protein concentration	(g/kg)	29.6	28.4
Protein yield	(g/day)	607	599

Source: Fitzgerald and Murphy, 1992.

Concentrate feeding level in the experiment in Table 2 was 7 kg/day and maize distillers was included at 49% of the concentrate. Where concentrates are fed at this level, it is advisable to keep the inclusion rate of maize distillers below 50%.

The negative effect of maize distillers on milk protein concentration is probably related to its high oil content (10-12%) and the resulting high oil level of concentrates where it is included in large amounts. Including tallow in the concentrate (protected or unprotected) was shown by Murphy and Morgan (1983) to decrease milk protein concentration. Concentrates with high oil levels (6-7%) are likely to decrease milk protein concentration although where protected oil is included, the type of oil may influcnce the response obtained.

Table 3 gives the results of a trial comparing conventional protein sources with soyabean meal. The results are given relative to the soyabean meal treatment. There was no difference between the milk production of cows fed the different protein sources. The cottonseed fed group (a high fibre, low oil grade) had a significantly reduced protein concentration compared to the soyabean meal fed group and the groundnut fed group also tended to have a lower milk protein but the difference wasn't significant. There was no difference in performance between cows fed rapeseed and soyabean meal. This trial showed that cheaper sources of protein than soyabean can be used for dairy cows with only small differences if any in production.

Table 3. Effect of protein source in the concentrate on milk yield and milk protein concentration

	Protein source			
	Soya	Groundnut	Cottonseed	Rapeseed
Milk yield	100	101	100	99
Protein concentration	100	95	94	99

Source: Murphy, Gleeson and Morgan, 1985.

3. *Energy ingredients in concentrates*

The inclusion of wheat as a high energy, high starch ingredient in concentrates was investigated in two experiments in Moorepark. The effect on milk protein concentration is shown in Table 4. In the first experiment, wheat inclusion had no effect, but in the second protein concentration increased as wheat inclusion in the concentrate increased.

Table 4. Effect of wheat inclusion in the concentrate on milk protein concentration

	% Wheat inclusion		
	0	30/34	60/69
Expt. 1	3.09	3.06	3.05
Expt. 2	3.04	3.15	3.24

Source: Fitzgerald, 1988.

One possible reason for the lack of response in some situations could be a very rapid digestion of the wheat giving rise to digestive upsets. Caustic (sodium hydroxide) treatment of wheat would result in a slower rate of digestion and might alleviate any negative effects of a rapid digestion. However, in a trial at Moorepark, caustic treated wheat gave no improvement in performance over ground wheat. Therefore, caustic treatment is not the answer to obtaining improved performance from wheat and because the response to wheat is not consistent, the inclusion should be based on its cost relative to the energy and protein content.

Other concentrate energy sources widely used in Ireland are beet pulp and corn gluten meal. They have been examined as replacements for barley in trials at Moorepark and the results are given in Table 5. These feedstuffs gave no significant differences in milk yield or protein concentration.

Table 5. Relative performance of barley, beet pulp or corn gluten as concentrate energy sources (barley = 100)

	Percentage of Concentrate DM	Milk yield	Protein concentration
Barley	70	100	100
Molassed beet pulp	70	99	102
Corn gluten	77	102	99

Pressed pulp and fodder beet are often used by farmers to replace part of the concentrate portion of the diet and thus lower the concentrate cost per unit of dry matter. Table 6 shows that replacement rates can be high without seriously affecting performance although it did tend to be poorer. Where they were fed as an extra feed, which is the equivalent of feeding extra concentrates, production was increased as expected.

4. *Forage quality and type*

Thomas (1984) reviewed 6 experiments examining the effect on cow performance of silage digestibility (DMD). The average difference in DMD was 6.9 percentage units and the higher DMD silage gave an increase in both milk yield and protein concentration, which would more than outweigh a decrease in milk fat concentration, especially as the importance of fat relative to protein in price schemes decreases (see Table 7).

Table 6. Performance of dairy cows when fed pressed pulp or fodder beet as a replacement for barley or as an extra feed

	% of mixture DM	Milk yield	Protein concentration
Barley	70	100	100
Pressed pulp	79	95	98
Fodder beet (1)	65	95	97
Fodder beet (2)	65	99	96
Extra feed			
Pressedpulp (2.1 kg DM/day)		112	105
Fodder beet (2.0 kg DM/day)		107	99

Table 7. Effect of high digestibility silage on milk yield and composition (average of 6 experiments)

DMD		+ 6.9 units
Milk yield		+ 2.1 kg/day
Protein concentralion	(g/kg)	+ 1
Fat concentration	(g/kg)	-1.5

With regard to silage type, there is currently a lot of interest in maize silage as a replacement for grass silage. Phipps, Weller and Siviter (1990) found approximately a 9% increase in milk protein yield for forage mixtures containing 50 or 75% maize silage on a dry matter basis. This was achieved through a combination of higher milk yields and protein concentrations. Preliminary results from a trial ongoing at present in Moorepark would indicate a similar increase in milk protein yield, virtually all due to increased milk yield. Maize silage can be regarded as a forage which will increase milk protein yield and possibly protein concentration provided its quality is good.

5. *Complete diet feeding*

Where concentrates or concentrate equivalent make up less than 50% of total dry matter intake (i.e. less than 8-9 kg/day), research has not shown any increase in production from complete diet feeding. Where concentrates make up more than 60% of total dry matter intake, i.e. more than 10-11 kg/day), there were improvements in milk yield or milk fat concentration but protein concentration was not altered.

Conclusions

Protein can be increased through breeding, though progress is slow. From the nutritional viewpoint, high quality grass silage will increase milk protein concentration. High quality maize silage will increase protein yield and possibly protein concentration. Higher concentrate feeding level : will also increase it but feeding level is generally decided by other factors. Later calving in spring results in higher lactational milk protein concentration by indirectly affecting the nutrition of the cow.

With regard to concentrate ingredients, fishmeal will increase milk protein yield and possibly milk protein concentration but the economics of feeding it are marginal. Wheat may increase milk protein concentration but because the response is uncertain, the cost of concentrates should not be increased by its inclusion .

Finally, factors which decrease protein concentration are equally as important as those that increase it. Maize distillers grains at levels above 50% of the concentrate will reduce milk protein as will concentrates with oil levels above 6-7%, especially in the form of unprotected oil.

References

Butler, T. M., Gleeson, P. A. and Morgan, D. J., 1983. Effect of supplement feeding level and crude protein content of the supplement on the performance of spring calving cows. Irish Journal of Agricultural Research, 22: 69-78.

Dillon, P. and Crosse, S., 1992. Optimising herd calving patterns. Irish Grassland and Animal Production Association Journal.

Fitzgerald, S. and Murphy, J., 1992. Effects of feeding low levels of high protein concentrates differing in protein source on milk production of dairy cows. Paper No. 39, British Society of Animal Production Winter Meeting.

Fitzgerald, S., 1988. Evaluation of wheat and corn gluten as conentrate ingredients for milk production. Irish Grassland and Animal Production Association, 14th Annual Research Meeting.

Murphy, J. J. and Morgan, D. J., 1983. Effect of inclusion of protected and unprotected tallow in the supplement on the performance of lactating dairy cows. Animal Production, 37: 203-210.

Murphy, J. J., Gleeson, P. A. and Morgan, D. J., 1985. Effect of protein source in the concentrate on the performance of cows offered grass silage ad-libitum. Irish Journal of Agricultural Research, 24: 151-159.

Phipps, R. H., Weller, R. F. and Siviter, J. W., 1990. Whole-crop cereals for dairy cows. In: Whole Crop Cereals - Making and feeding cereal silage. Proceedings of a seminar held at the AFRC Institute for Grassland and Animal Production, Hurley, 17th January, 1990.

Thomas, Cled, 1984. Milk compositional quality and the role of forages. BSAP, Occasional Publication. No. 9: Milk compositional quality and its importance in future markets.

A seasonal loan without the

How Competitive is Irish Dairying?

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The 1990's represent a decade of turbulence and change in the agrifood sector following the comparative stability of the last two decades. European community membership in 1973 provided Ireland with a large measure of policy stability, and the wider international political and market situation was reasonably predictable in the 1970's and 80's. Now however, the political changes in Central and Eastern Europe, the completion of the Single Market and the policy changes under discussion in the C.A.P. reform proposals and the G.A.T.T. Uruguay round, all suggest a more unstable and unpredictable decade ahead. The greater uncertainty likely in the future, with the prospect of movement towards less protected markets, make this an appropriate time to compare the Irish and other EC dairy industries.

Milk production cost comparisons

A detailed comparison of milk production costs was presented to the Grassland Conference in 1991 by Boyle[1]. This comparison showed that Irish milk production costs are matched only by Belgium, with production costs for rival dairy industries such as Netherlands and Denmark being approximately 35% and 70% higher (Table 1). A number of associated milk production cost comparisons were then completed by Boyle, including (a) the further addition of imputed land, capital and labour costs, (b) the estimation of costs at standardised milk solids levels rather than actual solids, (c) the estimation of variable or specific costs rather than total costs.

Table 1: Milk production cost comparisons, F.A.D.N. costs 1988/89[1]

	£1/00 kgs	Index Ireland = 100
Germany	20.0	154
France	15.0	115
Italy	18.1	139
Belgium	12.4	95
Netherlands	17.5	135
Denmark	22.3	172
Ireland	13.0	100
U.K.	15.3	118

[1]Explicit F.A.D.N. Costs, actual solids, ex farm. Source: Boyle et al[1]

Note: To convert £/100 kgs to pence per gal, divide by 0.21363.

Milk price comparisons

While milk production costs may be lower in Ireland than most other E.C.

countries, this advantage could be counteracted if the processing and marketing sectors in other countries have an ability to pay higher prices for milk and can sustain these advantages over time. In this section the ability of other European countries to pay higher milk prices than Irish dairies is analysed.

Milk prices may be compared at actual milk solids levels or on a standardised solids basis, as in the case of production costs. Milk prices are first outlined at actual solids for direct comparison with the milk production costs shown earlier, and then the effect of adjustment to standardised solids is shown.

In the E.C. milk prices at actual solids level, ex farm, exclusive of V.A.T. are published each year by Eurostat. However an alternative milk price series is available from the annual milk price analysis carried out by Pitts[2]. This latter price series takes into account a number of additional factors such as end-of-year bonuses and is the more accurate series. Therefore, the milk price data assembled by Pitts, which have been kindly made available, are used for this paper.

Milk prices over the last five years show considerable fluctuations and for this reason it was decided that a three-year-average was preferable to single year prices for comparative purposes. The price in 1989 for Ireland was totally atypical, hence that year is ignored and price data for 1986-88 is used. The milk prices in actual currencies for the different countries were first converted to £IR per 100 kgs using the annual average market exchange rates for each country. It should be noted that market rather than "green" rates are being used in this conversion so that gains or losses in countries due to positive or negative MCA's and due to "green" rate conversions for intervention prices, etc. are included in the prices. The results in Irish currency terms for each country show considerable differences between countries, with prices in Italy 47% higher than Ireland, Denmark 37% and Netherlands 36% (Table 2).

Table 2: Producer milk prices, actual solids, ex farm, excl. VAT 1986-88 average

	£/100 kgs	Index Ireland = 100
Germany	23.3	129
France	19.7	109
Italy	26.4	147
Belgium	20.6	115
Netherlands	24.5	136
Denmark	24.6	137
Ireland	18.0	100
U.K.	18.2	101

Milk prices and competitivenes in processing and Marketing

In normal circumstances the payment of a high price for raw materials (e.g. milk) would not be seen as a critical indicator of competitiveness for an industry. Important indicators of competitiveness would normally include:

(a) achievement of economies of scale which minimise cost, and/or provide an element of market power;

(b) product differentiation; a strong brand identity;
(c) a steady rate of new product development, as older products move to the decline stage of the product life cycle;
(d) a satisfactory rate of investment in R. and D.
(e) a good profit margin or surplus;
(f) demonstration of added value and vertical integration.

Given that the European dairy processing sector is substantially owned by producer co-operatives, milk (or raw material) price may be afforded a higher status than normal as an indicator of competitiveness. However, the other indicators above are also important.

Comparison with milk production costs

These milk prices paid to producers for actual milk supplied, excluding V.A.T at their own farm may be compared with the milk production costs estimated earlier. From this it is seen that countries with higher milk production costs than Ireland generally benefit from higher milk prices so that much of the disadvantage of higher milk production costs is negated. For example, Ireland's margin over production costs of £5/100 kgs is only in fourth place in the ranking of eight countries, being between 40 and 70% lower than Italy, Belgium and Netherlands (Table 3). Germany, the U.K. and Denmark are substantially lower than the others, being little more than half that of Ireland in margin over milk production cost terms. This comparison can also be made by comparing milk production cost differences relative to Ireland with milk price differences (Table 4).

Table 3: Milk price and production cost comparisons

Country	Milk Production Costs (1)	Milk Price (2)	Margin over Costs (2) - (1)	Margin over Costs Ireland=100	Margin over Costs Rank
		£/100 kgs			
Germany	20.0	23.3	3.3	66	6
France	15.0	19.7	4.7	94	5
Italy	18.1	26.4	8.3	166	1
Belgium	12.4	20.6	8.2	164	2
Netherlands	17.5	24.5	7.0	140	3
Denmark	22.3	24.6	2.3	46	8
Ireland	13.0	18.0	5.0	100	4
U.K.	15.3	18.2	2.9	58	7

From this it is seen that Italy and Netherlands, with production costs 35 - 40% higher than Ireland, have this cost disadvantage more than fully offset by higher milk prices. Denmark, Germany and France, with production costs 72%, 54% and 15% higher than Ireland, have 70-85% of their cost disadvantage negated by higher milk prices. Finally Belgium has its small production cost advantage further supplemented by a higher milk price of 14% (Table 4).

Table 4 : Milk price and production cost differences relative to Ireland

	Milk Production Cost	Milk Price	Percentage Cost Difference Relative to Ireland accounted for by Milk Price Difference
	Difference relative to Ireland £/100 kgs		
Germany	7.0	5.3	76
France	2.0	1.7	85
Italy	5.1	8.4	165
Belgium	-0.6	2.6	—
Netherlands	4.5	6.5	144
Denmark	8.7	6.6	71
U.K.	2.3	0.2	9

Reasons for milk price differences

Many reasons can be proposed for producer milk price differences between Ireland and other E.C. countries, with for example the effect of 12 different reasons being quantified in a milk price comparison in the early 1980's.[3] Some of the main factors are now reviewed.

Milk solids levels

All prices and costs discussed earlier were for a given kg. of milk at actual solids levels. Milk solids levels vary widely among E.C. countries, with Irish fat levels of about 3.55% being among the lowest in the E.C. and almost 20% lower than Denmark (Table 5). Irish protein percent is also relatively low at about 3.2%, however protein varies much less widely than fat with Irish protein levels about 9% lower than Denmark (Table 5). The extent to which milk solids levels account for milk price differences between Ireland and other E. C. countries depends on the valuation of fat, protein and other solids.

In this price comparison, the ex-farm milk prices at actual solids shown earlier were standardised at 3.7% fat and 3.3% protein for all countries. This isolates the effect on milk prices of variation between countries in fat and protein.

Table 5: Fat and protein content of milk deliveries

	Fat		Protein	
	1985	1990	1985	1990
Germany	3.91	4.10	3.34	3.32
France	3.86	3.94	3.10	3.10
Italy	3.52	3.59	3.12	2.98
Belgium	3.63	3.85	3.31	3.39
Netherlands	4.18	4.37	3.40	3.44
Denmark	4.32	4.43	3.45	3.37
Ireland	3.55	3.54	3.26	3.23
UK	3.94	4.00	3.27	3.27

Source: Agra Europe 1991 Dairy Review

Table 6: Milk price comparison, ex farm, 3.7% fat, 3.3% protein, £IR/100 kg

	Price at 3.7% fat, 3.3% protein[1] (1)	Price at actual solids, ex-farm (2)	Difference (1) - (2)
Germany	22.6	23.3	-0.7
France	19.5	19.7	-0.2
Belgium	20.4	20.6	-0.2
NL	22.8	24.5	-1.7
Denmark	22.7	24.6	-1.9
Ireland	18.7	18.0	+0.7
UK	17.8	18.2	-0.4

[1]Actual protein for France

Inevitably standardisation for milk solids brings ex-farm prices considerably closer throughout the Community (Table 6). Sizeable price reductions occur for Denmark and the Netherlands, reflecting their very high fat and protein levels. In contrast the standardised prices represent an increase for Ireland. The amount by which the original price differences relative to Ireland are reduced by standardising the milk is shown in both absolute and percentage terms in Tables 7 and 8. It is seen that in the case of Netherlands, Denmark, Belgium and Germany between 25 and 40% of the original price difference is attributable to differences in fat and protein levels. In the case of France, standardisation for fat alone accounts for over half of the original modest price differences between Ireland and France. (The standardised milk price data for Italy seem unreliable, hence Italy is ignored in this latter comparison).

Table 7: Milk price differences relative to Ireland, IR£/100 kgs

	Actual fat, protein, ex-farm	3.7% fat, 3.3% protein[1],	Difference explained by fat and protein[1]
Germany	5.3	3.9	1.4
France	1.7	0.8	0.9
Belgium	2.6	1.7	0.9
NL	6.5	4.1	2.4
Denmark	6.6	4.0	2.6
UK	0.4	-0.9	-1.3

[1]For France, fat only

In this analysis it was decided to make price comparisons at ex-farm level in order to remain as close as possible to the final price received by farmers for milk. This may be contrasted with the very valuable annual review of milk prices by Pitts[2] in which the precise definition of the E.C. target price for milk is taken (3.7% fat, excl. V.A.T. delivered dairy), prices are adjusted to this definition for

Table 8: Milk price difference relative to Ireland

	Percentage of price difference at actual fat and protein attributed to fat and protein difference	Percentage of price difference at actual fat and protein attributed to other factors
Germany	26	74
France	53	47
Belgium	35	65
NL	37	63
Denmark	39	61
U.K.	—	—

each country and expressed as percentage of the target price. While each price comparison is equally valid for the purpose for which it is intended, it is important to be clear about the precise definition used in each case .

M.C.A's

While fat and protein account for some of the difference in milk prices between Ireland and other countries, very substantial differences remain. One important factor is the impact of MCA's. Estimated average annual MCA rates for the period 1986 - 1988 are shown in Table 9. The estimated effect on milk prices shows that, in the case of Germany, Netherlands and Belgium, about 20% of the difference in milk price relative to Ireland can be attributed to MCA's in the period studied, (Table 10). While this factor was quite significant in the 1986-88 period, it should be noted that MCA's have greatly reduced or disappeared for most countries now, hence the effect on milk price differences would be much less.

Combining the effect of fat, protein and M.C.A.'s it is seen that, with the exception of the U.K., about half of the original milk price difference is explained by these factors (Table 11). Fat, protein and M.C.A.'s are the most readily quantifiable factors. Other possible explanatory factors, which are not readily quantified are now discussed.

Table 9: Estimated annual average MCA rates in dairying, %

	1986	1987	1988	Average 1986 - 1988
Germany	+2.9	+2.1	+1.4	+2.5
France	-1.5	-3.3	-3.S	-2.8
Belgium	0	0	0	0
Netherlands	+2.9	+2.1	+1.4	+2.5
Denmark	0	-0.7	0	-0.2
Ireland	-1.2	-3.0	-3.5	-2.6
UK	-13.7	-23.1	-10.1	-15.6

Table 10: Estimated effect of MCA's, £/100 kg

	Average 1986-1988	Differences Relative to Ireland	% Price Difference relative to Ireland due to MCA's
Germany	+0.5	+1.1	21
France	-0.6	0	0
Belgium	0	+0.6	23
Netherlands	+0.5	+1.1	17
Denmark	-0.1	+0.5	8
Ireland	-0.6	—	—
UK	-3.3	-2.7	—

Table 11: Milk price differences and explanatory factors

	Milk Price Difference Relative to Ireland £/100 kg	Percentage attributable to Fat and Protein	Percentage attributable to MCA's	Percentage attributable to fat, protein, MCA's	Percentage attributed to other Factors
Germany	5.3	26	21	47	53
France	1.7	53	0	53	47
Belgium	2.6	35	23	58	42
Netherlands	6.5	37	17	54	46
Denmark	6.6	39	8	47	53
UK	0.4	-	-	-	-

Capital

Capital in dairy firms or cooperatives can be obtained either from retentions of profits or surplus, from suppliers (in the form of increased share capital or other means), or from commercial borrowings. The approach to this issue varies among E.C. member states depending on national laws and in particular taxation law. For Irish cooperatives, the retention of a sizeable surplus has been most common up to now, whereas in the Netherlands, the unnamed reserves in a cooperative are very limited due to taxation law. The remaining capital requirements for cooperatives in the Netherlands, in addition to commercial borrowings, are obtained from members by means of a wide range of devices which are interest bearing to differing degrees. The consequences for milk price are that in the case of Ireland, the larger retentions result in a lower milk price being quoted. In contrast, countries such as the Netherlands with much lower retentions will have higher quoted milk prices, but supplier members will then be obliged to provide much of the capital requirements through other means.

Seasonality

Seasonality, product mix, market location and scale economies are all linked factors which are now discussed in turn. Manufacturing milk supply is highly seasonal in Ireland unlike other E. C . countries . Taking average monthly supply as a percentage of the peak as an indicator of capacity utilisation, Ireland has a utilisation of about 55% compared with a utilisation of about 80% for other E.C. countries . There are two major consequences for Ireland beyond the farm gate; (a) due to much lower capacity utilisation, costs in processing, storage, assembly and distribution are considerably higher than other E.C. countries; (b) the product mix tends to be confined to a limited range of storable products . Seasonality essentially is a choice, and represents a major strategic question for the Irish dairy industry.

Product mix

Product mix is a perennial topic in discussions of the Irish dairy industry, with many commentators suggesting that Ireland's dependence on intervention products or commodities is a cause of lower milk prices and advocating a shift away from these products.

Ireland's dependence on butter relative to cheese has been regularly highlighted, with a continuing butter : cheese milk allocation ratio of between 4 :1 and 5 :1 over the last 20 years in contrast with close to a 1:1 ratio for all other leading E.C. dairy exporters. This ratio has persisted despite an increase in European Community cheese consumption of 43% from 2.1 to 3.0 mill. tonnes between 1973-75 and 1990 in contrast with a decline in butter consumption of 25% from 1.8 to 1.1 mill. tonnes.[4]

Over the last few years three main product alternatives have been discussed, consumer ready products, specialised food ingredients and commodities. An initial problem has been that definitions of these alternatives have been unclear, hence the following are suggested:

(a) Consumer ready products; products developed for sale to final customers/ consumers at retail or catering level. These may be manufacturer branded, own or retailer branded or caterer ready to use.
(b) Specialised food ingredients; products developed for further processing which have a unique or semi-unique specification and are sold to meet the requirements of specific end users.
(c) Commodities; products which are unbranded , sold for further processing and are of a standard specification. Commodities are usually manufactured in large volumes internationally, can be sold in a variety of markets and often have public price quotations.

Ireland's dependence on commodities has never been more fully highlighted than in 1990 and the first half of 1991 where Ireland accounted for about one-third of total E.C. intervention purchases.[4] More critically intervention sales as a percentage of Irish milk deliveries for Jan-June 1991 were over 40%. If the home market is excluded, intervention sales as a proportion of export availabilities were of the order of two-thirds in this period. Given that consumer ready products and food ingredients for export would require longterm customer commitments, the above estimate of two-thirds of export availabilities gives a reasonable indication of Ireland's dependence on commodities .

Many commentators have argued that this dependence should change. The very comprehensive review of the Agriculture and Food Sector completed by the Agricultural and Food Policy Review Group in December 1990[5] stated "in 1990, almost 70% of whole milk will be made into butter and 50% of skim milk into skim milk powder. In view of such factors as the declining consumption of butter and the uncertainty about future intervention arrangements for skim milk powder, the industry is clearly in a vulnerable position. While the absence of a large domestic market is undoubtedly a factor, the Irish dairy industry has been out-performed, both in terms of product range and willingness to invest in marketing a broader range of products, by the industry of some other E.C. Member States. As demand for butterfat declines and the role of intervention diminishes, it will be essential that the Irish dairy industry devotes more effort and resources to developing and marketing dairy products other than butter and cheddar cheese".

With regard to policy directions in relation to product mix, the review Group does not believe that policy should favour exclusively any one of these options (i.e. commodities, food ingredients, branded products). However they conclude: "There should be a clearly expounded policy in the dairy and beef sectors in particular; it should promote moves away from selling commodities, especially intervention commodities; the policy should not favour new 'producer's brands' for export products except where a market niche has been credibly identified or where such factors as control over distribution networks abroad bring costs within reasonable bounds; it should take the view that 'business-to-business' sales abroad are the main area into which most of our food firms should move in the medium term, building a base that would permit more firms to reach out directly to the consumer at a later stage with 'producer brand' products" .[5] The recently published "Culliton" report emphasises possible opportunities for cheese in particular.[6]

An important related issue to product mix is the location of markets. Since European Community membership in 1973 there has been a long held ideal that Ireland should be supplying Community markets with value added products rather than third countries/intervention. Despite nearly 20 years of Community membership half or more of dairy exports go to third countries/intervention, with even higher levels in Jan-June 1991 as outlined earlier. While some fault for this may attach to Irish companies, it is also policy related. Ireland is on the periphery of an economic trading block which has a considerable surplus of dairy (and grass based) products. Despite quota cuts, this surplus has persisted and proposed import concessions to Eastern European countries will only accentuate the Communities' exportable surplus. Basic economic logic suggests that, given Ireland's location, European Community exports or intervention sales would come from Ireland in the first instance. This has been demonstrated in a recent transportation model application to E.C. and world dairy markets.[7] From a policy viewpoint, the implications are that a policy of supply management which would bring Community production and consumption more into balance, would in turn create the environment for increased sales of Irish value added products in Community markets. Otherwise, if large E.C. surpluses continue, one can expect

Table 12: Dairying in Europe, 1990

	Company	Country	Turnover, £ billion	Milk Pool Million Gals.
1.	Nestle	Switzerland	4.02	840
2.	Unigate	U.K.	1.94	375
3.	Campina Melkunie	Holland	1.8	760
4.	Friesland	Holland	1.64	475
5.	ULN	France	1.57	560
6.	Besnier	France	1.57	810
7.	Dairy Crest	U.K.	1.57	640
8.	BSN	France	1.54	140
9.	MD Foods	Denmark	1.38	640
10.	Sodiaal	France	1.38	550
		Ireland		
An Bord Bainne			1.17	—
Kerry			0.58	100
Avomnore			0.49	140
Waterford			0.43	135
Dairygold			0.32	192
Golden Vale			0.21	140

that Ireland on the periphery will continue to be pushed towards selling on the volatile world market.

Economies of scale

With the advent of the single European Market, major merger activity has been occurring both in European dairying and other industries. The motivation to merge springs mainly from the desire for increased market power and the achievement of economies of scale. Modern retailing is now dominated by large supermarket chains with about 20 in the European Community now having a turnover in food of £1.5 billion or greater,[8] and an overall turnover of at least £5 billion. These retailing firms wield very considerable market power which is likely to extend further as transnational retailing alliances develop. As well as the desire for countervailing market power, dairy and other food manufacturers also identify economies of scale achievable through merger, particularly in the area of marketing branded products. Thus a "Division 1" of European dairy product manufacturers seems to be emerging which does not at present contain any Irish company, (Table 12). (An Bord Bainne, though not a manufacturer, would just rank as a "player" in this league in turnover terms). Although some Irish dairy cooperatives of a decade ago have made successful moves towards becoming internationally competitive food firms, it is sobering to think that "it would take a consolidation of the entire Irish food industry to match the average sales of the top 40 competitors in international food markets"[9]. While economies of scale may be a factor in explaining milk price differences between Ireland and other E.C. countries, the objective in any activity is to achieve the scale appropriate to that activity. International marketing of branded products, some commodity trading and some manufacturing processes require very large scale, however "niche" marketing and many services may operate successfully on a small scale. Thus small dairy or food firms can best survive by identifying and exploiting these opportunities, rather than attempting to do the same things as larger companies on a smaller scale. With increased scale, issues of competitiveness will become of even greater concern in the future, and international dairy comparisons as advocated by Zwanenberg[10] will have an important role to play in promoting competitiveness .

Conclusions

With inevitable movement towards a less protected market, both within the E . C . and externally, international competitiveness in dairying will be vital for survival. Irish milk production costs are lower than most E.C. countries, however this cost advantage is counteracted to an extent by lower milk prices. Lower milk prices arise due to lower fat and protein levels, MCA's in past years, and a variety of other factors. It is important that the effect of these factors is reduced wherever possible. With high levels of efficiency in the industry at all levels, production, processing, marketing, the Irish dairy industry has the potential to be highly competitive regardless of policy change.

References

1. Boyle, G. E. with Kearney, B., McCarthy, T. & Keane, M. The Competitiveness of Irish Agriculture. Allied Irish Bank Group. sponsored Study 1992, Dublin.
2. Pitts, E. European Producer Milk Prices (various years). National Food Centre, Teagasc, Dunsinea, Castleknock, Co. Dublin.
3. Keane, M. and Pitts E. A Comparison of Producer Milk Prices in E.E.C. Countries. An Foras Taluntais, 1981.
4. Simms, N. Intervention - A Bord Bainne Perspective. Seminar, The E.C. Intervention System and the Irish Food Industry, U.C.C., 1991.
5. Government Publications. Agriculture and Food Policy Review, Dublin 1991 .
6. Culliton, J. *et al.* Industrial Policy for the 1990's; Appendix, The Food Industry, Government Publications, Dublin 1992.
7. Keane, M. and Lucey, D. I. F. Irish Dairying - Modelling the Spatial Dimension. Agribusiness Discussion Paper No. 10, U.C.C. 1991.
8. Van Rijk, G. and Mackel, C. Dutch Agriculture seeking for Market Leader Strategies, European Review of Agricultural Economics 18. 3/4. 1991 .
9. McCarrick, J. Scale and Competitiveness. Food Ireland, 1991.
10. Zwanenberg, A. Dairy Company Comparisons in the Netherlands and Europe. Annual Conference, Agricultural Economics Society of Ireland, Dublin 1991.

Building Irish Owned International Food Companies

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There are simple choices facing the future of the Irish food industry, and by implication, Irish farmers. This industry can evolve to provide a range of basic food products, heavily reliant on the machinations of political and bureaucratic decision makers in Brussels, or it can forge a presence on the international food market, being active, expansive, and progressively developing businesses linked directly to consumer markets. In this paper I will address some of the obstacles that I believe stand in the way of developing a progressive food industry in Ireland.

There are three leading characters in this play (i) Cooperatives (ii) Irish farmers and (iii) Government. Each of these relevant interest groups must adopt clear policies on the structure and direction of the industry overall if success is to be achieved. I would define success as the establishment of a number of companies that rank as leading international players in the products which they manufacture. The product range under their control must be present in markets that offer consistent growth in demand either directly from consumers, or through intermediaries such as processed food companies or distributors. Unless that is achieved it is hard to see how the Irish food industry will develop as an independent and profitable industrial force.

Co-operatives

During the last seven years five Irish co-ops have employed the hybrid co-op/plc structure as a method of funding their growth and expansion. Although not readily apparent this has been a pioneering development, not only in Ireland but in the context of the international co-operative movement. Flexibility has been the hallmark of the Irish co-op movement's history and that has allowed the sector to grow and prosper. It stands in stark contrast to the bureaucratic shambles which the UK co-operative sector is in. Further afield, continental EC and US co-ops could well be under resourced to meet the challenges of the future.

These advances by Irish co-ops should not be surprising. I would challenge the concept that co-ops in Ireland were established in a haze of lofty co-operative principles. I do not share the view of some revisionist historians that the co-ops were a symbol of the pure cooperative spirit. Rather, co-ops were powerful economic tools employed by Irish farming producers to combat the control then exerted by local merchants. They helped overthrow a punitive system that provided insufficient returns for farmers - straightforward enough. Likewise, the evolution of co-op/plcs is a development designed to allow overseas expansion by Irish food businesses that recognise the limits of depending on domestic agriculture. That is a legitimate concern and further advances need to be made in that direction. Because of this, I am convinced that the 51% limit on co-op shareholdings in the plcs will be relinquished sometime in the next twoyears as these companies seek further equity funding to assist their growth. Furthermore, substantial levels of pent-up value exist in those co-ops with majority shareholdings in plcs. At some stage this will undoubtedly be released. That is a logical and valid development from where we stand presently and one that farmers should support.

In the event of this happening it raises the question of whether or not control over Irish food companies will slip from farmers hands. That will only happen if these businesses fail to deliver the performance demanded by the investment community. In addition it would be wrong to interpret a shareholding below 50% as indicating susceptibility to predators. Many companies have strategic shareholders with holdings of between 10%-20% who effectively control the ownership of their businesses. Furthermore in the event of takeovers occurring, the possibility of farmers, through their coops, buying out domestic processing assets should not be discounted.

Aside from what happens to those companies on the stockmarket, the profile of the co-operative sector as presently constituted has ample potential to change and restructure in parallel with the progress of the plcs. The matter of what structure should be adopted by Irish coops has been thrashed out regularly over the past five years. The arguments in favour of consolidation have been outlined many times and I do not intend to regurgitate them again. It should however be noted that no less than 45% of the Irish milk pool has changed ownership during the last four years through a process of acquisition and merger. I am firmly of the view that an unstoppable momentum is in progress throughout the dairy industry. This is reducing the number of co-ops in the country and it is a process that will continue in the future. The changes in co-op taxation after the Budget will itself exert pressure on those co-ops largely dependent on trading milk, feed and fertilisers. Such a trend is the right one, because if we are serious about growing Irish owned food companies, with the ability to expand abroad, they will have to attain critical mass at home to enhance profitability and provide the resources for acquisitions.

Farmers

The direction of the food industry in Ireland is also quite dependent on the direction given by the country's primary processors either through their representative organisations, through their co-ops, or as private investors in the quoted companies. The level of influence varies depending on which conduit is chosen, but it is undoubtedly a force to be reckoned with.

The role of farmers in this process is debatable. Some advocate a minimal contribution to the structure of the industry, emphasising instead measures that will maximise the price of their output, and minimise the cost of inputs. Others believe that it is farmers that should decide in detail the decisions taken by Irish agribusinesses. The answer, like many things, lies somewhere in between.

Many harsh lessons have been learnt in the past about the problems associated with too much democracy in the boardroom. The existence of boards with forty members and more must be a thing of the past, as it interfered with and complicated the commercial decision making process. Farming representatives on boards will have to adopt an increasingly commercial attitude to the boardroom and this will be helped by overseas expansion. Parochial political issues will not be relevant to investments in the UK or US. As for maximising returns for producers, there is no doubt that this factor will remain on the agenda of each company/co-op. The vigilance of producers should ensure that raw material costs will remain competitive.

In addition to the level of authority that farmers enjoy in the sector, they must also be cognisant of certain responsibilities. For instance, there are two areas at present where I believe farmers are neglecting important issues: (i) the beef sector and (ii) Bord Bainne.

Almost two thirds of the Irish beef industry has been put under examinership in the last eighteen months. This is by any measure a dark cloud hanging over a sector that represents almost forty per cent of domestic agricultural output. I have been surprised by the lack of response by farmers and their representative organisations to this issue. There is a real prospect of a sea-change in the ownership of the industry over the next two years, yet farmers have shown only limited interest in the subject. The co-operatives need to revisit the industry and consider reinvesting in it. Many farmers will not warm to such a concept, given the traumatic experiences of the co-op sector and beef in the past; Cork Marts-IMP, Clover Meats, and NCF's experiences were disappointing. However, lessons have been learned. Committees of over forty should have no role in the commercial decision making process and cattle prices cannot be determined by farmers. However, while the co-ops were castigated for their inability to control the industry, the developments of the past two years show the private sector lacking in the required skills too. A fresh look is required. That may involve some radical thinking - for example payment on the day may need to be reconsidered, given the voracious appetite for working capital evident in the sector. Nonetheless, it is clearly difficult to make money in beef processing in Ireland. A benign interpretation of the Beef Tribunal evidence would suggest it is extremely difficult to obtain a satisfactory level of profit from Irish beef without stretching the regulations surrounding the industry. Something has to give in the industry and rather than waiting for falling prices, farmers should adopt an innovative approach to the problem. Unless that matter is addressed, what viable future can beef farmers look forward to ?

The other issue is the future of Bord Bainne, which could potentially play a part in developing an internationally competitive Irish owned industry. Presently, Bord Bainne operates in a form of corporate limbo-land, answering to a group of incompatible masters. On the one hand it is used occasionally as a political football by farming organisations and member co-ops pursuing agendas at variance with the future development of the Bord. At other times it is blamed for not providing the guiding light to the future of the industry. This state of affairs is probably due to the structure of the business. Its capital structures limit the commercial value that co-ops put on their investment, while the presence of farming organisations on the board limits the effectiveness of that forum for corporate development. It is high time that a clear unequivocal decision was made regarding Bord Bainne, for the sake of the business itself and the industry in general. There are two stark choices facing its owners.

The company is given full commercial status with a board that operates solely to maximise the commercial development of the business, and without representatives from what are, after all, political farming organisations. This has implications for the corporate structure of the group too. Ideally, the Bord should be a conventional buyer of produce from the domestic dairy industry, its shareholding should be of value, and tradeable, and finally it should have full freedom to pursue investment and expansion policies that help enhance its value. Perhaps GPA could provide a role model for such a change.

Alternatively, the logical outcome for the business is for it to be broken up, with the proceeds being distributed to the existing shareholders. Its valuable Kerrygold brand would then be sold to the highest bidder. There are no in-between solutions on this issue because the sands on which Bord Bainne were built, that is the individual manufacturing co-ops, are shifting rapidly. My own preference would be for the first option to be adopted and allow the Bord to implement strategies designed to maximise profits and value.

Government

The other major influence on the direction of the food industry is the approach taken by Government, through its respective agencies such as the IDA and in specific instances such as Greencore.

The IDA has in the past outlined its policy of supporting a small number of strongly financed companies in its grant-aid programmes. It is important that this policy is strictly adhered too, if our industry, which is operating under a number of serious disadvantages, is to succeed. Every effort must be made by the Government through its agencies and the education system to support and encourage our leading companies. After all, internationally, they remain minnows in the world food industry. If that is to change and if the Irish food sector is to replicate, say, what the Swiss have done to the world pharmaceutical industry, substantial resources will have to be applied.

In regard to Greencore, it is presently unclear what stance the Government is adopting towards the company. Although the headlines have been grabbed by the political controversy surrounding the group, investors are most concerned about operational issues and the Government's 30% shareholding. If it is simply waiting for January 1993 before disposing a further tranche of shares, it will be difficult for the share price and the company to make progress in the interim. Preferably, the Government should commit itself to its holding for at least a further two years, in order to regroup confidence in the stock.

Given the range of issues I have outlined here, you might ask what type of industry would I like to see developing in Ireland. I want to see the evolution of an industry whose shareholders are primarily Irish, in the form of private investors, farmers and domestic institutional shareholders. This industry would comprise eventually of a handful of powerful companies with interests stretching across many countries. An industry that can provide opportunities for Irish graduates on one side and provide returns for the state in the form of advanced marketing, technological and corporate skills, that can be used to further advance the sector. These are the type of objectives I would set. However, it is the producers who have a far greater say in what type of food industry does, in reality, develop.

Executive Summary

The two primary industries in Irish agriculture, beef and milk, are undergoing a process of fundamental change. In the course of the past five years, no less than 45% of the Irish milk pool has changed hands through a process of merger and acquisition. During the last two years, almost two-thirds of the Irish beef industry was placed under Examinership.

A process of consolidation will continue in the domestic dairy sector, a trend that will probably be accelerated by the co-op taxation changes announced in the Budget.

Some of the co-op/plcs are likely to relinquish the 51% holding rule that presently pertains. This will release substantial value to co-op shareholders and provide flexibility in the funding options being considered by the relevant companies.

The beef processing sector is likely to undergo a process of restructuring and change in ownership. Co-ops should consider re-investing in the sector on a measured and controlled basis, despite the harsh experiences of the 70s and 80s. The profitability of the industry has to be addressed and improved. A movement away from payment on the day for cattle may be needed and farmers should review their stance on this issue.

The role of Bord Bainne in the future of the food industry needs to be addressed. It has the potential to be a progressive and dynamic force in the sector but its present structure is unsatisfactory. The Bord must be allowed to pursue independent commercial strategies, and its shareholding should be tradeable and allowed to vary in value with the profitability of the business.

