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The Potential for Grassland Based Ruminant Production Systems Beyond 2000

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Grassland in all its variety and forms represents one of Ireland's most important national resources. From an agricultural perspective it provides a low cost renewable feed source of high nutritional value and is the corner stone on which our ruminant production systems are based. A range of diverse grassland farming systems exists but typically they have in common pasture grazed *in situ* accounting for the greater portion of the animals' diet. Such systems comprise four components: a physical resource (the environment upon which the production system depends), a forage resource, an animal resource and a management system. The three resource levels are interactive, the degree of interaction being strongly influenced by the system of management (Figure 1). How the system and its individual components might change and evolve in the post millennium era will form the basis of this paper. The production, harvesting, ensilage and feeding of conserved grass in the form of silage, although important to the overall system, will not be dealt with in this paper. Here, our attention will be focused exclusively on grazing.

Physical resource

Ireland occupies a total land area of 6.89 m ha, of which agriculture and forestry account for approximately 92% of the total. Of this, grassland and rough

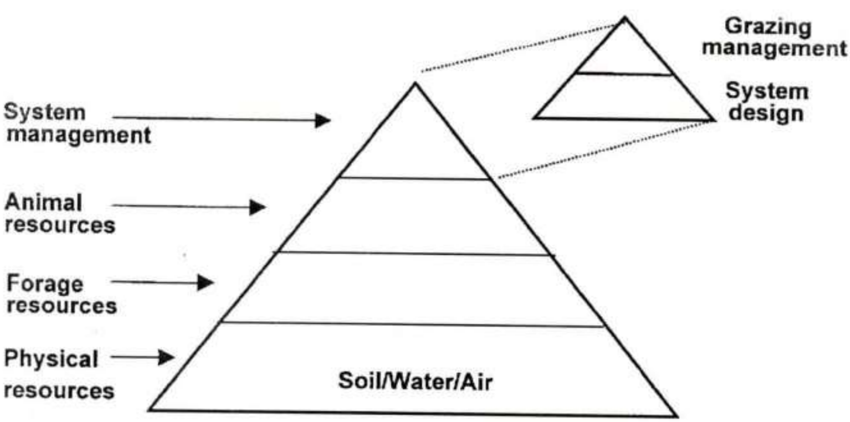

Fig. 1 – A hierarchical structure of grassland systems
Source: Sheath & Clark, 1996

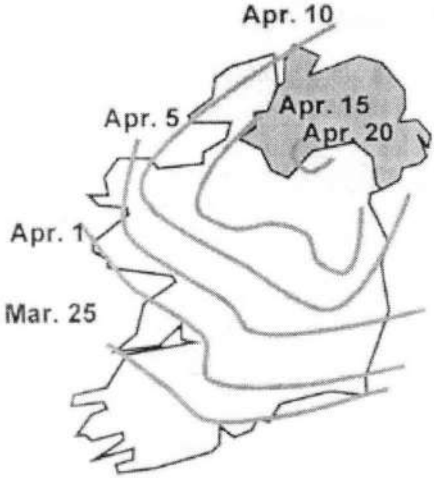

Fig. 2 – Estimated starting dates of the grazing season in Ireland
Source: Brereton, 1995

grazing combined occupy 81% (C.S.O., June 1998). The dominance of grassland is due in the main to the suitability of the climate for producing grass. In terms of physical resources we have few natural advantages over our EU neighbours who are favoured with more agreeable cereal and forage maize growing conditions, but our temperate humid climate, modified as it is by North Atlantic currents, confers significant grass production advantages (Jones and Carter, 1992). Climate largely determines the start and end of the grazing season, beginning in late February/early March in the more favoured south-west and becoming progressively later the further north and east the location (Figure 2).

Even with the application of all available technologies, there exists at least a 3-week gap between north and south. This gap is also present at the end of

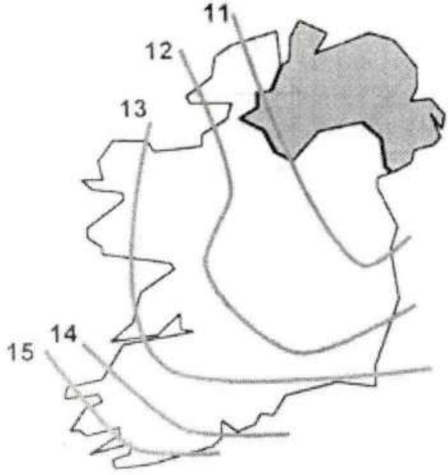

Fig. 3 – Model estimates of annual dry matter grass production (t ha^{-1})
Source: Brereton, 1995

the grass growing season, where again the south-west has up to a 3-week advantage. Thus, for similar soil types, the effect of geographic location means that annual grass yields range from in excess of 15 t DM ha^{-1} in the south-west to less than 11 t DM ha^{-1} in the north-east (Figure 3). In terms of feed costs, the effect of location results in costs ranging from £37 in the south-west to £52 t DMD (digestible dry matter) in the north-east (O'Kiely, 1994; Brereton, 1995). Weather can cause huge variation in year to year annual grass production (i.e. + or - 20% difference from the long-term average) and can alter production costs from £42 in the best grass growing year to £63 t^{-1} DMD in the worst (Table 1). Soil wetness can also increase production costs from £47 on dry free draining soils to £56 t^{-1} DMD on wet heavy clay soils.

Table 1

Effect of location, weather and soil type on grass production costs

	£t^{-1} digestible dry matter
Location	£37 in SW £53 in NE
Weather	£42 in best grass growing season £63 in worst grass growing season
Soil type	347 on dry well drained £56 on wet poorly drained

Source: O'Kiely, 1994; Brereton, 1995

In effect therefore, climatic variation means that the farmer cannot know the quantity or quality of grass that will be produced over the grazing season or the conditions that will prevail for utilization. With the exception of soil drainage, there is little that can be done to control these factors. However, whilst we have little hope of manipulating the effect of climate and location at farm level, the possibility that our climate itself might be changing cannot be ignored.

There is now a considerable body of scientific data to support the hypothesis that a significant change in world climate is taking place. Whether this is due to a natural cycle or is a result of increased concentrations of greenhouse gases is much less clear. Carbon dioxide is the most important of these greenhouse gases and its concentration in the atmosphere, although small, is thought to be increasing by 0.5% per annum of the total carbon dioxide concentration. In Ireland it is predicted that by the middle of the next century the average annual temperature will increase by 2°C and precipitation will increase by 5-10% in winter but decrease by 5-10% in summer. (The average global surface temperature in 1998 set a new record, surpassing the previous record year of 1995 by 0.2°C, the largest increase ever recorded). The effect of such changes, principally temperature and rainfall on crop production, can be simulated using a range of crop climate models. Some of the predictions from a range of models are summarized in Table 2.

Table 2
Simulated changes in dry matter yield of grassland in a changed climate

Model	Climatic Condition	Soil Type	% Yield Change	Source
WATCROS	Temperature rise (3°C)	Sand	+5	Olesen (1990)
	Temperature rise (3°C)	Loam	+2	
	Rainfall increase (30%)	Sand	+20	
	Rainfall increase (30%)	Loam	+8	
Hejmdal	Temperature rise (3°C)	–	-27	Olesen (1990)
	Rainfall increase (30%)	–	+32	
	CO_2 increase (325 ppmv)	–	+54	
Hurley Pasture Model	Temperature rise (2°C)	–	-6	Thornley et al (1991)
	CO_2 increase (250 ppmv)	–	+65	
Johnstown Castle Model	Temperature rise (1°C)	–	+12	McWilliam (1991)
	Temperature rise (3°C) and rainfall increase (30%)	–	+38	

Source: Jones and Carter, 1992

As can be seen, the majority of models are predicting DM yield increases from 2 to 65%. An increase (at modest levels) in total annual DM production is to be welcomed but how will this be distributed over the year? The winters will be wetter; soil type will not change, so utilisation on many Irish farms will continue to be a problem. It is also possible to envisage a situation where summer droughts become a regular feature on many grassland farms and maize silage (grown nation-wide) acts to bridge the summer feed deficit! For many farmers cereals either grown on farm or purchased may offer a better alternative than silage, but how then do we control the massive burst of spring growth which the ensiling process captures?

Exploitation of physical resources from a grassland perspective is increasingly coming under pressure from environmental interests. For example, when cattle graze paddocks either late in autumn or early in spring, they can cause treading damage which displaces surface soil and reduces infiltration rates. As a result, the potential for increased water runoff and sediment contamination of waterways is increased (Lambert *et al,* 1985). Sustainable eco-friendly systems of the future will not countenance such practices if proven to be environmentally unsound. Similarly, amenity and tourism groups exert considerable financial and political pressure (witness the proliferation of golf courses around the country and the designation of specific areas of conservation (SAC)). In the not too distant future it can be envisaged that increasing emphasis will be placed on the protection and even expansion of such areas. This will very likely occur at the expense of developed grasslands

Forage resources

Forage resources occupy the second tier in the hierarchy of interacting levels.

Table 3
The yield potential and estimated proportion of grassland suitability classes

Suitability Class	Yield Potential (t DM ha^{-1})	Ireland	EC-10
		(proportion grassland area)	
A	10 - 12	0.32	0.09
B	8 - 10	0.13	0.19
C	5 - 8	0.21	0.26
D	3 - 6	–	0.22
E	1 - 5	0.34	0.24

[1]Ranking scale from A to E: A = well suited for grassland;
E = very poorly suited to grassland

Source: Lee, 1984

There is little 'natural grassland' in Ireland. What exists has been brought about by the activity of man who cleared forests and cultivated land for crops. Subsequent development of grassland (including moorland) and its maintenance by centuries of biotic influence has resulted in the dominance of the landscape by a range of 'artificial' vegetation types. A dated but still useful classification of grassland types is that presented by Lee (1984) who used climatic and soil data to classify the soils of Europe into 5 suitability classes. These ranged from A = well suited for grassland to E = only poorly suited to grassland (Table 3).

Three soil or land properties were assumed to be of major importance: (i) soil moisture availability, (ii) poaching susceptibility and (iii) accessibility to machinery. Ireland with 0.32 Class A land has the highest proportion of this land category in Europe. Land in classes A and B combined represents 0.45 of total grassland in Ireland and is considered to be free from major limitations to production. These classes compare with 0.28 for the EU-10. In addition, the proportion of Irish grassland classified under Categories D and E is considerably less than that of the EU-10 (0.34 compared with 0.46). Grassland in these categories have a low yield potential between 1-5 t DM ha^{-1} $annum^{-1}$ due to unfavourable soil climatic conditions and are not suitable for mechanisation.

It takes no great insight to appreciate that this resource exists within a dynamic environment in which species competition and quality is related to environmental factors and the system of management imposed. It is important to appreciate that botanical composition is not in itself a prime determinant of productivity but rather it is the means by which the production potential of a given sward is realised. Species and varieties have different inherent yield potentials. All will be most productive on warm, humid highly fertile soils but for any given site with a particular combination, temperature, fertility and management, only one or two pasture species will be capable of expressing the full site potential. This is an important consideration since in less favoured situations species other than *Lolium perenne* (perennial ryegrass) may prove to be more suitable. Under simulated grazing, several secondary grass species have been shown to out-yield *Lolium perenne* at 0 and low N levels (Table 4).

Table 4

Annual dry matter yields (second year) of a range of secondary grass species under simulated grazing at different N rates (kg ha^{-1})

N rate (kg ha^{-1})	0	120	480	0	120	480
Grass species (*Lolium* = 100)		DM			DOM	
Lolium perenne (L)	100	100	100	100	100	100
Agrostis stolonifera (L)	140	93	77	71	79	68
Cynosurus cristatua (L)	149	82	84	81	76	80
Festuca rubra (L)	134	100	91	70	92	84
Poa pratensis (L)	87	81	96	43	70	88
Holcus lanatus (L)	217	100	90	115	92	85

Source: Frame and Tiley, 1988

Lolium with a higher OMD% was superior in DOM yield when N was applied. The quality of secondary species is also known to decline rapidly in early season. Given a future scenario of low input extensive grassland farming (REPs etc.) on one hand and intensive grassland utilisation (driven by N) on the other, it can be expected that secondary grass species will attain greater prominence relative to *Lolium* (or some 'new' primary grass?). Factors of animal acceptability and ease of grazing management will require consideration - the challenge being to maintain secondary grasses in a young tillering state - new sward height guidelines may be required.

An increasing reliance on grass/clover swards can also be anticipated in situations where extensive grassland management is practised. Grass/clover swards can reduce production costs by savings made on N fertiliser and improved growth rates due to the higher feeding value of the clover. Under cutting, grass and clover swards have been shown to give DM yields equivalent to monocultures of grass receiving 200 kg N annum^{-1} (Morrison, 1981). How these advantages can be incorporated into grazing systems still requires work. For many, systems based on grass/clover are seen as carrying high levels of risk, with year to year variations in herbage and livestock production greater than that from N fertilised swards. However, Davies *et al.* (1992) have shown that over 6 years at Bronydd Mawr (Wales), lamb production from grass/clover pasture varied from 80-114% compared with 75-125% for grass swards receiving 200 kg N ha^{-1}.

Poor growth of grass/clover swards in the spring is also a major constraint limiting production at present. Longer term (with climate change?), an increase in mean soil temperature will go some way to easing this problem. However, in the short to medium term there is much that can be done with strategic use of N fertiliser and the inclusion of more N tolerant clover varieties. Progress has also been made in breeding for improved winter hardiness and spring growth (Rhodes and Webb, 1993).

The impression amongst many is that to opt for extensive systems, technology is 'thrown out the window'. The opposite is in fact the case and a greater degree of technical and management skill is required to successfully manage a grassland system based on clover as opposed to N fertiliser. In the future we can expect clover-based systems to evolve which incorporate both continuous and rotational grazing, swards being continuously grazed in the spring and early summer in order to encourage clover development, and then rotationally grazed in order to efficiently utilise the resultant supply of herbage.

On intensive grassland farms *Lolium* will continue to be the predominant species of choice, principally because it is highly productive in response to N fertiliser, has high acceptability to stock, is relatively persistent if soil fertility is high, is tolerant of intensive grazing and cutting, exhibits rapid establishment and has good tillering ability. Under non-limiting conditions of light, soil, moisture and temperature, potential biomass production from *Lolium* dominant swards has been shown to be in the order of 65 t DM ha^{-1} (Parsons, 1988; Gordon, 1996). However, because of loss processes associated with respiration and senescence, harvestable yield is only 20% of potential at 13 t DM ha^{-1} (Table 5). There is clearly huge scope for reducing losses.

Table 5
The potential within a *Lolium* dominated sward defoliated at intervals

	t DM ha^{-1}
Total photosynthesis	65.0
Respiration	
Shoot	-27.6
Roots (including growth)	-8.1
Shoot decay	-16.3
Harvested yield	13.0

Source: Parson, 1988; Gordon, 1996

In Ireland, under optimum conditions, production from grass swards can be very high. Culleton and Murphy (1987) recorded DM yields of 17.5 t ha^{-1} from *Lolium multiflorum* while Collins (1985) has obtained 17.2 t DM ha^{-1} from *Lolium perenne*. At farm level, production is significantly less than this, varying from 15 t DM ha^{-1} in the extreme south-west to less than 11 t DM ha^{-1} in the north-east (Brereton, 1995). The potential for improvement is great. For the best farmers using modern technology, a realistic target is likely to be near 20 t DM ha^{-1} (Leafe, 1978).

Is there scope to increase harvestable yield? Grass output has been near static for decades. The best yielding maturing variety on the 1998 Irish Recommended List is the tetraploid Anaconda which, relative to the highest yielding variety in 1994 Bastion, increased production by 0.41 t^{-1} DM ha or 0.03 t DM ha^{-1} $annum^{-1}$ over the intervening period, hardly a dramatic increase in production (Table 6).

Table 6
Relative increase in annual yield (t DM ha^{-1}) of highest yielding early perennial ryegrass variety on 1998 Irish Recommended List

Year	Variety	t DM ha^{-1}
'84'	Bastion	16.70
'95' - '98'	Anaconda (T)	17.11

Source: Irish Recommended list, 1984-1999

A similar story exists with regard to late heading varieties. In terms of overall system production costs, yield of DM ha^{-1} is important and if it cannot be improved by conventional means, alternative methods such as genetic manipulation or biotechnology should be investigated.

Other criteria are also important. Ulyatt (1981) suggested that an ideal plant would have:- "high protein content, particularly increased sulphur amino acids; high levels of soluble carbohydrate; some features such as thicker cell walls in the soft tissues or presence of tannins that would either slow the release of soluble protein or render it less soluble; an easily ruptured epidermis, vascular tissue that is sufficient to maintain agronomic merit but is fragile to terms of (sheer) strength; concentrations of minerals sufficient to maintain animal health."

Add to this a canopy architecture that affords easy prehension to the grazing animal and the problem would be solved. If only! We are now 18 years further on and still awaiting significant progress. However, there are several interesting developments in the pipeline, whilst not necessarily enhancing the role of grass, should ensure its long-term survival in our systems of production. Research at IGER has found that some grasses and forage crops contain high levels of polyunsaturated fats and that feeding cattle on these crops causes the beef itself to contain higher levels of these healthier fats. Green plants are a rich source of these beneficial acids and early studies show that a small but useful amount of forage is absorbed by the cattle and appears in beef. Collaborative work between IGER and Teagasc Grange is ongoing in this area.

A major problem with our current statutory herbage evaluation system is

Table 7
Cattle grazing preference among 20 ryegrass cultivars

Cultivar	Heading date	Ploidy	Preference ranking*
Condessa	Late	Tetraploid	1
Bastion	early	Tetraploid	3
Hercules	Late	Diploid	7
Respect	Mid	Diploid	19

*1=highest preference; 20=least desirable

Source: O'Riordan, 1996

Table 8
Varietal effects on short-term intake

	Variety A	Variety B	sem
Sward height (mm)	238	243	4.4
Live leaf (%)	64	61	3.6
Intake/bite (g DM)	0.8	0.9	0.06
Biting rate (btes min^{-1})	48	52	2.9
Intake/hour (kg DM)	2.3	2.7	0.12

that it is based on assessment under a cutting regime. For varieties to sell and make money for the breeder, they have to be submitted for evaluation and essentially found to yield better than the current control variety, have high digestibility and reasonably persistency. Nowhere in our current evaluation process does the end-user have anything to say about the quality on offer. We are all familiar with the concept of the customer having the final say with regard to quality, real or perceived. Why therefore do we not apply the same rational to our four legged brethren? Some work carried out in Grange a few years ago clearly showed animal preference for some varieties over others (Table 7).

What are animals displaying here? Call it preference, choice or palatability, but they are making definite choices. It is not practical or financially viable to run statistically robust animal grazing trials to determine the intake potential of all varieties submitted for testing. We need an alternative approach: how to gather affordable and repeatable measurements of animal intake for a range of species, varieties or sward states? An experimental protocol developed to measure short-term intake (1 hour) may offer some potential if the results in the short-term can be correlated with daily intakes (Table 8).

Under experimental conditions, variety B had a significant higher intake potential than variety A. There is a need to confirm that differences in intake $bite^{-1}$ also apply over the longer term but in due course, grasses will be bred for increased intake at grazing.

Animal resources

The animal component, our third tier in the system hierarchy, determines the demand which will vary for animal type, genotype, sex and physiological state. Forage resource, location and management will all impact on the success of the farmer in providing for the demand of the animal. Without dwelling unduly on this resource, it is pivotal to the system and without ruminants to convert grass DM to animal product, grass would have little value.

In terms of ruminant livestock numbers, Irish grassland supports in the region of 7.8 m cattle, the vast majority of which are found in beef enterprises. Sheep account for approximately 8.3 m individuals and others such as horses, deer, and goats approximate to 0.112 m (Table 9). In terms of L.U. equivalents, cattle

Table 9
Ruminant livestock numbers in Ireland June 1998

	'000 head	L.U. Equivalent
Cattle	7795	5646
Sheep	8373	1587
Others	112	80
Total	16280	7313

National stocking rate = 0.6 ha/LU (1.5 ac/LU)

Source: CSO, June 1998

account for 5.6 m compared with 1.6 m sheep. This equates to a stocking rate on the grassland and rough grazing component of utilised agricultural land of 0.6 ha/LU or 1.5 ac/LU.

Ruminant production accounts for 0.92 of gross agricultural output equivalent to £3 billion. More than half of this is accounted for by beef, followed closely by dairy and lastly sheep (Table 10). These data serve to illustrate the importance of grass to the competitiveness and sustainability of our production systems.

Table 10
Ruminant production as % of gross agricultural output 1998

	% Total*
Dairy	34
Beef	49
Sheep	9
	92 (=£3 billion)

*estimate

Source: Fingleton and Cushion, 1998

I would argue that over the last 10-15 years, researchers and leading farmers have focused more on the animal, looking to breed type and genetic potential to make a contribution to overall farm profitability. In the dairy industry, high genetic merit cows have been introduced which are very efficient at producing milk. Arguably, these animals are of an extreme type with a high-energy demand and perhaps less suited to low input systems than the more traditional cow. Certainly there appear to be fertility and longevity problems associated with these animals. Relative to existing standards they have the potential to produce an extra 5 l milk day^{-1}, i.e. a 16% increase in milk yield (Table 11). Such animals have an increased intake demand which has to be met from grass. In the main this is achieved by providing increased allowance of high quality feed.

In truth this has been achieved by exploiting existing potentials within the grass crop, not by increasing the grass potential *per se*. Put differently, we are

Table 11
Increasing genetic merit – what happens?

	PIN^*_{95} £9 vs PIN_{95} £61
Milk yield	+ 16% (5 litres/day more milk)
Food intake	+ 4.2%
Milk yield/unit food consumed	+ 11%
Liveweight change (kg/day; 150 days)	+0.34 vs -0.02

* Profit index

so busy trying to service the increased animal potential that nobody is able to step back and look critically at our raw material with regard to increasing the potential of the grass crop itself! In general it would appear that the genetic potential of breeding stock in all grassland systems of production is set to increase, be it yield of milk, beef or lamb. It is therefore likely that in the future there will be increased specialisation of breed type for specific purposes and that the great diversity (inconsistencies) witnessed in our beef herd will become a thing of the past.

Management system

It is outside the remit of this review to address specific and detailed management issues. However, certain management practices may well change and evolve in the times to come and so it is relevant to at least consider the essentials. Management system is the uppermost tier in our pyramid which can be sub-divided into system design and grazing management. A profitable system will be a compromise between the feed demand of the grazing animal and the pasture supply pattern (+supplementation?). Grazing management is the fine tuning mechanism and relates to the day-to-day decisions such as 'where and when to move the grazing animals'.

It is a tall order to develop efficient grassland systems that consume current growth when approximately 60-79% of annual production occurs in 4 months. Consequently, systems have evolved to the stage where decisions on oversupply (and deficit) have to be made and implemented. However, the difficulty lies in the fact that within grassland systems there are fewer options available than in the more complex production systems that use a range of inputs, produced either on the farm or produced from outside sources.

In simplistic terms, inputs into grazing systems can be distilled into stocking rate, nitrogen (clover), rotation length and severity of defoliation. These are the factors under farmer control. By balancing these inputs the farmer has to satisfy 3 basic objectives:

1. To achieve the correct balance between the land resources available and stock numbers on the farm. Nitrogen is the controlling factor here,
2. To ensure that sufficient silage is produced for the winter period.

3. Adjust stocking rate during the season to keep feed demand and supply in the grazing area in balance as herbage growth rates change.

The land resources available and stock number on the farm are fixed. These factors in conjunction with N determine stocking rate. High stocking rates can only be sustained with high levels of N fertiliser (@ 400 kg ha^{-1}) but at low stocking rates a much reduced input of N or increased dependence on clover will suffice (Table 12).

Table 13 summarises the current situation existing within the EU in relation to legislation enacted or pending to regulate fertiliser inputs.

Table 12
Stocking rate and Nitrogen requirement

Stocking rate L.U./ha	Nitrogen kg ha^{-1}
1.5	0
2.1	100
2.4	225
2.8	300
3.0	390

Table 13
Sample of legislation enacted or pending to regulate fertiliser input

Country	
Norway	Environment tax on N fertiliser
Sweden	Environment tax on N fertiliser Levy on Cadmium in phosphate fertilisers
Netherlands	Mineral balance administration system
Belgium	Mineral balance administration system
Ireland	Cork County Council - restrictions on N & P

Result – long term downward pressure on inputs

From the grass farmers' perspective, N inputs, one of the few tools at his disposal to control grass supply, is likely to become restricted to a greater or lesser extent. It will therefore be important to increase the efficiency of use of fertilisers, organic manures and slurries. Techniques for rapid in-field analysis of soil mineral N have been developed, which enable fertilisers to be used only in the amounts required to supplement soil supplies of nutrients in relation to herbage production targets. Potentially there are savings of up to 40% of fertiliser N use in intensive systems with no loss in production and major environmental benefits. The impact of GATT, CAP, Agenda 2000 and general consumer perceptions must also be considered.

Aside from the input of N, there are not many input variables left at the farmer's disposal. In terms of a daily budget, sward height and rotation length are the main control parameters. Certainly, some of our current guidelines will alter depending on the intake requirements of any particular group of animals. High merit cows at grass require access to tall leafy pasture and cannot be forced to graze as tightly as current recommendations suggest without adversely affecting performance. Leaving a high residual herbage mass will cause its own problems with regard to sward quality and will have to be removed. This may necessitate a second group of animals behind the leading group to clean out swards. This is simple in theory but will further complicate the grassland systems of the future. Aids to increase the precision management of grassland farming in the future will include increased use of strategic and decision support models, equipment for rapid analysis of forage quality and ensiling potential, and for the assessment of herbage yield and green leaf mass for grazing.

Conclusions

We must look beyond management issues to sward genetics to afford significant progress in grassland production systems, the objective being to raise the genetic quality and potential of the grass crop. In the short to medium term, factors outside farmers' control are going to dictate the curse and direction of change with emphasis being placed on animal welfare and the environment before the economics of ruminant production at farm scale. Grassland systems have in the eyes of the public a green clean image and perhaps this will allow the product to attract a premium price over and above other more intensive systems of production. It is difficult to envisage major changes with our systems given the relatively few input variables at farmers' disposal. Consequently, it will be up to the breeders and nutritionists to 'design' the herbage varieties of tomorrow. However, it is the responsibility of the grassland/grazing researcher to set the targets - tell the breeder what is required. To do this requires a vibrant and visionary research programme that is adequately funded.

References

Brereton, A. J. (1995). Regional and year-to-year variation in production. In: *Irish Grasslands their biology and management* (Eds. D. W. Jeffrey, M. B. Jones and J. H. McAdam). pp. 12-22. Royal Irish Academy, Dublin.

Collins, D. (1985). Forage production in temperate climatic zones. *Research Report 1984.* An Foras Taluntais, Dublin.

C.S.O., June (1989).

Culleton, N., and Murphy, W. F. (1987). Effects of seeding rate and of mixtures of *Lolium multiflorum* Lam. and *Lolium perenne* L. on productivity. *Irish Journal of Agricultural Research* 26, 93-104.

Davies, D. A., Fothergill, M. and Morgan, C. T. (1992). Assessment of contrasting perennial ryegrass, with and without clover, under continuous sheep stocking in the uplands. 4. Animal performance in years 4-6. *Grass and Forage Science* 47, 245-258.

Fingleton, W. A., and Cushion, M. (1988). *Irish Agriculture in Figures.* Rural Economy, Teagasc.

Frame, J. and Tiley, G. E. D. (1988). Herbage productivity of secondary grass species. *Proceedings of 12th General Meeting European Grassland Federation, Dublin Ireland.* pp. 189-193.

Gordon, F. J. (1996). Potential milk production from grass and limiting factors. *Irish Grassland and Animal Production Association Journal.* 30, 103-114.

Jones, M. B. and Carter, T. R. (1992). European grassland production in a changing climate. *Proceedings of 14th General Meeting European Grassland Federation.* pp. 97-110. Lahti, Finland.

Lambert, M. G., Devantier, B. P., Nes, P. and Penny, P. E. (1985). Losses of nitrogen phosphorous and sedimentary run-off from hill country under different fertilizer and grazing management regimes. *New Zealand Journal of Agricultural Research.* 28, 371-379.

Leafe, E. L. (1978). Physiological, environmental and management factors of importance to maximum yield of the grass crop. In: *Maximising yields of crops.* ADAS-ARC Symposium, Harrogate, H.M.S.O., London.

Lee, J. (1984). Suitability and productivity of land resources of EC-10 for grassland use. *A study carried out on behalf of the European Community.* pp. 101-131. Johnstown Castle Research Centre. An Foras Taluntais, Dublin.

Morrison, J. (1981). The potential of legumes for forage production. In: Legumes and fertilisers in grassland systems. Winter Meeting 1981, British Grassland Society, Hurley, U.K. pp. 1-10.

O'Kiely, P. (1994). The cost of feedstuff for cattle. *Technical bulletin No. 6.* R&H Hall, 151 Thomas St., Dublin, Ireland.

O'Riordan, E. G. (1966). Cattle grazing preference among ryegrass cultivars. *Agriculture Research Forum,* UCD, Dublin. pp. 49-50.

Parsons, A. J. (1988). The effect of season and management on the growth of grass swards. In: *The Grass Crop* (Eds. M. B. Jones and A. Lazenby). pp. 129-177.

Rhodes, I. and Webb, K. J. (1993). Improvement of white clover. *Outlook on Agriculture* 22. 189-194.

Sheath, G. W. and Clark, D. A. (1996). Management of grazing systems: Temperate pastures. In: *The ecology and management of grazing systems* (Eds. J. Hodgson and A. W. Illius). pp. 301-323. CAB International, Wallingford, U.K.

Ulyatt, M. J. (1981). The feeding value of herbage: can it be improved? *New Zealand Journal of Agricultural Science* 15, 200-205

Maximising the Potential of Farm-Produced Forage with New Varieties

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1) INTRODUCTION

Herbage plant breeding has made a significant contribution to the profitability of grassland agriculture and ruminant production and the Welsh Plant Breeding Station, now the Institute of Grassland and Environmental Research (IGER), founded by Sir George Stapledon in Aberystwyth in 1919, has played a major role in this success. The long term nature of plant breeding programmes necessitates that breeders plan well ahead when setting breeding targets. This is made difficult because political pressures and policies over the last 80 years have had more impact on grassland agriculture than changes brought about by the industry itself. The development of forage plant breeding can therefore be looked at in three distinct phases:

a) Breeding in an era of increasing production

For the first fifty years after the founding of the Welsh Plant Breeding Station, plant improvement was targeted towards providing varieties which would increase ruminant output per hectare. This resulted from the need to increase food production during and after the Second World War. Breeding concentrated primarily on increasing dry matter yield (Breese, 1968) and this generally gave varieties with high growth potential up to flowering. Research in the 50's and 60's showed that ryegrass species were the most useful in temperate regions because they produced good yields of high quality forage (Raymond, 1969; Walters, 1975) and responded well to nitrogen fertilizer. Therefore, from the mid 60's onwards there was a rapid decline in the use of other species and at present over 90% of the grass seed sown in the UK is made up of perennial ryegrass, Italian ryegrass, and hybrids between these two species (MAFF 1997).

b) Breeding in an era of overproduction

Over production of ruminant products from the early 70's onwards has led to a major change in breeding objectives. Current targets aim at increasing the efficiency of ruminant production to maintain farm profitability without necessarily increasing output. While a good dry matter yield is still necessary, traits like nitrogen use efficiency (Wilkins *et al,* 1997), quality (Wilkins, 1995; Humphreys, 1996) and an extended growing season have become the major targets.

c) Breeding in an era of agricultural sustainability

Present thinking on the future direction of grassland farming suggests that there will be an increasing emphasis of sustainable production systems where both the output of agricultural products and the development of the rural countryside will be given equal consideration. A sustainable grassland agriculture will encompass the whole range of farming systems from low to high input and all of these will rely increasingly on farm produced feed. Plant breeding objectives must therefore endeavour to develop new varieties which satisfy all these requirements.

2. RECENT DEVELOPMENTS IN GRASS VARIETY PRODUCTION

Grass varieties currently emanating from breeding programmes at Aberystwyth reflect the emphasis placed on improving the efficiency of production of ruminant products. The multidisciplinary approach to plant breeding at Aberystwyth has enabled a wide range of breeding objectives to be considered. Basic research on genome mapping and genetic engineering provides the know how and material for selecting for novel traits while the ruminant nutrition group has enabled breeders to give increased attention to traits which influence the efficiency of the ruminant animal.

a Nitrogen use efficiency (NUE)

Nitrogen is a key requirement both for plant growth and as a building block for plant proteins. Making more efficient use of nitrogen both inorganic and organically fixed by white clover will both lead to cheaper fodder and hopefully reduce nitrogen leaching thereby assisting with environmental protection. One approach to improving nitrogen use efficiency (NUE) is to even out the normal seasonal growth curve of ryegrass to give increased early spring and autumn production whilst maintaining high yields for conservation. AberElan, the first variety to be developed from this programme shows improved nitrogen recovery at low and high levels of inorganic nitrogen application and improved grass clover compatibility (Fig. 1). The latest variety, AberDart, combines high yields of good quality forage with significantly better spring and autumn production than other comparable varieties (Fig. 2).

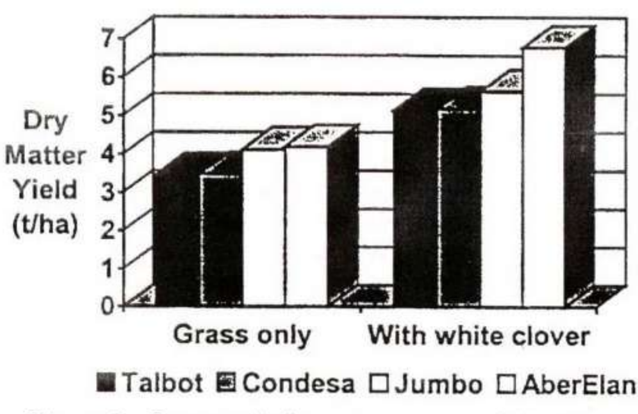

Figure 1 – Improved nitrogen recovery of AberElan

b) Herbage quality

During the last thirty years, breeders have concentrated on improving the energy value of forage and the value of this to the ruminant animal is a product of intake x digestibility x utilisation. Research in the 60's and 70's (Green,

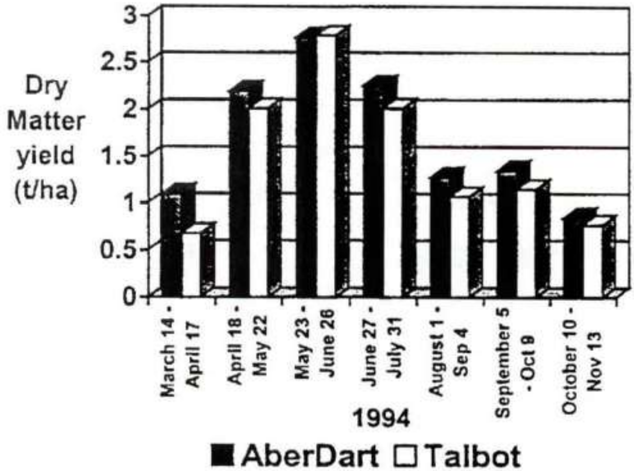

Figure 2 – Seasonal yield of AberDart

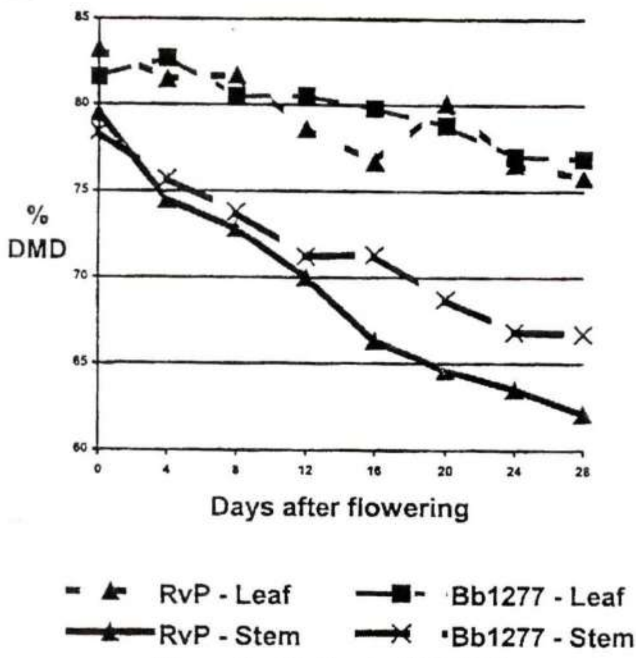

Figure 3 – Decline in % D.M.D.

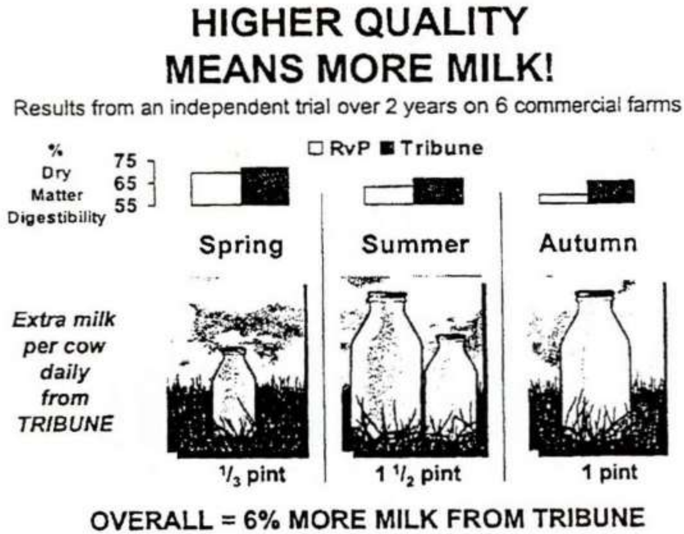

Figure 4 – Milk production from Tribune and RvP

1968) established that digestibility declined as yield increased and breeding would therefore need to look at the balance between yield and quality. Laboratory based pepsin-cellulase techniques were developed enabling cheap and repeatable measurements to be made on breeding material. It was also found that the water soluble carbohydrate content (WSC) of grasses is an important element of digestibility being the readily digestible component of the plant cell. Present breeding programmes have had considerable success in using these techniques for improving nutritive value of perennial, Italian and hybrid ryegrasses.

