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# Anthelmintics - What are you Spending your Money on?

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**Introduction**

Endoparasitic infections in farm animals are a concern in terms of both welfare and productivity. This is reflected in the significant part anthelmintics play in the animal health market. In 2003, sales of animal health products in Ireland were valued at €92 million of which anthelmintics accounted for 27%, indicating the importance of worms (Animal and Plant Health Association, 2004). Currently there are only 3 groups of broad-spectrum anthelmintics available on the market (Table 1). The value of anthelmintic-based approach in controlling parasites is under threat because of the emergence of anthelmintic resistance. Anthelmintic resistance has now been reported worldwide with the magnitude of the problem being much greater in the southern hemisphere (Coles, 2002). In this paper, some of the current recommendations in the literature aimed at delaying anthelmintic resistance will be reviewed against a background of the information gathered in Irish flocks over the past few years with respect to parasite control practices and anthelmintic resistance on lowland farms.

**Table 1. Anthelmintic groups and mode of action**

| Group | Class of anthelmintics | | Mode of action |
|---|---|---|---|
| 1. | Benzimadazoles & Probenzimadazoles (White drenches) | 1-BZ | Disrupts parasites metabolism - leads to starvation |
| 2. | Imadazothiazoles (Levamisole) & Tetrahydropyrimidines (Morantel) | 2-LM | Causes muscular paralysis and rapid expulsion |
| 3. | Macrocyclic Lactones: Avermectins & milbemycins | 3-AV | Causes flaccid paralysis |

While the full prevalence of anthelmintic resistant nematodes in sheep flocks in the UK is unknown, there are good indications that resistance to benzimidazoles in particular is high. For example, in a study conducted by Keith Hunt in southeast England, on farms that were interested in having resistance tests done, 80% had benzimidazole resistant nematodes, 37% had levamisole resistant nematodes and 30% had worms resistant to both groups (Coles, 2002). In Scotland, 64% of farms surveyed showed evidence of benzimidazole resistant worm populations but there was no evidence for levamisole resistance (Bartley *et al.*, 2003). A disturbing development has been a case report of multiple anthelmintic resistance (i.e. roundworms resistant to all 3 broad spectrum drugs: benzimidazole, levamisole and ivermectin) in Scotland (Sargison *et al.*, 2001).

The extent of anthelmintic resistance in Ireland is largely unknown, but the first evidence for benzimidazole resistance in sheep was reported by O'Brien in 1992. A summary of investigations concerned with anthelmintic resistance in Irish flocks up to 2002 is presented in Table 2. With the exception of the study by Good *et al.*, (2003), benzimidazole was the only anthelmintic tested. This study was prompted by results of poor drug efficacy in flocks involved in a partnership project with Teagasc Technology Evaluation and Transfer. As part of this project, faecal egg counts (FEC) were monitored on a number of farms using FECPAK technology, developed in New Zealand. Details of this DIY technology may be found in an earlier paper (Good, 2000).

**Table 2. Summary results of benzimidazole resistance tests carried out on Irish flocks prior to 2003**

| Year | Type of test* | Number of flocks tested | Results | Authors |
|---|---|---|---|---|
| 1989 | FECR | 4 | AR** confirmed on all flocks | O'Brien, 1992 |
| 1991 | EHA | 26 | AR confirmed in 5 flocks and suspected in 3 flocks | Parr & Gray, 1992 |
| 1993 | FECR | 17 | AR confirmed in 1 flock | O'Brien, Strickland *et al.*, 1994 |
| 1994-1995 | FECR | 26 | AR not found | Murphy, Hanrahan & Flanagan, 1995 |
| 2002 | FECR | 9 | AR found in 7 out of 9 farms | Good, Hanrahan & Kinsella 2003 |

*Type of test: FECR = Faecal Egg Reduction Test, EHA = Egg Hatch Assay

**AR = Anthelmintic Resistance

While in general the faecal egg counts results determined over 3 grazing seasons reflected reasonable parasite control on most farms, there was *prima facia* evidence of an efficacy problem with regard to benzimidazole on 5 farms. In one case this was clearly attributable to a faulty closing gun. This prompted the more detailed evaluation of anthelmintic efficacy on these farms (Good *et al.*, 2003). Subsequently, a faecal egg count reduction test was undertaken on 11 farms (7 in Wicklow and 4 in Monaghan) in the autumn. Individual faecal samples were taken from 30 ewe lamb replacements, uniquely identified, on each farm. After the faecal sampling, 15 lambs were given a benzimidazole product and 15 lambs were given a levamisole product. On the return visit (between 10 and 14 days post-treatment) faecal samples were again taken from these lambs. Two farms were removed form the study as the average flock FEC was too low to run the test (Coles *et al.*, 1992). As shown in table 2, evidence for benzimidazole resistance was evident in 7 out of 9 farms. Evidence for levamisole resistance was found on 3 out of the 9 farms tested while on 3 farms there was evidence for both benzimidazole and levamisole resistance (Good *et al.*, 2003). In 2004, this work was extended to a survey conducted by Patten *et al.* to examine parasite control practices and the prevalence of anthelmintic resistance on lowland sheep farms in Ireland. Farms with greater than 100 ewes and a long-term lowland sheep enterprise were surveyed (116 flocks) about parasite control practices. In this study the method used to detect resistance was a larval development assay, which involved the incubation of fresh parasite eggs in various concentrations of the anthelmintic drug. If larvae develop from eggs incubated in a medium containing what is known as the discriminating dose of the drug then resistant larvae are present (Coles, 2005). Preliminary evidence, using this discriminating dose as the cut-off, suggests that there is a high incidence of resistance to benzimidazoles (>70%) and levamisoles (>20%) in the flocks examined (n=66 flocks; Patten *et al.* 2004, unpublished).

**Living with anthelmintic resistance**

From the evidence above, it is clear that Irish flock owners need to be fully aware that the development of anthelmintic resistance is in progress on many farms. As there are no effective 'non-anthelmintic'-based roundworm control measures available, it is clear that anthelmintic efficacy needs to be preserved and a serious effort has to be made to minimise the development of resistance. The crucial question "how anthelmintic resistance can be delayed" has been the subject of much literature (Coles and Roush, 1992; Coles, 2002; Stubbings, 2003; Abbot *et al.*, 2004). Against a background of an increasing prevalence of anthelmintic resistance in sheep nematodes on farms in the UK, parasite control measures have been reappraised in order to develop a set of national strategies and recommendations to slow the development of resistance (Stubbings, 2003, Abbot *et al.*, 2004). The key elements to developing a sustainable control strategy on the farm identified are:

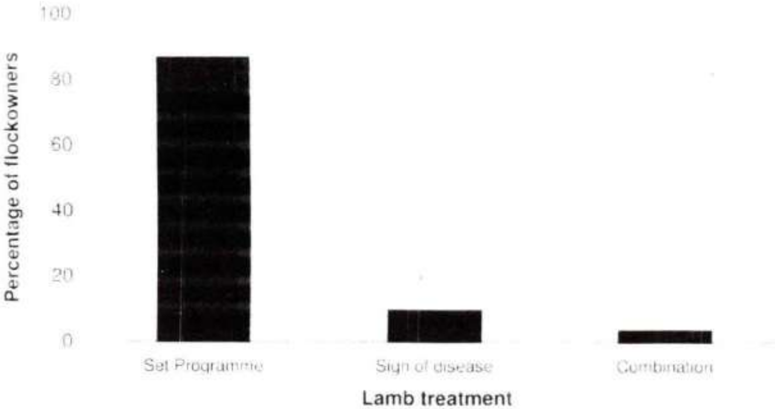
- the effective administration of anthelmintics
- only dosing when necessary
- using the appropriate anthelmintic
- reducing the dependence on anthelmintics
- avoiding the introduction of resistance onto a farm by treating purchased stock
- regular testing for anthelmintic resistance
- maintaining a susceptible population of worms.

A comprehensive manual (Abbot *et al.*, 2004) detailing these recommendations has been published by SCOPS (Sustainable Control of Parasites in Sheep) (www.nationalsheep.org.uk).

Results from the survey on worm treatment practices on Irish lowland sheep farms (n=164) by Patten *et al.* (2005) revealed wide variation in treatment practices and highlight that some changes would be appropriate if the selection for anthelmintic resistance is to be reduced. Judging whether animals require treatment involves the careful monitoring of animal performance and faecal egg counts (FEC). As discussed previously (Good, 2000) the determination of faecal egg counts is the only practical method available to measure parasite burden and is a valuable tool in informing decisions regarding the timing and appropriate use of anthelmintics. FEC can be determined through the services of the veterinary laboratories or more recently by DIY technology (FECPAK©, New Zealand). It is clear from the results of Patten *et al.* (2005) that over 99% of flock owners used anthelmintics to control parasites and that over 80% followed a set programme in delivering anthelmintics to lambs (Figure 1). The majority of farms (92%) administered a minimum of 3 anthelmintic treatments to lambs per annum (Patten *et al.*, 2005).

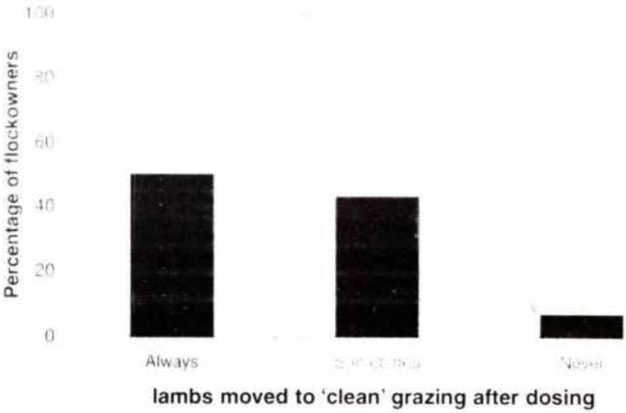
The recommendation that anthelmintics should be used as effectively as possible is unchanged. Using the correct dose rate (dose at the rate recommended for the heaviest in the group), correct drench technique (dose over the back of the tongue), checking the calibration of the dosing gun are all crucial. In determining the correct amount of anthelmintic to be administered to lambs, 53% of farmers stated that they weighed and treated according to the heaviest lamb (Figure 2). Guessing the weight and dosing to the average weight of the group, as reported by the remaining flock owners, will likely lead to under-dosing of a significant proportion of the lambs in the flock and encourage the development of resistance. While over 89% of farmers reported that they checked the accuracy of the dosing gun, over 30% of these admitted that this was done only on an irregular basis (Patten *et al.*, 2005).

**Figure 1. Farmers response to the question 'on what basis do they decide when to treat for stomach worms?' (Patten, Good, Hanrahan and de Waal, 2005)**




Restricting feed for 12 to 24 hours (but with access to water) prior to drenching with benzimidazole or macrocyclic lactone has been shown to improve the efficacy of these drugs. Withholding feed has the effect of reducing rumen fill, slowing the rate of digesta flow and prolonging the length of time that the parasite is exposed to the drug (Hennessy, 1997). It must be emphasised though that this should only be practiced when it is unlikely to cause harm (i.e. never in ewes in late pregnancy) (Stubbings, 2003, Abbot *et al.*, 2004). From the survey results 28% of Irish lowland farmers reported that they withheld food before dosing lambs. It was not clear from the survey whether this practice was anthelmintic class specific (i.e. benzimadazole, levamisole, macrocyclic lactone) but in the majority of cases the duration of the withholding period was more that 6 hours but less than 12 hours (Patten *et al.*, 2005) and therefore insufficient.

**Figure 2. Farmers responses to the question about their method of calculating drug dosages for lambs (Patten, Good, Hanrahan and de Waal, 2005)**

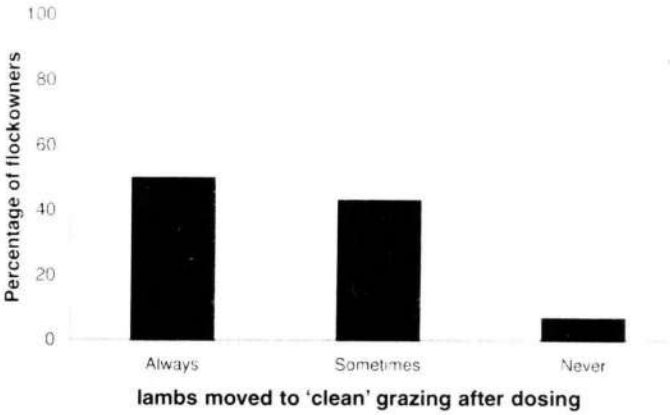


With a high prevalence of anthelmintic resistance, it is now considered advisable to treat all bought-in sheep with a drug from the macrocylclic lactone drug class and a drug from the levamisole drug class. These drugs should not be mixed but given as separate doses (sequentially). Following treatment these sheep should be kept off pasture for at least 24 hours. The reasoning behind the use of two products is that macrocylclic lactone will remove all parasites that might be resistant to benzimidazole and levamisole (but not those resistant to macrocylclic lactone) and that levamisole will remove all parasites resistant to macrocylclic lactone (Stubbings, 2003; Abbot *et al.*, 2004). The retention time post-treatment is to minimise the risk of any anthelmintic resistant parasites surviving on pasture. This recommendation would also apply to sheep being returned to the home farm that had been grazing land where the status of anthelmintic resistance is unknown e.g. rented land/land used by a number of flock owners. According to the survey conducted by Patten *et al.* a high percentage of farms (93%) reported that they treated purchased livestock prior to mixing with the rest of the flock. Over 70% of farmers reported that the product used to treat these purchased animals would be the same one as that being used in the current year. Of the farms that reported that they would use a different product, 69% used a product from macrocylclic lactone class only (Patten *et al.*,unpublished 2004).

Historically, most recommendations on dosing strategies supported the concept of 'dose and move' as a successful method in achieving good control of the effect of worms on lamb performance. Lambs dosed and moved to graze pastures with low level of worm challenge ensured that pasture contamination remained low for an extended period of time, thus providing a window of opportunity where parasite infection did not impact on lamb growth and recourse to anthelmintic treatment was unnecessary (Abbot *et al.*, 2004). It is now recognised that this approach is likely to be highly selective for resistance since any worms that survive treatment will benefit from having an extended period of time for reproduction over unselected worms. All the time that sheep remain free of re-infection from the "low-contamination" pasture, any worms that survived treatment within the sheep will be contaminating the pastures with their eggs thus increasing the proportion of anthelmintic resistant, free-living infective larvae on the pasture. Any sheep grazing this pasture will subsequently be subject to a worm population that is more resistant than before. This scenario (dose and move to low contaminated pasture) repeated on a farm over several years can eventually lead to a situation where the parasite population is highly resistant (Abbot *et al.*, 2004). About 50% of Irish farmers surveyed reported a dose and move to 'clean' grass as a routine practice (Patten *et al., unpublished* 2004) (Figure 3). Two approaches as to how a farmer may reap the production advantages of a 'low-contamination' pasture without penalising future chemotherapeutic options by heavily selecting for anthelmintic resistance have been suggested; (i) delay the 'move' after the treatment and (ii) 'part-flock' treatment. (Stubbing 2003, Abbot *et al.*, 2004).

Delaying the movement of treated sheep to "low-contamination" pasture allows the flock to become lightly reinfected so that so that the sheep bring a mixed population of both resistant and susceptible parasites to the new pasture (Stubbings, 2003; Abbot *et al.*, 2004). The length of time that the sheep should remain grazing on contaminated pasture before moving them to the 'low- contamination" pasture will be influenced by variations in pasture infectivity (i.e. the number of infective larvae on the pasture) and climatic factors which favour parasite survival. Abbot *et al.* (2004) have suggested that if the pastures are of high infectivity and the sheep are vulnerable to parasites (e.g. lambs during their first grazing season) then '4 to 7 days of grazing' on the contaminated pasture 'may be a satisfactory compromise between making the best use of the clean pasture resource and

**Figure 3. Farmers response to the question about whether they usually moved their lambs to 'safe' grazing after dosing (Patten, Good, Hanrahan and de Waal, 2004)**




reducing the selection pressure for anthelmintic resistance'. However where drugs with a persistent activity are used, it has been suggested that it would be better to move then dose, but details on the level of flock infection and subsequent challenge on the pasture would be essential in gauging the best time to treat (Molento *et al.*, 2004; Coles, 2005). The second approach, which would also reduce the selection for anthelmintic resistance involves leaving a sub group of the flock, untreated before a move to 'low' contaminated pasture. This untreated sub group of lambs would subsequently contaminate the 'low-contamination' field with a population of unselected parasites (thus diluting the contamination that might happen from worms that survived treatment in the treated lambs) (Stubbings, 2003; Abbot *et al.*, 2004). Of concern, would be which sheep to leave untreated and the concession that the low infection status of a 'clean' field is now shortened. Essentially this approach is 'a compromise between some lower level of production because of a reduction in worm control and a higher risk of selection for anthelmintic resistance' (Abbot *et al.*, 2004).

**Conclusions**

The increased prevalence of anthelmintic resistance compels every flock owner to take a fresh look at his or her current parasite control practices. As important today, as yesterday, successful worm treatment relies on effective on-farm management practices. Fundamental questions, which need to be asked, are:

- When and if I need to treat?
- Do I know the efficacy of the drugs that I am using?
- How can I delay the development or spread anthelmintic resistance?

As no equally-effective non-anthelmintic-based roundworm control measures are available and if animal health, productivity (and profitability) are to be maintained then it is clear that anthelmintic efficiency needs to be preserved and serious efforts must be made.

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# Finishing Lambs on Summer Pasture and Response to Creep Feeding

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**Introduction**
For farmers involved in mid-season lamb production, the general aim is to produce suitable lambs for sale mainly in the June to September period. It is desirable to achieve high lamb growth rates on grazed pasture, with a minimum reliance on creep feed. Specific targets may vary from farm to farm: -

- achieve high lamb growth rates on pasture only pre and post weaning. Draft a high proportion of lambs (70 to 80%), by mid September, with the remainder either sold as stores or finished in late autumn.
- Aim for a higher performance with over 90% drafted by mid September. This may require a small input of creep feed.
- Some may want to have lambs drafted earlier, with over 90% drafted by late August. This will generally require a higher input of creep feed.

Each of these targets can be achieved with appropriate grazing management and strategic use of creep feed.

**Lamb weaning weight**
The average weight of lambs at weaning (age 98 days/14 weeks) gives a good indication of flock performance, and which of the above three targets (if any) will be achieved. The figures in Table 1 give a range of weaning weights that may be recorded on farms without creep feeding. A twin lamb, weighing 4 kg at birth, 32 kg at weaning and drafted at 42 kg will have achieved 74% of its total live-weight gain by weaning. High weaning weights are, therefore, critical where early drafting of lambs is required. Given that typical growth rates of lambs, on grass only, post weaning average about 1 kg/week, each reduction in weaning weight of 1 kg will delay the average sale date by 1 week.

**Table 1. Average weaning weight (kg) of lambs at 14 weeks without creep feeding**

| Low | Medium | High |
|---|---|---|
| 28-30 | 31-33 | 33-35 |

The low weaning weights would suggest serious problems with grassland management. The medium weights should be achievable on most farms, with set stocking or paddock grazing, even at moderately high stocking rates. The high weaning weights are more easily achieved in a mixed grazing situation or where creep grazing of lambs is practised.

**Increasing weaning weight on grass**
The challenge here is to provide enough, high quality, leafy grass from turn-out until weaning.

Early Grass
The requirements for producing early grass, i.e. autumn closing date and spring N application, are well known. Late closing and scarcity of grass at lambing is a problem for some farms. To grow early grass a sheep pasture should be closed early enough to have

a dense cover of grass, 4 to 5 cm, in late January/early February at the time of N application. Grazing a pasture bare (2 cm) in late December/January will obviously reduce grass growth in spring and delay by about 2 to 3 weeks, the date when a desirable grass cover of 5 to 7 cm at turn-out is achieved. This in turn has implications for feeding concentrates to ewes at grass after lambing. No concentrates are necessary if sward height is 5 cm or higher, but may be necessary when sward height falls to 3 to 4 cm for an extended period.

**April-May period**

This should be the time for achieving near maximum growth rate in lambs when grass is leafy and highly digestible. If set stocking, the target should be to keep sward heights close to 6 cm (range 5 to 7 cm). Tight grazing at 4 cm reduced lamb growth rate by about 40 g/day, equivalent to a loss of almost 3 kg at age 10 weeks. However lax grazing on high grass of 9 cm had little benefit for lamb growth but results in pastures becoming stemmy in June and needing topping (Table 2).

**Table 2. Effect of sward height on lamb growth (g/day) to 10 weeks with set stocking**

| | Sward height (cm) | | |
|---|---|---|---|
| | **4** | **6** | **9** |
| Lamb growth rate (g/day) | 267 | 306 | 315 |

With paddock grazing, the post-grazing sward height must be considered. A balance must be achieved between tight grazing that prevents pasture regrowth becoming stemmy, and grazing too tightly, which will reduce lamb growth. Ideally lambs should have access to adequate leafy grass at all times, especially as their grass intake increases between 5 and 14 weeks. A post grazing height of about 4 cm is suggested at this time.

Lamb growth in June (10 to 14 weeks)

Low lamb growth rates at this time of year are a major cause of low weaning weight on many farms. It may go largely unnoticed when lambs are not being weighed. It results from the fact that lambs are becoming increasingly dependent on grazed grass at a time when pastures are becoming stemmy, especially if undergrazed in late May/early June. The challenge here is to provide adequate high quality grass for lambs in this month pre-weaning. Sward height and quality are the key factors affecting lamb growth at this time (Table 3). For set stocking, an increase in sward height from, 5 to 6 cm in May to 6 to 7 cm in June is beneficial. In paddocks, an increase in post-grazing height from 4 cm in May to about 5 cm in June can be beneficial where it avoids lambs grazing stemmy/low digestible herbage near the base of the sward.

**Table 3: Effect of sward height and type on lamb growth rate (g/day) from 10 to 14 weeks.**

| | Grazed pasture | | Aftergrass |
|---|---|---|---|
| | **5-6 cm** | **6-8 cm** | **7-9 cm** |
| Lamb growth rate (g/day) | 224 | 263 | 286 |

Lamb growth rates of 200 g/day or less are frequently recorded during this time. Given that a loss in growth rate of 35 g/day reduces the potential weaning weight by 1 kg, the loss in weaning weight can range from about 1 to 3 kg for this month alone.

**Maximising weaning weight on grass**

Mixed grazing

It is well established that lamb growth rate is generally better with mixed cattle/sheep grazing than with sheep only and this may add about 2 kg to average weaning weight (Nolan, 2003).

Creep grazing

While not widely practised on sheep farms, it is an alternative method of ensuring that lambs have access to adequate grass, ahead of the ewes, from about 7 weeks to weaning. It helps to maintain high lamb growth rates, and can add over 2 kg to weaning weight in a rotational grazing system. An additional advantage is that ewes may be exploited to graze the paddocks tightly in the last grazing cycle pre-weaning in June, resulting in a more leafy regrowth for weaned lambs (Grennan, 1999).

Lambing date/weaning date

This may have an effect on the weaning weight of lambs. A lamb born on 1 March will be 14 weeks on 7 June, as against 8 July for a lamb born on 1 April. The early born lamb is weaned before pastures become stemmy and should achieve high growth rates from 10 to 14 weeks. For the late-born lamb the month pre-weaning corresponds with June/early July when pastures maybe stemmy, resulting in lower growth rates. Factors such as availability of adequate grass for the earlier lambing date must also be considered.