The Government should play an active role in developing a group of Irish owned, internationally competitive food companies. Its grant-aid, educational and support systems should be structured accordingly. It also needs to outline clearer commitments to its shareholding in Greencore, if that company is going to thrive in the future. A mere nine month commitment to holding the remaining 30% shareholding in the company will not help to increase the value of the group.

A Farmer's View

M. MAGAN
Killashee, Co. Longford.

As a dairy farmer, my objective has always been to improve the genetic quality of the herd. This report is a summary of my views which have evolved over a number of years, and which have been rearranged as a result of disease.

Farm background

I farm in partnership with my now retired father and brother on 73 adjusted hectares (180 acres) of good land. We have a milk quota of over 1 million litres (237,000 gals.) after deductions. When I started to farm in 1971 we had 40 cows with 2730 l per cow and 25 kg of meal fed per head. We made steady progress for the next 10 to 12 years moving up towards 200 cows by 1983. Over that time we reinvested all farm profits back into land development, buildings and increased stock numbers. We had a totally closed herd until 1983 when we lost 50 cows with TB. That happened in April, when quotos were being established.

We bought 30 head in the autumn of that year which, combined with a yield increase from 900 l/cow to 6360 l gave us a reasonable milk quota. I also availed of a unique situation in our co-op area to acquire some extra quota. In our last full year of production ending in November 1990 we had 150 cows with an average yield of 7500 l.

The one nightmare every farmer faces is the possibility that at some stage he may lose his entire herd through disease. It happened in November 1990 with BSE. Having considered staying out of dairying which was not practical, I then began the process of trying to plan our future with a new herd. Due to our favourable quota to land ratio, high yield with fewer cows suits us. We also enjoy a winter bonus pricing system from Lakelands co-op. Thus, all year round milk production is an option open to us. Most dairy producers farm with a system that has developed over a number of years and one that changes to reflect current market trends.

High milk price in the past helped us to decide on additional farm expenditure which has now to be funded at less profitable times. We have invested heavily in developing our farm to make it user friendly and we wanted to build a herd of cows that two labour units plus relief help could run efficiently.

When planning the new herd I examined what was good and what to avoid in the old herd. If fifteen years of milk recording at an estimated total cost of £10,000 was not to be a total waste, I had to undertake a critical appraisal. It is worth noting that some countries have discipline imposed on their producers whereby all second calf animals are mated to test sires. This gives a large number of new bulls to select from each year. The marketing strategy of some A. I. groups at present seems to be the sale and distribution of other countries' semen. This, plus a plethora of semen selling groups/companies, means that millions of pounds are leaving our dairy industry each year. This money is needed for the development of a native bull programme. High semen costs are based largely on fashion followed by the proceeds of the sale of 'Mr. Right Bull' into the promotion of the next super bull. The old Irish saying, "Ta adharca fada ar na bolacht thar lar' or 'far away bulls have long horns' was never more apt.

Our plan for the future is to concentrate on full milk production but at as low a cost as possible, by using more grass and by producing better silage from both grass and maize

As we strive to reduce costs of producing milk, essential costs such as, semen must be tightly controlled.

While I acknowledge the importance of our beef industry, it has been used for far too long for holding up the process of developing a meaningful dairy bull list. In the past bulls have been rejected if their beef shape failed to meet certain criteria despite the fact that they were very good for milk production. I have always been sceptical about the term 'dual purpose bull'. To me this implies only half good enough at either job. We all know of a case of a heifer breed for beef which found its way into the dairy herd and performed well. But this cannot be replicated on a widespread basis. Fixing type is very difficult at the best of times but it is further complicated when breeds are mixed. The choice of a beef bull is ever present for any of us at any time but we should strive to develop a generic single purpose breed to help us maximise our efficiency.

Milk recording

Central to any successful young sire test programme is the need for having a realistic percentage of the national herd recorded. Our pitifully low figure of less than 10% is only matched by the non dairying mediterranean countries. Any single farmer can make a case not to record but that is leaving the work to others. We must find a way to reduce the cost of milk recording and to attract more people into the scheme. I commend Dairy Gold on their promotion of the 'A8' scheme to their suppliers. This scheme is within 5% accuracy of the more widely used 'A4' scheme. The efforts of a large dairy co-op in increasing the number of cows recorded must be applauded.

In summary, herd performance is progressing nicely. Fat and protein production has averaged 3.8% fat, 3.35% protein for the winter, giving us a bonus of 0.9p per l (4p per gal) in addition to our winter bonus of 4.4p per l (20p/gal).

We are using maize silage in the diet but at 20% dry matter, it may not be contributing anything. In 1989/90 we brought in 70 first calved heifers into the herd, 35 in the spring and 35 in the autumn. The autumn calving heifers averaged 7300 kg at 3.63% fat and 3.43% protein, with the spring calvers yielding 6000 kg at 3.6% fat and 3.25% protein. Within this group of heifers we had a wide range of indices ranging from 450 to 805. With very few exceptions the best heifers on yield of milk, fat and protein were the high index ones. We had a top yield of 9200 kg at 3.75% fat and 3.3% protein while the highest index heifer produced 8000 kg at 4.14% fat and 3.66% protein. She was also the best looking heifer and had been contracted as a bull mother for A.I. All animals received equal treatment as we feed the herd on a complete diet.

The case is well proven that high index cows are more efficient under any level of input or management system than cows of low genetic merit. The long running experiment at Langhill in Scotland proves this conclusively. If each index point is worth an extra £1 in profitability I believe that it is necessary to build the highest index herd possible. We as farmers use science as a management aid in many ways on the farm but have virtually ignored it when it comes to cattle breeding. To me that is illogical. I am also convinced that high index cows do not necessarily mean that we lose functional type.

I regret the lack of a meaningful genetic evaluation trial in this country. We enjoy the excellent work done by two of the leading Dairy Research Centres in the world - Moorepark and Hillsborough. But unfortunately very little research has gone into this vital area of genetic improvement. Nonetheless I accept the results of the international R & D work on animal breeding. So, the challenge was to locate animals with superior breeding.

What I look for in a cow

1. Functional type with good dairy character, good legs and feet
2. Capacity - to facilitate forage utilisation
3. Sound udders with teats pointing down
4. Capable of high production

She must have her first calf at 2 years of age, produce a calf every year and be retained in the herd long enough to reproduce her own replacement.

As we are paid 55% of our milk price on a protein basis we were determined to place a lot of emphasis on protein in the new herd. While it may be possible to influence protein percentage in milk with certain feeding practices it is important to have a good protein base to start with. This presented us with our first problem where to get good protein cows in Ireland?

The very low number of cows milk recorded in this country left us with very few options. We located a small number of animals here but if we were to complete the herd with Irish cows we would have to compromise our aims and objectives. After looking at a number of countries, Denmark and Canada were the two main sources from which I selected the foundation of the new herd.

Denmark has an excellent disease free status which means there is no quarantine for cattle coming from that country. Thus, it was the only country in Europe that could compete on a price basis with Ireland. Most dairy cows in Denmark are milk recorded which gives a large selection of animals to choose from. I selected 106 in-calf heifers from Denmark, the first of which were due to calve shortly after arrival in Ireland in May. Most of the animals came from small farms but I felt that they would fit in with our system. The average production of the dams which we selected in Denmark was 7400 kgs at 4.00% fat and 3.4% protein.

In Canada we looked for cows that were a little different. We were aiming at top north American genetic merit, selected for depth of pedigree, high production, excellent type and high index, in other words the complete package.

The Canadian group have formed the nucleus herd within the larger unit. A selected number of animals from the larger herd are being used as embryo recipients. We are flushing the best of the Canadian cows to the best available bulls to speed up genetic progress and also to capitalise on the high investment incurred therein. We also have a store of U.S.A. embryos contracted from some of the best cows identified by the U.S. Department of Agriculture. This was the project we had embarked on before we lost the last herd and unfortunately the first crop was lost when the herd was disposed of in November 1990.

Returning to the subject of top bull, I await eagerly the time when we can compare bulls from different countries on a unified standard basis. At present 'Top Bull' means a very expensive bull. I aim for a bull with a high RBI of 140 plus, plus for percentage protein, has an acceptable type scoring but most importantly has a wide proof or a big weighting. The best way to measure the success of a national breeding programme is in its international semen sales. Using this simple measurement, the most succesful countries are U.S.A., Canada, Holland, France, Germany, Denmark and New Zealand, while North American genetics are enjoying tremendous success at present, I believe their position will be challenged by Continental Europe.

Where does all of this leave Ireland? I won't dwell on the past except to note our dismal performance in developing a bull, even one bull that can compete in the international arena. We must now decide where we are going in the future. The recently proposed merger of the A.I. bodies into two groups must be matched by a well defined disciplined programme to test a large number of bulls for extensive home use at least and international sales at best. In taking a leaf out of other countries breeding programmes I feel that it is vital to test bulls out of cows that perform in an environment and on a system that their daughters are likely to perform under.

After ten months back into production we obtained a yield of 6000 kg per cow - concentrate usage was high as the Danish cows needed supplementation at grass. I think this was just a start up, stress related problem which I hope will not re-occur in the coming season. The smaller nucleus herd is performing very well and looks set to out-yield their herd mates by 20%. The only concession made to this herd is that they are housed in a small group to eliminate space competition.

Application of New Zealand Dairying Techniques to Irish Conditions

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We are two Consulting Officers for the New Zealand Dairy Board working in Munster, funded by Dairy Gold, Golden Vale and Kerry co-ops with the aim of helping to put more money in Irish dairy farmers pockets.

We've found farmers here to be very aware of the need to lift farm efficiency and to maintain their standard of living but not so sure on where to start or how far to go. Much of the current focus of farmers is on quota, CAP and tax, i.e. factors outside of their control. Many farmers are not focusing on their core business; they do not have a clear objective of maximising profit from their dairy enterprise.

Wide variation in costs

NZ farmers rely solely on unstable world prices, hence they must always maximise margins to survive when milk price is low. Like Ireland, NZ depends primarily on grass to produce milk. Within Ireland there is an enormous range in costs from 40 to 90p/gal. with most farmers producing milk at 60-65p/gal. Ireland produces 1000 million gallons of milk annually. A 10p/gal. saving on farm costs would put an additional £100 million pounds in farmers pockets. The priority for most farmers should be to lift efficiency to the level of the best operators, by using existing Irish technology.

NZ is producing milk at a cost of around 18p/gal. Most of the difference between Ireland and NZ are not due to climate but to the focus on profit. The entire NZ industry has an unshakeable belief in low cost production and the key principles that lead to low cost production. There is on going research plus extensive measurement on farms, reinforcing those key principles and guiding management.

Discussion groups

One of the cornerstones of the NZ dairy industry is it's extension service, the success of which is partly reflected in the narrow range of production costs. What is extension? Broadly speaking, extension is helping people to help themselves. In NZ the role of a Consulting Officer is to help lift farm profit. We do this mainly by working with farmer discussion groups and focusing on the key principles of low cost production .

Discussion groups are a vital extension method in NZ. Over 50% of dairy farmers attend one or more discussion groups. They enable each CO to contact, on average, 350 farmers regularly, providing a low-cost and effective extension service to farmers.

The NZ discussion group may be and probably is fundamentally different to the discussion groups operating here in Ireland. Some of the key points that in NZ have made discussion groups so successful are:

* FARMERS GROUPS: The farmers are responsible for organising meetings, activities and attendance. It is not a closed group, anyone in the area can attend though the groups tend to remain stable.

* MANAGEMENT MEETINGS: They meet once per month, during the day, on a farm. The farmer attends the discussion group to help his business. Meeting during the day keeps the group calibrated on measurement.

* ROTATING VISITS: The group visits a different member each time. The host farmer sets the objectives for the day. Issues relevant to the whole group are discussed based around the host farm situation.

* OBJECTIVES: The group helps define objectives more clearly, gives options and opinions so that at the end of the day the farmers make their own decisions and understand the basis for them.

* DISCUSSION: The CO is not there as an 'expert' to give a lecture or answer farmers questions; the ideas are nearly always within the group. The CO helps keep the discussion focused on the key principles that affect profit, adding technical information where necessary. The group focuses on relevant issues for the time of year, for example, submission rates and non-return rates at mating, cow condition scoring and feed budgeting in the autumn, grass dry matter intake and utilisation throughout the year.

* ANALYSIS: The CO helps the group analyse all options, relating them back to profit. Farmers develop an ability to analyse better any situation on their farm.

The discussion group concept has been very successful in NZ at encouraging and helping farmers increase profitability. As adults we are self-directed learners, i.e. adult learning is initiated, planned, directed and carried out by ourselves. Professionals have a relatively small influence on farmers decision making. Other farmers are possibly the most influential social group for a farmer.

To lift profit there must be a clear farm objective, be focused on the dairy enterprise and understand the key principles of efficient dairy farming. To achieve this objective a good discussion group helps farmers very significantly.

Key principles

The major difference in dairy technology between Ireland and New Zealand is NZ's focus on the farm as a business and on the key principles of low cost dairying. We believe that in Ireland a similar focus on these critically important principles would put more money into farmers pockets. What are the key principles of turning grass to milk at low cost? They are: stocking rate, calving date, cow genetic merit and grazing management.

These principles which were developed under the very favourable conditions of Ruakura have, over the last decade, been proven to be equally as valid in the cold South Island of NZ where climatic conditions are generally similar to the south of Ireland. The principles do not change with the weather, soil type or any other variable. We realise that this winter has been unusually mild, but everything we know about Ireland suggests strongly to us that these key principles are just as relevant here. There is enormous scope to increase profits on dairy farms. The most efficient farmers here are producing milk at around 40p per gal. We are convinced that under normal Irish conditions milk can be produced at 25p/gal.

How much does it cost to produce a gallon of milk? Do you know what your farm profit margin is or where it disappears to? Do you really have a clear objective of maximising profit and a strategic plan to achieve that? Many farmers seem to concentrate on increasing output, avoiding tax and end up losing control of costs.

In any business there must be a clear objective of maximising profit. You want to build on your assets each year to provide a better quality of life for yourselves and the next generation. That means re-investing time and profit in areas that will give the best return and turning grass to milk at lowest cost. To reach this objective, there must be a clear management strategy. That management strategy should be:

1. Analyse current performance - compare yourself with the efficient farmers. What are your costs of production? What is your income: What is your real margin? If you don't know how to do this, seek help from your advisor or accountant.

Dairymis data here show that farmers with lower costs of production are more efficient than average in all areas i.e. they have better financial control of the business. Tax accounts provide very little management information. NZ farmers regularly make and use cashflows and budgets to monitor and control their business.

2. Concentrate on the key principles of low cost production which are; stocking rate, calving date and pattern, cow genetic merit and grazing management. Use objective measurement to monitor yourself against your targets. The more grass used, the less meal fed and the less silage fed, hence less to replace. High grass utilisation at low cost is dependant on an adequate stocking rate and a compact calving close to grass.

Grass utilisation

How do you know how well you're utilising grass? The pasture management we observed last autumn throughout Ireland was succeeding mostly in minimising growth. For most farmers the aim seemed to be how soon could the farm be grazed out. The aim should have been how to continue to provide and utilise good grass for the cows to reduce costs. The next aim should then have been preparing for early turnout.

NZ farmers use simple techniques, such as, grass assessment and condition scoring to assess what is happening on the farm. Action is then taken to ensure pasture and feeding targets are met. These techniques would apply equally to Ireland. Grass assessment means measuring grass cover using, for example, an electronic probe or plate meter. These indicate kilograms of grass dry matter available, grass growth rates, and grass left after grazing, hence utilisation.

As a balance, cows are regularly condition scored to ensure, firstly, that young cows dry off early enough to reach Irish score 3 before calving, and secondly, that the feeding level is maintaining the condition of older cows at around score 2.5 up to calving. Expensive winter feed is wasted on overfat cows and by not giving priority to young cows which could give a payback on extra condition.

Calving date

While stocking rate determines how much grass is eaten, calving date and pattern determine when it is eaten.

In Ireland milk bonuses and the chase for extra money from beef calves confuses farmer thinking. An example of this is the Curtins farm trial, where a later calving close to grass lifted profits by a whopping 10p/gal. Yet few farmers are making a significant effort to do this. Reasons given for not calving closer to grass are usually:

- loss of milk bonuses,
- lower calf prices,
- worry about late calvers going even later.

Many farmers begin calving in January and are still calving cows in April, May or even June. Few are actually analysing their situation to see if later calving will lift profits on the farm, or examining why the calving is spread, or, how a compact calving pattern can be achieved. Moorepark has researched and developed practical systems for getting cows in calf compactly.

Compact calving

In NZ mating time for the herd is one of, if not the most important, period in farm management. Compact calving close to grass matches grass supply and demand more closely and, as Curtins farm has shown, lifts profit. Achieving a compact calving takes time and effort. Good calving records will help, and for example, recording all heats for 3-4 weeks prior to mating will show up problems before mating commences. NZ farmers aim to have a 90%+ submission rate and a 70% conception rate. They monitor and record exactly what is happening throughout this period.

NZ researchers have also researched and developed practical systems for getting cows in-calf compactly. In contrast to Ireland, these techniques have been taken up by the majority of commercial farmers. Tailpainting is a good example, simple and highly effective if used properly. Ninety percent of NZ farmers use tailpaint compared with 10% of Irish farmers. The net result is that in NZ the majority of farmers will target and succeed in having a compact calving.

Breeding policy on the farm

The two objectives of mating are:

a. Getting cows in-calf on time;
b. Breeding sufficient high RBI replacements.

Far too few cows in Ireland are mated to high RBI sires because of a perceived drop in value of the calf and the perceived lack of benefits under a quota situation. Replacement rates and use of high RBI sires is so low that the national herd is probably going backwards. In addition, milkfat and protein percentages have changed little in Ireland, while the rest of European farmers have been successfully breeding to increase the value of their milk.

In the chase for a few extra pence per gallon from calf and beef sales, costs are driven up and income driven down by inefficient cows. Profit is suffering and the trend according to Al usage last season is still downwards.

Calf and cull sales in Ireland contribute the same proportion to dairy income as in NZ Yet NZ farmers still aim for 20-25% replacement rate of high RBI heifers each year. In addition, nearly all commercial dairy farmers in NZ use a simple system of recording the breeding index of their dairy animals and are able to monitor the genetic progress with the herd. Similarly, nearly all commercial dairy farmers in NZ mate at least 3/4 of the herd to proven high breeding index sires. Why? Trials and farmer experience worldwide have repeatedly confirmed that under all conditions and management, high genetic merit cows out perform their herd mates of lower genetic merit. For example, translating the results of the NZ breeding index trials to Ireland would suggest that a lift of 25% in the herds Bl could drop milk production cost by 10/gal.

In NZ, calves, heifers and cows are now largely sold on the basis of their Breeding Index. The animal value increases relative to the basis of their Bl. In Ireland, the same market is beginning to develop where higher prices will be paid for higher RBI replacements.

But how do you know if your breeding programme is going forwards or backwards, if your cows are becoming more or less efficient? How do you go about raising genetic merit? A high replacement rate of high RBI sired heifers will give the most rapid lift. Use proven sires and keep good records so you know where you are going, because in all animal based industries, increased genetic merit lifts profits.

Summary

There is enormous scope to increase profits on dairy farms in Ireland. Do you want more money in your pocket? If you do then set a clear farm objective of maximising profit. Concentrate your management on the dairy enterprise and on the key principles of low cost milk production, which are: stocking rate, calving date and pattern, cow genetic merit and grazing management.

Low Cost Dairying in a Colder Climate

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Ashburton, South Island, New Zealand.

The base of the New Zealand economy is pastoral agriculture. Fifty per cent of NZ exports are grass based. We view our farms as grass farms first, and dairy farms second. Decades of farm production research have been aimed at increasing the quality and quantity of the herbage grown and utilization of that feed with higher genetic merit cows at the lowest possible cost. The focus of this paper is on our experience in moving from the traditional dairying areas of New Zealand and beginning a new land use in the South of New Zealand and the techniques developed to farm there.

Reason for moving

In the late 1 970's we believed our future as dairy farmers was in doubt - we had an average size operation in the North Island with reasonable levels of production but I was worried about the ability of that farm to provide for our families future. We began investigating the feasibility of moving farms from the North Island to the South Island. The South Island of New Zealand had certain appeal. There were a few dairying enthusiasts who believed that there was potential. This belief was supported by the Dairy Board Consulting Officer of the time. The sceptics in both the traditional areas and the South Island all said it was impossible to successfully dairy farm there because of the cold winters and low pasture growth that ensued. Certainly, the climatic data showed much lower soil temperature and the pasture production data showed much lower winter growth.

The dairy industry that had been strong in Canterbury and Southland declined rapidly over the 1950's and 60's. Many of the remaining dairy farms had systems that depended on massive winter inputs from 7 to 10 tonnes silage per cow. This was ten times that being used by us in the North.

Despite that, I was optimistic about the South Island. It appeared to me as if farm management practices lacked the benefit of applied research. It appeared as if no effort was being made to enhance winter grass growth. The remainder of the season had a very reliable and predictable pasture production pattern guaranteed by irrigation in Canterbury. My vote went with the enthusiasts.

In 1980 we purchased a sheep and crop farm and immediately converted it to dairying. The first season was not as easy as I thought - there were local differences and we did not know all the answers. The small band of local dairymen with the support of the Dairy Company and the local Ministry of Agriculture and Fisheries (MAF) decided that we needed some applied research to identify that limiting factors for achieving high levels of low cost production - the theme was "Can Canterbury achieve 500 kg milkfat per ha"?, equivalent to 1200 gal per acre at 3.6% fat corrected milk. The dairy experts from Ruakurs were invited to lead the effort and fortunately at that time the funding was available. It was decided to monitor local data against similar information from the Ruakura No. 2 Dairy. After the first season when information was collected from three farms in the region it was decided to target more detailed information from one farm. We were to be the guinea pigs! Critical measurements were:- pasture growth - pasture utilised - stocking rate - calving spread - cow condition/ health - milking machine efficiency

Our first season in the South Island yielded 315 kg milk fat per ha. At the conclusion of the three year monitoring project production reached 520 kg milkfat per ha.

Dairy herd expansion on South Island

The results excited the dairy farmers of New Zealand. Interest in dairying in the South Island was stimulated. The 7 dairy farms in our county in 1980 has now grown to 77 - mostly people moving from other areas of New Zealand bringing their cows with them as land use pressures from horticulture, racehorses and urban subdivision made the South Island attractive. Now Southland is experiencing the surge in farm conversions as people rediscover dairying in the region.

Today, as in 1980 we seek greater efficiency, greater profitability, - that is what drives our farm strategic plan. Research has identified four critical factors that require major policy decisions on each farm:-

1. Stocking rate - The number of cows per hectare.
2. Calving date - The planned starting day.
3. Calving spread - How fast the herd calves.
4. Cow quality - Genetic ability.

Farm management policy

On our farm the policy is:-

* Stocking rate 2.9 cows per ha
* Calving date August 10
* Calving rate targets:-

PS- MP	15 days
MP - Last Cow	30 days
Total	**45 days**

Those policies create a feed demand curve which can be applied to the supply curve and identify the periods of likely deficits and surplus. Two significant options available to us are:

1. Strategic use of nitrogen, regular autumn application of 20 kg N per ha are used as the volumes of irrigation water applied over summer leave soil nitrogen depleted.
2. Off farm winter grazing is an ongoing strategy. Taking the herd off the farm for 60 days adds a different dimension to the demand curve and it is from such basic data that we fine tune the operation to exploit our farms ability to produce grass and our herds ability to produce milk.

Focusing on the late autumn/winter/early spring periods we begin with a feed budget, a statement of what is available by way of feed stuff - grass on the farm (average cover), likely growth and supplements according to herd demand for maintenance, production and weight gain. A predictive picture is then generated of what happens to the average cover on the farm and targets for that very important yardstick are set. The low point for the year is what drives the whole decision making process. This point represents the time that we run out of feed. Obviously the closer we can get this point to the date that daily growth exceeds the herd demand the better - the 'magic day'.

In our operation the target level and the target date are set six months in advance and we work backwards using the feed budget predictions to set the next target point, this being when the first cow calves, then to the point that the herd returns to the farm from winter grazing, and finally the most flexible and probably the most important date of all - drying off date.

Six to eight weeks prior to likely drying off we develop a target average cover graph. Weekly monitoring of the whole farm gives an actual line which is plotted against the target. Provided that the actual average cover on the farm falls between tolerance levels on the graph we will continue milking. The only other factor influencing drying off decisions is cow condition. Our feed budgets have assumed a weight gain requirement and cow condition must not be allowed to fall below target levels. We dry individual cows or groups of cows off early on this liveweight (condition score) criterion regardless of production levels.

Autumn management

Pasture management during autumn is aimed at encouraging a sward that will maximise winter growth. Intensifying the farm subdivision with temporary electric fence reels can increase the daily stock density thereby forcing cows to graze lower and clean out any rough patches that have developed over summer. Thus the grazing rotation is lengthened giving more time between grazing as daily growth rates fall. This limits cows' intakes and slows the reduction in the farm's average cover. Some supplements are commonly fed at this point usually in the form of silage or crop residues which are readily available in our region - barley or grassed straws which increase the bulk of feed offered and preserve cow condition, thus adding a few days to the lactation length.

Winter

At drying off, the herd will be in a condition that will allow them to reach target condition score at calving with the feed available both on the grazing off property and the home farm. The average cover on the farm will be at the level, given that predicted growth rates over winter reach the target. Pasture composition will be such as to give greatest winter growth - dense, vigorous, leafy pasture allowing maximum sunlight interception and penetration.

Regular monitoring against our targets all winter allows for constant fine tuning. Greater than predicted winter growth rates could allow for higher winter feeding levels and the herd arriving back on the farm a few days earlier and a bit heavier. Less than predicted growth rates could require the opposite or the use of nitrogen to boost grass growth in early spring.

Calving season

Planned start of calving will be 6 to 8 weeks before the "magic day" i.e. the day growth equals demand. This is our most hectic period on the farm. With many mobs of cows requiring differing feeding levels i.e. late calvers, early calvers, freshly calved cows and milkers.

However the objectives do not change: careful feed allocation, good utilization, monitoring the resource of average cover and daily growth, measuring daily milk production. Usually one complete rotation of the farm is achieved from the beginning of calving to the point when daily supply exceeds demand. There can be some tolerance of underfeeding of the herd at this point as our high BI cows will bounce back after a short period of underfeeding, say 10 days.

Rotation length and pasture quality

The rotation length will remain at about 30 days until grass growth accelerates. At that point we adopt a fast grazing round - 10 to 12 days in an effort to control pasture and maintain a high quality sward. Research indicates there is little long term advantage in one rotation length over another once daily growth rate is ahead of herd demands. The objective must be to fully feed the cows and maintain a high quality pasture.

We find that by following this process we are able to identify management targets. Questions, such as: Can we calve a little earlier? Can we lift the stocking rate? can be answered with some logic.

Conclusion

Although this paper is targeted at our pasture management techniques it must be emphasised that the herd's concentrated calving pattern is a major key to successful seasonal dairy farming. It is a major management issue and takes precedence over everything during that time. With the total herd being dry for 90+ days the importance of having every cow calved as soon as possible after the planned start is the only way of gaining lactation days.

The results of these strategies are measured in our production and our profitability.

Production for this season will be 207 kg milkfat per cow (all milk counted), giving 600 kg milkfat per ha (1012 kg fat and protein per ha).

Making Silage a Less Variable Feedstuff

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On typical calf-to-beef or spring-calving dairy farms, grass silage now accounts for about 24% of the annual intake of feed dry matter (DM), with grazed grass and concentrates contributing approximately 66 and 10%, respectively. The significance of silage becomes more important when one considers that those quantitative contributions from silage, grazed grass and concentrates represent about 36, 30 and 35% of the annual feed bill, respectively. Consequently, the yield and quality of silage are of major importance on all livestock farms, both in terms of the reliability with which they can be consistently achieved and the cost of feeding animals with silage. The purpose of this paper is to quantify how variable grass silage is on Irish farms, and identify ways of making it a less variable feedstuff. This is addressed in the form of four questions:

1. How variable is silage?
2. Why is silage so variable?
3. Does the variability matter?
4. How can silage be made less variable?

1. HOW VARIABLE IS SILAGE?

The yield of silage per hectare can be very variable. Where typical first-cut yields of 5 tonnes grass DM/ha are achieved on May 24, this can vary by 20% from year to year on the same farm. Variation in grass yields in July and August may be considerably greater. When grass yields are expressed on a fresh (green) basis, the magnitude of variation is enlarged further, with first-cut yeilds on May 24 ranging fromn 20 to 50 tonnes per hectare. The scale of variation in silage quality is shown in Tables 1 and 2. On a national basis, considerable variation in silage composition occurs from year to year, and among cuts within years. For example, first-cut silages were drier and had better preservation and digestibility in 1991/92 than 1992/93, while the reverse held for second-cut silages. Looking at first-cut silages in 1991/92, the maximum and minimum values recorded among samples analysed by Grange Laboratories were dry matters of 350 and 120 g DM/kg, pH values of 8.2 and 3.5, crude proteins of 250 and 95 g CP/kg DM and dry matter digestibilities of 840 and 340 g/kg DM, respectively.

Silages also vary widely in their aerobic stability upon exposure to air at feeding time. Among 84 farm silages evaluated for their aerobic stability under controlled conditions (10 days), quantitative dry matter losses ranged from 0 to 575 g/kg and qualitative losses in dry matter digestibility ranged from O to 248 g/kg DM (O'Kiely, 1989).

Table 1
Mean composition of first- and second-cut silages analysed by Grange Laboratories in 1991/92 and 1992/93.

	1991/92		1992/93[1]	
	First-cut	Second-cut	First-cut	Second-cut
Dry matter (g/kg)	225	214	215	221
pH	4.1	4.3	4.2	4.0
Lactic acid (g/kg DM)	100	74	87	89
Ammonia-N (% N)	11.3	16.4	14.3	10.9
Crude protein (g/kg DM)	152	162	152	153
DMD in vitro (g/kg DM)	691	651	679	669

[1]Average to October 7, 1992

Table 2
Silage quality - percentage distribution within selected ranges of silages analysed by Grange Laboratories.

	Dry matter (g/kg)			pH			Lactic acid (g/kg DM)		
	<200	200 to 250	>250	<3.8	3.8 to 4.2	>4.2	<100	100 to 130	>130
1991/92: first-cut	31	50	19	12	61	27	48	30	22
second-cut	49	36	15	10	46	44	71	16	12
1992/93[1]: first-cut	44	41	15	4	59	37	59	22	19
second-cut	30	54	16	25	61	14	57	29	14
	Ammonia-N (%)			Crude protein (g/kg DM)			DMD in vitro (g/kg DM)		
	<10	10 to 15	>15	<150	150 to 180	>180	<650	650 to 700	>700
1991/92: first-cut	41	46	13	44	46	10	24	24	52
second-cut	25	38	37	25	57	18	48	32	21
1992/93[1]: first-cut	24	40	35	46	45	9	32	25	43
second-cut	46	40	14	42	49	9	31	44	25

[1]to October 7,1992

2. WHY IS SILAGE SO VARIABLE?

Variable weather conditions have a large effect on silage-making. Irish climatic conditions differ widely from those in most of northern and western Europe. Keane (1988) has shown that solar radiation and the incidence of consecutive rain-free days are lower in Ireland, and vary widely within and between years, while Thram and Broekhuizen (1965) showed that relative humidities are higher in Ireland.

Yield

Grass dry matter yields are affected by a number of factors such as soil fertility and nutrient supply, sward botanical composition, season, growth interval, environmental conditions, etcetera. Weather conditions immediately before and during harvesting significantly influence the dry matter concentration in grass, and therefore the yield of fresh (green) grass. For example, if a 25 tonne/ha crop of 200 g dry matter/kg received a rainfall such as to reduce its dry matter concentration to 170 and 140 g/kg, the fresh yield would increase to 29 and 36 tonnes/ha, respectively.

Rate of decline in digestilility

As grass develops from the vegetative to inflorescence phases, the proportion of leaf decreases, lignification increases and the digestibility declines. The initiation of this process is significantly influenced by day-length (Jones, 1988) and therefore tends to be predictable from year to year. However the rate of digestibility decline can be altered by factors such as drought which causes the proportion of leaf to decrease more rapidly (Jones, 1988), while high tempera-

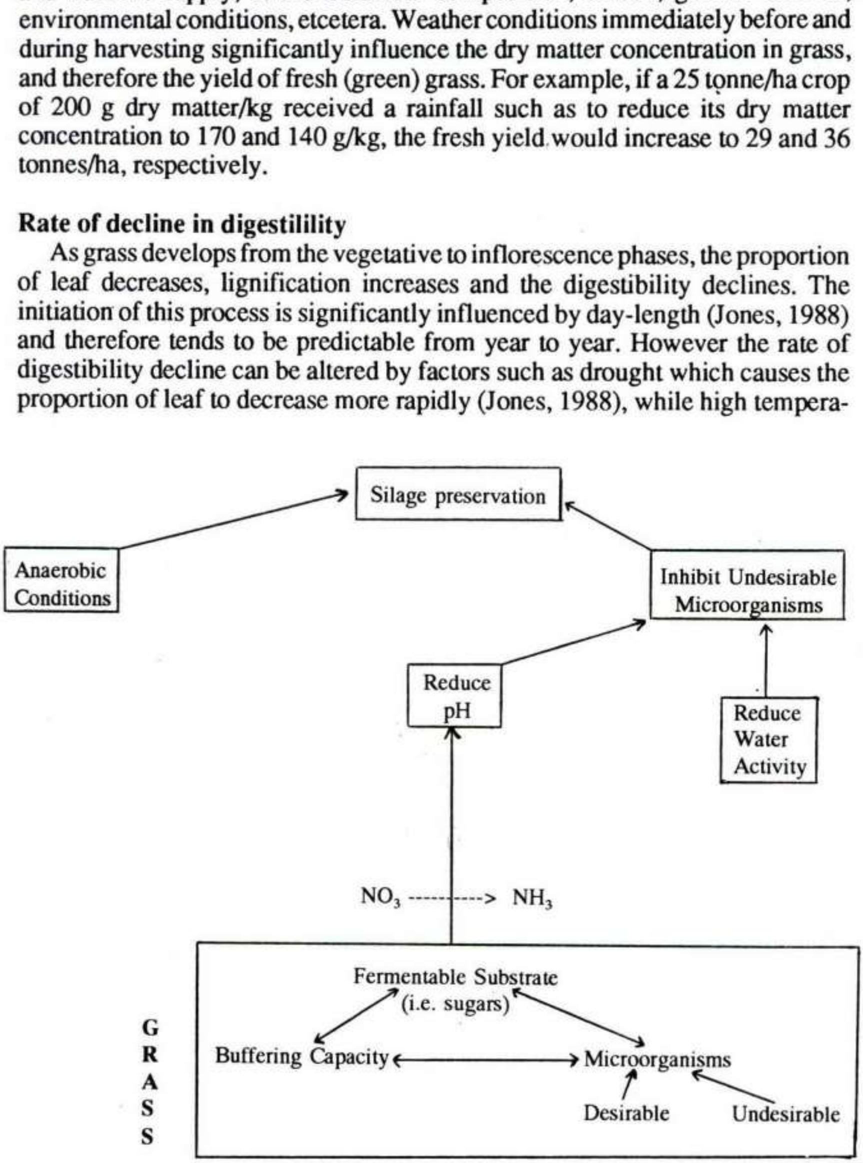

Figure 1. Simplified schematic outline of components controlling silage fermentation (environmental temperature, etc. assumed to be normal)

Source: O'Kiely (1992a)

tures increase the rate of lignification and the rate of senescence of the lower leaves (Deinum, 1984). Severe crop lodging during wet weather also increases the rate of decline in digestibility (O'Kiely et al. 1987) and, in some circumstances, plant diseases may also be important. Experiments are in progress at Grange to determine if grass growth during mild winters reduces the digestibility in late May due to the accumulation of dead vegetation at the base of the crop.

Silage fermentation

The principle of preserving grass as silage is based on storing it in an oxygen-free environment which will inhibit plant enzymes and undesirable micro-organisms. This is usually accomplished through the fermentation of sugars in the crop to lactic acid by lactic acid bacteria (Figure 1).

Due to the low dry matter concentration in Irish silages, they normally undergo an extensive fermentation (Wilson and O'Kiely, 1990). However, since a myriad of management, environmental and crop factors interact to determine the type of fermentation (Pitt, Muck and Leibensperger, 1985), and many of these factors vary considerably and are outside the farmers control, it is not surprising that the fermentation characteristics of farm silages are so variable. Most of the procedures undertaken in silage-making aim to facilitate lactic acid bacteria to dominate the fermentation. However, even where lactic acid bacteria are dominant, the fermentation of unwilted grass on farms is still relatively uncontrolled compared to industrial fermentation processes where ingredient composition and environmental conditions are strictly controlled.

Water soluble carbohydrates (WSC). Non-structural carbohydrates such as glucose, fructose, sucrose and fructans, which are soluble in cold water, are energy sources for lactic acid bacteria during silage fermentation. The amount of WSC present in the grass at harvesting is critical, since sufficient lactic acid must be produced during fermentation to reduce the pH from about 6.0 to approximately 4.0. The WSC content is a balance between the sugars anabolised during photosynthesis and those catabolised during respiration or used for growth. Temperature has an effect on this balance, with lower temperatures tending to restrict respiration more than photosynthesis, the result being that WSC levels increase (Deinum, 1984). Solar radiation correlates positively with grass WSC values (Deinum, 1984). Deinum's studies therefore suggest that WSC levels in grass DM are highest when plants are grown at high light intensities and low temperature and lowest in shade and high temperature. McGrath (1988) has shown that within WSC, the balance of individual sugars is influenced by both season and climate.

Grass WSC, expressed as g/l aqueous phase, vary considerably. Weather (Figure 2), together with grass species/cultivar and fertiliser (Table 3) have a major effect, while season, physiological growth stage and time of day have lesser effects. The major diurnal effect is that of dew. Rainfall, by wetting the crop, clearly lowers the WSC content in the aqueous phase. Consequently, if a crop of 200 g dry matter (DM)/kg and 150 g WSC/kg DM received a rainfall such as to reduce its DM content to 170 g/kg or 140 g/kg, the WSC content in the aqueous phase would decrease from 37.5 g/l to 30.7 or 24.4 g/l, respectively.

Table 3.
Variation in ensilability due to grass species or N fertiliser

Species	Grass species effects[1]		Nitrogen fertiliser effect[2]		
	Sugar (g/kg DM)	Buffer capacity (g LA/g DM)	kg N/ha	Sugar (g/kg DM)	Buffer capacity (g LA'kg DM)
Italian ryegrass	200	63	30	147	61
Perennial ryegrass	188	54	60	133	65
Timothy	93	44	90	118	70
Meadow fescue	104	43	120	103	74
			150	89	79

Source: [1]Podkowka (1985); [2]following regression of data of Podkowka (1984).

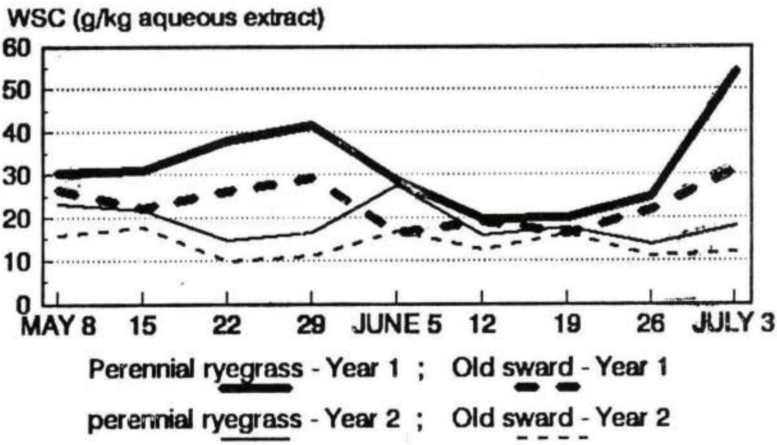

Figure 2. WSC in primary growths of Lolium perenne and Old Permanent Grassland swards in two successive years

Source: O'Kiely et al (1987)

Figure 2 demonstrates the variation in grass WSC during May to July in successive years when both the crop and management practices were constant (O'Kiely et al 1987). Most of this variation was weather related, tending to decrease during wet, overcast, warm conditions. If 30 g WSC/l is taken as a threshold above which the grass should be relatively easy to preserve as silage, the ensilability of grass was very variable and was strongly influenced by weather. However, the entire fermentation process can interact with ambient temperature. O'Kiely (1991 - unpublished data) has shown that by increasing the ambient temperature at which autumn harvested grass was stored during ensilage from 7°C to 18°C, mean silage pH, ethanol, acetic acid and propionic acid levels increased from 4.2 to 4.7, 25 to 70 g/kg DM, 21 to 91 g/kg DM and 0.4 to 8.5 g/kg DM respectively, while lactic acid decreased from 83 to 19 g/kg DM. This difference probably reflects the dominance of Enterobacteria rather than lactic acid bacteria due to the changed environmental conditions in that experiment.