In Italian ryegrass, material collected in the Po Valley region of Italy (Bp1277) was found to have high levels of stem digestibility and WSC combined with high autumn yield, rapid regrowth and good persistency but had poor conservation yield, poor disease resistance and low cold tolerance. It was also found that the high stem digestibility which is so important for good silage production was slower to decline than in other comparable varieties (Fig 3). A concentrated breeding programme using this material had led to three varieties which are currently on UK Recommended Lists (Tribune, Trajan, AberComo). Tribune, the first of these, was tested on six commercial dairy farms and gave significantly higher milk yields than a commercial variety used widely at the time (Fig. 4). This information has helped to confirm the benefits of high DMD & WSC and has led to the development of the other two varieties. These varieties have been a significant step forward in providing a long grazing season combined with high conservation yields of high quality forage.

Perennial ryegrass material collected in Switzerland and Hungary was found to have high levels of WSC but poor disease resistance and work at IGER (Munro *et al,* 1992) showed clearly this material had the potential to improve lamb production (Fig. 5) giving breeders the incentive to develop these lines. Breeding

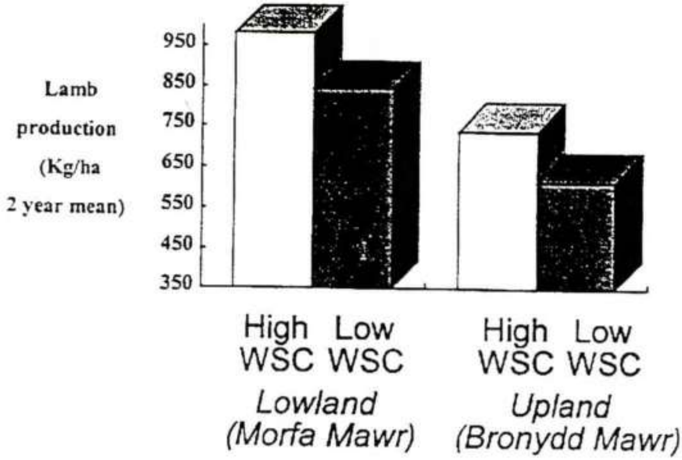

Figure 5 – Lamb production from perennial ryegrass with contrasting WSC content

aimed at improving dry matter yield and its distribution and disease resistance whilst maintaining the high WSC levels has led to the development of a late flowering diploid ryegrass variety which is currently in official trials in the UK. An experimental variety of perennial ryegrass exhibiting high levels of WSC throughout the growing season is currently being fed to dairy cattle in a zero grazing trial at IGER in a project funded by MDC, MAFF and Germinal Holdings. Early results (Table 1) are extremely encouraging showing significantly higher milk production from this variety than the IGER variety AberElan which has the best simulated grazing yields on the NIAB recommended List. This work has also shown that dairy cattle have greater intakes on the high WSC material than AberElan and are converting more of the plant protein into milk as shown by the reduced production of ammonia and N in the urine

Table 1
Mean effect of treatment on feed intake, diet, dry matter digestibility, milk yield and milk consumption, adjusted for covariate

Grass Variety:	AberElan	AberDove	s.e.d.	Sig†.
Forage DM intake, kg/d	10.8	12.5	0.65	*
Diet DM digestibility, g/g	0.64	0.71	0.014	**
Digestibility DM intake, kg/d	9.16	11.31	0.381	**
Milk yields, kg/d	12.6	15.3	0.87	*
Milk yield/digestibility DM Intake, kg/kg	1.38	1.35	0.065	

†Significance of effect: *=P<0.05, **=P<0.01

Table 2
Mean effect of treatment on N partitioning

Variety:	AberDove	AberElan	s.e.d.	Probability
N intake, g/d	268	278	14.2	0.530
N output, g/d				
Urine	71	100	5.0	0.001
Faeces	103	113	10.9	0.400
Milk	82	69	6.2	0.075
Total	256	282	9.4	0.035
N balance, g/d	12	-4	10.3	0.180

(Table 2). This early finding has important implications for future breeding objectives where the target of improved rumen efficiency is now a viable option. A new variety, AberDart (Fig. 6), which combines high levels of digestibility and WSC with high dry matter yield and a long growing season will be available in the UK in 2000.

*c) **Hybrid ryegrass***

Hybrid ryegrasses are relatively new species where the aim has been to combine the best attributes of perennial and Italian ryegrass. Italian ryegrass possesses considerable growth potential with a long growing season but its persistency in response to grazing and climatic stress is limited, while re-growth is often stemmy and of low quality. Perennial ryegrass is more leafy, persistent and shows better environmental stress tolerance but does not have the growth potential of Italian ryegrass for conservation. The aim is therefore to provide flexible varieties suitable for both grazing and conservation with improved stress

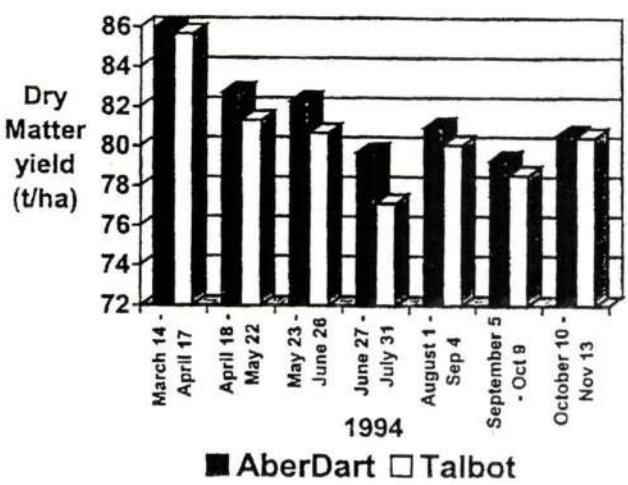

Figure 6 – Seasonal trends in digestibility

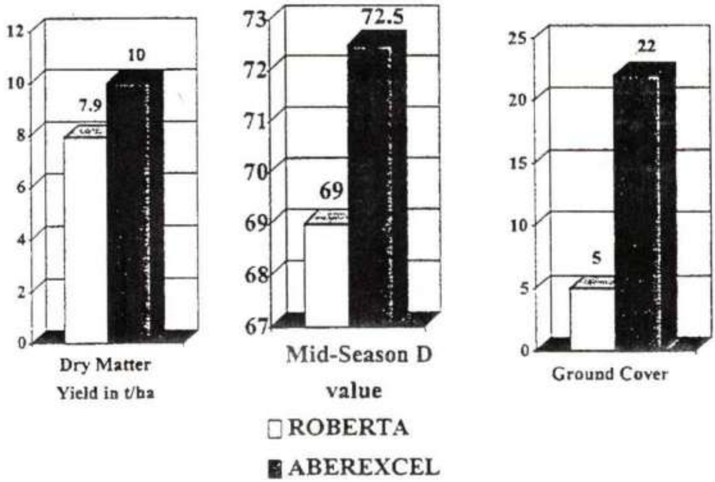

Figure 7 – Performance of AberExcel in 4th harvest year

tolerance giving a life span of between 4 and 6 years. The first varieties developed at IGER were closer in type to the Italian ryegrass parent and Augusta, which has been widely used for a number of years, showed improved intake and quality leading to improved beef live weight gains compared to diploid Italian ryegrass on six commercial farms. New hybrids being developed at IGER are a significant improvement on Augusta and combine the best traits of the two parent species. The newest of these, AberLinnet and AberExcel, have recently been recommended for use and combine high mid-season 'D' value and WSC content with a long growing season, high conservation yields and good persistency (Fig. 7). At present ryegrass hybrids are being underutilized and there are considerable opportunities in the dairy sector where a long grazing season combined with high quality conservation is essential.

4) FUTURE DIRECTION AND OPPORTUNITIES

There are some exciting but increasingly challenging opportunities for herbage breeding in the new Millennium with an increasing emphasis on agricultural sustainability and the consequent increased dependency on home produced ruminant feed.

a) Efficient use of forage production

A key element in the efficiency of these systems will be to optimise the protein/energy balance in the rumen. While breeders have made significant advances in improving the energy value of grasses through improved digestibility and water soluble carbohydrate (WSC) content, recent developments following the BSE crisis and the reduced public acceptance of using feeds like fishmeal suggest that there is now an urgent need to produce more on-farm plant protein. Increasing the usage of legume protein is one method of satisfying this demand

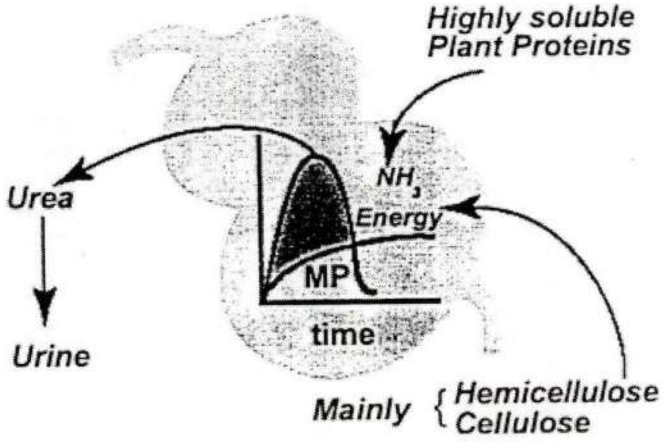

Figure 8 – Ruminal N metabolism

but sustainable systems of ruminant production are impeded by generally low utilisation of forage protein. Up to 40% of the dietary nitrogen (N) in fresh forage may be lost as ammonia because of the inability of rumen microbes to capture the non-protein nitrogen (NPN) release during the proteolysis of plant proteins (Fig. 8). Leaf proteins are rapidly attacked by plant and microbial proteases on ingestion. If release of NPN and energy in the rumen are asynchronous, large quantities of ammonia may be absorbed before microbe assimilation into protein occurs. Significant improvements in the use of forage protein can be made by providing additional energy to increase the N capture by rumen microbes. The development of high WSC accumulating gasses (Humphreys, 1989) has, to some extent, achieved this but further potential to increase utilisation of forage protein by breeding to reduce protease activity may also exist. The important role that plant proteases can have in rumen protein degradation has only recently been appreciated (Theodorou *et al,* 1996), although proteolysis mediated by plant enzymes during ensilage is well documented (Wetherall *et al,* 1995). Breeding grasses to modify plant protease activity could therefore have far reaching consequences in terms of efficient use of N in animal production. For example, a naturally occurring mutant gene has been transferred from meadow fescue to ryegrass which reduces the normal breakdown of chlorophyll binding protein during leaf senescence and thus reduces leaf protein degradation (Thomas & Smart, 1993). The combination of high energy (WSC, digestibility) with reduced protein degradation in one variety is an exciting prospect.

b) Healthier ruminant products

At present the consumption of ruminant products is suffering severely in the aftermath of the BSE crisis with a need to demonstrate that meat and milk are safe, healthy products. Supermarkets and consumers are increasingly dictating the quality of the product they require so breeders must begin to develop

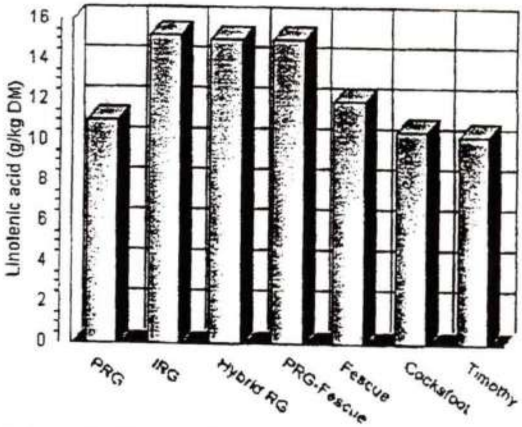

Figure 9 –Linolenic acid levels in grass species

new and novel breeding objectives. For instance, ryegrass species, especially Italian ryegrass, contain high levels of unsaturated fatty acids which could help reduce blood cholesterol levels through their incorporation into ruminant products (Fig. 9). Thus, plant breeders are currently developing selection criteria for increasing the levels of omega-3 linoleic acid in their breeding material.

c) Improved ruminant intake

Having increased the yield and quality of grasses and lengthened the growing season, plant breeders would dearly like to increase the intake of the ruminant animal to improve utilisation. Breeding for intake has, however, been hampered by a lack of knowledge about the traits that control it. Grazing behaviour research both at IGER North Wyke (Penning *et al,* 1998) and in Ireland is giving a valuable insight into these factors that influence variation in intake by ruminant animals. In the near future we should be able to determine which plant traits are important and therefore begin to actually improve this important component of ruminant production.

CONCLUSION

Plant breeding has and is making a significant contribution to maintaining the profitability of the grassland sector. Future changes in CAP payouts and consumer preferences will dictate that farmers will have to rely increasingly on home-produced ruminant feed to remain viable. As Ireland probably has the best climate for forage production within the EU and certainly some of the best farmers then this should pose no major challenge. There is however a need to give grass a true status as a crop which forms the cornerstone of ruminant farming. To maximise the potential of this crop farms should have a realistic reseeding policy to ensure that they keep up with the developments being introduced into new varieties by plant breeders.

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References

Breese, E. L. (1968). Improving Britain's grassland output. SPAN II, 3.

Green, J. O. (1968). Yield and digestibility. Grass Conservation Handbook. Nat. Grass. Cong. Conference, Bristol 1967, 22-30.

Humphreys, M. O. (1989). Water-soluble carbohydrates in perennial ryegrass breeding. II. Cultivar and hybrid progeny performance in cut plots. Grass and Forage Science, 44, 37-244.

MAFF (1977). Seed Traders Annual Return Summary.

Miller, L. A., Neville, M. A., Baker, D. H., Evans, R. T., Theodoru, M. K., MacRae, J. C., Humphreys, M. O. and Moorby, J. M. (1999). Milk production from dairy cows offered perennial ryegrass selected for high water soluble carbohydrate concentrations compared to a control grass.

Munro, J. M. M., Davies, D. A., Evans, W. B. and Scurlock, R. V. (1992). Animal production evaluation of herbage varieties. I. Comparison of Aurora with Frances, Talbot and Melle perennial ryegrass when grown alone and with clover. Grass & Forage Science, 47, 259-273.

Penning, P. D., Gibb, M. J., Parsons, A. J., Orr, R. J. and Harvey, A. (1998). Behavioural and physiological factors limiting intake by grazing ruminants. In: Extensification of Beef and Sheep Production on Grassland. Occasional Publication No. 3, EU Concerted Action CT93-0947, Dublin, Sept. 1996.

Raymond, W. F. (1969). The nutritive value of forage crops. Advances in Agronomy, 21, 1-107.

Theodorou, M. K., Merry, R. J. and Thomas, H. (1996). Is proteolysis in the rumen of grazing animals mediated by plant enzymes? British Journal of Nutrition, 75, 507.

Thomas, H. and Smart, C. M. (1993). Crops that stay green. Annals of Applied Biology, 123, 193-219.

Walters, R. J. K. (1975). Variation between grass species and varieties in voluntary intake. Proc. 5th Gen. Meeting, European Grassland Fed., Uppsala, 1973, 184-192.

Wetherall, J. A., Armstrong, D. G., Finlayson, H. J. and Rooke, J. A. (1995). Reduction of proteolysis during ensilage of perennial ryegrass by protease inhibitors. Journal of the Science of Food and Agriculture, 68, 497-505.

Wilkins, P. W. (1995). Independence of dry matter yield and leaf yield among perennial ryegrass varieties differing in seasonal yield distribution. Grass & Forage Science, 50, 199-208.

Wilkins, P. W., MacDuff, J. H., Raistrick, N. and Collison, M. (1977). Varietal differences in perennial ryegrass for nitrogen use efficiency in leaf growth following defoliation: performance in flowing solution culture and its relationship to yield under simulated grazing in the field. Euphytica, 98, 109-119.

Developments to Enhance Sward Intake and Quality (Mid-Season)

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1) Introduction

Prior to the introduction of milk quotas in Ireland, the objective on intensive dairy farms was to maximise sales from the farm. This was achieved by increasing cow numbers and milk yield per cow. This strategy resulted in very rapid growth in milk quota in Ireland (55 per year) and this rate of increase was higher than in other European countries. The introduction of milk quotas resulted in quota size rather than land area being the limiting factor on many dairy farms. The blueprint for efficient dairying in Ireland recommended from Moorepark changed to reflect this new reality. Profit is now maximised by cashing in more on grass. This has been achieved on spring-calving herds by (1) calving cows closer to the start of the grazing season i.e. February/March calving, (2) Turning cows out earlier to spring grass, (3) Reduced stocking rate, thereby increasing the supply of grass efficiently in spring and autumn.

This has resulted in an increase of 72% to 85% of total milk produced from grazed grass. The level of milk production as well as improved milk composition is important in maximising profit. Milk protein and composition will be largely influenced by the quantity of grass eaten/cow/day. Therefore the factors that influence daily herbage intake will be important. The main factors are the intake and quality of grass supply. To enhance performance further we must continue to improve these factors.

The paper will examine: (1) the need to improve the intake and quality of grass supply and the work ongoing to achieve this, (2) The links that have been established between the industry, production research and plant breeders to achieve this objective.

The need to increase intake

The intake requirements of the dairy cow are increasing and we will have to enhance our swards to suit this. The increase in intake requirements of cows at Moorepark clearly illustrate this (Tables 1 and 2).

The demand of the animal is controlled by the drive of the animal to feed. This drive is controlled by the breed, age and reproductive stage of the animal. This has been highlighted with the work on high genetic merit animals at

Table 1
Daily grass intake (kg DM/cow) measured at Moorepark for cows at various levels of milk yield (May to July period)

Milk yield (kg/cow	4,681	5,617	6,553	7,490
Dry matter intake (kg DM/cow/day)	15.2	16.8	18.6	20.3

Table 2

Intake requirement for cows with different yield potential on a grazed pasture (mid-May period)

Milk yield (kg/cow/day)	25	30	35	40
Liveweight (kg/day)	540	545	550	555
Liveweight change (kg/day)	+0.2	+0.2	+0.2	+0.2
M.E. requirement				
Maintenance	57	58	58	59
Milk yield	128	154	179	205
Weight change	7	7	7	7
Total (MJ)	**192**	**219**	**244**	**271**
DMI (kg/day)	16.0	18.2	20.3	22.6

Moorepark where the requirements and demands of the high genetic animals have been shown to vary. The results show that the high genetic merit animals have a higher intake which was achieved with a higher biting rate rather than an increased grazing time (Table 3). The potential of these animals to increase biting rate suggests a high potential to increase intake in optimum sward conditions. These optimum conditions must be understood in order to maximise the potential of this increased animal demand. The programme at Moorepark is currently addressing these issues.

RECENT DEVELOPMENTS TO INCREASE GRASS INTAKE

1. Precision management

In the past, emphasis was on the quantity of the grass supply and animal performance was assessed using milk yield. Recently significant progress has been made in bringing the feeding of herbage by grazing to the same level of precision and control as can be achieved indoors. The use of a precision feeding at pasture has overcome the control of quantity of grass reaching the animal (O'Donovan and Dillon 1997). The development of precision management of this kind means that irrespective of periodic fluctuations, herbage production potential is fully exploited. These developments were explained in detail at the 1998 Spring conference.

Table 3

The effect of cow genetic index on grazing behaviour

	High RBI	**Medium RBI**
Grazing time (hrs)	10.2	10.2
Biting rate (No/min)	54.5	48.7
Grazing bouts (No)	5.5	4.8
Ruminating (% of time)	26.4	21.0

O'Connell et al., 1999

2. Identification and control of sward structural factors affecting intake

We have now a method to manage grass supply (precision management). We need to also ensure that the sward is presented in a manner that can optimise intake. This for example could allow the increased demand of higher genetic merit animals to be fully exploited. An understanding is required of what these optimum sward conditions are, and what effect their link to intake is? This must be achieved to optimise the potential of different animal feed demands. In the past there was inadequate information on the traits that could enhance grass intake and utilisation so as to overcome these restrictions. This type of information is critical for plant breeders.

Would an increase in height or density of the sward increase intake? Recently production research work at IGER in the UK, at Crossnacreevy in Northern Ireland and at Moorepark is helping to gain an understanding of the plant-animal interface in detail and so address these issues. It has allowed the identification of the relationship of sward structural features to grass intake. The work has resulted in an understanding of the grass canopy structure and height suitable to optimise the relationship between herbage offered and herbage intake. Also, techniques have evolved that allow the assessment of different varieties of varying structure. This approach has led to a clearer understanding of plant structural features that limit intake and utilisation (Casey, Brereton, Laidlaw and McGilloway 1997). This level of detail has indicated that the leaf density of a sward has a direct effect on bite size. A decrease in all sward bite dimensions also occurred with decreasing leaf density (Table 4).

However, the height of the sward has been shown to have a greater influence. Using these techniques the effect of stem and other structural features can also be explored. At mid-season there is likely to be increased selective grazing due to the presence of stem. The identification of, and control of these midseason structural features that effect intake should therefore also enhance utilisation at this time of year. Consideration of the control of these structural differences was also examined by detailed leaf development work (Casey, Brereton, Laidlaw and McGilloway 1999). The potential for selecting for sward structural character is also being explored.

Table 4

Technique to assess the effect of sward leaf density on bite size

	High Leaf	Intermediate	Low Leaf
Sward bite (g DM)	1.27	1.14	0.66
Fistulate bite (g DM)	1.21	1.04	0.95
Bite depth (cm)	13.3	12.4	10.4
Bite area (cm^2)	67	60	59
Bite volume (cm^2)	918	749	610

HL = High Leaf Density

IL = Higher Intermediate Leaf Density

LL = Lower Leaf Density

This work is leading to the understanding of the structural limitation imposed by the sward. This information has been urgently needed by plant breeders so that they can consider plant structural traits of importance. Information on the structural features that affect intake are important to avoid any knock-on effects on sward utilisation and regrowth potential when selecting grasses of high digestibility. This issue has been emphasised and this has highlighted the importance for information in this area (Laidlaw and Reed 1993).

3. Restriction due to sward structure at farm level

An example of the restriction on intake due to structure is given here. In general a low grazing height was much more evident on farms rather than high post-grazing height (O'Donovan, Dillon and Stakelum, 1998). Severe grazing at pasture obviously results in a restricted intake, but also even at normal recommended grazing intensities intake is restricted (Figure 1).

This is due to the physical restriction imposed on the animal by the structure of the sward (Figure 2). Not only does this arise due to decreased quantity of leaf and reduced height as the sward is depleted but it is also due to increased time spent selectively grazing against stem. Although recommended tight grazing at pasture may have beneficial effects for regrowth it has a negative effect on intake.

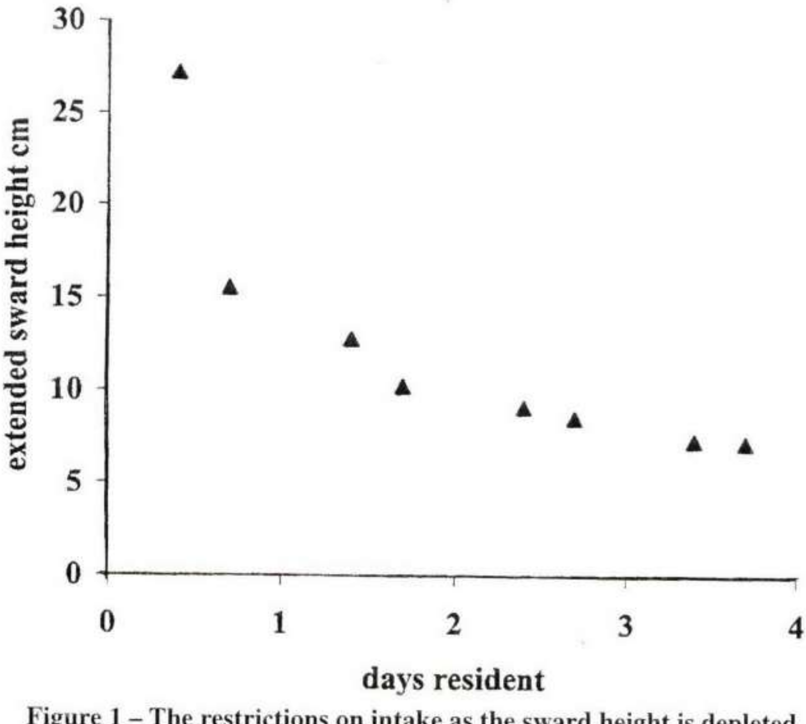

Figure 1 – The restrictions on intake as the sward height is depleted

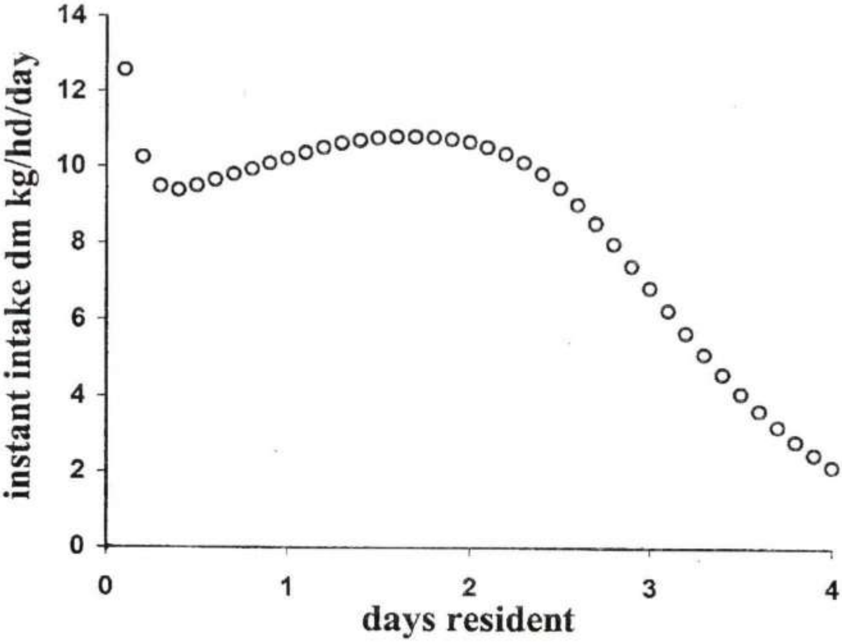

Figure 2 – The reduction on intake associated with increased residence time on pasture

The need to optimise quality

An optimum quality sward is one that suits the nutritional requirements of the animal. The quality of the sward has been shown to directly effect the milk yield of the cow. This work at Moorepark has highlighted that the sward must have a suitable dry matter digestibility, water soluble carbohydrate and crude protein content (Table 5). There is a need to more objectively define the chemical qualities required to suit the nutritional demands of the animal. For example increased rumination was observed in high genetic animals. A decrease in rumination time may be possible if quality to enhance digestion in the rumen was more clearly defined. This would allow more time for grazing. More

Table 5
The effect of grass organic matter digestibility on (OMD) intake

	High	Medium	Low
OMD (%) sward	79.6	77.1	74.4
DMI kg/cow/day	19.8	14.3	12.6
Milk yield (kg/cow/day)	19.5	18.3	17.2

Stakelum and Dillon, 1989

emphasis recently has been placed on increasing efficiency of ruminant production by enhancing sward quality. This issue has been highlighted by the industry, particularly at mid-season, when alterations in milk quality are particularly associated with a reduction in sward quality.

Recent developments to enhance quality

1. Identification of factors affecting sward quality

Variation in the morphological and chemical quality of the grass swards needs to be considered. Morphological variation occurs because there are two types of tiller, leafy vegetative and stemmy reproductive. At mid-winter there is a mass conversion of tillers from the vegetative to the reproducing stage. Not only is there a difference in nutritional quality between these tiller types but also the reproductive tillers increase the time spent selectively grazing and thereby it affects grass intake. Work carried out by Dillon and Stakelum indicated that defoliation at the correct time should overcome this problem, by decapitating reproductive tillers. However year to year variation in weather conditions in spring influences both the rate of tiller recruitment and the duration of tiller recruitment with the result that the amount of reproductive material in summer is variable.

2. Controlling sward quality

A. Morphology

Work is ongoing to examine the relationship of reproductive tiller development and tiller appearance to spring temperature. The aim of the work is to allow herbage growth and quality in mid-season to be predicted and to develop a management programme that will overcome the problem of late flowering tillers. This information will allow farmers to predict and control summer grass quality. This information could be incorporated into the Teagasc growth model so that grass growth and quality can be predicted and action taken to minimise adverse effects of a high proportion of reproductive tillers. The relationship is different for different varieties. The work is expanding to examine variation under real grazing conditions to avoid bias caused by examining swards under simulated grazing conditions alone.

To complement this work area, Aberystwyth has indicated that it is possible to breed a variety that does not head. A research programme is targeted at developing varieties that have improved vegetative growth (Wilkins and Davies, 1994). A knock-on effect on dry matter yield must be avoided. The development of these vegetative grasses in conjunction with the model above are complimentary and should allow more control over morphological variation in mid-season.

B Chemical composition

Improving the actual digestibility of the tillers has generally been reported to increase the drymatter intake. The water soluble content of the grass has been shown to be an important element of digestibility (Figure 3).

There is a positive correlation between the water soluble carbohydrates and milk production. This is associated with the higher carbohydrate energy available which enhances protein utilisation and reduces nitrogen losses in the rumen. It is, however, insufficient to select for this trait alone as this increased water soluble carbohydrate must also be accompanied by enhanced cell wall digestibility. This is required as increased carbohydrate levels decrease rumen pH, reducing the ability to breakdown cell walls. The leaf development work on sward structure has begun to show how the quantity of these chemical components are likely to be influenced by management and variety. Cell structure of the leaf responds to different environment conditions (Casey, Brereton, Laidlaw and McGilloway, 1999). This is also likely to affect the contribution

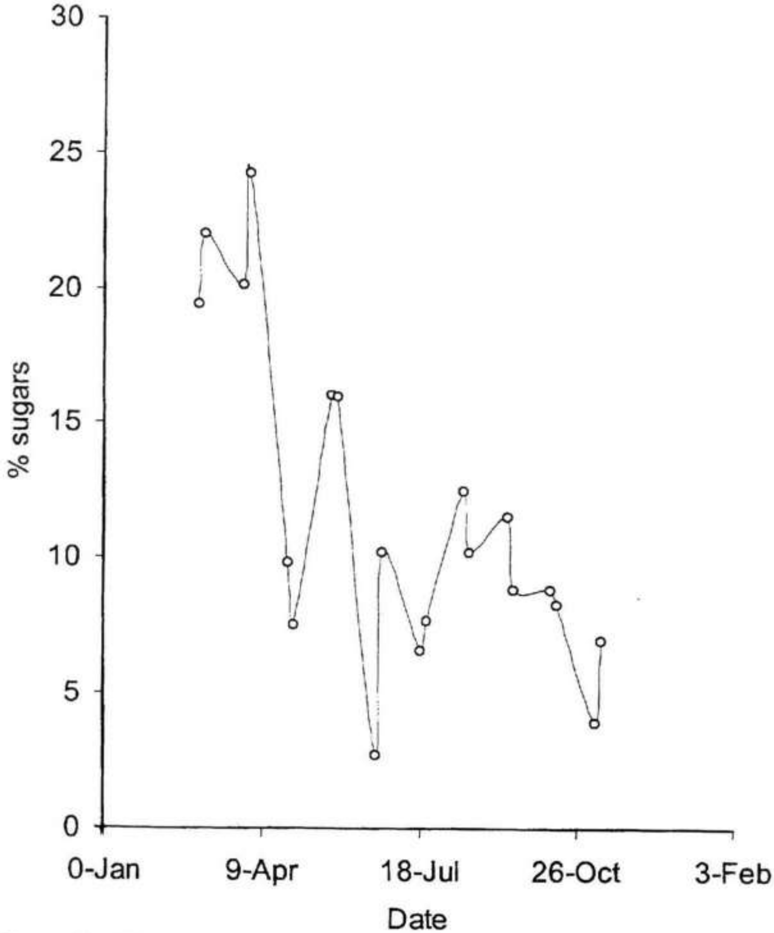

Figure 3 – The effect on time of year on the water soluble carbohydrate content of grasses, estimated using the Parson and Thornley model of grass growth

of components such as water soluble carbohydrates to the plant. The environmental conditions under grazing are quite different to simulated grazing and therefore the levels of these traits need also to be assessed under grazing.

3. Sward quality under grazing

In conjunction with the developments above new grass varieties are now being examined under grazing under Irish conditions at Moorepark. Very little information is available in this area although some studies have been carried out in Holland (Table 6). These trials will involve detailed sward measurement and the measurement of water soluble carbohydrates. The detailed sward measurement will be carried out in conjunction with animal production trials at farmlet and production scale to assess if desirable traits are transferred in a grazing situation. The realistic gain from these traits can then be monitored in terms of milk production. Management may need to be refined to optimise the expression and subsequent profit from these new traits. This is the beginning of a far larger programme in this area to ensure the transfer of the full potential of recent developments in plant breeding to profit at farm level.

Future developments

The problems associated with seasonality of production is also an issue that is continually being discussed by the industry. One aim in this area is to produce the same production in the second-half of the season as in the first-half of the season. Spring growth is restricted by temperature rather than light while in autumn light is the limiting factor. Recently genetic material may be available to overcome these limitations. Although breeding for varieties out of season is a high possibility, sward damage and poor utilisation cannot be overlooked. A combination of traits will need to be carefully explored if this is to occur successfully. The Nitrogen use efficiency, regrowth and winter-hardiness are areas where there is great potential. The next issue must be to assess the efficiency of these varieties in grazing conditions and to monitor their efficiency carefully. There is a very large potential for improving our grass supply with the wide range of genetic material that is available. There is sufficient genetic variation in many traits to justify breeding for them. The identification of the critical traits however is an essential part of this work. In the future climate of demand

Table 6
Effect of cultivar on intake and cow milk production

	Cultivar	
	Wendy (D)	Condesa (T)
Daily herbage intake	17.1	17.6
Milk yield (kg/cow/day)	28.4	29.6
Milk protein (%)	3.39	3.48
WSC protein (%)	9.9	83.0
digestibility (DMD %)	83.0	83.0

for lower inputs and high quality and change, we will need to continually consider our options. Ruminant nutritionists, agronomists and production researchers can only provide the links to do this successfully.

Summary

In the future, emphasis is more likely to be placed on the quality of product and efficiency of production rather than quantity of product output. Considering that we have successfully developed precision management to enhance quantity of supply we now need to link with breeders to optimise efficiency by seeking a grass supply that is of high physical nutritional character, a long growing season and rapid regrowth. In the past it has been a serious omission that we could not tell farmers the difference in quantitative terms between the realistic production of grass varieties. To achieve this requires the co-operation of plant breeders, animal nutritionists and production research. The goal is the beginning of a longer term co-operation between production researchers and plant breeders.

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References

Casey, I. A., Brereton, A. J., Laidlaw, A. S., McGilloway, D. A. J. 1997. Assessment of methodology for short term grazing behaviour of cattle. Proceedings of the British Grassland Society England, 45-51.

Casey, I. A., Brereton, A. J., Laidlaw, A. S., McGilloway, D. A. J. 1997. The effect of sheath tube length on the leaf development of *Lolium perenne. Annals of Applied Biology* (in press).

Laidlaw, A. S. and Reed, K. F. M. 1993. Plant improvement. The evaluation and extension processes. Proceeding of the XVII International Grassland Congress, Palmerston North, 1993, pp. 385-392.

O'Donovan, M. and Dillon, P. 1997. Using pasture measurements to monitor performance on intensive dairy farms. *Proceedings of Irish Grassland Association,* Dairy Conference Limerick, p. 21-34.

O'Donovan, M. Dillon, P. and Stakelum, G. 1998. Grassland management: the effect on animal herd performance. *Proceedings of Irish Grassland Association,* Dairy Conference Limerick, p. 39-54., 167-175.

Smith, K. F., Reed, K. F. M. and Foot, J. Z. 1997. An assessment of the relative importance of specific traits for the genetic improvement of nutritive value in dairy pasture. *Grass and Forage Science* 52, 167-175.

Stone, B. A. 1994. Prospects for improving the nutritive value of temperate perennial pasture grasses. *New Zealand Journal of Agricultural Research.* 37, 349-363.

Wilman, D., Goa, Y. and Altimimi, M. A. K. 1996. Differences between related grasses, times of year and plant parts and digestibility and chemical composition. *Journal of Agricultural Science, Cambridge.* 127, 311-318.

Wilkins, P. W., Davies, R. W. 1994. Progress in combining high dry matter yield with reduced flowering and improved digestibility in perennial ryegrass. Proc. Eucarpia fodder Crops Section for 1994, 247-252.

The Effect of Level of Daily Grass Allowance on the Performance of Spring-calving Dairy Cows

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Introduction

The main effect of Agenda 2000 for the Irish Dairy sector will be the considerable reduction in milk prices at farm level. Future expected changes will continue to remove the relatively high level of protection engaged by the EU countries. Market forces are likely to determine producers returns much more in the future. Therefore, with lower milk prices likely, Irish dairy farmers will have to become more efficient producers of milk. Grass when grazed efficiently is by far the cheapest feed available on the dairy farm (Dillon *et al*, 1991). Since grazed grass is the most cost-effective feed available on the farm, greater emphasis has to be placed on achieving high performance at pasture by dairy cows. This is achieved by high intakes of high quality grass by cows as a very strong relationship exists between the amount of grass eaten and daily milk production. However, O'Donovan *et al* (1997) monitored performance of grazing diary cows on intensive dairy farms and found that many dairy farmers are not achieving the potential performance from their cows on grazed pasture.

This paper highlights how to achieve high intakes of grazed grass and thereby ensuring high performance from grazing dairy cows. The consequence of this will be to reduce the costs of milk production and increase returns by improved milk yield and composition.