**Lamb growth on pasture post weaning**

Growth rate of weaned lambs on pasture can vary greatly, typically from 100 to 200 g/day. Sward height (for set stocking), post grazing sward height (for rotational grazing), leafiness of sward and clover content are the main factors affecting growth rate. The leafiness of the sward will affect the optimum sward height for set stocking and post grazing height for rotational grazing. If a stemmy pasture is topped in June at 6 cm height, this layer will have less green leaf in the regrowth than the layer above 6 cm. Therefore forcing lambs to graze below 6 cm may result in lambs consuming herbage of low digestibility and low growth rate. The effect of sward height on growth rate of weaned lambs, set stocked on pasture, is shown in Table 4.

**Table 4. Growth rate of weaned lambs in relation to sward height (set stocking)**

| | Average sward height (cm) | | |
|---|---|---|---|
| | **5** | **7** | **9** |
| Growth rate (g/day) | 115 | 141 | 162 |

Similarly pasture type, and post grazing sward height in a rotational grazing system have a significant effect on lamb growth (Table 5). The value of clover in improving lamb growth has long been recognised due to its high digestibility and high intake by lambs. The benefit of clover will be proportional to the actual contribution of clover in the diet. Growth rate on aftergrass is generally better than on pasture grazed up to weaning by sheep due to pasture quality and reduced level of sheep parasites on the pasture.

**Table 5. Effect of pasture type and post-grazing sward height on lamb growth (rotational grazing)**

| | Post grazing height (cm) | | |
|---|---|---|---|
| **Pasture type** | **4** | **5** | **6** |
| Grass | 100 | 140 | 160 |
| Grass/clover | 117 | 173 | 222 |

In summary, the maximum growth rates expected on pasture post weaning (July-Sept), either set stocked, or grazed rotationally, at appropriate sward heights are: sheep grazed pasture 150 to 170, aftergrass 170 to 190 and grass-clover swards 180 to 220 g/day respectively. This is equivalent to a range of about 1.0 to 1.5 kg liveweight gain per week. It would therefore take from 8 to 12 weeks to add 12 kg liveweight to a lamb post weaning. This may act as a guide as to which lambs would be expected to be drafted by September without creep feeding.

**Creep feeding lambs at pasture**

The practice of creep feeding spring-born lambs on pasture has increased in recent years, as indicated by the sales of creep feed, creep feeders and the frequent sighting of creep feeders in sheep paddocks. The objective is to improve lamb growth, leading to earlier drafting, or higher carcass weights at the same age of drafting. In general, creep feeding will improve growth rates, though the response to creep will depend on both the grass supply and the level of creep offered to lambs.

Creep feeding pre-weaning

In earlier studies at Belclare, March-born lambs grazed rotationally around 4 paddocks from lambing to weaning. Paddocks were grazed tightly (to an average of 4.2 cm) or less tightly (5.1 cm) while some groups also had the facility for lambs to creep graze ahead of ewes. Creep feed was offered to some groups at 250 g/day and intake to weaning was 17 kg/lamb. The response to creep, in terms of kg creep required to give 1 kg extra liveweight is shown in Table 6.

**Table 6. Response to creep feeding pre-weaning**

| | Post grazing sward height (cm) | |
|---|---|---|
| | **4.2** | **5.1** |
| Feed conversion rate | 4.8 | 6.3 |
| With creep grazing | 11.3 | 14.9 |

The results showed that the response to creep feed varied with grass supply, ranging from about 5 to 6 kg creep per kg liveweight with a restricted grass supply, to 11 to 15 kg creep where lambs could creep graze with no restriction on grass supply.

In an intensive system of lamb production over 2 years at Athenry, lambs also grazed around 4 paddocks with facility to creep graze. The response to 14 kg creep, offered at 230 g/day from 5 to 14 weeks, was small, with a feed conversion rate of 12.7 in year one. In the 2$^{nd}$ year there was no response to this rate of creep. Grass supply and quality for lambs was very high. Lambs weaned in early June, were 34.0 kg at 14 weeks without creep, and growth rates on pasture from 5 to 14 weeks were quite good at 303 g/day. These results support the view that the response to creep pre-weaning depends, in part, on grass supply and quality.

Creep feeding weaned lambs

A number of trials carried out at Belclare examined the response to concentrate supplementation of lambs on pasture in the period July to November. Concentrates were offered at rates of 250 to 550 g/day, or *ad-lib.* (1500g/day). A commercial product, at 16% crude protein was generally used. Lambs were drafted for slaughter to determine the response in terms of feed conversion rate for carcass gain. Concentrates generally increased the liveweight, carcass weight and kill-out %. The feed conversion rates achieved (kg concentrates per 1 kg carcass gain) are summarised in Table 7. They generally ranged from 7 to 14 kg, with better feed conversion rates at the lower rates of 250g. Responses were lower at the higher rates of 400 to 550 g or *ad-lib*. In some trials, the response was somewhat better where grass was scarce rather than available *ad-lib*. At the rates that are likely to be used on farms, responses in the range 7 to 10 would be expected.

**Table 7. Feed conversion rates for carcass gain for concentrates offered post weaning**

| Rate of concentrate offered | Range of feed conversion rates | | | |
|---|---|---|---|---|
| 0 vs. 250 | | | 6.7 | |
| 0 vs. 400 | | | 9.8 | |
| 0 vs. 500 | 8.6 | | 12.0 | 20.0 |
| 1500 | | 13.7 | | |
| 250 vs. 500 | 11.7 | | | 12.0 |
| 250 vs. 550 | | | 13.0 | |

Creep-feeding pre and post weaning

Recent studies at Athenry examined the response to creep feeding lambs pre and post weaning. Ewes and lambs were set-stocked on pasture from turnout to weaning. Two stocking rates, (20 or 24 ewes on 1.5 ha) were used, the lower stocking rate to maintain sward height near optimum at about 6 cm and the higher stocking rate to maintain sward height below optimum at about 5 cm. Creep feed was offered to lambs, from age 3 weeks, at rates of 0, 300, or 600g/day. After weaning all the lambs were rotationally grazed and creep feed was continued at the same rates as pre-weaning. Results in Table 8 show average lamb performance to weaning over 4 years.

**Table 8. Average lamb performance to weaning**

| | Low grass | | | High grass | | |
|---|---|---|---|---|---|---|
| **Creep** | **0** | **300** | **600** | **0** | **300** | **600** |
| Wean. wt. (kg) | 31.4 | 34.3 | 36.9 | 33.7 | 36.7 | 37.5 |
| Creep intake | 0 | 20.1 | 36.4 | 0 | 19.4 | 34.0 |
| F.C.R. | - | 6.8 | 6.6 | - | 6.2 | 8.8 |
| | 600 vs. | 300 | 6.4 | | 16.7 | |

The results show that good weaning weights can be achieved without creep where sward height is maintained near optimum. Creep feeding as expected, increased weaning weights. The feed conversion rate for the lower rate of creep was 6 to 7 at both sward heights, but there was a lower response to the high rate of creep on the high grass allowance.

Results in Table 9 show the average lamb performance to drafting. Creep feeding, in line with the higher weaning weight increased the percentage of lambs drafted at weaning in late June. This figure is important, as this group is likely to achieve higher prices than those drafted later. Average age of drafting was reduced by 4 to 6 weeks depending on pasture type and rate of creep feed used.

**Table 9. Average lamb performance to drafting**

| | Low grass | | | High grass | | |
|---|---|---|---|---|---|---|
| **Creep** | **0** | **300** | **600** | **0** | **300** | **600** |
| Wean. wt. (kg) | 31.4 | 34.3 | 36.9 | 33.7 | 36.7 | 37.5 |
| Drafted at weaning (%) | 7.3 | 20.7 | 42.8 | 20.4 | 41.2 | 53.7 |
| Sale age (days) | 167 | 140 | 125 | 154 | 126 | 118 |
| Total creep (kg) | 0 | 32.5 | 52.9 | 0 | 27.5 | 46.0 |
| Cost @ 26 c/kg | 0 | 8.45 | 13.7 | 5.0 | 7.15 | 11.96 |

Some details in relation to carcass weights are given in Table 10. Creep feeding increased the carcass weight, kill out %, and also had small effects on fat score and conformation of the carcasses.

**Table 10: Carcass data**

| | Low grass | | | High grass | | |
|---|---|---|---|---|---|---|
| **Creep** | **0** | **300** | **600** | **0** | **300** | **600** |
| Sale wt. (kg) | 42.6 | 41.7 | 41.9 | 42.4 | 41.2 | 41.0 |
| Carcass wt. (kg) | 17.8 | 18.5 | 19.0 | 18.2 | 18.7 | 18.8 |
| KO% | 41.8 | 43.8 | 45.3 | 42.9 | 45.3 | 45.9 |
| FAT | 2.98 | 3.11 | 3.10 | 3.11 | 3.13 | 3.20 |
| Con | 2.91 | 3.16 | 3.21 | 3.08 | 3.14 | 3.22 |

(R3 Grade)

**Discussion on finishing lambs**

Given that grazed grass costs about 5 cent per kg dry matter as against about 25 cents per kg of concentrates, the first priority is to achieve high lamb growth rates pre and post weaning on grass, without creep feed. Early grass, control of sward height and good growth rates in the month pre-weaning are key factors in achieving high weaning weight. Mixed grazing or creep grazing can give an added lift to weaning weight. Leafy grass, aftergrass and clover are the key factors in achieving high growth rate in weaned lambs.

The decision to creep feed lambs may be taken (a) to draft a good proportion of lambs in June/early July at prices higher than later in the year. Lambing in early rather than late

March should help in this situation provided enough early grass is available. The proportion of lambs actually drafted at the higher price will largely decide the profitability of this system. Lambs offered creep at 300 g/day will consume about 20 kg creep pre-weaning (about 25 kg by late July), costing about €5 per lamb or €500 for 100 lambs. In the years 2003/2004 lamb prices dropped from about 440 cent at end of May to 400 at end June to 360 at end of July, equivalent to a decrease of €7.20 and €14.40 per lamb at 18 kg carcass. Assuming that the creep feed increased the proportion drafted at the higher price, from, say 30 to 70% the cost of the creep at €500 would largely be spread over 40 lambs, costing about €12.50 per lamb. Clearly the proportion drafted and price achieved largely determine profitability of creep feeding.

Results in Table 11 show the average proportion of lambs drafted at certain dates on the high grass at Athenry. In addition to earlier drafting, lambs receiving creep were on average about 0.5 kg heavier carcass weight, worth about €2 per lamb.

**Table 11. Average percentage of lambs drafted at varying dates at Athenry**

| | Creep feed (g/lamb) | | |
|---|---|---|---|
| **Date** | **0** | **300** | **600** |
| 7 July | 23.8 | 50.8 | 65.4 |
| 27 July | 51.9 | 83.1 | 87.1 |
| 18 August | 58.9 | 91.3 | 94.7 |
| 7 September | 77.6 | 98.1 | 98.3 |

(b) Creep feeding may also be used to increase carcass weight at the same date of drafting. At a feed conversion rate of 10:1 or better for carcass gain, this should leave a margin over cost of concentrate even at lamb prices of 360 cent/kg.

(c) Lambs offered creep at 300 g/day pre and post weaning were drafted about 28 days earlier than those not receiving creep (Table 9). They consumed about 30 kg creep, costing about €7.50 per lamb. An extra 30 to 40% of these lambs sold by late July would achieve a higher price. Earlier drafting would save 28 days grazing, worth about €2 per lamb (provided the saved grass is put to good use). An average of 1 less dose per lamb would be needed where monthly dosing is practised. (If all farmers resorted to creep feeding would the earlier drafting pattern nationally simply lead to the lamb price drop coming earlier in the season?).

(d) At Athenry Nolan (2002) developed a high output system where the target was to have all lambs drafted by early September at an average 18 kg carcass weight. High quality grass, and rotational grazing with creep grazing of lambs resulted in good weaning weight of 34 kg, without creep feed. After weaning lambs under 36 kg were offered creep at 250 g/day until they reached this weight while the lambs over 36 kg received no creep. This resulted in all lambs being drafted by target date, with an average concentrate input of 7 kg per lamb including triplets.

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## Progressing a World Class Breeding Programme

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### Introduction
Irish Cattle Breeding Federations (ICBF) stated objective is to "achieve the greatest possible genetic improvement in the National cattle herd for the benefit of Irish farmers, the dairy and beef industries and members". Achieving genetic improvement in dairy cattle is dependant on 3 things;

- Access to accurate data on animals to be selected
- A genetic evaluation system that will identify the most profitable animals for breeding
- A breeding program that ensures that the best of these animals get used widely throughout the cattle breeding industry.

The current rate of genetic gain within the Irish dairy herd is some €5.2/year (milk recorded cows only). This is considerably less than the optimal gain identified (€23/cow/year based on 100 bulls tested/yr or €100 million by 2015). Looking at trends in data recording and progeny testing in Ireland gives some insight into why higher levels of genetic gain are not being achieved, especially when one considers it against other international countries (Table 1). Relative to Ireland, these countries all enjoy much higher participation in milk recording (on average 84%), much higher use of AI (on average 86%), more bulls tested (on average 260 bulls tested) and higher levels of genetic gain (as evidenced by the improved milk solids performance of dairy animals in each of the 3 countries).

**Table 1. Comparison of breeding programs for 4 international countries**

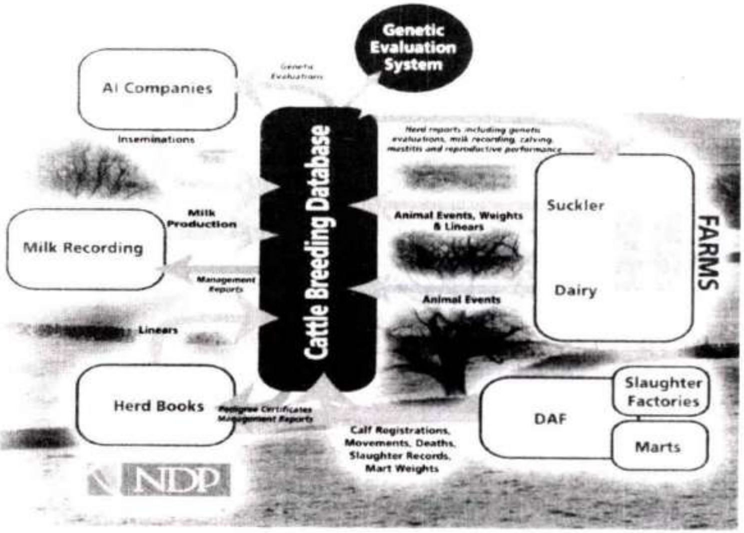
| Country | Total Cows | % milk record | Milk yield per cow | F (%) | P (%) | F+P (kg) | AI penetration rate* (%) | Bulls tested per year |
|---|---|---|---|---|---|---|---|---|
| Ireland | 1.15 m | 33 | 4,649 | 3.71 | 3.28 | 325 | 35 | 30 |
| Norway | 250 k | 95 | 5,639 | 4.14 | 3.27 | 418 | 90 | 125 |
| The Netherlands | 1.47 m | 86 | 7,807 | 4.45 | 3.51 | 621 | 86 | 225 |
| New Zealand | 3.85 m | 74 | 3,942 | 4.68 | 3.54 | 324 | 75 | 300 |

*% Total cows receiving a first insemination to a dairy AI sire.

For Ireland to compete with these (and other countries) on international dairy markets, more focus must be given to the benefits of cattle breeding. This paper is an attempt to summarize the key features of a successful breeding program, with particular reference to aspects of the current program that must be improved if Irish dairy farmers are to have a world class breeding program.

### Participation in data recording
The establishment of the ICBF cattle breeding database (January 2002) has revolutionized the quantity and quality of data available for genetic evaluations (Figure 1).

**Figure 1. Overview of the Irish Cattle Breeding Federation database**




All ICBF member organizations (some 30 in total) use the database for the provision of services to farmers, thereby reducing data recording errors (through the shared use of Animal Events as the 'single point of entry' for cattle breeding data) and costs of data recording (through the removal of duplication in data entry). To date, some 21% of herds and 35% of calves are involved in cattle breeding activities through the cattle breeding database. Whilst the introduction of the ICBF cattle breeding database has brought about dramatic improvements in the level of data recording (e.g., the level of recording of calving performance data has increased from 18,183 in 2001 to 345,221 in 2004), there is still significant scope for improvement, as evidenced by data contained in Table 2.

**Table 2. Traits linked to profitable milk production – past, present & potential level of recording**

| | 2001 | 2004 | 100% recording* |
|---|---|---|---|
| Calving performance | 18,183 | 345,221 | 1,150,000 |
| Fertility (inseminations) | 0 | 451,117 | 1,564,000 |
| Milk recording | 391,975 | 381,530 | 1,150,000 |
| Beef | 12,131 | 116,171 | 425,161 |
| Mastitis | 0 | 17,965 | 172,500 |
| Lameness | 0 | 1,481 | 57,500 |

*Based on total number of cows & typical incidence figures.

Feed-back from farmers suggests the two main reasons for not getting involved in data recording schemes are hassle and cost. Achieving the "target" levels identified in Table 2 will therefore require major changes in the way cattle breeding data is currently collected. This must come through better use of technology and greater integration/synergy within the dairy industry. Examples include:

*Animal Events* (e.g., calving performance) – ways must be examined of getting more farmers involved in the Animal Events system. One of the initial benefits of Animal Events was that it removed duplication in recording of cattle breeding data (i.e. between white cards, milk recording and IHFA birth registration). Given the benefits of Animal Events in removing this unnecessary duplication (and cost), the principle could be extended to cover other areas of data recording at farm level, e.g. the bovine herd registrar and the animal remedies record. Expanding the ICBF database to support the collection of this data (and provision of the required reports to farmers) would have the desired effect of reducing red-tape for farmers and increasing the number of farmers wishing to participate in the Animal Events system.

*Insemination data.* Given the economic importance of fertility at farm level, the recording of insemination data in the ICBF database (Table 2) is surprisingly low. This is due to a number of reasons; (i) duplication of data recording between on-farm breeding charts and Animal Event sheets, (ii) no incentive to send insemination data to ICBF (in the form of management reports), (iii) errors in recording cows ID on AI dockets (which accounts for a 40% fall-out rate in the number of potential inseminations from technician AI), and (iv) a general decline in AI in the dairy herd. In an attempt to overcome these constraints in AI data recording, ICBF have launched a number of new initiatives with its AI members, Teagasc and vets, aimed at promoting the recording and reporting of insemination data at farm level and addressing the decline in AI. These include;

a) Breeding Charts. All dairy herds on the cattle breeding database (some 8,000 in total) received individual herd breeding charts in Spring 20005 detailing calving date, ancestry & EBI for each cow on the farm. The charts were designed to promote easy recording of insemination data as well as easy return (via free-post envelopes) for data keying and reporting. Breeding charts are currently being returned and processed by ICBF.

b) Management reports. A number of management reports have been designed to promote the return of insemination data. These include summary fertility reports (including infertile rate), and expected calving reports. Further "real-time" reports will be launched in Spring 2006, including submission rates, 3-weekly fertility figures action lists.

c) Technician AI 'hand-helds'. These are currently being trialed and will be launched Spring 2006. The 'hand-held' will have a number of features; (i) all cows on the farm will be listed, thereby eliminating identification errors, (ii) it will carry out an inbreeding check against all proposed matings, (iii) it will support a "mating plan" specific to the individual farm, (iv) it will include a docket function for invoicing purposes, and (v) it will form an integral part of a new fertility management service aimed at increasing % AI in the dairy herd.

d) DIY Insemination recording. A number of new developments are being considered including; (i) SMS text messaging, (ii) web-site recording, and (iii) insemination recording sheets (to be returned weekly).

*Milk recording* – if the number of herds involved in milk recording are to be increased, then three major constraints must be overcome: (i) high start-up costs for the farmer (through purchase of milk meters), (ii) insufficient milk recorders, (iii) increasing labor costs at farm level. To that end, the introduction and expansion of an Electronic DIY (EDIY) milk recording service, across all parts of the country is essential. The service operates on the principle of one recorder servicing 140 herds in a given area (20 mile radius) and moving meters from farm to farm in a 6-8 week cycle. The farmer, using an electronic data-handler and the milk meters, captures all data electronically. At present, some 300 herds (from a total of 6,600 herds in milk recording) are involved in EDIY recording, with very positive feed-back reported. Farmers wishing to avail of this new service should speak with ICBF, their local co-op and/or Teagasc.

*Health data* (mastitis/lameness). The price/cost squeeze at farm level will ensure that in the future, cost of production traits e.g., mastitis and lameness will become more important in the EBI. Farmers must have a "trouble-free" cow if they are to remain profitable. To that end, ICBF are currently examining options for the routine recording of health data. Options include; (i) integrating animal remedies recording into Animal Events (see above) (ii) linking with veterinary systems (for farmers involved in "herd health" systems), and (iii) use of farm relief services (for recording of data such as lameness). In all case the need for duplication in data recording must be removed.

*Sustainable systems.* In the future farmers will be required to record information on all relevant inputs and outputs from the farm (in the form of N, P & K). Much of that data is already contained in the cattle breeding database, e.g., animal inventory, milk recording, beef recording & slaughter data. With minor adaptation, herd-level information could be recorded thereby ensuring; (i) future farmer compliance with EU regulation (with little extra paper-work), (ii) management reports on nutrient efficiency, (iii) a pro-active approach to sustainable farming (as opposed to a "wait-and-see" approach, as with the nitrates directive), and (iv) an increase in the number of herds involved in the cattle breeding database as a result.

The foremost requirement (and biggest obstacle) to genetic improvement in dairy cattle is data recording. To that end, the Irish dairy industry has a tremendous strategic advantage over other international countries, through its close relationship with the Department of Agriculture and Food (DAF) for CMMS & slaughter data, and integration within the cattle breeding industry. Nevertheless, data recording levels are very low and whilst the infra-structure may now be right to expand these levels of data recording, a radical change in the way data recording services are presented and promoted must be established if a world class breeding program is to be delivered.

**Identifying the most profitable animals for breeding**

After data collection, the second component of a genetic improvement program is to have an index that identifies the most profitable animals for breeding. The Economic Breeding Index (EBI) was introduced in January 2001 as a single figure profit index, aimed at identifying bulls and cows that would leave more overall profit through a combination of high profit and good fertility. Since its introduction in 2001, the index has been updated twice to include information on new traits (e.g., calving performance) and latest economic data on the price/cost ratio at farm level. A further update is due in November 2005 (EBI 2006) and will include new information on SCC/udder health. A summary of the traits included in EBI 2006 are given in table 3.

**Table 3. Traits included in the EBI 2006, including economic values and relative emphasis**

| Sub Index | Traits | EBI 2006 | % Emphasis | Overall |
|---|---|---|---|---|
| Milk production | Protein | 5.27 | 25 | 49% |
| | Fat | 1.55 | 9 | |
| | Milk | -0.084 | 14 | |
| Fertility | Survival | 10.80 | 14 | 32% |
| | Calving interval | -7.17 | 17 | |
| Calving performance | Calving difficulty maternal | -1.73 | 1 | 8% |
| | Calving difficulty direct | -3.26 | 3 | |
| | Gestation length – matings | -4.47 | 3 | |
| | Calf Mortality | -2.58 | 1 | |
| Beef | Mature cow carcase weight | 0.04 | 0.7% | |
| | Carcase weight | 1.40 | 5 | |
| | Carcase conformation score | 5.99 | 1 | |
| | Carcase fat score | -4.49 | 1 | |
| Udder Health | Udder Health | -55.48 | 5 | 5% |

As can be seen from Table 3, the most important traits in the EBI are milk production (e.g., protein kg at 25%), followed by fertility (17% & 14% for CI and SURV respectively), calving performance and beef. Udder health (a new trait added in 2006) has an overall weighting in the new index of 5%.