Buffering capacity. The buffering capacity of grass is its ability to resist a change in pH and is expressed as milli equivalents (m.eq)/kg DM required to reduce the pH from 6.0 to 4.0. It can be quite variable in grass and is influenced by protein, organic acids, chlorides, orthophosphates, nitrates etc. (Muck, O'Kiely and Wilson, 1991a; Muck, Wilson and O'Kiely, 1991b). It tends to decrease as grass develops into the inflorescence phase (Muck *et al.*, 1991a) but can also be influenced by grass species/cultivar, fertiliser and weather. Typical values for the primary growth and subsequent summer regrowths start at 400 to 450 m.eq./kg DM and decline linearly by about 20 m.eq./kg DM/week. Buffering capacities remain high in autumn grasses (Muck *et al.*, 1991a). Muck and Walgenbach (1985) showed that buffering capacities in alfalfa are higher in leaf than stem and decrease more rapidly in stem than leaf. Consequently, climatic influences on the leaf to stem ratio could indirectly influence buffering capacity. The data of Muck and Walgenbach (1985) also suggest that the uptake of Zn, Fe, Cu and Al, and to a lesser extent K and Mn, increases buffering capacity - their uptake could also be related to climatic conditions.

Microflora. The lactic acid bacteria of most importance in silage production include Lactobacillus, Pediococcus, Streptococcus and Leuconostocs. Moran and O'Kiely (1989) monitored counts of total lactic acid bacteria (LAB) on grass grown for silage between May and September. Much higher counts were obtained in Ireland (5.50 log10 CFU/g grass; s.d. 1.26) (Moran and O'Kiely, 1989) than in many other countries (Pahlow, 1991). This was attributed by Moran and co-workers to the lower influx of ultra violet radiation, the higher humidity and less variable temperature than other countries, as well as to the dense crops of grass grown for silage. In addition, Pahlow (1991) has proposed that in Ireland LAB are less likely to enter a somnicell phase (i.e. dormant) as a result of stress caused by climatic conditions than in other countries, thereby explaining the higher counts of viable LAB cells found on Irish grasses. However, O'Kiely (1989 - unpublished data) has found very low LAB counts on grass in very dry and sunny weather in a very sparse crop. Clostridia and Enterobacteria are two of the main undesirable bacteria found in silage. Soil and animal manure contamination are the main sources of inoculation. With good silage-making practice their effects should be reduced. Nevertheless, to permit efficient recycling of nutrients, slurry is normally spread on the bare grass stubble. In the absence of rainfall in the days after spreading, the likelihood of contamination carrying through to harvesting is increased. This is shown in Table 4 where the increased content of butyric acid suggests the activity of saccharolytic clostridia.

Table 4
Silage fermentation when cattle slurry is applied by different techniques

	Slurry application			
	None	Splash-plate	Bandspread	Shallow injection
Lactic acid (g(kg DM)$^{-1}$)	86	93	101	75
Acetic acid (g(kg DM)$^{-1}$)	18	14	20	19
Butyric acid (g(kg DM)$^{-1}$)	0	12	3	1
pH	3.94	4.01	3.94	3.93

Source: O'Kiely and Carton (1990)

Field drying. Solar radiation - radiant energy falling on the crop - is the primary driving force for moisture evaporation. Drying rate is also influenced by the temperature and the humidity of the ambient air (vapour pressure deficit), moisture content of the soil and thickness of the swath. Mechanical and chemical treatments can speed field-curing under good drying conditions, but they cannot compensate for poor drying weather (Bolsen, Brent and Dickerson 1991). Shown in Table 5 are the hours required to dry alfalfa from 80% down to 20% moisture, under constant weather conditions (Rotz and Chen, 1985). These range from 12 to 48 hours. Because environmental conditions rarely remain constant, particularly when the drying period extends overnight, actual fieldcuring times are longer. They would be considerably slower if weather conditions were wet.

Table 5
Hours to dry alfalfa from 80 to 20% moisture in constant weather conditions

		Air temperature, °C				
Sun	Soil conditions[2]	10	15.6	21.1	26.7	32.2
Cloudy	Wet	44	41	38	35	33
Cloudy	Dry	36	34	31	29	27
Sunny	Wet	16	16	15	15	15
Sunny	Dry	14	13	13	12	12

[1] Cloudy = 100 Btu/hr-ft^2 solar radiation; sunny = 280 Btu/hr-ft^2 solar radiation.
[2] Wet = 20% moisture content; dry = 9% moisture content.

Source: Rotz and Chen (1985)

Partial field drying of grass is sometimes used prior to ensiling as a mechanism to reduce, or prevent, effluent production and to facilitate good preservation. The mean dry matter (DM) contents of grass at cutting or after 6 or 24 hours wilting in 13 experiments at Grange between 1980 and 1985 were 208, 223 and 268 g DM/kg, respectively. In each case wilting conditions were good. Simultaneously, wilting experiments planned for pre-selected dates were postponed on

15 occasions due to wet weather and on four other occasions wilting was attempted and failed. In a separate series of experiments where field wilting was carried out, it was shown that tedding grass to achieve full ground cover, together with frequent turning, was essential to maximise drying rates (Table 6). Rain reduced DM and WSC concentrations more immediately after it fell on an uncut rather than a mown untedded crop (O'Kiely, 1988/89a), but the standing crop also dried more rapidly.

Table 6
Effects of wilting on grass DM and WSC contents

Time	0 hrs	6 hours				24 hours				30 hours			
Treatment		1	2	3	4	1	2	3	4	1	2	3	4
Dry matter (g/kg)													
- mean	197	214	236	264	264	200	267	301	329	222	330	388	413
- s.d.	37.3	43.1	53.0	60.5	65.1	31.7	66.5	77.7	93.5	38.7	99.5	110.3	121.9
WSC (g/kg juice)													
- mean	29	34	38	46	48	29	45	58	63	34	66	83	92
- s.d.	11.4	11.3	13.8	18.0	20.1	7.6	16.4	26.2	29.1	11.7	30.7	37.4	35.0

Treatments 1 through 4 were 1) standing crop, uncut, 2) mown and untedded, 3) mown and tedded once (at cutting) and 4) mown, tedded immediately and after 6 and 24 hours.

Source: O'Kiely (1988/89a)

Additives. The type of silage additive recommended, if any, is strongly influenced by weather conditions, with preservatives such as acid or sugar additives being preferred where ensiling conditions are difficult (Table 12) and inoculants of LAB where ensiling conditions are good (Table 13). Whatever additive is used, the application rate is expressed per tonne harvested grass. In the absence of weighing facilities on farms, the rate of harvesting is difficult to identify when expressed as tonnes/hour but not when expressed as hectares/hour. However, as a crop gets wetter during rain the yield of fresh grass per hectare can readily rise by 60% (Table 14), thereby necessitating a corresponding increase in additive application.

Rate of achieving anaerobiosis. When anaerobic conditions are achieved quickly after harvesting, good preservation (Wilson and Flynn, 1979) as well as enhanced aerobic stability at feeding time (Honig 1991), are facilitated. Very wet weather at harvesting can retard the speed with which the silo is filled and thereby detrimentally prolong aerobic conditions.

Aerobic deterioration

Since ensilage is by necessity an anaerobic process, silage, once it comes in contact with air at feeding time, is inherently unstable. Silages vary enormously in their instability when exposed to air, the rate of deterioration depending on management factors (based on minimising the duration of exposure to air), weather and silage microbiological, physical and chemical composition (O'Kiely, 1989). Higher ambient temperatures increase the rate of aerobic deterioration of silage (Table 7), as do dark and humid conditions (O'Kiely, 1988/89b).

Table 7
Effect of ambient temperature on aerobic deterioration

	Ambient temperature	
	10°C	25°C
n	84	84
DM loss (g/kg)	26	269
Days to pH rise	9.9	5.8
Days to temperature rise	9.5	3.1
Accumulated temp. rise (degree days)	12	105

Source: O'Kiely (1989)

Grass ensilability in 1992

Over 1000 grass samples from farms were analysed by Grange Laboratories during 1992, as part of a service to help farmers estimate the ease of preserving grass as silage. The results are summarised in Tables 8 and 9 and show low and variable WSC and dry matter concentrations while both the first and second cuts were being harvested. However, average buffering capacities of first-cut grasses were extremely high (compared to data of Muck et al, 1991a) until mid June. The low WSC concentration and high buffering capacity meant that these grasses had poor ensilability characteristics and would be very difficult to preserve properly.

3. DOES THE VARIABILITY MATTER?

The variability in the yield, digestibility, preservation and aerobic stability of silage have a major impact on the cost of producing silage (Table 10) and on the feed cost per unit of animal production.

The following can be deduced from Table 10:

(a) The yield of grass dry matter is the most important silage characteristic influencing the cost of producing silage. Assuming a fixed harvesting cost/ha and constant DM and DMD concentrations, the relative cost (£/tonne silage digestible DM) is highly sensitive to DM yield, with light crops being very expensive to produce and heavy crops much less expensive -the lowest to the highest values differ by more than a factor of two.

(b) Assuming a constant yield of harvested DM, the wetter the grass in a **direct-cut or unwilted silage** system, the more expensive silage digestible DM becomes. This is due to greater in-silo losses (especially effluent and fermentation) and requirements for preservative (applied per tonne **fresh** grass) with wetter grass.

(c) At a constant yield of dry matter and a constant DM concentration, higher

Table 8

Average, maximum and minimum values for dry matter, water soluble carbohydrates (WSC) and buffering capacity of first- and second-cut grasses in 1992

First cut	May			June			
	11 to 17	18 to 24	25 to 31	1 to 7	8 to 14	15 to 21	22 to 28
Dry matter (g/kg)							
- average	157	175	181	162	179	196	213
- maximum	200	280	290	208	237	286	276
- minimum	116	121	112	116	136	120	168
WSC (g/kg juice)							
- average	22	23	20	13	16	20	23
- maximum	48	47	43	25	34	41	40
- minimum	5	10	8	8	8	10	16
Buffer.cap. (mEq/kg DM)							
- average	467	456	417	405	356	361	292
- maximum	630	749	576	765	453	625	444
- minimum	293	281	249	283	260	207	209
Second cut	July			July/Aug	August		
	6 to 12	13 to 19	20 to 26	27 to 2	3 to 9	10 to 16	17 to 23
Dry matter (g/kg)							
- average	190	177	183	191	199	159	182
- maximum	274	236	262	296	262	176	266
- minimum	130	128	142	140	144	140	140
WSC (g/kg juice)							
- average	21	18	20	19	22	14	14
- maximum	45	32	34	38	32	21	35
- minimum	8	7	10	10	9	9	9
Buffer.cap. (mEq/kg DM)							
- average	366	379	390	344	369	401	362
- maximum	510	528	589	492	522	484	484
-minimum	242	220	256	247	217	286	263

digestibility silage has a lower relative cost compared to low digestibility silage, even allowing for the likelihood of greater use of preservative with leafy grass.

(d) Delayed harvesting, corresponding with a rapid increase in yield and a decrease in DMD, results in a decrease in the relative cost of silage digestible DM. However, to fully compare silages of differing DMD, the relative feed cost/kg carcass gain or milk production should be calculated, with the largest benefits from high DMD being obtained at lower levels of concentrate supplementation.

Table 9

Grass ensilability - percentage distribution within selected ranges (1992)

	Dry matter (g/kg) <160	160 to 199	>199	WSC (g/kg juice) <10	10 to 24	>24	Buff. cap. (mEq./kg DM) <400	400 to 549	>549
First cut									
May 11 to 17	58	41	1	1	69	30	9	84	7
May 18 to 24	19	71	10	0	65	35	21	70	9
May 25 to 31	17	64	19	1	81	18	43	57	0
June 1 to 7	42	55	3	15	82	3	55	42	3
June 8 to 14	24	63	13	5	87	8	74	26	0
June 15 to 21	7	52	41	0	67	33	74	22	4
Second cut									
July 6 to 12	8	61	31	3	68	29	74	26	0
July 13 to 19	32	45	24	8	74	18	61	39	0
July 20 to 26	11	68	21	0	81	19	53	43	4
July 27 to Aug 2	20	55	25	0	85	15	85	15	0
Aug 3 to 9	13	40	47	7	53	40	67	33	0
Aug 10 to 16	55	45	0	18	82	0	36	64	0
Aug 17 to 23	40	40	20	30	60	10	70	30	0

Table 10

Variation in grass yield or wetness and silage digestibility or preservation and their effects on relative costs

(a) **Yield** effect - at constant 200 g DM/kg and 730 g dig. DM/kg DM						
Grass yield (t/ha)	15	20	25	30	35	40
Grass DM yield (t/ha)	3	4	5	6	7	8
Silage DM yield (t/ha)	2.4	3.2	4.0	4.8	5.6	6.4
Relative cost £/t silage dig. DM	186	144	118	**100**	88	79
(b) **Grass wetness** effect - at constant harvested DM yield/ha						
Grass DM concentration (g/kg)	140	160	180	200	220	240
Grass DM yield (t/ha)	6.5	6.5	6.5	6.5	6.5	6.5
Grass yield (t/ha)	46.4	40.6	36.1	32.5	29.6	27.1
Silage DM yield (t/ha)	5.2	5.3	5.5	5.6	5.7	5.9
Relative cost £/t silage dig. DM	113	109	103	100	97	93
(c) **Digestibility** effect - at constant yield and DM concentration						
Silage DM digestibility (g/kg DM)	600	650	700	750		
Relative cost £/t silage dig. DM	108	104	**100**	97		
(d) **Digestibility** effect - increasing yield and constant DM concentration						
Silage DM digestibility (g/kg DM)	600	650	700	750		
Silage DM yield (t/ha)	7.4	6.6	5.8	5.0		
Relative cost £/t silage dig. DM	90	94	100	107		
(e) **Preservation** effect						
Preservation standard (NH_3-N, % N)		Good(7)		Bad (18)		
Relative feed cost £/kg carcass gain	**100**		126			

(e) Poor preservation increases the relative cost of silage, due to greater conservation losses and possibly the production of toxins. The latter reduces silage intake and necessitates additional concentrate supplementation.

4. HOW CAN SILAGE BE MADE LESS VARIABLE - MORE RELIABLE?

Weather patterns, both directly and indirectly, impact in a very major way on the yield, dry matter concentration, digestibility, preservation and unit cost of silage. Consequently, there is a clear limit on the extent to which any of these factors can be reliably controlled. It may not always be possible to reduce variability and when it is possible, it will often depend on the ability to react or respond quickly and with flexibility to particular circumstances that arise due to weather. This ability to respond is often difficult to achieve, especially if it is remembered that 80% of silage is harvested by contractors, so a farmers flexibility may be constrained.

Yield

Assuming that soil fertility, structure, drainage and nutrient supply are satisfactory, the yield of a particular sward is substantially dependent on weather. At that stage, the main mechanism for achieving a given yield is by altering the harvesting date. However, delaying harvesting date to increase yield is normally accompanied by a decrease in digestibility. The correct balance between yield and quality will depend, among other factors, on the type and intensity of enterprise on the farm and the relative costs of forage, concentrates and animal product. However, relative variability in dry matter yield may be reduced by harvesting the first-cut in the final week of May rather than in mid May. The major problems emanating from variable yields usually occur in July/August harvests. On farms that are prone to severe drought this may be an insurmountable problem with grass swards.

To assist achieving consistent yields, soil analysis each 5 years should be used to determine the P, K and lime status of the silage fields. Appropriate fertiliser inputs should be based on these results, together with replacing what the crop removed and what was supplied by slurry. Maintenance of high fertility is important as it leads to less fluctuation in yield from year to year (Murphy, 1992). Nitrogen should be applied at least 6 weeks pre-harvesting and, in some cases, sulphur should be applied in mid-season. Slurry should be applied only onto bare stubble - this should be completed by March for first-cut silage and immediately after the previous cut for regrowths (see next section on preservation).

Dry matter

Grass dry matter concentrations impact on the fresh yield, effluent losses and the ease of preservation. The progression in grass dry matter concentration from 200 g DM/kg to 180, 150 and 120 g DM/kg reflects the effects of dew, a heavy rain shower and several days rain, respectively. Clearly, the ideal option to reduce variability in DM concentration is to harvest grass when the dew has gone and in the absence of rain. This is often not feasible.

Digestibility

Normally, to achieve a pre-specified digestibility for the first-cut of a particular sward depends on selecting the correct harvesting date. This can be achieved by using mono cultivars or alternatively mixtures of cultivars of similar heading date. The onset of a decrease in digestibility is normally regulated by changing day length, which is predictable, and the rate of decline is mediated through the relative development of leaf and stem, the rate of lignification and the emergence of the inflorescence (seed head). However, dominance of the sward by early maturing poor quality grasses (e.g. meadow foxtail), the duration and rate of wilting, bad silage preservation, excessive losses via effluent and possibly the accumulation of dead or decayed vegetation due to, for example, crop lodging, can magnify the rate of decline. Consequently, having ryegrass swards whose constituents are of similar digestibility, only wilting where rapid drying is likely, ensuring good preservation and harvesting grass once it lodges can help achieve a more predictable digestibility. As mentioned before, some of these require flexibility in the time and method of harvesting, which is not always possible in practice.

Preservation

As mentioned before, the process of silage fermentation is not nearly as controlled as industrial fermentations, such as are involved in beer or yoghurt manufacture. In the latter, ingredient composition, temperature, duration etc. are highly controlled, thereby producing a predictable and consistent product. In silage production on the other hand, grass type and composition, weather, filling speed etc. vary enormously, so the extent of control over the precise end quality of silage is relatively poor. **Current good silage-making practice therefore seeks to promote the likelihood of a lactic acid fermentation, at a modest cost, without being able to control the precise final composition.** Guidelines to achieve this include:

1. Fast filling and perfect sealing of the silos - this is the single most important factor.
2. Ensile only clean grass, free of all sources of contamination. Guidelines describing the factors determining the correct timing and rate of application of slurry are contained in the accompanying paper at this conference by Carton (1992). Cattle slurry should be spread at not more than 33 t/ha (3000 gal/ac) and 17 t/ha (1500 gal/ac) for first and second cuts, respectively. Rates in excess of these can increase the risk of poor fermentation. For firstcuts, slurry can be applied up to mid-March provided crops are not advanced. For second or third-cuts it should be applied immediately (2 to 3 days maximum) after the previous cut - it should never be applied after swards have greened up.
3. Ensure added nitrogen is spread early and at the appropriate rate. Murphy (1992) recommends that permanent swards of grass should receive total nitrogen inputs of 100 to 125 kg N/ha (80 to 100 units N/acre) in a single (first) cut system and 110 to 140 kg N/ha (90 to 110 units N/acre) and 75 to 100 kg N/ha (60 to 80 units N/acre) for first and second cuts, respectively in

a two cut system. In some circumstances, higher rates may be justified (e.g reseeds or after continuous cereals). The above rates will need to be reduced where other potential sources of nitrogen such as slurry are applied - cattle slurry applied for first cuts may supply 5 to 8 kg N per 4500 litres (10 to 15 units per 1000 gallons) and for second-cuts, depending on weather, supply 0 to 5 kg N per 4500 litres. Murphy (1992) estimates that for fertiliser N applied to the primary growth, the daily utilisation of N will be about 1.3 kg/ha (1 unit/acre) until late March (e.g. 24 March) and about 2.5 kg/ha (2 units/acre) thereafter. The rate of uptake can be many times more rapid than the rate of utilisation, leading to a transient high concentration of non-protein nitrogen in grass. This can be associated with reduced dry matter and sugar concentrations and increased buffering capacity and nitrate values. For second-cuts daily uptake of about 2.5 kg N/ha would be expected. The rates of uptake for the primary growth or regrowth assume normal grass growth patterns - the uptake may stop during intervals of very restricted growth such as happens during very cold or dry weather. Murphy (1992) stresses that it is important that N is spread early, both to achieve the maximum yield response and to avoid any negative effects on grass ensilability. In the case of the primary growth the aim should be to have N applied by mid March, if possible.

4. Where high inputs of P and K fertiliser, or application of lime, are necessary, they should be spread in the autumn.
5. Grass should be analysed for its ensilability immediately before harvesting. This should include dry matter and water soluble carbohydrate (WSC) concentrations and buffering capacity at a minimum, and possibly also nitrate concentrations.
6. Wilting should only be carried out during good drying conditions, and should not be attempted in large, narrow rows (see Table 11). At a minimum, where a large mower conditioner is being used, the gates at the back of the mower should be opened wide to allow the grass be spread in a wider swath (Forristal, 1992). Successful wilting can produce excellently preserved silages capable of supporting high animal performance. However, animal performance and productivity are still usually inferior to what is achieved with well preserved unwilted silage (O'Kiely et al., 1988, O'Kiely, 1992b).

Table 11

Effect of swath treatments on grass DM concentration at selected times following cutting (9 am; day 1).

Swath treatments	Time after cutting 9 am (Day 1)	6 pm (Day 1)	3 pm (Day 2)
Standard mower	160	182	225
Conditioner (narrow swath)	160	185	233
Conditioner (wide swath)	160	191	277
Intensive tedding	160	231	371

Source: Forristal (1992)

7. Where successful wilting (above 250g DM/kg) is achieved quickly, additives are not normally justified. In the absence of successful wilting, it is appropriate to use a silage additive (Figure 3). The correct type of additive varies, with preservatives (P) being appropriate under difficult conditions and enhancers (E) appropriate under good conditions. Each year Teagasc publishes a Directory of Silage Additives which lists the products on the Irish market, categorises them and, if sufficient information is available, rates them as preservatives or enhancers.

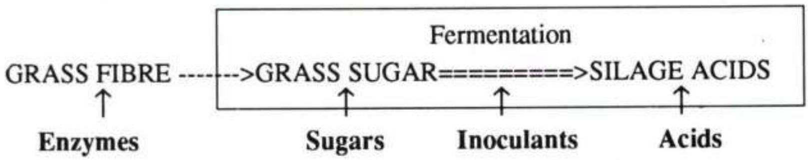

Figure 3. Schematic illustration of mode of action of various categories of silage additive.

Teagasc considers that the primary role for preservatives is under conditions where silage made without additive would preserve poorly. Under these difficult ensiling conditions, the even application of adequate preservative should produce satisfactory preservation (Table 12). On the other hand, grass frequently preserves well even when no additive is used and it is under these conditions that enhancers have been shown to be capable of enhancing the feeding value of silage (Table 13). The decision on whether to use a preservative or an enhancer will be based either on experience or on a grass ensilability test. The choice within either category of additive then depends on applicator availability, harvesting system, the requirement to absorb effluent or indirectly supply concentrates to cattle (e.g. beet pulp) and, of course, price.

Due to the vagaries involved in controlling silage fermentation, a strong theoretical case has often been made for preserving grass by preventing fermentation and achieving a low pH by adding large amounts of organic acids (i.e. 4 to 6 l formic acid/tonne grass). However, in spite of its theoretical attractions, the economic and practical benefits are much less compelling.

One major practical problem when applying preservatives, having decided on the correct application rate, is achieving that application rate. The recommended application rate is per tonne fresh grass harvested. Consequently, if grass is wet, the fresh tonnage harvested per ha is much higher. An example of this is given in Table 14 where the effect of the wetness of a crop on its fresh yield per ha is shown. The progression in dry matter concentration from 200 g DM/kg to 180,150 and 120 g DM/kg simulates the effects of dew, a heavy rain shower and several days rain, respectively. Clearly, if the desired rate of preservative is to be applied, it is essential for silage-makers to **get an accurate estimate of the tonnage of grass** in trailers (weigh trailer loads of grass or measure strips of cut grass) and the time taken to fill the trailers or harvest a hectare. It is also important to verify that the applicators are adding the required rate.

Table 12

Influence of applying adequate effective preservative to unwilted grass where silages preserved well or badly in Grange experiments

Preservation of untreated silage	Good		Bad			
Dominant bacteria in untreated silage	Lactic acid bacteria		Clostridia		Enterobacteria	
Additive	None	Formic acid	None	Formic acid	None	Formic acid
pH	3.86	3.86	4.98	3.98	4.95	4.38
Lactic acid (g/kg DM)	142	82	42	132	65	67
Acetic acid (g/kg DM)	31	16	37	23	62	31
Butyric acid (g/kg DM)	2	1	51	2	1	0
Residual sugars (g/kg DM)	11	22	6	17	6	11
Ammonia-N (g/kg N)	61	42	223	87	161	91
Crude protein (g/kg DM)	211	210	171	162	248	241
DMD *in vitro* (g/kg DM)	736	723	640	705	693	734

Source: O'Kiely (unpublished)

Table 13.

Influence of inoculants (E) under good silage-making conditions - average of 3 Grange experiments

	No additive	Inoculant
pH	4.0	4.0
Ammonia-N (g/kg N)	103	100
Silage DM intake (kg/day)	5.0	4.8
Liveweight gain (kg/day)	0.64	0.72

Source: O'Kiely (1990a; 1990b; 1991)

Table 14

Influence of grass wetness on tonnage of fresh grass

Grass dry matter (g/kg)	Grass yield (fresh tonnes/ha)
200	25.0
180	27.8
150	33.3
120	41.7

8. Ryegrass swards are much easier to preserve than old swards with low ryegrass content. It is also easier, where the maturity span of the constituent grasses in the mixture is narrow, to attain a more consistent digestibility (Keating et al., 1990).

Aerobic spoilage

Silage, whether well preserved or badly preserved, is inherently unstable and on opening the pit it begins to deteriorate (O'Kiely, 1989). This can be seen as heating, increased waste or refusals and in severe cases, visible mould growth. The presence of any of these when a pit is first opened indicates that there was not complete exclusion of air (oxygen) during storage. Properly sealed silage (i.e., air having no access to silage during storage) will have no waste, heating or mould when it is first opened. Mouldy silage should not be offered to livestock.

The three main factors affecting aerobic deterioration once silos are opened are (1) management, (2) weather, and (3) silage characteristics. Of these, management is the most important. Management practices must aim to minimise the contact time between silage and air. This involves:

- Moving through the silage face quickly.
- Presenting trough-fed animals with only as much silage as they can eat in a day.
- Keeping the silage face as undisturbed as possible - rough or careless removal of silage from the silo leaves behind a tattered silage face into which air can penetrate deeply.
- Keeping polythene on top of the pit fully weighted down and taut as far as the front of the silage.
- Not covering the silage face with polythene at feeding time as this creates a "mushroomhouse" environment.

There are no chemicals available for treatment of the silage face which effectively prevent aerobic deterioration.

It has been shown, in Grange experiments (Table 7) that warmer weather increases the susceptibility of silage to aerobic deterioration. Consequently, the above mentioned management practices are crucially important during periods of mild warm weather, as deterioration is more extensive in such conditions. The economic penalty for aerobic spoilage depends on the extent of deterioration and is normally severe. High losses from aerobic spoilage can result in over 10% of the conserved grass not being available for consumption by animals.

CONCLUSIONS

Grass silage is the dominant conserved fodder in Ireland, and underpins ruminant nutrition during the winter on almost all intensive commercial farms. It fulfills this role because it integrates into existing farming systems quite well and, across a broad range of conditions, because it delivers sufficient winter feed of adequate quality and acceptable cost compared to alternative feedstuffs. On a minority of farms at present this may not be the case. Grass silage dominates the winter fodder scene despite handicaps such as variability in yield and quality, the occurrence of silage effluent, the cost of concrete silos, etc. With the anticipated decrease in the cost of concentrates, the cost competitiveness of grass silage may become less attractive. Consequently, it is important that, where grass silage is used, it is a reliable feedstuff produced at a competitive cost.

A large number of factors determine the magnitude and consistency of important characteristics of silage such as yield, digestibility, preservation and aerobic stability. All of these are significantly influenced by our changeable weather conditions. However, clear guidelines are available, and have been presented in this paper, showing how high yields of good quality silage can be produced with reasonable reliability. Firstly, good grass production and silage-making practices must be used consistently. Secondly, our changeable and unpredictable weather will impose variation on the yield and quality of grass silage, just as it will with many other crops. The key to responding to this source of variation depends on the ability to operate a flexible, adjustable silage-making system (ie. ability to alter harvesting date, select preservative or enhancer additives as appropriate and apply them evenly and at the correct rate) and to know the changing status of factors such as soil fertility, grass ensilability and grass yield (or harvesting rate). In the longer term, reseeding with perennial ryegrasses of similar heading characteristics, helps reduce variability considerably. Where the above mentioned guidelines are possible, and many commercial farms currently achieve these targets, the variability in silage can be reduced in most cases, but not prevented.

References

Bolsen, K.K., Brent, B.E. and Dickerson, J.T. (1991). Hay and silage in the 1990s. Field guide for hay and silage management in North America. National Field Ingredients Association, p 1-12.

Carton, O.T. (1992). Management and utilisation of slurry on cattle farms. Irish Grassland Association Beef Conference, Portlaoise, November 27, 1992.

Deinum, B. (1984). Chemical composition and nutritive value of herbage in relation to climate. Proceedings of 10th general meeting of the European Grassland Federation, p 338-350.

Forristal, D. (1992). Essential technology for beef farmers. Beef series No. 10., Teagasc, P 77-79.

Honig, H. (1991). Reducing losses during storage and unloading of silage. Landbauforschung Volkenrode, Sonderheft 123, p 116-128.

Jones, M.B. (1988). Water relations - In "The grass crop - the physiological basis of production". Edited by M.B. Jones and A. Lazenby; Chapman and Hall Ltd., 205-242.

Keane, T. (1988). Features of the Irish climate of importance to agriculture: comparison with neighbouring Europe. Proceedings of Conference on Weather and Agriculture. Dublin, 14-24.

Keating, T. and O'Kiely, P. (1990). Beef production from silages produced from Italian ryegrass, perennial ryegrass and permanent grassland swards. Irish Grassland and Animal Production Association Journal, 24: 38-44.

McGrath, D. (1988). Seasonal variation in WSC of perennial and Italian ryegrass under cutting conditions. Irish Journal of Agricultural Research, 27: 131-140.

Moran, J. and O'Kiely, P. (1989). Lactic acid bacteria on grass grown for silage. Farm and Food Research, 20: 28-30.

Muck, R.E. O'Kiely, P. and Wilson, R.K. (1991). The buffering capacity of permanent grass swards and factors influencing it. Irish Journal of Agricultural Research 30: 129-142.

Muck, R.E. and Walgenbach, R.P. (1985). Variations in alfalfa buffering capacity. Winter meeting of American Society of Agricultural Engineers, Chicago, Paper 85-1535.

Muck, R.E., Wilson, R.K. and O'Kiely, P. (1991). Organic acid content of permanent pasture grasses. Irish Journal of Agricultural Research, 30: 143-152.

Murphy, W.E. (1992). (Personal communication).

O'Kiely, P. (1988/89a). Effect of wilting on grass DM and WSC contents. Animal Production Research Reports, Teagasc, Dublin, p 56-57.

O'Kiely, P. (1988/89b). Aerobic stability of farm silages, (B) covering the silage face at feeding time. Animal Production Research Reports, Teagasc, Dublin, p 54-55.

O'Kiely, P. (1989). Deterioration of silage at feeding time. Farm and Food Research, 20: 4-5.

O'Kiely, P. (1990a). Evaluation of Topcut Dry as an additive on unwilted silage offered to finishing beef heifers. Teagasc Research Report (Edited by C.J. O'Rourke), 94-96.

O'Kiely, P. (1990b). Evaluation of a Lactobacillus inoculant as an additive for silage fed to heifers. Animal Production, 50: 584.

O'Kiely, P. (1991). Further evaluation of a Lactobacillus inoculant as an additive for silage offered to heifers. Irish Journal of Agricultural Research, 30: 78-79.

O'Kiely, P. (1992a). Silage production as a pollutant: new ways to reduce its environmental impact. Proceedings of Eight Annual Symposium - Biotechnology in the Feed Industry. Edited by T.P. Lyons, 151-163.

O'Kiely, P. (1992b). A note on the performance of Friesian steers offered unwilted or wilted grass silage diets from weaning through to slaughter. Irish Journal of Agricultural and Food Research, 31: 71-76.

O'Kiely, P. and Carton, O.T. (1990). Effects of method of slurry application and rate of nitrogen application on silage composition. Proceedings of 9th silage conference. University of Newcastle upon Tyne, Sept., p 92-93.

O'Kiely, P., Flynn, A.V. and Wilson, R.K. (1987). New concepts in silage making. Irish Grassland and Animal Production Association Journal, 18: 13-23.

O'Kiely, P., Flynn, A.V. and Wilson, R.K. (1988). A comparison of the chemical composition of unwilted and wilted grass silage, and of the intake, performance, carcass composition and rumen fluid volatile fatty acid concentration of steers fed the silages. Irish Journal of Agricultural Research, 27: 39-50.

Pahlow, G. (1991). Role of microflora in forage conservation. Landbauforschung Volkenrode, Sonderheft 123, p 26-36.

Pitt, R.E., Muck, R.E. and Leibensperger, R.Y. (1985). A quantitative model of the ensilage process in lactate silages. Grass and Forage Science, 40: 279-304.

Podkowka, W. (1984). Materially nieopublikowane, ATR Bydzoszoz.

Podkowka, W. (1985). Materially nieopublikowane, ATR Bydozoszoz.

Rotz, C.A. and Chen, Y. (1985). Alfalfa drying model for the field environment. Transactions ASAE, 28 :1686-1691.

Thram, P. and Broekhuizen, S. (1965). Agro-climatic Atlas of Europe. Agro-ecological atlas of cereal growing in Europe. Wageningen: Poduc Centre for Agricultural Publishing and Documentation.

Wilson, R.K. and Flynn, A.V. (1979). Effects of fertiliser N, wilting and delayed sealing on the chemical composition of grass silages made in laboratory silos. Irish Journal of Agricultural Research, 18:13-23.

Wilson, R.K. and O'Kiely, P. (1990). A note on the chemical composition of Irish farm silages 19851988. Irish Journal of Agricultural Research, 29: 71-76.

Causes and Prevention of Hypomagnesaemic Tetany

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This paper summarises the research results on hypomagnesaemia, its causal factors, factors which influence magnesium (Mg) absorption, dietary Mg requirements for lactation, effects of hypomagnesaemia and the times of high risk.

Hypomagnesaemia means low blood Mg level. Normal levels are 1.7-3.0 mg per decilitre. Levels between 1.2-1.69 mg are hypomagnesaemic and below 1.2 mg are severely hypomagnesaemic. In tetanic cases, plasma Mg is usually 0.2-1.0 mg per dl.

Causes of hypomagnesaemia

A normal level of plasma Mg depends on adequate day-to-day absorption of Mg. Plasma Mg falls if the amount of Mg absorbed is less than 2.5g plus that lost in milk (0.12 g per l milk). Removal of Mg supplement during high-risk periods can be followed by a severe fall in plasma Mg and tetany within 1-2 days.

The net amount of Mg absorbed is reduced by any of the factors which reduce feed intake, reduce the Mg content of the feed, or reduce the availability of dietary Mg. If Mg requirements for maintenance and for milk production exceed the net amount absorbed from the digesta, the cow goes into negative Mg balance and hypomagnesaemia follows. Severe stress activates adrenalin release and fat mobilisation. This can reduce Mg and Calcium (Ca) levels in blood. Stress superimposed on hypomagnesaemia can trigger an outbreak of tetany.

Magnesium absorption

The amount of Mg absorbed per day depends on two factors: (a) total daily intake of Mg and (b) net availability of dietary Mg.

Intake of Mg by cows depends on feed DM intake and the Mg content of the feed DM. Mg level in feeds can vary widely, for example, herbage DM may contain 0.13% - 0.26% Mg and the DM of mangel tops may contain 1.00%-1.43% Mg. Table 1 shows the Mg content of some common forages and feeds. On unsupplemented grass or grass silage, Mg intake can range from below 20 to more than 40 g per day.

In winter, intake by calved diary cows fed silage and concentrates is about 15 kg DM per cow per day (Table 2). If the silage and concentrates contain 0.20% and 0.35% Mg respectively, total Mg intake would be about 38 g per cow per day.

In May, on good grass alone, DM intake by cows on grazed pasture may be up to 3.5% of liveweight, i.e. about 19 kg per day. At 0.19% DM, Mg intake from spring grass is about 36.6 g per cow per day (Table 2). However, lush grass often has Mg levels in the range 0.13-0.19% DM, thus Mg intakes from such grass could be 25 g per cow per day or lower.

Table 1.

The levels of Ca, Mg and P (% DM) in common forages

	Ca	P	Mq
Herbage	0.40-1.00	0.25-0.60	0.09-0.26
Grass silage	0.45-0.85	0.22-0.42	0.10-0.24
Maize silage mature	0.14-0.34	0.15-0.29	0.05-0.34
Wholecrop fodderbeet silage	0.88-1.28	0.16-0.30	0.15-0.27
Hay	0.45-0.85	0.10-0.27	0.14-0.36
Straw (barley)	0.25-0.51	0.04-0.16	0.06-0.14
Kale (leaf + stem)	1.48-2.28	0.25-0.45	0.10-0.20
Rape (leaf + stem)	1.29-2.29	0.18-0.36	0.14-0.34
Roots			
Fodder beet, sugar beet	0.20-0.32	0.14-0.22	0.12-0.30
Mangels	0.24-0.34	0.16-0.26	0.33-0.53
Turnips, swedes	0.56-0.76	0.24-0.40	0.08-0.16
Tops			
Fodder beet, sugar beet	1.00-1.76	0.23-0.38	0.38-0.58
Mangels	1.70-2.70	0.23-0.37	1.00-1.43
Turnips, swedes	2.20-3.40	0.27-0.40	0.06-0.12

Note: Minimum levels needed in feed DM for lactating cows are 0.45% Ca 0.36% P and 0.20% Mg. At times of tetany-risk, cows may need 0.30-0.35% Mg or more in feed DM.

Table 2

Example of typical Mg intake and net absorption by 550 kg cow in winter milk or on May pasture. Net Mg absorbed (g/day) is often halved on spring grass

	In winter			At grass (May)		
	silage	concs	total	herbage	concs	total
Feed intake (kg/day)	50	6	56	96.5	0	96.5
Feed DM%	20	86	-	20	-	-
DMI kg/day	9.9	5.2	15.1	19.25	-	19.25
DMI (% LW)	1.8	0.95	2.75	3.5	0	3.5
Mg content (g/kg DM)	2.0	3.5	-	1.9	0	-
Mg intake (g/day)	19.8	18.2	38.0	36.6	0	36.6
Net Mg availability (%)			25			15
Net Mg absorbed (g/day)			9.5			5.5

Table 3
Example of typical Mg intake and net absorption by 550 kg cow in milk on summer pasture or suckling a calf on winter pasture. Net Mg absorbed (g/day) is often halved on winter pasture.

	On summer pasture		On winter pasture		
	herbage	total	herbage	hay	total
Feed intake (kg/day)	82.5	82.5	55.0	2.5	57.5
Feed DM%	20	-	20	86	-
DMI kg/day	16.5	16.5	11.0	2.2	
DMI (% LW)	3.0	3.0	2.0	0.4	2.4
Mg content (g/kg DM)	2.5	-	2.2	1.5	-
Mg intake (g/day)	41.3	41.3	24.2	3.3	27.5
Net Mg availability (%)		30			25
Net Mg absorbed (g/day)		12.4			6-9

In July, when milk yields and grass intake are falling, DM intake may fall to 3% of liveweight but herbage Mg may rise to 0.25%, so that Mg intake may be 41.3 g per cow (Table 3). DM intake by calved suckler cows on sparse winter pastures may be as little as 2% of liveweight. Even if a supplement of 2 kg hay DM per head per day is fed, their total Mg intake from grass + hay may be below 27.5 g per cow.

The net availability of dietary Mg can vary from 5%-35% of ingested Mg. In winter, on diets of dairy ration and silage, net availability of Mg may be 20%-30%. Specific Mg-antagonistic factors in lush grass (high-K, high-N, high fatty acid) reduce net availability to 5%-20%. Also, lush grass passes quickly through the animal thereby reducing the absorption of Mg and trace-elements. The net absorption of dietary Mg may be halved (Tables 2 and 3) in spring (5.5 g per cow per day) compared with summer (12.4 g per cow per day. Availability of Mg may also be low in lush autumn aftermath. Therefore, Mg intake must be doubled to maintain the same daily absorption of Mg on lush grass.