Grazing management

The supply of feed in the form of grazed grass matches or exceeds the demand for feed by spring calving dairy cows from mid-April to mid-September for systems of milk production generally recommended in Ireland (Dillon *et al*, 1995). Major grass budget decisions are made with regard to overall stocking rate, nitrogen input and conservation management that help to ration grass on a long term and medium term basis. This is because there is a limit to the quantity of grass grown each year on a farm and its growth pattern is very unevenly distributed across the year. The objective in grazing cows is to achieve high intakes of high quality grass every day if possible. This is achieved firstly by keeping an adequate supply (1600-2000 kg DM/ha) of high quality grass ahead of the cows. Monitoring the supply of grass by walking the farm on a regular basis as outlined by O'Donovan *et al* (1997) will enable the farmer to have high quality grass in front of the cows throughout the grazing season. Surpluses (or deficits) in grass supply are established at an early stage and can be tackled before supply goes out of control. Secondly, enough grass must be offered to the herd each day (or over a 2-3 day period) so that the herd can consume enough grass to sustain their yield of milk. However, because of the tendency of grass to deteriorate in quality (digestibility), it is also extremely important to avoid offering the herd too much (i.e. leaving too high a residue in paddocks when moving on to the next paddock.)

Intake of grass

The grass intake i.e. the amount of grass eaten by dairy cows is affected by factors which relate to the animal and pasture/management. The animal factors determine the herd demand for grass. The pattern of feed demand is determined by the date of calving and calving spread. The cow factors influencing the herd demand relate to size of the animal, its potential production in terms of yield, stage of lactation (see Dr. Ryan's paper) and body condition at calving (Grainger *et al,* 1982). However, the two main factors that determine how much grass cows need are as follows: Firstly, the bigger the size of the cow, the more feed she needs to maintain herself. As size of cow increases, demand increases by 1.5-2.0 kg DM/100 kg liveweight (Stakelum and Connolly, 1987).

Secondly, a cow's genetic potential will determine her ability to produce milk. A cow yielding 6.5 gallons of milk per day will consume more grass than a cow yielding 4.5 gallons of milk at the same stage of lactation. This factor is discussed further later in this paper. A complicating factor is the loss of weight by cows in early lactation and the gain in weight by cows from mid-lactation onwards. When cows lose weight in early lactation, they are in effect supplementing their intake of feed in order to assist milk production. They can by this mechanism produce high yields than is possible from their dietary intake of grazed grass. Additionally, when cows are preparing for the next lactation and gaining in weight, they require more intake of feed than is required by their output of milk and maintenance.

Management/Pasture factors affecting intake of grass

Three important factors impact on the ability of the cow to eat enough grass.

1. How much grass is offered?
2. What is the quality (digestibility) of the grass?
3. Ground conditions during grazing.

Grass quality

When the quantity of pasture available is not limiting, the primary factor influencing the intake of grass by cows relates to the digestibility of the grass consumed (Hodgson et al, 1977). The rate of passage of ingested material through the rumen increases as the digestibility of the feed improves. The digestibility of the grass exhibits a characteristic pattern during the year. Spring grass has the highest digestibility and summer grass has generally the lowest digestibility. The changes in digestibility are generally associated with changes in the concentrations of green leaf, mature stem and dead material, and therefore influence the feeding value of the herbage (Ulyatt, 1981), Green leaf is highly digestible. Grass will be low in digestibility when it has a lot of stem, flower heads and dead material through the pasture. The problem with this type of pasture is that intake will be low because cows don't like the material offered. They find it difficult to graze and they digest it less, i.e. they extract less nutrients from it.

Grass allowance

The single most important factor influencing the intake and performance of grazing dairy cows is amount of pasture offered, i.e. **Grass Allowance**. Daily grass allowance is basically the utilisable grass in a paddock divided by the number of cows grazing on that paddock and then divided by the number of days the herd stays in the paddock. It is a very important concept in grazing management. The amount of pasture available to cows is controlled to some degree, by forcing them to graze close to ground level. If the allowance is too low, the herd intake will also be low. The herd will graze out the paddock extremely well. Therefore, as daily allowance is reduced, intake falls and the amount of grass left behind in the paddock after grazing also falls. In addition, the opportunity for the cows to select from pasture is reduced and the digestibility of the herbage consumed may also be depressed. In practice grass allowance is dictated to a large extent by the stocking rate. Recent assessment of grazing management on farms (O'Donovan *et al,* 1998) suggests that many dairy farms are highly stocked especially in the April - June period. As a result cows are not allocated enough grass, cows graze very tight and intake is low. This may also occur in periods of poor growth as the farmer tries to maintain a 21-day rotation with little or no supplementation.

The Moorepark research programme on the feeding and management of dairy cows focuses heavily on achieving very high performance from cows on grazed pastures. The key to this is to ensure that high intakes of high quality grass are achieved on a daily basis. During 1995 and 1996 a series of experiments were carried out to examine the effect of daily grass allowance on dairy cow performance. Daily grass allowance is defined as the quantity of grass dry matter (DM) offered to a cow on a daily basis above a height of 4 cm. The DM content of grass varies across the grazing season. Initially in early spring (February/March) grass DM content is very high (18% to 25%), much lower in April-June (14% to 17%), in July-September (15% to 19%) and in October-November (13% to 15%). Grass availability is defined as the quantity of grass available above a height of 4 cm as it is almost physically impossible for cows to graze below this height.

Different groups of Spring-calving (February/March) cows were allocated **Low** (16-17 kg DM/cow/day), **Medium** (20 kg DM/cow/day) or **High** (23-24 kg DM/cow/day) levels of grass allowance on a daily basis. The experiment began in early May but terminated early in late August because of a drought. The cows grazing in 1995 had a RBI '95 of 107 and in 1996 a RBI '95 of 113.

The quantity of grass immediately ahead of each herd of cows was determined on a regular basis. The DM of the grass was also established. The DM yield was calculated and each herd was allocated a grazing area on the basis of this yield and particular allowance. Temporary electric fences were erected to allocate grass to cows. All grazed areas were topped to prevent any sward quality imbalances arising in future rotations. An example of how the grazing area is calculated is shown as follows.

Amount of grass DM per ha (10,000m^2 = 1,600 kg DM/ha
Grass allocation (DM) per cow = 20 kg DM
Grass allocation (DM) per 40 cows = 800 kg DM **(Herd Demand)**

Area to be given to 40 cow herd

$$= \frac{\text{Herd Demand (kg DM)}}{\text{Amount of grass per ha (kg DM)}}$$

$$= \frac{800}{1600}$$

= 0.5 ha (1.25 acres)

The following series of tables show both the quantity and quality of grass offered and the resulting cow performance from it. The amount of grass left behind is also shown.

Table 1
Results from 1995 experiment

Effect of grass allowance on cow performance (May '95 - August '95)

	Grass Allowances		
	Low	Medium	High
Grass allowance (kg DM/cow)	16	20	24
DM intake (kg)	15.3	16.5	17.1
Milk yield (gals)	4.4	4.8	4.9
Fat %	3.83	3.84	3.75
Protein %	3.25	3.28	3.36
Average bodyweight (kg)	572	574	575
Condition score	2.17	2.32	2.33

Chemical composition (%) of grass offered (May '95 - August '95)

	Grass Allowances		
	Low	Medium	High
Crude protein	17.7	18.4	17.4
Ash	9.0	9.1	8.6
MAD fibre	19.6	19.8	19.7
OM digestibility	82.3	82.3	81.8

Yield (kg DM/ha) and height (cm) of grass offered and residual pasture

	Grass Allowances		
	Low	Medium	High
Yield of grass grazed	2316	2420	2481
Height of grass grazed	18.4	18.1	18.1
Post-grazing yield	310	464	591
Post-grazing height	4.4	5.5	6.5

These series of experiments were true grass allowance experiments as cows in all treatments were presented with swards of similar DM yield (Tables 1 and 2), sward height (Table 1) and chemical composition (Tables 1 and 2).

Table 2
Grass yield (kg DM/ha) & digestibility (OMD%) of grass offered during '96

	Grass Allowance		
	Low	Medium	High
Late Spring/Early Summer: OMD	84.9	84.8	84.3
Grass yield	1899	1991	1955
Late Summer/Early Autumn: OMD	82.7	82.5	83.2
Grass yield	1886	2045	2099
Late Autumn/Early Winter: OMD	81.2	80.9	81.1
Grass yield	2776	2761	2789

Table 3
Cow performance during 1996

Effect of grass allowance on cow performance (May '95 - August '95)

	Grass Allowances		
	Low	Medium	High
Milk yield (gal/cow/day)	5.2	5.3	5.6
Fat %	4.16	4.10	4.04
Protein %	3.41	3.46	3.43

Effect of grass allowance in late Spring/early Summer '96

	Grass Allowances		
	Low	Medium	High
DM intake (kg)	15.2	16.5	16.8
Milk yield (gal/cow/day)	3.6	3.9	3.9
Fat %	4.69	4.68	4.56
Protein %	3.47	3.54	3.62

Effect of grass allowance in late Autumn/early Winter '96

	Grass Allowances		
	Low	Medium	High
DM intake (kg)	15.1	15.6	16.1
Milk yield (gal/cow/day)	2.0	2.0	1.9
Fat %	5.38	5.09	5.45
Protein %	4.08	4.11	4.23

Cow intake and milk production

The series of experiments outlined above demonstrate the effect of grass allowance on DM intake and milk production. There is a strong positive relationship between grass intake and daily milk production. Cows with a genetic index of RBI'95 of 110 - 115 need to be allocated 21-23 kg Dm/cow/day (above 4cm) (Table 3) to optimise performance from grazed grass in early lactation. This will allow the cows to consume 17-18 kg of grass DM/cow/day. As the lactation progresses, the demand of the cow is reduced. Therefore allocating 20 kg DM/cow/day will allow the cow eat 16-17 kg of DM/cow/day (Table 1 and 3) which is adequate to meet her metabolic requirements. Although the level of milk production is low in late lactation, intake of grass is reasonably high at approximately 15-16 kg DM/cow/day (Table 3). Firstly, this is because cows are gaining in body condition and advancing in pregnancy. Secondly, the energy value of autumn grass is low even though the digestibility of it is relatively high (Givens, 1993) therefore the cow has to consume more DM to obtain an adequate ME (or NE) intake. This is one of the reasons why the best responses in milk production to concentrate supplementation are achieved in the late autumn period despite spring-calving cows being in late lactation. Throughout all of the above experiments, grazing cows to a height of **6 cm** will enable cows to perform very close to their genetic potential from a diet of grazed grass. This will ensure that the cow is well fed. However, little is known of level of intake being achieved.

Table 4

Effect of grass allowance on post grazing height (cm)

	Low	Medium	High
Late Spring/Early Summer:	4.7	5.5	6.6
Late Summer/Early Autumn	5.1	5.8	6.7
Late Autumn/Early Winter:	4.4	5.3	5.9

Milk composition

Throughout all the experiments, there was no significant effect of grass allowance on milk fat content. However, a very obvious trend was evident. As grass allowance increased, milk fat content was reduced. This is most likely due to a combination of reasons. Firstly, that the digestibility of the pasture selected is generally lower and fibre content higher as cows graze tighter into the sward. A greater proportion of stem and dead material exists in the lower strata of the sward structure. Secondly, intake and therefore milk yield improved as grass allowance increased. This suggests that the concentration of fat would be diluted.

The milk content improves substantially as grass allowance increases particularly in the summer/autumn period. Cows allocated a high pasture allowance will graze lax and therefore will eat more but also consume a greater proportion of leaf than either stem or dead material. The digestibility of the pasture consumed is improved thereby enhancing energy intake. This effect was evident but very small when analysed. It is therefore more likely that the higher level of intake (Bryant, 1979) rather than the higher energy intake has a greater influence on milk protein content. Therefore, offering cows generous amounts of grass (i.e. grazing cows laxly) may not result in significant increases in milk yield. However the protein content of the milk will be substantially improved.

Cow liveweight and body condition

Many other experiments have shown allowance effects (Bryant, 1980; Glassey *et al,* 1980) and intake effects (Hodgson and Wilson, 1967) on cow liveweight and body condition. These experiments demonstrate little or no effect of pasture allowance on liveweight gain or cow body condition. However the levels of intake achieved were high and therefore cows were reasonably well fed unlike other experiments.

Post-grazing sward height

Sward height has been advanced as a major tool in controlling grazing management in order to optimise cow performance from pasture. The results of these experiments and previous research (Stakelum and Dillon, 1990) at Moorepark clearly show major advantages to grazing to a residual sward height of **6 cm** particularly in the April to June period without affecting milk production and thereby optimising cow performance from pasture. A post-grazing height of 6 cm implies that a mosaic of well and not so well grazed areas will appear on the paddock. These tall and short grass areas are the inevitable consequence of cow grazing. Cows will graze the areas around the dung deposits less severely than the clean areas. To attempt to graze the paddock so as to force the cows to eat out all of the tall grass areas will severely depress intake. The compromise is to leave the paddock grazed to a degree where the tall or partially rejected areas comprise around 20-25% of the paddock area and are reasonably well grazed.

Although cow performance may improve somewhat, offering high daily allowances of grass or grazing laxly (>7cm) will result in a higher residual yield or sward height. As a result, the nutritive value of the pasture will be reduced in subsequent grazings to the extent that cow performance also declines (Stakelum and Dillon, 1990). However, removal of high residual yields by topping pastures after grazing will eliminate the adverse effects of lax grazing on cow performance (Stakelum and Dillon, 1990).

Genetic merit

The average herd demand for grass in Ireland is around 16-18 kg DM daily, depending on genetic potential. The national RBI is around 105-110. Top dairy farmers are closer to 115 and their herd demand is likely to be about 18 kg of grass DM daily/cow. However the rate of gain in the genetic merit of the national dairy herd in Ireland is now quite rapid (about 1.5%/yr). Studies from New Zealand have shown that cows of high genetic merit at pasture consume more grass (5-20%), produced more milk (20-40%) and were more efficient converters of food into milk (10-15%) than cows of lower genetic merit (Holmes, 1988).

Table 5
The pedigree index of the two genotypes being compared

Genotype	RBI 95	Milk (kg)	Fat (kg)	Protein (kg)	Fat (%)	Protein (%)
HGI	134	620	23	20.5	-0.02	0.00
MGI	117	120	10	7.1	+0.09	+0.05

In the autumn of 1994, two contrasting groups of in calf-heifers were assembled at Moorepark. The pedigree index of the two groups is shown in Table 5. The animals of high genetic index (H.G.I.) had an RBI '95 of 134 and medium genetic index (M.G.I.) an RBI '95 of 117. It should be noted that average RBI '95 for first lactation animals in 1995 nationally was 104 (IDRC).

Three different feeding systems were compared with each genotype. The Moorepark feeding system (System A) incorporates high stocking rate 2.54 cows/ha), high nitrogen input (440 kg N/ha) and a planned concentrate input of 500 kg/cow (Dillon *et al,* 1995). System B had a similar stocking rate and nitrogen input to System A, but twice the level of concentrate. System C had a similar level of concentrate and nitrogen to System A but with unrestricted levels of high quality grass throughout the year. To maintain System C, achieving second-cut silage was not a priority. The feeding systems were applied from mid-April to end of November. A total of 48 H.G.I. and 48 M.G.I. animals were used. Excess grass was harvested as wrapped baled silage to maintain grass quality. Grass was considered to be in excess when pre-grazing yields were greater than 2000 kg DM/ha. In 1996, a total of 3.2 ha in System A, 3.8 ha in System B, and 4.8 ha in System C were harvested in this manner. Table 6 shows the milk production for both genotypes (averaged across the three feeding systems).

Table 6
Effect of cow genetic index on milk production (1996)

	M.G.I.	H.G.I.
Milk (gallons/cow)	1,465	1,659
Fat %	4.02	3.89
Protein %	3.43	3.41

Source: F. Buckley and P. Dillon

The H.G.I. cows produced significantly more milk (+194 gals) with similar protein content. The average daily milk production for M.G.I. and H.G.I. cows was 4.8 gals and 5.5 gals per cow over the lactation.

Grass allowances, intake measurements and post-grazing heights are shown in Table 7. During the 3 measurement periods (June to September), cows on feeding Systems A and C were on grass only while cows on feeding System B received 3 kg of concentrates daily per cow. The H.G.I. had higher intakes

Table 7
Effect of cow genetic index and feeding system on grass allowance, intake and post grazing height

	Feeding system					
	A		B		C	
	H.G.I.	M.G.I.	H.G.I.	M.G.I.	H.G.I.	M.G.I.
Grass allowance (kg DM/cow/day	26	24	23	21	29	27
Grass DM intake (kg)	20.3	18.6	19.6	18.3	20.7	19.2
Total DM intake (kg)	20.3	18.6	22.2	20.9	20.7	19.2
Grazing height (cm)	5.8		6.1		6.4	

and were allocated greater daily allowances of grass to achieve these intakes. Supplementation with concentrates at pasture (System B) significantly increased total dry matter intake and milk yield (Table 8) with only a small reduction in grass dry matter intake. Allocating larger amounts of high quality grass (System C) improved intake on average by 0.5kg DM per cow per day. However, this extra intake resulted in improved milk protein content rather than an improvement in milk yield. This is similar to earlier observations in this paper with cows of lower genetic merit. Similarly, grazing cows of high genetic index to a height of 6 cm (Table 7) will enable the cow to perform very well at pasture.

How to estimate the level of intake achieved in a paddock

Very many Irish dairy farmers cannot judge how much pasture is available for grazing and how much was eaten in a particular paddock. In order to improve the ability of the farmer to feed the cows properly at pasture, those two basic points need to be learned. This can only be taught and demonstrated in the field and if the farmer wants to increase his skills in this regard he must spend more time studying his paddocks and assessing grass supply. Experience and participation in one of the 235 Teagasc Dairy Discussion Groups will improve your ability.

Establishing the level of intake being achieved is a simple sum when the grass yield level before and after grazing in a particular paddock in known or is estimated. An accurate procedure for estimating the amount of grass available

Table 8
Effect of cow genetic index and feeding system on milk production

	Feeding system					
	A		B		C	
	H.G.I.	M.G.I.	H.G.I.	M.G.I.	H.G.I.	M.G.I.
Milk yield (gal/cow)	1630	1405	1739	1543	1606	1450
Fat %	3.76	4.11	3.97	3.96	3.96	4.03
Protein %	3.37	3.39	3.41	3.45	3.45	3.45

(above 4 cm) was outlined by O'Donovan *et al* (1997). This method was developed because of much lower potential errors associated with it as compared to the plate meter or grass probe. The procedure is also based on yield of available grass i.e. the yield above 4 cm.

When establishing the intake figure, it will be more meaningful if done across a number of paddocks (say 5-6), as any error will be evened out somewhat. If the intake is very much out and is not a meaningful figure, it is very likely that the estimation of pre-grazing grass yield is inaccurate. In most cases the post-grazing yields will be estimated much better. A knowledge of how daily milk yields are progressing will indicate gross inaccuracies. A less likely cause is that the paddock area is wrong. However, an accurate measurement of paddock areas is a help.

The following is an example of how intake can be calculated based on yield assessments.

1) Pre-grazing = 2000 kg DM/ha (above 4 cm).
2) Post-grazing = 300 kg DM/ha (above 4 cm).
3) Paddock size = 0.81 ha (2 acres).
4) Residency time in the paddocks = 2 days (4 grazings).
5) Herd size = 40 cows.

Then intake/cow/day can be calculated as $\frac{(1\text{-}2) \times 3}{4 \times 5}$

e.g. $\frac{(2000\text{-}300) \times 0.81}{2 \times 40} = 17.2$ kg DM

Wet ground conditions

Soft ground conditions are quite anatagonistic to good utilisation of pastures (Wilkins and Garwood, 1985) and these conditions are more prevalent at the beginning and at the end of the grazing season. Even where cows have enough pasture, intakes are often low because grass becomes soiled due to walking and poaching. Deposition of soil on pasture renders grass less palatable and thereby reducing cow intake. In these conditions, the aim is to minimise damage, reduce soiling and maintain cow performance. A lot of time and money is spent on developing facilities in the farm yard. However, cows spend most of their lifetime at pasture. Having a good network of farm roadways, adequate if not multiple access to paddocks and plenty of drinking points will greatly improve the potential to utilise grass especially when grazing conditions are difficult. Different grazing techniques are shown in Fig. 1 that aid grass utilisation in early spring/late autumn or at any other time when grazing conditions are marginal. All of these techniques may be useful under different circumstances and conditions. Cow Walks (A) have been used to great effect on the Wetland Research Farm at Kilmaley, Co. Clare where grazing conditions are often marginal and are also in use on the Dairy Farm at Kildalton Agricultural College, Co. Kilkenny. When grazing silage ground, the Spokes of Wheel (B) technique may be useful in early spring especially when there is only a single drinking point (normally at the entrance). During periods of poor grazing conditions, cows should be allocated fresh/clean grass after every milking if out fulltime or every day if out by day only. Cows should not walk over previously grazed areas. All these techniques (Fig. 1) try to facilitate this objective. However, cows in early lactation will give an economic response (milk production and reproductive performance) to concentrate supplementation when the supply of grass is poor and/or when difficult ground conditions prevail (Dillon, 1996).

Conclusions

In the future successful dairy farming will remain very dependent on the efficient conversion of grass into milk. Grazing management must succeed in keeping the cow well fed throughout the grazing season. High performance of cows at pasture can only be achieved by having high quality grass in front of the cows but more importantly by offering enough grass to the herd on a regular basis. Grass can be allocated to cows after every milking, on a daily basis or over 2 days but they must be offered enough. In summary, the amount of feed (as grazed grass) the herd (RBI'95 105-115) will need each day will be about 16-18 kg DM/cow. Therefore, 20-23 kg of grass DM/cow must be offered daily. If there is insufficient grass available and/or poor ground conditions to allow for an intake figure of this magnitude then supplementary feeding may be necessary. Cows of higher genetic merit (RBI'95 120+) must be offered more grass as more needs to be consumed. To simplify matters, if the cows eat down to a post-grazing height of **6 cm** in the paddock and are then moved on to the next paddock, the farmer can be satisfied that the herd is well fed. This is also important for controlling the quality of the grass that will be subsequently offered for grazing in the following grazing rotations.

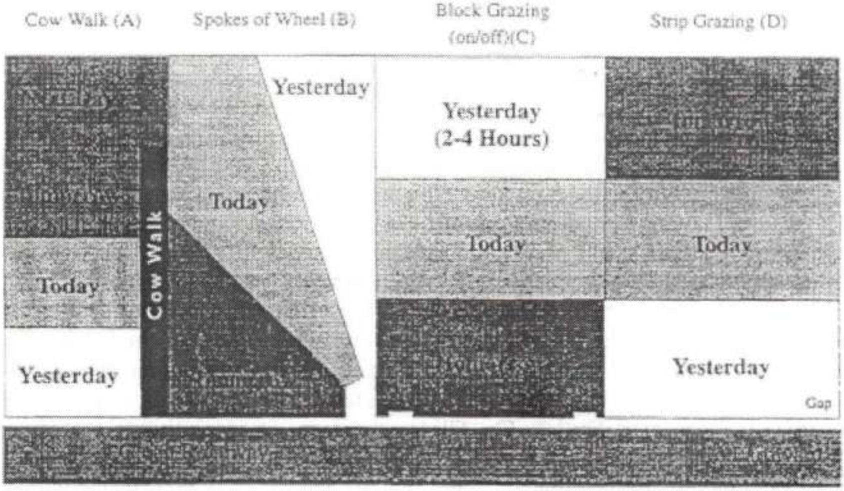

Figure 1 – Grazing techniques during periods of marginal ground conditions

References

Bryant, A. M. (1979). Effects of nutrition on milk composition. *Proceedings of Ruakura Farmers' Conference.* pp. 121-129.

Bryant, A. M. (1980). Effect of herbage allowance on dairy performance. *Proceedings of the New Zealand Society of Animal Production,* 40, 50-58.

Buckley, F. and Dillon, P. (1998). The effect of genotype and feeding system on the performance of Holstein Friesian cows at pasture. *Proceedings of Irish Grassland Association Dairy Conference*, pp. 1-15.

Dillon, P., Crosse, S., Stakelum, G. and Flynn, F. (1995). The effect of calving date and stocking rate on the performance of spring-calving dairy cows. *Grass and Forage Science,* 50, pp. 286-299.

Dillon, P. (1996). Maximising profit in creamery milk production using current research and technology. *Proceedings of Irish Grassland Association 50th Anniversary Dairy Conference*, pp. 5-26.

Dillon, P., Cliffe, D. and Hurley, C. (1991). Scope for reducing the costs of milk production. *Irish Grassland and Animal Production Association Journal*, 25, pp. 68-79

Givens, D. I. (1993). Influence of growth stage and season on the energy value of fresh herbage. 1. Changes in the metabolising energy content. *Journal of the British Grassland Society*, 48, pp. 166-174.

Glassey, C. B., Davey, A. W. F. and Holmes, C. W. (1980). The effect of herbage allowance on the dry matter intake and milk production of dairy cows. *Proceedings of the New Zealand Society of Animal Production,* 40, 59-63.

Grainger, C., Wilhelms, G. and McGowan, A. (1982). Effect of body condition at calving and level of feeding in early lactation on milk production of dairy cows. *Australian Journal of Experimental Agriculture and Animal Husbandry,* 40, 9-17.

Hodgson, J. (1977). Factors limiting herbage intake by the grazing animal. In: *Animal Production from Temperate Grassland (International Meeting),* pp. 70-75 (Ed. B. Gilsenan), Dublin: *Irish Grassland and Animal Production Association,* An Foras Taluntais.

Hodgson, J. and Wilkinson, J. M. (1967). The relationship between liveweight and herbage intake in grazing cattle. *Animal Production,* 9, 365-376.

Holmes, C. W. (1988). Genetic merit and efficiency of milk production by the dairy cow. In: *Nutrition and lactation in the dairy cow* (Ed. P. C. Garnsworthy), Butterworths, U.K.

O'Donovan, M., Dillon, P., Stakelum, G. and Crosse, S. (1997). Using pasture measurements to monitor performance on intensive dairy farms. *Proceedings of Irish Grassland Association Dairy Conference*, pp. 21-33.

O'Donovan, M., Dillon, P., Stakelum, G. (1998). Grassland management - the effect on herd performance. *Proceedings of Irish Grassland Association Dairy Conference*, pp. 39-53.

O'Donovan, M. Dillon, P., Stakelum, G. Harrington, D. and Rath, M. (1999). An evaluation of four different techniques of pasture mass estimation. *Irish Grassland and Animal Production Research Forum, 25th Meeting U.C.D. Belfield,* pp. 99-100.

Stakelum, G. and Dillon, P. (1990). Influence of sward structure and digestibility on the intake and performance of lactating and growing cattle. In: Mayne, C. S. (ed). Management issues for the grassland farmer in the 1990's. *Occasional publication No. 25, British Grassland Society*, pp. 30-42.

Stakelum, G. and Connolly, J. (1987). Effect of body size and milk yield on intake of fresh herbage by lactating dairy cows indoors. *Irish Journal of Agricultural Research,* 26, 9-22.

Ulyatt, M. J. (1981). The feeding value of temperate pasture. In: Morley, F. H. W. (ed). *Grazing Animals*, pp. 125-141.

Wilkins, R. J. and Garwood, E. A. (1986). Effects of treading, poaching and fouling on grassland production and utilisation. In: Frame, J. (ed). *Grazing,* 19-31. *British Grassland Society Occasional Symposium*, No. 19. B. G. S. Hurley.

Grazing Management of Autumn Calving Cows

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Introduction

Seasonal milk production is a feature of the Irish dairy industry. More than 85% of manufacturing milk is produced between March and October and the remaining 15% from November to February. Since dairy product-mix is determined largely by seasonality of milk supply, Ireland's current product mix is mainly orientated towards commodity products. Both the Culliton Report (Industrial Policy Review Group, 1992) and the Report of the Expert Group on the Food Industry (1993) agreed that continued dependence on intervention products is not in the long term interests of Irish producers, processors and consumers. They proposed the view that seasonal production of milk needs to be reduced in parallel with the development of genuinely market-led dairy products.

The costs associated with winter milk production are higher than those for summer milk production. Winter milk production systems are generally perceived as 'high silage input' systems. Previous research with autumn-calving cows has focused mainly on indoor feeding of silage and concentrates. There has been very little research into grassland based systems of milk production with autumn-calving cows. It is important to exploit the potential of grazed grass because it is a low cost, high quality feed. Full exploitation of grazed grass will have a large influence on the profitability of winter milk. This paper is focused on the grazing management practices for autumn-calving cows at different periods during the year.

Moorepark study on systems of milk production

A research programme was initiated in the autumn of 1995 to investigate the effect of three contrasting calving patterns on animal production and grazing management. The herds were assembled at the Solohead Research Site in Co. Tipperary. The study was carried out over two lactations. The experimental animals had an average RBI '95 of 115. The three contrasting systems were:

System A: 100% Autumn Calving – Sept./Oct. calving, stocking rate of 2.52 cows/ha, high nitrogen input and a planned concentrate input of >1,000 kg.

System AS: 50% Autumn and 50% Spring Calving – Sept./Oct. calving and Feb./Mar. calving, stocking rate of 2.52 cows/ha, high nitrogen input and a planned concentrate input of >1,000 kg.

System S: 100% Spring Calving – Feb./Mar. calving, stocking rate of 2.52 cows/ha, high nitrogen input and a planned concentrate input of ~500 kg.

Milk yield and composition

The effect of system of production on milk yield, milk composition and lactation length is shown in Table 1.

Table 1
The effect of system of production on milk yield, milk composition and the level of concentrates fed

	Year	System A	AS	S
Total milk yield (kg/cow)	1996	6,638	6,513	6,179
	1997	6,435	6,200	6,101
305-day milk yield (kg/cow)	1996	6,322	6,235	6,038
	1997	6,219	6,103	6,011
Milk fat (kg/cow)	1996	269	270	250
	1997	265	261	242
Milk protein (kg/cow)	1996	232	229	215
	1997	213	221	213
Milk lactose (kg/cow)	1996	309	306	287
	1997	295	290	281
Fat %	1996	4.08	4.15	4.06
	1997	4.14	4.22	3.96
Protein %	1996	3.51	3.52	3.50
	1997	3.52	3.57	3.51
Lactose %	1996	4.64	4.70	4.66
	1997	4.59	4.68	4.61
Lactation length (days)	1996	322	318	304
	1997	309	292	298
Concentrate fed (kg)	1996	1,524	1,095	666
	1977	949	719	560

There was a tendency towards higher milk production with **System A** in both years of the trial but no statistical difference was recorded. **System A** had a longer lactation length in 1996. This longer lactation length would account for some of the difference in milk yield but when all treatments had their lactations adjusted to a 305-day lactation, there was still a tendency towards higher milk yield with **System A**.

There was no significant difference in milk fat, protein and lactose yield in year 1 and year 2 of the experiment. Milk fat concentration was significantly lower for **System S** in year 2, with no significant difference in year 1 of the experiment. The large reduction in concentrate feeding level between year 1 and year 2 was due to early turnout to pasture in 1997 and a higher digestibility silage conserved.

The data in Figure 1 show the highest peak milk production was achieved with **System S**. **System A** had higher milk production levels in the latter half of lactation and were more persistent until the end of lactation. The cows on

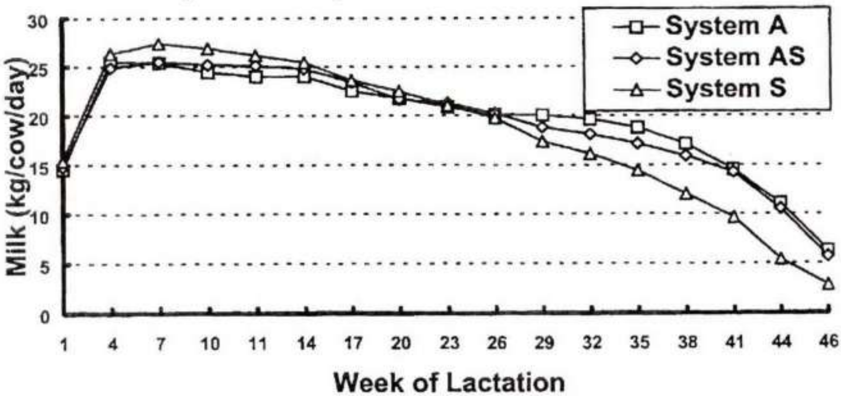

Figure 1 – The effect of system of production on milk production by week of lactation in 1996

System A had a 'secondary peak' whereby milk yield rose in mid-lactation. This coincided with the cows being turned out to pasture. **System S** had the lowest milk production levels at end in both years of the trial. The seasonality of milk supply of the three systems of production is shown in Figure 2. **Systems A** and **S** had highly seasonal milk supply patterns whereby **System AS** had a more uniform milk supply pattern.

Grazing management

Early spring period

Spring grass is higher in terms of feeding value than grass at any other stage in the season. Autumn-calving cows are in mid-lactation at this time and are still producing high milk yields. The provision of early spring grass is an

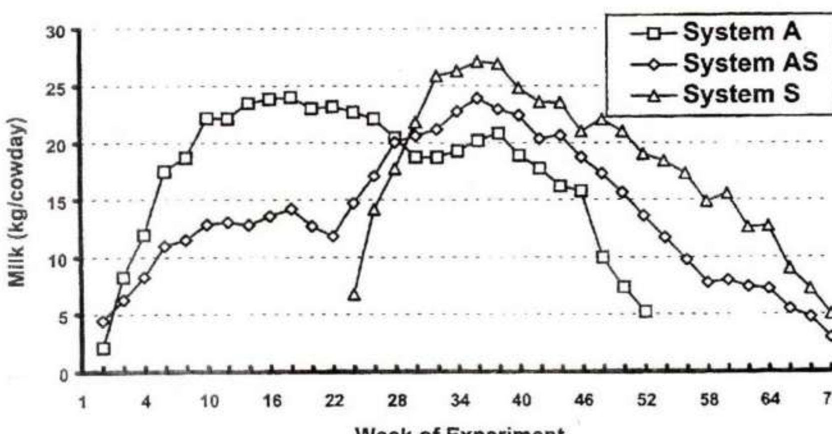

Figure 2 – The effect of system of production on milk production by week of experiment in 1996

Table 2
The effect of different daily herbage allowances on milk yield and composition for autumn-calving cows in the spring herd

	Daily herbage allowance (kg DM/cow)		
	17 kg DM/cow	20 kg DM/cow	23 kg DM/cow
Milk yield (kg/cow/day)	17.4	18.5	18.8
Protein content (%)	3.73	3.76	3.78
Fat content (%)	4.38	4.30	4.32
Protein yield (kg/cow/day)	0.65	0.70	0.71
Fat yield (kg/cow/day)	0.76	0.80	0.80

Source: Maher, Stakelum and Rath, 1998)

important consideration on farms with autumn-calving cows. The primary objectives are to give autumn-calving cows access to grazed grass as early as possible and to budget that grass until grass supply equals demand. The results of a study at Moorepark in 1997 where autumn-calving cows were offered different daily herbage allowances in the late spring period are shown in Table 2. Three levels of daily herbage allowance (17, 20 and 23 kg DM per cow), (> 3.5 cm) were offered to autumn-calving cows (mean calving date September 23). The experiment lasted from late April to mid June. There were 14 cows per treatment with an average RBI of approximately 112. The average pre-grazing herbage yield in the experiment was 1,904 kg DM per ha (> 3.5 cm). The autumn-calving cows grazed to a residual herbage yield of 401, 498 and 618 kg DM per ha and a residual sward height of 5.0, 6.0 and 6.9 cm for the low, medium and high allowances respectively.

There was a response in daily milk yield, protein and fat yield in early lactation up to the highest level of daily herbage allowance. There was a very small response in milk fat and protein yield and milk fat and protein concentration going from the medium to the highest level of daily herbage allowance. The results show that 20 kg DM/cow/day was capable of supporting a high level of milk production and also optimum pasture utilisation. Higher levels of daily herbage allowances resulted in only a small increase in milk production and under utilisation of pasture.

Mid-summer period

Supply of feed in the form of grazed grass exceeds demand for feed for autumn-calving herds from mid-July onwards (Ryan, Crosse and Rath, 1998). There is an increase in farm grass cover for autumn-calving cows because of low herd demand for feed (cows non-lactating) during this period. Grass growth rates are still relatively good at this time of year. The supply of grass on the farm should be monitored so as to avoid large surpluses (increase in farm cover) occurring. There was a large area conserved as surplus for the 100% autumn-calving herd (16.4 ha) than for the 50% autumn: 50% spring-calving herd (13.1

Table 3
Dry cow grazing measurements for 1996 and 1997

Date	1996	1997
Pre-grazing height	8.97	8.13
Post-grazing height	5.77	6.46

ha) or 100% spring-calving herd (12.6 ha) during the two years of the systems study. Surplus grass on the farm should be conserved and fed indoors in the winter period as a high quality forage.

Autumn-calving cows will generally have a higher body condition score at the end of lactation. It is important that they should not gain excess body condition during the dry period and that they calve down at a body condition score of 3.0 - 3.5. Over fat animals tend to eat less post-calving than animals in optimum condition and have large bodyweight losses in the first 3 to 4 weeks of lactation. The strategy followed at Solohead during the systems study was to graze the milking cows ahead of the dry cows. The pre- and post-grazing heights for the dry cows for the two years of the systems study are seen in Table 3. The dry cows entered paddocks with contrasting pre-grazing heights and grazed these paddocks at a pre determined height of 6 cm. Grazing dry cows behind the milking cows allows for more restriction in the level of intake during the dry period. This can be difficult to achieve when grass growth is high. A post grazing height of 6 cm results in dry cows being maintained at an optimum body condition score and pasture quality is also improved for the remainder of the grazing season.