The benefits of EBI are now well acknowledged at farm level. In simple terms; EBI = profit/l. Based on this principle and in an attempt to further promote EBI at farm level ICBF, Teagasc, the Farmers Journal & ACC bank recently launched a new EBI €100 competition aimed at identifying herds that were combining good breeding & management to maximize profit/l. The overall winner of the competition had an average herd EBI of €67 and an average common profit/l of 20.7 cents/l. Based on 220 cows, these figures indicate that, compared to the average cow in genetic evaluations (born in 1995 and milking in 2000), these cows are expected to leave on average (€67 x 2) x 220 = €29,480 more profit/year. Looking more closely at data from within this herd confirms the benefits of using EBI as a tool on which to make breeding decisions. For example, the average EBI of the top 40 cows on the farm is €100 compared to the bottom 40 at €34. In overall terms the high EBI cows are expected to leave (€66 x 2) = €128/lactation more profit that the bottom EBI cows. Looking at the actual performance of both sets of cows in 2004 indicates that on average the high EBI cows left €176 more profit/lactation, which is consistent with the expectation based on EBI.

**Table 4. Comparison of top 40 & bottom 40 cows for overall profit/lactation on 2005 EBI €100 competition winners farm**

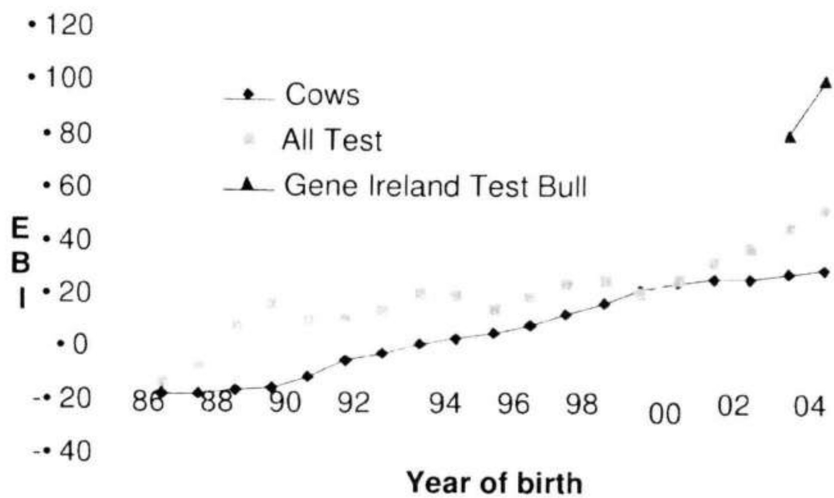
| | EBI (€) | M kg | F (kg) | P (kg) | F (%) | P (%) | CI | Total |
|---|---|---|---|---|---|---|---|---|
| Top 40 | 100 | 5,740 | 232 | 217 | 4.05 | 3.75 | 365 | |
| Bottom 40 | 34 | 5,730 | 215 | 207 | 3.75 | 3.62 | 379 | |
| Difference | 66 | 10 | 17 | 10 | | | -14 | |
| Value (€) | | -1 | 26 | 52 | | | 99 | **176** |

The EBI is now well accepted across the Irish dairy industry as the key breeding tool to increase profit on farms. Nevertheless, its effectiveness is somewhat compromised by the fact that milk co-ops continue to purchase milk on the basis of a flat rate payment system with bonuses for milk constituents over a certain base level. This contrasts with EBI which values milk on the basis of total solids minus the costs of processing (which is how milk is sold). This anomaly further detracts from a focus on increasing milk solids/cow. Other improvements to the EBI will happen in due course, e.g., lameness data and insemination data as predictors of CI & SURV. Combined with other developments in the dairy industry (e.g., milk pricing developments), increased gain can be achieved but will require all groups within the industry buying into and supporting the national breeding index.

**Ensuring the best animals are available through AI**

The final part of any genetic improvement program is to ensure that the very best animals (cows and young bulls) are available to the breeding program. As noted earlier, rate of genetic gain within the dairy cow population is somewhat less than other international countries and only 25% of what could be achieved from an optimal program. Such a program if established, could generate an extra €100 million for in 10 years time, with cumulative improvements of €25 million thereafter. Figure 2 indicates the rate of gain currently being achieved in our dairy cow and young bull populations.

**Figure 2. Rate of genetic gain for progeny test bulls and cows**




Before the introduction of the cattle breeding database, AI organizations had limited control over progeny testing (in terms of semen distribution and the participation of herds in data recording). This resulted in lower reliability proofs, longer generation intervals (due to carry-over of bulls), reduced genetic gain and increased costs for AI organizations. The launch of the ICBF cattle-breeding database (January 2002), together with the introduction of the EBI for dairy and beef cattle, presented ICBF with an unprecedented opportunity to establish a new national progeny test program for Irish dairy and beef farmers. Looking at trends from Figure 1 indicates a marked increase in average EBI of young bulls for 2004 & 2005. This is a direct consequence of introduction of the Gene Ireland progeny test program, with the average EBI of bulls involved in this program in 2004 & 2005 being €80 and €100 respectively.

Gene Ireland is a new progeny test initiative involving ICBF and its member AI organizations, NCBC and Dovea AI. It was launched in April 2005 and currently has some 150 herds contracted. This program is distinctly different from the previous programs operated by AI organizations in that it is "driven" from the cattle breeding database. As part of the Gene Ireland program, ICBF provides the following services to AI participants;

i) Candidate lists. AI Organizations are routinely provided with lists of potential candidate animals for progeny testing, along with herd-owner details.

ii) Contracting herds. Using the cattle breeding database, herds with a suitable profile for progeny testing are contracted (i.e., number of replacements/year, commitment and data quality).

iii) Setting minimum criteria. Only bulls meeting certain minimum criteria on genetic index (e.g., average EBI for Spring 2006 program = €100) are allowed entry to the program. This is to safeguard the interests of participating farmers and to ensure genetic gain is not compromised.

iv) Allocation of semen. To ensure accurate and unbiased proofs, semen is allocated randomly to participating herds (minimum 10 bulls * 5 straws = 50 straws per herd). Furthermore, sufficient semen is distributed to ensure a minimum of 100 daughters across 100 herds per bull.

v) Management of inbreeding. Farmers are provided with in-breeding checks for all cows in the herd * the progeny test bulls allocated to them.

vi) Distribution of semen. Semen is delivered to a central depot by participating AI organizations and then dispatched by ICBF to all contracted herds (includes both DIY and non DIY AI users).

vii) Data collection. Collection of all relevant cattle breeding data is overseen including information on; (i) insemination events, (ii) calving event, (iii) beef performance, (iv) milk performance, and (v) functional type.

viii) Management reports. Participants are provided with routine reports on records/sire and "unofficial" proofs for participating bulls.

ix) Ensure full proofs. Control over the distribution of semen and participation of the herds, ensures that ICBF can commit to giving participants full proofs at the end of the progeny test period.

x) Payment of incentives. In addition to administering the payment of cash incentives on behalf of herd-owners, ICBF has committed to paying 50% of the cash incentive (e.g., €25/heifer in 2008), with the remaining 50% coming from the AI participants.

Whilst the establishment of the Gene Ireland program has revolutionized the approach to progeny testing, there are still a number of constraints to the program, which are limiting its effectiveness. These include;

i) Insufficient bull mothers. Work completed by ICBF has indicated that, relative to other countries, the most profitable animals for progeny testing are located on Irish dairy farms. Nevertheless, the number of bull mothers exceeding certain minimum standards as bull mothers (e.g., EBI greater than €80, functionally correct & registered in the IHFA herd-book) is still well below that required to achieve 100 bulls tested per annum. Increasing the number of potential bull mothers requires an increase in the number of herds involved in herd-book activities. Whilst this may seem an unnecessary cost in the eyes of some, the cost benefits are obvious when considered in the context of increased sale of breeding stock (e.g., bulls calves for the Gene Ireland progeny test program are currently making €1600).

ii) Insufficient progeny test herds. At present some 150 herds are involved in the progeny test program. On average, these herds had an average herd size of 100 cows and used 60 straws from 12 bulls on the herd in 2005. Based on these figures, progeny testing 100 bulls will require over 800 herds to be involved in progeny testing. There are a number of major benefits to becoming a Gene Ireland progeny test herds;

Increased rate of genetic gain – average EBI of test bulls for Spring 2006 is €100, which is equivalent to top proven bulls on the ICBF active bull list. The target for 2007 will be €120, which is higher than the rate of increase for bulls on the active bull list (€7/year).

Increase in number of potential bull mothers – in the future, progeny test herds will become the key source of genetic material for the progeny test program, by virtue of the fact that they will have the 1st daughters of the new top bull.

Complimentary semen – herds involved in the program receive free semen for progeny test bulls.

Cash incentives – herds involved in the program receive a €50 cash incentive for each progeny test heifer in milk recording.

Support structure – herds involved in the program are supported in a number of ways above the general services available through AI, milk recording and IHFA. These include specialized management reports (e.g., inbreeding), benchmarking reports (relative to other Gene Ireland herds) and improved data recording options (e.g., PAM pilots).

iii) Earlier collection and delivery of semen. Due to the seasonal nature of milk production in Ireland, early collection and dispatch of semen (12 months of age for test bulls), is critical to avoid unnecessary lengthening of the generation interval. ICBF and its AI members are currently reviewing strategies to ensure more calves achieve semen delivery by 12 months.

iv) Improved herd health on farms. IBR and Johnnes are 2 infectious diseases prevalent on Irish dairy farms. Reducing the incidence of these diseases will have the desired effect of increasing selection intensity amongst young bulls.

**Summary**

In cattle breeding terms, Ireland is well positioned to deliver a world class breeding program. It has many of the vital components; (i) low cost/high profit focus, (ii) committed dairy farmers, (iii) the necessary infra-structure to expand data recording and (iv) a genetic index that identifies animal based on profit. However, increasing the level of genetic gain will require a radical re-appraisal as to how records are kept and the information reported to farmers. Data recording and reporting services must become lower cost and higher value, if the level of data recording prevalent in other countries is to be achieved in Ireland. Improving the cost/benefits of data recording and reporting services, will result in more herds involved in cattle breeding activities, more top bulls each year (for Irish farmers and for export) and increased profit for farmers and organization involved in the Irish dairy industry.

# The Potential for Profit – a Review of the Strain Comparison Study

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**Introduction**

The Irish dairy industry will experience considerable change in the years to come. Among the main catalysts of change, the reform of EU agricultural policy is anticipated to result in a reduction in dairy product prices paid to dairy farmers (Binfield *et al.*, 2003). The challenge for Irish dairy farmers is to increase the competitiveness of their businesses through increased scale in the long term but also through increased innovation and efficiency within their current operations. One of the main factors influencing farm profit now and into the future is the genetic make-up of the dairy herd, which will be critical to the profitability of any dairy enterprise.

Until recently, milk yield has been the main objective criterion for selection in most temperate countries, and the use of Holstein-Friesian genetics of high milk production potential has been widespread. Overwhelming evidence shows that selection solely on production traits results in reduced herd health, fertility and welfare (Pryce and Veerkamp, 2001; Horan *et al.*, 2004; Evans *et al.*, 2002) with a reduction of 1% in calving rate to first service for every 1,000kg increase in phenotypic milk yield (Evans *et al.*, 2005). Reproductive performance affects the amount of milk produced per cow per day of herd life, breeding costs, rate of voluntary and involuntary culling, and the rate of genetic progress for traits of importance (Plaizier *et al.*, 1997) and consequently results in a reduction in the overall profitability of a dairy herd (Britt 1985; Dijkhuizen *et al.*, 1985, Lopez-Villalobos *et al.*, 2000). In Ireland, the relative importance of fertility is higher because milk production is based to a large extent on seasonal pasture production systems and thus profitability is influenced by the ability to calve cows rapidly at the optimum time.

Since 2001, the Economic Breeding Index (EBI) has been in effect in Ireland to identify genetically superior animals to increase profitability within Irish dairy herds (Veerkamp *et al.*, 2002). The EBI is currently composed of four sub-indexes (relative emphasis in parenthesis): milk production (49%), fertility/survival (32%), calving performance (8%), beef performance (6%) and health (5%). The EBI rewards animals whose progeny have a long herd life, annually producing a large quantity of high composition milk within a 365-day calving interval, are easy calving and have progeny who themselves calve easily in the future and exhibit large carcase weights of good conformation.

In 2006, approximately 30% of replacements entering Irish dairy herds will have originated from AI sires, with the remainder resulting from the use of stock bulls (DAFF, 2005). The average EBI of dairy cows and stock bulls recorded in Ireland is €24 and €8, respectively, with the average EBI of the dairy cow population only rising by €1 per annum (ICBF, 2005). Clearly, the perceived importance of genetics among Irish dairy farmers has been eroded in recent years. The objective of the present paper was to investigate the influence of herd EBI on overall farm profit among strains of HF dairy cows differing in genetic potential for milk production and reproductive performance across a variety of pasture-based production systems and to thereby quantify the benefit of using high EBI sires on Irish dairy herds.

**Experimental design**

Three strains of HF cows differing on EBI were compared: high production North American (HP), high durability North American (HD) and New Zealand (NZ). The HP strain was selected on the basis of superior pedigree index for milk production with their overall EBI (= €51) derived exclusively from their milk production potential. The HD strain were selected on the basis of superior milk production, fertility and muscularity with their overall EBI (= €58) derived equally from their milk production and fertility potential. The NZ strain was selected using the highest possible genetic merit within the New Zealand genetic evaluation system (Breeding Worth). The overall EBI of the NZ group was €75 and was evenly derived from their milk production and fertility potential. The EBI and component sub-indices for each strain is displayed in Table 1.

**Table 1. The Economic Breeding Index (EBI) values for the three strains of Holstein-Friesian cows studied**

| **Strain** | | **High Production** | **High Durability** | **New Zealand** |
|---|---|---|---|---|
| **Overall EBI (€)** | | **51** | **58** | **75** |
| Sub-Indices | Milk (€) | 46 | 32 | 41 |
| | Fertility (€) | 2 | 25 | 38 |
| | Calving (€) | 2 | 0 | 5 |
| | Beef (€) | 1 | 1 | -9 |

All values were obtained from the February 2005 evaluation.

Each strain was examined in three pasture-based production systems: high milk output per cow from pasture (MP); high concentrate feeding system at pasture (HC); and high milk output per unit area from pasture (HS). The MP system was designed at 2.47 cows/ha, where cows received 300kg of concentrate fresh weight per cow with the remainder of the milking cow diet derived from grazed grass. The HS system was identical to the MP system in all respects except the stocking rate on this system was 2.74 cows/ha. The HC system was identical to the MP system in all respects except concentrate supplementation, with the cows in this system supplemented throughout the lactation at pasture and in total receiving 1,450kg of concentrate fresh weight per cow. The concentrate supplementation pattern for each of the three systems is shown in Table 2.

**Table 2. Concentrate supplementation strategy (kg per cow per day)**

| **Production system** | **Calving to March 15** | **March 15 to March 31** | **April 1 to early May** | **Early May to end of lactation** |
|---|---|---|---|---|
| MP | 6 | 4 | 2 | 0 |
| HS | 6 | 4 | 2 | 0 |
| HC | 8 | 8 | 6 | 4 |

There was a total of 99, 117, 117, 126 and 126 animals used in years 1, 2, 3, 4 and 5, respectively divided between strains of HF and production systems. In 2001, all 99 cows were first lactation; in 2002, 45 animals were first lactation and 72 were second lactation; in 2003, 9 animals were first lactation, 45 were second lactation and 63 were third lactation; in 2004, 27 animals were first lactation, 9 animals were second lactation, 36 animals were third lactation, and 45 animals were fourth lactation; while in 2005, 27 animals were first lactation, 18 animals were second lactation, 18 animals were third lactation, 36 animals were fourth lactation, and 27 animals were fifth lactation. Replacements were produced within the respective strains.

**Production data results**

Milk production results

The milk production data for each of the three genetic groups on the study from 2001 to 2004 is shown in Table 3 below. **These milk production results are those achievable in a herd scenario where the age profile and calving dates of each group are identical and are not influenced by differences in reproductive performance.** As expected based on the differential in production potential, the HP strain had the highest total lactation milk yield, the NZ strain the lowest, while the HD strain were intermediate. All three genetic groups reacted differently to different feeding systems. The reduction in daily milk production in the HS system was similar for both the HD and NZ strains (0.5 and 0.6 kg/day, respectively) whereas it was reduced by 1.2 kg/day for the HP strain. Also, the milk production response to increased concentrate supplementation was greater for both the HP and HD strains (1.08 kg milk/kg concentrate DM for HP; 1.00 kg milk/kg concentrate DM for HD) than the NZ strain (0.43 kg milk/kg concentrate for NZ).

**Table 3. The effect of herd EBI on milk production in three pasture-based feeding systems where the same age profile is maintained in each herd (2001-2004).**

| Feed system | MP | | | HC | | | HS | | |
|---|---|---|---|---|---|---|---|---|---|
| Strain | HP | HD | NZ | HP | HD | NZ | HP | HD | NZ |
| Milk (kg/cow) | 6,900 | 6,495 | 6,093 | 7,893 | 7,434 | 6,352 | 6,645 | 6,439 | 5,898 |
| Fat (g/kg) | 40.6 | 40.9 | 43.9 | 40.0 | 40.1 | 44.5 | 41.0 | 41.1 | 45.6 |
| Protein (g/kg) | 34.5 | 35.6 | 36.5 | 35.4 | 35.8 | 37.2 | 34.8 | 35.5 | 36.1 |
| Lactose (g/kg) | 46.3 | 46.6 | 46.7 | 47.7 | 47.1 | 47.5 | 46.6 | 46.7 | 46.6 |
| Bodyweight (kg) | 536 | 549 | 508 | 535 | 540 | 508 | 543 | 564 | 516 |

**Herd fertility results**

Table 4 shows the fertility performance of each genetic group and system of production from 2001 to 2005 over a 13-week breeding period commencing on April 20 in each year. All services during the breeding season were to AI, and all straw batches were tested prior to usage.

**Table 4. Effect of strain of Holstein-Friesian and feed system on reproductive performance (2001-2005)**

| | Strain of HF | | | Sig. | Feed system | | | Sig. |
|---|---|---|---|---|---|---|---|---|
| | HP | HD | NZ | | MP | HS | HC | |
| Calving date | $61^{a}$ | $51^{b}$ | $46^{b}$ | *** | 55 | 52 | 52 | NS |
| 24-day submission rate (%) | $77^{a}$ | $88^{b}$ | $87^{b}$ | ** | 86 | 79 | 86 | NS |
| Pregnant to first service (%) | $47^{a}$ | $52^{b}$ | $59^{b}$ | ** | 53 | 49 | 56 | NS |
| 6-week pregnancy rate (%) | $53^{a}$ | $64^{b}$ | $71^{b}$ | ** | 64 | 61 | 63 | NS |
| Empty rate (%) | $26^{a}$ | $14^{b}$ | $9^{b}$ | *** | 14 | 19 | 15 | NS |

$^{abc}$ Figures with different superscripts differ significantly, NS = Non-significant.

The data shows that both the NZ and HD strains, selected for lower milk production and better reproductive traits, had better reproductive performance than a North American HF strain selected for high milk production and that **offering additional concentrate to animals of inferior genetic potential for fertility may not alleviate the reduced reproductive performance of such animals** where adequate allowances of high quality pasture are provided.

**The influence of fertility on animal productivity**

In real terms, the milk production differential between strains outlined in Table 3 will not be realised at farm level as a consequence of differences in reproductive performance. As the replacement rate within a herd increases, more 1st lactation animals will be required to maintain that herd each year. First and second lactation animals will produce only approximately 75 and 90%, respectively of the milk of a mature cow and consequently **higher replacement rates result in a failure to realise the production potential of the herd**. In an actual farm situation the HP herd will be younger (due to higher replacement rates) and will calve later (due to longer calving intervals) than their HD and NZ counterparts and will therefore not deliver on their higher milk production potential. The data presented in Table 5 is the expected levels of animal performance achievable in a normal dairy farm. In such a farm, the average maturity of the HP, HD and NZ strains would be 2.6, 3.2 and 4.3 lactations, respectively and have a mean calving date of March 1, February 19, and February 12, respectively based on the differences in reproductive performance observed. These differences will result in total lifetime performance of 17,647, 21,202 and 26,530 kg of milk for the HP, HD and NZ strains, respectively (or 1331, 1618 and 2157 kg of milk solids, respectively).

**Table 5. The effect of strain of Holstein-Friesian on animal performance in three pasture-based feeding systems**

| Feed system | MP | | | HC | | | HS | | |
|---|---|---|---|---|---|---|---|---|---|
| **Strain** | **HP** | **HD** | **NZ** | **HP** | **HD** | **NZ** | **HP** | **HD** | **NZ** |
| **Milk Production** | | | | | | | | | |
| Milk (kg/cow) | 6748 | 6656 | 6293 | 7724 | 7588 | 6553 | 6531 | 6527 | 6197 |
| Fat (g/kg) | 40.6 | 40.9 | 43.9 | 40.0 | 40.1 | 44.5 | 41.0 | 41.1 | 45.6 |
| Protein (g/kg) | 34.5 | 35.6 | 36.5 | 35.4 | 35.8 | 37.2 | 34.8 | 35.5 | 36.1 |
| Lactose (g/kg) | 46.3 | 46.6 | 46.7 | 47.7 | 47.1 | 47.5 | 46.6 | 46.7 | 46.6 |
| Average live-weight (kg) | 536 | 549 | 508 | 535 | 540 | 508 | 543 | 564 | 516 |
| **Reproduction** | | | | | | | | | |
| 6-week pregnancy rate (%) | 53 | 64 | 71 | 53 | 64 | 71 | 53 | 64 | 71 |
| Empty rate (%) | 26 | 14 | 9 | 26 | 14 | 9 | 26 | 14 | 9 |
| Replacement Rate (%) | 33 | 23 | 18 | 33 | 23 | 18 | 33 | 23 | 18 |

**Economic Analysis**

The Moorepark Dairy Systems Model (MDSM) (Shalloo *et al.*, 2004), a farm simulation model was used to identify the effect of herd EBI on farm profitability. The model includes animal inventory change, milk production receipts, feed costs, land rental charges and labour costs in the economic analysis. All single farm payment entitlements have been excluded from the current analysis.

Land area was treated as an economic cost with additional land rented in when required and leased out when not required for on-farm feeding of animals. Variable costs (fertiliser, contractor charges, medical and veterinarian, artificial insemination, silage, reseeding), fixed costs (machinery maintenance and running costs, farm maintenance, car, telephone, electricity and insurance) and prices (calf, milk, cow) were based on current prices (Teagasc, 2004). The key herd default parameters used in the model farm are shown in Table 6. The EU milk quota was taken as 468,000 kg with a reference 36.0 g/kg fat. The corresponding gross milk price was 22.5 c/kg, assuming 33.0 g/kg protein with a relative price ratio of 1:2 for fat: protein.

Replacement heifer costs were estimated at €1,397 (all costs including land, labour and capital). All male and female calves were assumed sold at one month of age. A differential was placed between the strains in terms of male calf and cull cow value based on the variation in strain live-weight. The value of male calves of North American origin was €102, compared to €64 for the lighter NZ strain calves. All female calves were assumed sold for €320 (irrespective of strain). The proportion of cows removed from the herd in each breed accounted for cow deaths and cows that failed to become pregnant by the end of the breeding season.