In mid-summer, net availability may be 20-35%. On winter pasture with energy deficits, availability may be less. The net absorption of dietary Mg may be halved (Table 2) on winter pasture (6.9 g per cow per day) compared with summer (12.4 g per cow per day). Therefore, Mg intake on winter pasture must be doubled to maintain the same daily absorption of Mg.

Sodium (Na) levels in grass and forages are often deficient (below 0.15% DM) for lactating cows. Apart from adverse effects on fluid balance and milk yield, Na deficiency can reduce Mg absorption. The provision of salt helps.

Dietary magnesium requirement

Mg levels in feed for lactating cows should exceed 0.20% DM. If Mg-antagonists, energy deficits or stress are present, Mg levels in feed may need to be 0.30%-0.35% DM or more. Lush grass often contains less than half of those levels.

Daily absorption of Mg from the digesta is needed to maintain normal blood Mg levels in adult ruminants. To remain in zero Mg balance, cows must absorb 2.5 g Mg for their own tissues plus 0.12 g Mg per l milk. Thus, cows giving 30l milk need to absorb (2.5 + 3.6) = 6.1 g Mg per day. As can be seen from Tables 2 and 3, net Mg absorbed can be less than the requirement. In times of acute Mg shortage, the Mg reserves of adult ruminants can not be mobilised effectively. In that case, release of Mg from bone is inadequate to maintain plasma Mg. Hypomagnesaemia may follow within 2 days.

Effects of hypomagnesaemia

Apart from increasing the risk of tetany, hypomagnesaemia influences productivity in other ways. It may reduce feed intake, causing a drop in mean milk yield in dairy herds. It reduces turn-over of Ca from bone in late pregnancy thereby increasing the risk of hypocalcaemia, milk fever and uterine inertia at calving. Therefore, one should aim to keep blood Mg levels as normal as possible throughout the year. This needs more Mg supplement than is required to reduce tetany incidence.

Risk periods

Herd or flock hypomagnesaemia is usually confined to lactating females especially those at peak milk production or those suckling young. The main risk periods are: 1. Spring, for 6-8 weeks after calved cows or lambed ewes go to grass 2. Autumn, in winter-milk herds on lush aftermath; September to March in out-wintered suckler cows calving in that period; for 2-3 days after weaning in suckler cows.

Herd hypomagnesaemia occurs occasionally with Cu deficiency in suckler calves from 3-6 months of age. It is rare in older dry-stock but may arise if serious errors of feed formulation occur. Once tetany is confirmed, all susceptible animals in the group should be fed Mg supplements. To prevent relapse after a tetany case is treated, oral Mg supplements are recommended at twice the preventative rate (see below) for 2-3 days after treatment.

Mg supplements alone may fail to control an outbreak of winter tetany in suckling cows. In that case it is best to house all calved cows and to increase their feed supply as well as providing Mg supplements.

Prevention of hypomagnesaemia

Prevention is discussed under three heading: Mg supplements, stress and Mg antagonists.

1. Magnesium supplements

Mg supplementation does not build up a usable reserve of Mg. Omission of the supplement for 1-2 days during risk periods can leave the herd at risk from tetany if stress factors arise.

Calcined magnesite contains about 85% magnesium oxide (Mg 0) which contains 60% Mg. Thus, calcined magnesite contains (85 x 60/100) = 51% Mg.

A supplement of 6-14 g Mg per cow per day reduces tetany incidence in spring and autumn. However, much larger doses (20-60 g Mg per day) are needed to maintain group mean blood Mg in the normal range. This may be essential to maintain peak milk yield in dairy cows. Even then, some cows in the group may have moderate to severe hypomagnesaemia. Even 30-60 g Mg per day may fail to maintain normal plasma Mg and prevent tetany in beef cows suckling calves on winter pasture.

The three best methods of preventing grass tetany are feed medication, pasture dusting, water medication. All three methods are equally efficient. However, even with the best methods, 10-20% of treated animals may have plasma Mg levels below 1.7 mg per dl (mild hypomagnesaemia) but well above those usually associated with tetany.

Provision of 30 g MgO per cow per day in the last month of pregnancy can reduce the risk of milk-fever. The supplement is effective if sprinkled on easy-feed silage. Alternatively, 100 g of a pre-calving mineral mix, high in Mg (15% Mg), or water medication with a 15 g Mg per cow per day as a soluble Mg salt is effective.

Cows may consume 112 g (4oz) MgO without side effects but 168 g (6oz) or more can cause scouring, drop in milk yield and urinary stones. Under no circumstances should high-Mg feeds for cows be fed to calves, dry-stock or sheep; severe scour, urinary stones and death can result. Also, high-Mg ewe nuts should not be fed to lambs.

(a) Pasture dusting

MgO is available in two forms, fine powder and granular. Only the powder form is suitable for pasture dusting; granular MgO falls to the soil and does not dust the leaf. Dusting requires a good quality fertilizer spreader. Grass height must be at least 10 cm. The dust can not adhere if there is inadequate leaf surface to carry it. Dusting must be even because given the chance, cows prefer to graze undusted strips. Lowgrade magnesite or dolomitic limestone has too little Mg to be of use. Soluble Mg compounds (sulphate, chloride, acetate) are unsuitable because rain can wash them off the grass.

Pasture dusting with 17-20 kg per ha of MgO is an effective preventative. Sufficient paddocks can be dusted to supply 1 week's grazing. Set-stocked systems need 34 kg MgO per ha, repeated every 2 weeks. The cows are kept on treated pasture until the risk is over. Dusting is economical at stocking rates of 2.5 cows or more per ha. It is expensive at low stocking rates.

(b) Magnesium supplements in feed

Calcined magnesite is the cheapest source of Mg. It costs £145-£185 per tonne. Feeding an extra 30-50 g Mg per day (60-100 g calcined magnesite) in the concentrate ration usually maintains normal plasma Mg in cows. Farmers who mix their own rations may include those amounts in the daily allowance of concentrate.

Dairy concentrates from a given commercial source usually have a fixed rate of Mg inclusion. This can be a mistake because one formulation cannot suit widely varying levels of concentrate feeding. For example, a dairy ration with 1.0% added Mg would supply 30-50 g Mg per cow per day (adequate) if fed at 3-5 kg per cow per day but would supply 70-90 g Mg (excessive) if fed at 7-9 kg per cow per day. A ration with 0.5% added Mg would supply 15-25 g Mg (inadequate) if fed at 3-5 kg per cow per day but would supply 35-45 g (adequate) if fed at 7-9 kg per cow per day. To cater for variation in feeding rates, compounders may need to sell rations with two levels of Mg inclusion, one at double the inclusion rate of the other. The "double strength" ration may be fed at low levels and the "half strength" ration fed at high levels e.g. a ration with 0.5% Mg inclusion fed at 7-9 kg per head per day, and one at 1.0% Mg inclusion fed at 3-5 kg per cow per day. Farmers feeding 6 kg of ration could feed 50/50 of both rations. In this way, the Mg intake is kept within the range 30-50 g per head per day at all levels of concentrate feeding.

This "double strength and half strength" principle applies to all mineral and vitamin additions. If compounders can be persuaded to adopt the principle the feeding of major elements (Ca, P, Mg, Na), trace elements (Cu, Co, Se, I, Mn, Zn) and vitamins (A, D3, E) to stock will become much more precise than is the case today.

If no concentrates are fed and Mg is needed indoors, for example, by suckler cows housed on silage after an outbreak of winter tetany, the correct amount of calcined magnesite can be sprinkled over the silage, half in the morning and half in the afternoon. If dry forage (straw or hay) is used, the forage should be dampened before sprinkling with magnesite to prevent it from falling to the bottom of the feeders.

(c) **Magnesium supplements in a palatable carrier**

After turnout to grass, cows may not be fed concentrates. However, a small amount of carrier may be fed to carry the 60-100 g calcined magnesite. If 0.5 kg per cow per day is fed, the Mg content should be 6-12%; if 1.0 kg per cow per day is fed, the Mg content should be 3-6%. The composition of the carrier is not important, as long as it is palatable and is fed daily. The carrier can be commercial magnesium nuts, cakes or cobs. These are used widely in Scotland and the Netherlands. Commercial carriers, such as, molassed beet-pulp nuts are used in Ireland. Home-mixed carriers include rolled barley or beet-pulp, grass-meal, pollard etc, to which 6% molasses is added. Feeding in the parlour is preferable to group feeding as shy cows may consume little or none if trough space is limited.

(d) **Magnesium supplements in water**

MgO is largely insoluble in water and is unsuitable for water medication unless an agitation system is used to keep the MgO in suspension.

The common soluble salts of Mg are the chloride and the sulphate which are both hydrated and both 10% Mg, and a dehydrated chloride (25% Mg). The acetate may also be available but may be more expensive. Water medication with 20-40 g Mg per cow per day as soluble Mg salts (chloride, sulphate, acetate) effectively controls and prevents tetany in spring and autumn. Medication with more than 40 g Mg per cow per day as Mg sulphate may cause scouring. Higher levels of medication, up to 60 g Mg per cow per day, as Mg chloride can be tolerated without scouring but there is little if any extra benefit as regards improved blood Mg status over the lower level of medication.

There should be no other water source except the medicated water. Medication should be confined to water offered to lactating cows or recently weaned suckler cows. Water medication with 10-15 g Mg per cow per day can also be used in milkfever prevention (see below). Water for calves and dry-cattle should not be medicated unless hypomagnesaemia is diagnosed in these cattle.

Water can be medicated by two methods: dispensers and pumps. The dispenser consists of a 4-201 plastic drum with a special nozzle. The daily allowance of Mg is set at 20-30 g per cow per day. The required amount of Mg salt for the herd is calculated as follows:

Herd allowance (kg/day) = (number of cows x 20 x 100) / (1000 x Mg% in the salt).

Examples:

(1) The dose of Mg sulphate (Epson salts, 10% Mg) for a 50-cow herd is (50 x 20 x 100)/(1000 x 10) = 10 kg per day .

(2) If Mg stock solution is used (Brand X, 7% Mg), the amount of Brand X solution for a 50-cow herd is (50 x 20 x 100) / (1000 x 7) = 14.3 kg per day.

Half the dose is given in the morning and half in the afternoon. Half of the day's dose of Mg salt is dissolved in water in the dispenser, or half of the day's dose of commercial Mg solution is poured in. Leave 7-12 cm of an air cap in the dispenser. The nozzle is attached and the dispenser is floated upside-down in the trough. To ensure that the trough is emptied by the cows at least once per day, water volume in the trough should be reduced, using concrete blocks or sand, so that the water capacity in the trough is about 4.51 per cow. Even on wet days cows will usually drink a minimum of 5-10 litres of water per head. Thus the trough of water and its Mg dose must be consumed by the herd each day.

In the case of Mg sulphate, while 20 g Mg per cow per day is satisfactory, higher levels cause scouring, drop in milk yield and other problems. If cows refuse to drink sulphate-medicated water, dilute the trough with 1-2 times the volume of fresh water and skip the next half day's dose; then continue as before. If they still refuse to drink, it may be necessary to reduce the dose but blood Mg can not be maintained in the normal range if the dose is below 20 g Mg per cow per day.

Mg chloride solution (5% Mg) is available commercially. When added to the water supply at doses of 400-1200 ml per cow per day the chloride solution is safe and palatable and causes no depression of water intake or scouring.

Pumps medicate the water at a fixed concentration, depending on the setting of the dose/water ratio control. They are plumbed into the water pipe system, either near the trough or centrally in the farmyard. Plumbing in at the farm-yard is not advisable if young-stock must drink from medicated troughs. Accurate mechanical pumps operating off water-mains pressure are available. Most pumps are expensive.

Water intake by cows can vary from 10 litre per cow per day on cold wet days to 73 litre (on hot sunny days). Therefore herd intake of Mg from pump-medicated water can vary more than 7-fold from day to day unless the output ratio knob is adjusted frequently to compensate for that. All pumps need careful day-to-day adjustment of the settings if one is to compensate for day-to-day variation in water and Mg intake. However, some commercial pumps are used at fixed setting. Yet they seem to control blood Mg levels effectively in spite of day-to-day variation in water intake.

Dispensers are preferable to pumps. They are cheaper and they ensure a more accurate day-to-day supply of Mg to the cows.

(e) **Magnesium in mineral licks. blocks, mixes**

For adequate prevention of tetany using ad libitum intake of blocks and licks, the farmer needs to know the Mg concentration in the product, the average intake of product per cow per day and the variation in intake between cows and between days. Products which contain too little Mg or whose intake is low or variable are not safe. The Mg intake (g per cow per day) is calculated by multiplying the Mg level (g per kg product) by the maker's figure for intake of product (kg product per cow per day). Products which supply less than 30 g Mg per cow per day are not recommended.

Intakes of 30-50 g Mg per cow per day in molassed mineral mixes, blocks or licks including home-mixed 50:50 molasses: MgO, usually are effective in preventing tetany but may fail to maintain blood Mg as effectively as the more controlled systems of Mg supplementation.

A home-made 50:50 molasses: MgO mix can be offered in tubs or half-barrels, one half-barrel per 20-25 cows. Twenty kg molasses + 20 kg MgO would supply 50 cows for 1 week. Intake averages about 114 g mix = 57 g MgO = 28.5 g Mg per cow per day. The mix needs stirring 1-2 times per day; MgO settles out especially if rain dilutes the mix. This allows pooling of molasses on top and the intake of MgO falls. Cows can be trained to the mix for 1 week before the risk period. This is done by offering a 5:1 molasses:MgO mix at the start, gradually increasing the strength to 1:1 over 5-7 days. Variants include, cattle minerals:MgO:Molasses 1:1:2 fed in tubs, or molasses:MgO in ratios of 3:1 to 10:1 fed in ball feeders.

While group mean intake per day of palatable molassed blocks or 50:50 molasses : MgO mix may be adequate, wide variation in individual intake of Mg supplement is a basic problem with all free-choice systems. Cow-to-cow variation in Mg intake can be up to 30-fold on a given day and day-to-day variation can be large also. Some cows consume little or none; others consume too much and may develop side effects e.g. scouring, drop in milk yield, subclinical urinary calculi.

In suckler herds or low-yielding dairy herds grazed in inaccessible or marginal areas, methods (a) to (d) may not be practicable. Free access systems may be considered; they are more effective than Mg bullets.

(f) Magnesium bullets

Mg bullets for cows release 1 g Mg each per day. Compared with 30 g Mg per day from 60 g calcined magnesite, 4 bullets release only 4 g Mg per day. Two bullets may not prevent tetany in cows, although they may reduce the incidence somewhat. Even 4 bullets may fail to maintain normal blood Mg in cows but they may be the only practicable way to reduce tetany risk in suckler cows on marginal land. If they must be used, suckler cows need at least 4 bullets every 5 weeks. In suckler calf tetany, 2 bullets may suffice.

(g) Soil fertilisation

Fertilisation with Mg is not reliable as a means of preventing hypomagnesaemia. It is ineffective in raising plant Mg sufficiently high to overcome low availability of herbage Mg in spring or on autumn aftermath.

2. Stress reduction and feeding

Climatic stress can be reduced by housing during periods of harsh weather. Planting fast-growing trees or hedges provide useful shelter for stock at pasture. In some countries cows at pasture in spring and autumn are provided with cheap but effective blankets to protect against cold and damp. Rough handling, unnecessary use of sticks and dogs can be avoided.

Cattle, including dry-stock, sometimes "faint" when restrained in a crush. Hereford cattle are especially susceptible. The restrained animal may bellow, tremble and struggle before going down in a complete faint. "Crush tetany" or fainting may be confused with grass tetany but most cases are simply a form of fear, unrelated to hypomagnesaemia. Releasing the head-restraint may suffice. If not, pouring cold water over the animal's head and helping it to its feet may suffice. If this does not work, grass tetany induced by stress, may be suspected and specific treatment should be given immediately.

The intake of grass DM by freshly-calved cows at pasture and the intake from winter pasture can be well below the cow's needs. The DM intake of a cow at grass is about 3-4% of body weight. The quality of winter pasture, or of pastures which have been managed badly can be below that of spring and summer pasture. Supplementary feeding, especially extra energy, may be needed where DM intake or quality are suboptimal.

Suckler cows are given little if any supplementary feed at grass. In the case of outwintered suckler cows the provision of adequate energy and shelter is crucial. Many tetany outbreaks in out-wintered cows fail to respond to Mg supplements but can be controlled by housing and provision of more feed or better quality feed.

Many winter forages need to be supplemented with Mg. Diets based on silage, straw or poor hay may contain 0.10-0.19% Mg in the DM, levels which are too low for cows in late pregnancy or in lactation. Forages may also need to be supplemented with other minerals (salt, phosphorus, trace elements) and vitamins (especially Vit A and E). Winter feed analyses for quality and minerals will indicate whether specific supplements are needed.

3. Reducing Mg-antagonists in the diet

Reduction of Mg-antagonists reduces the severity of hypomagnesaemia and the risk of tetany.

As K fertilisers have been used for many years now, some farms have excessive K in soil in the grazing areas. Soil tests for K at 3-year intervals can be used to monitor soil K. High levels of K in the diet increase the risk of hypomagnesaemia and tetany. Omission of K fertiliser, when indicated by soil K levels, can save money as well as reduce the risk. Autumn application of K reduces luxury uptake of K in spring herbage.

Maximum output of pasture DM depends on heavy use of fertilisers (chemical or organic) and on tight grazing. High DM yields have negative and positive implications. Intensively grazed pasture tends to be very lush. The adverse effect of lush pasture on the availability of Mg and of many trace elements has been discussed. In addition, Mg levels in rapidly growing grass are often low, less than 0.20% DM. Heavily lactating cows and ewes need much more than that when Mg antagonists are present.

Heavy use of slurry, farmyard manure, poultry litter should be avoided on grazing land. Apart from producing lush grass, they can reduce herbage palatability, DM intake by cows and milk yield.

If hypomagnesaemia is due to excessive fat in the concentrates, the fat level should be reduced.

SUMMARY

Grass tetany is a clinical disorder of cattle and sheep. Signs include nervousness, staggering, recumbency, convulsions, coma and death. Tetanic animals can die within 1 hour. Times of high risk are:-

1. Spring, for 6-8 weeks after lactating cows or ewes go to grass
2. Autumn, in winter-milk herds on lush aftermath
3. September to March in out-wintered suckler cows calving in that period
4. For 2-3 days after weaning in suckler cows.

Grass tetany is associated with hypomagnesaemia, low blood magnesium levels. There is a genetic component in the control of blood Mg level. Some animals need much higher Mg intakes than others to maintain normal blood Mg.

Stress can trigger hypomagnesaemia. Tetany is rare in dry-stock but may arise from serious errors of feed formulation, e.g. inclusion of more than 6% fat in the ration. It can occur with Cu deficiency in suckler calves from 3-6 months old.

Normal plasma Mg levels in cattle and sheep are 1.7-3.0 mg per dl. In tetanic animals, blood Mg levels are very low (0.2-1.0 mg per dl) and the mean plasma Mg level in the group is usually below 1.3 mg per dl. Grass tetany and hypomagnesaemia are usually confined to lactating cows or ewes.

Hypomagnesaemia may be clinical, subclinical or non-clinical. Clinical signs are those of grass tetany. Subclinical signs are: reduced feed intake; reduced herd yield in high-yielding dairy herds; reduced release of calcium from bone and

increased risk of milk fever in dairy cows. In non-clinical hypomagnesaemia there are no obvious signs of ill-health or lower productivity. Many animals with plasma Mg below 1.0 mg per dl do not develop tetany or other signs. Many apparently healthy groups may have moderate to severe hypomagnesaemia.

Magnesium is required daily. A low Mg intake, compounded by a low net availability, greatly reduce the amount of Mg absorbed per day. Adult ruminants depend on daily absorption of Mg from the feed, as they are poorly able to release Mg from their bone reserves in times of Mg shortage. Withdrawal of Mg supplement in high-risk periods can precipitate tetany within 2 days.

The prevention of hypomagnesaemia depends on: Mg supplementation in periods of risk, reduction of stress, and reduction of Mg-antagonists in the diet.

Mg supplements for cows include: pasture dusting with powdered calcined magnesite; feeding 30-50 g Mg per day as calcined magnesite; water medication with 20-40 g Mg per day as soluble Mg salts such as, chloride, sulphate, acetate; access to 30-50 g Mg per day in mineral mixes, blocks or licks. Daily supplements for ewes are about 10% of the daily cow supplement.

Mg bullets for cows release 1 g Mg each per day. Compared with 30 g Mg per day from 60 g calcined magnesite, 4 bullets release only 4 g Mg per day. Even 4 bullets may fail to maintain normal blood Mg in cows but they may be the only practicable way to reduce tetany risk in suckler cows on marginal land. If used, suckler cows need at least 4 bullets every 5 weeks. In suckler calf tetany 2 bullets may suffice.

The costs of Mg supplements vary widely. Calcined magnesite (MgO) is the cheapest source of Mg. MgO in the feed is the cheapest and most reliable method. Home mixed 50:50 molasses:magnesite is the next cheapest but is less reliable. Commercial products for water medication and Mg bullets are the most expensive methods.

The reduction of stress and proper feeding reduces the risk of tetany. Tetany in outwintered cows may not respond to Mg supplements alone; provision of adequate energy and shelter are crucial.

Reduction of Mg-antagonists reduces the severity of hypomagnesaemia. Lush grass passes quickly through the animal, thereby reducing the absorption of Mg and trace elements. It also contains specific factors, especially high levels of N, K and fatty acids which reduce Mg absorption. If soil tests indicate a need for K fertiliser, it is good practice to apply it in autumn rather than in spring. This reduces luxury uptake of K in spring herbage. Reduction of the fat level in the diet is necessary if hypomagnesaemia is due to excessive fat intake. Supplementary salt is needed if sodium levels are low in feed.

The Impact of Cap Reform on Feed Costs in Beef Production

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The decisions, finalised on May 21 1992, on the reform of the Common Agricultural Policy (CAP) sketch the broad outline of the institutional arrangements within which the beef industry will be operated in the 1990's. Since the changes affect both the input and the output side of beef production, the adjustments by farmers are necessarily complex and this renders an accurate assessment of the outcome rather difficult. Although the adjustment path will also be influenced by many of the detailed operational regulations which have yet to be finalised the general framework is now largely defined. This paper examines the impact of CAP reform on:-

1. The evolving relationship between commodity support prices.
2. Concentrate feed costs.
3. Composition of costs and returns in beef production.
4. The relationship between concentrate costs and the value of silage.

The evolution of commodity support prices

As in the original CAP, the market arrangements for cereals occupy a pivotal position. An outline of how institutional support prices for the main commodities will evolve over the next few years is shown in Figure 1. The institutional prices

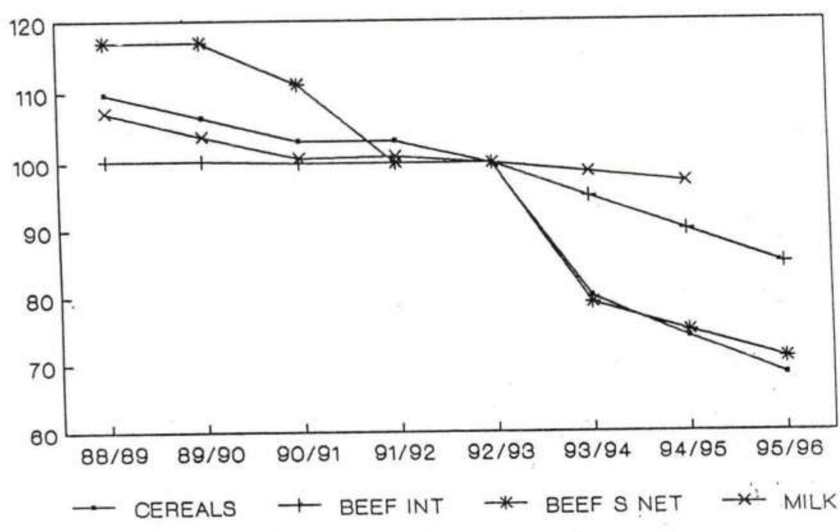

Fig. 1 – Commodity support prices
Index 1992=100

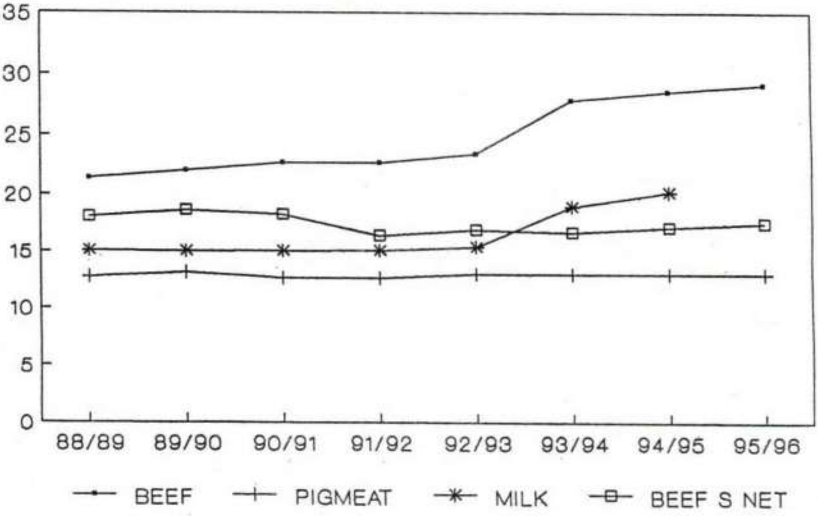

Fig. 2 – Price support levels – livestock to cereals ratio

for cereals are projected to decline by about 30% and, while it is not formalised, the intention is that pigmeat prices will track those of cereals. Also there is a planned reduction of 15% over three years in the normal intervention price for beef. However, the level of reduction in "safety net" intervention for beef is similar to that for cereals. The adjustments to the support price for milk are modest compared with those for meat and cereals.

Livestock product to cereal price ratio

In all livestock production systems, animal feed is the main input cost item and is a major factor affecting profitability. Cereal prices are the main determinant of animal feed costs. Hence, some appreciation of how the economic returns from the various livestock production systems might evolve can be gleaned from examining how livestock support prices evolve relative to those for cereals (Figure 2). For milk production the indications are that the profitability of feeding concentrates will increase over the next few years. For beef the profitability of feeding concentrates will increase if beef prices are supported by the intervention price. However, if beef prices are dependent on the "safety net" for support then the changes in the profitability for feeding concentrates will be marginal. Since it was assumed that institutional support for pig prices would decline in line with cereal prices, the profitability of pig production would be largely unchanged.

Meat price ratios

The consumer demand for the different types of meat is highly dependent on their relative prices. The evolution of the relationship between the institutional support prices for beef and pigmeat is presented in Figure 3. If beef prices are

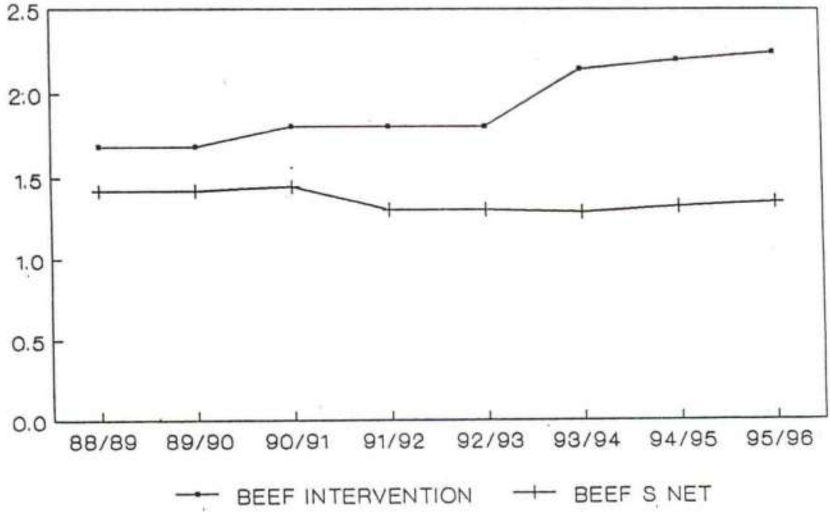

Fig. 3 – Price support levels – beef to pigmeat ration

supported by the general intervention level it would appear that there has been a decline in the competitiveness of beef relative to pigmeat and this could decline even faster in the future. Figure 3 shows that beef prices would need to decline in line with safety net intervention for beef to remain competitive with pigmeat. These tentative conclusions can be garnered from an analysis of the changes in the relative support prices of the various commodities. However, it is difficult to anticipate with accuracy what will happen in practice because many of the detailed rules are not yet in place. Furthermore, market prices in the future, as in the past, will also be influenced by the relevant EC Market Management Committee's assessments of the actual market situation and the decisions and actions arising from these assessments.

Implications for beef producers

In Ireland a profile of beef producers encompasses a range varying from full-time commercial beef farmers to various "full" and "part-time" farmers who are in beef production for social as well as economic reasons. In fact there is considerable evidence that many of the farmers who, either voluntarily or compulsorily, have opted out of other farm enterprises continue to produce beef. For these reasons beef production is almost as much influenced by factors affecting other enterprises as the factors directly affecting the economics of beef production. Even within the beef sector the changes resulting from CAP reform are many and varied because they affect both costs, revenue and volume of production.

Implications for cereal policy

Significant changes in costs and cost structure arise as a result of the reform of cereal policy. The main changes are summarised in Charts 1 and 2. While the reformed system will be phased in over three years the transition period is ignored to simplify the presentation. Under the existing CAP policy the income of cereal producers is supported by a relatively high cereal price and the incentive is to maximise output, expand the resource base. There is also free entry into and exit from the sector (Chart 1). In the "reformed" system the support price will be much lower and incomes will be maintained through an area-related payment which will be conditional on land being taken out of cereals (ie setaside). In addition the size of the area payment will be conditional on a National or producer area quota. Under the new regime the incentive for the cereal producer will be to minimise costs and possibly to change crop mix and/or to reduce inputs. It is also likely that entry into cereal production will be restricted by area quotas. Quotas, set-aside and possible future quota reductions for cereals all indicate that more "surplus cereal land" will become available for alternative uses. Traditionally, beef production has been the preferred outlet for this surplus land.

Concentrate feed prices

Under the existing CAP system for cereals, the price of animal feeds was primarily determined by the intervention price for cereals and this made concentrate feeds expensive (Chart 2). This in turn provided the incentive to find cheaper feeds either in the form of cereal substitutes and even protein feeds or forages. Under the reformed system, the intervention price for cereals will be considerably lower, cereals and consequently concentrates will be a much more competitive livestock feed. For bovine livestock feeders this raises the possibility of a new optimum feed mix resulting from the change in the price ratios between cereals, cereal substitutes, protein rich feeds, grass silage and possibly even grazed grass.

Teagasc research shows that concentrate ration formulations are highly sensitive to the relative price of cereals, cereal substitutes and protein rich feeds [(4)]. This study also shows that the sensitivity of ration formulation to changes in the relative price of ingredients varied greatly between countries and for ration types. Ration formulations for The Netherlands provide substantial evidence that the price of cereal substitutes is pitched at a level to maximise their inclusion in compounds. This would indicate that under the reformed CAP the existing cereal to cereal substitute price ratio will be largely maintained to ensure maximum inclusion of substitutes in feeds. It is also likely that cereal substitutes will continue to be attracted into the EC as long as there is a significant difference between the EC and the world price for cereals [(4,5)].

Recent Teagasc research indicates that as the EC attempts to align its cereal prices with world prices, feed ingredient prices in the EC will become more volatile [(6)]. This in turn will increase the variability in the livestock to feed price ratio and is likely to precipitate the classical pig cycles and variable meat prices[(6,7)].

The maize silage subsidy

There were several Teagasc published reports over the last decade which outlined the significance of the declining concentrate feed prices in the Community for the competitiveness of grass based beef and milk production in Ireland [1-5]. In the recent CAP reform agreement the link between the lower support price for cereals and the reduced value of forage was recognised explicitly when the area payment for cereals was extended on a *pro rata* basis to maize silage (Chart 1). As noted by Dunne 1992, the same logic would equally apply to the entire grass crop in Ireland [8]. It is certainly difficult to understand why the maize silage subsidy does not equally extend to the "harvested grass crop" as this at least would be administratively feasible. The implications of this for the economics of feeding grass silage will be examined later.

CHART 1 CEREALS "REFORM"

Existing System	Reformed System
PRODUCERS:	
1. Prices/income determinants:	
(a) **Intervention** (£129.63/tonne	(a) Lower Intervention (£87,88/tonne)
	Plus
	(b) Area payment approx £/acre Cereals 90 Maize silage 86 Grass zero
	Plus
	(c) **Set aside area** (0 to 15% @ £90/acre)
	Plus
	(d) Quotas (National/regional)
	Plus **Possibly**
	(e) Future Quota buy-out
2. Consequences:	
(a) incentive to **Maximise output**	(a) Incentive to **Minimise costs**
(b) **Expand resources** i.e. land/capital	(b) **Change production mix** ? By: (i) Lower inputs (ii) change crop mix
(c) **Free entry/exit**	(c) Quotas —> exit only
	(d) Quotas, Set-aside and Quota reductions for cereals all lead to more **"surplus" land** becoming available for alternative uses.

CHART 2. CEREALS "REFORM"

Existing System	Reformed System
CEREAL USERS — FEEDERS:	
1. Price determinant:	
"intervention"	Lower "intervention"
2. Consequences:	
(a) Cereals/feed expensive	(a) Cereals/feed "cheap"
(b) Find cheaper feeds (cereal substitutes, protein feeds and forages)	(b) Concentrates cheaper
	(c) New optimum feed mix Change in price Ratios between cereals and: (i) cereal subs ? (ii) protein feeds (iii) grass silage (iv) grass
	(d) Feed prices volatile ? (stronger link between EC and world cereal prices)

Some implications of the changes in beef policy

The existing CAP support system for beef resulted in beef being expensive for the consumer and there was a financial incentive to switch to "white meats" Chart 3). Under the reformed beef regime the price of beef could be considerably reduced for the consumer. However, cheaper beef does not necessarily mean that beef secures a greater share of the meat market if beef is still expensive relative to other meats. If we accept the earlier scenario that the reduction in white meat prices will track the reduction in cereal prices, then beef prices would have to decrease in line with safety net prices in order to maintain the present beef to "whitemeat~ ratio (ie a reduction of about 30%. The implications of this for beef producers will be evaluated later.

Under the existing CAP system, the beef producer's income is supported mainly by the intervention price for beef and this has been supplemented in recent years by premiums for suckler cows and a single premium for male cattle (Chart 3). Like all other CAP products, there was no formal restriction on entering or ceasing beef production. In fact, the main incentive was to increase the resource base and maximise output. Under the reformed CAP the intervention price will be considerably reduced and "headage" payments substantially increased with the objective of maintaining producers incomes. However, suckler cow and cattle numbers will be constrained by quotas.

CHART 3. BEEF "REFORM"

Existing System	Reformed System
CONSUMERS:	
1. Price determinants:	
"intervention"	Lower "intervention"
2. Consequences:	
(a) Expensive Beef	(a) "Cheaper" Beef
(b) Find alternatives pigmeat/poultry	(b) Change in Price Ratio ? with: (i) other meats (ii) other foods?

The beef producer's response

There is limited information available on the likely response by beef producers to this change. Any analysis of the response is complicated firstly by the fact that the "headage" will form a large proportion of the producer's revenue and the method and timing of the payment of the premiums are not yet finalised. Secondly, beef production in Ireland consists of a series of almost autonomous sub systems which will also respond to the methods of paying the premiums and the changes in the relative cost of concentrate feeds.

Under the reformed CAP further expansion in beef production is constrained by quotas and the major incentive will be to minimise costs (Chart 4). Since headage payments will be a major component of the beef producer's revenue it is likely there will be a change in the production mix. As a consequence of the changes in the method of paying the beef producer and the changes in the animal feed cost structure there will be a new optimum balance between:-

a) the value of "keeping the animal alive" and the value of its carcass,

b) the cost and returns from animal maintenance and growth,

c) the cost and value of animal performance at grass compared with overwintering.

Finding the new optimum mix is rather complex because there are a number of variables involved and some of which are not easy to quantify. Furthermore, the introduction of quotas and possible quota reductions for most of the main land based enterprises has resulted in "surplus" land and altered the opportunity cost of land.