Late autumn period

The costs associated with winter milk production are higher than those for summer milk production. Grazed grass is the cheapest feed available to Irish dairy farmers. The full exploitation of grazed grass and conserved forage will have a large influence on the profitability of winter milk production systems. The focus as autumn cows start calving is to meet the nutritional needs of the cow and to achieve high levels of animal performance from home produced forage. Therefore, grazing management should aim to utilise the maximum amount of grass in the late autumn period with autumn-calving cows. The objective is to achieve high intakes of grass up to mid-November if ground conditions permit. However, grazing beyond mid-November will reduce the supply of grass available for grazing in early spring. It should be noted that autumn grass has a lower nutritive value than spring grass. Generally, grass grown in the autumn/early winter period has a low dry matter content and has also a lower energy content. The amount of time cows can spend grazing is also reduced due to shortening daylight hours. The utilisation of autumn pasture is more difficult because of the lower DM concentration of the herbage, increased fouling due to poor ground conditions (Wilkin and Garwood, 1986), reduced grazing time and a lower metabolizable energy content in the DM (Givens,

Table 4
The effect of treatment on milk yield and composition

	Treatment G	Treatment S
Milk yield (kg/cow/day)	23.27	22.48
Fat yield (kg/cow/day)	0.99	0.96
Protein yield (kg/cow/day)	0.83	0.68
Lactose yield (kg/cow/day)	0.94	0.85
Fat %	4.30	4.29
Protein %	3.55	3.04
Lactose %	4.72	4.42
Average bodyweight change (kg)	-0.39	-0.75

1993). The nutritional status of the autumn-calving cow is particularly important at this time of the year. Poor nutritional status and negative energy balance may have consequences for production levels in early lactation and the reproduction efficiency of the cows. There are two studies reported here with autumn-calving cows on pasture.

A study was undertaken in the autumn of 1997 to compare grazed grass versus grass silage as a forage source for autumn-calving cows in early lactation. Animals on Treatment S were fed a diet of grass silage ad-libitum and 6 kg concentrate. The cows on treatment G were offered 20 kg grass DM/cow/day and 6 kg concentrate. Herbage was allocated on the basis of pre-grazing yields (> 4 cm). The grass and silage comparison lasted eight weeks between 29th September 1997 and ceased on 17th November 1997. The comparison ceased due to high rainfall levels and poor ground conditions. There was fifty per cent first lactation animals in each treatment. The cows had an average RBI '95 of 118.

The effect of treatment on milk yield and composition during the experiment is shown in Table 4.

There was no statistical difference in milk yield recorded in the experimental period. There was no significant difference in fat and lactose yields or concentration in the experiment. Milk protein yield and protein concentration was significantly higher for Treatment G. The cows on Treatment S had a significantly higher bodyweight loss during the study than the cows on treatment

Table 5
The effect of treatment on dry matter intake (kg DM/cow)

	Treatment G	Treatment S
FDMI	12.03	6.03
TDMI1	17.27	11.27

FDMI - Forage Dry Matter Intake TDMI - Total Dry Matter Intake

G. There was 0.36 kg/cow/day difference between the grazed grass group and the grass silage group for bodyweight loss in the first seven weeks of lactation.

The intake levels for the cows offered grazed grass and grass silage are shown in Table 5. The cows outdoors on grazed grass had a significantly higher forage dry matter intake and a significantly higher total dry matter intake. The group intakes for Treatment S during the experimental period were approximately 8.5 kg of forage dry matter intake (FDMI) but for no apparent reason the intake dropped to 6 kg FDMI during the same period as the intake run.

The silage fed in the study was of good quality as measured by the in-vitro digestibility (763 g/kg DM), crude protein (134 g/kg DM) and the ash (93 g/kg DM) indicating very little soil contamination. However, for a dry matter content of 149 g/kg, the pH of 4.26 was higher than desirable. The grass analysis measured over the experimental period shows that the modified acid detergent fibre levels on average were 242 g/kg DM. The organic matter digestibility levels over the experimental period on average were 805 g/kg OM. The quality of the sward was good as measured by the OMD figures.

Immediately post-calving, the autumn-calving cows diet should consist of a mixture of grass and concentrates. The level of concentrate feeding will depend on the quality and quantity of the grass available. The results of a study carried out at Moorepark in the late autumn/early winter period of 1996 in which grass was supplemented with different levels of concentrate are shown in Table 6. Three groups of autumn-calving cows were allowed graze by day and night and were offered 209 kg of grass DM/cow/day (> 4 cm). This grass had a low dry matter content (14%) and a moderate DMD (77-78%). It is important to note that the grass quality was low in this study because the grass cover was too high.

There was a large response in milk yield to concentrate feeding. The response was approximately 0.75 kg milk per kg of concentrate consumed. In addition, the cows on the highest level of concentrate feeding had the highest milk protein content. The improved performance is associated with an increased total energy intake.

Grass silage should be introduced into the diet when grass supply becomes limiting or when poor grazing conditions prevail. The cow's diet is a blend of

Table 6

The effect of level of concentrate feeding on the performance of Autumn calving cows in early lactation

	Grass only	Grass + 3kg conc.	Grass + 6kg conc.
Milk yield (kg/cow/day)	20.9	23.3	25.2
Fat %	4.62	4.56	4.50
Protein %	3.16	3.34	3.43

Source: Maher and Ryan, 1997

grass, concentrates and silage until the cows are fully housed indoors. The cover of grass available for grazing ahead of the cows should not exceed 2,000 kg DM per ha (> 4 cm) for herds with 100% autumn-calving herds. If grass supply is not controlled, too much grass on the farm will lead to a deterioration in pasture quality and it will also have a negative effect on animal performance. Grazing high yields of grass at the final grazing will retard the supply of grass available for grazing in spring. In addition, grass growth rates are reduced, sward vigour will be depressed and consequently the swards may become very open.

Blueprint for winter milk production

The above components are part of an overall system of winter milk production which can result in very high levels of performance from grazed grass and conserved forage. The overall blueprint for autumn-calving cows is outlined below.

Calving date for winter milk production is concentrated around September/ October calving. The optimum calving pattern for the spring and autumn components of the herd will vary widely depending on the winter milk scheme available. A realistic target for technically efficient dairy farmers using this system is 6,400 litres milk per cow with an average fat content of 3.9% and a protein content of 3.4%. This level of performance is achievable at a stocking rate of 2.7 cows/ha with a nitrogen input of 300 kg per hectare and a mean calving date in mid-October. The inputs per cow include 1.2 tonnes (DM) of concentrates, 2.9 tonnes (DM) of grazed grass and 1.4 tonnes (DM) of silage. Using this blueprint, a total of 450+ kg of fat and protein per cow (300 day lactation) is possible. The system requires a high digestibility silage with high intake characteristics, which cannot be restricted if this level of performance is to be achieved.

Cows in the 100% autumn-calving herd calved in the September-November period. Post turnout to pasture, the grazing management in the early grazing season is similar to the spring-calving herds. The autumn-calving cows are grazed to the same post-grazing height, offered similar daily herbage allowances and a similar per cent of total area is closed for first and second cut silage. However, the grazing management diverges after late summer when the autumn-calving cows cease lactation. The demand for pasture is reduced after this period due to dry cows. Grass growth rates are still relatively good at this time of year. This results in an increase in farm cover. It is important to make full use of this feed supply. The autumn-calving cows should remain outdoors full-time until ground conditions or grass necessitate them being housed. Maximising grazed grass in the diet of the autumn-calving cow during this period will reduce the quantity of silage fed. Poorer fertility performance is associated with autumn-calving cows. Heat detection can be more difficult in autumn-calving herds. A combination of more intensive heat detection and some heat synchronisation may be necessary.

An overview of the current recommended system for winter milk production is shown in Figure 3.

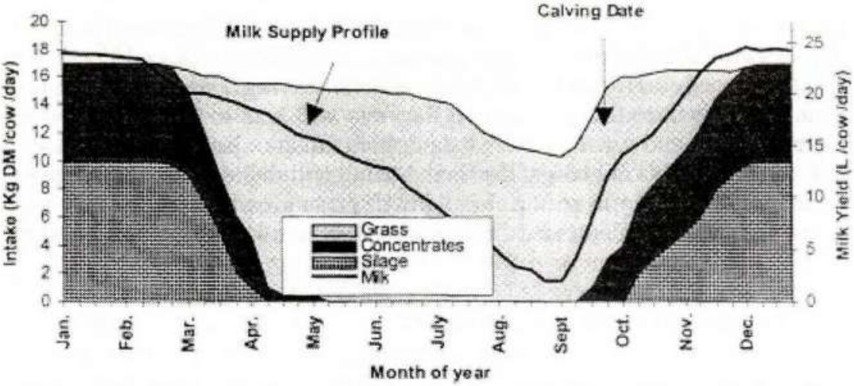

Figure 3 – Milk supply profile (Y axis on right of graph) together with the feed budget (Y axis on left of graph) for a system of milk production based on 100% autumn-calving

The seasonality of milk supply together with the fat and protein content of the milk for 100% autumn calving is shown in Figure 4.

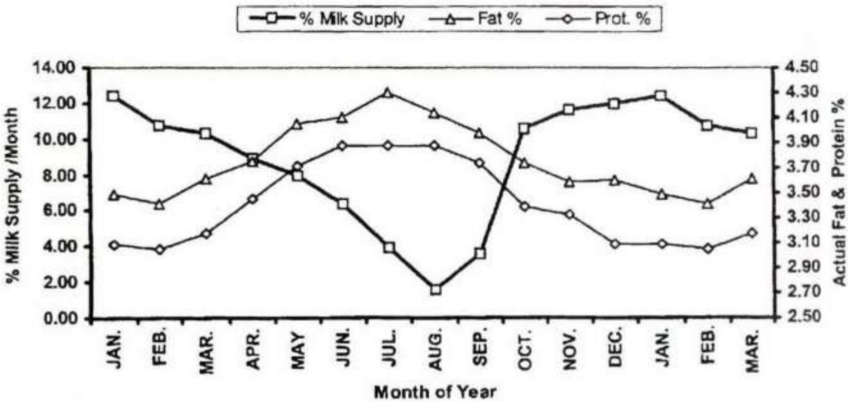

Figure 4 – Seasonality of milk supply (% supply/month) and the fat and protein content of milk for a herd with 100% autumn-calving

Some management considerations in relation to winter milk production

- Herd management was more difficult with **system AS** than with **system A or S.** There are cows in different stages of lactation and this makes management more difficult. In **system A** or **system S** the workload is concentrated around a few main periods. The management decisions within **systems A and S** are done on a herd basis which simplifies the milk production system. Split calving patterns leads to four groups of replacement heifers which makes management more difficult.
- Autumn-calving cows should be allowed access to grazed grass as early as possible in the spring time. Turnout to pasture results in a 'secondary peak'

in milk yield, rise in protein yield and lower milk production costs. The optimum allowance in the spring is 20 kg DM/cow/day resulting in high levels of milk production and optimum utilisation of pasture. Higher allowances may be necessary with cows of higher genetic merit.

- There is low herd demand for feed (cows non-lactating) in the mid-summer period for autumn-calving cows. It is important to monitor farm cover during this period to avoid surpluses. Surplus grass should be conserved as high dry matter, high digestibility silage and can be fed indoors in the winter period.
- Graze dry cows behind the milking cows during the dry period. The milking cows are offered herbage of higher energy content. The dry cows graze to a pre-determined height which improves pasture quality and insures dry cows are in optimum body condition at calving.
- The optimum calving pattern for winter milk production will vary widely depending on the winter milk scheme. Cows calving in September and October lead to the possibility for outdoor calving in favourable weather conditions thereby reducing the workload and minimising the risk of disease.
- Herd calving based on September and October allows for the inclusion of some grazed grass post-calving. Improved milk protein yield and concentration were obtained from autumn-calving cows on grazed grass in early lactation. The cows on grass silage lost more bodyweight than the cows on grazed grass. Systems of milk production incorporating autumn-calving cows should aim to incorporate the maximum amount of grazed grass in the cows' diet to improve animal performance, animal intakes and to reduce the requirement for silage. This reduces the cost of milk production during the late autumn/early winter period.
- The cow's diet is a blend of grass, concentrates and silage until fully housed indoors. The optimum level of supplementation in the autumn period will depend on the quantity and quality of grass available.
- The utilisation of grass in the autumn period is one of the most important factors influencing animal performance. The pre-grazing yield for autumn-calving cows in early lactation should not exceed 2,000 kg DM per ha. The autumn-calving cows should remain outdoors full-time until ground conditions or grass supply necessitates them being housed.

References

Givens, D. I. (1993). Influence of growth stage and season on the energy value of fresh herbage. 1. Changes in the metabolisable energy content. Journal of the British Grassland Society, 48, 1660174.

Industrial Policy Review Group (1992). A time for change: Industry policy for the 1990's. Chairman: J. Culliton, Government Publications, Dublin 1992.

Maher, J., Stakelum, G. and Rath, M. (1998). Effect of lactation stage, season and herbage allowance on the performance of dairy cows. Proceedings of the Irish Grassland and Animal Production Association, Research Forum 24th Meeting, UCD, Belfield. p. 171-172.

Maher, J. and Ryan, G. (1997). Feeding the autumn-calving cow. Todays Farm, Vol. 8, No. 3, September/October, 1997.

Report of the Expert Group on the Food Industry (1993). Department of Agriculture, Food and Forestry. April 1993.

Ryan, G., Crosse, S. and Rath, M. (1998). The effect of three contrasting calving patterns on the grazing management of dairy cows. Proceedings of Irish Grassland and Animal Production Association Research Forum, 24th Meeting, UCD, Belfield. pp. 169-170.

Wilkin, R. J. and Garwood, E. D. (1986). Effect of treading, poaching and fouling on grass production and utilisation. In: 'Grazing' (ed. J. Frame), Occasional Symposium, No. 19, British Grassland Society, pp. 19-31.

Improving Cow Performance with Increased Use of Grazed Grass

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Farm details

Total home farm area is 44.1 ha, 39 ha of this area is allocated to the dairy herd. Sugar beet is grown on 2.5 ha, and barley/whole crop is grown on 2.5 ha. Fifty dairy cows are milked on the farm, which fill a quota of 77,000 gallons (1540 gallons/7209 kgs/cow). It is a total spring calving herd - mean calving date 11th of February. The soil type is brown podzolic; the home farm is located on a tributary to the Lee Valley; some of the lower farm is exposed to winter flooding.

Two other farms exist, the first farm is allocated to the calf and heifer rearing enterprise (18 ha), the second farm (8 ha) is run as a dry hogget unit. In our system - all farms are integrated in the REP Scheme.

Labour units

Two labour units manage the farm, my wife Angela and myself.

Production figures (1996-1998)

Table 1
Farm production performance (1996-1998)

	1996	1997	1998
Milk yield (kg/milk/cow)	6039	6507	7181
Milk protein (%)	3.20	3.24	3.34
Milk fat (%)	3.69	3.70	3.79
Milk fat yield (kg MS)	223	237	272
Milk protein yield (kg MS)	193	211	240
Total solids (kg)	416	448	512

Table 2
Total feed budget (1996-1998)

Feed budget (t/DM/cow)	1996	1997	1998
Grass (Allowance)	3.9	4.7	5.7
Conc (Allowance)	0.38	0.40	0.58
Silage (Allowance)	1.0	1.05	1.0
Maize (Allowance)	0.40	0.34	–
Total	**5.7**	**6.5**	**7.3**

In the past two years we have leased more quota. Rather than increasing cow numbers we have chosen to increase the output of milk per cow. We are now filling 15,000 gallons of extra quota with the same number of cows as we previously had. In the past two years our milk yield per cow has increased by 1142 kg milk per cow (244 gal per cow). This yield has not come at the expense of extra concentrate feeding. The majority of the improved animal performance has come from feeding the animals better at grass. Consistently over the past 3 years our total feed budget has increased and this has resulted in an increased animal production performance. The grass allowance has increased by over 45% from 1996 to 1998. Our current feed budget incorporates 290-300 days at grass. Turnout is in early February as cows calve, and housing during the early days of December. The feed budget has increased in three different areas.

a) Increased grass availability in spring

Generally paddocks are closed in rotation starting October 10th. The closing farm cover therefore has a wedge shape to it i.e. the paddock with the highest cover is the first closed paddock, the paddock with the lowest cover is the last closed paddock. Early nitrogen is applied in January whenever ground conditions and soil temperatures allow. With a cover of grass on the farm at nitrogen application grass growth is stimulated. Then, as cows calve they graze by day; when grass supply allows grazing by night starts.

b) Increased grass availability in autumn

With the low stocking rate we can generally graze until late November depending on ground conditions. With the total farm available to graze post second silage, our farm cover increases to high levels during September and early October.

b) Improved daily herd grass allowance (mid-grazing season)

With the potential of the herd we aim to feed the cows fully at grass. This requires a larger grass allowance i.e. 23 kgs DM/cow/day. We closely monitor milk yield and milk protein. Combining grass allowance, milk yield and milk protein together, enables us to see whether we are feeding the animals correctly or not.

Grassland management/measurement

We have been involved in the Moorepark grass measurement project for the past three years, since its inception we have learned quite a deal about - grass cover, grass allocation, post grazing height and monitoring the animal factors i.e. milk/milk protein and cow condition score. We base our grazing management on five cornerstones:

(a) Farm cover
(b) Pre-grazing yield in paddock
(c) Daily grass allocation
(d) Post grazing sward height
(e) Grass quality

a) Farm cover

We generally aim at keeping our farm cover at 900 - 1000 kg DM per ha. This means keeping a high amount of kg DM per cow. Therefore the possibility of running out of grass is usually low, although it has happened on a number of occasions most vividly during the mid April period of 1998.

b) Pre-grazing yield in paddock

The key to keeping the cover in check during periods of high grass growth rates, is maintaining a manageable yield ahead of the herd. We find that pre grazing yields in the range of 1,700 kg/DM/ha are adequate to graze out properly, with a high proportion of live leaf. If the pre grazing yields run too high ahead of the herds, then the paddock is cut and it is either baled or pitted. Storing baled silage in the yard is never a problem - it is a saleable product if not needed by our own herd. In the case of grazing a higher cover i.e. 2800-3000 kg/DM/ ha where post grazing height may be lenient - the pasture is topped post grazing.

c) Daily grass allowance

In general the daily allowance of grass to the herd at turnout and for the rest of the grazing season is high. Post turnout we strive to place as much grass in front of the herd as our budget allows. Our low stocking rate is of great benefit to us - with the area available we can graze a lot of ground in the early spring. Turnout by night in the past two years has been the 7th March (1997) and 21st February (1998). With the production capacity of animals in the herd we aim to allow the herd up to 23 kg grass DM/cow/day during the main grazing season. We aim to produce as much milk as possible from grazed grass, so therefore we present the animals with enough of the feed to fulfil their potential. However, we do not hesitate to feed concentrates when required. By monitoring the grazing situation closely, we always know how well the animals are fed - the key pointers to this are post grazing sward height, daily bulk tank yield, milk protein percentage and the amount and quality of grass in the paddock immediately ahead of the cows. The awareness of these principles in grazing management is the key to the success in our system.

d) Post grazing sward height

With the high allowance of grass which we offer the herd one always must be willing to top the pasture to maintain a quality sward in front of the herd. At times our post grazing height is lenient but as a general rule we aim to graze pasture down to about 5.5 - 6.5 cm depending on yield and quality of the sward. In general we top paddocks twice a year, but we also have the facility to alternate our silage ground around the farm, we do not have one specific area for cutting silage.

b) Grass quality

Grass quality is not a big problem in our system. With the amount of topping and the high proportion of ryegrass in the swards, maintaining a good digestible sward is not a major problem. We have a reseeding policy in place where 5-8% of the entire home unit is reseeded each year - this system runs concurrently with our tillage system.

Herd predicted index

Table 3
Herd predicted index profile (1996-1998)

	Milk (kg)	Fat (kg)	Protein (kg)	Fat (kg)	Protein (%)
1996	186.3	6.9	5.9	-0.01	0.004
1997	234.1	7.9	7.0	-0.01	0.001
1998	254.8	9.1	8.1	-0.01	0.00

Currently our herd is bred for milk with little emphasis on milk solids, due to the use of high milk bulls in the past. Over the past two years we have moved our breeding policy to use bulls with 400-500 kg of milk and positive protein (%) . We have specifically used Irish bulls to do this, namely, JOS, MFX, GMI and MAU. Our future breeding policy will focus on maintaining milk volume and increasing milk solids as much as possible.

Type of cow

Strong, well muscled cows with good feet and udders are our objectives, the type of animal that can maintain 1600-1700 gallons (8000 kg) milk yield at 3.5% protein and 4.0% fat, and more importantly can maintain herself in a spring calving herd for 5 to 6 years.

Fertility performance

Table 4
Herd fertility performance (1996-1998)

Year	1996	1997	1998
Cows served in first three weeks (%)	77	86	80
Calving to 1st service interval (days)	110	75	80
Services per conception	2.1	1.7	1.95
Pregnancy rate: 1st service (%)	44	60	66
2nd service (%)	56	47	27
3rd service (%)	42	86	20
Infertile rate (%)	10.4	4.8	14

In the past three years our fertility performance has been variable. In 1998 our infertile rate increased to 14% from 4.8% in 1997. We use D.I.Y. AI; it seems to work satisfactorily on the farm. We are concerned that given the results of the three year Moorepark study, where the high merit animals had a much higher infertile rate than the medium merit animals, that this may mirror itself on our farm. We do not have a problem submitting cows for AI, the problem we have is animals not conceiving to the services. Using tail paint, pre service scanning and pregnancy scanning are part of our breeding programme, without these aids our infertile rate would most definitely be higher. We are now involved in the Moorepark fertility study - and hopefully we will receive the relevant guidance as to where to focus our future breeding policy and what to breed for.

Cost structure and future direction of the farm

In the medium term we would like to increase our quota size; this will mainly be done through leasing more quota. Our current cost base is quite low, our fixed costs are running at 38.3 per gal which includes the cost of quota lease of 23.2p. per gal, variable costs are running at 23.9p. per gal. There is possibly some more room for improvement in reducing these costs; however the most crippling cost is the leased quota. One of the bigger problems about leasing extra quota is taking on more land. We do not intend putting non paying enterprises to use this extra land. We would hope to fill about 100,000 gallons of milk in the next 2-3 years. We should carry this extra quota with no extra labour cost. With our cost base, expansion in our current capacity is our main aim.

Acknowledgements

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Role of Partnerships in the Future of Irish Dairy Farms

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It is generally accepted that dairy farming profitability will not continue at the relatively high level of recent years. Apart from the predicted decline in milk prices, dairy farm output is also being reduced by depressed values of calves and cull cows. As a consequence, there will be increased emphasis on cost reductions. There is a limit below which cost cutting cannot go, and ultimately survival will not be achieved without increase in size. Additional resources must be procured by means of purchase, lease, or amalgamation such as share farming or partnership.

Expansion of farm size

The prevailing market prices of land with milk quota often give quite unattractive returns on investment. In many instances, the farmer has no requirement for the additional land. With margins declining in all sectors, acquiring land surplus to dairying requirements at exorbitant prices makes bad business sense.

The leasing of land with quota can be commercially justified if the land will be profitably used and the quota price is not excessive. The value of quota to a particular farmer varies with size being leased relative to owned quota, seasonal distribution and fat percentage. It is sometimes not realised that a quota with a low base fat content is vulnerable to reduction in size. For example, lease a quota of 30,000 gallons with a fat base of 3.55%; increasing the fat percentage to 3.95% will reduce the quota by 2160 gallons.

The possibility of increasing unit size by amalgamation of resources in a formal partnership has not been a traditionally popular option but is being widely discussed in recent times. Partnerships have many positive features but also carry pitfalls. Prior to establishment, it is important that the serious implications are thoroughly examined by the partners.

Requirements for partnership success

Before any physical farm factors are considered, there are certain human attributes required for a successful partnership i.e. compatibility in terms of personality, attitude, commitment and trust. Major differences in any of these parameters will inevitably lead to divorce proceedings.

The second essential area to be satisfied is the viability of the new entity. Farmers that have been performing unprofitably, and carrying significant borrowings, may not be appropriate participants in a partnership. Ideally, an independent competent professional should be used to determine the projected profitability. The feasibility study should examine both short-term and long-term performance.

An important third aspect is clear understanding by each proposed partner to the implications of partnership operation. It must be absolutely recognised that partnership is not leasing in disguise. A partnership is a well defined legal entity that will keep accounts, apportion profits in an agreed manner and make tax returns (each partner).

Intending partners should be aware that at the present time, partnerships enjoy no special privileges with regard to milk quota regulations. The official interpretation is that since each partner will transfer land and quota to a new entity, each quota will be subject to 20% clawback. It is hoped that if there is sufficient positive demand, this position would be altered. It is on this basis that the concept is being openly discussed.

Benefits of partnerships

Whilst partnerships cannot be expected to resolve all of the problems facing dairy farmers, they can certainly help to alleviate some of the major obstacles:-

1. Unit size:

The most common problem is small quota size i.e. 20,000 to 40,000 gallons on 60 or 100 acres of land. With reducing values of dairy farm produce and declining margins in other enterprises, size of unit will be the limiting factor to future viability.

2. Labour requirements:

Farming, particularly when inefficient, gives poor returns on labour relative to industrial employment. There are two aspects to the farm labour problem:

(i) Returns to the farmer himself are often quite low for the effort involved. Smaller units cannot afford hired labour. These have traditionally survived on the contribution of family labour. This situation is rapidly changing with better education and employment opportunities. Even relatively large dairy farms are finding that no family member is interested in continuing the business due to the moderate rewards for the work involved.

(ii) Hired labour is becoming unaffordable and very often unavoidable. A typical farm labour unit costs about £12,000 per year. An operator with managerial expertise or specialist skills will cost significantly more. Without adequate size, a hired labour unit cannot be afforded. A herd size in excess of 100 cows is required before a permanent hired labour unit can be considered.

Partnerships have very obvious benefits to offer. There is potential to rotate weekend work and organise holiday time. If necessary, and desirable, a partner could supplement income with some off-farm employment.

3. Quality and safety standards:

Compliance with constantly increasing hygiene standards and safety regulations requires investment that individual farmers often cannot afford or justify. Increased size will help to carry these costs.

4. Profitability of secondary enterprises:

The relevant secondary enterprises that occupy land are beef cattle, sheep and cereals. The latter is not applicable without area aid eligibility. In many instances, significant capital investment is required to improve efficiencies in animal performance and labour usage. The combining of resources in a partnership may afford the opportunity for proper development. In some situations the rearing of replacement heifers and fattening cull cows could become part of this operation.

5. ***Environmental standards:***

Complying with requirements pertinent to the environment is proving difficult on many farms because of the inability to make the necessary capital investments. Increasing the size of the unit, and the opportunity for specialist enterprise operation, should be of great assistance. The target should be to have all drystock units participating in REPS. This would benefit the farm and environment.

Partnership operation

There is a wide variety of circumstances in which partnerships have a positive contribution to make. Potential farmers vary in age, health status, land area and quality, milk quota, secondary enterprises, farm structures, and financial position. Common requirements are the need to improve efficiency, profitability, and quality of life.

Details of two farms for which a feasibility study was undertaken are shown in Table 1. Farmer A has ill-health and has three children at various stages of education. Farmer B has recently taken over the family farm and recognises that he must expand his existing operation.

Table 1
Summary data on proposed farm partners

	Farm A	Farm B
Acres (map)	132	77
Acres (adjusted	123	72
Milk quota (gallons)	67,492	26,014
Beef system	45 calf to beef	20 calf to store
Age (years)	49	28
Permanent labour units	1	0

The two farms could quite easily be structured into a partnership on the following basis:

(i) A will become the Dairy Farm with 90 cows and 22 replacement heifers.

(ii) B will operate as a Beef Farm with 64 steers reared calf to beef.

(iii) The permanent labour unit will not be required and will be replaced by Farmer B, and Farm Relief Services.

Details of actual income and expenditure on the individual farms and projections for the proposed partnership are presented in Table 2. These data show the profit increasing to £70,721 compared with the existing combined total of £46,997. The extra profit is generated by income increase of £7,254 and expenses reduction of £16,470. The major cost savings are achieved by elimination of hired permanent labour and quota leases.

Table 2

Actual income and expenditure on individual farms and partnership projections

Income:	Farm A (£)	Farm B (£)	Partnership (£)
Gross output livestock	25,651	8,964	41,140
Gross milk receipts	70,918	25,598	96,311
Current receipts	8,268	1,678	10,880
	104,837	36,240	148,331
Expenses:			
Seeds & sprays	1,362	—	851
Fertilisers & lime	8,694	3,078	12,755
Livestock maintenance	4,163	1,466	6,122
Feed & fodder	12,914	3041	17,331
Casual labour	897	360	2,000
Transport hire	644	116	504
Machinery hire	4,626	1,266	7,177
Daily variable costs	804	254	2,202
Milk & livestock levies	1,191	135	2,273
Silage additive & polythene	616	208	1,866
Machinery operating costs	4,828	688	5,014
Vehicle costs	3,031	1,237	2,103
Telephone & ESB	3,205	595	2,697
Permanent labour	13,903	—	—
Rent, rates & insurance	2,791	712	2,444
Loan interest & charges	1,069	52	1,215
Quota lease	2,307	670	—
Repairs, renewals & hardware	3,234	445	2,221
Accountancy fees	920	855	1,169
Miscellaneous expenses	871	78	1,402
Depreciation	5,696	1,058	6,264
	77,766	16,214	77,610
Profit:	27,071	19,926	70,721

This type of improved performance is typical of the potential that is achievable on many units throughout the country. The concept could make rapid progress if the obstacles of milk quota clawback were removed.

Summary

There are very obvious benefits to be derived from partnership establishment in Irish dairy farming. These include improved efficiencies, higher profits and better quality of life.

To proceed with the introduction of partnerships a first requirement is the removal of the imposition of clawbacks on milk quotas. Assuming this is achievable, none of the other potential difficulties are insurmountable if the partners have a committed attitude.

Partnerships have advantages over leasing in terms of retention and use of resources and taxation implications.

Trends Within Danish Dairy Farming

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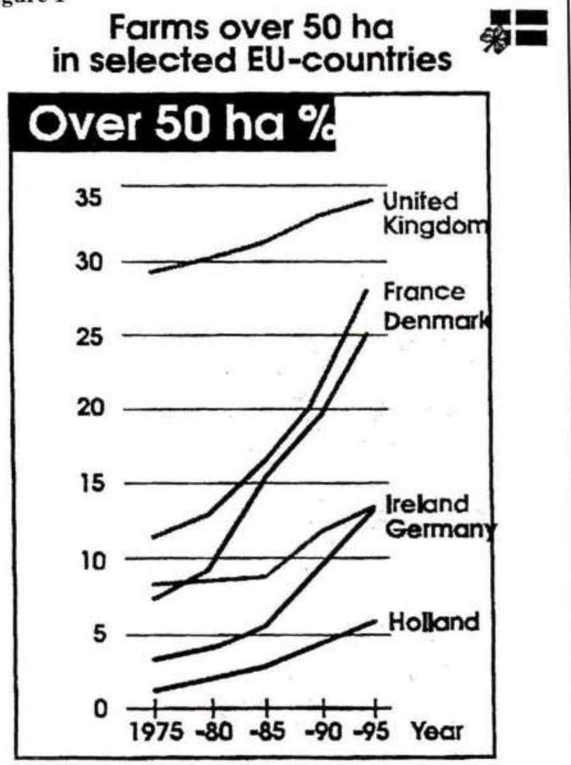
Danish agriculture - past and present

Denmark is a Scandinavian country with a total area of 43,000 km^2 and a population of 5 million people. 1000 years ago our famous and disreputable ancestors, the Vikings, plundered and raped away from home while their wives were farming at home. Since then we have turned more peaceable and farming has become one of our most important businesses. Even today where Denmark is a high-tech industrial society, farming is of immense importance to employment and the economy. More than two-thirds of the agricultural produce are exported.

Owner-occupancy is more widespread in Danish agriculture than anywhere else in Europe with a very small proportion of farms tenant-run.

Figure 1



No. of farms: 60,910 in 1997 compared with 140,200 in 1970. The average size rose from 21 to 44 hectares. The percentage of farms over 50 hectares rose from 7 per cent in 1975 to 25 per cent in 1995 (Fig. 1).

Employment: Full-time employees in 1996 numbered just under 13,000 against 20,000 in 1985. Only one in four farms had full-time assistance. However, including industries directly linked to agriculture, the farming sector provides jobs for 233,000 people.

Approximately 1,200 young people embark on agricultrual education every year. The average age of people setting up in farming is 27 years. The average age of farmers is 51 years.

Table 1

Agricultural area in Denmark by type of crop

1,000 ha	1982	1998
Cereals	1,706	1,519
of which winter wheat	241	673
barley	1,333	677
Pulses	29	107
Oil flax	0	6
Rape seed	168	118
of which non food rape seed		10
Set-aside		144
Roughage incl. green cereals, total	760	578
Cereals for green fodder	53	111
Maize for silage	16	45
Fodder sugar beets	131	33
Grass in rotation	324	247
Grass outside rotation	235	142
Potatoes	32	38
Beets for sugar production	74	64
Seeds for sowing	45	83
Horticultural products	28	21
Other	11	1
Total cultivated area	2,854	2,679
cultivated on farms	2,828	2,658
Area cultivated on farms in per cent of Denmark's total area	66.2	62.4

Source: Ministry of Agriculture

Production: The annual output of animal products could satisfy the requirements of 15 million people or 245 per farm.

Exports: More than two-thirds of the total farm production is exported. In 1997, 60 per cent of exports went to other EU countries while Japan and the US were the main markets outside the EU.

Agricultural exports in 1997 were worth 54 billion Danish kroner in foreign currency. The industry's requirements for imported operational materials accounted for 15 billion kroner only. The difference - 39 billion kroner - contributed significantly to pay for imported raw materials and equipment for other industries as well as cars and other consumer goods.

Farm product prices and costs: Between 1980/84 and 1997, the farmgate prices of products for the home market rose by 2 per cent while the general price level rose by 68 per cent.

Income: The total net income in agriculture amounted to approx. 7 billion Danish kroner in 1995, 1996, 1997 and is estimated to decrease considerably in 1998 because of the dramatic drop in pork prices. For full-time farmers, the net income in 1997 was 231,000 Danish kroner in crop production. 195,000 Danish kroner in cattle/milk production and 501,000 Danish kroner in pig production.

Organic production: In 1997 there were 1,617 authorised organic holdings with a total area of 64,329 ha in Denmark. This corresponds to an average area of 39.8 ha.

Structural changes: When talking about structural development in Danish agriculture, pig production is often mentioned. Denmark is the world's leading pork exporter with an annual production of 25 million pigs. As you can see in Table 2, Denmark produced 9.4 per cent of the total EU pig meat production. In recent years pig production has been concentrated in still fewer and larger farms.

Table 2
Livestock production in the EU

1,000 tonnes	Beef & veal	Pig meat	Poultry meat	Eggs	Milk	Butter	Cheese	Skm'd milk powder
1995 total	7,964	15,976	7,944	5.341	112,996	1,735	5,798	1,186
1996 total	7,950	16,316	8,317	5,223	113,410	1,794	5,942	1,191
1997 total	7,887	16,249	8,575	5,154	113,315	1,756	5,983	1,126
Of which:								
Belgium/Luxembourg	340	1,015	311	205	3,199	100	74	56
Denmark	175	1,523	185	85	4,433	50	290	23
Germany	1,449	3,562	745	840	27,171	442	1,591	334
Greece	69	142	161	120	549	1	9	0
Spain	592	2,401	987	557	5,397	24	185	14
France	1,718	2,220	2,290	975	22,922	466	1,521	366
Ireland	569	220	126	31	5,254	139	96	102
Italy	1,160	1,396	1,136	720	9,877	92	799	0
Netherlands	564	1,376	670	592	10,519	131	705	41
Austria	206	489	100	100	2,421	41	80	18
Portugal	104	303	246	103	1,673	21	47	13
Finland	99	179	55	71	2,369	57	88	25
Sweden	148	326	85	109	3,276	54	119	31
UK	694	1,096	1,479	645	14,255	140	380	105
Denmark as % of total	2.2	9.4	2.2	1.6	3.9	2.8	4.8	2.0

Source: Ministry of Agriculture

The changes in Danish dairy farming have involved a high number of farmers. In the following paragraphs some of the main characteristics of this development will be described, including the impact of the new milk quota transfer market. Finally, the challenges of the future will be pointed out.

When Denmark joined the EEC in 1973, the total number of dairy farmers was nearly 70,000 who produced a total of 4.5 billion kg milk. Today 10,400 dairy farmers produce the same volume of milk. This decline in farm numbers of about 85 per cent is indeed very remarkable (Figure 2).

The total number of dairy cows has also dropped considerably. In 1973 there

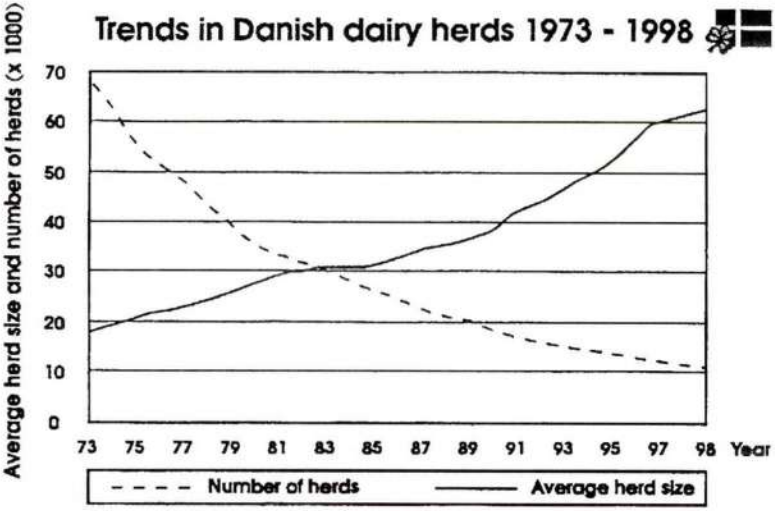


Figure 2

were a total of 1.2 million whereas the present number is a little below 700,000. In other words: The milk yield per cow has gone up by more than 50 per cent and for milk recorded cows the average yield per cow is now 7,327 kg (Table 3).