**Table 6. Assumptions used in the economic analysis**

| Strain of Holstein Friesian | HP | HD | NZ |
|---|---|---|---|
| Farm size (ha) | 40.0 | 40.0 | 40.0 |
| Quota (kg) | 468000 | 468000 | 468000 |
| Reference fat (g/kg) | 36 | 36 | 36 |
| Price protein to fat | 2.00 | 2.00 | 2.00 |
| Quota lease price (c/kg) | 4.3 | 4.3 | 4.3 |
| Replacement Heifer price (€) | 1,397 | 1,397 | 1,397 |
| Labour costs (€/month) | 1,905 | 1,905 | 1,905 |
| Gross milk price (c/kg) | 22.3 | 22.3 | 22.3 |
| Reference cull cow price (€) | 270 | 270 | 257 |
| Reference male calf price (€) | 102 | 102 | 64 |
| Concentrate costs (€/tonne) | 189 | 189 | 189 |
| Opportunity cost of land (€/ha) | 267 | 267 | 267 |

Scenarios investigated

Three economic scenarios were investigated. In Scenario 1 (S1), it was assumed that farmers were constrained by the EU milk quota, i.e. quota applied at farm level. Farmers with higher producing cows would reduce cow numbers to exactly meet quota (evaluation based on a fixed output). Surplus land was leased out. In Scenario 2 (S2), it was assumed that EU milk quota applied at an industry level thereby allowing farms with high producing cows to maintain cow numbers and lease the additional quota required. Where quota leasing was an option the lease cost was taken at 4.3 c/kg of milk. Scenario 3 (S3) was a no quota scenario with higher producing cows resulting in greater milk income with no additional quota costs. Cow numbers were identical for all strains in S2 and S3.

Results

In all scenarios investigated the milk price shown for each group is based on a projected base price of 22.5 c/l (Binfield *et al.*, 2003), with increases based on fat and protein composition in excess of the base level.

*Scenario 1. Milk Quota applied at farm level*

Table 7 shows the key herd output parameters from the model for the three strains for the MP, HC and HS systems within the current quota system (S1). In S1, the number of cows

**Table 7. Key herd parameters in a fixed quota scenario (S1) for three strains of Holstein Friesian cows; High Production (HP), High Durability (HD) and New Zealand (NZ) within the Moorepark (MP), High Stocking Rate (HS) and High Concentrate (HC) production systems.**

| Feed System | MP | | | HC | | | HS | | |
|---|---|---|---|---|---|---|---|---|---|
| Strain of Holstein-Friesian | HP | HD | NZ | HP | HD | NZ | HP | HD | NZ |
| Milk price (c/kg) | 24.7 | 25.2 | 26.4 | 25.0 | 24.9 | 26.9 | 24.9 | 25.2 | 26.7 |
| Total hectares used | 35.6 | 36.3 | 35.3 | 28.8 | 29.4 | 29.0 | 37.1 | 36.2 | 34.5 |
| Quota lease (kg) | | | | | | | | | |
| No. Cows calving | 69.7 | 70.8 | 70.2 | 61.4 | 63.1 | 66.7 | 75.5 | 72.1 | 68.6 |
| Livestock units (LU) | 79.4 | 81.3 | 80.9 | 70.0 | 72.5 | 76.8 | 86.0 | 82.8 | 79.0 |
| Stocking rate (LU/ha) | 2.23 | 2.24 | 2.29 | 2.43 | 2.47 | 2.65 | 2.32 | 2.29 | 2.29 |
| Labour units (h) | 2,754 | 2,791 | 2,772 | 2,484 | 2,532 | 2,656 | 2,945 | 2,835 | 2,720 |
| Milk produced (kg) | 441,258 | 441,981 | 414,541 | 444,698 | 449,351 | 409,710 | 441,469 | 438,487 | 401,633 |
| Milk sales (kg) | 428,435 | 428,963 | 401,629 | 433,398 | 437,736 | 397,450 | 427,590 | 425,225 | 389,012 |
| Fat sales (kg) | 17,436 | 17,340 | 17,623 | 17,383 | 17,331 | 17,637 | 17,444 | 17,467 | 17,652 |
| Protein sales (kg) | 14,778 | 15,253 | 14,675 | 15,340 | 15,568 | 14,810 | 14,951 | 15,060 | 14,120 |
| Milk returns (•) | 105,766 | 108,034 | 106,181 | 108,259 | 109,160 | 106,936 | 106,634 | 107,256 | 103,797 |
| Livestock sales (•) | 34,562 | 32,993 | 30,255 | 30,426 | 29,475 | 28,743 | 37,381 | 33,606 | 31,042 |
| Total costs (•) | 132,660 | 121,130 | 115,496 | 126,966 | 119,439 | 119,805 | 140,601 | 123,694 | 114,274 |
| **Total profit per farm (•)** | **7,669** | **19,897** | **20,939** | **11,719** | **19,196** | **15,873** | **3,414** | **17,167** | **20,564** |
| Margin per cow (•) | 110 | 281 | 298 | 191 | 304 | 238 | 45 | 238 | 300 |
| Margin per kg milk (cents) | 1.7 | 4.50 | 5.05 | 2.64 | 4.27 | 3.87 | 0.77 | 3.92 | 5.12 |
| Feed costs per kg milk (cents) | 5.21 | 5.31 | 5.52 | 6.80 | 6.86 | 7.81 | 5.60 | 5.47 | 5.72 |
| Replacement costs (•) | 32,927 | 22,396 | 18,034 | 28,628 | 19,982 | 17,122 | 35,640 | 22,816 | 17,627 |
| Total labour costs (•) | 34,089 | 34,519 | 34,287 | 30,726 | 31,420 | 32,845 | 36,422 | 35,058 | 33,643 |

Table 8. Key herd parameters in a quota leasing scenario (S2) for three strains of Holstein Friesian cows; High Production (HP), High Durability (HD) and New Zealand (NZ) within the Moorepark (MP), High Stocking Rate (HS) and High Concentrate (HC) production systems.

| Feed System | MP | | | HC | | | HS | | |
|---|---|---|---|---|---|---|---|---|---|
| **Strain of Holstein-Friesian** | **HP** | **HD** | **NZ** | **HP** | **HD** | **NZ** | **HP** | **HD** | **NZ** |
| Milk price (c/kg) | 24.7 | 25.2 | 26.4 | 25.0 | 24.9 | 26.9 | 24.9 | 25.2 | 26.7 |
| Total hectares used | 43.8 | 44.0 | 43.2 | 40.3 | 40.0 | 37.4 | 42.2 | 43.2 | 43.19 |
| Quota lease (kg) | 126,266 | 116,373 | 114,000 | 219,082 | 200,249 | 145,689 | 75,097 | 103,302 | 124,373 |
| No. Cows calving | 85.9 | 85.9 | 85.9 | 85.9 | 85.9 | 85.9 | 85.9 | 85.9 | 85.9 |
| Livestock units (LU) | 97.9 | 98.7 | 99.0 | 97.9 | 98.7 | 99.0 | 97.9 | 98.7 | 99.0 |
| Stocking rate (LU/ha) | 2.23 | 2.24 | 2.29 | 2.43 | 2.47 | 2.65 | 2.32 | 2.29 | 2.29 |
| Labour units (h) | 3,288 | 3,288 | 3,288 | 3,288 | 3,288 | 3,288 | 3,288 | 3,288 | 3,288 |
| Milk produced (kg) | 543,676 | 536,413 | 507,210 | 621,738 | 611,244 | 527,988 | 502,533 | 522,381 | 502,762 |
| Milk sales (kg) | 527,878 | 520,614 | 491,411 | 605,939 | 595,445 | 512,189 | 486,734 | 506,583 | 486,963 |
| Fat sales (kg) | 21,483 | 21,155 | 21,563 | 24,303 | 23,575 | 22,728 | 19,857 | 20,809 | 22,097 |
| Protein sales (kg) | 18,208 | 18,512 | 17,955 | 21,447 | 21,177 | 19,085 | 17,019 | 17,941 | 17,675 |
| Milk returns (• | 130,315 | 131,116 | 129,917 | 151,358 | 148,488 | 137,807 | 121,383 | 127,777 | 129,932 |
| Livestock sales (• | 42,504 | 39,968 | 36,943 | 42,401 | 39,968 | 36,943 | 42,504 | 39,968 | 38,773 |
| Total costs (• | 165,168 | 148,599 | 142,683 | 180,541 | 165,287 | 156,091 | 161,067 | 148,747 | 144,436 |
| **Total profit per farm (•)** | **7,651** | **22,485** | **24,177** | **13,218** | **23,169** | **18,659** | **2,820** | **18,998** | **24,269** |
| Margin per cow (• | 89 | 262 | 281 | 154 | 270 | 217 | 32.8 | 221 | 283 |
| Margin per kg milk (cents) | 1.41 | 4.19 | 4.77 | 2.13 | 3.79 | 3.53 | 0.60 | 3.64 | 4.83 |
| Feed costs per kg milk (cents) | 5.19 | 5.30 | 5.53 | 6.81 | 6.92 | 7.82 | 5.61 | 5.47 | 5.73 |
| Replacement costs (• | 40,570 | 27,181 | 22,065 | 40,026 | 27,181 | 22,065 | 40,570 | 27,181 | 22,065 |
| Total labour costs (• | 40,663 | 40,663 | 40,663 | 40,663 | 40,663 | 40,663 | 40,663 | 40,663 | 40,663 |

**Table 9. Key herd parameters in a no quota scenario (S3) for three strains of Holstein Friesian cows; High Production (HP), High Durability (HD) and New Zealand (NZ) within the Moorepark (MP), High Stocking Rate (HS) and High Concentrate (HC) production systems**

| Feed System | MP | | | HC | | | HS | | |
|---|---|---|---|---|---|---|---|---|---|
| Strain of Holstein-Friesian | HP | HD | NZ | HP | HD | NZ | HP | HD | NZ |
| Milk price (c/kg) | 24.7 | 25.2 | 26.4 | 25.0 | 24.9 | 26.9 | 24.9 | 25.2 | 26.7 |
| Total hectares used | 43.8 | 44.0 | 43.2 | 40.3 | 40.0 | 37.4 | 42.2 | 43.2 | 43.19 |
| Quota lease (kg) | 126.266 | 116.373 | 114.000 | 219.082 | 200.249 | 145.689 | 75,097 | 103.302 | 124,373 |
| No. Cows calving | 85.9 | 85.9 | 85.9 | 85.9 | 85.9 | 85.9 | 85.9 | 85.9 | 85.9 |
| Livestock units (LU) | 97.9 | 98.7 | 99.0 | 97.9 | 98.7 | 99.0 | 97.9 | 98.7 | 99.0 |
| Stocking rate (LU/ha) | 2.23 | 2.24 | 2.29 | 2.43 | 2.47 | 2.65 | 2.32 | 2.29 | 2.29 |
| Labour units (h) | 3.288 | 3.288 | 3.288 | 3.288 | 3,288 | 3,288 | 3,288 | 3.288 | 3,288 |
| Milk produced (kg) | 543.676 | 536,413 | 507,210 | 621,738 | 611,244 | 527,988 | 502,533 | 522,381 | 502,762 |
| Milk sales (kg) | 527.878 | 520,614 | 491,411 | 605,939 | 595,445 | 512,189 | 486,734 | 506,583 | 486,963 |
| Fat sales (kg) | 21.483 | 21,155 | 21,563 | 24,303 | 23,575 | 22,728 | 19,857 | 20,809 | 22,097 |
| Protein sales (kg) | 18,208 | 18,512 | 17,955 | 21,447 | 21,177 | 19,085 | 17,019 | 17,941 | 17,675 |
| Milk returns (• | 130,315 | 131,116 | 129,917 | 151,358 | 148,488 | 137,807 | 121,383 | 127,777 | 129,932 |
| Livestock sales (• | 42,504 | 39,968 | 36,943 | 42,401 | 39,968 | 36,943 | 42,504 | 39,968 | 38,773 |
| Total costs (• | 160,408 | 144,212 | 138,385 | 172,282 | 157,738 | 150,599 | 158,236 | 144,853 | 139,748 |
| **Total profit per farm (•)** | **12,411** | **26,872** | **28,475** | **21,477** | **30,719** | **24,151** | **5,651** | **22,892** | **28,957** |
| Margin per cow (• | 144 | 313 | 331 | 250 | 358 | 281 | 66 | 266 | 337 |
| Margin per kg milk (cents) | 2.28 | 5.01 | 5.61 | 3.45 | 5.03 | 4.57 | 1.13 | 4.38 | 5.76 |
| Feed costs per kg milk (cents) | 5.19 | 5.30 | 5.53 | 6.81 | 6.92 | 7.82 | 5.61 | 5.47 | 5.73 |
| Replacement costs (• | 40,570 | 27,181 | 22,065 | 40,026 | 27,181 | 22,065 | 40,570 | 27,181 | 22,065 |
| Total labour costs (• | 40,663 | 40,663 | 40,663 | 40,663 | 40,663 | 40,663 | 40,663 | 40,663 | 40,663 |

required for a 468000l quota is similar for all strains (70 cows approx.) in the MP system, thus highlighting the inadequacy of milk production potential as a measure of animal productivity in the absence of good herd fertility. With all genetic groups and systems of production, the entire 40-hectare farm was not required as quota is the primary limitation to scale of production in this scenario.

In the MP and HS system, the NZ strain farm profit was greater than that of the HP and HD strains. The differential in farm profit in both systems is explained by differences in the value of milk supplied (due to milk composition), stocking density achieved (due to animal maintenance requirements) and replacement costs (due to reproductive performance).

Within the HC system the highest profit was realised with the HD strain. In the MP system, the NZ strain farm profit was €13270 and €1042 greater than with the HP and HD strains, respectively, while in the HC system the HD strain farm profit was €7477 and €3323 higher than the HP and NZ strains, respectively. The results also show that with both the HP and HD strains, the farm profit in the HC system was greater than that in the MP system, while with the NZ strain the farm profit in the MP system was greater than in the HC system.

*Scenario 2. Milk Quota applied at industry level*

The quota-leasing scenario allows farmers to lease in the additional quota required to allow them to supply the production of 85.9 cows of each group (Table 8). In some groups additional land will be required to produce the quota in order to meet the energy requirements of the herd in that system.

Similar to the S1 scenario, if farmers are able to lease additional quota the highest EBI group will again achieve the highest farm profit in the MP and HS systems. The HD strain will again deliver the highest farm profit in the HC system. Importantly, these results also indicate that in the MP system the differential in farm profit in favour of the highest EBI strain over both the HD (EBI = €58) and HP (EBI = €51) strains increases in a quota leasing scenario. In the MP system, the NZ strain farm profit in a quota-leasing scenario was €16526 and €1692 greater than the HP and HD strains, respectively. Once again, the HD strain farm profit was €9951 and €4510 greater than the HP and NZ strains, respectively in the HC system. These results once again highlight the large influence of herd EBI on farm profitability, and that this influence becomes even more critical when quota leasing is an option.

*Scenario 3. No Quota*

The no quota scenario allows farmers to supply the production of 85.9 cows of each group free from the constraints of quota or the costs of quota leasing (Table 9). Similar to the S2 scenario, in the no quota scenario, some groups will require additional land to produce the quota in order to meet the energy requirements of the herd in that system.

Similar to the S2 scenario, if farmers are able to produce milk in the absence of quota restrictions or quota related costs, the highest EBI group will again achieve the highest farm profit in the MP and HS systems. The HD strain will again deliver the highest farm profit in the HC system. In the MP system, the higher EBI NZ strain farm profit in a no quota scenario was €16064 and €1603 greater than the HP and HD strains, respectively. Once again, the HD strain farm profit was €9242 and €6568 greater than the HP and NZ strains, respectively in the HC system.

*General Comments:*
In the current analysis, it is assumed that all systems are managed to the optimum level possible. Optimum management of the HC system requires that grass utilisation is maintained at the same level as the MP and HS system. Consequently, in the HC system, an increase in stocking rate of 11% (above 2.5 LU/ha) is achieved to ensure a high rate of utilisation. **The higher stocking rate required in the HC system may or may not be permitted under the nitrates directive. Secondly, if milk price is below expectation (less than 22.5 c/l), then no marginal financial benefit would be achieved through concentrate supplementation. Such limitations would make a higher profit in a HC system impossible to realise.**

Ultimately, the highest farm profit observed in all scenarios was realised with the higher EBI NZ strain within the low concentrate MP system. The gain in farm profit with these higher EBI animals was entirely consistent with that expected based on the differences in herd EBI. The average EBI of €75 delivered an additional 3 c/l and 0.3 c/l of quota above that of the HP (€51) and HD (€58) strains, respectively in the MP system within all milk production scenarios.

**The large differential in profitability between the HD and HP strains from a similar overall EBI demonstrates the importance of selecting for a balance of all traits of economic significance (production and health) when increasing the overall genetic potential of the herd.** The profitability of the HP (EBI = €51) group is far below expectation because this €51 is derived entirely from production traits and will therefore be unrealisable in the absence of good herd health.

When the EBI of animals on the strain comparison study is compared to the average prevailing EBI in the national dairy cow population (EBI = €24), and based on the gains observed in the present study, an increase in profit of €3500 per 468000 litres (100,000 gallons) of quota per year through the development of a high EBI herd can be expected in the coming years.

**Conclusions**
The purpose of this paper is not to recommend any given existing strain of HF for use in Irish pasture-based systems. This paper firstly seeks to demonstrate the benefit of EBI on total farm profit and the importance of a robust breeding strategy on dairy farms in the coming years. On the basis of the current analysis, the marginal financial benefit of using high EBI AI sires considerably outweights the costs or inconvenience associated with their use. Secondly, the paper identifies the critical genetic characteristics desirable for profitable dairying within Irish pasture-based systems. In such a system, profitable characteristics include:

- the capability to produce high yields of good quality milk from a predominantly pasture
- diet, based on a persistent lactation profile without extreme peaks and troughs
- the capability for good reproduction and health to: maximise productivity by maintaining a pre-dominantly mature dairy herd, reduce the number of replacement animals that must be reared, calve cows quickly at the optimum time, walk long distances and produce high quality milk
- the capability to survive fluctuations in feed supply and maintain adequate body condition throughout lactation on pasture

- the capability to achieve high grass DM intakes in order to attain high milk output without depleting body reserves
- the capability to survive in a larger herd, requiring lower labour input per kg of milk produced

Finally, this study serves to illustrate the magnitude of genetic variation that exists within the Holstein-Friesian population. Such large genetic variation will permit Irish dairy farmers to make significant genetic progress in the coming years using an index of total economic merit such as the EBI. From an industry perspective, the variability observed in this study highlights the importance of an Irish national progeny-testing program, focused on the selection of fertile highly productive sires from within the Irish dairy herd. Such a program will add value to the industry and provide dairy farmers with world class sires to advance genetic improvement and farm profitability in the future.

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# Stating the Reality

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**Introduction**
The dairy industry is one of the most important sectors of Irish agriculture accounting for 31% of Agricultural output. Approximately 27,000 dairy farmers are involved in the production of 5.35 million tonnes of milk per annum. The dairy processing industry has become one of the country's most important indigenous industries with a turnover of over €2.5 billion in 2001 and employing over 9,000 people in related activities. The dairy industry has also made a significant contribution to sustaining rural communities over the last decade. Milk producers in Ireland have received a relatively high milk price when compared to world market prices in recent years, sustained through the application of a milk quota regime within the EU as well as other measures such as tariffs on imports and export refunds, etc. European Community membership in 1973 provided Ireland with a degree of policy stability as the wider international political and economic climate was reasonably predictable in the 1970's, 80's and 90's. The purpose of this paper is to highlight the reality of dairy farming over the next 5 to 8 years, and the influence of such factors as;

- Future policy environment and industry structure
- Changes in farm numbers and milk quota size
- Efficiency gains
- Farm profitability

**Future policy environment and industry structure**

<u>WTO</u>
Agricultural policy is generated at global, EU and national level. There is strong pressure at global level for a relaxation of trade-barriers via the WTO discussions. A compromise in these negotiations has yet to be reached and despite the WTO failure in Cancun, it is possible that a more fundamental agreement on agriculture trade reform could yet emerge from the Doha Round.

<u>CAP Reform</u>
The Mid-Term Review of Agenda 2000 is dictating the current policy environment for the dairy industry. A perspective on the outlook up to and beyond 2010 is critical for strategic planning in the immediate years ahead. Movement towards a free market seems inevitable and the only question is how rapidly this will occur. The strategic development plan for the Irish dairy processing sector has recently been published (Prospectus report, 2003). The FAPRI Ireland report has charted the likely changes nationally in relation to farm structure and income levels (Breen and Hennessy, 2003). The Mid Term Review (MTR) was brought forward from 2003 to 2002. In the Luxembourg agreement on the reform of the CAP (Mid Term Review), Fischler agreed to the decoupling of direct payments from agricultural production. Along with decoupling, Fischler also agreed to the implementation of a reduction of the intervention price for butter and SMP. The intervention price for butter will be reduced by 25% over five years, resulting in a 10% price cut relative to Agenda 2000. Butter prices will be reduced by 7% in 2004, 2005 and 2006 and by 4% in 2007. A 15% cut in the intervention price for SMP was agreed, as set

out in Agenda 2000. The reduction is and will take place from 2004 to 2006, in 5% steps. Dairy compensation will be paid from 2004 at a rate of €11.8/t (1.19c/l) increasing to €23.65/t (2.42c/l) in 2005 and reaching the maximum value of €35.5/t (3.63c/l) in 2006. Compensation is based on milk production in the calendar year 1999/2000 and has been decoupled from production from 2005. By 2006, entitlements on dairy farms will include all direct payments claimed in the reference period as well as the decoupled dairy compensation established in 2005. The EU Commission seem to be intent on driving down the price of milk paid to dairy farmers throughout 2004 and 2005.

***Environment and animal welfare***

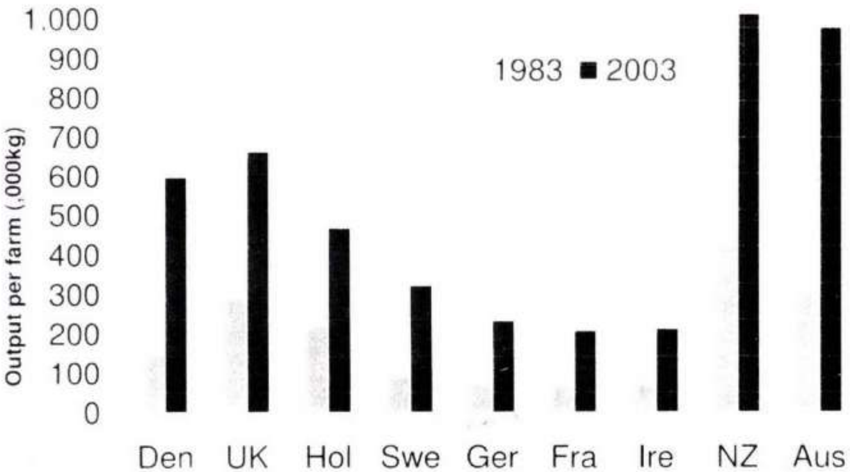
Compliance with EU Directives particularly on the environment and food safety (Nitrogen Vulnerable Zones, Water Framework and Strategic Environmental Assessment) and with International Agreements (Kyoto Protocol and Gothenburg Protocol) are going to be a part of farming going forward. Farming systems need to be sustainable in terms of the environment and animal welfare. Ireland has a good track record in this regard, but needs to build on this strength. Irish cows graze outdoors for most of the year and consumers perceive this production as more 'natural' and 'welfare friendly'. There needs to be no conflict between profitable dairy farming and ecological sustainability. Irelands comparative advantage within Europe is grass based low cost systems of milk production. The potential for dairy farmers to secure higher prices for their output to compensate for their increasing costs and downward pressure on product prices as a result of policies at EU level to lower the value of price and market support is limited. Therefore it is important that we do not erode the competitiveness of grass based systems relative to other high input high cost systems of milk production through the introduction of policies that may or may not have any impact on the environmental.