Costs and returns post CAP reform

As outlined above, CAP reform affects both the input costs and the revenue composition in beef production and this complicates the analysis of future trends of costs and returns. In the future, quotas will be the major constraint on production expansion. Milk and beef cow quotas (other things being equal) constrain the number of calves which is the primary raw material in beef production. In the future, farmers will optimise their costs and returns based on

CHART 4. BEEF "REFORM"

Existing System	Reformed System
PRODUCERS	
1. Prices/income determinants:	
£/kg	£/kg
(a) Intervention (3.01) safety net 72 % (2.17)	(a) Intervention (2.56) safety net 60% (1.54)
Plus	Plus
(b) Headage £/head	(b) Headage £/head

Existing System — Headage £/head

suckler cow	52
male premium	35

Reformed System — Headage £/head

	normal	<1.4LU/Ha
suckler cow	123	149
male premium		
10 months	79	105
22 months	79	105
slaughter (Jan-Apr)	53	53

Existing System	Reformed System
	Plus
	(c) Quotas
	Plus Possibly
	(d) Future Quota buy-out
2. Consequences:	
(a) incentive to Maximise output	(a) Incentive to Minimise costs
(b) Expand resources i.e. land/capital	(b) Change production mix Live animal/Carcass maintenance/growth summer/winter feeding
(c) Free entry/exit	(c) Quotas —> exit only
	(d) Quotas and Quota reductions for beef, dairy and cereals all lead to more "surplus" land and this in turn to extensification of "beef" which also reinforces (a) and (b) above, except for the slaughter premium.
	(e) Cereal Reforms lead to better concentrate feed price ratios: (i) concentrate/forage (ii) energy/protein

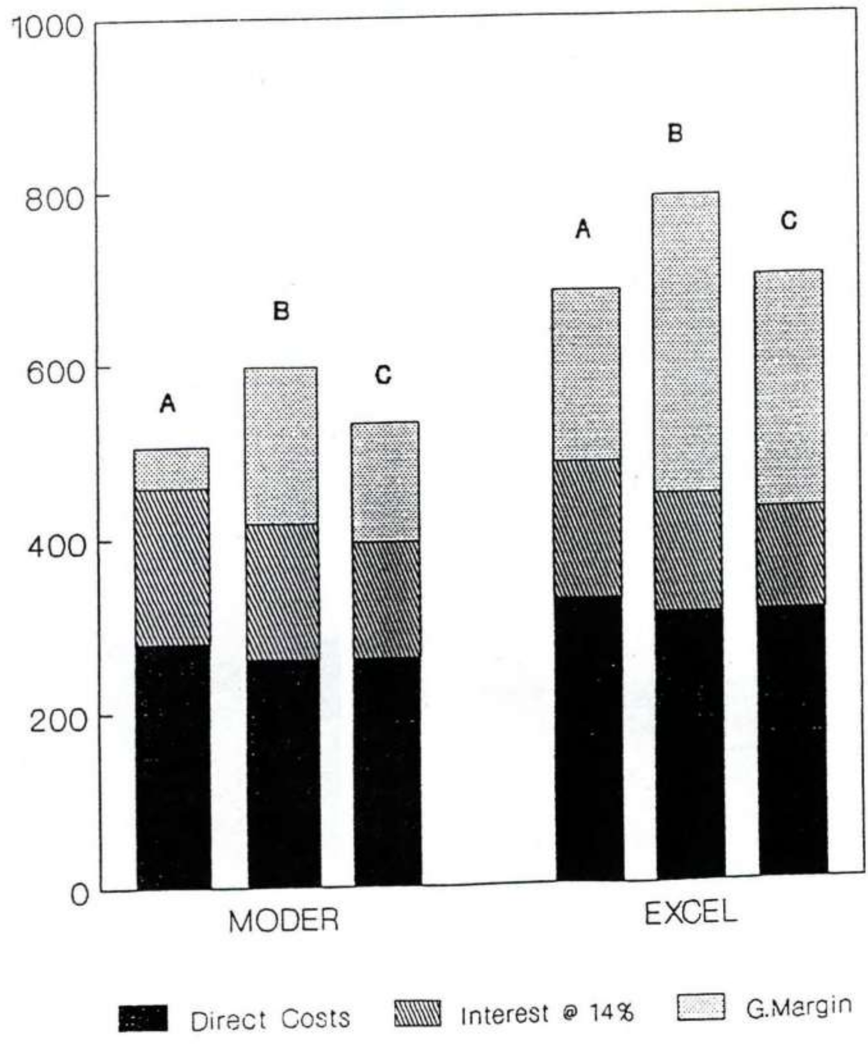

Fig. 4 – Costs and margins per suckler cow (£/head)

their quotas, it therefore seems appropriate to evaluate the costs and returns per cow rather than per unit area. To confine the analysis to manageable proportions the budgeting exercise was restricted to a spring calving, single suckling enterprise producing, where possible, finished beef at two years. This circumvents the problems associated with the timing of the headage premiums and how they might influence intermediate stock valuations. Since female progeny are not counted in determining stocking rates and they are not eligible for premiums it was assumed that stocking rates would be such that the "extensification"

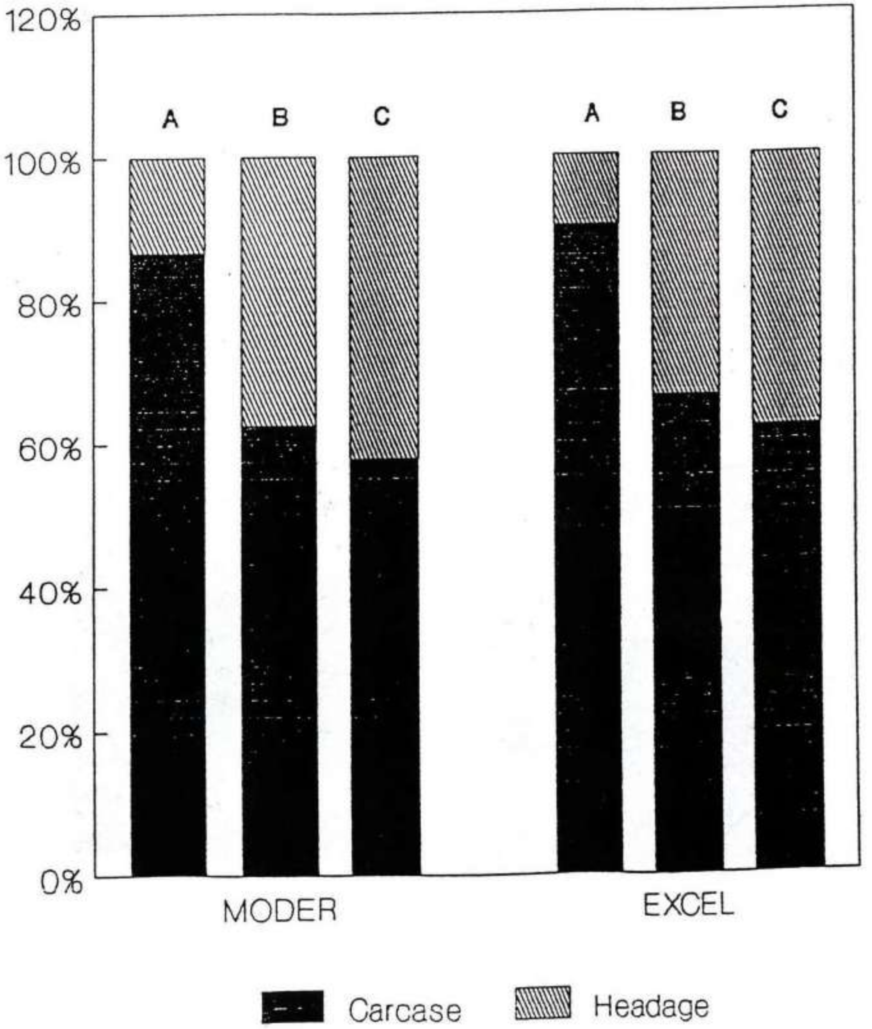

Fig. 5 – Composition of output per suckler cow

premiums apply. To further delimit the task the budgets were prepared for both a moderately efficient and an excellent production unit. Costs and returns were evaluated for:-

A. Existing CAP,

B. Reformed CAP with beef prices reduced by 15% and cereal prices reduced by 30%.

C. Reformed CAP with beef and cereal prices reduced by 30%.

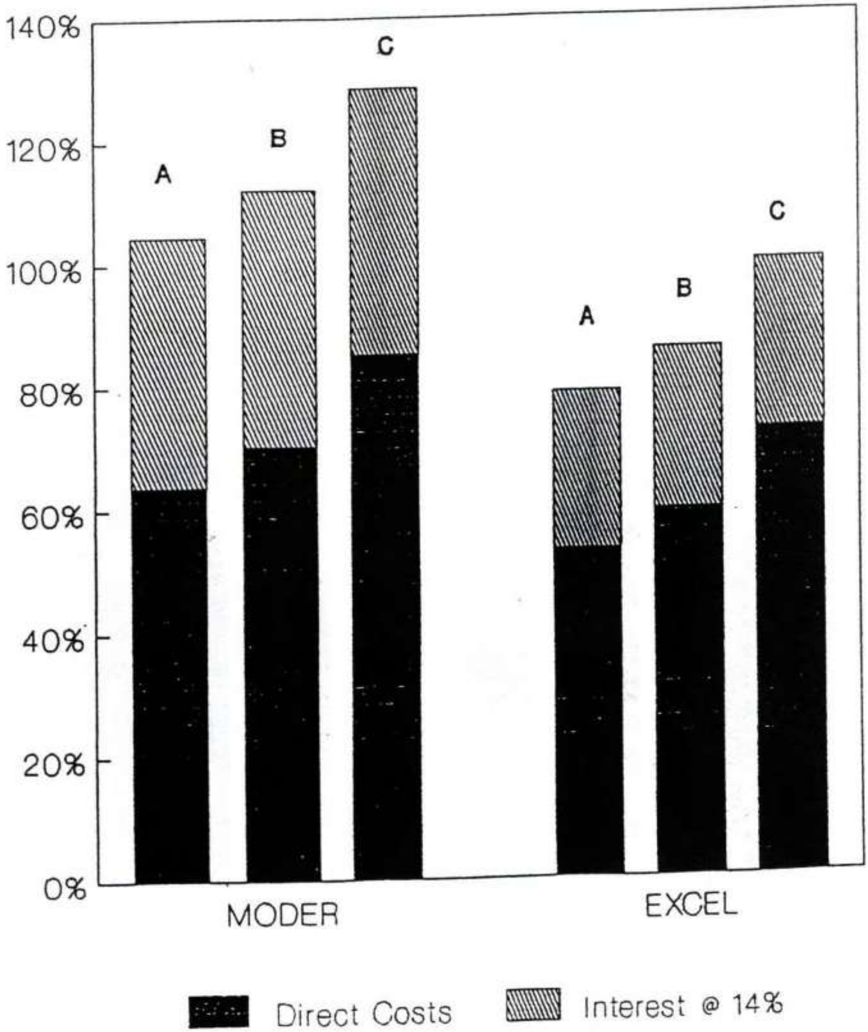

Fig. 6 – Production costs - percent carcass value

Costs and margins

The estimated output, costs and gross margins per suckling cow are shown in Figure 4. The estimates show that the total revenue per cow will increase under CAP reform but the increase would be marginal if beef prices decreased by 30 %. The reduction in cereal prices causes a reduction in direct costs but it is small due to the low level of concentrate used. Interest charges also decline mainly as a result of the decline in the value of the animals. The estimated changes in gross margins per suckling cow is highly sensitive to the price of beef

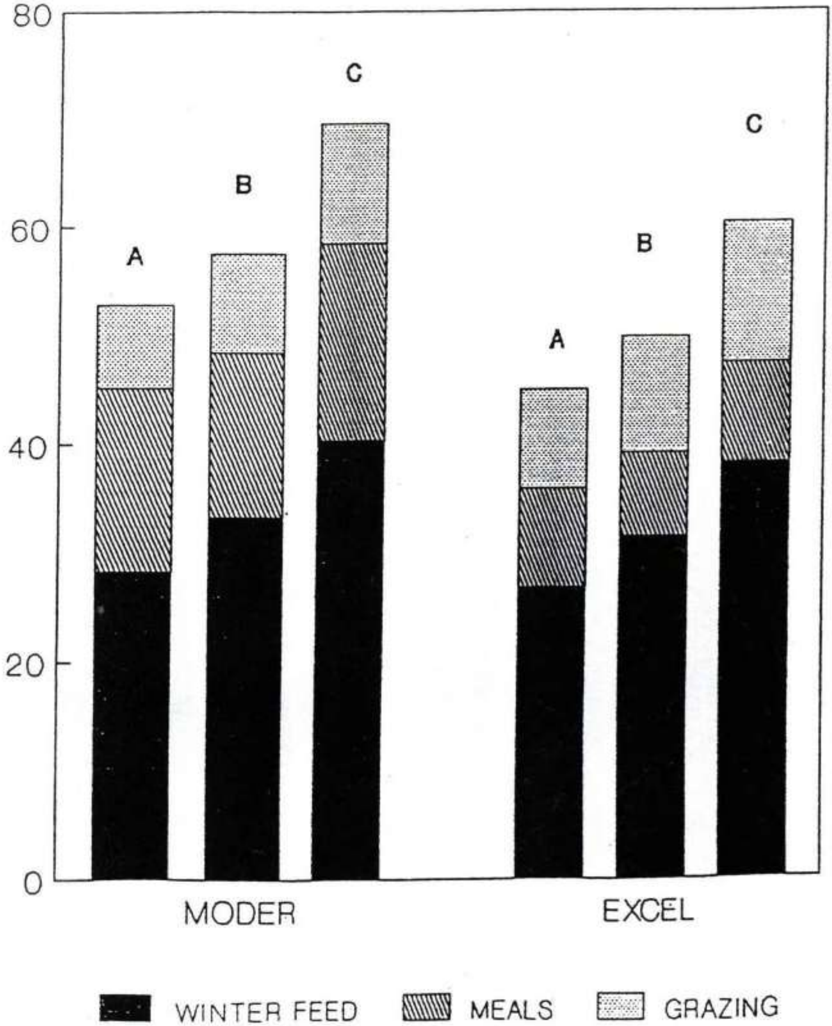

Fig. 7– Feed Costs - percent of carcass value

and to a lesser extent the level of interest rates on capital. Should beef prices decline by 30 percent, the increase in gross margin will be small and will mainly benefit beef producers with moderate efficiency operating on borrowed capital.

Changes in revenue composition

The estimated composition of the revenue received by beef producers is examined in Figure 5. Under the existing CAP arrangements, headage payments account for less than 15% of producer's revenue but under CAP reform these payments could account for almost 40% of revenue, especially if beef prices decline by 30%. This has interesting implications for future input and output relationships in beef production. As the market value of the finished animal declines, production costs become more important. In the short term the only costs that are under producers' control are direct costs. Should the price of beef decrease by about 30% then direct costs as a percentage of the carcass value will increase by about 20 percentage points (Figure 6). Indeed, if interest charges are included with direct costs for the excellent producer these costs would be approximately equal the value of the carcass. For the moderate producer these costs would actually exceed the value of the carcass by almost 30% .

Feed costs and carcass value

Since animal feed costs are the main component of direct costs it is appropriate to examine feed costs in more detail. The estimated relationship between feed cost and the value of the carcass is shown in Figure 7. Under CAP reform feed costs could amount to over 60% of the value of the carcass and this in turn would focus attention on the cost of winter fodder in particular. Also, the value of winter fodder (silage) is coming under pressure from concentrates as a result of the CAP reform for cereals.

Changes in concentrate prices

Under the CAP, the market support arrangements for cereals relate primarily to wheat prices. Therefore, the cost of obtaining feed energy from concentrate feeds is mainly related to the price of wheat. When CAP reform for cereals is fully implemented the intervention buying-in price for wheat will decrease (assuming no change in green currency rates) from the current level per tonne of £129.63 to £87.88, a price decrease of 32%. The actual reduction in feed prices is difficult to predict as allowance must also be made for changes in the balance between cereal supply and demand, transport and processing costs. Nevertheless, the price decrease for processed feed wheat could be of the order of £50, a decrease from about £160 to approximately £110 per tonne. The evidence from other studies would indicate that there would be a *pro rata* reduction in the price of energy-rich concentrates.

The value of silage

The breakeven cost of obtaining feed energy from wheat and grass silage of three different dry matter digestibilities is shown in Figure 8. It is clear that as the price of wheat declines the derived value of grass silage decreases rapidly and there is also a reduction in the value differential between average and excellent silage. For example, if wheat costs £160 per tonne then silage of 20% dry matter (DM) and 72% dry matter digestibility (DMD) is worth £28 per tonne whereas when wheat costs £110 the same silage is only valued about £19 per tonne. Similarly, the value of silage of 20% DM and 62% DMD declines from a value of about £24 to only £16 per tonne. It is noteworthy that, the difference in value between the two silages is about £4 per tonne when the wheat costs £160, but it declines to £3 per tonne when wheat is £110 per tonne. Figure 8 shows that as

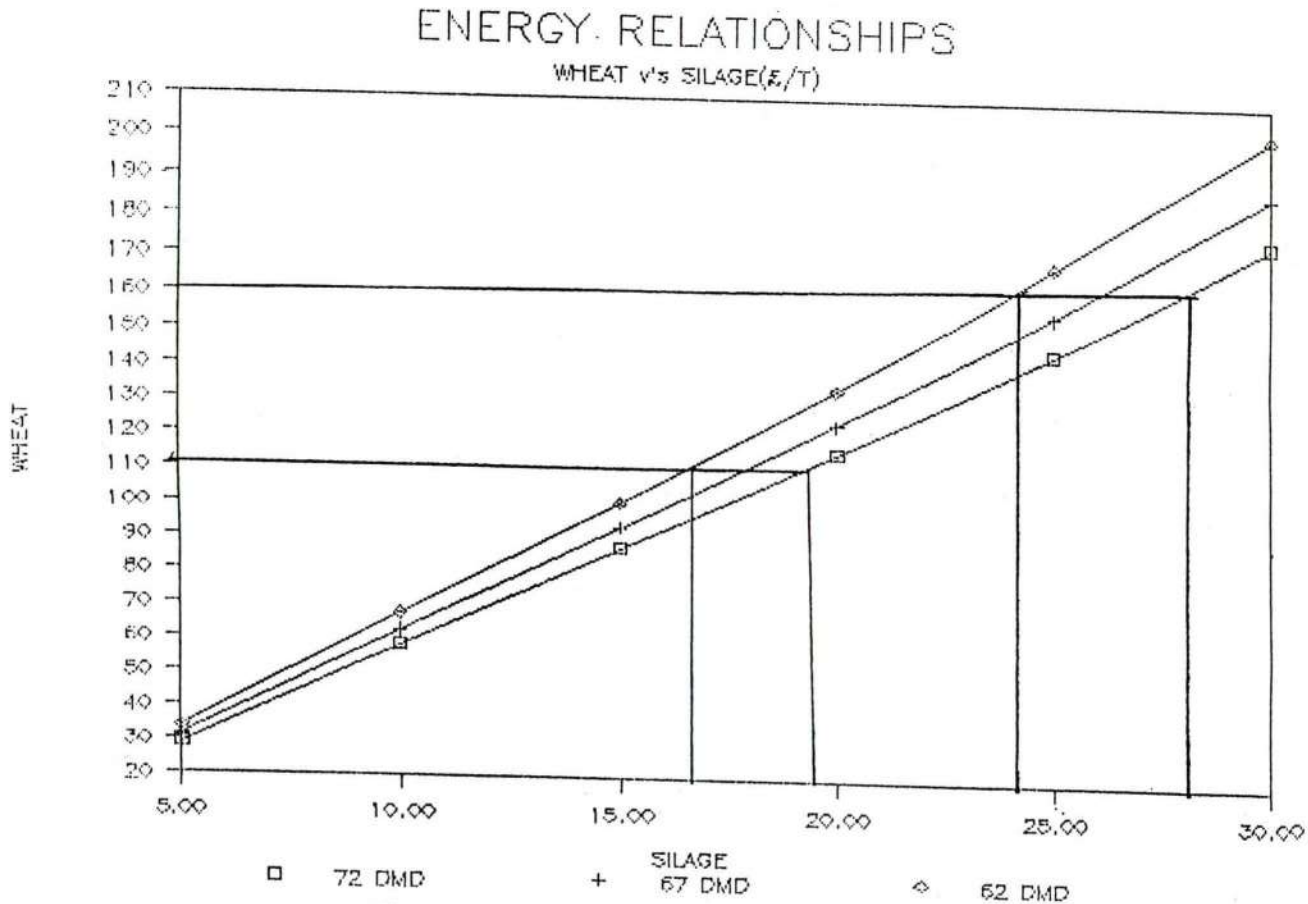

Fig. 8 – Energy relationsahips - wheat vs silage (£/T)

the cost of cereals declines the overall reduction in the value of the silages is of the order of £8 to £9 per tonne, this could be considered the grass silage equivalent of the maize silage subsidy discussed earlier. Indeed, future investigations might interestingly compare the impact on the seasonal cost of producing beef of such a grass silage subsidy with that of the current spring slaughter premium.

It is obvious from Figure 8 that under the current CAP system cereals and concentrates were very expensive relative to grass silage. However, in the post CAP reform situation the cost differential between concentrates and silage has narrowed considerably with an estimated upper limit on the value of silage of the order of £16 to £18 per tonne depending on its quality.

On Irish farms the cost of making silage varies enormously depending on the specific circumstances. For example, the costs could be extremely low in a situation where crop yields are high and the extra costs of growing the grass may only be the cost of the fertiliser and the opportunity cost of labour, harvesting equipment and land are also low. On the contrary, costs could be very high when land is rented, grass yields are low and full contractor charges are incurred. It is in this latter situation that concentrate feeds are most likely to be competitive in the future.

References

(1) Dunne, W. (1980). What Fuels the Butter and Beef Mountains? Farm and Food Research, An Foras Taluntais (Teagasc) 11(1): 18-19.

(2) Dunne, W. (1981). Could there be an Energy Solution to the CAP budget Problems? Farm and Food Research, An Foras Taluntais (Teagasc), 12(4): 125-127.

(3) Dunne, W. (1986). An Evaluation of the European Communities Cereal Market Support Agreement of 1986. An Foras Taluntais (Teagasc) 19 Sandymount Avenue, Dublin 4.

(4) Dunne, W. (1990). The Imposition of Levies on Cereal Substitutes. Commissioned Report, Rural Economy, Teagasc, 19 Sandymount Avenue, Dublin 4.

(5) Dunne, W. (1990). Rebalancing within the GATT: Implications for Cereal and Livestock Production. Paper presented to The Agricultural Economics Society of Ireland, December, 1990.

(6) Dunne, W. (1991) Cereal Proposals Could Destabilise CAP. Farm and Food, Teagasc, 1(3): 10-12.

(7) Dunne, W. and Wirsching, S.D. (1992). Making Livestock Markets More Volatile. Farm and Food, Teagasc, 2(2): 18-20.

(8) Dunne, W. CAP Reform: Cheaper Feed For Livestock Farmers ?. To-day's Farm, Teagasc, 3(2): 13-15.

Selection of Bulls for Merit

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The conditions under which the Irish beef farmer must now operate his business have changed dramatically in recent years. These changes have been particularly significant under the recent modifications to the common agriculture policy. Intervention prices are projected to fall by 15% and will be compensated for by directly paid premia. Intervention will account for a much lower proportion of our overall production of beef in future. In addition the quality aspects of beef will demand even greater attention. The production of hormone/additive free beef of best quality in terms of fat levels, conformation, and meat quality must now be the priority for every farmer. Producers must therefore develop their production enterprises to optimise their returns under the new EC support regime and evolving consumer demands. Due regard will have to be given to managing quotas and stocking rate limitations to maximise returns from premia, however significant attention to efficiency and quality of production will still be required.

This paper addresses some of the areas relating to the potential for improvement in the efficiency and quality of beef production. In particular it will deal with the importance of variation within breed and the potential it offers for improvement in growth, quality and efficiency which are the traits of primary economic importance. The relative merits of the different breeds for each trait are well known. For many traits there is a significant overlap in the genetic merit of the different breeds which is not immediately apparent from breed mean comparisons but which the farmer should be fully aware of.

The genetic basis of phenotypic performance

The appearance and performance of an animal, its 'phenotype', is governed by two factors:

- the genes it inherited from its parents, its 'genotype', and
- the extent to which that 'genotype' is influenced by the environment in which the animal is reared.

Although significant short-term improvements in performance have resulted and will continue to result from changes in environmental influences such as housing and nutrition, improvements resulting from changes in the genotype are in contrast cumulative and are passed on from generation to generation. These genetic improvements are maintained at no further cost while non-genetic improvements may continue to require ongoing increased costs in order to be maintained.

Two types of traits are of interest to the farmer. The first, the qualitative traits such as coat colour are governed by one or at most a few genes and their phenotypic expression conveys their genetic basis or genotype. The more important group however are the quantitative traits such as growth rate, food

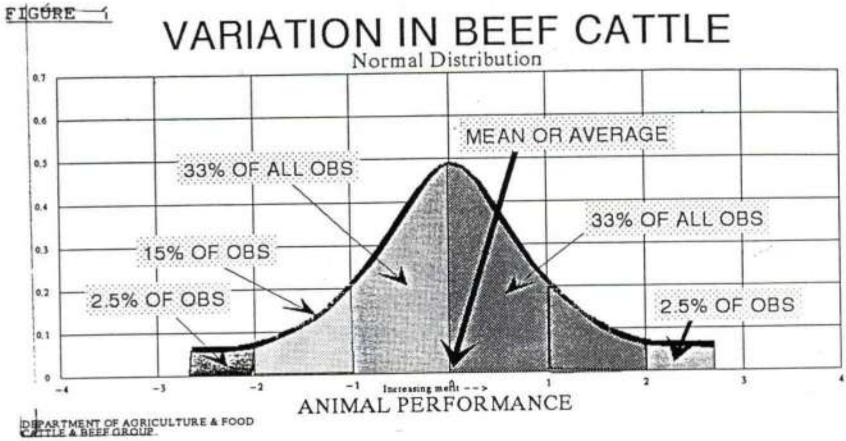

Fig. 1

conversion efficiency and killout. These traits are controlled by many genes each contributing small components with some often acting antagonistically to one another.

As already stated phenotypic variation is composed of a genetic and an environmental component. A trait for which a large component of its total variation is genetic in origin, is said to have a high heritability and will respond well to selection. Table 1 includes some typical heritability estimates for traits of economic importance. Also included are estimates of phenotypic variation.

Figure 1 graphically depicts the variation of a typical trait which follows the normal distribution curve. Most of the animals are concentrated around the mean

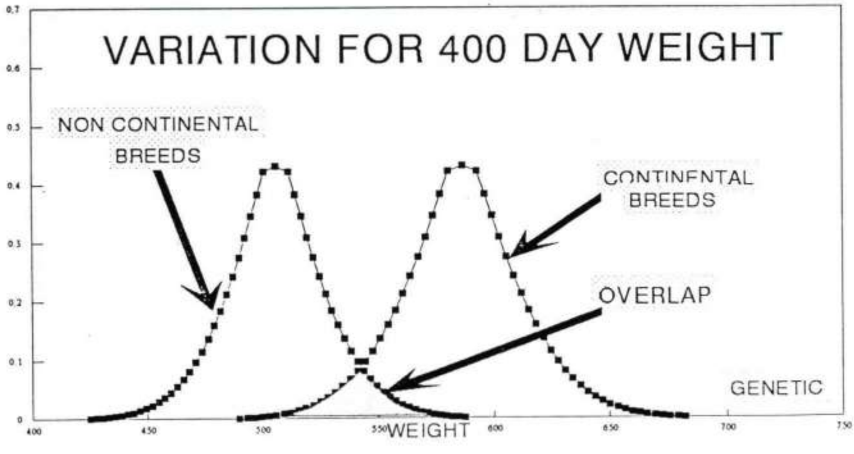

Fig. 2

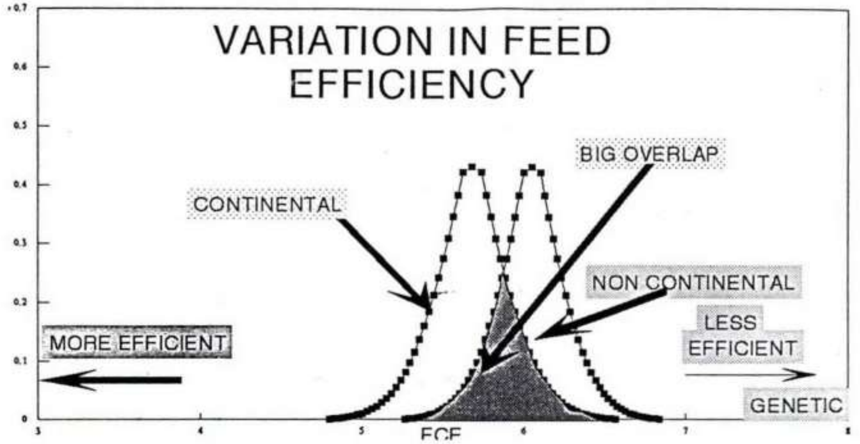

Fig. 3

or average. Variation in a trait is usually expressed in units of standard deviation. An animal whose value for a trait is over one standard deviations from the mean comes from the top 15% of the population. Similarly 66% of the population of animals will lie between plus and minus one standard deviation from the mean of the population. Thus for each trait, all breeds will have means and standard deviations which may be different from each other.

Figures 2 and 3 compare 400 day performance test final weights and food conversion efficiency respectively, averaged for the continental and non-continental breeds. Differences in genetic variation and means are highlighted in these figures. It is important to note that there is a significant area of overlap between the two distributions. This overlap demonstrates that there are significant numbers of animals in the breed with higher mean values which are genetically poorer than a large proportion of animals in the breed of lower mean value. The message would be that once having selected a breed, then select the best from within that breed for economic worth.

Genetic improvement

Genetic improvement is primarily concerned with selection for traits of economic importance. The response to selection is given by the following formula.

Response = Intensity X Heritability X Standard deviation ($ih^2\sigma p$)

Luckily the traits of economic importance are highly heritable and have significant levels of genetic variation. It is therefore under the breeders control to exploit this potential by applying intensive selection. His objective should be to produce animals which are likely to have a combination of genes which will maximise the efficiency and quality of overall production. He does this each season when he makes choices on what sires he will use to breed to his cows. These choices can have very important economic consequences for the beef farmer as they can significantly influence the final carcase value and costs of production of his beef enterprise. The opportunity for selection on the female side is limited because of the high replacement rates required simply to maintain the herd. This restriction does not apply on the male side especially where AI is used. Thus the farmer has much more discretion on what bulls he may use in his herd to sire the slaughter generation and thus exploit the genetic potential available to him.

Genetic evaluation

Over the last few decades but in particular the last fifteen years, the procedures by which the genetic merit or breeding value of a bull can be determined have improved dramatically. As stated, a bull's visual performance is a function of his genetic make-up and the environment in which he is managed. In order to make fair comparisons of the genetic merit of different bulls, corrections must be made for these non-genetic factors so that bulls can be compared on a standard basis.

A bull's breeding value can be estimated with varying degrees of accuracy using information from:-

– parents' performance;

– the animal's own performance (Performance Test Results);

– performance of progeny (Progeny Test Results).

Currently the Department of Agriculture and Food operates the national evaluation programme for beef cattle. This programme is carried out in co-operation with the breed societies and the AI stations. The important components of the programme are:-

- the on-farm weight recording scheme which records performance in pedigree herds;
- central performance testing in the Tully performance test station of young pedigree bulls selected mainly through the weight recording scheme;
- central progeny testing of bulls in AI centres for beef traits on the basis of the performance of random samples of their progeny and calving ease determined from a survey of over 200 calvings.

Beef trait and calving survey evaluations are published each spring while performance test results are reported at the end of each completed test at the central performance test station at Tully.

An ANIMAL MODEL BLUP (Best Linear Unbiased Predictor) system of genetic evaluation would allow the genetic value of bulls to be estimated more accurately. This is possible because the information on all relatives including their genetic relationships are built into the system. This allows performance records on all relatives to be used to estimate the breeding value of each individual. It is hoped to introduce such an animal model BLUP system here in the near future.

Selection for more than one trait

A farmer is generally interested in improving a number of traits at the same time. Thus some method of combining a bulls evaluation for the different traits

Table 1
Economic weights

Trait	Continental	Traditional
Final weight	£0.63.kg	£0.63/kg
Food conversion efficiency	£62.00/unit	£62.00/unit
Conformation score	£45.00/carcase	£38.00/carcase
Fat score	£23.00/carcase	£35.00/carcase

into a single figure is essential. Selection Index theory provides the solution to this problem. Using relative economic values, heritabilities and genetic and phenotypic correlations which relate traits together, an index of merit can be calculated. The use of a selection index significantly improves the rate of genetic progress in economic terms when compared to the alternative methods such as truncation selection. A new selection index for Tully Performance Tested bulls to be known as the BEEF MERIT INDEX will be published from January 1993.

Beef Merit Index for Tully performance tested bulls

In deriving the index, the most important economic traits to be improved were considered to be-

- final weight;
- food conversion efficiency;
- conformation score (EURO grading system);
- fat score (EURO grading system).

As the bulls are not slaughtered, conformation scores and fat scores must be estimated indirectly through other traits such as eye muscle area, fat area and muscling which are genetically related to them and can be measured directly. The traits therefore used to calculate the index are:-

- final weight;
- food conversion efficiency;
- eye muscle area (ultrasonic);
- fat area (ultrasonic);
- height;
- fleshing score.

In deriving the appropriate weights to apply to these traits, it was necessary to :-

- calculate the economic values for the traits to be improved (Table 1)
- estimate heritabilities, standard deviations and genetic and phenotypic correlations between the different traits (Table 2);
- apply selection index theory using the above economic values and parameter estimates to compute the weightings for the different traits.
- avoid the need for two main indices (ie one for measured traits and one for visual assessment) and so it was decided to include visual assessment in the overall beef merit index assigning it a weighting corresponding to 25% of the overall index variation.

Table 2
Genetic parameters used in deriving the Beef Merit Index

	FWT	FCE	EMA	FAT	HGT	MUSC	C.SCR	F.SCR
FWT	.4	-.4	.1	.1	.6	.25	0.0	0.0
FCE	-.44	.35	.0	.2	.0	-.4	.0	.3
EMA	-.1	.0	.4	-.3	.0	.5	.3(T) .6(C)	-.2
FAT	.1	.1	-.2	.4	.0	.0	.0(T) -.2(C)	.5
HGT	.6	.0	-.1	.0	.4	.0	.0	.0
MUSC	.4	-.3	.4	.0	.0	.3	.4(T) .6(C)	-.4
C.SCR	-	-	-	-	-	-	.25(T) .30(C)	.0 -.2
F.SCR	-	-	-	-	-	-	-	.3(T) .3(C)
VAR(σ^2)	2300 Kg.	0.249 Unit	21.0 sq. cm	1.7 sq. cm	10.5 cm.	4.2 Unit	0.207 EURO	0.312 & EURO

Note: Heritabilities on diagnonal, Genetic correlations above the diagonal and Phenotypic correlations below the diagnoal. (T) Traditional breeds, (C) Continental breeds.

- re-scale these weightings so that the index would have a mean (average) of 100 and a standard deviation of 10.

The following basis for calculating the overall index resulted.

BEEF MERIT INDEX = 100

+	0.073 X (RELATIVE FINAL WEIGHT - BREED MEAN)	(Kg)
-	8.592 X (RELATIVE FCE - BREED MEAN)	(Units)
+	0.120 X (HEIGHT - BREED MEAN)	(cm)
+	0.727 X (EYE MUSCLE AREA - BREED MEAN)	(Sq cm)
-	1.769 X (FAT AREA - BREED MEAN)	(Sq cm)
+	0.670 X (MUSCLING SCORE - BREED MEAN)	(UNITS)
+	0.596 X (VISUAL ASSESSMENT - BREED MEAN)	(UNITS)

The relative importance of final weight, FCE and beef quality traits and visual assessment in the beef merit index are approximately the same. In addition four sub-indices for growth, feed conversion efficiency, carcase merit and visual assessment score are calculated (Figure 4). These sub-indices allow the breeder to easily establish how good a bull is for each of the component traits. Bulls scoring 110 or greater for all indices are from the top 15% of the population and bulls scoring 90 or less come from the bottom 15% of the population.

AI Bull progeny test evaluations

AI beef progeny proofs are currently reported separately for growth rate, carcase conformation and carcase leanness. These proofs are expressed as relative breeding values. A bull having a relative breeding value of 110 for

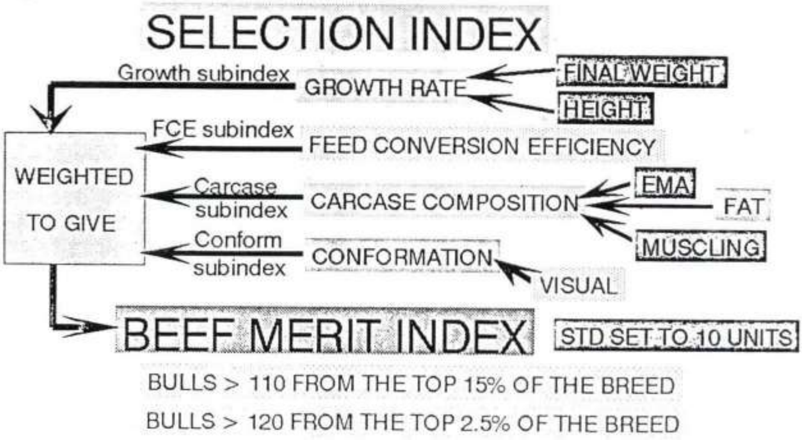

Fig. 4

growth rate will transmit half of this to his progeny thus increasing the average performance of his progeny by 5% of the mean for that trait.

Calving ease evaluations are also published for AI bulls. The figures are estimates of the values expected when the bulls are mated to Friesian cows. While in theory such evaluations could be included with other traits in a beef merit index, the determination of the economic cost of calving difficulties presents problems. Accordingly truncation selection is normally practised for ease of calving.

Summary

By choosing a bull from the top of its breed a producer can expect to increase his overall profitability by either reducing costs or increasing carcase value. A bull contributes half the complement of genes to its progeny. Thus a bull with a breeding value of plus 10% can be expected to produce progeny which on average will be 5% above the mean of the population. Such potential improvement in one or more traits offers a great opportunity for improved profitability in beef production. Use of the BEEF MERIT INDEX for performance tested bulls and individual breeding values for progeny tested bulls is therefore advocated in order to optimise genetic progress and maximise profitability.

Quality Control of Animal Feedingstuffs – Legislation

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1. INTRODUCTION

There have been significant changes in Irish feed legislation since we joined the EC in 1973. The legislation in force at that time was concerned primarily with the manufacture, marketing and labelling of straight and compound feedingstuffs and mineral mixtures. In the meantime practically all of this legislation has been replaced, and to a large extent supplemented, by various EC Directives and EC Regulations.

The main objective underlying EC legislation is to harmonise existing legislation within Member States in order to facilitate trade, while at the same time taking cognisance of the purpose for which the legislation was initially introduced (to provide information on quality and use, to prevent fraud or to protect animal and human health). The essential difference between a Regulation and a Directive is that a Regulation is binding in its entirety and directly applicable in all Member States, while a Directive is binding in each Member State as regards the result to be achieved but leaves the choice of form and methods to the national authorities. Hence, Member States have somewhat greater flexibility regarding the manner in which a Directive is enforced. All EC Directives on feedingstuffs are given effect in Ireland by means of national Regulations introduced under the European Communities Act, 1972 (S.I. No. 27 of 1972).

The intention of this paper is to provide an outline of our legislation governing the marketing of straight and compound feeds, feed additives, undesirable substances and products in feedingstuffs, bioproteins, medicated feeds and the heat treatment of poultry feed. The various national Regulations relating to animal feed are listed in Appendix 1.

2. MARKETING OF STRAIGHT AND COMPOUND FEEDINGSTUFFS

The Directives on the marketing of straight (77/101/EEC) and compound feeds (79/373/EEC) and subsequent amending Directives have been given effect in Ireland under a number of Regulations (7,12,14,23). This legislation deals essentially with the labelling of feedingstuffs; the aim being to provide farmers with accurate and meaningful information on the nature, use and analytical composition of the feedingstuff to the extent that this can be determined using methods of acceptable accuracy and precision.

2.1 Straight feedingstuffs

Scope of regulations

National legislation on straight feedingstuffs applies to all single feedingstuffs sold to farmers and also to materials sold as feed ingredients to compound feed manufacturers. The Directive, on the other hand, only applies to straight feedingstuffs sold to farmers. However, we availed of a derogation allowing Member States to adopt similar provisions for feed ingredients.

The Schedule to the Regulations contains a list of 152 materials authorised as straight feedingstuffs together with a description and the analytical parameters required or allowed on the label in each case. The particulars contained in the Schedule for eight of the more common straight feedingstuffs are set out in Appendix 2. Materials not listed may be marketed as straight feeds provided they comply with the general requirements applicable to all straight feedingstuffs, i.e. they must be wholesome, unadulterated and of merchantable quality, and must not be harmful to animal or human health or marketed in a manner liable to mislead.

Quality standards

Implementation of the composition requirements (min. crude protein, max. crude fibre, etc) set out in the Directive is optional to Member States. These were not incorporated in our national legislation as it was felt they could cause a significant increase in the price of straight feeds sold to farmers for home mixing. Community standards were however fixed for botanical purity (95%) and sand and silica, which is determined as ash insoluble in HCl (2% in DM). Materials sold to farmers may not exceed these levels but the standards may be exceeded in the case of feed ingredients, provided the level is declared on the label.

Labelling

A general feature of EC feed legislation is to prescribe not only the particulars which <u>must</u> be indicated on the official label but also those particulars which manufacturers <u>may</u> indicate. Other information is allowed on the bag provided it is clearly separated from the statutory information. In the case of bulk, the statutory information must be provided on a document accompanying each load.

The compulsory and optional labelling particulars are set out in Appendix 3. The names prescribed for straight feeds are intended to provide some indication as to quality and feeding value (e.g. partly-decorticated cotton seed expeller) and this name must be used if the material complies with the description given. Terms like "Fatty maize" are not acceptable.

The compulsory and optional analytical declarations vary depending on the material. In general, the main analytical parameters influencing the nutritional value of the feed must be indicated. For many feeds the full traditional chemical analysis is required (protein, oil, fibre and ash).

When declaration of an analytical parameter is required on a feed, the legislation always provides for a tolerance to allow for inherent variation in sampling and analysis and also some batch to batch variation. The analytical tolerances applicable to straight feeds are set out in Appendix 4.

2.2 Compound feedingstuffs

A licence is required to manufacture compound feeds and mineral mixtures for sale. To obtain a licence a manufacturer must have suitable premises and equipment and possess a reasonable knowledge of animal nutrition and the legislation governing the manufacture of feedingstuffs. Approximately 120 firms are currently engaged in the manufacture of compound feeds with about 10 specialising in the production of mineral mixtures/premixtures, mainly for licenced compounders.

The Regulations apply to compound feeds marketed for all domesticated animals including pets. Definitions of the various types of compound feeds are provided (complete, complementary, molassed feeds, mineral mixtures and milk replacers).

Labelling

All of the statutory particulars required or allowed on a compound feed must be indicated either in a display panel on the bag or on a label attached to the bag. In the case of bulk the particulars must always be provided on an accompanying document.

Details of the information required on the label are set out in Appendix 5. In addition to providing information for the farmer the indication of the type of feed has legal significance in determining acceptable levels for additives and, in some cases, tolerances for undesirable substances. Maximum dose levels for additives are fixed on the basis of complete feeds and these levels may be exceeded for complementary feeds but only in proportion to the amount of the feed in the daily ration. In this country compound feeds for pigs and poultry are usually complete feeds, while all compounds for ruminants are classed as complementary feeds.

Ingredient/category declarations

The declaration of ingredients in compound feeds has been a contentious issue, both at EC and national level, for a number of years. As far as control is concerned, the main difficulty is the analysis of samples with an acceptable degree of accuracy and precision. The standard laboratory technique used is microscopic analysis and years of experience is required to provide meaningful results. The Member States with most experience in this area are Denmark, Germany and the Netherlands since, for many years, their legislation required a quantitative declaration of all ingredients in a compound feed. However, a ring test, conducted by the Commission in 1987 to determine the competence of laboratories experienced in this area, gave very disappointing results. In the case of qualitative analysis, the majority of laboratories could detect all ingredients contained in the sample although some laboratories reported false negatives and, worse still, a few reported false positives. However, very variable quantitative results were reported, with errors of + 100% common for a large proportion of laboratories.