Table 3
Average production of milk recorded in Denmark, 1997/98

Breed	No. of cows*	Cows per herd	% of all cows	Kg milk	% fat	Kg fat	% protein	Kg protein	Kg fat + protein
Danish Holsteins	401,735	64	69.0	7,769	4.16	323	3.39	264	587
Danish Jerseys	72,615	60	12.5	5.389	6.07	327	4.12	222	549
Red Danish	56,731	49	9.7	7,089	4.25	302	3.58	254	556
Red and White	5,468	53	0.9	6,897	4.16	287	3.45	238	525
Crossbreds	45,658	61	7.8	6,860	4.48	308	3.57	245	553
Total	582,207	62	100.0	7,327	4.36	320	3.49	256	576

*Nearly 90 per cent of all Danish dairy cows are under official milk recording.

Today 90 per cent of all Danish dairy cows are under official milk recording. Together with a unique registration system and a national database this forms the basis of farm management tools, calculation of breeding values and a quality young-sire testing programme where 300 Holstein bulls, 100 Jersey bulls, 80 red Danish bulls and 15 Red and White bulls are tested annually.

Large improvement of productivity

Measured by labour input, the average dairy farm is much larger today than 25 years ago as the present input is 3,700 hours against about 3,100 hours 25 years ago. This means that by means of a modest increase in labour input it is today possible to run a farm with more than three times as many dairy cows as in 1973 which is indeed a dramatic improvement.

At the time the farms were less specialized than today as cattle production accounted for only 60 per cent of the gross margin in the middle of the 1970s against 75 per cent in the middle of the 1990s.

The area of the farms has of course increased in this period from 25 to more than 60 hectares. 55 per cent of this area is today used to produce roughage against 45 per cent in 1973. The roughage area per cow has been stable at 0.6 ha.

An interesting change that has taken place over the past 25 years is that dairy farms produce much less beef today. 25 years ago the net sales of animals made up more than 30 per cent of the total receipts from animals and milk whereas the figure today is only 15 per cent. This is due to the fact that fewer cows are needed to produce the same amount of milk but also that beef prices have not increased at the same rate as milk prices. Beef prices have been especially low in the last few years.

Danish average farm ranked second in the EU

Table 4 shows the structural development in a number of selected EU countries. At the beginning of the new milk quota year 1999/2000 there will be about 10,400 Danish milk producers with an average milk quota of 428,000 kg. This means that a Danish average farm is close to being the largest in the EU - thus outranking the UK farm. If the about 6,000 "passive" UK quota owners are left out, the average quota is not 380,000 kg as stated in the table but about 450,000 kg - in this case the UK still has the largest farms.

The recent rapid structural changes are caused by the successful introduction of the new milk quota transfer market in April 1998. This issue will be described later on in this paper.

As appears from the table, the development in Holland has been relatively stagnant in the recent years. The French milk production is characterized by large structural differences - from highly intensive milk production in the northern part to extensive and environmentally sound production in the mountains in the area near the Mediterranean. The farms in the northern regions have nearly 50 per cent higher quotas than the average quota of 165,000 kg. A similar geographical structural difference also exists in Germany where the farms in the northern regions are comparable to medium-sized Danish farms.

Table 4
Structural changes in selected EU countries, 1983-1997/98

	Denmark	UK (3)	Germany (2)	Holland	France	Sweden	Ireland (3)
No. of farms							
1983	35,400	58,000	395,000	61,000	427,000	37,400	86,000
1990/91	21,400	45.000	278,000	47,000	212,000	24,800	51,000
1997/98	12,255	37,809	165,178	38,557	144,833	15,188	35,000
Average milk quota per farm, kg							
1983	153,000	290,000	72,000	218,000	65,000	96,000	66,000
1990/91	217,000	320,000	112,000	243,000	124,000	138,000	102,000
1997/98	363,000	380,000	168,000	285,000	165,000	217,000	150,000
Average number of cows per herd (1)							
1983	28	57	14	41	16	17	18
1990/91	34	63	23	40	25	22	25
1997/98	54	64	30	43	26	31	33

All figures are computed as per 1 April 1998

Source: ZMP, Dairy Facts & Figures, Eurostat and EU Commission

1) Estimates
2) 1983-figures include West Germany only
3) Inclusive of "passive' quota owners

Traditionally, the farms in the former German Democratic Republic are large - and they still are - whereas the farms in the southern regions are smaller than the national average. The structure within Danish cattle farming is probably the most homogenous in the EU.

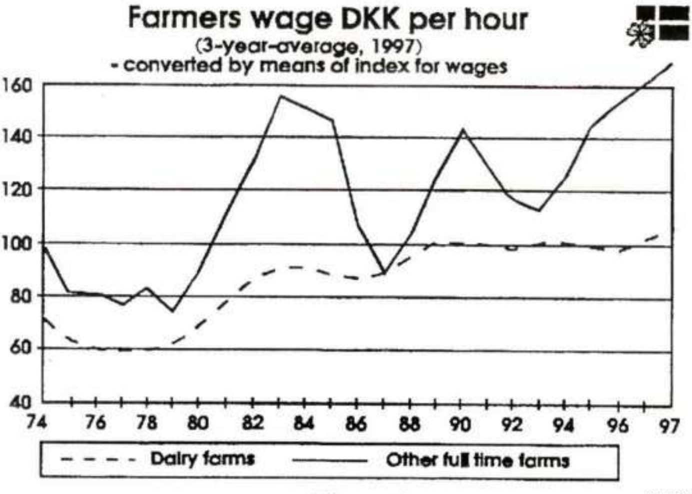


Figure 3

Income

Measured by income per hour, the result of the Danish dairy farms has been considerably lower than the average of full-time farms concentrating on arable production or pig production (Figure 3).

The average difference is about 30 Danish kroner (DKK) per hour (present value). Only by the end of the 1980s was the income of the dairy farms almost equal to that of the other enterprises. The economic incentive to switch from dairy cows to another enterprise, mainly pigs and/or plant production, has thus been present.

Attention should also be paid to the level itself with a relatively low income per hour until the early 1980s, a higher but still low level until the late 1980s and a figure nearly 100 Danish kroner in the last 8-10 years. Even though this cannot be compared with labour market wages, the income is modest by Danish standards.

Measured by current income, the Danish dairy farms have also had a lower income than other enterprises even though the difference has been somewhat lower than the income per hour. One of the reasons is that the dairy farmers have generally contributed about 10 per cent more labour than the average of arable and pig farms.

Investment and financing

When Denmark joined the EEC, the general opinion was that there was a basis for increasing farm production. This had the effect that in the 1970s the investments of the dairy farms were 50 per cent higher than the depreciations whereas in the 1980s they invested 15 per cent more than they wrote off. In the 1990s investments were nearly 35 per cent higher than depreciations.

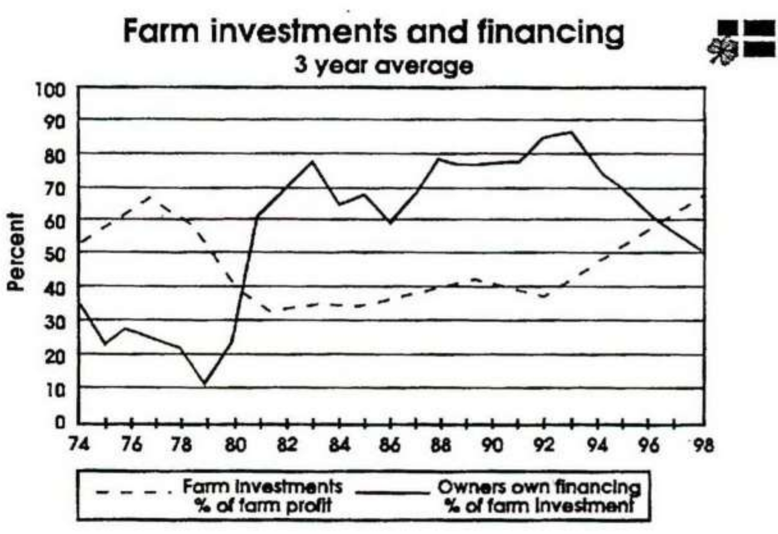


Figure 4

The general investment level and the development in income per hour have to be considered when evaluating the development shown in Figure 4. It shows the relation between investment in farm assets and farm profit. The figure shows that the investments in the 1970s were not covered by an operational surplus but later on investments turned more prudent.

Of course, the introduction of milk quotas in 1983 played an important role in this development as for some time they curbed the decline in farm numbers (see Figure 2).

Generally, more caution was displayed following a violent crisis in Danish agriculture in the early 1980s when the optimism of the 1970s received a blow. The rise in the investment share over the past few years is probably due to the fact that the farmers took up a reserved attitude until they knew whether the milk quotas became freely transferable or not and also that the share is measured at a lower operational surplus.

Generally, investments have been more prudent since the early 1980s which appears from the self-financing curve in which depreciations are included as well.

In the 1970s the money invested was mainly borrowed money whereas since then the farmers have mainly invested their own money although borrowings again have increased dramatically in recent years, but now at a much lower interest rate than in the 1970s. The actual interest in farm property is about 7 per cent at 30 years mortgage loans. Up to 70 per cent of the value of the farm property can be financed via these loans.

Savings

An important element in an economic assessment is the volume of savings for consolidation. This has changed drastically for the dairy farmers since 1973 which is shown in Figure 5 displaying the annual savings of 5-year periods.

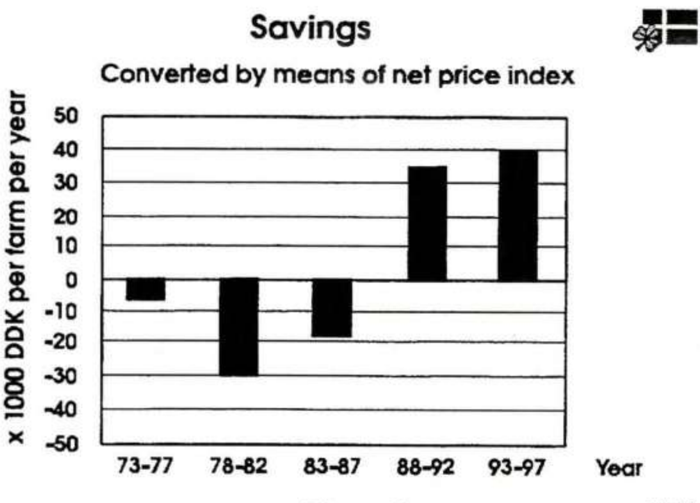


Figure 5

The figures clearly show that the development has turned from a deficit to a pretty good surplus over the past 10 years. It can be concluded that in general the existing dairy farms have a healthier economy than for many years.

It has in no way been a problem-free development as thousands of dairy farmers have dropped out of dairy farming. To this must be added that outgoers schemes have made the decision of stopping to produce milk easier than perhaps even attractive to elderly farmers. The present possibility of selling quotas has in principle the same effect.

Impact of new milk quota exchange

The milk quota exchange is the most recent vehicle for restructuring the Danish dairy industry. It was set up last year and is aimed at increasing flexibility, to break the ties between land and quota and to allow the market rather than the political system to fix the price of quota. It gives farmers who are willing to expand, the opportunity to move quickly up to 80 cows. Other farmers have to make the decision whether they want to stay in milk production in the future.

How is the exchange working?

- Producers, wanting to sell, make an offer to the Danish Dairy Board stating the volume they want to sell and the minimum price.
- Producers, wanting to buy, make an offer to the Danish Dairy Board stating the volume they want to buy and the minimum price.

The offers to sell are recorded in a supply curve according to increasing prices, and the offers to buy are recorded in a demand curve according to falling prices (Figure 6). The cut-off between the two curves constitutes an equilibrium price or market clearing price, which is the point where the quantity offered for sale equals the quantity which buyers want to purchase as the same price.

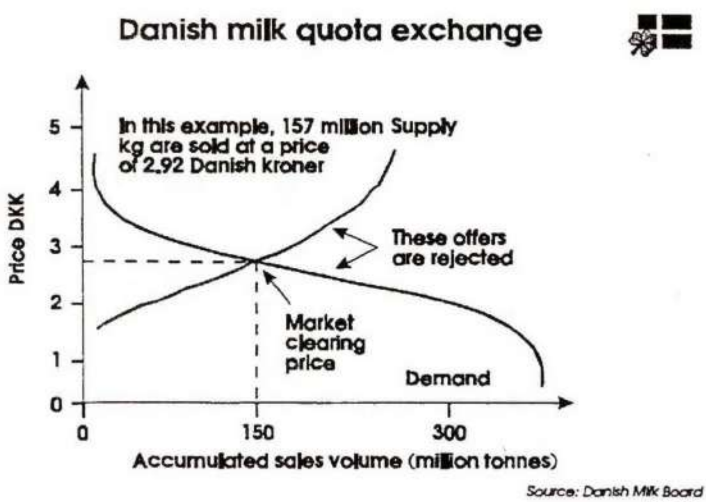


Figure 6

- Producers, who have stated that they want to sell at a price, which is lower or equal to the equilibrium price, will sell at the equilibrium price.
- Producers, who have stated that they want to buy at a price, which is higher or equal to the equilibrium price, will buy at the equilibrium price.

Other offers to buy or sell (located to the right of the intersection) are rejected and may "try" again in the next exchange round.

The equilibrium price of the exchange applies to milk quota with an average fat content of 4.36% and each producer's price/price offer is differentiated according to fat content.

The price formation of the quota exchange is based on the condition that there are many producers wanting to buy and sell. This means that individual offers cannot affect the equilibrium price - neither unrealistically high offers to buy nor unrealistically low offers to sell.

Possibilities and limitations of buying milk quota - for farms already having a milk quota the following rules apply:

- rented quota is included when calculating the volume of the quota and the following upper maximum limits apply:

1977-1988:	800,000 kg
1998-1999:	850,000 kg
1999-2000:	900,000 kg
2000-2001:	950,000 kg
2001-2002	1,000,000 kg

- if a farm has a quota below the upper maximum limit, the farmer can buy up to 150,000 kg per year or 300,000 kg over 5 years.
- the milk quota purchased includes the allocation, if any, received as a newly established farmer. After the purchase the quota must not exceed the upper maximum limit.

Special rules for newly established farmers

To encourage the producers to redistribute quotas through the exchange, a clawback of 33 per cent on direct transfers was introduced in 1997. The deducted quota goes straight into the national reserve and is redistributed to newly established farmers. These changes have huge effect on how quota is being transferred.

Newly established dairy farms:

- can apply to the Danish Dairy Board for a quota up to 560,000 kg (80 cows)
- max. one-third of the allocation is free quotas from the national reserve
- max. two-thirds of the allocation are bought at the equilibrium price

Newly established "empty" farms:

- can apply to the Danish Dairy Board for a quota up to 300,000 t
- max. one-third of the allocation is free quotas from the national reserve
- max. two-thirds of the allocation are bought at the equilibrium price

Table 5 shows the result of the first 3 quota exchange rounds. The first round was opened on 25 December 1997 and closed for sales and purchase offers on 16 January 1998. The result of this first round was as follows: A total of 6,840

Table 5
Key figures for the 3 first Danish milk quota exchange rounds, 1983-1997/98

	December	August	December
Market clearing price*, DKK per kg	2.28	2.68	2.92
Market clearing quantity, million kg	177.80	56.50	158.00
Accepted offers to sell or buy, total	4,8,5	1,564	4,017
Farms wanting to sell or buy quota (total offers)	6,840	4,103	5,500
Quota sales			
Accepted offers to sell quota	1,017	359	978
Offers to sell	1,394	439	1,100
Quota offered for sale, million kg	278.40	80.40	190.00
Average quota purchased, kg	174,800	157,400	161,600
Quota purchases			
Accepted offers to buy quota	3,818	1,236	3.039
Offers to buy	5,446	3,664	4,400
Quantity in demand, million kg	222.90	126.30	192.00
Average quota sold, kg	46,600	45,700	52,000

* 4.35% fat

Source: Danish Dairy Board

producers traded at the exchange, out of which 1,394 wanted to sell 278.4 million kg and 5,446 wanted to buy. 177.8 million was traded kg at the market clearing price of Danish kroner 2.28 per kg.

1,017 producers made sales offers below the marketing clearing price and sold their quota. 3,818 producers made offers to buy above the market clearing price and consequently they bought the required quantity. This means that 1,987 offers were not traded. 366 producers wanted too high a price for their quota and 1,627 producers did not offer enough to acquire the quota quantity they intended to. They were informed that their offers were not traded and they may try again at the next round of the quota exchange.

Since the milk quota exchange system started in the autumn of 1997, it has been decided to have two annual exchange rounds. The price has gone up from Danish kroner 2.28 per kg in the first round to nearly Danish kroner 3.00 at the latest in December 1998. Before the exchange the price was Danish kroner 1.60 per kg.

This high rise in prices is a clear indication that the relatively high income of the dairy farmers in the 1990s has created optimism so that they now believe in a satisfactory income from dairy farming in the coming years. After years of little or no investment on dairy farms there is now a resurgence. New barns for 140-150 cows are being built. Existing buildings are being expanded by farmers who are confident they are staying in the industry.

About 400 Dutch farmers have immigrated into Denmark and are now running mainly dairy farms here. They have contributed to creating further dynamics in cattle production because they demand large productive units and make heavy investments. Their farms are considerably larger than the Danish average dairy farm.

More stringent control

In recent years Danish farmers have experienced increasing public focus on farm production. This has resulted in a wide range of rules and regulations which the farmers have to observe.

1. Animal manure and area requirements

In order to reduce nitrate leaching to streams, lakes and seas strict rule stipulate how to use nitrogen and animal manure. Last year the so-called aquatic Environment Plan II was adopted, among other stipulating reduction of the maximum N application rates to individual crops. By way of example: spring barley 75-120 kg N per ha depending on soil type, pre-crop, irrigated or not irrigated, winter wheat 110-187 kg ha N per ha, grass 290-325 kg N kg per ha and grass for extensive grazing 140 kg N per ha.

The goals of the aquatic Environment Plan II are:

1 Wet meadows, increasing forest area
2. Increased feed utilization
3. Increased harmony between area and LU
4. Increased utilization of cattle manure
5. Decreased N-recommendation (10%)

Strict rules govern the utilization of N in animal manure. By way of example: Minimum 50 per cent of the nitrogen in cattle slurry must be utilized in the first year and 10 per cent in the second year. 9 months' storage capacity is required for slurry which must not be spread in the period from 1 October to 1 February and only on fields covered with green crops. Furthermore 67 per cent of all fields must be covered with green crops during the wintertime.

Nitrate directive

Reduction in N-leaching 100,000 tonnes

Now:	1 LU = 1 milking cow
From 1999:	1 LU = 100 kg N ex.storage

Application of cattle manure

Now:	N from 2.3 LU/ha (app. 270 kg N)
From 1999:	210 kg N/ha
From 2003:	170 kg N/ha

Mixed farms

Now:	2.0 LU/ha
From 2003:	1.4 LU/ha (140 kg N)

The area of land also has to be balanced against the livestock numbers on each individual farm. A cattle farm is allowed to have maximum 2.1 livestock units per ha. All types of livestock are converted to livestock units. One dairy cow of a heavy breed (i.e. Holstein) corresponds to 1.18 livestock units, 1 heifer: 0.35 livestock units, 1 bull from birth to 450 kg: 0.35 livestock units, 1 bull from birth to 450 kg: 0.35 livestock units, 1 sow with piglets and young females: 0.33 livestock units, 1 slaughter pig to 30-98 kg: 0.033 livestock units. Poultry, sheep, horses, mink etc are converted to livestock units as well.

As from 1 August 2002 the harmony requirement for cattle farms is 1.7 livestock units per ha and 1.4 livestock units per ha for other livestock types. However, for cattle farms 2.3 livestock units are required if sugar beets, grass or grass crops are grown on more than 70 per cent of the area of the farm.

Every year the farmer has to prepare a fertilizer balance to The Danish Ministry of Food, Agriculture and Fisheries, showing how much commercial fertilizer and animal manure have been applied to each individual crop and utilization of animal manure. Farmers who break the rules are fined.

The area requirements are tightened as well and this has brought about rapidly rising land prices in areas with many pig and cattle farms (up to 100,000 Danish kroner per ha). So far Denmark is the only country meeting the EU nitrate directive.

In the future, it is likely that pesticide balances are to be prepared and sent to the Ministry of Food, Agriculture and Fisheries and the farmers will no doubt be forced to reduce consumption. Denmark is already among the countries in the EU applying least pesticides (g per ha) - today it is compulsory to prepare a field record showing all pesticide treatments.

*2. **Veterinary rules***

Currently there is much public focus on veterinary and animal welfare issues and strict rules govern the use of drugs on cattle farms.

General rules

- The vet must only hand out or prescribe prescription drugs, provide he personally sets the diagnosis.
- It is not allowed to hand out antibiotics and chemotherapeutic drugs meant for injection through the skin of injection into udder or uterus.
- Strict rules govern the withdrawal of milk and slaughter after treatment with a prescription drug.
- Dehorning of calves must take place only following local anaesthesia carried out by a vet.

Health advisory agreement

A herd owner who enters into a written health advisory agreement with a vet is entitled to:

- 12 annual advisory visits by the vet
- drugs for post-treatment of cows, provided the herd's vet has made the diagnosis and started the treatment
- drying-off antibiotics, provided a positive bacteriological test of individual quarters
- drugs for the treatment and repeated treatments of calves and young stock, provided the herd's vet has made the diagnosis and started the treatment

National disease eradication programme

The Danish cattle stock has a high veterinary status and a great many diseases have been eradicated by means of sanitation programmes ("test and slaughter policy"). In the mid-1980s IBR was eradicated in a nationwide programme in which more than 15 per cent of all cattle was slaughtered. Denmark is now 100 per cent IBR-negative.

Right now we are eradicating BVD (bovine Virus Diarrhoea). Herds which have had an unbroken BVD-free status for more than 24 months and whose BVD-free status has been confirmed through a status test are free to sell or buy animals without preceding examination.

There are two types of status test (needed in case of transfer to another herd, exhibition at cattle show, pasturing, etc):

- Tank milk test, showing a value below 50 units
- If the value exceeds 50 or if no tank milk test is available (e.g. in beef cattle herds), 3 young animals (age: 8-10 months) are to be blood-tested for BVD-virus and antibodies with a negative result.

Animals from a BVD-free herd which has had BVD-free status for less than 24 months can only be sold/purchased if they have been blood-tested for BVD antibodies with negative result. Calves below the age of 3 months must be blood-tested for both BVD-virus and BVD-antibody with negative result (both on the same day).

All animals that are traded must be accompanied by a health certificate, showing the BVD-status of the animal and issued by the Minisry of Food, Agriculture and Fisheries.

3. Housing

Livestock housing has also been much debated in political circles. According to the existing regulations new livestock buildings must meet certain requirements as to ventilation, resting area, etc. Young stock below the age of 1 year must not be tied up and if young stock are housed on slatted floor, they must have access to cubilcles or deep liter. The existing animal welfare housing requirements will no doubt be tightened in the years to come.

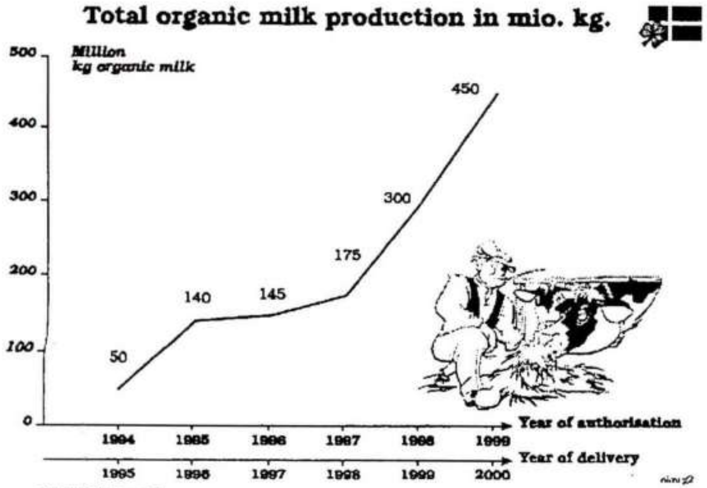


Figure 8

Organic farming is gaining ground

The increasing demand for organic dairy products in recent years has of course resulted in a dramatic increase in the number of farms converting to organic farming. In 1½ to 2 years 10 per cent of Denmark's dairy production will be organic. The price of organic milk is now about 25 per cent higher than that of conventional milk.

The higher milk prices paid during the period of conversion has accelerated the rapid development. As shown in Table 6, the average organic farm has a higher milk quota than the average conventional farm.

Table 6
Number of organic farms with milk quotas

	No. of farms	Total quota million kg	Average quota per farm, kg	Ave. quota per conventional farm, kg
1993/94	132	39	295,000	271,000
1994/95	146	47	323,000	290,000
1995/96	147	56	381,000	310,000
1996/97	344	140	407,000	330,000
1997/98	430	183	427,000	363,000
1998/99	672	333	496,000	392,000

Over the past 10 years there has been an unsatisfied demand for organic products among the Danish consumers. Organic products are trendy and the consumers are willing to pay extra. With the large expansion of production, demand and supply seems to balance.

Branded goods which have been successful as conventional goods, e.g. "Lurpak", are now introduced in an organic version. This product development is expected to lead to increasing demand.

In the future organic dairy products are to be exported, the UK, Germany and Sweden being the most interesting markets. Whether the high price of organic milk and the sound economy of this production can be maintained remains to be seen in the years to come.

High milk price needed

Denmark cannot rapidly expand production when quotas go. The whole country is a nitrogen sensitive area. Environmental restrictions already in place will limit the increase in milk production to between 5-10 per cent. Then why are we one of the four EU countries (Sweden, the UK, Italy and Denmark) calling for quota abolition in 2006 in agenda 2000? In the long term we are aiming to set up a dairy industry which will be viable - quotas or no quota.

The system of farming is high cost compared to Ireland. Grass has a role in reducing costs but the cold winters limit its potential. Cows are housed for 6-7 months and calving takes place all year round.

To survive in the future, we need large herd sizes but even more importantly, a high milk price is needed. Last year the milk price was Danish kroner 2.50 per kg. Organic milk, a sector in which the production as mentioned is increasing rapidly, made up to Danish kroner 3.25 per kg. Organic production together with intensive product development, aggressive marketing and increased efficiency are the most important tools to secure a high milk price.

To maintain high prices in the future we have set about targeting the high value added European markets. A strategic decision was made over 10 years ago to switch milk from commodities sold to third country markets and develop more profitable markets in European countries, particularly Germany. The milk pricing system was changing to encourage a more uniform year round milk supply. It seems that the policy is now paying off.

Postponement of milk reform gives concern

If we want to have a milk industry in 25 years time, we have to be able to compete in a free world market. We cannot do it with 30-40 cow herds. In a 30-cow dairy herd in the EU it costs about Danish kroner 300 to produce 100 kg milk. In the US the costs of producing 100 kg is Danish kroner 150 and in Australia Danish kroner 100 according to the International Farm Comparison Network. On EU-farms with 60-75 dairy cows it costs about Danish kroner 225 to produce 100 kg.

The Danish Dairy Board is pleased that an agreement was made in March concerning an agricultural reform in the EU. At the same time it is regrettable that the milk reform and thus the lowering of the guaranteed minimum prices of 25 per cent was postponed until 2003/04. This reservation leads to uncertainty about EU's long-term policy which neither the milk producers nor the dairy industry really need.

From a Danish point of view it is positive that the compensation is now divided equally without leaving out special producer groups. The Danish Dairy Board is clearly opposed to the extra quota allocated to Italy, Spain, Greece and Ireland.

The milk reform was postponed for budgetary reasons to make the political patience come out. This means that the EU will have much shorter time to adjust the system and the competitive power to the coming WTO agreement which is expected to be signed no later than in 2003. Furthermore, this situation also creates uncertain conditions for the enlargement of the EU with the East European countries.

What about the future of the quota system? In 2003 at the earliest this important question - which is of decisive importance to the milk producers and the dairy industry - will be dealt with. According to the Danish Dairy Board this is unacceptable in connection with the very dramatic structural development and the internationalisation now taking place.

The future

By 2006 the total number of producers in Denmark will be 5,500 with an average herd size of 80-90 cows to produce the national quota. This clear direction for the future is being backed by the advisory service and the government. Structures are being put in place. These include, as already mentioned, the milk quota exchange but also partnerships and co-ops to allow it to happen. By way of example, the two leading cooperative milk processors MD Foods and Kloever Milk merged one month ago. The new cooperative, named MD Foods, will process 91 per cent of the milk produced in Denmark and its total annual turnover is estimated at 26 billion Danish kroner. In the beginning of 1999 the two largest cooperative slaughterhouses Danish Crown and Vestjyske merged. The market shares of the resulting company, named Danish Crown, will be 85 per cent of all pig slaughterings and 65 per cent of all cattle slaughterings. It is the world's largest slaughterhouse and its total annual turnover is estimated at 38 billion Danish kroner. The Danish agricultural industry is preparing itself to compete with the biggest players on the future world market. Effectiveness, constant product development, professional marketing and introduction of high-priced branded goods are to secure the Danish farmers the highest possible prices for their products.

Key Factors in Growing a Business

P. BAKER

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I was honoured with a Nuffield scholarship in 1997. A Nuffield scholarship gives one the opportunity to travel the world and study one's chosen topic. Its main aim is to encourage active involvement and leadership within agriculture. The Nuffield network of past and present scholars in various parts of the world is a wonderful opportunity to meet with positive and interesting people. I would like to acknowledge the generosity of my sponsors: The Farmers Journal, FBD and IFA

Reason for looking at "the key factors in growing a business":

My main reason for choosing this topic was that I felt there was widespread stagnation within European agriculture. This was largely because of EU policies and restrictions which were perceived as obstacles to growth. Industry stagnation was, and is, taking a financial and human toll and my study was aimed at finding a way around these "obstacles".

Conclusion of this report:

I interviewed leading managers both from the corporate sector and within farming. From them, I formed the conclusion for my report which can be summed up in one quotation:

"Obstacles are what you see when you take your eyes off the goals".

If there is only one sentence to be remembered from my paper then that is it! The reasons are:

1. Business growth comes from a combination of management and capital.
2. Our management combines a mix of strategy (planning) and capability.
3. My simple deduction is that we all have a certain amount of capital or can get it if the idea is right. We would also like to think we have a reasonable degree of capability. Mostly we do not have our eyes on a goal or strategy for the future.
4. Because we generally do not plan or set clear goals in this "impossible" environment in which we operate then we see nothing but obstacles!
5. The general trend in the past has been for farmers to be reactive, to let the co-ops, the EU and God control our destiny. We must become proactive where we take responsibility for our own destiny. We must learn from the history of even the past 5 years. Individual businesses have stagnated over that period. The question to ask ourselves today is where do we see our businesses and their profits in 5 years time? To the vast majority, it will be where the bureaucrats are now telling you it will be. All very easy!
6. The vast majority will not plan. The average performer will be reactive and wait for direction from the "brainy boys".

The difference between real success and failure, as individual businesses, is the amount of time and effort we are prepared to put into setting goals and planning for the future.

The key factors in growth:

There are really three key factors to growing a business which I will briefly refer to: The Kerry Group is an example of an organisation that fully embraces these three factors. I was fortunate to visit Denis Brosnan and his team. The Kerry success formula states that "Sustained profitable growth" will come from a mix of:

STRATEGY **X** CAPABILITY **X** CAPITAL
(SCC)

a) Strategy:

Real success depends on thinking and planning, as cited by Denis Brosnan. Without strategic planning Kerry's growth would be 5% instead of the annual 15% actually achieved. Kerry work on the principal of the **80/20 rule:**

80% of the growth of successful business is due to time spent thinking and planning. Only 20% is due to doing the physical work. Arguably, many of our farm businesses suffer from the reverse, that is the "ostrich" syndrome. Far too much time is spent on the operational side and precious little time given over to planning where we want our business to go.

Strategy can be defined as asking three questions:

1. Where are we now?
2. Where do we want to be in a given period?
3. How do we go about getting there?

We must try to match realistic market opportunities with our own skills and balance it with personal ambitions, values, family issues, etc. Irrespective of the circumstances we must be proactive about our situation and we must all ask these questions:

1. Where are we now?

Some of the main questions to be answered might be:

- What is our core business?
- What are our limitations, our weaknesses?
- What is the value of our assets and actual returns being made?
- How much do we need to live and to pay tax?
- Do we consider our business a "lifestyle" business or a "growth" business?

Kerry started this process back in 1979. Then they were faced with a situation where they lost 20% of their milk pool through a brucellosis disease eradication scheme. Denis Brosnan's statement at the time was that they could never again be solely dependent on milk to grow their business. They decided at that stage to: "stop, think & plan".

2. Where we want to be in a given period of time:

We should examine

- What we see as our mission: where do we see ourselves in 5 years?
- Are there realistic future market opportunities? If not, what are the alternatives?

- Have we clear financial targets (based firstly around what we need to live and then creating real surpluses)?
- There should be a clear direction but with flexibility to respond to bigger picture factors. The most pertinent example of this would be whether your plan for the next 10 years is operable with or without milk quotas.
- What are our "soft goals"? i.e. family, where we want to live, what we want for our children?

For some, it may involve accepting that growth within farming, for the present, is limiting. Milking 50 cows now and blindly targeting 200 cows in 5 years time might not be a realistic plan under the current scenario. The exodus of many producers will present opportunities for those who plan to become serious players in the business.

The Kerry Group has a clear mission statement that revolves around becoming a major food ingredient corporation. they also have a clear goal to grow profits by 15% annually. They have detailed records of plans made over the years. The actual results consistently beat their plan. This is largely because all of management have agreed on the plan and are focussed on delivering the results.

3. How to get there:

We must answer the following four questions which increase profit in any business: Can we:

i. Increase production?
ii. Increase selling price?
iii. Add value with higher margin products?
iv. Cut costs?

The real question is whether we have fully explored all of these options. If the honest answer to all four is in the negative than we are all in trouble! This is why it becomes so vital for those of us who want to grow to plan. Some of this planning might revolve around:

- Isolating what you, as a team, are really good at and increasing the effort in that area. If your real skill is cows and grass, have you fully answered all four of the above questions? Are partnerships, for example, the route to efficiency and lowering costs that also free up more time to explore alternative strategies?
- Being prepared to be flexible and open to change. We have to aggressively research and pursue any alternative realistic strategies. A clear line will emerge between the serious commercial farm businesses and the "hobby" farms where an alternative source of income will be the mainstay. We have to be crystal clear which camp we plan to be in and then work toward the goal of getting there.

Capability

This is the second key factor in growing a profitable business. It has been described as: "the ability to formulate and implement strategy". The higher up the ladder of management in any business, the more important it becomes to be able to think strategically, to plan the growth of the business. The old argument is that the highest reward always goes to those who use their minds. Theoretically, it will always be possible to hire in physical labour. So we need to constantly question what we are doing and is it really contributing to the growth of our business?

We must all define the direction in which we want our businesses to grow and isolate the deficiencies in our own capabilities that might prevent that growth. A dairy farmer for example might be good in cow and grass skills but lack planning and financial skills. If, after careful consideration, your survival into the future can come from cows and grass alone then you must chase new ideas and the research available to do it better. The profits that you plan to generate will need to be invested to further grow the business. Have you the skills necessary to sensibly invest these profits to get as high a return as possible?

We all need to continually up skill and educate ourselves particularly in areas that allow us to maximise our resources. We all need to consider ourselves as "mature students". This may require formal tuition in areas of relevance: attending courses, reading or simply networking with positive, intelligent friends and business acquaintances. Recently, I was fortunate to be part of a group of 20 who took part in a "business" course. What did we achieve?

1. We up-skilled on how to evaluate our present businesses
2. We became very focused on the need to plan our business growth, to set goals
3. Received a comprehensive outline of various key types of investment from experts
4. Gained massively from mixing with a group of positive people who all wanted to succeed
5. Committed, on an on-going basis, to meeting regularly to learn and exchange ideas.

I present a case example of a New Zealand farmer who had a plan to grow his business around dairy farming provided that he could achieve a targeted percent return on his capital. He bought a steep 1000 acre hill sheep farm at one-twelfth the market price for normal land. He now milks 500 cows, putting them on once a day milking from mid-summer onward. Production is below average. The total focus is on keeping the operation as simple as possible. A manager (who has a 20% financial share in the venture) plus one staff are employed. No silage is made and no AI used. In this case example:

- The bottom line is that there is a clear plan for the business.
- There is the capability to think outside the square, to implement a plan and to involve other people to help the business to grow.
- He has the clear financial focus of always aiming to get a targeted return on his capital.

Capital

Planning and management capability are very much linked. Given a clear, realistic business plan and the capability to carry it out, then capital should always be available. Sometimes our expectations, as farmers, is that we have large assets and therefore the banks should give us loads of money! Unfortunately the cash generated on many farms is low in relation to the value of capital employed.

One accountant suggested that we should first examine: "Profits first then choices". Maybe too many of us moan about the obstacles to growth that we see without ever seriously looking at fine tuning our own business first. The common factor in successful businesses is their strong cash generating ability.

A simple formula for maximising financial growth is:

Surplus cash + Leverage X High rate of return X Compounding = Financial growth

The key to using capital is to invest in businesses that can give a high rate of return over a long period of time i.e. they are given the opportunity to compound. The power of compounding is probably one of the simplest, and yet least understood, concepts of growing a business. The following example shows the value of a single £1000 invested for either a 30-year or a 50-year time frame.

Sum invested	Annual compound interest	Age at investing	Age at encashment	Total accumulated
£1000	15%	20	70	**£1.083m**
£1000	15%	40	70	£66,194

This illustrates the power of time where compounding is allowed to work - too late for most of us to think of the 50 year investment. To those of us who wish to cater for the next generation or even for our retirement, we must ask if it is responsible to dump money into a low return business We must focus on getting a higher return for every £ made or borrowed. The average return from farm businesses is estimated to be well under 5%. Isolating areas either on farm, or off farm, that can be shown to give a consistently high return is the challenge.