The EU Nitrates Directive (91/676/EEC) which states that 'the amount of livestock manure applied to land each year, including by the animals themselves, shall not exceed 170 kg organic N per hectare', (91/L375/EEC; 7). The implementation of such legislation is likely to reduce production efficiency and potential profitability and may lead to higher input systems incorporating crops such as maize in the dairy diet. The cultivation of maize requires the ploughing of permanent grassland containing very large reserves of N (7 t N /ha approx.) in the plough layer (Gardiner and Radford, 1980; McGrath and Zhang, 2003). This N, which is otherwise stable, becomes exposed and therefore available when the soil is ploughed. Whitmore *et al.* (1992) suggested that cultivation of long-term grassland could result in the release of up to 500 kg of N/ha in the first year of cultivation. These quantities are beyond the uptake capacity of maize and hence lead to substantial losses of N to the environment through volatisation, denitrification and leaching. Although, there are few comparisons of greenhouse gase emissions (GHG) from grazing ruminants and those fed TMR diets, Van der Nagel *et al.*, (2003) states that total greenhouse gas emissions from TMR diets were nearly twice as much as pasture (1.53 vs. 0.84 kg $CO_2$ equivalent/kg of milk). Such a shift to higher input systems (driven by environmental policy) may actually be more damaging to the environment than the traditional grass based systems of milk production. Lovett *et al.*, (2005) have shown that increasing the proportion of grass in the diet also has a positive effect on GHG emissions.

**Farm numbers and milk quota size**

A more accelerated exit from dairy farming than that experienced in recent years is expected in the future due to the changes in the coupled profitability of dairy farming resulting from the Fischler reforms. The decoupling of dairy compensation makes retirement or exit from dairy farming more attractive as this payment can be retained even if milk is no longer produced. Lower margins are expected to push farmers out of the industry while decoupled dairy compensation is likely to entice them out. As dairy compensation is decoupled from production as well as reduced milk prices from 2005, it is projected that a large number of farmers will exit or retire from dairy farming, sell their milk quota and retain their decoupled payments. Figure 1 shows projections of dairy farm numbers under a continuation of Agenda 2000 and also under the Fischler reforms.

**Figure 1. Development in milk output per farm over the period 1983 to 2003 in selected countries**




There are approximately 26,500 dairy farmers in Ireland at present. If past exit trends were to continue, then about 22,000 dairy farmers are expect to remain by 2012, a 17% reduction on current numbers. The FAPRI-Ireland's farm level research (Breen and Hennessy, 2003) projects that post decoupling, farm numbers will fall more rapidly. It is projected that there will be a 33% reduction in dairy farm numbers between 2003 and 2012.

All EU member states have experienced very significant structural changes in relation to milk production since the introduction of milk quotas in April 1984. Figure 1 shows the change in milk output per farm from 1983 to 2003 for EU countries as well as New Zealand and Australia. At the introduction of the milk quota scheme in the EU there were 32,700 and 62,010 milk producing farms in Denmark and Ireland respectively, while in 2004 this number has reduced to 6,600 (20%) and 26,500 (43%), respectively. Over this same period average milk quota per farm has increased from 152,000 and 73,790 kg to 675,000 and 215,000 kg for Denmark and Ireland, respectively. However this is in contrast to New Zealand where the number of dairy farmers has only reduced from 15,881 to 12,751, while nationally the quantity of milk processed has doubled (6,956 to 14,599 million litres). In New Zealand where over the same period dairy cow numbers have increased from 2,280,273 to 3,851,302 and average herd size has increased from 114 to 302 cows (LIC, 2003).

**Efficiency Possibilities**

**Irish milk production costs**

Table 1 shows the evolution of costs, receipts and margins from 1990 to 2003 for specialist dairy farms in Ireland. The results show that total costs have increased on average by 0.15 c/l per year from 1990 to 2003, of which direct costs accounted for 0.05 c/l and overhead costs were 0.10 c/l. The CSO Agricultural price index for total agricultural inputs rose by 13.6% between 1990 and 2002, whereas total costs for specialist milk production (Table 1) showed an increase of 11.2%. This indicates a real decrease in unit costs of 2.4% over a twelve-year period. The results also indicate that overhead costs increased at twice the rate of direct costs, which are to a large extent not under the direct control of the dairy farmer.

**Table 1. Itemised costs, receipts and margin (cent/l) of milk production for specialised creamery herds 1990-2003**

| Year | Direct | Overhead | Total | Net Receipts | Margin | Cost/Receipt Ratio |
|---|---|---|---|---|---|---|
| 1990 | 8.39 | 8.11 | 16.50 | - | - | - |
| 1991 | 8.11 | 7.83 | 15.94 | - | - | - |
| 1992 | 8.39 | 7.83 | 16.22 | - | - | - |
| 1993 | 8.89 | 8.25 | 17.14 | - | - | - |
| 1994 | 9.40 | 7.86 | 17.26 | 29.76 | 12.51 | 0.58 |
| 1995 | 9.90 | 8.51 | 18.41 | 31.10 | 12.70 | 0.59 |
| 1996 | 9.88 | 8.67 | 18.55 | 30.07 | 11.55 | 0.62 |
| 1997 | 8.65 | 8.25 | 16.90 | 28.56 | 11.67 | 0.59 |
| 1998 | 9.12 | 8.66 | 17.78 | 29.32 | 11.53 | 0.61 |
| 1999 | 9.09 | 8.06 | 17.15 | 27.88 | 10.74 | 0.62 |
| 2000 | 8.84 | 8.95 | 17.79 | 29.49 | 11.70 | 0.60 |
| 2001 | 9.05 | 8.76 | 17.81 | 30.67 | 12.86 | 0.58 |
| 2002 | 9.38 | 9.20 | 18.58 | 28.85 | 10.27 | 0.64 |
| 2003 | 9.16 | 8.13 | 17.29 | 28.05 | 10.82 | 0.62 |

Source: W. Fingleton (2003), Rural Economy, Teagasc. Derived from NFS records

Table 2 shows the direct costs, overhead costs and net margin for the lowest 20% and highest 20% of specialist dairy farmers in 2002. The cost of production among the lowest 20% was 13.58 c/l, compared to 23.40 c/l for the highest 20%, a difference of 9.82c/l in net margin. These results suggest that a large proportion of milk producers must focus much more attention on achieving cost efficient milk production. Some of the difference in the costs on specialist dairy farms may be due to differences in soil type and location which affects the quantity of grazed grass in the diet of dairy cows.

**Table 2. Cost variation for the medium, highest 20% and lowest 20% cost producers in 2002 for specialised dairy farms (c/litre)**

| | Mean | Highest 20% | Lower 20% |
|---|---|---|---|
| Total Costs | 18.18 | 23.40 | 13.58 |
| Direct Costs | 9.63 | 12.31 | 7.61 |
| Overhead Costs | 8.55 | 11.10 | 5.97 |
| Net Margin | 10.27 | 5.67 | 14.91 |

Source: W. Fingleton (2003), Rural Economy, Teagasc. Derived from NFS records.

**The Impact of scale at farm level**

The Prospectus Report recommends that changes to the milk quota system are required to enable milk producers to grow from (2003) 181,600 litres to 485,780 litres or that prevailing presently in Denmark (485,780 litres), Netherlands (381,360 litres) and Northern Ireland (349,580 litres). Projections from FAPRI-Partnership, The Luxembourg CAP Reform Agreement: Analysis of the impact on EU and Irish Agriculture (Breen and Hennessy, 2003) showed that the projected number of dairy farmers in 2012 will be 18,000 with an average quota size of 295,100 litres (65,000 gal). Table 3 shows the quota required by the specialist dairy farms to obtain a net farm profit of €40,000 in both 2005 and 2010 using (NFS) data for 2003 as shown in Table 1. Using the average cost farm for 2003 the quota required to obtain €40,000 net profit increases from 454,545 litres (100,000 gal) in 2005 to 701,754 litres (154,388 gal) in 2010, an increase of 54%. For the 20% highest cost producers, increasing milk quota will not be sufficient to maintain farm profitability, while for the 20% lowest costs producers milk quota would have to increase from 303,030 litres (66,667 gal) in 2005 to 396,040 litres (87,130 gal) in 2010 (31% increase). These increases are in nominal terms; when an inflation rate of 3% per year is considered the corresponding increase required are 78% for the average and 47% for the lowest cost producers, respectively. These results suggest that increases in quota size alone will not maintain farm profitability for high cost producers. Therefore increases in efficiency as well as scale are essential at farm level if the dairy enterprise is to remain viable into the future.

**Table 3. Shows the size of milk quota required (litres) to maintain a farm net profit of €40,000 (excluding the single farm payment (SFP)) in both year 2005 and year 2010 for specialist dairy farms**

| Year | Average costs | High costs | Low costs |
|---|---|---|---|
| 2005 | 454,545 | 952,380 | 303,030 |
| 2010-nominal | 701,754 | - | 396,040 |
| Increase (%) | 54 | - | 31 |
| 2010 adjusted | 807,018 | - | 455,446 |
| Increase (%) | 78 | - | 47 |

Source: W. Fingleton (2004), Rural Economy, Teagasc. Derived from NFS records

**Farm profitability**

Modelling specialist dairy farms 2004 to 2013

The following is a cost benefit analysis examining options available to the average specialist Irish dairy farmer under the Fischler reforms. The average specialist dairy farmer in the NFS was used in the analysis: milk quota of 209,000 kg (46,000 gallons), with 44 hectares, 43 cows plus replacements and various alternative enterprises. Within this analysis the SFP is included in the calculations of profitability going forward. The following assumptions were used in the analysis:

(1) The key input variables used in each of the 10-years of the analysis are shown in Table 4.

(2) Extra milk quota to allow for expansion was financed by a 5-year loan at 4% interest, which is available for restructuring milk at various banking institutions in Ireland.

(3) Labour requirement was based on data from the Moorepark Labour Study. At a herd size of less than 50 cows, labour requirement was 50.5 hours/cow/year,

between 50 and 60 cows 46.1 hours/cow/year and at a herd size of greater than 60 cows labour requirement of 35 hours/cow/year. The cost of the first labour unit was free, while any extra requirement was charged at €12.40/hour.

(4) The book value for the existing buildings and machinery were those for the sixth and seventh year since building or purchase respectively. A 15-year bank loan at 7.3% interest was used to fund the cost of these. Investment in milking facilities was increased by €3,174 for each additional 7 cows in the herd, financed by a 15-year loan at 7.3% interest.

(5) Both variable and fixed costs (excluding labour) were increased on average by 1.34% and 2.5% respectively per year for the 10 years.

(6) All expansion in cow numbers was from within the farming system.

(7) Each scenario was modelled both for the 25% of lowest cost producer and for the average cost producer. The total variable and fixed costs for the low cost producers and average cost producers were 14c/litre and 17c/litre, respectively.

A total of five scenarios were considered:

*Scenario 1: static option*

No change in overall production between 2004 and 2012, but the farming system is subjected to inflation, reduced milk price and modulated direct payments.

*Scenario 2: extensive option*

In this scenario an extensive system of milk production is modelled. The farmer participates in the Rural Environment Protection Scheme (REPS). Cost of compliance with REPS was taken as an increase of 21% in fixed costs per year (McEvoy, 1999). Stocking rate was reduced to 1.85 cows/ha, and N fertiliser use of 100-kg N/ha.

*Scenario 3: 50% increase in milk production using conventional housing*

Cow numbers are increased by 50% between 2004 and 2008. This is achieved by rearing 65% of female calves for replacements, as opposed to 55% in the static scenario. As herd size increases the additional cows are housed in a conventional type house at a cost of €1591/cow (Teagasc, 2002), which is financed by borrowing over 15-years at 7.3% interest. The overall farm stocking rate remains the same.

*Scenario 4: 50% increase in milk production using low cost housing*

This scenario is similar to scenario 3 except that the additional cows are wintered on a stand-off pad and an earth bank tank is used to contain slurry and soiled water. This system has a cost of €262/cow, which is financed with a 15-year loan at 7.3% interest.

*Scenario 5: 50% increase in milk production with no increase in housing costs*

In this scenario it is assumed that there is adequate housing available for the 50% increase in cow numbers.

Table 5 shows the trends in net farm profit (Loss) and net cash flow for the five milk production scenarios for 2004 to 2013 for low cost producers. In the static scenario (S1) the net farm profit and cash flow in 2013 is reduced in nominal terms by 4% and 10%, respectively. In all three-expansion scenarios, the farm profit in the first four years is lower than either in the static (S1) or the extensive scenario (S2), while in the last five years the expansion scenarios are more profitable With a 100% expansion, the cash flow trends in the first four years are all less than €30,000. In nominal terms relative to S1 the net farm profit by 2013 is + 7%, + 14%, + 22% and + 23% for S2, S3 (50% expansion with conventional housing), S4 (50% expansion with low cost housing), S5 (50% expansion with no increase in capital) respectively. Table 7 shows the total discounted farm profit and increase in net worth (livestock only) for the five scenarios over the 10 years. The highest discounted farm profit was for the Extensive 50% and 100% expansion scenarios with no increase in capital costs (S5/S86) and was similar to theor low fixed costs scenarios (S4/S7) extensive system S2. The least profitable were the 50% expansion scenarios with conventional housing, plus S1. However wWhen changes in net worth are also considered, expansion with either no increase in capital cost or with a low capital investment is considerably morest profitable. The next most profitable is the extensive system (S2), while remaining static (S1) or expansion with conventional housing are least profitable.

**Table 4. Key input variables used in the model farm 2004-2013**

| | **2006** | **2007** | **2008** | **2009** | **2010** | **2011** | **2012** | **2013** |
|---|---|---|---|---|---|---|---|---|
| Male calf price (€) | 89 | 91 | 94 | 97 | 99 | 102 | 104 | 107 |
| Land opportunity cost (€/ha) | 267 | 267 | 267 | 267 | 267 | 267 | 267 | 267 |
| Conc. cost (€/t) | 187 | 185 | 185 | 183 | 182 | 180 | 180 | 180 |
| Cull cow price (€) | 265 | 270 | 277 | 283 | 290 | 296 | 300 | 300 |
| Labour cost (€/hr) | 12.4 | 12.4 | 12.4 | 12.4 | 12.4 | 12.4 | 12.4 | 12.4 |
| Milk price (c/kg) | 23.8 | 23.2 | 22.8 | 22.4 | 22.2 | 22.0 | 22.0 | 22.0 |
| Farm size (ha) | 44.5 | 44.5 | 44.5 | 44.5 | 44.5 | 44.5 | 44.5 | 44.5 |
| Decd. Payment (€) | **12977** | **12977** | **12977** | **12977** | **12977** | **12977** | **12977** | **12977** |
| Quota Price (c/l) | 27.2 | 26.6 | 26.3 | 26.3 | 26.1 | 25.9 | 25.8 | 25.8 |

Trends in net farm profit (loss) and net cash flow for the five milk production scenarios for 2004 to 2013 for average cost producers are shown in table 6. In nominal terms relative to S1 the net farm profit by 2013 is + 9%, + 6%, + 17%, + 18% for S2, S3, S4 and S5 respectively. Compared to the low cost producers, S2 is more profitable than S3 with average cost producers. Compared to the low cost farms, the highest discounted farm profit (Table 7) in the average cost farms was for the extensive (S2) system. The least profitable were the 50% expansion scenarios with conventional housing. When changes in net worth are also considered, expansions with either no increase in capital cost or with a low capital investment were very similar to the extensive system (S2).

The results of the modelling milk production scenarios 2004 to 2013 indicate:

- For low cost producers the most financial rewarding scenario was expansion in milk production with low cost housing (S6) over the period 2004 to 2013. The least profitable was remaining static (S1).
- For average cost producers expansion in milk production using low cost housing was as profitable as extensive systems (REPS) over the period 2004 to 2013. The least profitable was remaining static or expansion using conventional housing.
- High rates of expansion will only be possible in low cost systems using low cost capital investment.
- On higher cost farms increased efficiency will be a priority as expansion will be very difficult to finance.
- Dairy farmers need to consider their long-term plans when deciding which scenario to adopt. An expansion policy is necessary for those considering remaining in dairy farming into the future.

**Table 5. Trends in Net Farm Profit (Loss) and Net Cash Flow for five milk production scenarios, 2004 to 2013 for low cost producers**

| Year | Static S1 | Extensive (REPS) S2 | Expansion 50% (Conventional) S3 | Expansion 50% (Low Cost) S4 | Expansion 50% (No Capital) S5 |
|---|---|---|---|---|---|
| Net Profit (€) | | | | | |
| 2004 | 36,450 | 37,866 | 31,302 | 31,302 | 31,302 |
| 2005 | 35,241 | 37,862 | 28,142 | 29,731 | 29,901 |
| 2006 | 36,405 | 39,433 | 29,117 | 31,943 | 32,213 |
| 2007 | 35,548 | 38,741 | 25,478 | 29,452 | 29,963 |
| 2008 | 35,366 | 38,710 | 37,406 | 42,696 | 43,344 |
| 2009 | 35,537 | 39,010 | 39,945 | 43,845 | 44,331 |
| 2010 | 35,385 | 38,971 | 39,943 | 44,063 | 44,407 |
| 2011 | 35,044 | 38,727 | 40,094 | 43,879 | 44,204 |
| 2012 | 35,447 | 39,175 | 41,439 | 44,907 | 45,210 |
| 2013 | 35,110 | 38,921 | 41,460 | 44,622 | 44,903 |
| **Net Cash-Flow (€)** | | | | | |
| 2004 | 42,772 | 44,188 | 37,696 | 37,696 | 37,696 |
| 2005 | 41,324 | 44,179 | 27,144 | 28,487 | 28,746 |
| 2006 | 42,050 | 45,078 | 33,687 | 35,849 | 36,266 |
| 2007 | 40,807 | 44,001 | 28,997 | 32,061 | 32,653 |
| 2008 | 40,276 | 43,620 | 40,666 | 44,727 | 45,511 |
| 2009 | 40,133 | 43,605 | 41,078 | 44,233 | 44,842 |
| 2010 | 39,700 | 43,285 | 40,493 | 43,648 | 44,257 |
| 2011 | 39,116 | 42,799 | 42,483 | 45,638 | 46,247 |
| 2012 | 39,181 | 42,909 | 44,309 | 47,464 | 48,073 |
| 2013 | 38,545 | 42,356 | 45,115 | 48,270 | 48,879 |

**Table 6. Trends in Net Farm Profit (Loss) and Net Cash Flow for five milk production scenarios, 2004 to 2013 for average cost producers**

| Year | Static S1 | Extensive (REPS) S2 | Expansion 50% (Conventional) S3 | Expansion 50% (Low Cost) S4 | Expansion 50% (No Capital) S5 |
|---|---|---|---|---|---|
| Net Profit (€) | | | | | |
| 2004 | 28,709 | 29,808 | 23,350 | 23,350 | 23,350 |
| 2005 | 27,500 | 29,803 | 19,458 | 21,047 | 21,218 |
| 2006 | 28,715 | 31,428 | 19,659 | 22,485 | 22,755 |
| 2007 | 27,916 | 30,798 | 15,164 | 19,138 | 19,649 |
| 2008 | 27,789 | 30,824 | 26,433 | 31,722 | 32,370 |
| 2009 | 28,013 | 31,179 | 28,521 | 32,871 | 33,357 |
| 2010 | 27,916 | 31,197 | 28,952 | 33,072 | 33,416 |
| 2011 | 27,628 | 31,010 | 29,085 | 32,871 | 33,195 |
| 2012 | 28,083 | 31,512 | 30,414 | 33,881 | 34,185 |
| 2013 | 27,797 | 31,312 | 30,417 | 33,579 | 33,860 |

**Net Cash-Flow (€)**

| | | | | | |
|---|---|---|---|---|---|
| 2004 | 35,031 | 36,129 | 29,744 | 29,744 | 29,744 |
| 2005 | 33,583 | 36,121 | 18,461 | 19,804 | 20,063 |
| 2006 | 34,360 | 37,073 | 24,229 | 26,391 | 26,808 |
| 2007 | 33,176 | 36,057 | 18,682 | 21,747 | 22,339 |
| 2008 | 32,700 | 35,735 | 29,692 | 33,753 | 34,537 |
| 2009 | 32,609 | 35,775 | 30,104 | 33,260 | 33,868 |
| 2010 | 32,230 | 35,512 | 29,502 | 32,657 | 33,266 |
| 2011 | 31,699 | 35,082 | 31,474 | 34,630 | 35,239 |
| 2012 | 31,817 | 35,247 | 33,283 | 36,439 | 37,048 |
| 2013 | 31,232 | 34,747 | 34,071 | 37,227 | 37,836 |

**Table 7. Total discounted farm profit and changes in net worth for the eight systems of milk production 2004 to 2013 for low and average cost producers**

| | Low cost producers | | Average cost producers | |
|---|---|---|---|---|
| | Farm Net Profit € | Changes Net Worth € | Farm Net Profit € | Changes Net Worth € |
| Static | 307,802 | - | 242,397 | - |
| Extensive (REPS) | 334,871 | - | 266,798 | - |
| Expansion (50%) Conventional | 301,830 | 22,544 | 214,044 | 22,544 |
| Expansion (50%) Low Costs | 329,309 | 22,544 | 241,523 | 22,544 |
| Expansion (50%) No Capital Costs | 332,150 | 22,544 | 244,364 | 22,544 |

**Conclusion**

Continued reform of both economic and environmental policies within the EU will result in increased pressure on dairy farm income through reduced product prices and increased costs of compliance with EU regulations. The Nitrates Directive is just one of a host of environmental regulations that will lead to increased costs at farm level and therefore reductions in the competitiveness of the Irish grass based systems of milk production. The reform of CAP (Luxembourg Agreement) will lead to a reduced milk price (partially compensated for by the SFP). Dairy farm numbers have declined by approximately 3% per year since the introduction of milk quotas. This decline in numbers is projected to increase significantly under the Luxembourg Agreement but will be dependent on milk price. Given the projections for reductions in milk price, the current level of restructuring is inadequate to allow dairy farmers to increase in scale and therefore to counteract the price cost squeeze at farm level. Analysis of NFS data has shown that there is large variation in milk production costs. Dairy farmers need to increase efficiency as well as scale to maintain real incomes in the decoupled milk price environment. Analysis of farm profitability for the average specialist dairy farms in Ireland has shown that if they remain static over the next 10 years farm income (including SFP) will decline in nominal terms and real terms by 4% and 34%, and 3% and 33% for low cost and average cost producers, respectively. When the low and average cost producers are compared over a ten-year period the low cost producers earn €65,405 or 21% more profit, indicating there are requirements for increases in both scale and efficiency at farm level.

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# Norwegian Breeding Strategy – Lessons for Ireland

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**Introduction**
Norway is a small country, and has never been a major contributor to world animal production. Nevertheless animal breeding has played an important role in Norway for a great many years. Norwegian farmers have been and are very active in farm animal recording, and consequently they are also eager to participate in national breeding schemes. As a result Norway has a well established national breeding programme for dairy cattle, beef cattle, swine, sheep and dairy goats. This paper will focus on dairy cattle breeding.

**Norwegian Red**
The background of the Norwegian Red (the principal dairy breed in Norway), is a mixture of about 10 old local Norwegian breeds, imports from Sweden and Finland in the 40's, 50s and 60s together with some earlier imports of Ayrshire and Shorthorn. The creation of the Norwegian Red started in 1935 in opposition to the Authorities' idea of keeping one local breed per region and even per valley. It soon became obvious that the bringing together of all potential good breeds and making first a crossbred population, a synthetic, then a new breed, was much better than the existing programme. Gradually Norwegian Red spread all over Norway, and in 1968 all the old breed organisations were amalgamated to form the Norwegian Red Association, which is now Geno. In Norway 98% of the cow population is Norwegian Red, the remaining 2% comprising cows of the old local breeds, Holstein and Jersey.