A compromise was subsequently reached between those Member States who supported a quantitative declaration of ingredients and those who opposed any declaration, whereby manufacturers must either declare each ingredient in descending order of its proportion by weight or declare the categories to which the ingredients belong. Categories of ingredients have recently been agreed at EC level and these apply in all Member States (Appendix 6). In drafting the categories, account was taken of the need to indicate the origin of the ingredients within a category and also provide some information on nutritive value. Nevertheless, the list is a compromise between proposals for as many as 21 categories and for as few as eight.

Cereals and oilseeds were each subdivided into processed whole seed and fractional products derived therefrom, as this was felt to be the most meaningful split for farmers. A maximum crude fibre standard of 25% was set for a number of categories in order to prevent the masking of ingredients of low nutritive value. Ingredients which fail to meet this standard fall within the category "High fibre materials" and must be declared as such. An exception was made, however, for ingredients which contain either high oil (> 5%) or relatively high crude protein (> 15%), as this was considered to compensate to some degree for the excess fibre. The standard for crude ash (50%) in the categories "Land animal products" and "Fish products" is intended to divert ingredients with excess ash into the category for minerals. Minerals containing more than 5% sand and silica must be declared separately. This also applies to any ingredient used which does not fit into one of the established categories.

Analytical declarations

The analytical declarations required and allowed on compound feeds are set out in Appendix 7. In addition to the normal proximate analysis for all compound feeds, lysine is required on pig feeds and methionine on poultry feeds. The declaration of magnesium above 0.5% is intended to provide information on the suitability of the diet to prevent grass tetany and this should be expressed as total elemental magnesium.

Energy declarations

Although discussions started in the early 80's on the adoption of a harmonised Community system for declaring energy in compound feeds for poultry, pigs and ruminants, to date agreement has only been reached on a model for poultry. Some progress was made in developing an equation for pigs but discussions were abandoned by the Commission several years ago due to priorities in other areas and lack of resources. A common system for ruminants was never discussed in any depth and we are unlikely to see much if any progress in this area for several years, considering the current legislative position whereby Member States may adopt their own national systems for labelling purposes.

While declaration of energy on poultry diets is optional for manufacturers, any declaration made must be in accordance with the EC system (Appendix 8). For pigs and ruminants, the Directive provides for an optional declaration of energy, estimated in accordance with official national methods. Since no official methods have been incorporated in our national legislation (24), this means that it is illegal in this country to declare energy on the feed label for these species. The legislation does not however prevent manufacturers from referring to the energy content of their diets in advisory or promotional literature.

The EC poultry equation (Appendix 8) is the result of pooled data on 189 compound feeds fed to adult birds at five poultry research centres (DK, G, F, NL & UK). The low residual standard deviation (rsd) indicates the precision with which the equation predicts the in *vivo* ME of the trial diets, while the co-efficient of determination (R^2) indicates the high proportion of the total variation in the *in vivo* ME accounted for by the equation. The absence of an intercept has the advantage that the equation can be applied equally to data on a dry matter as well as an "as fed" basis.

Tolerances

The tolerances to be applied to analytical data on compound feeds are set out in Appendix 9. Unlike straight feedingstuffs, tolerances are fixed in both directions i.e. when the amount found on analysis is greater than or is less than the declared content. However, except for energy, the magnitude of the tolerance is not the same in both directions; tolerances for deviations of less nutritional significance (e.g. low crude fibre) are set at 2 or 3 times the equivalent tolerance in the opposite direction.

Prohibited ingredients

Our national list of prohibited ingredients has been replaced by an EC list (Appendix 10). For a material to be included in the EC list it must pose a risk for animal or human health. Very low nutritive value is no longer adequate grounds to prohibit a material.

3. FEED ADDITIVES

The additives which may be used in feedingstuffs and their conditions of use are specified in the Regulations (15, 20) giving effect to the Council Directive on additives in feedingstuffs (70/524/EEC). Community legislation in this area has reached a good degree of harmonisation, since Member States may only allow the use of additives specifically listed in the Annexes to the Directive and then only subject to the conditions laid down. To obtain authorisation in the Directive, a manufacturer must compile a dossier in accordance with established guidelines, setting out the identifying characteristics of the additive and the studies undertaken to demonstrate efficacy and safety for the target species, consumers and the environment. An additive is only approved following a rigorous assessment of this data at EC level.

Categories of additives

The various types of feed additives authorised under the Regulations are listed in Appendix 11. The inclusion of medicinal additives (growth promoters and antibiotics for growth promotion purposes, coccidiostats and anti-blackhead drugs) in the same list as nutritional and technological additives may appear artificial at first sight, given their similarity to medicinal substances used for prophylactic and therapeutic purposes. However, they were included in the Directive, which was the first piece of feed legislation adopted at Community level, due to their widespread use in animal feed and the absence of Community legislation on medicated feedingstuffs. The technological additives authorised have much greater significance in the manufacture of pet foods than in normal compound feeds for farm animals, with the possible exception of milk replacers.

Conditions of use

The conditions of use for the various categories of additives varies depending on the possible effects of misuse and the need to protect animal and human health. Hence, strict conditions of use are specified for all medicinal additives which include the category of animal for which the additive is authorised, the maximum age to which the additive may be fed, minimum and maximum dose levels and withdrawal periods where necessary. On the other hand, most technological additives are allowed without any restrictions on use. The situation is somewhat intermediary for nutritional additives (trace elements and vitamins).

Where minimum/maximum dose levels are laid down, these are fixed on the basis of the complete feed. Higher dose levels are allowed for complementary feeds, provided the feeding rate is specified on the label and the amount of the additive in the total daily ration does not exceed the level fixed for complete feeds.

The mixing of additives, with the exception of medicinal additives, from the same category or different categories is allowed provided the components are physically and chemically compatible. Medicinal additives within a category may not be mixed unless the mixture is specifically authorised in the Regulations (Two or more growth promoters or two or more coccidiostats, etc.).

Minimum conditions for the manufacture of medicinal additives, and also premixtures and compound feeds containing medicinal additives, are set out in Schedule 3 to the Regulations. Depending on the type of product, manufacturers must have suitable premises and equipment and employ trained staff. A monitoring programme adequate to ensure the identity, dose level, homogeneity and stability of the medicinal additives used, must be undertaken. Stability testing is not required for compound feed manufacturers. Medicinal additives and premixtures must be stored in a manner which facilitates identification and avoids confusion between batches and in a dedicated area of the plant which is locked when not in use. Detailed records covering the intake of raw materials and the manufacture and distribution of all products must be maintained.

A licencing system has been introduced for manufacturers who comply with these requirements. This system facilitates the distribution of medicinal additives which may only be supplied to premix manufacturers and, when incorporated in a premixture, to licenced compound feed manufacturers. Medicinal additives or premixtures containing medicinal additives may not be supplied to farmers.

Labelling

Detailed labelling requirements are laid down for additives, premixtures and compound feeds. In the case of additives and to a lesser extent, premixtures, the level of all active substances must be declared. The requirements for the declaration of additives in compound feeds are set out in Appendix 11. The level to be declared is the amount of active substance added to the feed. Normally this will be the total amount present except in the case of trace elements and vitamins which occur naturally in feed ingredients. For these nutrients the declared amount should be interpreted as the minimum amount present.

4. UNDESIRABLE SUBSTANCES AND PRODUCTS

The Regulations in this area (16, 19, 22) cover a range of substances and products that occur naturally in feed ingredients but which can endanger animal health, or human health due to their presence in livestock products. Since such substances cannot be totally eliminated from feedingstuffs, their presence is tolerated at levels known to be safe or, failing this, at the level of determination of the analytical method.

Maximum permitted levels are fixed for straight and compound feeds in respect of each of the substances and products set out in Appendix 12. Unlike the marketing Regulations, the term straight feeds only applies to materials sold to farmers. Feed ingredients for the compounding industry are not covered with the exception of aflatoxin B_1 in specified ingredients (200ppb) and cadmium in phosphates (15ppm). However, discussions are in progress with a view to adopting harmonised Community provisions for feed ingredients. At this stage it appears that, rather than fixing tolerances as was done for straight feeds, a declaration of the content in the ingredient will be required when it exceeds the tolerance fixed for the corresponding straight feed.

Normally the compound feed industry has little difficulty in complying with the tolerance levels laid down. However, in the case of aflatoxin B1 great care needs to be taken with certain feed ingredients to ensure compliance with the tolerances, particularity in dairy rations (5ppb). This tolerance is set at a very low level in order to minimize residues of the metabolite M_1 in milk, as this metabolite has been shown to be carcinogenic in laboratory animals.

5. NEW SOURCES OF PROTEIN

These Regulations (13, 18) give effect of the provisions of Council Directive 82/471/EEC which deals with non-traditional sources of protein use in animal nutrition. The Directive was adopted in the early 80's, primarily to control the marketing and use of single cell proteins (SCP) in animal feeds. In the 70's the high price of soya and other traditional protein sources stimulated considerable expenditure in research and development on SCP's. However, the price differential dropped significantly in the 80's leaving SCP's uncompetitive although the technology is now available to produce these products on a commercial scale should this become economic.

The basic provisions in this Directive are quite similar to those for additives in that only products listed in the Annex may be authorised for use in Member States. Manufacturers must demonstrate the efficacy and safety of their products to obtain authorisation in the Directive.

Products which fall within the scope of the Regulation are SCP, non-protein nitrogenous (NPN) compounds (e.g. urea and ammonium salts), by-products high in NPN and amino acids. The only SCP to obtain approval so far is the BP product "Pruteen". However, this product has never been marketed commercially for economic reasons. Similarly the use of NPN compounds in ruminant nutrition has disappeared in recent years due mainly to the relatively low price of vegetable proteins. Amino acids are the only products authorised which are currently used by the compound feed industry. Several sources of methionine, lysine, threonine and tryptophan have been approved and also two hydroxyanalogues of methionine.

6. MEDICATED FEEDS

Although the Directive on medicated feeds (90/167/EEC) has not yet been incorporated in our national legislation, it is possible at this stage, due to the nature of its provisions, to outline the main requirements as they will apply in Ireland.

1. Compound feed manufacturers will require a licence to manufacture medicated feeds. To obtain a licence, manufacturers must comply with minimum conditions similar to those already indicated for medicinal additives.
2. Only authorised medicated pre-mixtures may be used to manufacture medicated feeds and only in accordance with the conditions on the product licence. Member States still retain the right to evaluate and approve medicated pre-mixtures; the National Drugs Advisory Board is the competent authority in Ireland.
3. A medicated feedingstuff may only be supplied to a farmer on presentation of a veterinary prescription which is only valid for one treatment. A veterinarian may only issue a prescription for animals under his professional care and only in respect of such quantities of feed as are necessary for the purposes of the treatment, subject to any maximum amount specified in the product licence.
4. Medicated feedingstuffs must be supplied directly from the manufacturer to the farmer and, in the case of productive animals, the quantity must not exceed that specified in the prescription and the material must not be supplied in batches exceeding one months requirements.

7. HEAT TREATMENT OF POULTRY FEED

An Order (21) was introduced recently, under the Diseases of Animals Act, 1966, requiring the heat treatment of all feedingstuffs marketed for poultry. Introduction of the Order was prompted by the recent outbreak of Newcastle Disease and the opportunity was also taken to introduce standards for potentially pathogenic microorganisms (Salmonella and Enterobacteriaceae).

Essentially all poultry feed must be heat treated to a minimum temperature of 75°C for one minute at the core. In addition to the requirement to install automatic monitoring and recording equipment, most poultry feed manufacturers will need to modify existing pelleting equipment to achieve this standard.

Provisions intended to ensure hygienic storage, handling and distribution of poultry feeds have also been introduced, together with standards for Salmonella (absent in 25g sample) and Enterobacteriaceae (maximum of 300 in 1g sample)

Appendix 1

LEGISLATION ON ANIMAL FEEDING STUFFS

1. Fertilisers, Feeding Stuffs and Mineral Mixtures Act 1955
   No 8 of 1955
2. Fertilisers, Feeding Stuffs and Mineral Mixtures Regulations, 1957
   SI 264 of 1957
   (All Regulations pertaining to Feeding Stuffs and Mineral Mixtures repealed, except Reg 13 - licences)
3. Animal and Poultry Feeding Stuffs and Mineral Mixtures (Control of Arsenic) Regulations, 1972
   SI 124 of 1972
4. European Communities (Feeding Stuffs) (Methods of Analysis) Regulations, 1978
   SI 250 of 1978
5. European Communities (Feeding Stuffs) (Methods of Analysis) (Amendment) and (Methods of Sampling) Regulations, 1980
   SI 14 of 1980
6. European Communities (Feeding Stuffs) (Methods of Analysis) (Amendment) Regulations, 1982
   SI 261 of 1982
7. European Communities (Marketing of Feedingstuffs) Regulations, 1984
   SI 200 of 1984
8. European Communities (Feeding Stuffs) (Method of Analysis) (Amendment) Regulations, 1985
   SI 16 of 1985
9. Poisons (Control of Residues in Foods of Animal Origin) Regulations, 1985
   SI No 257 of 1985
10. Animal Remedies (Control of Sale) Regulations, 1985
    SI No 258 of 1985
11. Poisons (Control of Residues in Foods of Animal Origin) (Amendment) Regulations, 1986
    SI No 236 of 1986
12. European Communities (Marketing of Feedingstuffs) (Amendment) Regulations, 1986
    SI No 262 of 1986
13. European Communities (Protein Feedingstuffs) Regulations, 1986
    SI 433 of 1986
14. European Communities (Marketing of Feedingstuffs) (Amendment) Regulations, 1988
    SI 249 of 1988
15. European Communities (Additives in Feeding Stuffs) Regulations, 1989
    SI 49 of 1989
16. European Communities (Feeding Stuffs) (Tolerances of Undesirable Substances and Products) Regulations, 1989
    SI 216 of 1989
17. Diseases of Animals (Bovine Spongiform Encephalopathy) (Amendment) (No 3) Order, 1990
    S I No 196 of 1990
18. European Communities (Protein Feedingstuffs)(Amendment) Regulations, 1991
    SI No 195 of 1991
19. European Communities (Feeding Stuffs) (Tolerances of Undesirable Substances and Products) (Amendment) Regulations, 1991
    S I No 241 of 1991
20. European Communities (Additives in Feedingstuffs) (Amendment) (No 2) Regulations, 1991
    SI No 345 of 1991
21. Diseases of Animals (Poultry Feed) Order, 1991
    SI No 364 of 1991

Appendix 1 - contd.

22. European Communities (Pesticide Residues) (Feedingstuffs) Regulations, 1992
    SI No 40 of 1992
23. European Communities (Marketing of Feedingstuffs)
    (Amendment) Regulations 1992
    (To be published)

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Appendix 2

Names and Analytical Declarations for Straight Feedingstuffs and Feed Ingredients

Name of feedingstuffs	Compulsory declarations (As fed basis)	Optional declarations (As fed basis)
Maize gluten feed	Moisture ≥ 13% Crude protein Crude oil and fat Crude fibre Crude ash	Moisture < 13%
Wheat feed	Moisture ≥ 14% Crude fibre Starch Crude ash	Moisture < 14%
Wheat midlings	Moisture ≥ 14% Starch Crude fibre Crude ash	Moisture < 14%
Extracted toasted soya	Moisture ≥ 12.5% Crude protein Crude fibre Crude ash	Moisture < 12.5% Crude oil and fat
Partly-decorticated cotton seed expeller	Moisture ≥ 12% Crude protein Crude fibre Crude oil and fat Crude ash	Moisture < 12%
Extracted, partly-decorticated groundnut	Moisture ≥ 12.5% Crude protein Crude fibre Crude ash	Moisture < 12.5% Crude oil and fat
Meat and bone meal	Moisture ≥ 10% Crude protein Crude oil and fat Crude ash Total Phosphorus	Moisture < 10% Chlorides expressed as NaCl Methionine Lysine Volatile nitrogenous bases
Fish meal (products whose chloride content, expressed as NaCl, is less than 2% may be referred to as "low in salt")	Moisture ≥ 10% Crude protein Crude oil and fat Calcium carbonate Total phosphorus Chlorides expressed as NaCl	Moisture < 10%

Appendix 3
Labelling Particulars for Straight Feeds

Compulsory	*Optional*
The words "Straight Feedingstuffs" (except feed ingredients)	Trade mark
	Batch No
Name, as prescribed in the Regulations	Directions for use
Analytical declarations	Analytical declarations
	Shelf life
Net Weight	
	Country of origin
Name and address of the person responsible for the labelling particulars	
	Price

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Appendix 4
Tolerances for Straight Feeds and Feed Ingredients

Analytical Constituent	Declared Content	Tolerance	
		Down	Up
Moisture	> 10% 5 - 10% < 5%		1% unit 10% of declaraticn 0.5% unit
Crude protein	> 20% 10 - 20% < 10%	2% units 10% of declaration 1% unit	
Crude oil and fat	> 15% 5 - 15% < 5%	1.8% units 12% of declaration 0.6% unit	
Crude fibre	> 14% 6 - 14% < 6%		2.1% units 15% of declaration 0.9% units
Ash	> 10% 5 - 10% < 5%		1% unit 10% of declaration 0.5% unit
Calcium Phosphorous Sodium Magnesium Calcium carbonate	 > 15% 2 - 15% < 2%	Ca, P, Na, Mg 1.5% unit 10% of declaration 0.2% unit	Calcium carbonate 1.5% unit 10% of declaration 0.2% unit
Ash insol. in HCl NaCl	> 3% < 3%		10% of declaration 0.3% unit
Lysine Methionine Cystine	All	20% of declaration	
Total sugars Reducing sugars Sucrose Glucose Total solid	> 20% 5 - 20% < 5%	2% units 10% of declaration 0.5% unit	

Appendix 5

Labelling Particulars for Compound Feeds

Compulsory	Optional
Type of feed (Complete, complementary, etc)	Trade mark or trade name of responsible person
Category of animal	Name and address of manufacturer
Intended use	Batch No
Directions for use	County of Production
Ingredients (individually or by category) (see Appendix 6)	Price
Analytical constituents (see Appendix 7)	Analytical constituents (see Appendix 7)
Net weight	Physical condition and processing undergone
Shelf life	Date of manufacture
Batch No or date of manufacture	
Name and address of person responsible for labelling	

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Appendix 6

Categories of Ingredients which may be indicated in place of individual ingredients when labelling compound feeds intended for animals other than pets

	Category	Definition
1.	Cereal grains	Products from whole cereals with no fraction removed except hulls.
2.	Cereal grain products and by-products	Fractional products and by-products, except oils, with < 25% CF in DM
3.	Oil seeds	Products from whole oil seeds with no fraction removed except hulls
4.	Oil seed products and by-products	Fractional products and by-products with ≤ 25% CF in DM except materials with > 5% oil or > 15% CP in DM
5.	Products and by-products of legume seeds	Whole and fractional products and by-products with ≤ 25% CF in DM
6.	Products and by-products of tubers and roots	Products and by-products from tubers and roots, except sugar beet, with ≤ 25% CF in DM
7.	Products and by-products of sugar production	Products and by-products from sugar beet and sugar cane with ≤ 25% CF in DM
8.	Products and by-products of fruit processing	Products and by-products from fruit processing with ≤ 25% CF in DM except materials with > 5% oil or > 15% CP in DM

Appendix 6 - contd.

9. Dried forages	Dried green forage plants with ≤ 25% CF in DM except materials with > 15% CP in DM
10. High fibre materials	Feed ingredients with > 25% CF in DM
11. Milk products	All products except fat
12. Land animal products	Slaughterhouse waste except fat and materials with > 50% ash in DM
13. Fish products	Processed whole or parts of fish except oil and materials with > 50% ash in DM
14. Minerals	Ingredients with > 50% ash in DM except materials with > 5% sand and silica in DM
15. Oils and fats	All products and derivatives
16. Products from the bakery and pasta industries	Waste & surplus materials

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Appendix 7
Analytical Declarations for Compound Feeds

Feedingstuff	Analytical constituent	Compulsory declaration (as fed basis)	Optional declaration (as fed basis)
All Compound feedingstuffs except:	Moisture > 14%	All animals	
	< 14%		All animals
- Mineral mixtures - Protein concentrates - Molassed feeds	Crude protein) Crude oil) Crude fibre) Crude ash)	Farm animals + dogs and cats	) Pets other) than dogs and) cats
	Lysine	Pigs	Other animals
	Methionine	Poultry	Other animals
	Cystine	-	All animals
	Threonine	-	All animals
	Tryptophan	-	All animals
	Energy	-	Poultry (Appendix 8)
	Starch		)
	Sugar (as sucrose)	-	)
	Starch + Sugar	-	)
			) All animals
	Calcium	-	)
	Phosphorous	-	)
	Sodium	-	)
	Potassium	-	)
	Magnesium > 0.5%	Ruminants	Other animals
	< 0.5%	-	All animals

Appendix 8

EC System for Estimating Metabolisable Energy in Compound Feeds for Poultry

ME_n (MJ/kg DM) = 0.1551 CP% + 0.3431 EE% + 0.1669 ST% + 0.1301 SU%
rsd 0.315, CV 2.4%, R^2 0.975

Tolerance

± 0.4 MJ of the declared value

Sampling and Analysis

Official methods of sampling and analysis must be used. In the case of ether extract and starch (two official methods) the following methods must be used.

Ether Extract: method B (acid hydrolysis of the sample). Starch: Polarimetric method

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ME_n = Apparent metabolisable energy corrected to zero nitrogen retention

CP = Crude protein

EE = Petroleum ether extract following acid hydrolysis

ST = Starch

SU = Total sugar, expressed as sucrose

rsd = residual standard deviation

CV = Coefficient of variation

R^2 = Coefficient of determination or percentage fit

Appendix 9
Tolerances for Compound Feeds Except for Dogs and Cats

Constituent	Declared Content	Tolerance	
		Down	Up
Moisture	> 10%		1% unit
	5 - 10%		10% of declaration
	< 5		0.5% unit
Crude protein	> 20%	2% units	)
	10 - 20%	10% of declaration	) 2X[1]
	< 10%	1% unit	)
Crude oil and fat	> 15%	1.5% units	)
	8 - 15%	10% of declaration	) 2X
	≤ 8%	0.8% unit	)
Crude fibre	> 12%	(	1.8% units
	6 - 12%	3X (	15% of declaration
	< 6%	(	0.9% unit
Crude ash	> 10%	(	1.0% unit
	5 - 10%	3X (	10% of declaration
	< 5%	(	0.5% unit
Ash insoluble in HCl	> 10%		1% unit
	4 - 10%		10% of declaration
	< 4%		0.4% unit
Calcium	> 16%	1.2% units	)
Phosphorus	12 - 16%	7.5% of declaration	)
	6 - 12%	0.9% unit	) 3X
	1 - 6%	15% of declaration	)
	< 1%	0.15% unit	)
Magnesium	> 15%	1.5% units	)
Sodium	7.5 - 15%	10% of declaration	)
	5 - 7.5%	0.75 unit	) 3X
	0.7 - 5%	15% of declaration	)
	< 0.7%	0.1 unit	)
Lysine	All	15% of declaration	
Methionine	All	15% of declaration	
Cystine	All	20% of declaration	
Starch (ST)	> 25%	2.5% units	)
ST + SU	10 - 25%	10% of declaration	) 2X
	< 10%	1% unit	)
Sugar (SU)	> 20%	2% units	)
	10 - 20%	10% of declaration	) 2X
	< 10%	1% unit	)
Metabolisable energy (Poultry)	all	0.4 unit	0.4 unit

[1] Twice the appropriate tolerance in the opposite direction.

Appendix 10

EC List of Prohibited Ingredients

- Faeces, urine and digestive tract contents whether processed or not
- Leather and leather waste
- Dressed seed and any derived by-products
- Sawdust from treated wood
- Sewage sludge.

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Appendix 11

Categories of Feed Additives and Compulsory Declarations for Compound Feeds

Category of Additive	Declaration
Growth promoters	Name, amount, expiry date and conditions of use (withdrawal period, etc)
Coccidiostats and anti-blackhead drugs	Name, amount and conditions of use (withdrawal period, etc)
Vitamins	A, D, E; Name, amount, expiry date
Trace elements	Copper; amount added
Antioxidants	Name of active substance
Colourants	Name of active substance
Preservatives	Name of active substance
Flavours and sweeteners	None
Emulsifiers, stabilizers, thickeners and gelling agents	None
Binders, anti-caking agents, coagulants	None
Acidity regulators	None

Appendix 12

Controlled Undesirable Substances and Products and Main Sources of Contamination

Substance/Product	Main Source
Arsenic	Phosphates
	Fish meal
Lead	Phosphates
	Dried forages
Fluorine	Phosphates
Mercury	Fish meal
Nitrites	Fish meal
Cadmium	Phosphates
Aflatoxin B_1	Groundnut
	Cottonseed
	Maize
	Palm kernel
Hydrocyanic acid	Linseed
	Manioc
Free Gossypol	Cottonseed
Theobromine	Cocoa by-products
Volatile mustard oil	Rape seed
Vinylthio oxazolidone	Rape seed
Ergot	Cereals
Caster oil plant	Vegetable proteins
Crotalaria spp	
Toxic weed seeds	Rape seed
	Soya bean meal
Organochlorines (12 compounds)	Cereal by-products (3rd World Countries)

Control of Cattle Diseases with Emphasis on Respiratory Infections

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With the advent of outbreaks of major diseases in Europe, particularly during the 18th and 19th centuries, a system of controlling the entry of animals onto this island was initiated. Movement of cattle was limited and Britain was the main source of what few cattle were imported. In the nineteen sixties a quarantine station on Spike Island in Cork harbour was brought into use to hold and investigate cattle from mainland Europe prior to their entry into the national herd.

While this system of control of importation of animals by quarantine and import test requirements may have been considered to have been disruptive by some people, in general it protected the animals in the country from major diseases. Diseases such as contagious bovine pleuropneumonia, rabies and foot and mouth disease, which occur in mainland Europe at present, have not occurred in Ireland since 1892, 1903, and 1941 respectively. Undoubtedly the operation of an import control system has played its part in saving cattle in this country from these scourges.

Arrangements for the completion of the Internal Market of the EC were finalised on December 31, 1992. Included in this objective of the Single European Act is the free movement of animals and animal products. It is intended that animals and animal products should move freely within the community. However, this free movement will be subject to exemptions on the grounds of public and animal health risks.

The animal health risks are based on disease classifications agreed by the members states. Currently the Commission' s classification of diseases may be divided into three categories. In the first category there are diseases like Foot and Mouth disease and Rinderpest. Such diseases will be compulsory notifiable, emergency measures (such as a slaughter policy) will apply for their control and the EC will pay 50% of the cost of controlling outbreaks. In the second classification there are diseases such as Brucellosis, Leucosis, and Johnes disease. These diseases are subject to mandatory or voluntary control and financial contributions from the Community can be made available when National Eradication/Control programmes have been approved. The third classification is an unwritten one which includes all other diseases which occur commonly in the European cattle population.

Due to the advent of the single market the emphasis is now changing from national controls over the import of animals to one of control exercised by an individual farmer or group of farmers. The EC legislation will require evidence of freedom from the diseases listed in category one and most of the diseases in category two, if animals are to be moved to another country. However, control of the diseases associated with the third classification and some of the diseases in the second category will be the responsibility of the individual farmer or group of farmers but not the national authority. This means that farmers can set their own criteria for animal health requirements and insist on the highest health standards if they so wish. As a minimum the agreed "code of practice" for the importation of animals should be adhered to in order to reduce the risks of importing diseases into the country.

There is evidence that some "non-notifiable" diseases (i.e. some in category 2 and 3) exist in more severe forms in other European countries. Such diseases may cause an enormous financial loss if they were introduced and caused outbreaks of disease in cattle in this country. Each individual farmer or group of farmers will need to adopt their own mechanisms to prevent this occurring. This may be best appreciated by considering the possible defence mechanisms of the farm and the individual animal.

The defence mechanism of a farm will rest on importation of animals into the farm which have been shown to be clear of a number of diseases after having been tested for the same; and/or by a quarantine system for the farm. This system mirrors the national defence system that was in operation up to this year.

An individual animal's defence or protection mechanism is based on its immune system. The immune system is involved in killing invading organisms and is based primarily on antibodies although some specialised cells may also have a role to play.

Vaccination

If an animal is totally immune to a particular organism it will withstand infection with that organism whether this is a parasite, a bacterium or a virus. There are different broad general types of immunity. Innate immunity may be related to a species. For instance horses do not suffer from foot and mouth disease although they may be grazing next to infected cattle, and cattle themselves do not suffer from myxomatosis. Passive immunity is the type of immunity that animals receive in colostrum where antibodies from the mother protect the young. The treatment with specific antisera may act similarly such as is the case with tetanus antiserum. Active immunity is the response of an animal itself to a challenge with a "foreign" organism either in the natural state or in a modified form in a vaccine. Some forms of active immunity may be developed in hours whereas other forms may take 2 weeks or more. While natural exposure to organisms may effectively protect animals (if they do not succumb to severe disease) vaccination is less random in that one will know that the animals are really exposed and more likely to be protected.

Nowadays many different forms of vaccines are available in Ireland. There are vaccines against different agents, like parasites, bacteria and viruses. While traditionally only killed vaccines were available, live vaccines are also available presently. The route of vaccination also may vary, some vaccines are given via the traditional intramuscular or subcutaneous routes, while more recently vaccine administration through the oral or intranasal routes have become more common for vaccines aimed to protect the digestive or respiratory systems. Vaccines developed through sophisticated technological procedures in laboratories - genetic engineering - will play a more important role in disease control in the future. Such vaccines, produced by selecting only parts of the organisms in a laboratory may be able to confer immunity on animals without the danger of causing disease. Likewise by using sophisticated carrying agents it may be possible to enhance the effectiveness and protective nature of some vaccines. An example of the latter is the very successful use of a virus - the vaccinia virus - to carry parts of another virus - rabies into foxes - thus vaccinating them and so assisting in the elimination of rabies from parts of Europe in which it was endemic. Likewise, vaccines based on altered organisms having detectible markers which allow their effects to be distinguished from those caused by naturally occurring organisms will be used more often in disease elimination programmes.

Traditionally the main criterion for licensing a vaccine was safety; presently and more so in the future, efficacy will become more important for vaccines to be licensed in the EC. Although safety will still be a primary criterion such efficacy requirements will be aimed towards long duration of immunity, protection against a range of closely related organisms, evidence of the vaccine working in the field and having an economic advantage. These criteria together with convenience of use will be high on a users agenda. Such efficacy requirements will make it more difficult to have vaccines licensed as companies will need greater expenditure to prove some of these attributes and if the criteria are too strict then it may not be worthwhile for pharmaceutical companies to invest in vaccine production.

Irrespective of how efficacious vaccines are, they should never be considered as a substitute for good animal husbandry.

Generally disease results from the interaction of a susceptible animal, a poor environment and disease causing organisms. The importance of the combination of susceptible animals, poor environment and amount of pathogens in the environment cannot be overemphasised in relation to a disease associated with many different factors like respiratory disease.

While vaccination reduces the possibilities of animals being susceptible to particular disease causing organisms, environmental factors and the organisms need further consideration.

Environmental factors

If we consider the animal's environment in relation to respiratory disease we must accept that concentrating animals into a small space and housing them for prolonged periods is unnatural. In some countries it is the practice to gather cattle in large numbers outdoors. This practice undoubtedly increases the numbers of pathogens affecting the respiratory system in the immediate environment of the animals. If natural air currents do not dilute or eliminate such pathogens from the immediate environment then a build-up of pathogens is likely to ensue and disease may result. If animals are put in an enclosed air space with poor ventilation, either due to the intrinsic properties or siting of the housing or due to climatic factors, then there are greater possibilities for the build up of pathogens affecting the respiratory system. We have reported that a period of low or no air movement may be associated with outbreaks of respiratory disease in housed cattle (Gunn & Wilson, 1991). Periods of low or no air movement associated with mild temperatures put a strain on the ventilation systems of cattle sheds which are based on natural ventilation. This system of ventilation is based on differential temperatures within the shed being higher than those on the outside, thus causing convection currents to enforce air changes within the sheds. When such climatic conditions occur sheds that may have construction defects, from an air circulation point of view or placed in a sheltered area, may have such poor air change rates that a build up of respiratory pathogens may be inevitable in the unit.

If global warming continues as expected , the mean temperature of the earth will increase by 2°C by the year 2050. This increase in mean temperature will result in higher ambient winter temperatures and probably even put more "strain" on sheds having ventilation systems based on convection currents.

So while cattle in poorly structured sheds will always be likely to be exposed to higher concentrations of respiratory pathogens than those in sheds with better ventilation, uncontrollable climatic factors may also predispose cattle in well built sheds to increased concentrations of respiratory pathogens.

Respiratory disease

The term respiratory disease is used to describe infections of any part of the respiratory system whether it be in the nose (rhinitis), larynx (laryngitis), windpipe (tracheitis), bronchi (bronchitis), bronchioles (bronchiolitis, alveoli (alveolitis) and pleura (pleuritis). Pneumonia refers to inflammation of the lungs resulting from infection of the bronchi, bronchioles and alveoli only. Classification of respiratory disease may be made on an age basis e.g. calf pneumonia, the damage caused to the lungs e.g. cuffing pneumonia, or on an agent basis e.g. hoose pneumonia etc. Classifying the condition on an agent basis is valuable as it may allow us to do something about controlling the agents and hence the condition. The common agents involved in respiratory disease in cattle in Ireland may be considered under the headings of parasites, bacteria, mycoplasma and viruses.

The role of the parasite that causes hoose in cattle cannot be underestimated, as it is still a very common cause of pneumonia in cattle. Bacteria and mycoplasma are frequently associated with respiratory disease in Ireland and in other countries and pasteurella infections may be associated with viral infections in the condition termed "shipping fever". The three viruses most commonly associated with respiratory disease in Ireland are Infectious bovine rhinotracheitis (IBR), bovine parainfluenza three (PI3) and bovine respiratory syncytial virus (RSV) although other viruses such as bovine adenovirus three, rhinoviruses etc. may also affect Irish cattle. It is possible to treat parasitic and bacterial causes of respiratory disease with anthelmintics and antibiotics respectively. In general, antibiotics may be used to kill a broad spectrum of bacteria associated with respiratory disease but they do not have any direct effects on viruses. It is not practically possible to treat cattle for viral diseases; for this reason vaccination for preventative purposes is required. However in general, vaccination has to be aimed at specific viruses that are associated with an outbreak of respiratory disease.

We have developed techniques at the Veterinary Research Laboratory at Abbotstown to detect viral infections associated with respiratory disease which are more rapid and frequently more specific than previously available techniques. They also allow us to define viral infections in live animals which were not possible previously. The information gained by the use of these techniques has given us a greater insight into the factors and agents associated with respiratory disease in animals in Ireland. For instance, by investigating the records of tests carried out at the laboratory during the 1991/1992 autumn, winter, spring period it was possible to determine that 63% of severe outbreaks of respiratory disease in cattle in Ireland were associated with viral infections.

These tests are based on the use of specific antibodies to individual viruses produced at the laboratory which are linked to dyes which fluoresce when exposed to particular wavelengths of light and in this way locate cells that are infected with the virus. The infected cells themselves fluoresce when examined under a microscope with facilities for producing the specific wavelengths of light.

If we breakdown the cases into the specific viral agents associated with respiratory infections in cattle during the above mentioned period, 46% were associated with IBR infections, 31% associated with RSV infections and 23% associated with PI3 infections. These three viruses have their own specific lifestyles and although generally difficult to identify by observations on live animals, they may act on different parts of the respiratory system and in extreme cases have easily distinguishable effects. At the present time it is worth considering one of these - IBR - more closely.

IBR belongs to the herpesvirus family and can exist in animals which are clinically normal (carriers) and be reactivated and excreted by these animals. More severe strains of this virus exist in animals in both mainland Europe and in Britain. For this reason a policy of controlling the importation of IBR carrier (antibody positive) animals was pursued by the authorities in this country. These severe strains are associated with much more severe respiratory disease than strains presently in the country. Infections with such severe strains have been reported to be associated with mortalities of 15% or more of infected animals. Also, these strains can cause severe respiratory disease in cows and infertility problems in susceptible females. Our cattle population could well do without such infections, hence the logic of only importing IBR antibody negative animals. However one importation of animals carrying such severe strains could eventually be enough to contaminate the entire cattle herd in the country.

The problems associated with global warming and the possible introduction of more severe strains of viruses that effect the respiratory system paint a bleak picture for in-wintering cattle in the future. However, recently, a number of live vaccines against the common viruses associated with respiratory disease have been licensed for use in Ireland. Some of these vaccines are based on mutants of strains isolated form infected cattle and can be used in the face of an outbreak of respiratory disease as they act very quickly when given by the intranasal route.

However, their value will depend on knowing which virus or viruses are associated with the outbreak.

It must be recognised however that respiratory disease is often associated with concentrating and housing cattle and that the aim should be to limit the damage caused by the syndrome. For this reason vaccination policies should always be associated with good husbandry principles. It is interesting to note that vaccination programmes against viral diseases are standard procedures in other species such as horses and dogs.

On-going investigations are taking place into the effects of vaccinating housed cattle in Ireland with live viral vaccines.

Management

Some basic management practices may help greatly to reduce losses due to respiratory disease. Such practices as trying to reduce stresses, by keeping animals comfortable and in small groups, and recognising social orders in mature animals are all helpful. Regular feeding is important particularly when animals are moved over great distances and to a number of locations or even from farm to farm. Feeding of colostrum is also a valuable aid in reducing the severity of respiratory disease in calves as colostrum will also contain antibodies against respiratory pathogens. The value of "preconditioning" (a term used in other countries to describe preparation of animals for movement to other locations using such practices as introduction to concentrates, vaccination, early weaning etc.) of animals to be sold has yet to be determined under Irish conditions as market forces will determine its feasibility. Obviously buying directly from farm sources should greatly help reduce disease risks.

With increasing knowledge it may be possible to reduce the financial costs of respiratory disease outbreaks, currently estimated to be approximately £35 million annually in Ireland.

Conclusions

While cattle in Ireland may be exposed to greater disease risks in the future due to the possible introduction of pathogens from abroad and climatic factors may stress natural ventilation systems, modern vaccines may help reduce the risks of severe outbreaks of respiratory disease. Nevertheless good management and husbandry practices should always be used in conjunction with any vaccination regime.

Our forefathers dealt with the challenges of their day in their own way. If we are to deal with the challenges of the future in a much faster moving world we need our own "foundations" of basic knowledge on which to build suitable adaptations to protect the health of the cattle in this country.

Reference

Gunn, H. M. and Wilson, B. (1991). Observations on respiratory disease in intensively housed feedlot cattle and climatic considerations. *Irish Veterinary Journal,* 44, 41-42.

Optimising Herd Calving Patterns – Financial Returns on Farm

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Most dairying countries, particularly our EC competitors, have a comparatively uniform milk supply pattern throughout the year. In Ireland about 73% of the manufacturing milk is delivered to the processing factories during the six month period April to September. Until the 1970's Irish dairy co-operatives generally paid an even price for milk throughout the year. The only exception was in the liquid milk sector The choice of an optimum calving pattern was then relatively simple Spring-calving involved much lower costs than alternatives as milk production could be based mainly on grass The highly seasonal supply pattern of milk as a result has a number of consequences for processors Assembly, processing and distribution facilities have low levels of utilisation for much of the year, resulting in high unit costs. In addition, a highly seasonal milk supply pattern imposes limitations on the product mix, as short life products cannot generally be manufactured due to inadequate supplies of winter milk.

For these reasons a number of co-operatives have offered price incentives to increase milk supplies over the winter period. The strategy being to switch more calvings to the autumn period of the year These incentives have provided the dairy farmer with a much more complex problem in deciding on optimum calving patterns. He has to consider whether the price incentives over the winter months are sufficient to compensate for higher milk production costs, and when to calve his herd of cows to meet the winter milk requirements The problem is further aggravated now due to quota restrictions

The shift in the milk supply pattern in Ireland has been very small over the years as can be seen from Table 1.

Table 1
Index of monthly milk deliveries in Ireland
(average daily supplies in period April to March = 100)

	1973	1983	1990/91
April	117	140	140
May	174	170	170
June	178	172	167
July	164	152	149
August	150	127	131
September	117	108	110
October	88	76	74
November	43	42	42
December	24	28	30
January	28	30	33
February	41	57	58
March	71	95	93

There has been a slight increase in May to September production and an increase in the production of milk from January to April. The trough month of December has remained unchanged. Up to 1984, the calving dates were getting earlier but with quota introduction the mean calving date for creamery herds has slipped again.