The two golden rules of investing were quoted to me:

1. Never destroy capital and 2. never break rule 1.

As farmers, many of us have often broken that rule. We have often made the choices first and then hoped tor the profits.

Summary

Long-term success can be measured by sustained profitability growth over a minimum 5-year period. In managing our individual farm businesses we must ask: Have we achieved sustained profitable growth over the past five years? Can we envisage, under the present scenario, a £30,000 farm profit growing to £60,000 in five year's time? This is 15% compounded growth per annum. This is the rate of sustained profitable growth Kerry and others have achieved over the past 10 years. It can only be achieved if we take time to: "Stop, Think and Plan". If we do that then we are well on the way to believing that: Obstacles are what you see when you take your eyes off the goals".

Finally, I think it is important to remember in all of this that a balance in life is vital. Too many people in my year's study had driven the growth of their business at the expense of family. We in Ireland are perceived as having quality and balance in our lives. The challenge into the next century is to ensure that we can survive, grow and maintain that quality of life.

Innovative Practices for Increasing Farm Net Worth

J. ROSKAM

Ballymalone, Tuamgraney, Co. Clare

We milk cows to make money. This has been our overall goal since we started leasing my parents 23 hectare farm in 1995. We set three achievable goals: 1. To reduce the variable costs of production, 2. To increase the value of our product and 3. To grow our business. The strength of these objectives is the combination of them happening at the same time. This combination has created a large surplus on our farm which is the life blood of what we do. The surplus has rewarded us with two things:

- motivation to continue the effort that raising performance demands and also with
- development options.

The main practices that have taken place on our farm over the past four years are outlined in the paper. These practices are explained across the three areas on which we focused our farming efforts.

Production costs

Focusing on the costs of production was the natural starting point. In 1995 the cost of producing a litre of milk was 14.3p. In 1998 we had reduced it to 8.6p per litre. The first objective was the easiest, partly because our old system was a very high cost system. The summary points of the old production system on the farm are as follows:

- Cows fed one tonne of meal/head/year
- Huge emphasis on silage: two cut system. Often cows were left tight on grazing in order to fulfil the silage requirements that this system demanded
- Cows housed for five months
- Large labour requirement

Changing the cost structure brought about by these high costs practices was and remains a very straight forward job. I joined a discussion group to learn from sharing experiences with like minded farmers in the Tuamgraney/Scariff area. The group was active and a concentrated effort in the area of extending the number of grazing days allowed me to learn and implement new practices quickly and to great effect. I found this easy. Understanding the principles and science of extended grazing is necessary and at the end it came down to four practices on which I took action

- Improving the grass varieties in my pasture
- Spreading nitrogen throughout the September-April period at cost effective rates
- Increasing the number of hectares serviced with roadways
- backfencing

As a result, costs of production were reduced from 14.3p to 8.6p per litre in 1998. These practices allowed us to reduce the level of concentrate and silage being fed to cows. In addition, savings automatically followed on contractor costs. I have found a direct relationship between the level of grazed grass in the diet and profitability. I believe that I can bring costs of production to around 6p per litre (below 30p per gallon) on my farm with better budgeting of grass on the total farm area. With costs and labour time reduced I have valuable time to concentrate on other subtle but rewarding parts of our daily business.

Milk is the largest part of our turnover. In addition to producing milk cheaply we also want to offer Golden Vale a quality product for money. To do this effectively we concentrated on lifting protein percentage from 3.3% in '94 to 3.7% in '98 and an increased price from 22p to 27p per litre. I do not think that there is one magic formula but a combination of different factors each one of which is important in its own right.

Identification

The cows used for breeding the replacement heifers must be carefully selected. Usually there are large variations in the protein percentage of cows within the one herd. Milk recording enables me to identify cows which will be used for breeding. This has proved to be an essential part of raising our protein percentage. Half the cows are producing over 3.8% protein. To raise the lower half of the herd to that level would require two to three generations which would be a waste of time and money. So, it is essential to know which cows to breed from.

Breeding

After selecting the breeding cows we then select the bulls, usually three or four. The following factors are taken into account:

- an increase in protein of at least 0.10%
- a fairly high reliability of about 80%
- 300 to 500 kg increase in milk yield; for instance, to maintain a yield of 54,000 litres (1200 gallons) you need a bull which lifts milk yield by about 500 kg.

We match a bull with a cow according to her yield; we do not look too much at linear assessment as we are not breeding cows for shows. I believe that if a chosen bull is not very low in one of the important functional traits then it is a good match. There are some suggestions that cows with a sloping rump angle have less fertility problems; this is one aspect we will consider in the future.

Nutrition

To start with, a cow must be in good condition at calving. I like to feed a cow a sufficient quantity of high quality grass. As well as autumn saved pasture, wilted silage and concentrates are fed as necessary. Concentrates are only offered when necessary and are relatively inexpensive at £132 per tonne.

Vigilance

After making every effort to improve the protein percentage, one very important matter remains, that is, to make sure we are paid for what we produce. We take milk samples regularly and have them tested independently. By taking this approach, we have been compensated several times by our creamery, Golden Vale.

As shown by the figures stated earlier, a clear and uncomplicated breeding policy that we understand, matched with good animal husbandry, has achieved satisfactory results over the past few years. Our milk value has been increasing by over 1p per litre every year for the last four years. Although lifting the protein percentage in milk is a slow process, the money spent on milk recording, breeding, improving pastures and independent milk testing has been one of the best investments on our farm. In our case, with a 236,000 litres (52,000 gallons) quota, the high price we get for our milk is worth about £12,000 a year over the average milk price.

Growth

Using good farm management practices on a growing herd size is necessary in order to make a decent surplus. Money is targeted at areas that will make impact on our business net worth. Historically these have been the most significant areas on which this surplus will be spent. Since we started leasing my parents' 23 hectare farm in 1995 with 127,000 litres (28,000 gallons) milk quota our progress to date is as follows:

1995: We bought the 27 cows and replacement heifers and in the same year we bought a neighbouring 12 ha farm.

1997: We bought another 27 ha and sold the house on the farm; we planted 14 ha with trees. As a result, we are now farming 63 ha of which 40 ha are owned. Because we had a commercial lease on my parents' farm, we could buy milk quota through the restructuring system. In total, we bought 111,300 litres (24,500 gallons) in the last four years. We are now producing 238,700 litres of top quality milk. Our stock numbers have increased from 27 cows to 55 cows this year. We also keep the bull calves until they are one year of age.

Other information

We are in our third year of the Rural and Environmental Protection Scheme. Between forestry premia, REPS money, higher farm produce sales and lower production costs, we are now generating quite an amount of surplus money which with good investment is very valuable.

Conclusion

Our experience of farming to date has been very rewarding. Through the practices outlined in this paper we have produced a substantial amount of surplus money in a short period of time. This has given us cash flow to develop and grow. As a result, we are enthusiastic about continuing to grow and to increase our net worth. I see ourselves trying to do this in new ways. I cannot say now what the exact nature of these ways will be but we will always be interested in buying assets that represent value. While looking for such opportunities we will continue to remain with our present belief which is that management is making surplus money. Investment that increases net worth secures the future.

Achieving Growth in an Unregulated Environment - Principles and Lessons for Any Environment

J. VAN DER POEL

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Introduction

Are there more opportunities in an unregulated environment? Does every farmer in an unregulated environment enjoy growth? If not, why not?

Sue and I started our farming career in 1980 with $5,000.00 (£2,700), 16 cows and a Ford Cortina. Our first sharemilking job was milking 120 cows on 40 ha. We also married that same year and so had the added expenses. Our growth from that beginning to the present time finds us involved in ten dairy ventures: these being the owners of two farms, part owners of four further farms, involvement in three sharemilking positions and partnership in a grazing block. These ventures encompass 1604 hectares and 4500 cows in total producing 1,600,000 kg MS per year. Our personal share is 2260 cows producing 850,000 kg MS per year.

New Zealand dairy farmers receive the lowest price for their milk of any of the developed countries in the world. We have a small population and so 95% of our products is exported. After shipping our product 12,000 miles we find we are competing with multi-national companies and trading blocs such as the EU that use their economic power and subsidised products to compete with us on the world stage. We are shut out of exporting, apart from small quotas, into the richest economies in the world such as the EU, USA and Japan and therefore forced to trade in third world countries.

We have a government which is adamant that it is going to open up the New Zealand Dairy board to direct competition from other exporters from New Zealand. We have become the world's lowest cost producers from necessity. This is hardly an ideal environment to grow a business, but for all that, it still has opportunities to grow. Out of adversity comes opportunity - the key is that you need to be efficient in the way you produce milk. Being average is not good enough. In fact in the medium to long term, world trends and ever improving management practices will most likely mean that your business will come under immense pressure from more efficient farmers whether they be in Ireland, Europe or New Zealand. The farming practices needed to survive and prosper in the future need to be identified and implemented today.

The way that you conduct your business is more important than the environment you farm in. The factors which you yourself control will have far greater implications for your success than waiting for the government to create a so called 'level playing field'. I will focus on six factors that are fundamental to being successful:

(1) Identify your areas of influence
(2) Effort, Focus & Analysis
(3) Goal setting
(4) Create margins/profit
(5) Integrity
(6) Think laterally

Identify your areas of influence

Individually we can't influence weather, government regulations, what our neighbour is up to, etc. Our areas of influence are matters that we can control, such as, how well we use our resources, what day to day management decisions we make, how much we spend to achieve our production, where we focus our business. For us, this approach has helped us to get where we are today. If we had to spend too much time concerning ourselves about low prices, droughts, competition for sharemilking jobs etc, we wouldn't have been able to achieve the kind of growth that we have. The interesting thing that we have found is that by focusing on our area of influence, we have been able to increase our area of influence. For Irish farmers your opportunities will be different because you live and farm in a different environment but the same principles apply. Perhaps in Ireland your main areas of influence include your farming system, the allocation of resources between the dairy and beef enterprises, your approach to business management and perhaps traditions.

Effort focus and analysis

If you look closely at any successful business, farming or otherwise, somewhere in that operation there is someone who is driving it forward, keeping it on track, monitoring progress. Never underestimate the power of management. As owner or manager of your farm you have a far greater influence on the outcome or profit from your farm than most people realise. The decisions that are made and the effort that is applied to implement those decisions will greatly influence whether or not they will succeed.

We can no longer be directly involved in all the decisions regarding our operations. However, we talk to the managers about what goals are. Our managers/partners are invited to help set these goals to help identify management practices that will achieve them. We talk to them regularly to monitor, provide support and make sure progress is being made.

Also, when considering your management options, don't be afraid to try something different, something that is not normal practice for yourself, take some risks. If you are too afraid to try something new, and take some risks, how will you grow? You might make mistakes, 'but it is not the mistake that will hurt you, it is what you do next'.

Good farmers make just as many mistakes as anyone else - sometimes more because they take more risks. But the difference with the best guys is that often it is not obvious to others that a mistake has been made because they are in tune with their farm and recognise and correct the mistake quickly. Change can make you feel uncomfortable because it often means stepping outside from where you feel comfortable.

Goal setting

Goal setting needs no explaining but is very important. What is the use of running hard if you are headed in the wrong direction? Setting goals will also help you to keep on track. When setting goals think of where you want to be in, say, five years, both financially and from a family perspective. Keep your goals balanced. Once you have set your goals break them down into yearly measurements to monitor progress and then review them yearly. Don't ever consider them to be set in concrete because as your circumstances change, so will your measures of success.

Create margins/profit

Each of us will have a different reason for choosing to be dairy farmers. It could be because we enjoy the lifestyle, enjoy working with stock, running our own business. Whatever the reason we chose farming, it is a lot more enjoyable if you make a good net income from your efforts and it is your NET income that matters. Net income is the amount left over from your farming operation for:

— personal drawings
— debt servicing
— debt reductions
— savings
— extra investment

To make a high net income requires a will to maximise the gap between gross income and cost of production. This is a financial measure and cannot be confused with physical measures such as number of cows milked, production per cow, or indeed the size of your quota. Without any checks on the physical indicators and what they are costing to achieve, they don't necessarily tell the full story or help you achieve your goals. If we can achieve high per cow production over larger numbers of cows and do so profitably by keeping a tight control of our cost structure, then we really create some opportunities for ourselves.

If we are profit focused and achieve good margins and high net profits, we open up opportunities for our families and ourselves. With those profits we could choose to:

— improve our lifestyle
— Support our children with better levels of education
— Service larger debts for extra growth
— Pay off our mortgages faster
— Invest in other business opportunities

Whatever you do with those profits is up to the individual and will depend on your circumstances and goals. The important thing is that you have given yourself some choices. You have created the ability for you and your family to achieve your goals. On the other hand, however, if your farming operation is not generating profits, your options tend to be limited and it is hard to feel good about farming if you are working hard and not getting a reasonable reward for your efforts.

The controlling and management of profits requires a high level of awareness of the business performance. Financial monitoring systems need not be elaborate or time-consuming. The important thing is that you are always aware of how the business is performing.

Integrity

Some people believe that to get ahead you need to cheat or practice one-upmanship in business. I truly believe that the opposite is the case. Good business is where both parties benefit from the transaction, where the people who work for you provide service, value your business and look to continually do repeat business with you. We have found that by identifying people we want to do business with, explaining to them what standards we expect, giving them repeat business if these standards are met and paying our accounts on time, we have been able to negotiate favourable trading terms and get excellent service. Also we have found that by treating people fairly, we get more opportunities to grow. In New Zealand there are only 14,000 dairy farmers in the country so a bad reputation as well as a good one follows you.

Thinking laterally

As a dairy farmer the main product that is produced is milk. But your milk is not identifiable from your neighbour's. As far as the consumer is concerned, your milk is no different than mine or someone farming in the USA or Australia. So it's not as if we can all go out and produce different types of milk to differentiate from our neighbours. If we wish to do better in our farming operations than the average farmer, we can approach that from two different ways:

(1) We can do what the average farmer does, but better, and more efficiently and in a larger scale to give us some advantage.

(2) We can look at ways of farming differently, of finding better and more efficient ways of growing our business.

For us, this has meant questioning all aspects of how things have traditionally been done. In practical farming sense we first became efficient in harvesting pasture into milk and then started adding in other feeds to add value to our business, not something that is considered normal practice in New Zealand.

From a growth perspective, traditionally in New Zealand one progresses through the industry by getting a 50/50 sharemilking position where the sharemilker supplies labour, stock and machinery for 50% of the milk cheque. The young sharemilker normally moves from one sharemilking position to the next until they have enough cows to sell a portion and use the money to put down a deposit on a farm. At this stage they stop being sharemilkers and become farm owners. We followed this same pathway for the first eight years of our career but instead of giving up our sharemilking position and selling our cows to purchase our first farm, we kept our sharemilking position. We borrowed the extra revenue from both operations to service and repay the extra debt. From then on, we kept expanding this concept to where we are today. It was just a matter of farming really well in the first place, taking the strengths of the present system and adapting them to help to achieve our goals.

The same principles apply in ownership. Historically in New Zealand, dairy farms are operated by family units with a strong sharemilking system helping farmers reach their goals and dreams of farm ownership. This system was and still is coming under increasing pressure as farms need to increase in size to stay economic. High land prices mean that it is becoming increasingly difficult to achieve farm ownership from sharemilking.

To counter these obstacles and to help us achieve our own goals, we have recently become more involved in equity partnerships where a sharemilker that is ready for land ownership can afford to purchase a share in a large viable farming business. They earn their share of the net income from that investment and also earn a salary as the employed manager of that farm.

For us and our partners as shareholders in these farms, we have people operating these farms that are totally committed to their success and who consider these farms to be their own and treat them as such. We see this as a win/win arrangement where managers have farm ownership and we have committed managers. If you are aiming to grow your farming operation don't ignore what is tried and proven, but at the same time don't be afraid to think outside the norm.

Conclusion

The principles of success can be translated anywhere. Where you farm is not as important as how you farm. A banker once told me "A successful farmer would be successful in any business - it's just that he chose to be a farmer". I believe that it is the principles that make the business successful.

Success is a state of mind. The way you see a problem **IS** the problem. Some farmers see a problem; other farmers see solutions. The way you look at a problem is far more important than the problem itself. So, being successful in an unregulated environment requires the same mindset and commitment as in any environment.

Artificial Insemination of Sheep – Current Status and Possible Developments

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Introduction

Artificial insemination (AI) is probably the most important single technique devised to facilitate the genetic improvement of animals. The widespread use of AI in cattle has allowed for the rapid dissemination of genetic merit on a national and international basis to the benefit of both breeder and consumer. It also enables the use of sophisticated data analysis procedures to accurately identify animals of superior performance. Theoretically, similar benefits with regard to the rate of genetic progress, which may be achieved through the use of AI, should be available to sheep breeders. Availability of an efficient sheep AI service would be of great benefit to pedigree and commercial breeders wishing to respond positively and effectively to consumer demands. The widespread use of AI and the realisation of its full potential depend essentially on the use of frozen semen, and thus on the availability of techniques that result in acceptable fertility. However, the very low level of fertility obtained when frozen-thawed semen is used for cervical insemination has stemmed widespread interest/ uptake of AI in sheep. The alternative, laparoscopic AI, while an effective method of insemination with frozen-thawed semen, is costly, thereby limiting its use to pedigree breeders. It is therefore desirable and necessary to develop procedures that may form the basis of making AI a practical reality for sheep farmers.

Advantages of AI

1. Breeding efficiency

The use of AI, based on frozen-thawed semen, can greatly increase the number of offspring produced per sire per year because a ram has the potential to produce enough spermatozoa to inseminate thousands of ewes. Thus, genetically superior rams could be made accessible to all sectors of the sheep industry, thereby rapidly improving the quality of output from the sector.

2. Increased rate of genetic improvement

In Ireland, genetic improvement is hampered by the small size of pedigree flocks, which reduces the intensity of selection and leads to lack of consistency in breeding goals. Furthermore, available breeding value estimates are generally only valid for within-flock selection. These constraints severely impair the rate of genetic improvement being achieved nationally (Hanrahan, 1997). Sire Reference Schemes are currently being adopted by some breeds to overcome these disadvantages (Simm and Lewis, 1997). This also increases the precision of breeding value estimates through the application of BLUP procedures. Sire Reference Schemes are based on the use of a small set of rams to produce progeny in all flocks as a basis for providing genetic links among the flocks.

While these linkages can be produced by transfer of ewes to a single location for mating and/or rotating rams among flocks during the mating period, these options are stressful for the animals and this may affect fertility. There are also disease risks attendant upon such intermixing of animals from different flocks. AI based on frozen semen would eliminate these problems and allow the widespread dissemination of valuable genetic material even to small flocks, thereby leading to effective genetic improvement of the national sheep flock.

3. Easy transport of genetic material

AI can facilitate the introduction of new genetic material through international exchange of semen. It also allows large numbers of ewes to be inseminated by specific individual rams over a wide geographical area in a short time period. This enables across-flock genetic evaluation and high selection intensity.

4. Long term storage of semen

Successful storage of semen allows for the more widespread use of individual sires and the preservation of genetic material for future use. It also allows preservation of genetic material from rare breeds. Semen from rams can be frozen-stored, without loss of fertility, for at least 16 years (Salamon *et al,* 1985) but probably longer.

Disadvantages of AI

1. Reduced fertility

Fertility, encompassing both pregnancy and litter size, is adversely affected by AI especially AI using frozen-thawed semen. Despite intensive laboratory studies, the procedure of freezing and thawing ram semen inevitably reduces the viability of spermatozoa. The major obstacle to fertility in ewes cervically inseminated with frozen-thawed semen is the establishment of a large enough population of viable spermatozoa in the cervix and impaired transport from the cervix to the site of fertilisation.

2. Potential for inaccurate breeding

Accidental errors in insemination can occur if semen from individual sires is not carefully or properly labelled, particularly if semen from several sires is being used concurrently. Secondly, if breeding values of sires have been overestimated or determined incorrectly then genetic loss rather than gain could ensue. Additionally, use of sires with undetected genetic defects could result in the rapid spread of that defect.

3. Cost

As with any technololgy, production costs are incurred when AI is used. Costs include collection and assessment of semen, processing, freezing and storage of semen, delivery of AI, labour, management and drugs for synchronisation.

Semen collection and prepararion

Ultimately, the genetic impact of a superior ram is limited by the number of sperm produced, which is a direct function of testicular size. Therefore selected rams need to be placed on a high plane of nutrition and maintained in good conditions - otherwise semen production may be seriously impaired especially under the intensive collection regime required for AI programmes.

Semen may be collected by artificial vagina (AV) or by electrical stimulation. The AV method is preferable because it does not stress the animal, it is quick and simple and results in the collection of better quality semen. After collection the quality of semen is assessed for volume, motility, concentration and morphology on an individual ejaculate basis. Accepted ejaculates can then be inseminated raw (undiluted) as soon as possible after collection or stored in protective media on a short term basis. This is known as 'chilled' or 'liquid stored' semen where spermatozoa are held at 5°C and inseminated within 24 hours. Semen can also be frozen for long term storage. Frozen semen may be stored in PVC straws (0.5 ml and 0.25 ml), minitub straws (0.25 ml) or as pellets. Pellet freezing of ram semen has produced better conception rates compared with PVC straws, but not significantly better than minitub straws. These provide a useful alternative to pellets allowing for individual dose identification (required for export), easier storage and are less time consuming at insemination.

In the case of semen frozen at Athenry, a random sample of straws from each ejaculate is thawed and assessed. Semen containing less than 50% spermatozoa with progressive motility is discarded. This is considered a crucial step in the quality control process. Based on results of our studies to date we would expect to obtain about 500 useable straws per ram over a 4-week collection period.

Insemination techniques

Insemination of sheep may be vaginal, cervical, transcervical or intrauterine. The various methods differ in their complexity, cost and effectiveness.

Vaginal: This is the simplest form of insemination and involves depositing fresh semen in the anterior vagina without any attempt to locate the cervix. Reported success rates are highly variable and this method is unsuitable for use with frozen semen at present.

Cervical: The cervix is located, via a speculum with a light source, and semen is deposited into the first fold of the cervix. This is a cheap and relatively easy method of insemination. Conception rates with fresh or 'chilled' semen are good (65 to 75%) but unacceptably low (10 to 30%) if frozen-thawed semen is used. An exception is in Norway where mean conception rates of 60% are reported.

Transcervical: This method involves grasping the cervix and retracting it into the vagina with a pair of forceps to allow an inseminating instrument to be introduced into the cervical canal. Acceptable conception rates (57%) have been reported by Halbert *et al* (1990) but not by others who have tried this method. This procedure involved a high degree of manipulation and any resultant injury could compromise the ewe's ability to conceive naturally. As yet, no data are available on the efficacy of repeatedly using this technique.

Intrauterine: This utilises a rapid laparoscopic location of the uterus and direct injection of semen into the uterine horns using a fine pipette. This method circumvents the cervical barrier and radically improves fertilisation rates when using frozen-thawed semen; conception rates ranging from 50 to 80% have been reported. This method also has the advantage of only requiring a small number of spermatozoa, thereby allowing a more widespread dissemination of valuable genotypes. However laparoscopy has several disadvantages. It is an invasive procedure, requires veterinary expertise and is expensive in terms of equipment and labour. It is also possible that laparoscopic and transcervical AI may become unacceptable in the future based on welfare grounds.

AI Research in Teagasc

As an industry, sheep producers need an AI technique which is widely available, cheap and effective in terms of pregnancy rate. It also needs to take account of welfare issues. The aim of AI work carried out in Teagasc, Athenry is to develop an effective, nonsurgical cervical procedure for frozen semen from individual rams.

In Norway, good conception rates (approximately 60%) have been reported with cervical inseminations using frozen-thawed semen. The obvious objective was to determine if similar success could be achieved in Ireland by the adoption of Norwegian AI freezing and insemination procedures. However, breeds used in Norway are quite different from those found in this country and insemination is to a natural oestrus. In Ireland this would be impractical and any serious thought of applying AI here would require set time AI to a synchronised oestrus. It was necessary to determine if the good conception rates achieved in Norway are due to inherent Norwegian factors/practices. Therefore, issues such as freezability of semen from Irish and Norwegian rams and the effect of synchronisation and inseminator on pregnancy rate were addressed during the breeding season in 1997. Ewes (various breed types; n=297) were cervically inseminated (according to Norwegian methods) with either fresh or frozen-thawed semen to a natural or synchronised oestrus. Two people (Norwegian and Irish) carried out all inseminations.

The results, presented in Tables 1 and 2, showed that ewes inseminated with fresh semen had significantly higher pregnancy rates compared with frozen-thawed semen. This is consistent with the findings of others.

No significant differences were found in pregnancy rates or litter size between Irish frozen-thawed and Norwegian frozen-thawed semen or between ewes inseminated to a natural or synchronised oestrus. Therefore, the good conception rates achieved in Norway were not due to specific qualities of semen from Norwegian breeds (semen from both Norwegian and Irish rams were frozen according to the same protocol), nor were they due to ewes being inseminated

Table 1

Pregnancy rates for ewes inseminated with fresh and frozen-thawed semen

Semen type	Natural oestrus		Synchronised oestrus		Overall
	n	Preg. rate (%)	n	Preg. rate (%)	Preg. rate (%)
Fresh	28	82	30	70	76
Frozen - Irish	62	40	50	52	46
- Norwegian	68	34	59	37	36

Table 2
Effect of synchronisation on litter size adjusted for ovulation rate

Semen type		Natural oestrus		Synchronised oestrus	
		n	Preg. rate (%)	n	Litter size
Fresh		23	2.7±0.23	21	3.2±0.23
Frozen	- Irish	25	1.9±0.23	26	1.4±0.23
	- Norwegian	23	2.0±0.24	22	1.9±0.24

at a natural oestrus.

A notable finding (Table 3) was the significant effect of ewe breed on conception rate and such breed effects may be the reason for the good conception rates achieved in Norway. We had hoped to inseminate Norwegian ewe breeds with Irish frozen-thawed semen but Norwegian legislation on disease control did not permit this.

Litter size was lower in ewes inseminated with frozen-thawed semen and this adverse effect was greater in synchronised ewes (Table 2). This may reflect reduced fertilisation and/or embryo surgical rates due to damage caused by the frozen-thaw process on the structure and function of spermatozoa. In addition, the inseminator was influential in pregnancy outcome.

Table 3
Effect of ewe breed on pregnancy rate

Breed	n	Pregnancy rate (%)
Finnish Landrace	60	57
S. Blackface cross	104	54
Lowland crosses	133	38

A second trial (in 1998) set out to specifically determine if the ewe breed differences seen in 1997 were also evident among purebred ewes of terminal sire breeds, these being a target group for Sire Referencing Schemes.

A selection of purebred and crossbred ewes were inseminated cervically with fresh or frozen-thawed Norwegian or Irish semen. Results presented in Table 4 confirm the existence of highly significant differences among ewe breeds. Pregnancy rate ranged from 18% to 77% (the latter being equivalent to overall pregnancy rates with fresh semen).

The pregnancy rates achieved with Belclare, Scottish Blackface cross and especially Finnish Landrace breeds across two years show that cervical AI using frozen-thawed semen can provide a pregnancy rate acceptable for use in breed improvement programmes (around 50%). However fertility rates with terminal sire breeds were poor. The reasons for the very large breed differences in pregnancy rate remain unknown - it may simply be a function of the timing of AI relative to ovulation or to such factors as ovulation rate, anatomy of the

Table 4
Pregnancy rate for ewes inseminated with frozen-thawed semen

Breed	Frozen semen	
	n	Pregnancy rate (%)
Finnish Landrace	35	77
Suffolk	77	18
Texel	101	30
Belclare	25	44
S. Blackface cross	40	43
Suffolk cross	56	19

cervix or more subtle differences in uterine environment.

Future developments

Commercial implementation of an AI programme requires a procedure that yields consistent and acceptable pregnancy rates. It also must be cost effective and welfare friendly (i.e. via the cervix). Attainment of this objective requires overcoming problems involving both the ewe and the ram. The precise basis for ewe breed differences need to be determined but in addition further effort on devising freezing protocols that are less injurious to spermatozoa is required to minimise the impact of any specific ewe breed effects.

At ewe level, are the causes of differences in pregnancy rates between breeds of ewes physical or physiological? The cervix of the ewe is approximately 7 cm in length and contains about 5 funnel shaped rings. These rings have small openings, are not concentrically aligned and do not dilate during oestrus. The anatomy of the ovine cervix therefore precludes the deposition of spermatozoa into the uterus via the cervix. It is possible that the anatomy of the cervix differs between breeds. If the cervix could be dilated this would overcome any differences that may exist between breeds. Attempts have been made in this area by the use of pharmacological hormones, such as oxytocin. This however had detrimental effects on fertility. Pharmacological products, which successfully dilate the cervix without interfering with sperm transport, may become available. Similarly, the development of an instrument that would allow deposition of semen deep within the cervix or uterus could prove very beneficial for cervical insemination with frozen-thawed semen. Physiological issues may simply be a reflection of differences in the timing of ovulation between breeds. Studies designed to assess the timing of ovulation in relation to sponge removal for different breeds need to be done to identify the optimum time for insemination on a breed basis. Other more subtle parameters such as uterine environment may require investigation.

The freezing and thawing of semen causes ultrastructural, biochemical and functional damage to a significant proportion of spermatozoa. These changes are accompanied by decreased viability and fertilising capacity. There is therefore potential for improvement in the techniques of cryopreservation of ram semen, particularly at finding new cryoprotective dilutents that would give sufficient protection to ensure successful passage through the entire female reproductive tract. Development of better diluents for chilling without resorting to freezing may be another route worth investigating. If semen could be maintained for a couple of days, without losing fertilising capacity, it could solve geographical problems of distribution. The downside is a reduction in the number of ewes that can be inseminated by an individual ram in any one year.

One of the problems in the cryopreservation of ram semen is being able to evaluate the success of the freeze-thaw methods employed. Unfortunately, spermatozoa, which are highly motile post thawing, can give poor conception rates and vice versa. To date, *in vitro* assessment of the viability and structural membrane integrity of ram spermatozoa post thaw does not correlate well with actual fertility. The development of a test that would indicate actual fertilising capacity of spermatozoa post thaw would provide an important tool in choosing rams in an insemination programme. Work for this AI project included studies on the development of an IVF procedure to assess the fertilisation rate and development competence of ovine oocytes using semen from individual rams. Results showed that this IVF procedure was a useful test for predicting the relative *in vivo* fertility of frozen-thawed ram semen after laparoscopic insemination (G. Byrne *et al,* 1999). This is an exciting development which may prove useful in the assessment of semen from the commercially important breeds. Development of such *in vitro* tests, while requiring substantial research funding and commitment, deserves attention. It is reasonable to assume that, given the resources, procedures and instrumentation could be developed for the successful implementation of cervical AI using frozen semen.

Benefits to the producer

Genetic improvement is an effective strategy for altering the performance of farm animals. While it may be considered slow in comparison to other methods such as improved feeding, it is permanent, cumulative and generally sustainable. The benefits of AI, if used in conjunction with accurate Sire Referencing Schemes, can pay off in terms of improved growth rate and carcass traits.

The benefits expected to accrue to the commercial producer will depend on many factors but a reasonable estimate of the initial worth of access to genetic superior rams through AI is an increase of 2 to 3 kg in average weaning weight for the flock and heavier carcasses at a given level of fatness. It is estimated that the economic benefit of this would be around £200 to £250 per 100-ewe flock per annum. It is also to be noted that the genetic merit of rams will increase over time as effective genetic improvement systems are implemented in pedigree flocks.

If cervical AI using frozen-thawed semen becomes a commercial reality, it should be remembered that in itself it is not a magic wand. It should be considered as a tool to be used in conjunction with clear breeding goals and effective management strategies if the full benefits are to be realised.

References

Byrne, G. P. *et al.* (1999). Use of IVF procedures for assessing the fertility of frozen-thawed ram semen. Proceedings of 25th Agric. Res. Forum, U.C.D., Belfield, Dublin. pp. 3-4.

Halbert, G. W. *et al.* (1990). Field evaluation of a technique for transcervical intra-uterine insemination of ewes. Theriogenology 33: 1231-1234.

Hanrahan, J. P. (1997). Exploiting genetic resources to enhance the competitiveness of lowland sheep systems. Proceedings of Irish Grassland Association Sheep Conference, Carlow. pp. 22-23.

Salamon *et al.* (1985). Fertility of ram semen frozen for 16 years. Proc. 19th Ann. Conf. Aust. Soc. Reprod. Biol. p. 62.

Simm, G. and Lewis, R. M. (1997). Sire Referencing Schemes: A fast lane in Sheep Breeding? Proceedings of Irish Grassland Association Sheep Conference, Carlow. pp. 8-20.

Genetic Evaluation of Sheep Breeds for Meat Traits[1]

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Introduction

Various studies (e.g., Kempster et al., 1986) have shown that lamb carcases can consist of 20% to 26% fat in excess of that desired by consumers. This is a highly unsatisfactory situation, not only because it takes extra feed energy and therefore costs money to put on this fat but also because the consumers dislike fat. They are concerned about putting on excess weight and they are also concerned about the adverse effects that fat is likely to have on their cholesterol levels and the consequential likelihood of heart problems. In addition, consumers regard meat with excessive fat as poor value for money.

For these and other reasons, sheep meat consumption in Europe has remained low relative to other meats, decreasing from 8% to 5% (in the EC-12) of all meat between 1961 and 1991 (Bansback, 1993).

Commercial sheep breeding

If the Irish sheep meat industry is to develop, it must focus on producing and supplying leaner meat and presenting it as attractively as possible at a competitive price. Fortunately, in sheep meat production, meat quality and efficiency of production can be favourably correlated. Quality and efficiency are both increased by increasing lean tissue growth rate and by avoiding waste by producing the minimum of fat. One of the difficulties that both breeders and commercial sheep farmers often face is the lack of clear information regarding the economic benefit of producing leaner meat. Abattoirs too often do not pay adequately for higher lean percentage or penalise excess fat sufficiently. Reliable market information must be available, starting from the consumer and relayed faithfully right back to the pedigree breeder, otherwise all sectors of the sheep meat industry will not operate efficiently in a co-ordinated manner.

The first step in improving the genetic merit of sheep at commercial level is to identify the breeds and crosses that are most suitable to a particular production system. Genetic improvement at commercial level invariably involves crossbreeding. This takes advantage of hybrid vigour in lambing rate and lamb survival and combines the good features of different breeds. After that, further genetic improvement is usually brought about by the improvement of the pure breeds that are components in the cross by within- breed selection. Sustained improvement of pure breeds over time, combined with crossbreeding, is a very effective way of achieving continued genetic improvement at commercial level.

There are about 4.5 million commercial ewes in the country. The structure of sheep breeding can be described as a pyramid with the flocks that are participating in the Department of Agriculture's Pedigree Sheep Breed Improvement

1. The author wishes to acknowledge funding under the Operational Programme for Agriculture, Rural Development and Forestry 1994-99, Stimulus Fund T/G(55) - Ram Genetic Indexing

Programme at the top, other pedigree flocks as a second tier and finally the commercial flocks as the main part of the pyramid.

Pedigree sheep breeding

The pedigree sector of the industry is that sector which, over a long number of years, has developed breeds of sheep that are regarded as being genetically superior in economically important traits of value to commercial sheep farmers. In fact, the commercial sheep farmer and the pedigree sheep breeder are complementary and mutually dependent on one another. It is important, therefore, that they should be properly co-ordinated.

Like the commercial sheep farmer who supplies a quality product (high lean, low fat carcasses) to the factories, the pedigree breeder also supplies a quality product (genes of high genetic merit for increased lean meat production and low fat production) to the commercial sheep farmer, delivered in the form of semen and rams. That product must be capable of producing sustained genetic improvement in the quality of the commercial lambs, so that when given the appropriate environment (proper feeding and management), they will be well capable of meeting the needs of the consumers in the higher priced markets in the EU or elsewhere.

The pedigree breeders should be highly sensitive to the needs of the commercial sheep producers and the problems that they face in satisfying consumer demand. If one is to take this idea seriously, the breeding goal at pedigree level must be defined with the needs and requirements of the commercial sheep farmer in mind. This is greatly encouraged by the commercial farmers being proactive in demanding high genetic merit (for increased lean meat production and low fat production) from the pedigree breeder.

Genetic improvement in pedigree flocks

Genetic improvement of a pure breed can be achieved by following a fairly simple, clearly defined strategy.

- Firstly, one must define the breeding goal or breeding objective clearly and ideally, all members of the breed society should agree with this breeding objective. The breeding objective spells out the animal traits for which the breed is to be improved. It should also spell out the relative importance of each of these traits. For example, a meat type breed might wish to improve lean tissue growth rate with a minimum increase in fat deposition. It is advisable that the traits in the breeding goal should be confined to those traits that are of proven economic importance. If a trait is included that has not been proven to be of economic importance (e.g., width of the head), selection for other genuinely important traits may be compromised. Useful criteria for deciding what traits to include in the breeding objective include the requirements that
    - they are of economic importance in increasing the quality of the product or in reducing costs of production and that
    - they should show a reasonable amount of genetic variation.

  If a breed does not have a clearly defined breeding goal, or if all the members of the breed society do not agree with the breeding goal, it will find it difficult to make progress in any direction.

- Secondly, one must measure performance traits that are in the breeding goal, or are closely related genetically to the traits in the breeding goal. For example, if the genetic improvement of lean tissue growth rate is a part of the breeding goal, since this trait cannot be measured directly in the live animal, one can use rate of gain in live-weight (LWT), ultra-sonic muscle depth (UMD) and ultra-sonic fat depth (UFD) to predict breeding value in rate of lean tissue growth rate.
- Thirdly, by using up-to-date statistical methods to process the performance records (data on traits that have been measured) in order to make maximum use of the available information. The method currently most widely used is called Best Linear Unbiased Prediction (BLUP). This method provides us with estimated breeding values (EBVs) for all animals in the measured traits. These estimated breeding values are usually combined into a single figure for each animal called a "selection index". This makes the ranking of animals for selection considerably easier.
- Fourthly, by supporting developmental research into new methods of improving the efficiency of the genetic evaluation and selection. For example, there may be better methods of measuring traits that are more closely related to those in the breeding goal than those currently being used, (e.g., computer assisted tomography (CT)) or there may be better methods of rearing the pedigree lambs in order to minimize the nongenetic or environmental variation between them.