Discussions, both centrally and locally over the period when the Norwegian Red was competing with other local breeds highlighted the interest and importance of animal breeding. It also illustrated the effect of selection. This debate may be one of the reasons for the high participation in breeding work in subsequent years. Over the last decade more than 95% of all dairy cows are in the recording system, and around 90% are bred by AI. The result of this facilitates an efficient breeding programme even though the cow population is small.

**Breeding objectives**
The interest in the development of breeding traits was reflected in the interest amongst farmers to discuss their own breeding objectives. Since the 70's when traits like health and fertility were introduced into the selection criteria of Norwegian Reds, these changes in breeding criterion were discussed and decided by the farmers. Therefore it is correct to say that the breeding objectives in the Norwegian Reds is driven by farmers, though geneticists have taken part in the process by analysing alternatives to illustrate the effects of different breeding objectives.

Currently the existing breeding objective is geared towards a low emphasis on milk yield (only 24%), which allows for greater weightings on traits like health and fertility. Table 1 shows the existing relative weights in the Total Merit Index for bulls.

**Table 1. Relative weights in the Total Merit Index**

| Trait | Relative weight in % |
|---|---|
| Milk yield | 24 |
| Mastitis resistance | 22 |
| Udder and teats | 15 |
| Female fertility | 15 |
| Beef | 9 |
| Leg quality | 6 |
| Temperament | 4 |
| Other diseases | 3 |
| Still births | 1 |
| Calving ease | 1 |

1990 was a very important year in the development of the Norwegian Red breeding objectives. At that time the strategy of the breeding programme was revised, and a large part of that work was devoted to assessing breeding goals. With the history of health and fertility being a part of the selection decisions from the mid 70's, it had already demonstrated that selection on such low heritability traits had effect when based on large progeny groups. The big question in 1990 was if the Norwegian Red breeding programme should try to copy the big Holstein programmes in order to compete and avoid excessive semen imports, or if the programme should continue along the same lines with more emphasis on health and fertility.

Fortunately the latter alternative was chosen, not because improved milk yield has no value, but because this gave the Norwegian Reds a possibility to improve their functional traits so much that the effects are easy to document. The consequence of the choices made in 1990 is that the Norwegian Red today has something special to offer the world of cattle breeding.

Another speciality of the Norwegian Red breeding objective is that beef has always been included as a trait together with milk yield. Norwegian dairy farmers have always obtained a significant part of their income from producing beef on animals coming from the dairy herd. This is still the situation today. The weighting on beef in the breeding programme is to obtain a genetic change in growth rate and also a slight improvement in carcass grading. The intention however is not to have Norwegian Red cows become like Simmental cows. The goal is to maintain them as a dairy breed, but that they should be robust cows and heifers, and young bulls should grow fast to give a net income from beef production.

**Design of programme**

Once breeding objectives have been determined and a recording system for the various traits put in place, the possibilities for testing and selection have to be taken into account. To obtain high reliable proofs when traits with low heritability are an important part of the Total Merit Index, the progeny groups need to be large. Therefore the intensive use of test bulls is essential. For the past 25 years the guidelines to the Norwegian dairy farmers have been to use test bulls on 40% of all cows and heifers in the herd. It is very difficult to follow this up in any way other than to try and make farmers understand how important sufficient use of test bulls is in a progeny testing scheme which includes traits like health and fertility with very low heritability.

In Norway, such an approach has worked out very well. Over the last ten years the use of test bulls has varied from 37 to 39% in the recording system. If confined to Norwegian Red the percentage is slightly higher.

Since 1994 a data programme has been used to plan matings in herds. This programme is a good tool to obtain a steady use of test bulls from herd to herd. Herds in Norway are small, with an average herd size of 16 full lactation cows. Ten years ago it was only 13. Therefore it is of great importance for the quality of the programme to have the use of test bulls and also elite sires spread over the entire herd.

It is also important to use bulls in such a way that inbreeding will be kept at a low level. So far this has worked well. The effective number in The Norwegian Red population is 160 animals, which is quite good, but this is where it needs to be if the programme is to succeed in the future. Today the system has changed from slaughtered bulls with a large number of stored semen doses, to live bulls where the elite sires may produce semen on demand for the market. In this new situation it is very important to avoid too much use of some elite sires, which may in the long run pose a risk to the entire breeding programme. It can be expected that a situation will arise where an elite sire is out of service in Norway, but is producing as much as possible for the international market. An important task will be to make the Norwegian farmers understand the difference in how to use outstanding sires within a breeding programme compared to a totally commercial and international market.

**Environment – special breeding herds or nucleus herds**

Since the 60's the cow recording system has also been acting as the herd book for Norwegian Reds. In the 60's and 70's there was a tendency to use special breeding herds or regions, but this idea has died, and now all herds in the recording system are potential breeding herds. The result of this is that the data used in making selection decisions always comes from herds working in the environment where the selected animals will be used.

It has often been argued that feeding a diet mainly based on roughage produces a moderate yield level that reduces the gain in production from selection. This may be true, yet Norwegian Reds seems to be quite competitive to other breeds based on milk yield. At low feeding levels and with grass being a large part of the input they seem to do very well. Therefore what is the purpose of keeping dairy cows? Answer - to produce high quality food from grass and plants which are of no use to humans.

With such an open programme, there has never been a market in Norway for special breeding animals besides selling selected bull calves to Geno. There has been little discussion on establishing special nucleus herds because there is nothing to be gained from it compared with the scheme. Further, little attention has been paid to embryo transfer. Embryo transfer is not used as a tool for producing bull calves from selected bull dams. This has been done by purchasing calves from the very best cows and heifers. Herds are continuous screened in the recording system to find the best calves. With the well designed use of sires across herds and the use of the mating plan programme to make the best possible combinations, the choice of very good calves is not an issue.

**Future**

The most important task is to maintain the quality of the Norwegian Red breeding programme, especially for traits like health and fertility. With declining cow numbers this may become difficult. It will be possible to slightly increase the use of test bulls, but it is more likely that there will have to be a reduction in the size of the progeny groups. Having 250-300 test daughters per sire, it is possible to reduce this by 50 daughters per sire and still achieve the results needed.

With the income from the export of semen, it will be possible to use some of this money to encourage farmers to carry out the breeding programme in their herd in a more effective manner than today. However, with Norwegian Reds being used in other countries either in crossbreeding or as a pure breed, it should be possible to include information from other countries in the Norwegian breeding programme. This means that sufficient recording of international data will contribute to the expansion of the base of the Norwegian Red breeding programme making it possible to continue the selection for both production and functional traits. Such cooperation will need to be based on contracts, and to make it work as effective as it should, test sires have to be used outside of Norway.

There has always been, and there continues to be cooperation between the Nordic Red populations in Sweden, Finland and Norway. This does not contribute to any expansion of the Norwegian Red population because it already exists. However, it is very important to continue this programme in order not to loose something that has been gained to date.

Some important features from the Norwegian Red program

- High participation in recording
- Large use of AI
- Farmers are very interested in breeding work
- Possibility to use a high percentage of test bulls
- All recorded herds are potential breeding herds
- No use of special nucleus herds
- Very little ET
- Genetic gain is well documented
- Systematic publishing of information about animal breeding to educate farmers

# Maximising Grass in the Diet of Beef Cattle

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## Introduction

Grazed pasture is the cheapest feed source available to beef producers in Ireland (O'Kiely, 1994). However, the seasonal patterns of pasture production do not always match animal requirements in beef production systems. Pasture supply tends to exceed feed demand in the late spring and early summer whereas deficiencies in feed supply occur in late autumn, winter and early spring. The most efficient beef production system is the one that maximises the annual intake of grazed pasture for beef production. The challenge for beef farmers is to utilise a high proportion of the pasture produced while simultaneously achieving biological efficiency and meeting marketing requirements.

The objective of this paper is to describe management strategies for maximising pasture in the diet of beef cattle in Ireland. The strategies considered include altering feed demand through stock policy (e.g. stocking rate, calving date) and altering pasture supply through grazing management, nitrogen (N) fertiliser, growing different plant species or cultivars, and feeding supplements.

## Matching feed supply and demand

Maximising pasture intake by cattle is ultimately achieved by matching the seasonal patterns of pasture production to animal requirements on an annual basis. The match between feed supply and demand is in the first instance driven by total annual dry matter (DM) production and its seasonal variation. The most biologically efficient beef farming system is the one in which the maximum amount of pasture produced is utilised by the animal.

The challenge facing beef farmers is achieving the right combination of efficient beef production and marketing decisions. These decisions are not always complementary to one another. Market demands for large carcasses, out-of-season supply and product uniformity result in systems that are poorly matched to seasonal pasture supply and are therefore less efficient. The most profitable systems may be less biologically efficient, but achieve livestock production targets that are closely aligned with market requirements (Smeaton, 2003).

## Stock policy

The stock policy operated by beef farmers rather than adjustments to pasture supply is the key to matching the seasonal patterns of pasture production to animal requirements. The key features that influence the balance are stocking rate and calving date. Changing stocking rate moves the feed requirements vertically and changing calving date moves them horizontally over time (Matthews *et al.*, 1999).

Stocking rate and calving date decisions provide a long-term balance between feed supply and demand. Shorter-term balance can be achieved through stock policy decisions that effectively manipulate feed demand to match year-to-year variation in seasonal patterns of pasture production. These include:

- Animal performance targets (liveweight, cow condition)
- Weaning date

- Herd culling
- Buying and selling of cattle
- The balance of stock (e.g. lactating:dry stock)

Therefore, although beef systems are based on a desired stock policy reflecting an average feed profile and marketing requirements, this policy can be adjusted to overcome short-term differences in feed supply and demand.

Stock policy may be adjusted to maintain pasture quality, which also drives intake per animal. On many farms there is a proportion of cattle that can be used to 'clean up' pastures such as the suckler cow herd. However, the suckler cow is often expected to produce heavier calves at weaning. This could be difficult where she is also expected to consume poor quality grasses in summer to maintain pasture quality for young growing animals. Instead, management techniques that prevent the loss of control of pasture (e.g. topping, conservation) become increasingly important.

**Grazing management**

Grazing management strategies that adjust features such as average pasture cover, rotation length, and pre- and post-grazing sward conditions can be used to fine-tune the balance between feed supply and demand. However, they cannot overcome the year-to-year variation in pasture supply and must operate in conjunction with realistic stock policy decisions (Matthews *et al.*, 1999).

Some principles

Grazing management is based on the control of sward conditions in order to optimise net herbage production (growth minus decay) and utilisation. The main principles involved are:

- Herbage production after grazing has an early phase of slow production reflecting low leaf area and photosynthesis, a middle phase of active growth, and a final phase where herbage production slows due to a rapid increase in leaf decay.
- There is a broad range of herbage mass (approximately 1000-2500 kg DM/ha above ground for Ireland) within which net herbage production is relatively unaffected by differences in herbage mass. This range is likely to be lower in the winter and higher in the summer owing to changing environmental factors, such as solar radiation.
- Grazing management decisions only influence herbage production when the outcome forces herbage mass outside the optimum range.
- Herbage intake and cattle performance are sensitive to a range of sward characteristics, which can be described in terms of herbage mass or sward surface height (Matthews *et al.*, 1999).

Therefore, herbage mass targets can be selected to control herbage intake per animal (post-grazing), pasture quality (pre-grazing) and herbage production and utilisation (pre- and post-grazing). This type of information should be the basis for grazing management decisions and is specific to each stock class.

Subdivision and grazing management

Farm subdivision provides the basis for controlling of pasture production, quality and utilisation efficiency. Recent advances in electric fencing technology can enable high levels of subdivision to be achieved at a relatively low cost.

Continuous stocking can be used during periods of rapid pasture growth to maintain pasture control because it maximises the opportunity for cattle to consume all the pasture on offer. The key to successful continuous stocking is to select the appropriate stocking rate that will maintain a desired sward surface height. For example, herbage intake and performance per bullock may be expected to decline when sward surface height falls below 8-10 cm. Sward conditions greater than this will not improve intake and will result in reduced grazing efficiency, diet quality and herbage production.

Rotational grazing is based on herbage allowance per animal and acts as a rationing effect. It is an effective method of carrying herbage mass from periods of active pasture growth to periods of pasture shortage. However, if managers want to maintain pasture quality and cover at high levels in order to maintain high intake and performance per animal, there is limited scope for using variable sward targets to buffer the balance between herbage growth and intake per animal.

Rotational grazing, particularly over the late autumn and winter periods, has given rise to a number of different grazing systems, such as 'extended grazing', 'strip grazing', 'block grazing' and 'on/off grazing'. The latter is where cattle are offered their daily pasture allowance and then moved from the pasture to a wintering pad, for example. Research at Grange has shown that on/off grazing reduces treading damage during winter and leaves greater residuals to improve pasture growth (Busteed, 1999).

Research in New Zealand (Boom and Sheath, 2000) and at Grange has shown that, under specific conditions, rotation length and herbage allowance during the winter have limited effects on final slaughter weights, due to the effects of compensatory growth. In general, decisions on rotation length and herbage allowance during winter will depend on the balance of pasture supply and demand, and the element of risk that is acceptable with regard to treading damage and maintaining early spring pasture covers.

Feed budgets

Feed budgeting can be used to provide information on how available feed (pasture and supplements) may best be used to ensure optimal levels of animal intake and production. Budgets can be made to determine the least costly way of overcoming a feed deficit or using a surplus. After balancing the budget, a grazing plan can be prepared to ration the pasture to ensure that planned intakes are achieved. To make informed decisions, managers must be able to quantify the key components of a feed budget including animal requirements, pasture supply, expected pasture production and supplements.

**Nitrogen fertiliser**

Nitrogen (N) fertiliser is often the most effective means of altering the seasonal pattern of pasture supply in Ireland (Ryan *et al.*, 1984). Nitrogen application is a useful 'supplement' for many beef production systems, particularly in the late autumn and early spring. However, its need must be anticipated and planned several weeks in advance of its application.

The magnitude of the pasture growth response to N fertiliser depends on the current level of N deficiency, the suitability of climatic conditions for pasture growth, and the growth potential of the pasture. In general, N fertiliser responses on well-managed pastures can be more that 10 kg DM/kg N applied during the 'shoulders' of the growing season. Responses can be improved by applying fertiliser when conditions are suitable for growth, but in reality feed shortages usually occur when environmental conditions for growth are poor.

The economics of N responses will vary with product prices and the ability of managers to ensure the extra pasture produced is utilised profitably by animals that will generate the highest financial return. This often means that the extra pasture produced should be grazed by suckler cows or rapidly growing animals, thus maximising the returns on the money spent on fertiliser.

Farmers can improve the N response efficiency by using the lowest rate of N fertiliser possible to meet the feed requirement, and by allowing 4-6 weeks of pasture regrowth after N application. Low rates (20-30 kg N/ha) of N fertiliser are often more efficient than high rates because N leaching and volatilisation losses are lower. The most efficient rate can be determined by establishing small (2 m x 5 m) test plots under the farm's specific environmental conditions, and is usually the one which gives the greatest response in terms of kg DM/kg N.

**Pasture renewal, species and cultivars**

Pasture renewal ('reseeding') can be a way of altering seasonal or total annual pasture production and improving pasture quality by altering the botanical composition (e.g. increasing the legume content). As a general rule, priority for renewal should be given to paddocks that have the greatest production potential that can be realised with the least risk and at the lowest cost. This often means that pastures on fertile, well drained soils on easy-contoured land should be developed fully before pastures on lower producing land are renewed.

There are a range of new ryegrass and clover cultivars with different seasonal patterns of production and nutritive value that can be considered.

<u>Perennial ryegrasses</u>

Perennial ryegrass (*Lolium perenne*) is widely used for its ease of establishment and management, adaptability to a wide range of environments, and compatibility with other pasture species. Growth starts at an air temperature of 5°C, is at an optimum at 18°C, and ceases at 30°C. In Ireland, this means that perennial ryegrass has a wider seasonal pattern of production compared with most other grasses, and growth is seldom limited by high temperatures in summer.

Perennial ryegrass cultivars vary in their flowering time. In Ireland, pasture seed mixes tend to be composed of intermediate and late flowering cultivars. Spring growth is generally earlier for earlier flowering cultivars but so is seed-head emergence, which signals the start of a decline in pasture quality. There are also a number of late-flowering cultivars that may provide an opportunity to maintain grazed pasture or silage quality in the late spring and early summer, although some cultivars may be less suitable for early grazing (Humphreys *et al.*, 2001).

Ryegrass cultivars vary in their chromosome number. This is naturally diploid for perennial and annual ryegrasses. By doubling this, breeders have created larger tetraploid ryegrasses with bigger cells (and larger seeds) and a lower dry matter content. Tetraploids tend to have greater digestibility and voluntary intake by ruminants, but may require specific management and high fertility to express any production advantage. Their lower tiller number and higher crown, increase the risk of over-grazing that can lead to reduced persistence.

Italian ryegrass

Italian ryegrass (*Lolium multiflorum*) is an annual, with an erect growth form, large leaves and few tillers. It is sown in autumn to produce high quality, cool-season feed. Some of the diploid and tetraploid cultivars may persist for 2-3 years under ideal conditions without reseeding. The Westerwold types are true annuals that do not usually persist for more than a year without reseeding. Early spring production is a major advantage over brassica crops such as rape or kale, but regrowth can be reduced where apical buds are exposed to grazing.

Hybrid ryegrasses

Hybrid ryegrass (*Lolium hybridum*) is bred from perennial ryegrass and Italian ryegrass. 'Long rotation' hybrids contain a greater proportion of perennial ryegrass than short rotation hybrids, but have lower winter production. They can be used as the sole ryegrass component of a pasture mix and persistence is normally 3-5 years.

'Short rotation' hybrid ryegrasses contain more Italian ryegrass in their genetic make-up and consequently, have higher winter production than 'long rotation' hybrid and perennial ryegrasses. When sown alone they typically yield 70-90% of Italian ryegrass and persist for 3-5 years.

The inclusion of 'short rotation' ryegrasses in permanent pasture mixes adds to the ryegrass competition challenge on the slower establishing species such as white clover. This competition can be very strong because the hybrid Italian types have larger seed so establish faster than perennial ryegrass and provide 'early' high quality feed. Their negative feature of suppressing the slower establishing species compounds when they finally die out, leaving the residual pasture open to the invasion of undesirable species.

White clover

White clover (*Trifolium repens*) and other pasture legumes are widely regarded for their biological $N_2$-fixing ability. In addition, most pasture legumes are more nutritious than grasses, and pastures with a high proportion of legume will therefore enhance herbage intake and animal performance.

In general, grazing cattle will attempt to select a diet that is 60-70% white clover and 30-40% ryegrass. Individual animal performance is maximised when cattle are able to consume this diet. However, such high clover contents are seldom achieved in conventional grass/white clover swards. High clover content may be expected in young pastures where the soil N level is low after a cropping phase. White clover then can have an advantage over N-deficient grasses.

Compared with perennial ryegrass, white clover has higher concentrations of crude protein and digestible DM, but lower concentrations of lignin, cellulose and fibre. Because white clover has a high nutritive value, and grazing cattle can achieve high rates of white clover intake, cattle grazing white clover tend to achieve high liveweight gains and milk yields.

White clover has a higher optimum temperature for growth than perennial ryegrass. This means that white clover is most productive between late spring and early autumn. The decline in nutritive value of grasses in summer, due to an accumulation of dead material and reproductive stem, may therefore be compensated for by the increased amount of white clover in pastures.

**Supplementary feeding**

This paper has focussed on stock policy and agronomic strategies that can be used to balance seasonal variations in pasture supply and feed demand. However, it is important to note that supplementary feeds are often needed to alleviate deficiencies in the pasture supplied. There is increasing interest in the use of complementary pasture and supplement feeding strategies to optimise the efficient use of homegrown forages.

Concentrate or forage crop supplements are often used in specialised beef systems, but emphasis is usually placed on the effective use of conserved forages such as grass silage. For example, the effective integration of silage supplementation into winter grazing management systems can be facilitated by the use of low cost wintering pads.

**Conclusion**

There are a range of management strategies that can be used to control the quantity and quality of pasture supply, feed demand and hence, maximise annual pasture intake for beef cattle. Stock policy is the key to matching pasture supply and animal requirements. Agronomic strategies such as grazing management, N fertiliser and growing different pasture species should be used to fine-tune the balance. Supplementary feeds are needed to alleviate surpluses and deficiencies in pasture supply.

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# Herd Health Management: Stress and Animal Welfare

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## Introduction

The objective of a well-designed herd health program is to address multiple areas of management in order to reduce the likelihood of disease outbreaks occurring in calves and adult animals, and is a necessary step if economic returns are to be realised. The aim of successful calf rearing (suckled and dairy calves) is to produce a healthy calf which is capable of optimum performance throughout its life from birth through to finishing. A suitable calf rearing system has the following characteristics:

Good animal performance with minimal disease and morbidity and optimal growth rates
Low cost input
Low labour input

The survival of the calf involves all of those factors, plus a suitable post-birth environment, management and nutrition (Fallon *et al.*, 1998). Immunity against infectious diseases is a complex phenomenon, involving interaction between different cell types, each having unique function(s). The immune response is classified into two main categories: (1) humoral immune response, also known as antibody mediated immunity, passive immunity through colostrum and (2) cell-mediated immunity B cells produce the antibodies, which circulate in the blood.

***<u>Colostrum</u>***

The first and most important feed given a newborn dairy calf is colostrum. Maternal colostrum provides the main source of immunoglobulins (Ig) for the newborn calf. Immunoglobulins help to maintain the animal's health and reduce mortality rates by helping to eliminate foreign organisms from the body such as bacteria and viruses. In the bovine species, Ig do not cross the placenta *in utero* therefore, the newborn calf is dependent on antibodies obtained through ingestion of colostrum. Approximately 80% of all Ig in colostrum are of the IgG class thus, $IgG_1$ plays a critical role in Ig participation in pathogen clearance. IgA comprise 8 to 10% of bovine colostral Ig, while IgM make up 5 to 12%. These two types provide immunity against systemic infections.

Considerable variation exists between cows with respect to Ig concentration in the colostrum. A large difference in colostrum Ig concentration exists between beef and dairy cows (Table 1). High-yielding cows (Holstein) produce more dilute colostrum resulting in reduced IgG concentrations. In general heifers produce less colostrum compared with cows. It is of vital importance that all calves are fed 2 litres of colostrum within one hour of birth and receive a second 2 litre feed 4 to 6 hours later. Thus, Holstein x Fresian calves should be assisted to suckle or hand fed 4 litres of colostrum in two feeds within 6 hours of birth as the ability to absorb antibodies decreases over time and is finished within 24 hours of birth. The problem of low serum antibody levels with dairy calves is increased due to the use of high-yielding cows.

**Table 1. First milking colostrum $IgG_1$ (mg/ml) concentration**

| Cow breed | $IgG_1$ (mg/ml) |
|---|---|
| Charolais | 159 |
| Limousin x Friesian | 170 |
| Simmental x Limousin (x Friesian) | 168 |
| Holstein x Friesian | 83 |

Factors affecting calf serum Ig concentrations are:

- Ig concentration in colostrum,
- colostrum intake,
- Ig mass,
- calf age at first feeding,
- nutrition of the dam,
- method of ingestion,
- presence of the dam,
- age of the dam.