The seasonality question has received much study (Gleeson, 1988, Keane, 1985 and Pitts, 1983). In this paper we plan to look again at this question from the point of view of milk production and taking into consideration recent innovations from milk production research.

Relation between lactation yield of milk and milk constituents and month of calving

Most attempts to compare spring with autumn calving for milk production have, in the past, generally been made from survey data. It has been long accepted that the autumn calving cow gave a higher yield than the springcalving cow because it was still sufficiently fresh in lactation when turned out to grass to increase its yield and have a lengthened lactation, whereas the spring calver tended to have a shorter lactation, going dry in November. Likewise for spring calving herds a delay in calving date was always associated with reduced production and a shorter lactation length. An analysis of 4 experimental herds attached to the Moorepark Centre over a 4 year period is shown in Table 2.

Table 2
Effect of calving month on milk yield, milk constituent yield and lactation length

Calving Month	Milk (Kg)	Fat (Kg)	Protein (Kg)	Lactose (Kg)	Lactation Length (Days)
January	4603	164	154	206	294
February	4351	155	145	195	270
March	4098	146	136	184	246
April	3845	137	127	173	222

This data shows that there was a linear decrease in the yield of milk and milk constituents with later calving. This was also associated with a shorter lactation length. However, these results do not indicate the potential of spring calving herds since many later calving cows are not purposely managed as such but rather are the results of lack of explicit management in regard to month of calving. Recent innovations from milk production research have shown that it is possible to substantially alter the calving month effect through improved grassland management and by altering the system of production from what were slandardised systems of milk production based on early compact calving (Dillon and Crosse, 1992; Gleeson, 1988 and Stakelum, 1991).

The pattern of supply of manufacturing milk through the year is determined by the calving pattern and quality of feed available through the year and by management decisions such as level of concentrate feeding. The supply patterns

Table 3
Lactation curves and total milk yield ranking for various systems of production

	Jan.	Feb.	Mar.	Mar. (L.S.)*	Oct.	Nov.	Dec.
January	6.4	0.0	4.0	4.0	13.1	13.0	13.7
February	12.8	6.5	0.0	0.0	10.8	12.0	13.0
March	13.9	13.0	7.0	6.0	10.8	12.0	13.0
April	13.5	13.8	13.4	13.0	9.3	11.0	12.5
May	12.4	13.0	13.7	13.4	8.2	10.0	12.0
June	10.9	12.0	12.0	12.0	6.6	9.0	10.0
July	9.9	10.5	11.4	11.5	5.0	6.0	8.5
August	8.3	9.5	10.5	10.8	2.6	4.0	5.0
September	6.4	8.0	9.0	9.4	0.0	2.0	2.3
October	3.8	6.5	7.8	7.9	8.0	0.0	2.0
November	1.7	4.0	6.2	6.6	13.0	8.0	0.0
December	0.0	3.2	5.0	5.4	12.6	13.0	8.0
	(100)	(100)	(100)	(100)	(100)	(100)	(100)
Yield ranking	100	96	91	96	100	100	100

*March calving (Lower S.R.)

from cows calving in different months have been studied previously (Killen and Keane, 1978; Crosse, 1992). The shape of these curves differed from similar studies in the U.K. (Woods, 1969). More recently, herd performance under different calving patterns is being monitored in Moorepark (Dillon and Crosse, 1992). The results of this milk production experiment were incorporated into existing studies to derive supply patterns for this study. The effect of calving date and herd supply patterns for different calving months are shown in Table 3. Similar tables were also produced for milk fat and protein %. It should be emphasised that the curves for the late spring calving groups are not like the traditional pattern in Ireland where little or no supplemenatry feeding occurs in autumn. Supplementation in late lactation is likely to have an effect on milk quality as well as on milk yield.

Of particular importance is the supply pattern in the winter months. The data in Table 4 illustrates the effect of calving date on supply pattern per cow and on total supply.

Table 4
Milk yield per cow and supply pattern

Supply Period	Calving Date Mid-January Yield Kg (%)	Mid-March Yield Kg (%)	Mid-October Yield Kg (%)
March - September	3760 (78)	3501 (76)	2125 (44)
October - February	1060 (22)	1099 (24)	2695 (56)
November - December	85 (2)	535 (12)	1214 (25)
Total	4820 (100)	4600 (100)	4820 (100)

Calving date has a large influence on the quantity of milk available during the winter months for processing. It is assumed that there is no difference in total lactation yield between January calvers and October calvers.

Price incentives to influence the pattern of milk supply

Until the 1970's, the Irish dairy industry generally paid an even price for manufacturing milk throughout the year and provided no seasonal price incentives. In contrast, the liquid milk trade have always paid incentives for the "out-of-season" months. Bonus schemes were introduced to encourage some autumn-calving. The bonus incentive was paid provided the farmer met a specific quota requirement. An example of some of the off season bonus scheme paid by Dairygold Co-operative is shown in Table 5.

Table 5
Off season bonus scheme - DAIRYGOLD

	% Annual Quota	Payments p/Kg	(p/Gallon)
November	4.0 +	2.14	(10)
December	2.0 +	2.14	(10)
January	3.0 +	4.27	(20)
February	6.0 +	2.14	(10)

The data in Table 6 show some of the winter milk bonus schemes paid by Dairygold Co-operative and Waterford Foods Plc.

Table 6
Seasonal incentive schemes

	Dairygold	Waterford Foods
Total milk supply (October-February) (% of Annual Quota)	30	35
Total milk supply (November-December) (% of Annual Quota)	10	12
Payments paid monthly p/Kg (p/Gal.)		
Nov./Dec./Jan./Feb./(Oct.*)	4.27 (20)	4.27 (20)
October	2.14 (10)	

*Full Bonus paid in the case of Waterford Foods for all 5 months.

The data in Tables 5 and 6 represent only some aspects of the incentives which are available and these will be used to illustrate how they might affect the decisions a farmer might make when considering how to maximise returns from his farm.

Monetary returns

In order to calculate the monetary returns from farming the following Farm Profile was used (Table 7).

Table 7
Farm profile used to derive cost and returns

Farm Size (Ha)	36
Number of Dairy L.U.*	106
Milk Yield per Cow (Kg)	5,000
Milk Quota on Farm (L)	350,000
Value of Buildings and Machinery	50,000
Term Loan from Bank	20,000

*Dairy L.U. includes replacement heifers and cull cows

The model used is representative of intensive dairy farming in Ireland. A number of alternate systems of production were compared. These are outlined in Table 8. The main variable with these systems was calving date. Some of the systems also had a lower stocking rate. It should be recognised that if different assumptions are made then the results can be different.

Table 8
Comparison of various systems of production

Calving month /system	S.R. (D.L.U./Ha.)	Concentrates fed (Kg/DLU)	Milk delivered /cow (L)
January	2.57	752	4820
February	2.57	683	4600
March	2.57	467	4384
March (LS)	2.33	300	4602
October	2.57	1178	4820
November	2.57	970	4820
December	2.57	747	4820
Beef	2.47	620	

(L.S.) Lower stocking rate

The costs of production associated with these various systems is shown in Table 9.

Table 9
Costs of milk production for various systems of production

System	Costs /D.L.U.*	Addition to*** costs/D.L.U.	Addition to costs** /Kg milk quota	(p/Gal.)
Jan.	530	+10	-0.32	(-1.50)
Feb.	520	0	0.00	(0.00)
Mar.	486	-34	-0.21	(-0.98)
Mar. (L.S.)	479	-41	-0.90	(-4.21)
Oct.	600	+80	+1.14	(+5.34)
Nov.	566	+46	+0.43	(+2.01)
Dec.	533	+13	-0.25	(-1.17)

* Dairy Livestock Unit

** Addition to costs are calculated using February calving as a standard

The data in Table 9 show that there is a large difference in the costs per Dairy Livestock Unit depending on the system of production. The costs range from £479 to £600, a difference of £121/D.L.U. The additions to costs per D.L.U. and per kg of milk quota are also given. The February calving system is used as a base to represent early spring-calving. Systems of production where early lactation milk comes from grass has a large influence on reducing costs. There is a total difference of 2.04p/kg (9.5p/gallon) of milk in the cost of milk quota between the MAR. (L.S.) system and the system of production based on October calving (OCT.).

The receipts associated with various systems of production are given in Table 10.

Table 10
Receipts per Dairy Livestock Unit (D.L.U.) for various calving months/systems of production

	Dairygold Schemes				Waterford Foods
System	N.B.	E.S.	L.S.	W.B.	W.F.
Jan.	1088	1110	1090	1131	1135
Feb.	1084	1089	1092	1115	1122
Mar.	1067	1075	1078	1105	1113
Mar. (L.S.)	1109	1118	1121	1149	1158
Oct.	1124	1165	1151	1237	1243
Nov.	1112	1154	1131	1205	1205
Dec.	1097	1139	1103	1168	1170

N.B.: No Bonus; E.S.: Early Season Bonus; L.S.: Late Season Bonus; W.B.: Winter Bonus; W.F.: Winter Bonus (Waterford Foods).

The receipts obtained from the various systems depends on the system of milk production and on whether or not the herd meets the quota requirements for the high price winter milk incentives. As outlined in Table 10, the returns for the various systems recorded under the heading 'NB' assume that no bonus is obtained for any of the milk supplied. They are however, other possibilities. Milk from these various systems may or may not be part of a herd meeting the winter milk quota requirements. The receipts outlined for the various bonus systems outlined in Tables 5 and 6 and shown in Table 10 assume that the quota requirements for the herd are met. Receipts are highest from the systems of production which meet the winter milk bonus requirements.

The margins associated with the various systems of production and where the milk supply qualifies for the various bonus schemes is shown in Table 11. It should be noted that margins reflect the difference between the cost of production and the receipts obtained. Low cost systems do not necessarily mean that these systems will give the highest margins.

Table 11
Margins per Dairy Livestock Unit (D.L.U.) for various systems of production

	Dairygold Schemes				Waterford Foods
System	N.B.	E.S.	L.S.	W.B.	W.F.
Jan.	558	580	560	601	606
Feb.	564	569	572	595	602
Mar.	581	589	592	619	627
Mar. (L.S.)	630	639	642	670	680
Oct.	524	575	55 1	637	644
Nov.	546	595	565	639	643
Dec.	564	612	570	635	644
Beef	100				

N.B.: No Bonus; E.S.: Early Season Bonus; L.S.: Late Season Bonus; W.B.: Winter Bonus; W.F.: Winter Bonus (Waterford Foods).

Margins are highest when calving is concentrated to the start of the grazing season and where additional land is allocated to the Dairy Enterprise (March L.S.). The margins are lowest for October calving when no bonus is received for the milk. This is due to the high cost of production associated with this system. The margins for the various systems change markedly if the milk qualifies for the bonus schemes.

Given the supply patterns (Table 3) and the estimated returns (Table 11), the optimum calving pattern for a herd can now be estimated by means of linear programming. The objective assumed for a model dairy farm is to maximise net profit from the farm. The dairy farm is however faced with a number of constraints. Firstly, there is the overall Quota constraint for the whole farm. The quota constraint of 350,000 L (Table 7) is imposed as an absolute limit. In terms of seasonal quotas, it is assumed that the supplier is obliged to supply the minimum requirements for various times of the year as outlined in Tables 5 and 6. The data in Table 12 show the precise mathematical solution in terms of calving pattern.

Table 12
Total cow number, calving pattern and number of beef animals on the farm to maximise profitability

	Dairygold Schemes				Waterford Foods
System	N.B.	E.S.	L.S.	W.B.	W.F.
Calving pattern:					
MAR. (L.S.)	76	42	76	62	50
DEC.	-	32	-	-	-
OCT.	-	-	-	14	25
Total cows	76	74	76	76	75
Beef cattle	9	14	9	11	13

If no bonus is available then 76 cows is sufficient to fill the quota and the system used should be MAR. (LS) in order to maximise profit. Nine beef cattle are needed to use the remaining land. Likewise for the Late Season (LS) and Winter Bonus (W.B.), 76 cows are required but the systems used or calving pattern are different to exploit the Winter bonus (W.B.). Here 62 (82%) of the cows should calve in March and 14 (18%) of the cows should calve in October. In the case of the early season bonus 74 cows are necessary to fill the quota and 42 (57%) of these should calve in March with system of production MAR. (LS) and the remaining 32 (43%) should calve in December. To exploit the Waterford Foods Winter Milk Bonus Scheme (W.F.) where a greater requirement for Winter milk is imposed, 75 cows are necessary to fill the quota and 13 beef cattle to use the remaining land. Sixty seven percent of the herd or 50 cows should calve in March (MAR. L.S.) and the remaining 25 cows (33%) should calve in October. The total number of cows required to fill the Quota differs because the yield/cow differs depending on the month of calving.

The overall farm margin and a breakdown of receipts and costs per cow and per gallon of milk quota are shown in Table 13.

Table 13
Overall farm profit from optimum solution

	Dairygold Schemes				Waterford Foods
System	N.B.	E.S.	L.S.	W.B.	W.F.
Farm profit	48.852	48,171	49,765	51,205	51,314
% profit from dairy	98	97	98	98	97
Addition to farm profit	0	-681	+913	+2,353	+2,462
Addition to margin/cow (£)	0	-9.1	+ 12	+ 31	+ 33
/Gal. Quota (p)	0	-0.9	+1.22	+3.13	+3.28

In a situation where no bonuses are available, the overall farm profit is £48,852. If the farmer decided that he wanted to exploit the early season bonus, the net result is a loss of £681 per farm. This is because more expensive systems of production have to be used to comply with the supply pattern required to qualify for the bonus. In practice then the farmer should ignore this type of bonus system. The late calving bonuses and the winter bonus are very profitable.

Milk value per cow and addition to milk value and cost of production are given in Table 14.

Table 14.
Milk value and addition to milk value and to costs

	Dairygold Schemes				Waterford Foods
Bonus Scheme	N.B.	E.S.	L.S.	W.B.	W.F.
Milk value (£/cow)	892	909	909	948	968
Addition to milk value (£/cow)	0	17	17	56	76
Addition to milk price/gal (p)	0	-0.19	+1.8	+4.7	+6.2
Addition to costs/cow (£/cow)	0	21	0	2 2	41
Addition to costs/gal. (p)	0	1.1	0	1.73	3.32

The value of milk per cow increases from £892/cow for the no-bonus scheme to £968 per cow for the (W.F.) Winter Milk Scheme. The various bonus schemes generally resulted in higher value milk quota with the exception of the early season bonus scheme. Exploiting the bonus schemes also resulted in additional costs with the exception of the late calving bonus scheme. The extra value for the milk was more than sufficient to compensate for the extra costs involved. This was particularly so for the winter milk schemes.

The milk yield per cow and the seasonality of production are shown in Table 15.

Table 15
Milk yield per cow and seasonality of production

	Dairygold Schemes				Waterford Foods
Bonus Scheme	N.B.	E.S.	L.S.	W.B.	W.F.
Milk yield per cow (Gal) (delivered)	4602	4697	4602	4642	4675
Supply pattern:					
Oct. - Feb.	24	29	24	30	35
Nov. - Dec.	12	9	12	14	16

These results show that the optimum profit was only achieved when the minimum supply for October-February was met in the case of the winter bonus schemes. The supply in the November-December period was above the minimum requirement. In farm practice then, a safety margin would need to be included. The data in Table 16 show the effect of increasing the proportion of October calving relative to March calving (MAR. L.S.) on profitability and on seasonality of supply and on margins/gallon of quota.

Table 16
Effect of increasing the proportion of October calving relative to March calving on profitability, margin/gallon of quota and seasonality of production

Proportion of Oct.: Mar. (L.S.) calving	30 : 70	40 : 60	50 : 50
Yield per cow (Kg)	4,667	4,689	4,711
% milk (O - F)	34	37	40
% milk (N- D)	16	17	19
Addition to margin/kg Quota (p)	0	-0.15	-0.29
Farm margin	51,459	51,067	50,680

The results in Table 16 show that increasing the proportion of October calving reduced the margin obtained per gallon of milk quota. This reduction is offset to some extent by the additional returns from the beef component of the farm. In farm practice it is important to allow a safety margin when considering winter bonus schemes because a failure to obtain the bonus can result in a large reduction in margin.

Conclusions

Results presented in this paper show that system of milk production can have a large influence on the cost of milk production and on the seasonality of milk production. Winter bonus schemes can increase the profitability of the farm. It is evident from this study that decision making on farms which will optimise profit is a relatively complex issue especially when many constraints have to be considered. The use of computer aided programs such as the "DAIRYPLANNER' and linear programming greatly facilitate the decision making process. These techniques can also be used to compare winter milk incentive schemes.

In considering systems of production for the farm to optimise returns, the technical requirements for the various systems needs to be carefully considered. The cost associated with changing systems of production also needs to be considered before a final decision is made. The influence of system of milk production on calf rearing systems, labour requirement, capital requirement and on farm buildings needs further discussion.

References

Gleeson, P. (1988). Seasonality of milk supply - Technical and Economic Considerations. Moorepark Dairy Farmers' Conference, Teagasc.

Keane, M. (1985). Optimising Herd Calving Patterns under Quota constraints. Agribusiness Discussion Paper No. 3. Universily College Cork.

Pills, E. (1983). Economic Aspects of Seasonality of Milk Production. Situation and Outlook Bulletin No.3. An Foras Taluntais.

Dillon, P. and Crosse, S. (1992). Optimising Herd Calving Patterns - Dairy Herd Management. Paper presented to the Dairy Conference of the Irish Grassland and Animal Production Association.

Stakelum, G. (1991). The Production and Utilization of grass for Grazing and Silage. The Eleventh Edward Richards-Orpen memorial Lecture, Irish Grassland and Animal Production Association, J. 25 : 3-37.

Killen, L. and Keane, M. (1978). The Shape of Lactation Curves in Irish Dairy Herds. Ir. J. Agric. Res. 17 : 267-282.

Wood, P. D. P. (1969). Factors Affecting the Shape of the Lactation Curve in Cattle. Animal Production, 11 (3) 307-316.

Crosse, S. (1992). The Shape of the Lactation Curves for milk, fat, protein and lactose production and the use of Lactation Curves for the prediction of milk and milk constituents. Ir. J. Agric. Res. (Submitted).

Optimising Herd Calving Patterns – Dairy Herd Management

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Before the advent of milk quota restrictions on dairy farms, land was the major constraint to increased milk output from farms. The dairy farmer had a dual objective of increasing milk output per cow and per hectare (stocking rate). The major emphasis was on improving efficiency on a per hectare basis. The objective now on dairy farms is to continue to maximise profit from the farm while optimising the quota allocated to the farm as well as the land area.

Early compact calving (mean calving date in late-January) coupled with a high stocking rate (0.38 ha/cow) and a concentrate input of 500-750 kg per cow was advocated as a system of milk production in the pre-quota period. Earlier calving was justified on the basis that it resulted in a higher milk yield per cow. This coupled with a high stocking rate gave a high margin per hectare. A Moorepark survey on the cost of milk production has shown that the average cost of concentrate used on dairy farms was 1.7p/kg of milk produced. If milk could be produced with a much reduced concentrate input, it should be possible to reduce the cost of milk production significantly. One possible way of doing this is to calve cows much closer to the start of the grass growing season, thereby reducing the requirement for feeding high levels of concentrates post-calving.

Comparison of three systems of milk production

In 1989, a three year project was set up in Moorepark (Curtins farm) to compare the biological efficiency of three different systems of milk production. The Moorepark standard system (early compact calving; System A) was compared with two late calving systems (Systems B and C; Table 1). System B had a similar stocking rate to System A, while System C was at a lower stocking rate (0.38 ha/cow).

Table 1
Comparison of 3 systems of milk production (1989 - 1991)

System	Mean calving date	Stocking rate (ha/cow)
A	20th Jan.	0.34
B	15th March	0.34
C	15th March	0.38

The lower stocking rate used in System C allowed the opportunity to investigate if additional land would help optimise milk production from later calving. With the advent of quotas, the dairy farmer has to decide on the alternative use of land. The lower stocking rate resulted in the total production of 8-9 tonnes of settled silage per cow for System C, with most of the extra silage coming from the 1st silage cut. The extra silage was used as a supplement in the autumn period when grass growth rate declines and/or alternatively in mid-summer when drought conditions can arise.

A total of 75 Friesian cows balanced for lactation number and milk yield were assigned to the three treatment groups in the Spring of 1989. Each treatment had its own farmlet comprising of 20 paddocks per treatment (System A and B), and 23 paddocks per treatment (System C). Nitrogen was applied at the rate of 395 kg N per hectare. Silage was conserved from 9 and 7 paddocks respectively for first and second silage cuts for treatment A and B, while 12 and 8 paddocks from treatment C were conserved for the first and second cut, respectively. The grazing area received 18 kg P and 37 kg of K per hectare in the autumn of each year. The silage cutting area received 25 kg P and 111 kg K per hectare in the Autumn and a further 17 kg P and 74 kg K per hectare after lst-cut silage. Slurry was applied in the autumn. The silage areas were grazed once in spring prior to closing for silage (early April).

The results presented in this paper are for the first two years of the experiment. The study will be continued for one further year.

Grass production and grazing management

Figure 1 shows the average daily growth rates over the period 1982-89 and the growth rates for the years 1990 and 1991.

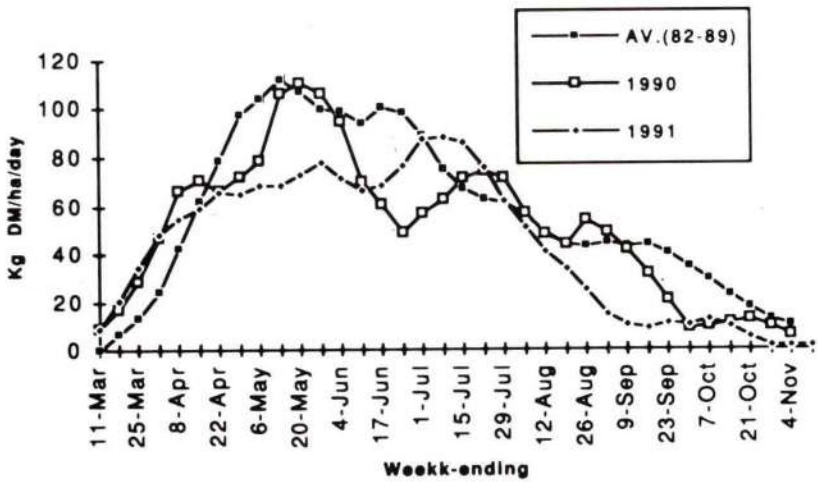

Fig. 1 – Average grass growth rate for the period 1982-92 and the average growth rate for the years 1990 and 1991.

Total grass dry matter production was 13.9, 12.5 and 10.9 tonnes on average for the period 1982-89, the years 1990 and 1991, respectively. Grass growth rate in 1990 was above normal from March to early-April, it was below normal in late June and early-July and below normal again from late-September to early-

October. Grass production in 1991 was very much below normal in the May-June period and again in September. Table 2 outlines the grazing management strategies employed for the two years.

Table 2
Grazing management strategies (1990-1991)

	1990	1991
Start of grazing season		
Out: by day	13/3	19/3
Out: by day and night	26/3	27/3
End of grazing season		
In: by night	30/10	8/11
In: by day and night	2/12 (22/12)*	2/12 (21/12)

*The data in brackets refer to System C.

All silages were well preserved in both years (Table 3). The dry matter digestibilities were higher for the first cut silage. For Systems A and B, 6.75-7.0 tonnes of silage was conserved per cow while for System C 8.5-9 tonnes of silage/cow was conserved.

Table 3
Silage dry matter yields and chemical composition

		1990		1991	
		1st Cut	2nd Cut	1st Cut	2nd Cut
Cutting date		23/5	18/7	27/5	22/7
Grass DM	(t/ha)	6.8	4.8	6.2	4.8
Silage pit estimate	(t/cow)	4.3	2.4	4.3	2.8
		(6.1)	(2.6)	(5.8)	(3.3)
Dry matter	(g/kg)	245	215	240	187
DMD	(g/kg)	740	710	750	710
pH		4.0	4.1	4.0	3.9

The data in brackets refers to System C.

Milk production

The milk production and milk composition data for the three herds for both years are shown in Tables 4 and 5.

In 1990, the milk yields for Systems A and C were significantly higher than for System B. Milk fat, protein and lactose yields were significantly higher for System C compared to System B. There was no difference between Systems A and B and between Systems A and C in terms of milk constituent yield. Milk fat

Table 4
Milk production and milk composition data for 1990

System		A	B	C	SE
Milk yield	(kg)	5863	5393	5789	118.2
Fat yield	(kg)	206	200	221	5.58
Protein yield	(kg)	188	180	195	3.95
Lactose yield	(kg)	264	247	265	5.64
Fat	(g/kg)	35.2	37.0	38.3	0.0502
Protein	(g/kg)	32.0	33.4	33.7	0.0230
Lactose	(g/kg)	45.0	46.9	45.8	0.0221

Table 5
Milk production and milk composition data for 1991

System		A	B	C	SE
Milk yield	(kg)	5955	5513	5450	83 .9
Fat yield	(kg)	210	204	208	4.23
Protein yield	kg)	186	184	184	2.71
Lactose yield	(kg)	263	245	241	4.22
Fat	(g/kg)	35.6	37.1	38.4	0.0612
Protein	(g/kg)	31.4	33.4	33.8	0.0271
Lactose	(g/kg)	44.3	44.5	44.4	0.0266

and protein concentrations were significantly higher for Systems B and C compared to System A. In the second year of the experiment (1991), System A had a significantly higher milk yield than Systems B and C. There was no significant difference in milk protein or fat yield. System A had a significantly higher lactose yield. Systems B and C had significantly higher milk fat and protein concentrations compared to System A with no difference in lactose concentration.

Seasonality of milk production

The milk proportions produced at different periods during the year are presented in Table 6 (average of 2 years).

Table 6.
Seasonality of milk production % (average 1990-1991)

	A	B	C
Jan. - March	30	9	10
April - September	62	75	70
October - December	8	16	20

Liveweight changes. Figures 2 and 3 show the liveweight changes of the three herds for the two years 1990 and 1991.

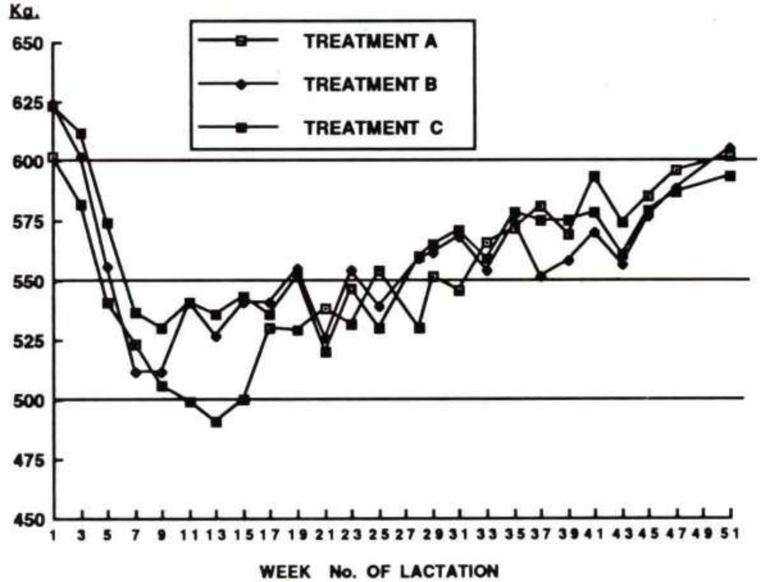

Fig. 2 - The effect of system of milk production on liveweight change for 1990.

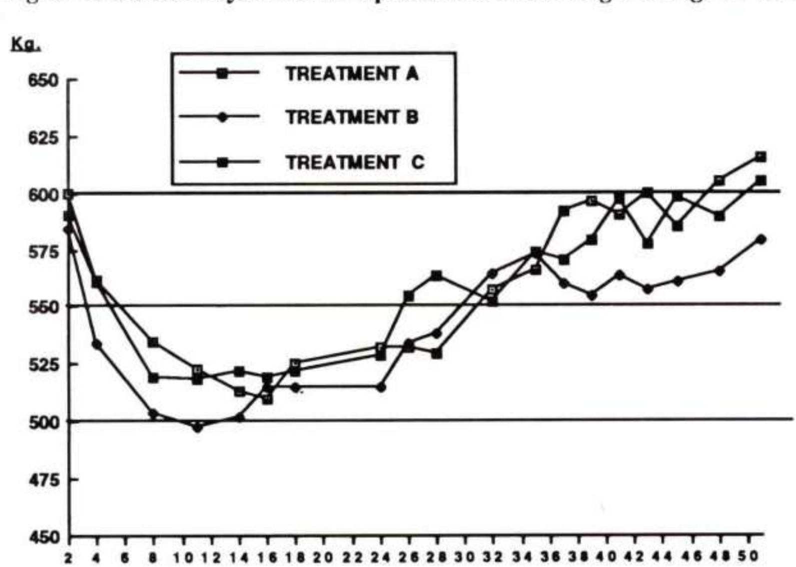

Fig. 3 - The effect of system of milk production on liveweight change for 1991.

Herd A dropped to a lower bodyweight post calving in 1990 compared to Herds B and C. However at the end of lactation all three herds ended up at equal bodyweight. In 1991 Herds B and C dropped to a lower bodyweight with Herd B ending up at a slightly lower bodyweight.

Herd fertility data

The fertility data for 1990 and 1991 is shown on Tables 7 and 8.

Table 7

The effect of system of milk production on herd fertility

System		A	B	C	SIG
Mean calving date	(days)*	24	74	73	–
Calving to service interval	(days)	78	76	78	NS
Calving to conception interval	(days)	82	82	85	NS
Services per conception		1.12	1.16	1.29	NS
Submission rate in 3 weeks	(%)	96	88	92	–
Conception rate to 1st service	(%)	80	80	68	–
% of herd not in calf at end of year	(%)	12	4	8	–

* Days from January 1st

Table 8

The effect of system of milk production on herd fertility

System		A	B	C	SIG
Mean calving date	(days)*	16	71	72	–
Calving to service interval	(days)	90	79	75	**
Calving to conception interval	(days)	95	88	88	NS
Services per conception		1.21	1.37	1.57	NS
Submission rate in 3 weeks	(%)	88	96	92	–
Conception rate to 1 st service	(%)	68	64	48	–
% of herd not in calf at end of year	(%)	12	16	16	–

* Days from January 1st

The breeding season was confined to 10 weeks for all three herds, 1st April until 24th June for Herd A and 18th May until the 10th August for Herds B and C). In 1990, all the important efficiency factors in reproductive performance are within the target values outlined by O'Farrell (1984). The fertility performance was not as good in the second year (1991) for all three herds. The calving to conception interval was greater than the target value of 85 days for all three herds especially Herd A. The conception rate to 1st service for Herd C was lower than the target value of 60%. However, there was no significant difference between the three herds in either of the two years.

Concentrate and silage supplementation

In-calf heifers and first lactation cows were fed 1.8 kg of concentrates/head/day in the pre-calving period. Table 9 outlines the concentrate input (post-calving) to the three herds for both years.

Table 9
Concentrate feeding (kg/cow)

System	A	B	C
1990	625	125	80
1991	735	305	80

The cows in System A were fed 7 kg of concentrates/cow/day post-calving with ad-libitum access to grass silage. Concentrates were phased out after turnout to pasture (mid-1ate April). All cows were supplemented with 0.5 kg of a high calcium magnesite concentrate until late May in both years. In 1990 herds A and B were supplemented with 2 kg per cow per day of concentrates from the 1 8th to 28th June while the animals in herd C were fed grass silage. This was due to poor grass growing conditions. In 1991 herds A and B were supplemented with 3 kg concentrates/cow/day from 7th to 1 6th May and from 7th June to 22nd June. They were also fed 3.5 kg from 14th to 22nd September. Herd B was also supplemented with 2.6 kg from the 27th September to 7th November. The animals in herd C were supplemented with silage from 20th September and 18th September in 1990 and 1991 respectively until housed by night. During this period they consumed approximately 1.50 tonnes of silage per cow. This silage was fed after morning milking over a 1.5 to 2 hour period.

Some conclusions from milk production system experiment

From the 1st two years of the study the following preliminary conclusions can be made.

1. Similar yields of milk, fat and protein can be obtained with late spring calving cows.
2. A lower stocking rate helps to optimise the production from later calving herds .
3. The higher milk composition levels recorded with the later calving herds need further clarification.

General management issues on dairy farms

The most important management factors relating to later calving are:-

1. Good grassland management
2. Correct autumn management
3. Compact calving.

Good grassland management is essential for all systems of milk production, but it is even more critical for later calving since you are producing a larger quantity of total lactation yield from grazed grass.

Figure 4 shows the milk production profile of cows for the second half of the grazing season on three different sward types (Stakelum and Dillon, 1990).

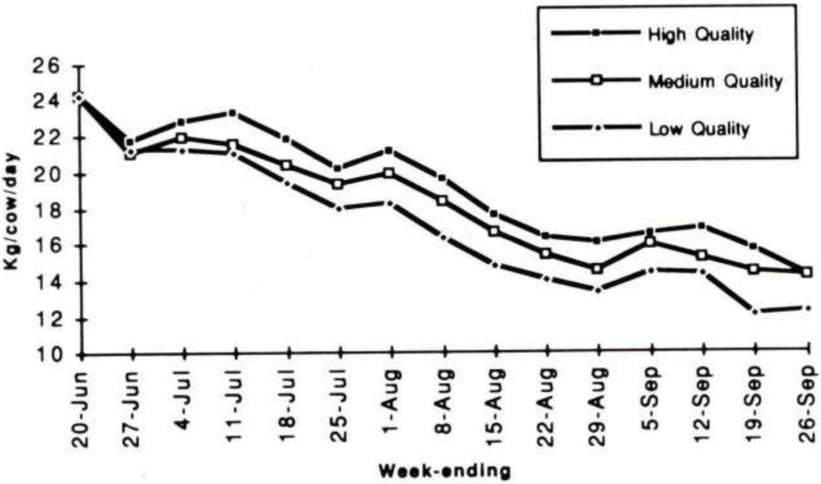

Fig. 4 - Daily milk production curves for cows grazing high, medium and low quality swards in 1987.

The higher quality pasture supported average daily yields of 19.7 kg/cow, compared to 18.3 and 17.3 for medium and low quality swards respectively. The high quality swards were the result of grazing to 6.0 cm in the April-June period while the low quality swards were the result of lax grazing (9-10 cm) during this period.

In the past, late spring-calving cows dried off in the autumn due to insufficient feed to maintain milk yield. To allow late spring-calving cows to have long lactation lengths of about 300 days, additional feed will have to be introduced into the system in the autumn. This feed may be in the form of grass, grass silage or concentrates, or a combination of all three. The lower stocking rate and the application of nitrogen in mid-September may facilitate grazing up to late December (Herd C) especially in dry land (using the extra silage as a buffer feed). The feeding of a low level of concentrate (2 kg) may be economically beneficial especially where winter milk prices are available.

With later calving, compact calving is more critical, so that the start of lactation coincides with the start of rapid grass growth. Delaying calving date will result in a larger proportion of milk being produced from feed other than grazed grass. While in this project the mean calving date target was the 15th March, this may not be the optimum calving date for all farms. In dairy farms where the expected turnout date is early March (e.g. South Munster) then the target mean calving date should be in late February - early-March. Therefore, adhering to the target values outlined earlier are critical.

References

O'Farrell, K. (1984). Assessing the reproductive performance of your dairy herd. Moorepark Farmers' Conference.

Stakelum, G. and Dillon, P. (1989). The influence of grass digestibility on dairy cow performance - its implications for grazing management. Irish Grassland and Animal Production Association Journal, Vol. 23: 93-104.

The Need for an Effective Dairy Breeding Programme

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Introduction

Too often in the past, the role of genetics has been viewed as nothing more than a tool, used by top pedigree farmers, in the promotion of quality breeding stock for sale. While this aspect may have received most of the publicity in the past, it would be naive to see this as its only use: genetics, and the creation of an effective breeding programme, is something which should be considered by *any* farmer who has a clear vision of what his/her goals are, and of the kind of dairy animal right for his/her economic situation. In this light, it should receive as much consideration, in the day-to-day running of the farm, as Nutrition, Pasture Management, Health Care, Fertility Programme, Calving Pattern, Replacement Policy and all the other constituents of a programme, designed to make the most of one's resources, under a quota situation. Genetic progress represents a small but significant as well as permanent change over and above any other management aids. It is for these reasons that care should be given, not only to the programme used by an individual on the farm, but to national and international policy as well. An effective breeding programme is only possible if the trait being improved has a reasonable amount of genetic variation; no variation implies that all animals are genetically equal and that any differences are due to management or other environmental factors. Fortunately, there is genetic variation for most production traits and it represents 25% - 30% of the total - a substantial amount. This would represent significant progress were it not for the fact that the genetic potential of an animal is invisible to us. Furthermore, traits like milk production are highly quantitative; they are composed of hundreds (perhaps thousands) of smaller genetic factors (ranging from something like gut capacity to the ability to convert energy to milk) and one cannot automatically partition the amount of variance by simple observation - it must be estimated. It is our knowledge of genetics that allows us to relate the observable trait (e.g., milk production) to the genetic potential of the animal by means of appropriate statistical modelling, and it is this area which has received much of the research during the last twenty years. While finding the most appropriate genetic model is essential, and will continue to be of high priority, it is only the first step in a good breeding programme: more important is what we do with the resulting information. The following four areas, their relative strengths and their interaction with each other, define the success or failure of that programme.

Monitoring of genetic trends

In some ways, genetic trends are simply an "extra" which results from our evaluation programmes: they are only available after the fact and, as such, are incapable of being used for the *current* programme. They are, however, an indication of how well the programme is achieving its desired effect as well as the speed with which it is being attained. Genetic progress is a ratio of the genetic superiority to the generation interval of the four genetic pathways: Sires of Sires, Sires of Dams, Dams of Sires and Dams of Dams. Increase the former or decrease the latter and genetic progress will improve. While there is generally a physiological limit on generation interval at most farm levels - juvenile MOET schemes represent some of the most extreme methods - calving heifers at two years old versus three years old is one small example of how a farmer can contribute to progress at the farm level. With regard to the other component (genetic superiority), this is a function of genetic variance, accuracy of evaluation and the intensity of selection. The variance is fixed (unless some new research shows it to be substantially higher than currently being used) whereas accuracy of evaluation represents limited potential and can be modified mainly at the national level or higher. Intensity of selection is the factor easiest to change at all levels and, simply put, is the risk one is prepared to take. Should one choose only the highest rated bull for replacements, or, say, the top four bulls? The same type of question applies to dams of replacements. At the National level, how many planned matings should be made and how many young bulls chosen for progeny testing? Obviously, there is more risk associated with choosing a few rather than many, but the rewards will also be greater, *on the average*, if we consistently pick fewer sires and dams for future generations. Of course this presupposes that everyone is trying to improve the same trait. If this is not the case, one must either question the policy or provide more choice, thus reducing the potential for improvement in all traits under selection. The main advantage in monitoring genetic progress is that it gives an indication of the success of the programme and whether or not the maximum possible improvement is being made. It will also provide an indication of the length of time it would take to change selection objectives (an example of the need for this might be the trend away from total production - water - and towards solids, either fat or protein weight). Therefore, while the factors which optimize genetic progress are important to the producer (i.e., farmers can play a role in their optimization), the value of the progress itself is of more importance to those evaluating the success of the programme and deciding on overall policy. It is the other three factors which affect the producer more and, over which, he/she has more control.

Increased accuracy of evaluation

While the movement from the Sire Model to the Animal Model was hailed as a great advancement in terms of accuracy for genetic evaluations, it was by no means a new concept; Henderson had proposed such a model more than twenty years before its adoption; it was, in fact, the obvious way to model genetic effects. Computers, however, were the weak link in the chain in that there was no easy way to account for relationships among animals, much less a way to obtain the solutions to large systems of equations. Therefore, the Sire Model was proposed as an approximation. However, with Henderson's "rules for the relationship matrix" in 1976 as well as later advances in computer power and algorithms, the door was opened for improvements in evaluations, allowing us to do what had been proposed in the first place but dismissed as impossible! Consider the example data set in Table 1:

Table 1
Example data set.