Level of participation of pedigree breeders in the Irish Department of Agriculture's Pedigree Sheep Breed Improvement Programme

In 1998, eight breeds of sheep (Suffolk, Texel, Charollais, Vendeen, Belclare, Beltex, Ile de France and Berrichon) participated in the Department of Agriculture's Breed Improvement Programme. The numbers of ewes and flocks in the three main breeds are given in Table 1.

It is important to note that only a quarter of the total number of pedigree flocks in these eight breeds in Ireland actually participated in the Programrne. The participation level was higher in some breeds (Texel 49%) than in others, (Suffolk 15% and Charollais 16%).

Only two (Texel and Charollais) of the eight breeds participated in a Sire Referencing Scheme and even in the Texel breed, the proportion of flocks that participated was very low (21%). Participation of the Charollais in the Scheme was 60%. Considering that the total population of commercial ewes in the country is about 4.5 million and considering that the number of ewes in recorded flocks is about 5,300, it is apparent that the usage of rams coming directly from recorded flocks per year to the commercial flocks is only a fraction of what is reasonably possible. Five thousand ewes could be expected to supply 3,000 rams per year to the commercial flocks. At 40 ewes per ram per year and each ram remaining in the flock for 4 years, one would expect that the flocks participating in the recording programme could supply enough rams to serve about 500,000 ewes

Table 1
No. ewes and flocks from the breeds participating in the Department of Agriculture's Flock Recording Programme in 1998

	No. ewes			No. flocks		
	Total nationally	In recorded flocks	In sire referencing	Total nationally	In recorded flocks	In sire referencing
Suffolk	13,000	2,100	none	430	65	none
Texel	3,700	2.025	665	153	75	16
Charollais	3,740	821	648	184	30	18
Vendeen	1,697	195	none	41	8	none
Others[1]	866	177	none	38	7	none
Total	23,003	5,318	1,313	846	185	34

[1]Other breeds participating in the Department of Agriculture's Pedigree Sheep Breed Improvement Programme, viz., Belclare, Beltex, Ile de France, Berrichon.

per year which is only a fraction of the potential number of ewes mated to meet breed sires each year. It is possible that many commercial lamb producers also use rams that are one or two generations removed from recorded flocks. This seriously slows down the transfer of genetic merit from the recorded flocks to the commercial flocks and limits the cost effectiveness of the recording and selection programme in the recorded flocks.

What is BLUP?

BLUP stands for Best Linear Unbiased Prediction. This is a specially designed statistical procedure for analysing performance data on animals in order to estimate breeding values (EBVs) for recorded traits. Although the basic concept had been in use since the 1930s (Lush, 1945), the procedure was developed further by C. R.Henderson to facilitate simultaneous adjustment of the performance records for non-genetic effects (such as flock effects) and to handle multiple traits. BLUP is now regarded as the best statistical procedure available for genetic evaluation and is used in all species of farm livestock in the developed world. All those involved in the genetic evaluation and improvement of sheep in Ireland are assured that the version of BLUP that has been used since 1998 in the Irish Department of Agriculture's Pedigree Sheep Breed Improvement Programme is the most up-to-date version that is currently available, viz., Multi-trait Individual Animal Model BLUP. It has the following features.

- It can estimate the effects of non-genetic factors such as sex, type of birth and rearing, age of the dam, age of the lamb at scanning, maternal effect of the ewe, and flock effect from the data being analysed rather than depending on pre-adjustment using estimates from other data-sets.
- It can include performance information from all known relatives of the animal being evaluated (on the maternal side as well as on the paternal side) in its calculations.

- It can adjust for the genetic quality of the ewes when evaluating a sire on the basis of its progeny's performances.
- It can include performance information from all measured genetically correlated traits.
- It can take account of the degree to which the trait is inherited (heritability) in deriving the estimated breeding values.
- It can take account of the maternal environment provided by the ewe as a nongenetic effect on her progeny.

What is estimated breeding value (EBV)?

The estimated breeding value (EBV) of an animal that is provided by BLUP is the best estimate of the additive genetic merit of the animal, i.e., the sum of all the animal's genes. However, to someone who is buying a ram for breeding purposes, what it transmits to its progeny is of greater relevance than its estimated breeding value (EBV). Because an animal transmits only half of its genes to its progeny, its predicted transmitting ability (PTA) is only half of its EBV. It is not always clear whether the quoted breeding value is an EBV or PTA and this can give rise to confusion regarding the predicted performance of the progeny.

When the estimated breeding values (EBV) are quoted for a number of rams, any two rams can be compared on the basis on the predicted differences between their progeny means, assuming that those progeny are obtained from similar samples of ewes. The progeny means of these rams are expected to differ by half of the difference between the ram EBVs. Therefore, if two rams differ in EBV by 4 kg., their progeny means are expected to differ by 2 kg.

In any given breed, the estimated breeding values (EBVs) for individual traits are always expressed as deviations (+ or -) from a "base value". In the Irish Department of Agriculture's Pedigree Sheep Breed Improvement Programme in 1998 (and this will be the case also in 1999), the base that was used for each breed was the average EBV of all lambs born in that breed in 1998. All animals in a particular analysis (breed) are expressed as deviations from the same base value. Therefore, all animals in a given breed, whether they are lambs, older rams or ewes, can be compared directly with one another.

Figure 1 shows a typical distribution of EBVs for 120-day liveweight of lambs in a given breed. The performances vary from approximately -20 kg to +20 kg around the average, but the EBVs vary only from about -5 kg. to +5 kg. This illustrates the fact that not all of an animal's superiority (or inferiority) in performance is regarded as heritable. This is consistent with a low heratability (see next section).

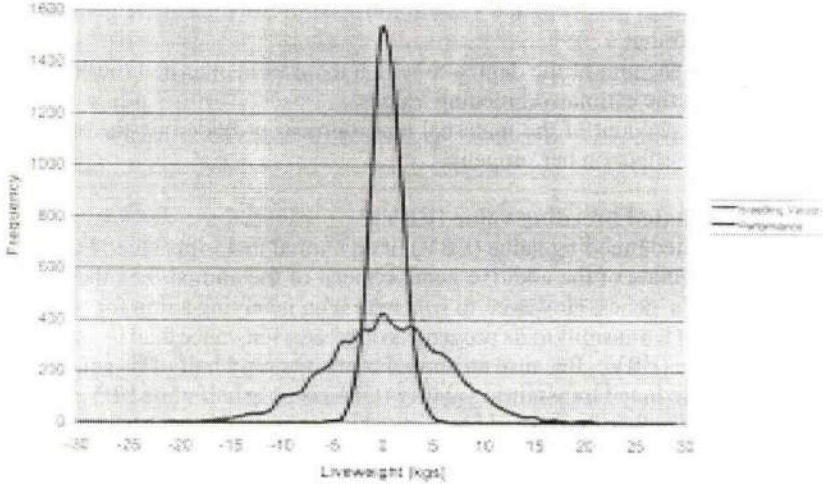
BLUP provides EBVs, not only for those animals that have performance records, but also for other animals that do not have performance records but are related to those that have such records. For example, sires and dams that have no records themselves but have progeny with records would be given EBVs.

What is "heritability"?

Heritability is

a. The proportion of the variation among animals in a given trait in a given

Figure 1 - Typical distribution of performance and breeding values for 120-day liveweight



population that is due to genetic differences among them

b. The proportion of the superiority (or inferiority) of an animal in a given trait in a given population that is regarded as genetic

c. The proportion of the difference between any two animals in a given trait in a given population that is regarded as genetic.

If the heritability of liveweight in a particular breed is, say, 15%, and if two animals differ by 20 kgs., we regard the genetic difference between them to be only 3 kgs (15% of 20 kgs). In other words, in order to be realistic in predicting the type of progeny that an animal will produce relative to another animal, we must reduce its apparent superiority in performance considerably (by about 85%) and only half of what is left (7.5%) is expected to appear in its progeny. If more control could be exercised over the degree of non-genetic or environmental variation among performance recorded animals, one would expect less variation in performance but the heritability of the trait would be higher and the animal's performance would be more useful as a predictor of its breeding value.

Reporting the Results

Table 2 shows the layout of the report produced by the Department of Agriculture in 1999.

What is meant by "accuracy"?

Estimated breeding values (EBYs) that are published in the Department of Agriculture's annual report to the breeders have an "accuracy" value associated with them. This accuracy, which is on a numerical scale between 0 and 1.0, indicates the amount of information available on the animal in question and, therefore, the level of confidence that the authors have in the EBV values. Statistically, "accuracy" is the estimated correlation between the EBV and the

Table 2 - **Layout of Report**

```
ANY BREED IMPROVEMENT PROGRAMME

                         Breeding values and INDEX for 1998 lambs
                         Date = June 19, 1998     Flock Code = XYZ
JOHN ROE
ANYWHERE             IN IRELAND


                                                         Breeding values           LMI-SR
                                                       ===================         (Mean=
                                                        LWT    UMD    UFD           100
Lamb No.         SIRE No.          Dam No.             (kg)    (mm)   (mm)   ACC   SD=30)
================ ================= ===============    =====   =====  =====  =====  =====
H/M/XYZ /98/058  H/M/ABC   /92/036 H/F/VFT  /95/099   2.75    1.39   -0.18  0.58   164
H/M/XYZ /96/009  H/M/ABC   /92/036 H/M/VFT  /94/008   1.04    0.33    0.18  0.67   117
H/M/XYZ /96/008  H/M/ABC   /92/036 H/F/CFR  /93/045  -2.14   -0.88    1.09  0.74    26
________________ _________________ _______________   _____________________  _____  _____
      ①                 ②                 ③                    ④             ⑤      ⑥
```

① Lamb No.	This is the lamb identity number. It has encoded in it the breed, sex, flock, year of performance and the ear tag number as the last 3 digits.
② Sire No.	This is the identity of the sire of the lamb
③ Ewe No.	This is the identity of the dam
④ EBVs for LWT, UMD and UFD.	These are the estimated breeding values (EBVs) for live weight (LWT), ultrasonic muscle depth (UMD) and ultrasonic fat depth (UFD), respectively.
⑤ Accuracy	This is a measure of how close we believe that the estimated breeding value is likely to be to the true breeding value. The accuracy values presented refer only to Live-weight. Time constraints at present do not permit the development of a procedure for calculating the accuracy of the Index.
⑥ LMI/LMI-SR	This is the calculated Lean Meat Index. It is designated as LMI-SR for Sire Reference flocks and LMI for the Non- Reference flocks.

true breeding value and is a function of the heritability of the trait.
Table 3 shows how the accuracy of EBV can change for different amounts and sources of information. The level of accuracy depends on

— the numbers and types of relatives considered

— the heritability of the trait.

High accuracy means that the EBV is not expected to change very much as new information comes available whereas low accuracy means that the EBV is expected to change as new information comes available. There is, therefore, a greater gamble involved in selecting animals on EBVs with a low accuracy than on EBVs with a high accuracy.

Finally, accuracy is our measure of assurance of the quality (high or low) of the product (genetic merit of the animal for lean tissue growth rate).

Table 3

How accuracy changes with different amounts of information available

Accuracy (approx.) Information available	Heritability (h^2)=0.1	h^2=0.2	h^2=0.3
Own performance only	0.32	0.45	0.55
Own performance and 10 offspring	0.52	0.65	0.79
Sire having 200 offspring only	0.91	0.95	0.97

The Lean Meat Index

Each animal in the Department of Agriculture's Pedigree Flock Recording Programme that has a performance record, or that is related to an animal that has a performance record, is given an EBV for liveweight (LWT), ultrasonic muscle depth (UMD), ultrasonic fat depth (UFD), carcass lean weight (CLW) and carcass fat weight (CFW). The EBVs for CLW and CFW are combined into a single figure called a Lean Meat Index (LMI).

The LMI is then scaled in such a way that the lambs in the "base" population have a mean value of 100 and a standard deviation of 30. The "base" population is the same as that referred to earlier, viz., all lambs born in that breed in 1998. Scaling the Lean Meat Index does not change the ranking of the animals within the breed but it makes it easier for breeders to compare animals in the same breed that had performances or relatives performing in different years.

Can animals be compared across breeds?

It is important to note that the LMI for one breed is not comparable with the LMI for another breed because their estimated breeding values are calculated independently and they have different "base" populations. Thus, an animal with a LMI of 100 from one breed cannot be regarded as having the same genetic merit as an animal with a LMI of 100 from another breed.

At present the information that is required to compare animals across breeds is not available. To do so one would need to have sufficient numbers of animals from the different breeds reared and measured under the same conditions. The necessary information could be provided by commercial producers if the performance and pedigree of the commercial animals were recorded. It would be important that the pedigree could be traced back to the pure breeds, at least on the male side.

Figure 2 shows the type of distribution of LMIs that one can get in a particular breed. As in most biological populations, the distribution of the LMIs is

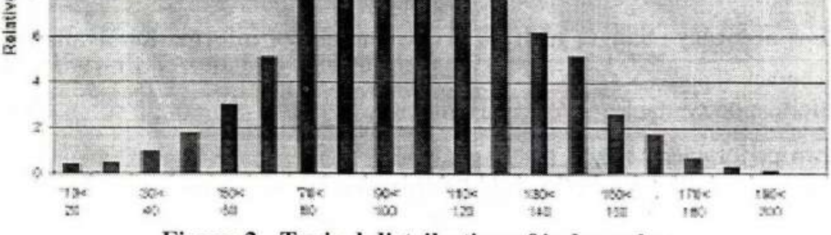


Figure 2 - Typical distribution of index values

approximately normal; most of the values are near the mean of 100 with relatively few at each extreme (as low as 0 or as high as 200). Animals with LMIs greater than 100 are regarded as better animals than those with indexes below 100.

In case anyone regards those animals with indexes less than 100 as being of poor breeding quality, it is important to state that they may well be much better than animals that have no performance records and for which one has no genetic evaluation. This includes rams and ewes in pedigree flocks that are not participating in the Department of Agriculture's Pedigree Sheep Breed Improvement Programme as well as those non-pedigree rams and ewes that are used for breeding in commercial flocks.

The environment

The genes that an animal carries on its chromosomes gain expression when the animal is exposed to an appropriate environment. By environment here we mean every influence that an animal experiences after it is conceived. Those genes that gain expression and that have an influence on performance in one environment may not gain expression in another environment or may be expressed to a lesser degree. This phenomenon is well known in biology and is called Genotype by Environment interaction. "Horses for courses" would be a familiar way of expressing the same concept, meaning that one type of animal is suited to one environment while another type is suited to another environment. In sheep production, the fact that certain breeds are more suited to mountain conditions while other breeds are more suited to lowland conditions is a good example of the existence of genotype by environment interaction.

Pedigree sheep breeders feed and manage their sheep very well. They claim that it allows the lambs to express their genetic merits better. If this was truly the case, then one would expect that the heritability of LWT, UMD and UFD would be greater than the value of 15% to 20% that that is generally found. Hanrahan (1997a, 1997b) reported that the differences between the progeny of rams at commercial level were not as great as one would have expected, based on the Lean Meat Index values of their sires. He claimed that the genetic parameters (heritabilities) used to predict progeny performance at commercial level were overstated, resulting in overstatement of their EBVs. Whatever the reasons for the discrepancies between predicted and actual performances at commercial level, the results that he obtained should give us all serious cause for concern. If we wish to encourage commercial sheep farmers to buy rams of high genetic merit, it is essential that the information presented in the sales catalogues gives a reliable indication of the performance of the progeny at commercial level.

Since the economic climate in which the commercial sheep farmers operate does not allow them to feed expensive diets, there may be large differences between the levels of feeding in pedigree and commercial herds. These differences may be so great as to cause (a) serious over-stating of the genetic differences between rams in terms of progeny performance and, more seriously, (b) changes in the rankings of those rams.

The responsibility of addressing these issues rests, to a considerable extent, with the commercial sheep farmers. In any production system, it is essential to monitor quality at each stage of production, thereby enabling one to identify the precise stage at which factors that cause poor quality occur. At present, there is no systematic structure in place by which commercial sheep farmers can *check* the genetic quality of the breeding stock that they are using in their flocks. This would require individual sire matings at commercial level and the keeping of records of performance and parentage of lambs. If such information were available, one could relatively easily analyse the data and relate the performance of lambs to their sires' breeding values and provide useful answers to a number of questions. Record-keeping is a task that nobody finds attractive but it is an essential part of monitoring product quality.

Some responsibility also rests with the pedigree breeder. It is in the long-term interest of the pedigree breeder to focus on product quality. High quality of product from the pedigree breeder ultimately means high genetic merit of breeding stock for meat traits under commercial conditions. Feeding practices and rearing conditions in pedigree herds should be such as to enable breeders to identify animals that conform to high product quality versus those that do not. It is necessary, therefore, to ensure that all animals get a fair and equal chance to express their genetic merit. More attention could be paid to

- compact lambing, to ensure that all lambs are as close as possible to being the same age through their rearing period.
- weaning reasonably early (8 weeks) to give the lambs a better chance to express their genetic merit free from maternal effects prior to weighing/ scanning at 120 days.
- Treating all lambs in the flock (particularly those of the same sex) as alike as possible.
- Ensuring that the level of feeding and management is not so excessively high as to cause serious genotype by environment interaction.

What are "reference sires"?

Reference sires are specially selected rams that are mated to ewes in several pedigree flocks in a given season in order to facilitate the separation of the flock differences in performance into their genetic and non-genetic (or environmental) parts. It is most effective when at least two rams are used in each flock and each ram has several progeny in each flock. However, this is difficult in very small flocks. The procedure enables breeders and sheep farmers to make more reliable comparisons between animals in different flocks on their genetic merits and thereby widens one's scope for selecting replacement breeding stock. It also enables the individual breeder to compare the genetic merit of his/ her flock relative to the genetic merit of other breeders flocks.

Prospects for improving selection on LMI in the pure breed flocks

The rate of genetic progress in any given animal trait depends on the amount by which the replacement stock each year exceed those that were used in the previous year. Table 4 shows, for a sample of 91 pedigree flocks, the mean LMI of the parents of lambs born in 1999.

Table 4

Lean Meat Index of parents of pedigree lambs born in 1999

	Young* parents		Older** parents	
Type of parent	No.	Average LMI	No.	Average LMI
Sires	66	135.2	113	109.1
Dams	308	104.4	1433	94.4

*Born in 1998 in the case of males, in 1997 in the case of females

**Born prior to 1998 in the case of males, prior to 1997 in the case of females

The young replacement parents had considerably higher LMIs than the older parents. There is, however, considerable room for improvement. Some young replacement rams had very low LMIs (12% of all young replacement rams had LMIs less than 100) and others (about 23%) appear to have come from flocks that were not participating in the Department of Agriculture's Pedigree Sheep Breed Improvement Programme (though they may have had an evaluation from elsewhere and may have been genetically acceptable). It is also very likely that many high LMI rams were sold to commercial flocks or to flocks not in the recording programme and were not available for use within the participating flocks. Considering a reasonable lambing rate of 160% and approximately 12 ewes mated per ram in participating flocks, it should be possible to achieve an average LMI of 160 in the case of young males (and an LMI of 130 in the case of the females).

Economic value of genetic improvement

- Banks (1994) in Australia and Simm et al. (1997) in the UK estimated a benefit cost ratio of more than 8:1 resulting from expenditure on testing and selection for meat traits in nucleus flocks. While this estimate could be regarded as being high, nevertheless it is true that expenditure in this area is sufficiently cost effective to justify a reasonable level of expenditure.

  There are a number of conditions necessary for achieving a high benefit:cost ratio.

- High level of participation of the nucleus (pedigree) sector in the genetic evaluation programme,
- Efficient use of the results of genetic evaluation in achieving a high rate of genetic progress in the nucleus (pedigree) population,
- Increased training on performance-based methods of selection, promotion of more comprehensive recording, improved design of breeding programmes including the promotion of sire-referencing schemes,
- Rapid transfer of the genetic gain from the nucleus (pedigree) sector to the commercial sector, increasing the usage of recorded rams in commercial flocks, or improving the dissemination of high merit breeding stock through the wider use of AI or other reproductive technologies.

Also, there should be continuing development and use of improved tools for selection (e.g., use of computer-assisted tomography (CT) to take whole-body scanning measurements on some animals).

It is difficult to see a disadvantage in putting greater effort and expenditure into genetic improvement, especially if the alternative is the increasing inability of the sheep meat industry to compete favourably in the high quality, high priced sheep meat markets. At pedigree level, genetic improvement can be cumulative, permanent and cost-effective. At commercial level, genetic improvement gives increased product value and greater competitiveness in higher-priced markets. It is a prize that we cannot afford to ignore.

Bibliography

Banks, R.G. (1994). Structural effects on returns from genetic improvement programs: a case study. Proc. 5th World Congr. Genetics Appl. to Livest. Prod., 18:123-126.

Bansback, B. (1993). Meat Demand Economics. In "Meat Consumption in the European Community". Proceedings of a workshop organised by the Director-General for Agriculture (DG VI) of the Commission of the European communities, Office for Official Publications of the European Communities, Luxembourg.

Hanrahan, J.P. (1997a). Evaluation of Lean Meat Index for Sheep. Summary of papers presented at Irish Grass. Anim. Prod. Assn. 23rd Annual Meeting, University College Dublin, Belfield. pp331-332.

Hanrahan, J.P. (1997b). Exploiting Genetic Resources to Enhance the Competitiveness of Lowland Sheep Systems. Irish Grassland & Animal Production Journal. 31:106-115.

Kempster, A.J., Cook, G.L., Grantley-Smith, M. (1986). National estimates of the body composition of British cattle, sheep and pigs with special reference to trends in fatness. Meat Science 1 986, 17: 107- 138.

Lush, J.L. (1945) Animal Breeding Plans. The Iowa State College Press, Ames.

Simm, G., Amer, P.R. and Pryce, J.E. (1997). Returns from Genetic improvement of Sheep and Beef Cattle in Britain. In SAC Animal Sciences Research Report 1997. SAC, Edinburgh.

Simm, G. (1998). Genetic improvement of cattle and sheep. Farming Press.

Simm,G. and R.M.Lewis (1997). Sire Referencing Schemes: A Fast Lane in Sheep Breeding? Irish Grassland & Animal Production Journal. 31 :97-105.

Simm, G. and W.S. Dingwall (1989). Selection Indices for Lean Meat Production in Sheep. Livestock Production Science, 21: 223-233.

Some Observations on Animal Disease, Ill Thrift and Infertility

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Cattle

Although bovine abortions occur throughout the year the highest incidence is generally during the first quarter. From our perspective the main agents continue to be Leptospira, Salmonella, Neospora, Listeria and Brucella. With our emphasis on diagnosis the quality of the sample is paramount. Indeed the quantity is also very important in that the more samples submitted the more one increases the chances of establishing the true cause of abortion where up to 70% fail to yield a specific cause. In view of this, it is advisable to bring the first aborted foetus to the laboratory and not to wait until perhaps the third or fourth incident before taking action.

With regard to stillbirth/early neonatal death, the single most important cause of loss is dystocia/anoxia or damage/stress at calving. However, events/conditions such as infections, deficiencies and mismothering leading to starvation are also involved.

Neonatal mortality (up to 28 days) is generally associated with pneumonia and diarrhoea or respiratory and enteric disease. The viruses rotavirus and coronavirus, *E.coli.* K99 E coli, cryptosporidia and coccidia are isolated from intestinal contents of calves with diarrhoea. With regard to pneumonia, while viruses and bacteria such as *E.coli* and Pasteurella are regularly isolated, foreign body pneumonia due to aspiration of milk into the lungs is also significant. Navel ill is a hardy annual. Starvation continues as a significant cause of death in neonatal calves and is probably due to the incorrect use of electrolyte solutions. In general, calves should not be left without milk for more than 24 hours. Immuno deficiency, that is where the newborn calf does not receive either sufficient quantity or quality of colostrum early enough in life to protect against disease, is a major contributory factor to neonatal mortality. The management system of shared space where pregnant and calved cows are housed together along with their calves will raise the incidence of calf diarrhoea and potentially neonatal mortality by a factor of three. In such situations the incidence of pneumonia is also similarly raised. Mineral deficiency, in particular, trace minerals may also be involved resulting in weakly born calves that are more susceptible to disease.

Ill-thrift in 1999 in all species was influenced by parasites and in particular fluke and worms although a number of cases of heavy lice infestation have been diagnosed. Copper deficiency again in both cattle and sheep continues to effect thrive and indeed fertility. In general, in our particular catchment selenium values recorded in blood samples and in tissue samples, such as kidney, are adequate. In some areas iodine deficiency continues to influence calf mortality, thrive and fertility.

With regard to infertility the obvious causes such as deficiency and disease are of course important. However, nutrition is probably more important than either of the aforementioned. It is advisable to have infertility investigated in order to establish a cause. It has been established that Ketosis in the perinatal period has a major influence on fertility and that the depth and duration of the Ketosis can result in prolonged infertility into the next breeding season with consequent effect on the calving interval. Leptospirosis is also regarded as a major cause of infertility. Diseases that cause a high febrile reaction such as Tick-borne Fever also affected fertility although this may be more important in sheep.

Sheep

In sheep the single most important cause of infectious abortions continues to be Toxoplasmosis, although increasingly Listeria, Salmonella and Chlamydia are appearing. Campylobacter is also seen occasionally. As with cattle it is important to bring all abortions to the laboratory and where available to also bring the afterbirth. Twin lamb disease or pregnancy toxaemia also causes abortion and generally the death of the ewe as well. Presently we see this condition most often in ewes that are too fat. While Leptospirosis has not been identified as a major abortifacient in sheep the flock can serve as a reservoir of infection for cows in the mixed farming situation.

Still birth and early neonatal death are most importantly due to dystocia/anoxia and starvation/exposure. Early neonatal death is also caused by infections causing diarrhoeas such as *E.Coli*, rotavirus and Salmonella and by navel infections causing tissue abscessation and septicaemia.

The incidence of Listeriosis in neonatal lambs appears to be increasing with the classical nervous disease manifestations but also in some cases with microabcessation of the liver and consequent death.

Just as with calves the incidence of disease in lambs is associated with high environmental contamination which increases as lambing progresses particularly when the flock is housed. Clostridial diseases are ever present.

This past year has been notable for parasitic infestations in sheep. Fluke and worms are a major cause of ill-thrift in sheep but also a major cause of death since sheep are most susceptible to acute fluke. The incidence of acute and chronic fluke has been seen at a level not recorded for many years. Copper and cobalt deficiencies have also been recorded; in some cases the copper deficiency has appeared as Swayback as well as ill thrift.

Infertility in ewes in our experience has been associated with Toxoplasmosis and Tick borne Fever. Ram infertility of course is also a major factor. However, disease and/or deficiency are not the only factors and poor management can have a significant negative influence if superimposed on an already at risk situation.

DETECTION OF ENTERO-PATHOGENS IN CALVES UNDER ONE MONTH

Period Jan - Mar 1999

Laboratory: Athlone

Entero-Pathogen	No. examined	No. Positive	Percentage Positive
Rotavirus	173	62	35.8%
Cryptosporidia	142	47	33.1%
K99+*E.coli*	175	13	7.43
Coronavirus	173	29	16.8%
Salm. typhimurium	172	2	1.2%
Salm. dublin	172	2	1.2%
Coccidia species	34	6	17.6%

DETECTION OF BOVINE ABORTIFACIENTS

Period Jan - Mar 1999

Laboratory: Athlone

TOTAL NUMBER EXAMINED - 136

Abortifacient	No. Positive	Percentage Positive
Brucella abortus	5	3.7%
Salmonella abortus	5	3.7%
Salmonella species	1	0.75
Actinomyces pyogenes	8	5.9%
Leptospira hardjo	13	9.6%
Listeria monocytogenes	1	0.7%
Fungal Species	1	0.7%
Neospora Species	3	2.2%

Ectoparasites of Sheep

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Ectoparasitic diseases of sheep have animal welfare, environmental and economic effects. The most common sheep ectoparasites in Ireland are mites, lice, ticks and flies.

Mites are the most serious. *Satcoptes scabei,* a biting mite, is frequently encountered in continental Europe and North Africa but is not generally a problem here. Neither *Chorioptes bovis* nor *Demodex ovis* cause serious problems. However, *Psoroptes ovis* is a sucking mite and the cause of the notifiable disease, sheep scab. It causes a serious, sometimes fatal disease of sheep with extreme pruritis exudative dermatitis, loss of wool. It lowers production by one third (Kirkwood 1980) and lambs born to infested ewes are ten percent lighter than those from uninfested ones.

Sucking lice *Linognathus ovillus* and *L. pedalis* which are confined to the hairy areas of the body, can cause problems but *Damalinia ovis* a biting louse is a more serious pest causing production losses to the fleece and hide damage.

The tick *Ixodes ricinis* (Castor tick) is the most common tick found on sheep in this country and although it causes some damage to the hides of sheep its main importance is as a vector of several viral and bacterial diseases.

Fly strike (Blowfly myiasis) causes great pain and suffering to sheep. *Lucilia spp* (Green bottles), *Phormia sp* (Block bottles) and *Calliphora spp* (Blue bottles) lay their eggs in the fleece of lambs and unshorn ewes having been attracted by the smell and condition of the fleece soiled by faeces and urine (French et al. 1996). The eggs hatch to larvae which burrow into the flesh and cause lesions which can be further exacerbated by the attention of other flies and bacterial infection. *Melophagus ovinus* (the sheepked) which is a wingless insect causes sporadic outbreaks of disease with wool lose and irritation. These are usually not serious. The nasal botfly *Oestrus ovis* is a minor problem in parts of the south of England but is not a pest here.

Control

It has become most important to use ecto-parasitic treatment systems in a judicious manner to ensure efficacy and avoid environmental damage. Likewise the timing of treatments, when they might give best results, must be well considered. Epidemiological experience and accurate diagnosis gives this information.

In the past when dipping systems alone were available all of these diseases were treated similarly. However, a divergence of treatment measures has now occurred with different therapies sometimes being effective against particular parasites.

Factors influencing the treatment for mites and lice would be similar as both groups are obligate, species specific parasites which have only limited survival time off the most (O'Brien et al. 1994). In the case of flies and ticks, both spend considerable periods away from the host, are often not species specific and their success and period of activity is governed by climate, weather, geographical and topographical factors.

Treatment systems

Historically, efforts to find treatments of these diseases commenced early in the nineteenth century when many chemicals were used externally and internally in efforts to control them. The first dips were produced by William Cooper in 1843. Substances used for control included, hellebore, mercury, kerosene and sulphur. The most successful were arsenic and nicotine, which products were used into the twentieth century. Organochlorines (OC) were first used in 1947. Downing (1947) and Wright (1957) first used organophosphates (OP) for the control of lice. The introduction of avermectins (Egerton et al. 1980) had a profound effect on parasite control. Invermectin was found to be effective against sheep scab (Psoroptes ovis) with two subcutaneous injections at 200 mcg/kg, 7 to 10 days apart (Soll et al. 1992, O'Brien et al. 1993). One injection of moxidectin at 200 mcg/kg was found to be fully effective (O'Brien et al. 1994). As with dipping, it was recommended that for field outbreaks two treatments be used and just one for prophylasic, as moxidectin has a prophylactic action of at least 28 days (O'Brien et al. 1996). Doramectin has been found to have a therapeutic effect with one injection at 300 mcg/kg (Bates et al. 1995).

These injectable products have become known as endectocides, as they control many internal and external parasites. It is strongly recommended that two injections of endectocides be used for the treatment of sheep scab.

A bolus preparation of ivermectin has now become available and has been assessed for efficacy against sheep scab at the VRL, Abbotstown and found to have therapeutic and prophylactic activity for over three months (O'Brien et al. in press).

The synthetic pyrethroids (SP) have been widely used as both dips and topical pour-ons since the early eighties. Several different SPs have varying efficacy against flies, mites, lice and ticks (Romano and Greco 1983, Hamel and Van Amelfoort 1987).

Until recently the most widely used dip products were OPs. They have a wide range of activity and can be used against all of these parasites. They work well if manufacturer's instructions are followed. They will not perform in the presence of organic matter (faeces, muck, etc.), in dirty water nor in the presence of old or spent dip. They must also be made up to the correct concentration or they will give disappointing results; replenishment must be carried out as recommended. It is essential to retain each sheep in the solution for one minute to allow a dose of active ingredient to be absorbed onto the fleece which must be at least 0.5 inches long. Most OPs give protection for six weeks or more if used correctly (Kirkwood and Quick 1981 & 1982).

The disposal of used dip solutions, OPs and even more so SPs must be carried out as recommended by local administrations or they will pose a serious threat to aquatic life and the environment generally. OPs also require careful use from a human health aspect and those using them require to be trained and licensed.

The choice of product must now be carefully made. Endectocides have much to recommend them being convenient, non labour intensive, safe, requiring no special equipment and can be used in any weather and in most locations even on mountain sides. They have an added advantage of also killing nematode worms. However, the injectable forms have no worthwhile effect against flies or lice and if these are present a diagnosis must first be made as disappointment and economic loss will ensue if mites are not the problem and of course endectocides are much more expensive to use.

In addition to the above mentioned products, Insect Growth Regulators (IGRs) are being more frequently used. Already they are popular for controlling fleas and Cyromazine is widely used to prophylactively control blowfly strike in sheep. It gives prolonged activity (O'Brien and Fahey 1991) and works by interfering with the development of the larvae of dipterous flies. More of these products will become available. Work continues on the development of vaccines against ectoparasites. However, it must be stressed that very few new products are being developed due to costs and time consuming trials required for registration. Hence, it behoves us to use these products wisely for already resistance is developing to some of these and there is concern over the safety of others.

References:

Bates, P.G., Groves, B.A., Courtney, S.A. and Coles, G.C. (1995). The Veterinary Record. 137: 491 -492

Downing, W. (1947). The Veterinary Record. 59: 581-582

Egerton, J.R., Birnbawn, J., Blair, L.S., Chabula, J.C., Conroy, J., Fisher, M.H., Morozik, J. Ostlind, D.A., Wilkins, C.A. and Cambell, W.C. (1980). British Veterinary Journal. 136: 88-97

French, N.P., Parkin, T.D.H. and Morgan, K.L. (1996). The Veterinary Record 139: 384-388

Hamel, H.D. and Van Amelsfoort, A. (1988). Veterinary Medical Review. 59: 162-166

Kirkwood, A.C. (1980). The Veterinary Record. 138: 210-211

Kirkwood, A.C. and Quick, M.P. (1981). The Veterinary Record. 108: 279-280

Kirkwood, A.C. and Quick, M.P. (1982). The Veterinary Record. 111: 367

O'Brien, D.J. and Fahey, G. (1991). The Veterinary Record. 192: 351-353

O'Brien, D.J., Gray, J.S. and O'Reilly, P.F. (1993). Irish Veterinary Journal. 46: 99-101

O'Brien, D.J., Gray, J.S. and O'Reilly, P.F. (1994). Veterinary Research Comunications. 18: (1)3 27-36

O'Brien, D.J., Gray, J.S. and O'Reilly, P.F. (1994). Veterinary Parasitology. 52: 91-96

O'Brien, D.J., Parker, L.D., Menton, G., Kearney, C., McCollum, E. and O'Laoide, S. (1996). The Veterinary Record. 139:438-439

O'Brien, D.J., Forbes, A.B., Pitt, S.R., Baggot, D.G. (1999). Veterinary Parasitology. 85: 79-85

Pearson, P. (1996). Proceedings Int. Conference on Sheep Scab, Tralee, Ireland. March 1996. 22-25

Romano, A. and Greco, J. (1983). Gacets Veterinaria. XLV: 57-69

Sargison, N.D., Scott., P.R., Penny C.R., Pirie, R.S. (1995). The Veterinary Record. 136: 287-289

Wright P.W. (19571. Rural Research in C.S.I.R.O. 20. 25-26

Producing Quality Beef for the Market

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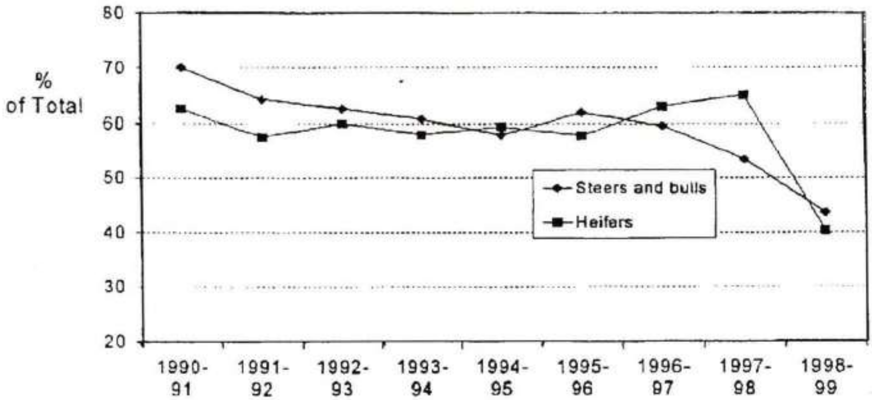
It is well recognised that given Northern Ireland's relatively small quality beef production, producers and processors must focus on supplying quality beef cost effectively into Europe. These markets are prepared to pay premiums for a top class/branded product providing sufficient numbers of cattle grading EUR with fat class 2 and 3 can be consistently provided 52 weeks of the year. Is the Northern Irish beef industry well positioned to respond to the challenge?

Decline in quality evident

The graph below shows the decline in the percentage of steers and heifers grading EUR over the past 10 years.



Change in conformation classification for cattle slaughtered in N. Ireland from 1990 until 1999 - EU and R grades combined

It is notable that the data post BSE excludes approximately 55,000 dairy bred bull calves which were removed under the Calf Processing Aid Scheme. Had these animals been added in, then only 36% of streers would meet the EUR specification.