Studies at Grange Research Centre, reported that healthy calves had higher serum Ig ($IgG_1$) than calves treated for respiratory disease or enteric disease, indicating the importance of high serum Ig content to prevent disease (Earley and Fallon, 1999; Earley *et al.*, 2000; Earley *et al.*, 2002). It is well recognised that Ig are absorbed from the intestine for only a short period post birth and that efficiency of absorption is dependent on ensuring that the calf receives adequate colostrum in the immediate post-partum period. The ultimate level of serum Ig achieved by the calf will depend on the total mass of Ig absorbed, which is a function of the Ig concentration of colostrum and the total amount of colostrum ingested during the period of maximum absorption. By feeding adequate quantities of colostrum to the calf immediately following birth and during the first 24h post birth, the incidence of *E. coli* septicaemia should be diminished. Colostrum feeding should continue as long as possible after birth. While Ig are not absorbed after 24 hours they continue to provide local protection in the intestinal tract.

**Calf mortality**

Calf mortality can best be subdivided into 4 main categories:

- Abortions (foetal loss at less than or equal to 270 days gestation).
- Perinatal mortality (foetal loss at greater than 270 days gestation and mortality during the first 24 hours of life).
- Neonatal mortality (calves born alive that die between 24h and 28 days).
- Older calf mortality (calves born alive that die between 29 and 84 days).

Morbidity and mortality of the young calf represent a major cause of economic concern for beef producers. Septicaemia and enteric disorders (scours) caused by strains of *Escherichia coli, Rotavirus, Neospora, Coronavirus, Cryptosporidium* or by *Salmonella* species are the main cause of neonatal mortality. Older calf mortality is mainly dominated by respiratory infections and salmonellosis. Disease is not a simple matter of exposure of a susceptible animal to an infectious agent such as a bacterium, virus or fungus. Calves are exposed to infectious organisms from the moment of birth, and natural defence mechanisms usually prevent the establishment of disease. Animals develop disease because of a complex relationship between the host (animal), the infectious agent (bacterium, virus, fungus, or toxic agent), and the environment. Control is largely based on prevention of exposure and immunity.

A disease prevention programme in the young calf should include:

- A clean calving area, which prevents the build up of infection. Clean and disinfect the calving box after each calving.
- Have a policy in place that ensures that the calf has an opportunity to obtain adequate quantities of colostrum as soon as possible after birth.
- If Johne's disease is a problem or potential problem - separate all suspect cows from the rest of the herd and keep all female calves away from suspect cows at and following calving.
- Post calving: provide suckler calves with a clean environment either indoors or outdoors that minimises disease build up. Do not add newborn calves to an indoor environment that has been or is being used to house older calves.
- Rear calves outdoors where practical.
- Health check - daily or ideally twice a day health checks should be undertaken to determine if animals are ill. If an illness is suspected in an animal, one should observe the animal's body temperature, breathing and heart rate. If an abnormality is suspected in the vital functions, suspect an underlying illness and be prepared to call for veterinary help.

Use the following as a general guide in a health check

Important characteristics of healthy calves

| | |
|---|---|
| Body temperature: | 38.5 to 39.5$^{\circ}$C |
| Pulse: | 72 to 92, strong and regular |
| Breathing: | Calm, regular, even. Respiratory rate: 20 to 40 per minute |
| Elasticity of the skin: | Raised skin fold immediately level out again (within 1 or 2 seconds). |

**Calf Diseases**

Calf diarrhoea:

Outbreaks of diarrhoea in calves are associated with the interaction of potentially pathogenic enteric microorganisms with the calf's immunity, nutritional state and environment. An outbreak may be triggered by a single infectious agent but is mainly due to mixed infections. The most common organisms involved are *Escherichia coli.*, *Salmonella species*, *Rotavirus*, *Coronavirus* and *Cryptosporidium*. Dehydration, acidosis, impaired growth rate or death are the major consequences.

*Escherichia coli infections (colibacillosis):* To be enteropathogenic, *E. coli* strains must be able to adhere to the small intestine. The K99 antigens allow adherence of the organisms to the mucosal wall. *E. coli* then produces an enterotoxin that causes excess secretion of fluid into the intestinal wall resulting in diarrhoea. Loss of body fluids in this way leads to dehydration. In animals deprived of colostrum, in particular the Ig subclass IgM, a rapidly developing shock-like syndrome (circulatory failure) occurs which results in sudden death.

*Salmonellosis:* Salmonellosis in calves is mainly caused by the organisms *Salmonella dublin* or *Salmonella typhimurium*. *Salmonella typhimurium* DT104 is highly pathogenic to calves, resulting in a high incidence of mortality. Furthermore, it has a wide range of antibiotic resistance and is capable of rapidly developing new resistance patterns. It is also an important cause of human food poisoning. In acute cases of calf salmonellosis, a septicaemia may occur, accompanied by blood stained diarrhoea. Calves that are affected more severely have an elevated body temperature (greater than 40$^{o}$C) are debilitated and have reduced feed intake. The calf may become infected as early as the second day of life with highest incidences occurring at 1 to 5 weeks of age. Outbreaks of *Salmonella typhimurium* are usually associated with purchased calves. Salmonellosis superimposed on calves with pre-existing pneumonia, cause an exacerbation of clinical signs and pulmonary damage.

A number of preventative measures have been adopted to control calf diarrhoea

- Vaccination of the dam against *E. coli* infection.
- Hyper-immunisation of the dam with the *E. coli* antigen provides passive immunity to the calf (via ingested colostrum) during the first 2 to 3 weeks of life, i.e. before it can produce its own antibodies.
- It is of vital importance that all calves are fed 2 litres of colostrum within one hour of birth and receive a second 2 litre feed 4 to 6 hours later. There is no merit from having enhanced quality colostrum from vaccination of the cow unless that colostrum is fed to and ingested by the calf.
- If salmonellosis is a problem on the farm then ensure a policy of vaccination of the calves. Similarly when purchasing calves, employ a programme of refusing to purchase any ill calves and vaccinating all calves on arrival using an appropriate vaccine against salmonella.
- Have your veterinary practitioner identify the causal organism causing the diarrhoea so that the most appropriate antibiotic treatment can be employed.
- A calf with diarrhoea will have a significant loss in body fluid so oral rehydration with an electrolyte solution should be immediately used to assist recovery.

**Calf pneumonia**

The underlying cause of bovine respiratory disease (BRD) is extremely complex with the involvement of viruses, bacteria and *Mycoplasma*. The incidence of infection (morbidity) is usually high, but the mortality rate is variable. Predisposing factors affecting ability to fight infection are stress, overcrowding, inadequate ventilation, draughts, fluctuating temperatures, poor nutrition and/or concurrent disease. In most cases it would appear that the primary infective agent is viral, producing respiratory tract damage that is subsequently extended by *Mycoplasmas* and secondary bacterial infections. Viruses are unaffected by antibiotics, however, antibiotic treatment is usually administered to kill off secondary bacterial infections and offer the calf the opportunity to fight the disease. *Mycoplasma* species are resistant to antibiotics that act on the cell wall and an antibiotic specific to the cell nucleus is required to inactivate it. In order to direct the appropriate treatment strategy, nasal swabs should be submitted to the Regional Veterinary Laboratory for accurate identification of the pathogen(s) involved. In addition, *Mycoplasmas* are known to suppress the calf's immunity to disease. Of the *mycoplasmas*, *M. bovis* is the most pathogenic and can act in unison with *Pasteurella species* to produce a very severe form of pneumonia. Following suppression of immunity the animal's ability to withstand an attack from *Pasteurella* and other organisms is reduced. *Pasteurella haemolytica* is an important secondary agent in respiratory disease.

### Vaccination against Respiratory Disease

Numerous vaccines provide a range of combinations of live and/or killed antigens. These include IBR, RSV and PI-3 Pasteurella spp. and *Haemophilus somnus*. Intramuscular modified-live virus vaccines quickly induce long-lasting immunity. Intranasal modified-live virus vaccines induce immunity at the mucosal surface. However, experience at Grange has shown that response to these vaccines were only evident in calves over two months of age when their own immune system was active. It is difficult to successfully vaccinate young calves against these diseases because protective colostral antibodies block the vaccine, resulting in maternal antibody interference of vaccination. The *Pasteurella* organisms and other bacteria that cause pneumonia are notoriously poor immunizers. Development of effective vaccines has been difficult. High serum Ig concentrations in young calves have a positive effect on reducing the incidence of respiratory disease. A study at Grange on purchased Friesian calves found that the incidence of respiratory disease and enteric disease and the requirement for frequent treatments was lower in dairy calves with a higher Ig concentration (Earley *et al.*, 2000).

Respiratory disease prevention should include:

- Housing with good ventilation and adequate space allowance.
- Avoid mixing old and young calves.
- Purchase calves in batches and operate an "all in - all out" policy.
- Clean disinfect and rest houses between batches.
- Avoid wet lying conditions and provide the young calf with shelter.

### Animal Welfare Research

Research at Grange has focused on 4 main husbandry management practices, namely, castration, weaning, housing and transportation. The main findings are summarised as follows:

Castration

Castration is performed on calves because it reduces management problems associated with aggressive and sexual behaviour of bulls. The main castration techniques used include rubber rings or latex bands (to restrict flow of blood to the scrotum), the bloodless burdizzo method (crushes spermatic cords) and surgery.

*Burdizzo castration*

Based on the principle that crushing destroys the spermatic cord carrying blood to the testicles, which subsequently atrophy but that the skin of the scrotum remains intact and because of the lack of open wounds the potential for haemorrhage or infection is minimised. A Burdizzo or clamp is used to crush the spermatic cord, but the blood supply to the scrotum remains preserved. Each spermatic cord is crushed twice (second crush below the first) for 10 s each along the neck of the scrotum with the Burdizzo to ensure completeness of the castration procedure.

*Banding castration*

This procedure involves the application of a specially designed elastic band with the aid of an applicator around the neck of the scrotum, proximal to the testicles. This will cause necrosis of the testicles, eventually leading to testicular atrophy and sloughing of the scrotum. Small rubber rings are used for calves less than one month of age (rubber ring castration), while for older calves, heavy-wall latex bands are used along with a grommet to securely fasten the tubing at the appropriate tension. Tetanus has been reported in banded animals therefore animals should receive a tetanus prophylaxis to minimise the risk.

*Surgical castration*

This is a surgical procedure involving the opening of the scrotum with a sharp blade and removal of the testicles by severing them from the spermatic cords. This is the most reliable method of castration. Asceptic conditions are vital and post-castration attention is necessary to ensure the prevention of bleeding and infection. A study in 2005 compared burdizzo and banding castration using 12 month old bulls, the results showed that there were no significant differences in the performance of animals that were castrated using either burdizzo or banding castration (Table 2).

A series of recent castration studies found that;

Surgical castration induced a greater stress response than bloodless "Burdizzo" castration.

Calves at 47 days of age exhibited lower stress responses (plasma cortisol and inflammatory responses) to burdizzo castration than older calves (76 to 165 days of age).

Systemic analgesia with a non-steroidal anti-inflammatory drug (ketoprofen) was more effective than local or epidural anesthesia in lowering stress levels (Earley and Crowe, 2002).

The pain-associated behavioural responses were similar following either burdizzo or surgical castration.

**Table 2. Performance (Mean total kg gained ± s.d.) of animals 0-12 weeks following banding and burdizzo castration compared with intact (control) bulls on four different farms in 2005. The numbers (n) of animals used per treatment are in brackets.**

| Castration | Farm 1 | Farm 2 | Farm 3 | Farm 4 |
|---|---|---|---|---|
| Banding | 60.7±16.3 (n = 35) | 68.4±26.9 (n = 28) | 58.7±32.1 (n = 12) | 70.8±21.1 (n = 17) |
| Burdizzo | 59.4±17.9 (n = 34) | 65.5±25.4 (n = 31) | 59.2±29.8 (n = 13) | 86.7±19.8 (n = 16) |
| Control (Intact bulls) | 73.1±24.4 (n = 33) | 99.3±28.6 (n = 29) | 88.8±22.3 (n = 13) | 103.7±18.5 (n = 18) |

Weaning

Weaning of the suckled calf from its dam can be particularly stressful for the calf and may be compounded by several other stressors, e.g. change of diet (grass and milk to conserved feed with or without concentrates), change of environment (outdoors to indoors), transport/marketing, de-horning and castration. As with the young calf the underlying cause of bovine respiratory disease (BRD) in weaned calves is extremely complex with the involvement of viruses, bacteria and mycoplasma. In most cases it would appear that the primary infective agent is viral, producing respiratory tract damage that is subsequently extended by *Mycoplasmas*, and secondary bacterial infections, *Pasteurella*. Predisposing factors affecting the calf's ability to fight infection are stress, overcrowding, inadequate ventilation, draughts, fluctuating temperatures, poor nutrition and/or concurrent disease. Suckled calves that have been eating 1 kg of concentrates/day in the 5-6 week period before weaning are less stressed at weaning than calves that have not been introduced to meals. Veterinary advice should be sought for a suitable vaccination programme and the widest protection will be achieved where the programme includes *Pasteurella* and the two most common respiratory viruses, RSV and P1-3. Hickey *et al.* (2003a) examining the effect of combined psychological and nutritional stress of maternal separation concluded that farm management practices at weaning should aim to minimise the social distress of calves during this time and allow calves a period of adaptation before other management stresses are imposed.

- Abrupt weaning should be avoided.
- Stress following weaning will be reduced if calves are consuming 1 kg of creep feed daily prior to weaning.
- Keep the herd in a properly fenced field with a good grass supply or with silage (or hay) supplementation and remove the cows gradually (up to one-quarter on any one occasion) to a location away from the calves. During this period the concentrate creep can be increased gradually to about 1 kg per calf daily.
- If cows and calves are housed together after weaning, then they should be housed in adjoining pens with calves having access to the cows for up to two weeks while getting accustomed to their new diets. Concentrates should be introduced gradually to the calves at this time if they have not been previously creep fed.
- Dehorning or castration should not be carried out in the four-week period before or after weaning.
- Similarly, immediate sale and transport will lead to undue stress, which could give rise to respiratory problems.

<u>Transportation</u>

The transport of livestock can have major implications for their welfare, and there is strong public interest and scientific endeavour aimed at ensuring that the welfare of transported animals is optimal. Teagasc, conducted a series of scientific studies to evaluate the effects of 1). transport by land and sea journeys (roll-on roll-off), and 2). stocking density, on the welfare of cattle transported within Ireland, from Ireland to Spain and from Ireland to Italy under conditions outlined in Directive 91/628/EEC.

- Transport from Ireland to Spain and Ireland to Italy had no adverse effect on animal welfare based on physiological, haematological and immunological measurements.
- There was no welfare advantage in transporting young bulls (230 kg) at 1.27m$^2$ versus the standard stocking density of 0.85m$^2$ on a 12-hour road journey. Within the conditions of the transport studies, and based on the physiological, haematological and immunological measurements that were made in assessing the welfare of control and transported animals, transport had no adverse effect on animal welfare (Earley *et al.*, 2005a; Earley *et al.*, 2005b).
- There was no significant effect on rectal body temperature, pre and post transport and in live weight among treatments on days 0 (pre-transport), 1, 4 and 10 (post-transport) on animals fasted or not fasted for 8 hours prior to an 8-hour road journey and their ability to cope with the stress of transport.
- Animals that were fasted and then transported lost 9.4% bodyweight following the 8-hour journey, while non-fasted and transported animals lost 7.2%. The control animals remaining at grass and non-fasted gained 2%.

It was concluded that, there was no evidence to suggest, under the conditions applicable to the transport studies, that transport adversely affected the performance of animals post-transport.

Housing

The welfare status of an animal is dependent on its ability to cope and exist in harmony with its environment, such that good physical and psychological health is maintained. Unlike other farm production systems (poultry, pigs and housed calves) a European legislative directive on the welfare of housed finishing cattle during housing is still outstanding. In many Irish beef production systems, animals are generally housed in a concrete slatted-floor shed for a 4-5 month winter period at a stocking density of 2.2 $m^2$/head for 500 kg animal (Dodd, 1985) and generally fed *ad libitum* grass silage with concentrate supplementation. High stocking densities of less than 2.0$m^2$/head have been shown to adversely affect animal performance and the frequency and duration of lying and levels of aggression within groups.

A series of studies from Teagasc, Grange Research Centre, can be summarised as follows:

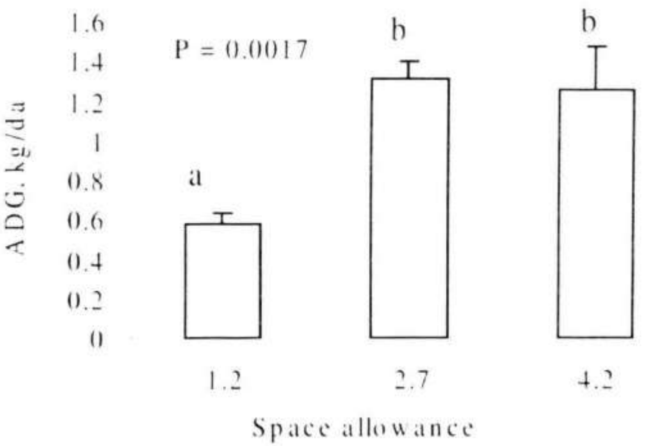
- Fisher *et al.* (1997) examined the effect of space allowance (1.5, 2.0, 2.5 and 3.0 $m^2$/head) on the welfare of finishing heifers housed for a three month period on slats. They found that there was no effect of treatment on the measured immune response.
- However the animals at the 1.5 $m^2$/head had a lower ADG. Hickey *et al.* (2003b) found that a space allowance (1.5, 2.0, 3.0 and 4.0 $m^2$) below 3.0 $m^2$ significantly reduced both feed intake and ADG (Table 3). However, irrespective of treatment, animal social and stereotypic behaviour was found to continually alter with extending housing duration (Hickey *et al.*, 2003b) and restricted spatial allowances in slatted floor facilities may present a challenge to the animal's ability to cope with housing stress. The measured welfare indices of animals housed on slats at 4 $m^2$/head did not differ from those of animals housed on straw, with the exception that the daily time spent lying increased from 12.3 to 13.5 h for the straw bedded animals.
- The housing of finishing bulls at a reduced space allowance of 1.2 $m^2$ (vs. 2.7 and 4.2 $m^2$) (Figure 1) significantly reduced animal growth without causing substantial effects on immune function (Gupta *et al.*, 2005).
- Long distance transport of weanlings under current EU legislation does not adversely affect the performance of animals post-transport.
- Mixing of weanlings during housing from different sources is likely to cause BRD when compounded with other stressors.

**Table 3. The effect of space allowance and floor type on animal performance**

| | Space allowance ($m^2$/hd)[w] | | | | | |
|---|---|---|---|---|---|---|
| **Parameter** | **1.5** | **2** | **3** | **4** | **4 straw** | **sig.** |
| Average daily live wt. gain (kg/d) | $0.60^b$ | $0.80^b$ | $1.10^a$ | $1.10^a$ | $1.10^a$ | *** |
| Final carcass wt. (kg) | $315.5^d$ | $323.0^c$ | $334.3^b$ | $341.6^a$ | $341.3^a$ | *** |
| Kill out proportion | $0.552^a$ | $0.549^{ab}$ | $0.535^b$ | $0.541^{ab}$ | $0.541^{ab}$ | * |
| Initial carcass wt (kg) | 268.7 | 265.9 | 269.7 | 269.5 | 269.7 | ns |
| Daily carcass gain (kg/d) | $0.48^a$ | $0.59^{ab}$ | $0.67^b$ | $0.74^b$ | $0.74^b$ | *** |
| Conformation score [x] | 1.9 | 1.8 | 2.0 | 2.1 | 2.1 | ns |
| Fat score [y] | 3.9 | 4.1 | 4.3 | 4.1 | 4.3 | ns |
| Kidney & channel fat (g/ kg carcass) | $40.8^c$ | $43.1^b$ | $47.3^a$ | $43.0^b$ | $46.8^a$ | * |
| Feed conversion efficiency [z] | $20.6^b$ | $19.0^b$ | $18.2^{ab}$ | $16.0^a$ | $15.9^a$ | * |

[w]Within rows, means without a common superscript are significantly different ($p<0.05$)
[x] Scale 1 to 5 (best conformation)
[y] Scale 1 to 5 (fattest)
[z] Feed conversion efficiency (FCR) = kg DM intake/kg carcass gain

**Figure 1. Effect of housing bulls at 1.2, 2.7 or 4.2 $m^2$ average individual space allowance on average daily gain (mean ± SEM; kg/day) from day 0 to 91**




**Conclusion**

Within any health management programme it is important to provide routine, planned procedures that will prevent or minimize disease.

- Reduce the risks of disease in the young calf by reducing the level of exposure and using natural colostrum antibodies for protection.
- Vaccinations help reduce the probability of disease but cannot solely be depended upon for prevention therefore, use where appropriate to protect against disease.

- Reduce stress at weaning through a planned approach to avoid multiple stressors acting in unison.
- Young animals are less stressed by castration compared to older animals.
- Banding castration is a viable alternative to Burdizzo castration.
- During the housing period, animals should have adequate space allowance to facilitate ease of movement and avoid overcrowding which impacts negatively on animal performance and welfare.

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# Efficient and Profitable Production of Quality Beef

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## Introduction

Beef production is currently in the process of transition from an environment in which decisions were often subsidy-driven, to a market-driven, subsidy-free system. To achieve positive net margins from beef production, producers will need to improve efficiency of productivity, whilst at the same time a significant increase in market value will be required for quality product. In 2004 the total subsidy received by beef cattle equated to the equivalent of approximately €1.60/kg of carcass beef produced. Currently greater than 55% of beef producers are part-time and it is projected that this figure will increase dramatically in the future.

To remain profitable in beef production, producers will need to increase output per labour unit, improve efficiency and obtain a higher return from the market place to offset the loss of €1.60/kg carcass in subsidy foregone. The aim of the current paper is to highlight potential savings that can be made in the costs of beef production, based on experimental data from recent studies undertaken by the Beef Unit at the Agricultural Research Institute of Northern Ireland (ARINI). Where financial data are presented, an exchange rate of £0.70 per €1 is assumed.

## Improving genetics of the suckler herd

Recent research on 43 commercial beef farms across Northern Ireland (Keady *et al.*, 2004b) evaluated the effects of 10 of the most common suckler cow genotypes on progeny carcass characteristics and subsequent reappearance rate. Results are presented in Table 1. Choice of suckler cow genotype can alter progeny carcass value by up to €47/head and reappearance rate at day 390 (number of cows producing another calf within 390 days) by 10 percentage units.

**Table 1. The effect of suckler cow genotype on progeny carcass characteristics and subsequent dam reappearance rate**

| Dam genotype | Reappearance @ 390 days (%) | Carcass Weight (kg) | Carcass Value (€) |
|---|---|---|---|
| Limousin x Simmental | 55 | 309 | 740 |
| Angus x Holstein/Friesian | 52 | 315 | 750 |
| Simmental x Holstein/Friesian | 49 | 318 | 759 |
| Hereford x Holstein/Friesian | 54 | 319 | 760 |
| Angus | 45 | 320 | 761 |
| Simmental | 50 | 320 | 767 |
| Charolais | 48 | 322 | 774 |
| Limousin x Holstein/Friesian | 53 | 322 | 771 |
| Limousin | 46 | 325 | 781 |
| Simmental x Charolais | 55 | 326 | 787 |

(Keady *et al.*, 2004b)

It should be noted that cows consisting of 50% of 2 breeds, e.g. Limousin x Holstein/Friesian, had better fertility than cows comprising predominantly of one breed, e.g. Angus, probably due to hybrid vigour effects. Consequently whilst there is potential between the worst and best cow genotypes to increase progeny carcass value by up to €47/head, realistically on most farms, when progeny carcass value and fertility are considered, the potential is approximately €28/head, which is equivalent to 8 c/kg carcass.