Cow	Yield	Sire
1	5000	A
2	4300	A
3	6380	B
4	6800	B
5	5400	C

An evaluation of these records can be performed with either a Sire Model or an Animal Model. Both methods will give proofs for bulls A, B and C, and both methods will have accuracies associated with those proofs. Based simply on observation, one might pick Sire B to have the best effect on improving yield in his daughters, followed by C and, lastly, A. In order to add the genetic component to the evaluation, knowledge of the relationships among the animals is required (see Figure 1). The problem with a Sire Model is that it only uses the known relationships among the sires themselves; from Figure l, it will be seen that A is not related to B or C, and that the only relationship to be added to the equations is the link between B and C (B being the sire of C). In fact, the rankings of the three bulls from this Sire Model are the same as we might have guessed (B followed by C followed by A). It is not the argument of this demonstration that a Sire Model is no better than simply using average-daughter production: rather, the aim of the example is to show what occurs when the model is changed, and *all known* relationships are included (see Figure 1 again). Table 2 shows the rankings of the three bulls under both models. Some might find it surprising to note that, under an Animal Model, Sire A is now ranked first. Careful examination of the relationships in Figure 1, however, will show that every female record is connected to that sire; i.e., A is either the sire or grandsire of every female in the data set. Hence, his genetic merit is estimated from *all* of the yields to which he has contributed, not just the two poorest - as was the case under the Sire Model, where his proof was based solely on his two daughters, 1 and 2. Likewise, there is now additional information regarding Sire B; he is the sire of C and, therefore, has a genetic input into the yield of Animal 5. Note also that by using an Animal Model, genetic rankings are available for the females as well as the males.

There are many advantages to be gained from the Animal Model. Firstly, it uses all available information in an optimal manner; i.e., given our knowledge of the biology, this is the best way to model it. It has good statistical properties which allow for more accurate predictions to be made concerning the published proofs and the performance of progeny. It adds a credibility to the proofs when

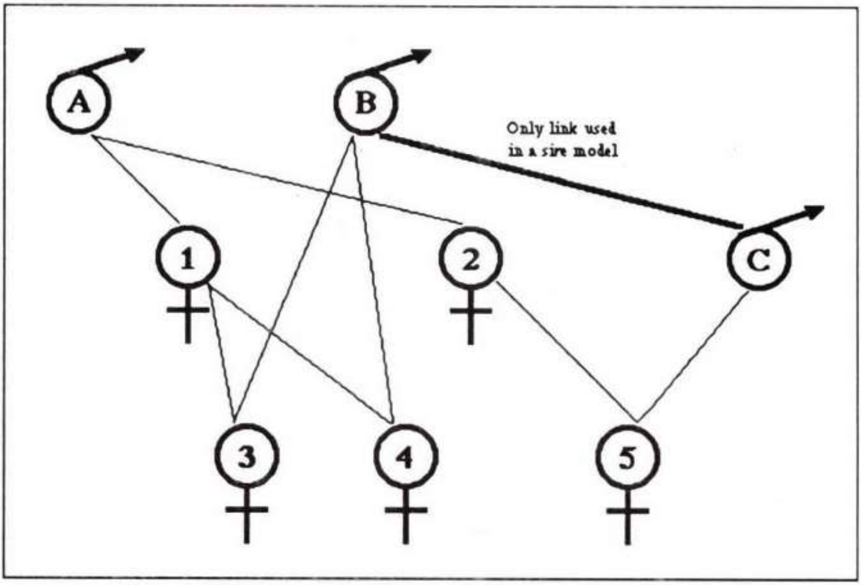

Fig. 1 – All *known* relationships among the eight animals - as used in an Animal Model.

comparing them across countries, since most are now using Animal Model methodology as standard procedure. The final, and perhaps the most important advantage of the Animal Model is the fact that accuracy increases by an average of about 10%; this means that bulls will reach a proven status earlier than with the Sire Model. There is no argument among researchers as to the advantages of the Animal Model; it is a question of implementation, and Ireland is on the verge of introducing such an evaluation. After an initial period when some re-ranking of bulls might occur (for the same reasons as demonstrated in the example) the consequences for the national programme can only be positive.

Table 2

Ranking of animals based on data in Table 1 using either a Sire or an Animal Model.

Animal ID	Ranking	
	Sire Model	Animal Model
1	-	1
2	-	4
3	-	3
4	-	2
5	-	5
A	3	
B	1	2
C	2	3

Identification of superior animals

Identification of genetically superior animals, both male and female, is an important part of any breeding programme and should be viewed on the global, the national and the herd level. As the world of commercial genetics becomes a much smaller market, and semen or embryos of animals with huge potential become available, certain areas need to be examined for each buyer (be it nation or individual farmer). The current method for comparison of bull proofs *across* countries is the use of Conversion Formulae. While based on certain sound statistical properties, it should not be forgotten that they are still approximations, and that the only true way to compare bulls from abroad with national contemporaries is to evaluate them in the same country *with a representative sample of daughters*. The importance of this last provision is the assumption that a bull is used randomly across herds and non-selectively on cows within a herd - neither of which condition is usually met. The result of evaluations, where these conditions are not met, is biased proofs for the selected bulls; i.e., those bulls that are used non-selectively will be given higher proofs than they deserve. While this might seem to be an argument in favour of conversion formulae, there is yet another consideration; implicit in their success is the assumption that those animals were selected for the same trait in all the different countries. Some national programmes may still be selecting on volume (water, essentially) while the importing country is now focussing on weight of solids. Once the selected trait is different, the conversion formula must use genetic correlations among traits, adding to the margin of error. Even if the trait *appears* to be the same in different countries/breeding programmes, their is the chance of a genotype by environment interaction. The result is, in fact, a different trait even though it appears to be the same. Unless there is a specific study done between the two different environments, there is no accurate way to adjust the conversion formulae. All these cautions are not meant to imply that these formulae are of no use; they are still relatively accurate. It simply serves to indicate that these conversions are *not* foolproof and may be the reason why a bull sometimes does not perform as the figures in the originating country would suggest. There is currently a lot of research being devoted to Global Evaluations. These represent the "state of the art" in current methodology for evaluating animals (male and female) across countries. They are restricted to Animal Model evaluations and have the possibility to become our most valuable indicator of genetically superior animals world-wide. This also emphasizes the need for Ireland to push ahead with its plans to implement its own Animal Model methodology so that its data can be incorporated in the data base currently being formed.

On a national level, there are other factors, besides introduction of the Animal Model, which will enhance the breeding programme. The selection sequence in the Irish Programme is shown in Figure 2. The stage which needs examining is the one which selects the top 50% of young bulls *based on their performance test in a series of beef characteristics*. To date, this policy has been justified, based on the argument that the preservation of a dual-purpose breed is in the best national interest. Perhaps it is time that this stage be re-evaluated, given the degree of specialization now being practiced in all areas of agriculture. By placing a pre-requisite of beef characteristics on bulls for future use in the dairy industry, there is a high chance that dairy progress is being lost, due to a negative correlation which exists between beef and dairy traits. It may also explain the increase in imports of semen, since most exporting countries have narrowed their selection goals in favour of their dairy markets. It is not that the potential of these countries for selection is so much greater than ours - as an example, Canada has approximately 2 million cows, versus 1.3 in Ireland, but is one of the world's leading exporters of semen and embryos - but rather a matter of deciding where to put the emphasis. This is not to say that beef quality is unimportant to the dairy industry; it forms an essential by-product that cannot be ignored. However, it can easily be argued that both dairy and beef sectors would benefit through maximum selection of future sires and dams for dairy traits along with sensible use of beef crosses for the lower portion of the dairy herd. Due to the small (but constant) rate of genetic progress, already discussed, it is obvious that a breeding programme which maximizes neither dairy nor beef traits will achieve little or no progress in either. Use of a beef bull on that portion of the herd, not required for replacements, represents a *better* method for obtaining quality carcasses, than through some small introduction of beef characteristics in the breeding programme itself. While there will be certain reduced profits from the sale of Holstein calves for beef, there will be greater gains from the production of milk and the sale of animals that are crossed with specialized beef breeds, and arguments concerning the unacceptability of beef resulting from highly selected dairy animals have long been dismissed by other countries, where there is also an equal interest in the preservation of both industries.

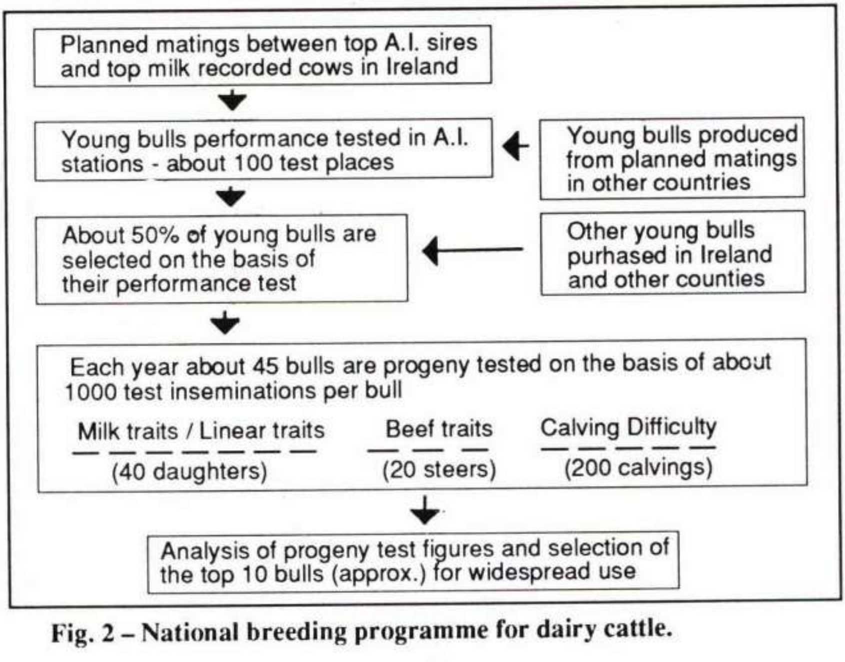

Fig. 2 – National breeding programme for dairy cattle.

Another vital way to improve the national breeding programme is through enlarging the data base; the more records that are available, the more accurate can be the bull proofs produced from the evaluations. It also means that the proofs will be more meaningful since they will represent a greater proportion of the producers. Of the 1.3 million dairy cows in Ireland, only about 10% are recorded in some official manner, thereby allowing those yields to be used in national evaluations. This figure is closer to 50% in North America. As soon as programmes are developed which convince producers of the value of milk recording (even if it is only through unofficial methods for now), the payoff will be seen in terms of national bull proofs. It is quite probable that there is far superior genetic material scattered throughout the country (in both pedigree *and* non-pedigree herds) than is currently being imported, especially given the fact that those potential parents are themselves products of the system we are trying to improve.

Herd information/decision making

The final - and arguably the most important - component to be affected by an improved breeding programme is the individual producer and his/her herd. If good selection practices are carried out here, then all other levels must automatically follow. There is a great need to believe that genetics are an important part of any industry which is based on getting high production from animals; that individual contributions in terms of official records, accurate sire identification and use of young bulls are vital when all are combined in a national policy; and that use of the best bulls (foreign or homebred) represents the best return for money at present, provided prices are not over-inflated due to demand. Some of these points need further elaboration.

Use of the Relative Breeding Index (RBI), as currently calculated by the Department of Agriculture is the best means for selecting dairy bulls for use in the Irish dairy herd. The reason for this is two-fold; firstly, the RBI is based solely on production - that which the producer is paid for; and secondly, its makeup is such as to promote an increased weighting on the solid components of milk (fat and protein) and not on the water component which plays so big a role in transport costs and which can always be added! Likewise, the availability of Cow Genetic Indices (CGI's) through use of the Animal Model will allow for an equivalent breeding decision to be made regarding females. While not currently as important a pathway in genetic improvement as males (due to A. I.), females are vital in the selection of bull dams, and their importance would increase dramatically if MOET schemes were to become more widespread.

Using a percentage of young bulls every year is also a sound policy. These represent our newest genetic material and therefore, on the average, our most superior. Of course the accuracies on these bulls are lower because we know less about them, thereby increasing the risk that the one used may not be better than what is already available at a proven status. However, one should always remember that probabilities play a large role in genetics and that if a consistent policy is adhered to, there should be more pay-offs than failures. Indeed, many A. I. Studs in North America are now arguing that the incentives, so often required in the past, should be removed as more and more people realize the great potential of these young bulls and assign more of their females to them. It is up to each individual to arrive at the percentage with which he or she feels comfortable, but that percentage should not be zero.

The last point worthy of mention is to emphasize the need for increased milk recording. It is up to the recording agencies to supply the extra information on nutrition, action dates, condition scoring etc. which will convince producers that they are not simply validating their cows' yields. As was noted at the beginning of this paper, the role of genetics should be more than the promotion of quality breeding stock for sale; it represents a substantial way to improve the farm income through methods which have been proven over time both here and abroad. Milk recording is something which every farmer should consider; if not through the official programme, then initially, through some unofficial method. Only when a farmer knows how animals are actually performing, can informed decisions be made on culling, breeding and use of beef crosses. Of course, the more of these records that can be used in national evaluations the far better will be the pay-back for all concerned. Only time and dedication by those delivering such a service can convince those involved that it is, in fact, an advantage.

Conclusions

The adoption of an effective breeding programme requires an improvement in attitude as well as in technology. Under a quota situation, the targets for selection need to become increasingly focused as specialization becomes a necessity rather than the luxury it has been in the past. Preservation of a dualpurpose species needs to be re-evaluated not only by the dairy industry, but also by the whole agricultural sector, in light of the fact that selective use of high quality beef breeds on portions of the dairy herd may represent a more efficient way of increasing income for all concerned. Despite the complex genetics involved in quantitative traits like milk production, it is relatively simple to decide on an effective breeding strategy once there is consensus over the trait of choice. Once selection for this trait is being maximized, the weights in the RBI will play a bigger role in determining choice of the most profitable bulls. It is, therefore, up to Irish producers to decide on their priorities and communicate them at the national level.

Once goals have been defined, the task of implementation falls to the researchers. Now that technology is finally catching up with the needs of the dairy industry, the potential for improvement is phenomenal in many areas. Implementation of an Animal Model and availability of more meaningful proofs from international sources, coupled with a greater understanding of the genetic makeup and an incorporation of biotechnology will increase the role that a breeding programme can play in overall dairy management. Since it is the producers which ultimately benefits from such research, there is a need to increase awareness and effectiveness through some of the ways outlined in this paper. Rather than simply follow a dictated policy, industry must begin to contribute to it also.

Dairy Herd Fertility: Update and Technology Developments

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The theme of most agricultural production research conferences these days is efficiency of output rather than output per se and this applies equally to the topic of herd fertility. In the dairy herd, overall reproductive efficiency determines, to a great extent, the efficiency of milk production. In Ireland the national dairy herd is mostly spring calving but, irrespective of calving date, a compact calving pattern is central to the achievement of efficiency. Also, because genetic improvement is both cumulative and permanent a level of A.I. usage consistent with maximising genetic improvement is also essential to further increase efficiency.

HERD FERTILITY

Management decisions taken not only during the breeding season but throughout the year have a major influence on the success of the breeding programme.

Records

A good recording system is an essential part of a good breeding management programme. Good individual records are not only part of good farm management practice but their analysis is also the first essential step in any herd infertility investigation. A comprehensive analysis of good breeding records will yield more useful quantitative information, to allow identification of the cause(s) of infertility, than can be frequently ascertained from blood, feed, herbage or soil analyses.

Herd reproductive targets

Overall reproductive targets for a dairy herd are presented in Table 1.

Table 1
Herd fertility targets

* 90% cows calved within 10 weeks
* < 5% culled for "infertility"
* 365 day calving interval

When these targets are reached other measures of reproductive efficiency, such as submission rate, conception rate and calving-to-service interval are certain to be optimal.

Most herds however, do not achieve these targets and have both longer calving seasons and higher culling rates. Long calving seasons result in losses of milk and calves and also in higher cost due to more A.I., higher replacement rates and higher cow maintenance costs. Depending on the milk and calf prices and the cost estimates used, the loss per day per cow in the herd is about £2.50 - 3.50 for every day lost over a 365-day calving interval.

Reproductive inefficiency in the herd arises mainly from inefficiency in 2 areas, viz., **heat detection** and **conception rate.** The effect of different levels of efficiency of these on the number of days lost is shown in Table 2.

Table 2
Effect of different levels of heat detection and conception rate on days lost

		Heat detection rate %				
		90%	80%	70%	60%	50%
	60%	0	6	11	18	27
C.R.%	50%	9	14	20	28	39
	40%	20	25	34	49	59

A 90% heat detection rate and a 60% conception rate optimises herd performance and, as tne efficiency of each of these falls, days are lost. A heat detection rate of 60% and a conception rate of 50%, levels which are not uncommon, result in a lost of 28 days, which at £3 per day per cow in the herd means a loss of £4,200 in a 50 cow herd.

Heat detection efficiency

Heat detection is a most time consuming and repetitive task of breeding management when using A.I. and it demands a very high commitment. O'Farrell (1982) has outlined not only the significance of, but also how to achieve a high submission rate for insemination. This requires frequent and careful checking for heat, especially in the early morning and late evening. This work has also described the advantage of using tail paint to reduce the burden of heat checking.

FACTORS AFFECTING CONCEPTION RATE

Even when heat detection and insemination are properly carried out a significant amount of reproductive wastage still occurs. Only about 55% of inseminations result in the birth of a calf at term and we have previously mapped the extent and timing of this reproductive wastage (see Fig 1).

These studies have shown that conception failure is almost synonymous with embryo death, the extent of which can vary with a range of factors, the most important of which are outlined.

Accuracy of heat detection

While, as indicated, a high submission rate is important it does not automati-

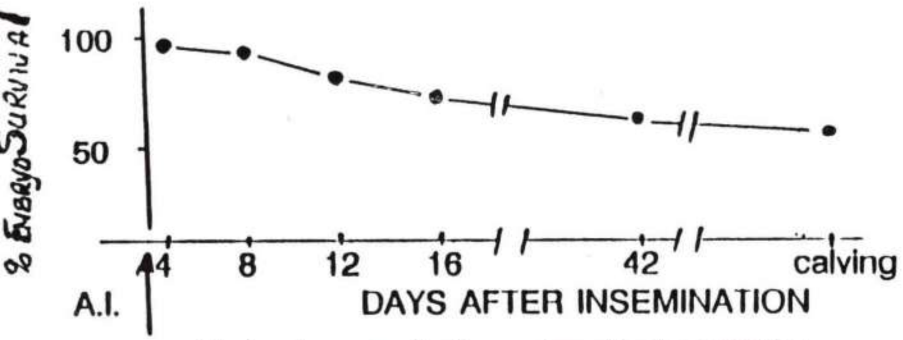


Fig. 1 – Cow reproductive wastage after insemination

cally mean accurate heat detection. Not only is heat detection efficiency on farms low but a significant proportion of the cows presented for A.I. are not in heat and this presents two problems. Firstly, if a cow is incorrectly declared in heat and is inseminated the chances of conception are nil. These cows will be seen to repeat at short and irregular intervals. Secondly, if a cow that is already pregnant is presented for insemination there is a risk of inducing death of the developing embryo or foetus. The accuracy of heat detection can be established by examining the pattern of repeat intervals as is illustrated in Table 3.

Table 3
Repeat Intervals after A.I.

	Days from A.I.				
	1-17	18-24	25-35	36-48	>48
Good	10	57	13	13	7
Inaccurate	18	26	14	19	23
Over-cautious	5	30	16	27	22

Accurate detection will result in about 60% of repeat intervals falling within an interval of 18-24 days from A.I. Patterns that deviate from this clearly suggest either sheer inaccuracy or alternatively, overcautious heat detection. A high proportion of cows repeating at intervals of less than 18 days is indicative of inaccurate heat detection while a high proportion repeating at about 42 or 63 days indicates overcautious heat and/or poor heat detection efficiency.

Calving-to-conception interval

A major factor affecting herd conception rate is the length of time cows are calved at insemination. The cow has only 80 days after calving during which her uterus must return to normal (which takes about 30 days), her oestrous cycles must resume, she must be seen to stand in heat and she must have a fertile breeding. Fertility does not return to normal until about 60 days after calving (see Table 4) and may even be longer in high yielding cows. Therefore the modern dairy cow, particularly the high yielding cow, is operating near the limit of her biological capacity to reproduce within a 365-day interval.

Table 4
Effect of calving - service interval on C.R. %

	Calving-to-Service (Days)				
	1-20	21-40	41-60	61-80	>80
C.R. %	0	30	54	63	72

Late calving cows are, of necessity, frequently inseminated at their first heat after calving when conception rate is often as low as 20-30%. In seasonal calving herds, late calving cows usually have a short calving-to-service interval and consequently tend to require more services to become pregnant that do earlier calving herd mates. When the breeding season is short (3 months) many of these cows are not in-calf when breeding ceases and end up being culled for failure to conceive. Of 104 cows culled from the Belclare dairy herd over an 8-year period for failure to go in calf, 25% had only been given one opportunity and 60% of them only two opportunities to become pregnant. There is evidence that the same is happening throughout the dairy industry with many cows being culling for failure to go in-calf simply reflecting late calving and insufficient time to become pregnant and not true infertility.

A compact calving pattern is essential if a high proportion of the herd is to be inseminated at an optimum interval after calving.

A.I. timing and technique

Provided that the standard recommendation of inseminating in the morning cows that were seen in heat the previous evening, and of inseminating in the evening cows that were seen in heat that morning, is adhered to, more exact timing of insemination is not critical. An exception to this, however, would be the use of semen from bulls of low fertility, in which case the optimum time to inseminate is 12-18 hours after heat is first observed.

DIY A.I.

The site of semen deposition within the reproductive tract of the cow has a significant effect on conception rate. Semen should be deposited in the body of the uterus. There is no benefit in going further to place the semen in each uterine horn. Attempts to place the semen in either uterine horn frequently leads to damage of the uterine lining. DIY operators should re-train at the start of each breeding season.

Energy nutrition

The relationship between nutrition and fertility is complex and direct associations are almost impossible to detect. However, it is important to understand that, in general, cows can not eat enough after calving to meet the demands of milk production. Their energy output is greater than their intake, which means they are in negative energy balance and will use their own body reserves to meet the demand. If the loss of body condition is excessive then cows take longer to resume cycles and their conception rate will be reduced.

Furthermore, cows that are over-fat at calving experience an even greater negative energy balance because they have a reduced appetite. Such cows rapidly mobilise fat which accumulates in the liver and this fatty liver syndrome is also associated with a delayed return to cyclicity and a reduced conception rate.

The best recommendations are to have cows in a target body condition score of 2.5 to 3.0 at calving, ensure that feed intake is maximised in early lactation and that cows are in a body condition score of 2.0-2.5 at breeding.

Protein nutrition

Another nutrition situation that has attracted our attention at Belclare is the drop in conception rate frequently seen after spring turnout. The fall in conception rate seems to coincide with peak grass growth and may be associated with an excess intake of rumen-degradable protein which is high in spring grass. Our current research programme indicates that this fall in conception rate can be reversed by supplementation with a rumen undegradable protein (see Table 5).

Table 5
Effect of protein supplementation on C.R.%

	Treatment		
	Control	Pulp	Protein
C.R. (%)	20/46 (43)	21/31 (68)	26/35 (74)
Service/conception	1.9	1.7	1.4

The possible mechanism(s) by which the protein supplement apparently reduces the extent of embryonic loss is now being examined.

Other factors that affect conception rate

Specific dietary factors such as mineral or trace element deficiencies or excesses can also reduce conception rate but are not considered to be of major importance and can be avoided by good management and proper nutrition.

There is a significant amount of investment by farmers on unnecessary mineral and or trace element supplementation as a possible means of correcting putative infertility. In most cases, however, infertility is due to management factors other than specific dietary deficiencies.

While the extent of bull infertility has not been documented in Ireland, U.K. data suggest that 3-5% of bulls in natural service are infertile while a further 30% are, to some degree, subfertile. Also, it should be realised that a bull may not remain fertile for his full working life or indeed for a full breeding season. Natural service bulls should be observed regularly and mating dates recorded in order to identify infertility at the earliest possible time.

BREEDING TECHNOLOGY DEVELOPMENTS

Apart from the benefits arising from genetic improvement schemes through the use of A.I. many dairy farmers are now also using cattle breeding technology such as synchronisation, embryo transfer and ultrasound pregnancy testing either to gain efficiency or simply as an aid to herd management.

PREGNANCY TESTING

Failure of a cow to be detected in heat following breeding in most instances means pregnancy. The proportion of non-repeating cows actually pregnant will, however, depend on the efficiency and accuracy of heat detection. On the other hand, 5-10% of pregnant cows show heat and may abort if inseminated or alternatively such cows would be inadvertently diagnosed non-pregnant and culled if heat activity alone was the only method of differentiating between pregnant and non-pregnant cows. About 10% of cows culled as barren each year are in fact pregnant.

Ideally, cows repeating at an interval of 2 months or greater from their last service should be checked for pregnancy.

Positive identification of cows in calf is clearly an essential part of good breeding management. A number of objective pregnancy tests are currently available and are outlined (see Table 6)

Rectal palpation

This is the routine method of pregnancy diagnosis carried out by veterinary practitioners. From about Day 45 of gestation the vet can, through the rectal wall, detect the difference between a pregnant (enlarged) and non-pregnant uterine horn with a high degree of accuracy (>90%). This test has greatest application as a general check carried out at about 8 weeks after the end of the breeding period to avoid the culling of pregnant cows.

Progesterone test

The hormone progesterone, secreted by the corpus luteum, is necessary for the establishment and maintenance of pregnancy. Three weeks after breeding, if fertilisation and normal embryonic development occurs, the circulating concentration of progesterone remains high, indicating a pregnancy. In contrast the concentration in the non-pregnant cow declines rapidly from about 18 days after insemination.

Progesterone level can be measured in milk or blood. High progesterone levels at Day 21 or 22 indicate pregnancy with an accuracy of about 80%, whereas low levels are indicative of non-pregnancy with an accuracy close to 100%. The reduced accuracy of positive pregnancy diagnosis arises from subsequent embryonic mortality.

Oestrone sulphate test

The concentration of the hormone oestrone sulphate is a highly accurate indicator of pregnancy because it is only produced when both the foetus and placenta are functioning normally. However, it can only be used as an indicator of pregnancy in cows that are bred about 120 days or longer. Its accuracy is close to 100% and like palpation it is most relevant as a general herd test carried out at about 8 weeks after the end of the breeding period to avoid the culling of pregnant cows. Both progesterone and oestrone sulphate tests are available as kits.

Scanning

Scanning or real-time ultrasonography is widely used to check for pregnancy as early as Day 15 in the mare. Scanning is also an accurate method of pregnancy testing in cows, but only from about Day 30-70 after breeding. However, the equipment involved is relatively expensive and sensitive requiring a reasonable level of operator skill, which, together with the fact that its use is confined to a relatively short period are limitations to its widespread use for cows.

Table 6

Pregnancy tests available for cows

Method	Test time after A.I.	Accuracy (%)
Heat detection	1-280 days	60-70
Progesterone	21 days	85 - Pregnant 95 - Non Pregnant
Oestrone sulphate	120-280	90-100
Ultrasound scanning		28-70 days 90-100
Rectal palpation	45-280 days	90-100

SYNCHRONISATION OF THE OESTROUS OR HEAT CYCLE

Synchronised breeding in the dairy herd can, 1) reduce the amount of heat checking, 2) facilitate A.I. and the use of genetically superior sires, 3) allow A.I. at a fixed-time and 4) induce earlier cycles in late calving cows.

Methods

Progestagens, PRIDs (Ceva Ltd) and CRESTAR (Intervet Ltd) are commercially available. CRESTAR is authorised for dairy heifers but not yet for dairy cows in Ireland. Prostaglandins, Estrumate (Pitman-Moore Ltd.), Dinolytic (Upjohn Ltd.) and Prosolvin (Intervet Ltd.) are commercially available. Only animals between Days 5-15 of the cycle respond. Two injections at an interval of 10-12 days induces most animals to respond after the second injection.

Heat response

In cyclic animals PRIDS and CRESTAR induce a heat response of 85%-95%

with the majority (80%) in heat between 24 and 60 hours after treatment. About 10% of animals fail to synchronise but come in heat within one week.

In cyclic cows and heifers the double prostaglandin injection induces a heat response of 80-90%, with about 60% responding between 48 and 72 hours and a further 20% between 72 and 96 hours.

In non-cyclic cows use only progestagens.

Breeding

Fixed-time A.l. at 48 and 72 hours after progestagen removal or one A.l. at 56 hours after a combined progestagen-prostaglandin treatment. Calving rates to fixed-time A. I . are 45-60% in heifers and 35-60% in cows.

Fixed-time A.l. at 72 and 96 hours after 2nd prostaglandin injection. Calving rates are 45-60% in heifers and 35-60% in cows.

Synchronisation applications

The main applications for the use of synchronised breeding are outlined.

Reduce heat checking: Synchronisation allows fixed-time A.l. without reference to heat. Most repeats occur in a confined period, facilitating heat checking. Where calving is compact about 70% of cows and all heifers are available at the start of the breeding season. A synchronised and one repeat breeding would provide adequate replacements.

The greatest potential for synchronised breeding is in heifer replacements, which traditionally are kept on an out-farm and bred by natural service. If they have been produced from proven bulls, it is good practice to breed them in turn to proven dairy bulls in a synchronised programme.

Late calvers: Treating individual late calving cows with a progestagen (PRID) can induce earlier cycles and reduce the calving-to-service and conception intervals.

Compact calving: Because cows must be calved 35-45 days before treatment, depending on the synchronisation product, the proportion available on a given day is restricted. This necessitates treatment of groups of cows at intervals.

Synchronisation 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 inseminations. This requires good basic cattle handling facilities and adequate labour. Synchronisation is only successful under good management; it must always be used as an aid to and never as a substitute for good breeding management.

EMBRYO TRANSFER IN DAIRY CATTLE BREEDING

At the beginning of each oestrous cycle the cow sheds a single ovum. Through superovulation up to 20 ova can be shed which, following fertilisation, are collected as one week old embryos for direct transfer to recipient heifers or cows or for longterm storage.

The combination of single calving and a gestation length of 9 months results in an average production of five calves per cow-lifetime in Ireland. This limits the cow's contribution to genetic improvement. Embryo transfer allows individual cows to produce several calves in one year thereby increasing the cows' contribution to genetic improvement. For a commercial dairy farmer it potentially allows the production of replacements from a smaller number of more select cows. It is widely used by pedigree breeders for the multiplication of individual cows deemed to be of high merit.

Over the past few years embryo transfer has developed from a complex surgical, to a relatively simple non-surgical procedure that can be carried out on the farm. Several companies and veterinary practices now offer a commercial embryo transfer service.

The procedure of *in vitro* fertilization, or IVF, has recently opened up a new source of high quality but inexpensive embryos for commercial use. Ova collected from the ovaries of slaughtered heifers are fertilized in the laboratory using semen from a range of selected continental sires. It is now possible to transfer such beef embryos into that portion of the dairy herd used for beef crossing to produce superior beefcross single calves or a proportion of twins if desired.

Role of embryo transfer in dairy cattle breeding

The greatest role to-date has been in a research context, and this will be even greater in the future. Commercial application of the technique has so far been limited, but the development of non-surgical procedures for embryo collection and transfer and of efficient freeze-storage techniques as outlined, have led to an expansion in its use. The ability to produce continental-cross beef embryos on a large-scale, by IVF procedures, means there is now potential to significantly increase the quality of the beef calf crop. The main roles, current and potential, for embryo transfer in dairy cattle breeding are outlined.

Accelerating genetic improvement: In any cattle breeding programme the rate of genetic change is a function of (1) the accuracy with which parents of the next generation can be selected, (2) the intensity of selection and (3) the generation interval. With the introduction of artificial insemination and progeny testing, cattle breeding programmes can accurately determine the breeding value of bulls.

Because a bull can, through semen dilution, storage, and A.I., breed up to 50,000 cows in a year, few bulls are required to breed any cow population. Furthermore, through progeny testing it is possible to reliably establish the breeding value of a bull for a range of commercially important traits. These two factors viz., the intensity and accuracy of selection mean that most genetic progress in a cattle population comes from sire selection. It is possible to operate a high level of selection intensity, selecting only the top ranked bulls. Thus, bulls in A.I. can be selected accurately, as well as with a high intensity, and can then be widely used within the national herd.

In contrast on the female side little selection is possible because, (a) each cow normally produces only one calf per year (b) 50% of all calves are males and, (c) about 20% of the herd will need to be replaced each year. Until recently the genetic merit of the cow could only be assessed mainly from her own performance data and with relatively low accuracy. The introduction of Cow Genetic Indices (CGIs) in 1989 for Pedigree and Grading up Friesians now make it possible to obtain a better estimate of the genetic merit of a cow for fat and protein production. Increasing the reproductive rate through embryo transfer allows an increased intensity of selection on the female side which gives modest, but in some cases, well worthwhile gains.

Selection of bull dams: This has a direct effect on accelerating the rate of genetic progress in a cattle population because such a bull dam, will through her male progeny, affect the genetic merit of thousands of offspring. Currently, only about 25% of the genetic improvement arises from selection of bull dams, while the remaining 75% comes from progeny testing and selection among the bulls themselves. The use of superovulation and embryo transfer would reduce by 50% the number of bull dams required and by taking care to minimise the rate of inbreeding, the proportion of genetic improvement arising from bull dam selection could be increased from 25% to 30%. This would result in an overall improvement in the rate of genetic gain of the order of 5%.

Most of the young bulls now entering A.I.are the result of planned mating, and the use of superovulation and embryo transfer increases the likelihood of getting a male calf from each cow selected for such planned matings.

Selection of dams to produce female replacements: In a dairy cow population, with a good breeding programme, the theoretical annual rate of genetic gain could reach 2% per annum. However, the realised rate is probably less than 1% because breeders frequently are attempting to simultaneously improve more than one trait. Of this gain, 90-95% comes from sire selection (including selection of their dams) and the remaining 5-10% from selection of dams of cows. Using embryo transfer to increase the selection intensity among females would increase the female contribution towards genetic gain two-fold, from 5-10% to 10-20%. This represents a relatively small improvement and probably not worthwhile considering that other options exist which have a more significant impact on the rate of genetic gain. In addition, exploiting this aspect of embryo transfer would require a very extensive programme, involving most cows in the population as donors or recipients which is impractical.

Individual breeders are currently using embryo transfer for reasons other than solely genetic gain. For example, breeders may be anxious to multiply a particular line of cows within a herd or to produce, for sale, daughters from particular cows.

Quality of beef calves from the dairy herd: Recently, there has been a significant development in the supply and cost of production of superior beef-cross embryos. The ability to retrieve immature ova from the ovaries of slaughtered animals and to mature and fertilize these in the laboratory has added a new dimension to cattle embryo transfer. This procedure of *in vitro* fertilization, or IVF, has opened up a new source of high quality but inexpensive embryos for commercial use. Three-quarter continental beef embryos can now be produced in large numbers from the ovaries of slaughtered heifers. The ova are fertilized in the laboratory using semen from a range of selected continental sires. Obvious uses for such embryos include the production of single high quality beef calves from dairy cows and also the induction of twin-calving. Where twin-calving is planned it is important that the 2 embryos be of comparable gestation length.

As an alternative to A.I. a beef embryo could be transferred to a dairy cow one week after heat. This would allow cows not required for breeding replacement heifers to produce 3/4 instead of 1/2 continental cross calves. Such calves would be expected to produce heavier (+10 kg), leaner carcases of a higher conformation score than Holstein x continental crosses. However, it should be remembered that the incidence of calving difficulty is likely to be higher. Because of this only older cows with a previous history of easy calving should be used.

Twinning in dairy cows: A series of Teagasc experiments showed that lactation yield was not affected in the lactations either concurrent or subsequent to twin-calving though there was evidence that peak yield was lower following twin-calving. The interval to resumption of cyclicity was similar but the calving-to-conception interval was longer in twin- than in single-calving cows. Twin-pregnant dairy cows had an extra energy requirement of about 1500 MJ ME during the last trimester of gestation.

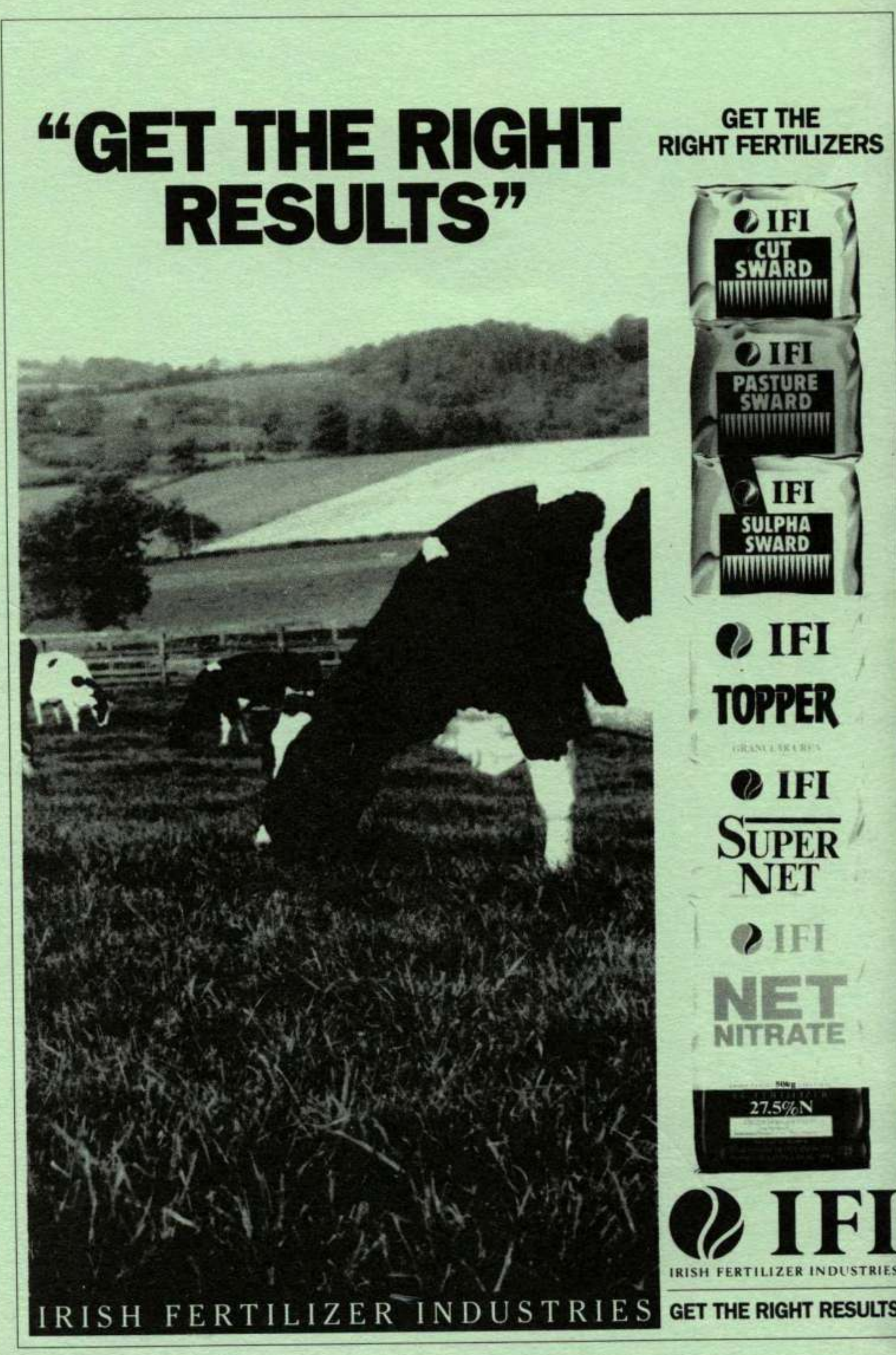
The incidence of retained afterbirth was.higher for twin (about 30%) than for single (about 7%) calving cows and the incidence of calf mortality was somewhat higher for twin (16%) than for single (10%) calves. While the overall level of calving assistance for single and twin calving cows was similar the types of calving difficulty encountered were different. Simultaneous presentation of both calves and/or breach presentation of one calf were the predominant difficulties encountered during twin calving while for single calving, large calf size was the predominant problem.

Many reports clearly show that naturally occurring twins give rise to high rates of calving difficulty, calf mortality and after-birth retention and longer calving-to-conception intervals. There was an indication from the Teagasc studies that subsequent fertility was reduced in the twin-calving dairy cows. Good pre- and postpartum nutrition is critical to minimise adverse effects of induced twinning on calving-to-calving interval. However, most of the problems arise because the twin calvings are unexpected. A considerable body of data is now emerging which indicates that such problems can be avoided by planned management, particularly in relation to feeding.

Reference

O'Farrell, K. The way to controlling dairy herd fertility. Moorepark Farmers Conference, May 1982, pp 43-53.

NOTES



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