Reasons for decline in quality

- Influence of Holstein genes in the dairy herd lowering the conformation of beef x dairy steers and indirectly through the supply of poorly conformed replacements to the suckler herd.
- Retention of poorly conformed heifers from within the suckler herd.
- Decline in the carcass weight of Continental x cattle.
- Reduction in the proportion of finished bulls slaughtered.
- Suspected increased usage of poor quality/scrub bulls.

Quality targets - a farm quality assurance plus scheme

Currently a quality beef scheme is being developed within the province the main aims of which are:

- supply a minimum of 2,500 cattle per year to the main processors with 75% grading EUR of fat class 2 and 3 by 2006.
- encourage information flow, intergration and competence development through training across the supply chain.
- develop minimum stress, high welfare, systems designed to meet consumer requirements. This will be based on limiting the number of holdings to 2 or 3 per animal combined with disease prevention programmes.
- monitor eating quality of all carcasses.

Achieving the quality targets

Bull improvement - terminal carcass sire

Within Northern Ireland the BLUP system is operated on behalf of Signet by AI Services NI. By removing the environmental effects the system allows the true genetic value of bulls to be compared through the use of Estimated Breeding Values (EBV's). EBV's are calculated using the bull's own measurements combined with measurements for its relatives. The EBV's are then rolled into an overall index known as the 'Beef Value' and reflects the financial benefit of using that bull. For example, the Beef Value of 24 for Greenmount's Cheadlewood Jupiter bull in Table 1 means that he will pass on approximately £12 extra margin to each of his progeny compared to the average for the breed on 1980.

Below each EBV is an accuracy percentage. The higher the percentage accuracy then the greater the chances are that the figure is unlikely to change.

Table 1
EBVs for two Limousin bulls

Run date 9/8/99	Gestation length	Calving ease	Birth weight	Calving value	200 day milk (kg)	200 day growth	400 day growth	Muscling score	Muscle depth	Fat depth	Beef value
Cheadlewood Jupiter											
EBV	2.0	-3.8	3.3	LM -2C	-7.0	39	49	0.7	0.5	0. 2	LM 24
Accuracy %	82	74	87	82	49	86	84	74	77	60	75
Index	84	80	64	80	67	138	126	119	140	81	119
Farland Orver (Jupiter son)											
EBV	1.8	-4.1	3.1	LM -2C	-6.0	57	77	0.8	0.6	0.2	LM 37
Accuracy %	64	47	65	61	35	65	60	48	55	34	52
Index	86	77	67	80	72	162	148	123	150	81	142

The higher the heritability of the trait, the amount of information on relatives and the number of contemporaries recorded, the better the accuracy. Generally the overall Beef Value should have an accuracy of 40%. The lower accuracy associated with Orvet (Jupiter's son) is a reflection of fewer records. As a result there is a greater chance that Orvet's EBVs may change in the future either up of down.

Recently Signet has added an index for each EBV reflecting how the performance trait compares to the present average for the breed. An index of 130 or above indicates that the animal is in the top 1% for the breed in that particular trait.

Both bulls have very high positive EBV's for growth rate and muscling. Both traits are normally associated with more difficult calving as indicated by a negative calving value and lack of milk as indicated by a negative 2000-day milk EBV. However it is possible to find a bull that demonstrates positive EBV's for all these important economic traits.

For commercial suckler producers contemplating purchasing a bull it is important to select a list of bulls which will improve the weakest aspect of your current calf crop. The aim may be to correct low growth rates or poor conformation or a combination of both. Having made the selection based on EBV's view the bulls and the select the best according to:

- soundness of legs and feet
- conformation and breed character
- large even sized testicles - associated with better fertility in male and female
- purchase the best value for money

In Table 2 results from a progeny test comparing two Limousin bulls differing in Beef Value by 7 points is compared. This indicated that through higher carcess weight, improved grading and better feed efficiency the bull with the highest Beef Value produced steers which were worth £73 more than the progeny from the lower quality bull. Further calculations show that combining estimated heifer and steer results would lead to an improvement in output of approximately £63 per finished animal. If this superior bull LM23 was used on an average herd of 19 cows producing 18 calves per year over 5 years then this bull would produce an extra £5670 over his lifetime compared to the moderate beef bull LM16. This is a clear example of how the quality bull plays a significant role in improving profit margins.

Table 2

Comparison of steer progeny from high and moderate beef value bulls

Beef value		LM 16	LM 23
Carcass wt. (kg)		344	375
Conform. grade (%)	0+	72	41
	R	28	41
	U	0	18
Days to slaughter		700	690
Reduced feed cost (£)			-£8
Overall output (£)		521	594

The use of AI

UsingAI successfully in the suckler herd is fraught with a number of practical difficulties. This is reflected in the low rate of usage of AI in the suckler herd. It is estimated from semen usage figures (1994 UK Dairy facts and figures) in 1993/94 that no more than 13% of the national suckler herd in the province would have received a single AI dose in that year.

The remoteness of many herds and difficult terrain make heat observation 3 times per day a challenge. Nevertheless certain committed producers who recognise the superior quality of AI bulls make use of a quad bike and binoculars to observe cows regularly. One producer currently covers 120 cows by AI and the other 40 cows while holding down a full time job. The same individuals are innovative in making use of a portable crush with pens attached which can be moved from field to field on the tractor pick up hitch. Electric fences are used to form a funnel to assist in moving the cows on standing heat into the service pen. Both are skilled in carrying out their own AI, regularly achieving conception rates of 60%.

Through the use of AI at Enniskillen College a double muscled Charolais Culard bull called Haubois was used last year on a herd of West of Ireland (WOI) black cows calving in January/February. The bull calves, now at point of weaning at 8 months of age, weigh 383 kg having achieved an average daily liveweight gain of 1.35kg since birth with no meal feeding. These animals have the potential to grade E and U. Some of these calves weighed up to 60kg at birth. However, no major increase in calving difficulty with Charolais Culards was observed in this relatively small batch of cattle.

Heavily muscled Charolais, Belgian Blues or Blonde D'Aquitaine bulls used on WOI black cows should produce lean well muscled lean carcasses suitable for the Continental market. *However a ¾ Continental cow crossed to a Continental bull is more likely to produce the desired carcass with minimal calving difficulty.*

Synchronisation

Despite these success stories many producers will not have the labour and handling facilities to cope with AI. It is feasible to successfully use synchronisation and AI and achieve a normal conception rate of 60%.

Given the current price of synchronisation drugs combined with lower prices for weanlings/stores it is difficult to justify the cost of synchronisation and double AI. However producers involved in calf to beef systems are likely to more than justify the costs of synchronisation and AI when the effects of extra carcass weight and improved grades are taken into account. This is currently under investigation at Greenmount.

Improving suckler cow quality

Three possible options:

1) Replacements from the dairy herd

Minimise/avoid obtaining suckler replacements from the dairy herd unless the herd is of British Friesian or other dual purpose breed. If some Holstein is evident in the beef x dairy replacement then consider producing $^3/_4$ breds from the $^1/_2$ breds as replacements.

This approach has been adopted within the LIMO suckler herd at Greenmount where beef production from progeny out of $^1/_2$,$^1/_3$ and pure-bred Limousin cows is being assessed. Cattle will be marketed through Linden Foods into Continental markets.

NOTE: Herds of dual-purpose dairy cows are scarce and will fall far short of suckler herd replacement demand. This increases the risk of introducing disease into the suckler herd.

2) Breed the suckler cows to one breed of bull and keep the heifer replacements. This will eventually lead to a pure bred herd.

Note: Simple to operate leading to a fairly uniform cow. Suffers from lack of hybrid vigour reducing output per cow by 22-23%.

3) Criss-cross breeding program

For the majority of suckler producers this will be the most cost effective solution to improve cow quality. This consists of a criss-cross programme using two different breeds of pedigree beef bulls both with positive 200-day milk EBV. The two breeds selected should be similar in size otherwise a wide range in ultimate cow size will result. This criss-cross breeding program will, after 6 generations, have virtually eliminated the Holstein genes settling down to a cow type alternating between 66% and 33% of both breeds. This approach when crossed to a terminal sire of a different breed will retain approximately 86% of the hybrid vigour obtained in a hybrid (dairy x beef cross) bulled to a terminal sire of a different breed. It is important to match the breed size and hardiness to the environment. Large breed types such as the Charolais x, Blonde x and particularly Simmental x cows should preferably be avoided in the Hill environment.

Currently a wide range of breeds is being assessed on farm in a major study being carried out by ARINI Hillsborough (Steen 1999). Calving difficulty, cow fertility, carcass output and quality will be monitored from a whole range of cow breed types currently carried on Northern Ireland farms.

Selecting breeder cows

Ideally, to breed replacements from within the herd select cows which calve early and have a proven history of a good temperament, milking ability producing a well conformed, sizeable calf each year. To obtain sufficient replacements approximately 40% of the herd will have to become breeder cows each year.

Breeding replacements from within the herd to calve down at two years of age will be difficult for the smaller Hill producer who traditionally sells his calves as weanlings or stores. In this situation it is likely that a number of lowland suckler herds will become specialised suckler replacements to calve down at two years of age. It is this route that the April/May calving Abbey herd at Greenmount is presently following with a criss-cross breeding programme between Saler and Limousin. The aim is to provide replacements for this lowland herd and a May/June calving herd at Greenmount Hill farm.

Why Limousin and Saler?

Limousin helps to retain conformation in the cow along with reasonably easy calving. Compared with the Limousin, the Saler brings up to 43% more milk (D'hour et al 1998), 23% larger pelvic area (D'hour et al 1998) and improved reproductive performance reaching puberty at the same weight as Limousin heifers but 1 month earlier (D'hour et al 1996). In a situation where feed was restricted in quantity and quality Salver cows came into heat four weeks sooner than Limousin. After 4 parities in a restricted nutritional environment appproximately 85% of the Salers remained in the herd compared with 60% of the Limousins. (D'hour et al 1997).

Given the current financial difficulties in beef production it is likely that herds will expand or producers will move to part time farming. In both scenarios less time will be available to calve cows or to encourage calves to get up and suckle. *It is felt that the Limousin x Saler when crossed to a muscular terminal sire will help over come these difficulties producing a quality calf at least cost.*

Does payment on grade reflect the quality?

The Livestock and Meat Commission (1999) carried out an assessment of saleable meat yield across 5 different grade bands as shown in Table 3.

Table 3
The effect of grade on saleable meat yield

Grade band	Carcass grades	% Saleable meat	% Price change from base
1	E2 E3 U4 URL	76.5	+7
2	R3 R4L O+3 O+4L	72	0
3	4H R4H O+4H 03 04L O4H	67	-7
4	0-3 0-4L 0-4H	66.5	-17
5	P3	66	-27

Within band 2 and 3 there is currently a price range of 18p per kg of carcass or £58 per average steer carcass. In moving from the base band 2 up to band 1 increases the current average price by 5 per kg of carcass and moving down to band 3 would decrease the average price per kg of carcass in this band by 5p. Such a scheme if adopted would more fairly reflect the yield of saleable meat rewarding the farmer better for producing a quality carcass. One processor in the province moved this year to reflect a block grading system paying base +4p extra for E 3 & 4L and U 2 & 3, base -6p for R 2 & 3 and U 4L with 0+3 fetching base -l0p. Base price was taken as U3 Brussels quoted price.

Conclusion

Getting the right quality of Continental terminal sire selected using EBV's and crossed onto a criss-cross bred Continental cow is the best recipe to achieve Continental consumer requirements that is carcases under 400kg grading EUR with fat score 2 and 3. At current prices improving carcass grade from O to U will increase the average value of the carcass by £77 and improving carcass weight by 10 kgs will improve output by approximately £17 per animal. Plan and make changes now to the breeding programme, it will take time for the benefits to feed through to put extra cash in your pocket.

References

D'hour P., Menissier F and Petit M (1998) in PJ Goddard (ed), Proceedings of European workshop on " The implications of extensification for the health and welfare of beef cattle and sheep" Aberdeen 5-6 March 1998.

D'hour P. and Petit M. (1997). Proceedings of"Suckler cow workers meeting" UK, Sept. 1997 pp 15-19.

D'hour P., Petit M and Garel J.P. (1996). Rencontres Recherches Ruminants, 3: 233-266.

Livestock and Meat Commission (1999). Lissue House 31 Ballinderry Road Lisburn Bt 28 2 SL.

Peck D. (1999) Scottish Agricultural College Beef/Sheep notes July 1999 P 23.

Steen R.W.J. Patterson D.C. Frost J.P. & Binnie R.C. (1996). Occasional Publication No. 22 March 1996 p92.

Steen R.W.J. (1999). Personal communication.

Breeding Policy for the Suckler Herd

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The aim in suckler beef production is to produce progeny of high growth potentialwithout undue calving problems and carcasses eligible for the highest priced markets. The highest priced markets available are in mainland EU and the animals required by these markets are lean and of good conformation. As breed is the main factor influencing these traits a continental breed of bull must be used for the production of suitable animals. There is a wide range of options for the cow breed type but the following factors must be considered in cow selection:

- Crossbred: to avail of hybrid vigour
- Satisfactory milk production potential
- At least 50 percent continental

Hybrid vigour

Hybrid vigour or heterosis is defined as the superiority of the crossbred over the average of the two parent breeds for a particular trait. A summary of the available data (Fallon and Drennan, 1999) shows that the overall advantage expected from using a crossbred suckler cow as opposed to a purebred in terms of kg of calf weaned per cow put to the buil is 13 percent (Table 1). This advantage results from a combination of improved fertility, lower calf mortality and higher calf liveweight gain to weaning. In addition, the available data indicate that using a sire of a third breed increased the weaning weight by a further 8 percent.

Table 1
Improvements from heterosis in suckler calf production

Cow	Calving rate	Mortality	Weaning weight	Overall calf weaned (kg)/cow to bull
Purebred	100	100	100	100
Crossbred	105	104	104	113

Fallon and Drennan, 1999

Cow breed comparisons

In one study at Grange, Hereford x Friesian cows were compared with Limousin x Friesians over 4 years. First calving was at 2 years of age using an easy calving Limousin bull while Charolais or Simmental sires were used for subsequent calvings. Male progeny (bulls) were taken to slaughter at 16 months of age and heifers at 21 months. Limousin x cows averaged only 15 kg greater liveweight (560 v 575 kg) than Hereford x cows. The progeny of the Limousin x cows had better killing-out rates, higher carcass weight gains (total 10 kg), lower carcass fat scores and lower kidney plus channel fat weights than Hereford x progeny (Table 2).

Table 2
Liveweights and slaughter data of progeny of Hereford x Friesian and Limousin x Friesian cows

	Hereford x Friesian cows	Limousin x Friesian cows
Weaning weight (kg)	319	323
Slaughter weight (kg)	578	584
Carcass weight (kg)	321	330
Killing-out rate (g/kg)	554	562
Carcass per day of age	599	616
[1]Carcass conformation score	3.5	3.5
[2]Carcass fat score	3.9	3.5
Kidney + channel fat (kg)	11.4	10.2

[1]Scale 1 to 5 (Best conformation) [2]Scale 1 to 5 (fattest)

In a second study Charolais cows were compared with Hereford x Friesians. Both were bred to Charolais sires as mature cows while an easy calving Limousin sire was used for first calving at two years of age. The Charolais cows averaged over 100 kg heavier. The overall incidence of calving problems was low and there was no difference in calf birth weights. Daily gains from birth to weaning were 1.10 and 1.19 for the calves from Charolais and Hereford x Friesian cows, respectively (Table 3). This amounted to a 240-day weaning weight difference of approximately 22 kg in favour of the Hereford x Friesian progeny. This difference in calf daily gain to weaning was a reflection of difference in milk yield of the cows. Averaged over two studies, milk yield at grass for spring calving Charolais and beef (Hereford and Limousin) x Friesian cows were 7.3 and 11.1 kg, respectively (Table 4).

In three experiments, the steer progeny of the Charolais and Hereford x Friesian cows were taken to slaughter and in two of these experiments the pistola from one side of the carcass was dissected into meat, fat and bone. The average age of the Charolais and Hereford x Friesian progeny at weaning was 217 and 222 days, respectively. Corresponding weaning weights were 304 and 328 kg

Table 4
Cow milk yields (kg per day)

	Charolais	Beef x Friesian
Experiment 1	7.6	12.1
Experiment 2	7.0	10.1

McGee 1997

(Table 5). When fed similarly from weaning to slaughter at about 2 years the final liveweights were 678 and 697 kg, respectively. Corresponding carcass weights were 384 and 393 kg. Thus, the weight difference between the progeny of the two breed types present at weaning was largely present at slaughter. Carcass produced per day of age was 531 and 540 g for the progeny of the Charolais and Hereford x Friesians, respectively. However, kidney plus channel fat weight and carcass fat scores were lower for the progeny of the Charolais cows, while carcass conformation was better than for the Hereford x Friesian progeny.

Table 5
Liveweight and slaughter data for steer progeny for Charolais and Hereford x Friesian cows (mean of 3 experiments)

	Charolais dam	Hereford x Friesian dam
Birth weight (kg)	49.1	49.5
Weaning weight (kg)	304	328
Slaughter weight (kg)	678	697
Carcass weight (kg)	384	393
Age at slaughter (days)	724	729
Carcass/day of age (kg)	531	540
Kidney + channel fat (kg)	11.4	15.7
Carcass fat score	3.8	4.1
Carcass conformation score	3.7	3.4

Table 6
Weight and composition of the pistola from the steer progeny of Charolais and Hereford x Friesian cows (mean of 2 experiments)

	Charolais dam	Hereford x Friesian dam
Carcass weight (kg)	371	383
Pistola (g/kg carcass)	468	456
Muscle g/kg)	675	643
Fat (g/kg)	153	181
Bone (g/kg)	172	176

When expressed as a proportion of carcass weight the pistola (higher priced cuts) of the Charolais progeny was greater than that of the Hereford x Friesian progeny (Table 6). The Charolais progeny had a greater proportion of meat and a lower proportion of fat in the pistola than the Hereford x Friesian. Although carcass weight of the Charolais progeny dissected was 12.1 kg less than that of the Hereford x progeny, the meat yield in the pistola was 5.0 kg greater (Table 7).

Due to the carcass weight difference the carcasses of the Hereford x Friesian progeny were worth £22 more than the Charolais progeny when a flat price

Table 7
Value of the steer progeny dissected when based on a flat price per kg or muscle yield

	Charolais dam	Hereford x Friesian dam	Difference
A. Carcass weight (kg)	371.2	383.3	-12.1
Pistola weight (kg)	173.6	174.6	-1.0
Fore weight (kg)	197.6	208.7	-11.1
Muscle in pistola (kg)	116.4	111.4	+5.0
B. Muscle in carcass (kg)	293.0	232.1	+6.9
[1]Value (£) based on A	668	690-	-22
[2]Value (£) based on B	719	+.693	+26
p/kg based on B	194	181	+13

[1]Carcass = 180 p/kg
[2]Pistola muscle = 454 p/kg Forequarter muscle = 155 p/kg
(pistola = 0.487 and 0.48 of carcass muscle for Charolais and Hereford x progeny, respectively)

of 180p per kg of carcass was used (Table 7). However, if the carcass is valued on muscle yield with pistola muscle priced at 454p per kg and forequarters (and flank) muscle at 155p per kg then the Charolais progeny are worth £26 more than the Hereford cross Friesian progeny. Based on muscle yield the carcass value of Charolais and Hereford x progeny are 194,181p per kg, respectively. Similar calculations (Keane) showed a difference in value of 20p per kg of carcass between Hereford x Friesian and Charolais x Friesian steers. Thus, assuming a constant carcass weight of 350 kg and the above price differentials, Charolais x Friesian and purebred Charolais steers would be worth £70 and £116, respectively more than the Hereford x Friesians. This calculation is based purely on muscle yield and does not allow for the higher priced markets available to the Charolais or their potentially higher carcass weights.

In conclusion, the Charolais progeny (and cull cows) result in carcasses of excellent quality (lean and of good conformation) but the purebred breeding programme does not avail of hybrid vigour and the cows have low milk (and colostrum) production potential.

Breed composition of the suckler herd

Presently there are 1.18 million suckler cows in Ireland and they account for 48 percent of the total cow population. Information on cow and sire breeds in both suckler and dairy herd was collected in the National Farm Survey (NFS) in autumn 1992 and 1998. In the suckler herd Friesian/Holsteins, early maturing breeds and late maturing breeds accounted for 20, 51 and 29% of the suckler cow herd, respectively in 1992 (Table 8). Corresponding figures for 1998 were 2, 46 and 52 percent. Thus, during this six year period the Friesian/Holsteins (no longer eligible for suckler cow premia) were replaced by continental crosses (mainly Charolais, Simmental and Limousin) with the early maturing breeds (Hereford, Aberdeen Angus and Shorthorn) decreasing by 5 percentage units.

Table 8
Cows and heifer breed types (%) in suckler herds

	Cows		Replacement heifers	
	1992	1998	1992	1998
Friesian/Holstein	20	2	7	1
Hereford X	35	31	31	19
Aberdeen Angus X	9	12	9	19
Shorthorn	7	3	2	3
Charolais X	7	17	15	20
Simmental X	9	16	13	15
Limousin X	8	15	15	20
Other	5	4	8	4
Total	100	100	100	100

An examination of suckler herd replacements showed that Charolais, Simmental and Limousin crosses combined increased from 43 percent in 1992 to 55 percent in 1998. Thus, the proportion of continental breed crosses in the suckler herd is steadily increasing and it is also expected that the proportion of continental genes in these crosses is also increasing. The data from the NFS show that 83 percent of mature suckler cows are bred to continental sire breeds (over half of which were to Charolais) with no major change between 1992 and 1998 (Table 9). Somewhat more than half of the suckler herd replacements were bred to continental sire breeds with 49 and 42 percent bred to early maturing breeds in 1992 and 1998, respectively. The data from the NFS also indicates that 49 and 61 percent of suckler cows were bred using natural mating in 1992 and 1998, respectively. The corresponding figures for heifers were 55 and 46. Thus,

Table 9
Breed of sire (%) used on suckler cows and replacement heifers

	Cows		Replacement heifers	
	1992	1998	1992	1998
Hereford	11	9	20	11
Aberdeen Angus	2	6	22	29
Shorthorn	2	1	2	3
Charolais	42	46	15	16
Simmental	16	16	11	10
Limousin	20	17	18	25
Other	7	7	10	5
Total	100	100	100	100

despite the small herd size most animals in the suckler herd are bred using natural mating and the trend with mature cows is for reduced use of artificial insemination (Al).

Future breeding policy in the suckler herd

The case for having the terminal sire from one of the continental breeds is clear (based on growth potential and market demands) and where a crossbred cow is used, the bull should be from a third breed. As the majority will be using natural service the availability of bulls of high beef merit will be essential. The breed type of suckler cow cannot be as clearly defined but the hybrid vigour resulting from using a crossbred and milk production potential are important. Limousin x Friesian spring calving cows bred to an easy calving Limousin bull for their first calving at two years of age and subsequently to Charolais (or Simmental) sires has been the main cow type used at Grange in recent years. Conformation scores of the steer progeny slaughtered at 23/24 months of age at over 390 kg carcass weight were 60 percent U, 39 percent R and 1 percent O (Table 10). Heifer progeny slaughtered at 20 months of age and 310 kg carcass weight resulted in 43 percent of U and 57 percent R. Fat scores for both steers and heifers were predominantly 4L and 4H. While the above carcasses are satisfactory, continued movement towards Holsteins in the dairy herd will gradually result in a decline in carcass quality from those three-quarter continental animals. Thus, in the longer term if carcass quality is not only to be maintained but improved suckler herd replacements will need to be sourced from within the suckler herd. While many breed combinations can be suggested, one suitable type cow would be obtained by alternate crossing of Limousin (good conformation) and Simmental (milk production potential) with a third breed used as the terminal sire (e.g. Charolais). The potential of these breeds to produce carcass of high quality has been clearly demonstrated in previous studies (Table 11; Keane, 1999). These breed types are already widely available and it is suggested that certain herds should specialise in the production of suitable replacements, i.e. herds with Simmentat X cows use a Limousin bull, while those with Limousin X herds use a Simmental sire.

Table 10

Carcass grades of the progeny of Limousin x Friesian cows (6 years data)

		Steers	Heifers
Conformation score (%)	U	60	43
	R	39	57
	O	1	–
Fat score (%)	3	9	15
	4L	42	47
	4H	37	32
	5	12	6

Table 11
Relative (Friesian = 100) performance[1] of Friesian and beef x Friesian steers

Sire Breed	Carcass weight	Muscle weight	Conformation score	Fat score	Eye muscle area	Feed efficiency
Friesian	100	100	100	100	100	100
Angus	99	94	127	120	100	90
Hereford	104	100	131	124	102	88
Limousin	105	111	140	101	118	83
Blonde	108	117	132	91	119	84
Belgian Blue	109	119	140	91	120	85
Simmental	108	115	134	101	118	86
Charolais	111	118	144	95	123	84

[1]At constant age for steers out of Friesian dams

Belgian Blue

Due to high carcass merit the "double muscled" Belgian Blue cattle receive premium prices compared to other breed types, particularly on the Belgian market. For that reason selection for double-muscling was widely practiced in Belgium and as a result the incidence of dystocia has increased with caesarian sections now common practice. Use of a Belgian Blue bull on other cow breed types results in an incidence of difficult calving similar to that recorded with other continental sire breeds. The main calving problems arises in purebred double muscled Belgian Blues and for that reason, use of Belgian Blue crosses could not be recommended as suckler herd replacements. In a study (Flynn, Drennan and Caffrey, 1999) involving a relatively small number of animals, Belgian Blue x Friesians (17 animals) had a higher incidence of calving difficulties (29% caesareans) than Limousin x Friesians (10% caesareans) or Simmental x Limousin x Friesian (no caesareans). However, further information is required on the incidence of calving problems in (1) Belgian Blue x Friesians, and (2) the progeny of Belgian Blue x Friesian from a continental bull breed, e.g. Limousin x Belgian Blue x Friesians compared with (3) conventional crosses (e.g. Limousin x Friesian) when crossed with either a standard continental breed of sire or a Belgian Blue sire. The availability of such data would allow informed recommendations on the possible role of Belgian Blue as suckler cow replacements.

Summary

- The highest priced markets require lean animals of good conformation and thus continental breeds must be used.
- Ideally the cows should be crossbred (1/2 to full continental breeds) and the terminal sire should be from a third breed.
- Purebred Charolais provide high quality carcasses but obviously lack the advantages of hybrid vigour and have low milk production.

- Based on muscle yield, 50 and 100 percent Charolais are worth 20p and carcass more than Hereford x Friesian.
- Information is required on the incidence of calving problems in Belgian Blue cross females.

References

Fallon, R.J. and Drennan, M.J. (1999). Determining the optimum suckler cow breed for Irish conditions. Beef Production Series No. 12.

Flynn, J., Drennan, M.J. and Caffrey, P.J. (1999). Level of dystocia in Belgian Blue x Friesian heifers compared to existing suckler breed types. Agricultural Research Forum: 33-34.

Keane, M.G. (1999). Beef crossing on the dairy herd. In: A New Agenda for Dairying Moorepark Open Day: 35-38.

McGee, M. (1997). Defining suckler systems in terms of efficiency of lean meat production and market requirements. Ph.D. thesis 1997.

Marketing Beef in Holland

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In this paper I will summarise Albert Heijn's purchasing policy and also discuss consumer trends, the way in which we identify these trends and our supplier strategy. But firstly I will present a short profile of Albert Heijn as part of the Ahold company.

Albert Heijn is part of Royal Ahold, a worldwide operating retail trading company. Besides many supermarkets in the Netherlands, Ahold also has supermarkets in the United States, the Far East and in South America. Last year the total turnover amounted to over 58.4 billion guilders. Albert Heijn's supermarkets are all found in the Netherlands with a high density population. Ireland is approximately twice the size of the Netherlands, yet we have approximately three times the number of inhabitants of Ireland. Albert Heijn has always been the largest supermarket chain in the Netherlands and currently has some 670 supermarkets, of which approximately 170 are operated as franchise stores. Last year the consumer turnover was approximately 12 billion guilders. Our market share in the Dutch foods and beverages market is approximately 28%. Albert Heijn has 45,000 employees. The Albert Heijn formula is characterised by a wide product range with a special focus on service and quality. This places Albert Heijn at the top end of the market.

During recent years we have abandoned the concept of a uniform supermarket and have focused on differentiation within and outside of the supermarkets. In the past, our supermarkets were mostly situated in the residential neighbourhoods of the cities. We are currently developing such new concepts as mini-supermarkets in Shell petrol stations and in railway stations, neighbourhoods shops, inner-city supermarkets, teleshopping and we now also even have a mini Albert Heijn in a major hospital. Our aim is to create a service concept catering for the individual, allowing us to serve customers wherever and whenever they want. Because consumers often vary per geographical region, Albert Heijn supermarkets in the Netherlands also vary. We do our utmost to take account of and cater for local circumstances for the local market.

Albert Heijn exists by the grace of the customer. If the customer changes, we, as market oriented company, will also have to change. And the Dutch customer is changing. He has become more selective, less predictable and he is far more demanding than previously. Customers wish to obtain their groceries in a supermarket with a wide product range, at low prices and with an excellent service level. Today's customer has less time and plans less. Fixed eating patterns have been abandoned under the increasing influence of individualisation. The moments at which people eat are now determined by the individual himself.

In the Netherlands the traditional family is no longer the corner stone of our society. There is a sharp increase in the number of small households (two or three persons) and the number of working women. Furthermore, there is a decrease in the number of farmilies with children. The traditional values and building blocks on which our society was based are slowly crumbling. A large number of people prefer to create their own purely individual lifestyle.

The customer doesn't exist anymore. What remains are individual customers whose purchasing behaviour can vary from moment to moment. We call this the moment consumer whose behaviour may be characterised as being erratic. A result of this change is that we have been forced to increase the product range in the supermarkets. Over the past few years the assortment in an average Albert Heijn has increased to 20,000 articles.

Albert Heijn strives to maintain its carefully built up quality reputation by focusing on so-called "anchor groups", such as fresh vegetables and fruit, coffee, bake-off bread, wine and fresh meat We make a clear distinction in assortments which consist of daily groceries and low-priced articles and assortments where emotion and surprise play an important role. In this way we cater for both the rational moments of our customers (daily groceries, ease, inexpensive), as well as the emotional moments (surprise, luxury, hedonism). The unique and innovative characters of our fresh food products and the ready-to-heat meals play an essential role in all of this. Top priority is that we ensure that all products sold under our name are of a consistently good quality. Whereas previously the retail market was extremely fragmented, nowadays concentration is the name of the game. Supermarket chains are turning into brand names and Albert Heijn is such a brand name for the Dutch consumer. Consistent quality of our fresh food products, such as meat, can help to establish and bolster such a brand name.

In order to serve the Dutch consumer better and cater for all his moods at all moments we have fine-tuned our strategy to this consumer. We have changed from serving the masses to serving the individual. As mentioned previously, differentiation is of the essence. Through differentiation we aim to be able to provide each customer with a vibrant and heterogeneous, own supermarket, a supermarket which is able to satisfy the true needs of the customer. These needs are constantly changing under the influences of factors such as: environmental considerations, better awareness of price and quality, time and demand for ease. Such new demands require new answers from service-oriented companies such as Albert Heijn.

We create added value for our customers and maintain our competitive edge through differentiation and through focusing on quality both inside and outside our supermarkets. But in order to ensure that the price difference with regard to our competitors doesn't get too large, cost management is an absolute necessity.

Differentiation, cost management and a focus on quality are therefore the three pillars on which our strategy is built. It is a combination of three factors which, according to traditional economists, is hardly feasible. However, thanks to the implementation of modern technology in our logistical processes such a combination has become possible. Albert Heijn is a front-runner in this field thanks to economies of scale and its position as market leader.

In order to make cost management and differentiation possible we have been busy for some time at improving processes both at the demand as well as the supply side of the chain. Close cooperation with our suppliers is essential, not only in order to cut back costs, but also to increase our added value and be able to cater for the needs of the changing market more quickly, more efficiently and in a more flexible manner.

Our goal is to achieve far more than simply to implement an efficient electronic messaging system between companies. We hope to be able to co-operate with our suppliers in such far reaching matters as product ingredients, production process, farming methods, promotional activities and product development. What we want is co-makership.

Our latest advertisement campaign with the slogan "Taste the day" has focused on quality: 'relax and enjoy our best quality products' is the message. When we say 'relax and enjoy' it means that as the largest supermarket chain in the Netherlands Albert Heijn has an indisputable social responsibility. The Dutch consumer expects us to take on such a responsibility as market leader, but also based on the sense of an individual's environmental and social awareness.

A good example is the successful introduction at the beginning of this year of a large range of organic products. As part of the introduction of these products Albert Heijn organised an open day during which our customers were welcome to visit farms throughout the Netherlands and take a closer look at the production methods.

The supermarket is the last link in the chain between the supplier and the customer, we offer a hand that reaches out to the consumer and hands him the end product. Customers can and do trust the quality of the products sold by Albert Heijn. It is therefore Albert Heijn's task to ensure that customers purchase an excellent piece of meat each and every time, which has been produced in a safe and sound manner and which, thanks to cooking instructions provided by Albert Heijn, customers know how to cook properly.

We are no longer the serving hatch through which products are simply passed on from the supplier to the customer, although some suppliers still think we are. Albert Heijn is not the sales person for the supplier; we are the buying agent for our customers. This is an essentially different approach. Our customers wish to have a certain supply and we offer it to them. If we can purchase the products locally in the Netherlands we will do so. If not, we will travel the world to find the necessary products.

In order to fully effect our responsibility towards the customer and to eliminate unnecessary costs, Albert Heijn is constantly striving to improve its supply chain management. We call this from field to yield. Customers also want to know the origin of certain products. They want to have an answer to specific questions regarding not only the product ingredients but also the production methods. Customers expect us to set an example in such areas as environmental care and health. We could even state that it is the customer who has forced us to improve our supply chain management. And management not in the sense of an up-down structure, but management in the sense of co-operation.

Only if we are able to properly manage the supply chain will we be able to guarantee the origin and quality of the products. We have no use for a product that finally reaches the shelves of our supermarkets after having been passed on between innumerable middlemen. The more parties concerned, the higher the cost price and the more anonymous the product.

Supply chain management calls for identification and traceability. It is for this reason that Albert Heijn insists on being informed by its suppliers about the origins and production methods of a product. We call this the supply chain guarantee system. Products can be checked during any moment in the supply chain process by means of the so-called 'traceability registration system'. This system has been implemented to a greater extent for certain product groups than for others, due to such factors as level of co-operation with suppliers, the market, competition, policy, etc.

The customer has become increasingly aware of quality and expects to find quality products in our supermarkets. He wishes to be able to purchase the same high-quality steak in the supermarket which he has eaten in a restaurant. Inferior quality won't do. As we say in the Netherlands: "the butcher is as good as his steak is".

As I have mentioned previously there is also the additional factor where meat is concerned and that is the fact that it is an "emotional" product, requiring that special touch. The true experience of quality and taste will only be fully realised if certain boundary conditions regarding product safety and health have been met.

The introduction of Argentinean beef in 1995 was a success. For this beef, we require that certain preconditions be met in the total supply chain: from the farm to Albert Heijn

Argentinean meat is produced in compliance with a stringent quality control programme which closely monitors such matters as type of cattle, herd management, feed and use of medicines. This same system had already been tried and tested for the Irish beef and is once again being used in Ireland after the re-introduction of Irish beef in May this year.

Whereas Argentinean beef serves a niche market for Albert Heijn due to the limited availability of this beef at the right price/quality ratio, the Irish Albert Heijn Greenfields beef has a far larger potential market. At present, we import between 1200 and 1500 head of cattle per week from Ireland. During special promotional activities this volume increases significantly. We expect a further structural increase in volume once the supply chain has been fully optimised.

I will now discuss in more detail the requirements set by Albert Heijn for Irish beef. Not only must Irish cattle farmers comply with stringent guidelines, the processors must do so as well. For instance, we only want continental breed from suckler herds, weighing at least 300 kg and at most 400 kg. We also try to limit the number of movements of the animals. All cattle should be traceable and be reared in compliance with certain animal welfare and environmental guidelines. A logbook must be kept by the farmer for registering animal health planning. In order to ensure a proper production process, it is essential that cattle are clean on arrival at the slaughterhouse.

General conditions must also be met by the processing companies. Compliance to these conditions (like Farm Quality Assurance) are checked during audits conducted by Albert Heijn. Terms and conditions that have to be met for the production of meat for Albert Heijn are: carcass weight, pH value, refrigeration, tenderisation process (i.e. refrigeration and electro- stimulation), temperature during processing, storage and transportation to Albert Heijn. In addition to the controls carried out by Albert Heijn, an independent certified institute controls the whole chain.

We expect that the total sales volume of Irish beef will increase. It is however essential that we continue to ensure a high quality of the end product both as regards extrinsic as well as intrinsic values.

At the beginning of the supply chain, more attention must be given to environmental aspects. The environment is something that concerns each one of us. It is a production aspect which has during the past few years received much attention in the Netherlands. The farmers who raise cattle for Albert Heijn must therefore do their utmost to use farming methods which do not place a burden on the environment. We intend to ensure that all cattle are delivered straight from the suckler herds to the meat processing companies. Cattle must be traceable, by means of an integrated control system, from birth right through to the moment they are supplied to Albert Heijn. As yet, there are still too many loose links in the supply chain which could cause problems in the process. Last but not least, a close relationship between farmer and the meat processing company is essential for the fine-tuning of the process. Price is still the most important factor. Although pricing will always remain important, it should be given its proper place amongst other equally important or more important factors which determine a co-makership relationship between farmer, meat processor and Albert Heijn.

As soon as we have been able to create the perfect environment for a perfect product we will be able to let our customers experience the perfect emotion. Meat, after all, is a product full of emotion.