Terminal sire

The effect of choice of terminal sire breed was evaluated on 43 commercial beef farms across Northern Ireland (Kirkland *et al.*, 2004a) and results are presented in Table 2. Choice of terminal sire breed can alter progeny carcass value (using current payment schemes in Northern Ireland) by up to €89/head and subsequent cow reappearance rate by 13 percentage units. Furthermore choice of terminal sire can have a major influence on herd output due to potential impacts on calving difficulty and subsequent cow fertility.

**Table 2. The effect of sire breed on progeny carcass characteristics, calving difficulty and subsequent suckler cow reappearance rate**

| Sire breed | Calving difficulty* | Reappearance @ 390 days (%) | Carcass | |
|---|---|---|---|---|
| | | | Weight (kg) | Value (€) |
| Angus | 146 | 53 | 306 | 721 (785)** |
| Saler | 164 | 50 | 307 | 720 |
| Limousin | 150 | 44 | 318 | 764 |
| Simmental | 158 | 47 | 318 | 759 |
| Charolais | 154 | 50 | 324 | 777 |
| Blonde | 149 | 52 | 327 | 786 |
| Belgian Blue | 169 | 40 | 334 | 809 |

* Calving difficulty: 100 = unassisted, 500 = Caesarean section

**Including AA Bonus Scheme

(Kirkland *et al.*, 2004a)

The results indicate that the Charolais and Blonde breeds produced high value carcasses without adverse effects on subsequent fertility (as assessed by reappearance rate) or calving difficulty. Consequently whilst there is potential to increase carcass value by up to €89/head, realistically, as most farmers are already using the better breeds, the potential is approximately €29/head, which is equivalent to 9c/kg carcass.

Fertility

Infertility is a major cost to the beef industry. Fertility in the suckler herd can be assessed either as weaning rate or reappearance rate. The target weaning rate is 95 calves weaned/sold per 100 cows put to the bull. Alternatively, the target reappearance rate by day 390 post calving is 78%. This allows a 22% annual culling rate. In the recent on-farm study on 43 farms across Northern Ireland (Keady et al., 2004b), on average only 51% of suckler cows produced another calf by day 390 post-calving. In the past many cows may have been retained in the herd because of their need to draw down the suckler cow quota and their low cull value relative to the higher value of potential replacement heifers when sold in the market. The top 20% of farmers based on reappearance rate, in the on-farm study attained reappearance rates at day 390 post-calving of 68%. Whilst there is a potential benefit from improved fertility of over €140/head on some farms, realistically on most good farms the potential for improvement is approximately €57/head, due to an improvement in reappearance rate by day 390 of 10%, which is equivalent to 17 c/kg carcass.

Source of replacements

Traditionally suckler cow replacements were sourced from the dairy herd. However, recently many producers are sourcing their replacements from within their own herds due to potential detrimental effects of increasing Holsteinisation of the dairy herd on progeny carcass conformation and perceived effects on herd fertility. Results from an on-farm study in Northern Ireland (Kirkland *et al.*, 2004b) using 5000 cows indicate that:

1. Continental x Holstein-Friesian cows bred from the dairy herd produced progeny of similar carcass weight and value to those produced from fl or more continental dams bred from the beef herd.
2. Angus or Hereford x Holstein Friesian dams produce progeny with the lightest, fattest and poorest conformed carcasses.
3. Cows that were fl or more continental had poorer fertility than continental cross Holstein Friesian dams.

Consequently, replacement suckler cows can be sourced from either the dairy herd, or within the beef herd, producing progeny of similar carcass value. However, sourcing replacements from within the beef herd restricts the choice of terminal sire breeds that can be used, and this can reduce progeny carcass value. For example in a 100-cow herd, to obtain 20 replacements it will be essential to rear 25 heifer calves. To obtain 25 heifer calves, at least 50 cows will need to be bred to the desired breed. Consequently, when the male and unmated female progeny are being sold, a loss in income of up to €89 per carcass due to reduced carcass weight and conformation score could be sustained, which when spread over the whole herd is equivalent to a loss of 13 c/kg carcass. It makes more financial sense to breed the entire suckler herd to the best terminal sire breeds and to purchase suckler cow replacements from dairy farmers or other beef producers.

**Nutrition of cattle in the growing and finishing periods**

Grass silage

Grass silage is still the basal forage for the majority of beef cattle during the indoor feeding period in Ireland. The feeding value of grass silage is determined by its intake potential and digestibility characteristics and this has a major impact on animal performance. Previous studies (Steen, 1987) have shown that each one unit increase in silage digestibility increases carcass gain by 28 g/head per day. Harvest date is the most important factor affecting silage digestibility. For each week delay in harvest date, digestibility declines by approximately 3.5 units of DMD (Keady *et al.*, 1999; Keady *et al.*, 2000). Consequently, to maintain performance of beef cattle, an additional 1.2 kg of concentrate per day is required for each week delay in harvest date, due to decreased silage digestibility and lower intake characteristics. In order to produce high DMD grass silage, aim to harvest the first cut by mid May and subsequent cuts at 6-7 week intervals.

The majority of beef producers produce medium feed value grass silage. Potentially they could increase silage DMD by up to 10 units of DMD, but an increase in silage DMD of 5% units is probably more realistic, equivalent to €71/head over a finishing animal's lifetime, which equates to 22 c/kg carcass.

Grazing management

Grass forms a major part of the diet of beef cattle during their lifetime. Grass quantity and quality, as well as previous plane of nutrition, are the major factors affecting animal performance during the grazing season. However, it is essential that lifetime performance be maximised rather than performance during the grazing season alone. Previous studies (Steen 1996a) have shown that in a set stocking situation, grass height should be maintained at 9 cm to maximise beef cattle performance.

In a paddock grazing situation, to achieve maximum levels of gain, swards should be grazed down to 6 cm from April - June, increasing to 8 cm in August and 10 cm in September. To maintain sward height the stocking density needs to be adjusted during the grazing season. For example, the stocking rate in the autumn would need to be approximately 25-50% of that in the early grazing season. Performance in the late grazing season is often below expectation due to a shortage of grass as a consequence of high stocking rate.

Recent studies (Keady *et al.*, 2005a) have shown that during the grazing season the same level of performance can be obtained by either decreasing stocking rate by 30% or by supplementing with 200 kg concentrate/head. Consequently good grassland management can potentially reduce costs of production by €35/head or 11 c/kg carcass, equivalent to the cost of 200 kg concentrate/head.

Alternative forages

Currently there is considerable interest in the use of alternative forages, particularly maize, because of their potentially lower cost of production relative to grass silage (Keady *et al.*, 2002) (Table 3). Furthermore the development of the complete cover plastic mulch (CCPM) system for maize production has enabled the use of higher yielding, later maturing varieties coupled with earlier sowing dates (Keady 2005). Recently Keady *et al.* (2005b) evaluated the effect of including maize and whole crop wheat silages in medium feed value grass silage (70 DMD) based diets for finishing beef cattle (Table 4). Including whole crop wheat as 40% of the forage component of the diet increased feed intake, did not alter carcass gain and decreased margins by €14/head, which is equivalent to a reduction of 4 c/kg carcass. In contrast, inclusion of maize silage increased carcass weight by 14 kg and margin over feed by €22, which is equivalent to 7 c/kg carcass.

**Table 3. The relative costs of forage production (all production costs including land charge)**

| Forage | Cost (€/t DM consumed) | Relative cost |
|---|---|---|
| Grazed grass | 104 | 100 |
| 3-cut silage | 121 | 116 |
| 4-cut silage | 136 | 131 |
| Fermented whole crop | 126 | 121 |
| Maize - no plastic | 134 | 129 |
| - plastic | 110 | 106 |

(after Keady *et al.*, 2002)

**Table 4. The effect of including maize and whole crop wheat on beef cattle performance during a 150 day finishing period**

| | Forage | | |
|---|---|---|---|
| | **Grass silage only** | **Maize + grass silage** | **Whole crop + grass silage** |
| Forage intake (kg/day) | 5.0 | 5.8 | 5.8 |
| Carcass weight (kg) | 326 | 340 | 324 |
| Margin over Feed (€/head) | 41 | 63 | 29 |

(Keady *et al.*, 2005b)

Stage of maize maturity at harvest and level of inclusion in the diet affects the response obtained to maize silage inclusion in beef finishing diets. Keady and Gordon (2006) (Table 5) concluded that the affect of stage of maturity of maize at harvest on subsequent animal performance was dependant on the level of inclusion in the diet. Including either low or high dry matter maize as 0.5 of the forage component of the diet increased carcass gain, due to increased forage intake, and margin over feed. However, when maize replaced grass silage as the forage component of the diet, low dry matter maize did not improve forage intake or carcass gain, whilst high dry matter maize silage increased carcass gain and margin over feed by €42 relative to grass silage offered as the sole forage. Furthermore, it was concluded that including low and high dry matter maize as 50% of the forage component or feeding *ad-libitum* reduced the required concentrate feed level by 1.3, 1.3, 0 and 2.5 kg/head per day to achieve the same carcass gain as feeding grass silage as the sole forage (Keady and Gordon, 2006)

**Table 5. Effect of maturity of maize at harvest and level of inclusion on animal performance during a 150 day finishing period**

| | Treatment | | | | | |
|---|---|---|---|---|---|---|
| | **Grass** | **Low DM Silage** | **High DM maize & grass silage** | **Low maize & grass silage** | **High DM maize** | **DM maize** |
| **Concentrate feed level (kg/d)** | **4** | **8** | **4** | **4** | **4** | **4** |
| Forage intake (kg DM/day) | 5.0 | 3.2 | 5.6 | 5.9 | 4.9 | 6.5 |
| Carcass weight (kg) | 351 | 388 | 364 | 363 | 348 | 373 |
| Carcass gain (kg/d) | 0.48 | 0.73 | 0.56 | 0.56 | 0.46 | 0.63 |
| Fat classification | 3.0 | 3.7 | 3.3 | 3.5 | 3.1 | 3.3 |
| Margin over feed (€/head) | 32 | 53 | 53 | 54 | 23 | 74 |

(Keady and Gordon 2006)

The value of maize silage, at different dry matter concentrations, relative to barley at 15% moisture content, at different prices, is presented in Table 6. A cost of €14/t has been included in the barley price to cover processing costs. On a per tonne of dry matter basis, 30% dry matter maize is valued at 5% more per tonne relative to 20% dry matter maize to reflect the higher feeding value of high dry matter maize. An allowance for 10% dry matter losses is included for in-silo and feed-out losses with maize. Furthermore, it is assumed that metabolisable energy from maize silage is utilised at 95% of the efficiency of metabolisable energy from barley. The price is per tonne of forage exiting the field, haulage for up to 5 miles and ensiling. Thereafter it is up to the purchaser to carry the cost of haulage over longer distances. For example a 30% DM forage maize crop is worth €32.60 per t fresh compared to barley (15% moisture) at €121/t.

**Table 6. The value of forage maize (€/tonne fresh weight) relative to barley**

| Cost of barley@ 15% moisture (€/tonne)* | Forage maize (% dry matter) | | | | |
|---|---|---|---|---|---|
| | **22** | **26** | **30** | **34** | **38** |
| 114 | 21.7 | 26.1 | 30.7 | 34.1 | 37.4 |
| 121 | 23.0 | 27.7 | 32.6 | 36.3 | 39.7 |
| 128 | 24.4 | 29.4 | 34.7 | 38.6 | 42.3 |
| 136 | 26.1 | 31.0 | 36.6 | 40.6 | 44.6 |
| 143 | 27.1 | 32.7 | 38.4 | 42.7 | 46.9 |
| 150 | 28.4 | 34.3 | 40.4 | 44.9 | 49.3 |

*Includes a €14/t processing charge
(After Keady, 2004)

Supplement management

Purchasing grain off the combine at harvest provides an opportunity to reduce supplement feed costs. Traditionally grain was either dried or treated with propionic acid and processed prior to feeding. Recent innovations in grain management have resulted in the development of crimping and urea treatments in which grain is harvested at approximately 30 to 35% moisture. For crimping, grain is passed through a crimper, cracking the grain, which is then treated with an additive to prevent aerobic deterioration, ensiled in a conventional silage pit and compacted. Urea treatment involves mixing the grain with urea and water in a forage wagon and then ensiling in a conventional silage pit. Recently the effect of grain storage and processing method on performance of beef cattle has been evaluated (Keady and Kilpatrick, 2005). Grain was either conventionally stored, treated with propionic acid and rolled prior to feeding, crimped or urea-treated, and offered to finishing beef cattle (Table 7).

**Table 7. Effect of grain storage and processing method on performance of beef cattle**

| | Treatment | | |
|---|---|---|---|
| | **Propionic acid + rolling** | **Urea treated** | **Crimped** |
| Feed intake (kg DM/day) | | | |
| Silage | 4.2 | 4.7 | 4.4 |
| Grain | 4.7 | 4.7 | 4.7 |
| Total | 8.9 | 9.4 | 9.1 |
| Animal performance | | | |
| Liveweight gain (kg/day) | 1.04 | 0.98 | 1.04 |
| Carcass gain (kg/day) | 0.60 | 0.55 | 0.61 |
| Carcass weight (kg) | 338 | 333 | 341 |

(Keady and Kilpatrick, 2005)

Urea treatment increased silage intake, but reduced liveweight and carcass gains by 6 and 8% respectively. Crimping did not alter feed intake or animal performance compared to propionic acid treatment. Method of grain storage or processing did not alter kill-out percentage, carcass conformation or fat classification grades. Similarly in a more recent study Keady and Kilpatrick (2006a) reported carcass weights of 383, 375 and 385 kg for cattle offered conventionally stored (propionic acid treated and rolled prior to feeding), crimped and urea treated wheat respectively. Supplement costs may be reduced by purchasing grain off the combine at harvest and storing either treated with propionic acid and rolled prior to feeding or crimped and ensiled. When purchasing grain it is essential to value on a per tonne of dry matter basis. For example, if grain is valued at €110 at 20% moisture off the combine, it is worth €89, €96 and €103 per tonne fresh weight at 65%, 70% and 75% dry matter respectively.

A number of research studies have evaluated the feed and financial values of different straight feeds for feeding to finishing beef cattle when compared with barley and soyabean meal. Simple mixes of high quality straights can support high levels of animal performance. Using prices of straights obtained from merchants in the Midlands and Southeast with prices of €134/tonne and €236/tonne for barley and soyabean respectively, barley, maize distillers rapeseed and maize gluten are good value for money (Table 8).

More recently Keady et al. (2004a) have shown that when the same feed ingredients are included in the supplement, similar levels of animal performance are obtained when the supplement is fed either as a pelleted ration or coarse mix (Table 9). Consequently, there is potential on some farms to reduce supplement cost by over €21/tonne. However, on those farms currently feeding straights the potential is approximately €10/head, which is equivalent to 3 c/kg carcass.

**Table 8. Relative value of feedstuffs**

| Feedstuff | Protein content (%) | Metabolisable energy (MJ/kg) | Cost (€/t) | Value (€/t) |
|---|---|---|---|---|
| Energy sources | | | | |
| Rolled barley (14% MC) | 9.5 | 11.4 | 134 | 134 |
| Rolled wheat (14% MC) | 11 | 11.4 | 136 | 134 |
| Maize meal | | | | |
| - high silage | 8 | 13.2 | 178 | 154 |
| - high concentrate | | | | 168 |
| Citrus pulp | 6 | 10.6 | 127 | 117 |
| Soya hulls | 11 | 10.6 | 135 | 131 |
| Molasses | 4 | 8.0 | 142 | 88 |
| Unmolassed sugarbeet pulp | 9 | 10.6 | 155 | 125 |
| Protein sources | | | | |
| Soyabean meal 50 | 46 | 11.6 | 236 | 236 |
| Maize distillers dark grains | 26 | 11.6 | 140 | 181 |
| Maize gluten feed | | | | |
| - growing cattle | 18 | 10.9 | 133 | 153 |
| - finishing cattle | | | | 140 |
| Rapeseed | 36 | 10.8 | 150 | 201 |

**Table 9. Effect of supplement feeding management on animal performance**

| | Supplement preparation | |
|---|---|---|
| | Pelleted | Coarse |
| Supplement (kg/day) | 4.50 | 4.50 |
| Carcass gain (kg/day) | 0.50 | 0.52 |

(Keady *et al.*, 2004a)

<u>Gender</u>

With the cessation of the Special Beef Premium (SBP) many producers are interested in finishing male cattle intact as bulls rather than as steers. Previous research (Steen 1996b) evaluated the effects of finishing male cattle either as bulls or steers and compared them to heifers (Table 10). When slaughtered at a constant age, bulls had increased carcass weights of 43 and 69 kg relative to steers and heifers respectively. Furthermore all bulls achieved the premium conformation grades (E, U and R) whereas 12 and 10% of steer and heifers graded O respectively. In comparison to steers, carcasses of heifers were 26 kg lighter. Furthermore, the carcasses of heifers were fatter than steers with 60% and 30% of the heifer and steer carcasses grading fat class 4 respectively. Consequently when slaughtered at the same age, finishing cattle as bulls increases carcass weight by 43 kg (for an increased intake of only 4%) which is equivalent to €104 extra margin/head. In practice, finishing cattle as bulls could reduce average costs of production by €51/head, as half of the progeny from the beef herd are heifers. This saving is equivalent to 16 c/kg carcass.

**Table 10. A comparison of bulls, steers and heifers for beef production**

| | Gender | | |
|---|---|---|---|
| | Bull | Steer | Heifer |
| Feed intake (kg DM/day) | 9.2 | 8.8 | 8.3 |
| Liveweight gain (kg/day) | 1.30 | 1.10 | 0.96 |
| Carcass gain (kg/day) | 0.87 | 0.67 | 0.58 |
| Carcass weight (kg) | 353 | 310 | 284 |

(Steen, 1996b)

As the weight of finishing heifers and steers increases the food conversion ratio (FCR) increases (i.e. it takes extra feed to put on each kg of carcass). The genetic potential of progeny from the suckler herd has increased considerably in the last 20 years due to the increasing proportion of continental genetics. Recently the effects of weight at slaughter on animal performance of young bulls from the suckler herd have been evaluated. Keady and Kilpatrick (2006b) slaughtered bulls at different weights ranging from 500 to 800 kg (Table 11) and concluded that increasing the weight at slaughter did not alter daily liveweight, gain, carcass gain or kill out proportion. Whilst the FCR increased marginally from 9.5 to 10.6 kg feed/kg carcass at slaughter weights of 500 and 800 kg respectively, the data clearly illustrates that bulls from the suckler herd, even when slaughtered at heavy liveweights are extremely efficient in producing carcass weight. Furthermore these bulls could have been taken to heavier weights costs effectively provided that there is a market requirement.

Many producers finishing young bulls offer *ad libitum* concentrate diets. Keady and Kilpatrick (2006b) concluded that replacing 50% of an *ad libitum* concentrate diet with high feed value grass silage (Dry matter = 23.8%, DMD = 80%) resulted in the same daily liveweight gain and carcass classification but reduced carcass weight by only 7kg during a 240 finishing period (Table 12). Furthermore replacing *ad libitum* concentrate diets with a 50:50 high feed value grass silage:concentrate diet increased margin over feed by €22/head during a 240 day finishing period. Consequently young bulls from the suckler herd can be finished at heavy slaughter weights efficiently. Furthermore replacing concentrate with high feed value grass silage increases margin over feed.

**Table 11. The effect of young bulls from the suckler herd on animal performance**

| | Slaughter weight (kg) | | | |
|---|---|---|---|---|
| | 500 | 600 | 700 | 800 |
| Food intake (kg DM/day) | 8.2 | 8.6 | 8.9 | 9.3 |
| Liveweight gain (kg/day) | 1.6 | 1.6 | 1.6 | 1.6 |
| Carcass weight (kg) | 299 | 352 | 404 | 457 |
| Conformation[1] | 3.6 | 3.7 | 3.8 | 3.9 |
| Fat classification[2] | 3.0 | 3.0 | 3.1 | 3.1 |
| FCR[3] (kg food DM/kg carcass) | 9.5 | 9.9 | 10.4 | 10.8 |

[1]EUROP scale: 5,4,3,2,1 respectively

[2]EU fat classification, where 5 = fat, 1 = lean:

[3]Food conversion ratio

(Keady and Kilpatrick, 2006b)

**Table 12 The effect of diet type effect to young bulls on animal performance**

| | Diet type | |
|---|---|---|
| | 50:50 silage: concentrate | *Ad lib-concentrate* |
| Food intake (kg DM/day) | 8.7 | 9.0 |
| Liveweight gain(kg/day) | 1.6 | 1.6 |
| Kill out (%) | 57.4 | 58.4 |
| Carcass gain (kg/day) | 0.83 | 0.89 |
| Carcass weight (kg) | 394 | 401 |
| FCR (kg food DM/kg carcass) | 10.5 | 10.5 |

(Keady and Kilpatrick, 2006b)

Finishing male cattle as bulls increases food conversion efficiency and animal performance. However, care is required when handling these animals, particularly in a grazing situation. Ensure that there is a market outlet for bulls prior to proceeding to finish male animals intact.

**The future**

Maximum potential, and *potential in practice* for improvements in efficiency, which are possible on beef farms, are summarised in Table 13. The data in Table 13 demonstrate that if all the individual *potential in practice* improvements in efficiency in genetics of the beef herd and in nutrition during the growing and finishing phases were achieved, the cost of production could be reduced by up to 106 c/kg carcass. However, whilst all of these individual improvements are possible, they are not cumulative and consequently are not possible for every beef animal produced.

**Table 13. Opportunities to improve efficiency and profitability in beef production**

| | €/head | | |
|---|---|---|---|
| | **Maximum potential** | **Potential in practice** | **c/kg** |
| Terminal sire breed | 89 | 29 | 9 |
| Suckler cow genotype | 47 | | 8 |
| Fertility | 140 | 57 | 17 |
| Replacements | 45 | 45 | 13 |
| Supplement procurement | 21 | 10 | 3 |
| Grass silage feed value | 142 | 71 | 22 |
| Maize silage | 42 | 22 | 7 |
| Grassland management | | 35 | 11 |
| Finishing males as bulls | 104 | 51 | 16 |

However, on most farms it should be possible to achieve half of the *potential in practice* improvements in efficiency. Consequently improvements in efficiency could reduce costs of production by up to 53 c/kg carcass. These improvements in efficiency increase in value as the beef price obtained by the producer improves.

The average beef price in 2004 was €2.48/kg carcass, whilst subsidy accounted for €1.60/kg carcass beef produced in Ireland giving a total income of €4.08/kg carcass beef. Improvements in efficiency could reduce cost of production by up to 53 c/kg carcass. Consequently, the producer would require an average of €3.55/kg carcass post decoupling to maintain the status quo in nominal terms.

**Conclusions**

It is concluded that:

1. Improvements in efficiency pre farm gate of up to 53 c/kg carcass are possible.
2. Major improvements in efficiency pre farm gate can be achieved by:
   - improvements in cow fertility
   - sourcing suckler cow replacements from the dairy herd
   - use of continental breeds, particularly Charolais and Blonde, as terminal sires
   - production of high feed value grass silage
   - use of forage maize in the finishing diet
   - reducing supplement cost by use of good quality straights
   - good grazing management
   - finish male progeny as bulls
3. The value of the improvements in efficiency increases with improvements in beef price.
4. As beef prices increase use of high input systems, e.g. *ad libitum* concentrate feeding, can become more attractive.
5. Even with these savings the producer needs to receive on average €3.55/kg carcass to compensate for subsidy removal post decoupling to maintain status quo.

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