Moorepark'13

Irish Dairying | Harvesting the Potential

ACKNOWLEDGEMENTS

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Irish Dairying- Harvesting the Potential

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There are two significant issues occupying the minds of dairy farmers at present; the abolition of milk quotas in 2015, which provides significant opportunity for expansion in milk production, and the weather-induced feed shortage during the winter and spring just passed. Ireland's competitive advantage in milk production is based on the efficient production and utilisation of pasture; this must remain the only viable model going forward. Moorepark 2013 Open Day provides dairy farmers with the opportunity to view and discuss the latest developments in key dairying technologies that will help them cope with future challenges. These include volatile milk price, extreme weather patterns and strategies to grow family farm businesses.

There is nothing dairy farmers can do about the weather, but there are lessons from 2012/2013 that can help minimise the impact of such events in the future. First and foremost, the recent feed shortage has provided a clear reminder that it is necessary to build up and maintain a reserve of winter feed to mitigate against weather-induced reductions in pasture growth. Winter feed stocks were not adequate on many dairy farms when cows were housed last winter, primarily a result of poor weather and low grass growth during the previous summer. Firstly, dairy farmers need to set a realistic target stocking rate for their particular farm; this will vary enormously depending on soil type, location and topography. Secondly, grass production will be maximised on farms where soil fertility status is high, adequate N fertilizer is being applied, pastures are predominately perennial ryegrass/white clover and soils are adequately drained. A large proportion of soils on farms are below optimum in pH, P and K (Index 1 and 2) resulting in significant reduction in grass production. Therefore farmers must place a much greater emphasis on soil fertility management. Although, fertilizer N costs have increased in recent years, it still represents good value for money in well managed grassland farms. Pastures that are predominately perennial ryegrass/white clover will significantly increase both annual and shoulder (spring/autumn) grass production. On heavy soils, current drainage infrastructure needs to be maintained and new infrastructure considered. During waterlogged conditions the levels of poaching and machinery damage to pasture must be minimised. In the longer term, dairy farms need to grow more grass to prevent a recurrence of the feed shortage that occurred this spring and for the increased stock numbers on expanding farms.

The dairy farming system adopted needs to be resilient to external forces. Resilient systems are designed to utilise their comparative advantage by having a low production-cost base. This insulates the dairy farm business from price fluctuations and allows family-based farms to generate sufficient funds in better times to meet family requirements. This requires a 'fit for purpose' system that will provide a consistent level of production at a consistent cost of production, within the general averages of climate, input price, and milk price uncertainty. The farming system will also need to have sufficient tactical flexibility to overcome unanticipated events that can lower short term profitability (e.g. cold wet spring, low milk price, etc), but the system principles remain the same. The farming system must be designed with land production capacity, soil class and rainfall in mind. The farm should utilise elite high performance animals suited to the system that are highly efficient per unit of land, labour and capital. Such business must provide a reasonable return on equity, be environmentally and animal welfare compliant, and provide an enjoyable and rewarding lifestyle for those working on the business. The key pillars of a resilient farm business in Ireland are the efficient utilisation of natural resources (grazed grass), a 'fit for purpose' animal (high EBI), strong business acumen in management, and a policy of continuous improvement of staff at all levels of the business. The application of key pasture-based technologies that have been researched and tested will greatly facilitate the achievement of this objective.

The imminent abolition of milk quotas provides dairy farmers with significant opportunity for expansion. Expansion entails risk as the additional infrastructural investment must be financed by the existing dairy enterprise(s). Expansion will put significant additional pressures on the existing dairy farm business and should not be considered without due regard for repayment capacity and the impacts on the family unit. While prudent use of debt is an effective part of a growing business, heavily geared farms are significantly exposed to downturns in product prices, increases in input prices, and the vagaries of climate, particularly during the developmental phase of the new business. Even with excellent management, expanding dairy farms rarely achieve high levels of productive efficiency during the initial years of expansion. The main reasons for this include new infrastructure and people, nutrient deficient soils and immature or mixed source herds take time to reach full production potential. As a result of the initial 'below par' operational performance, additional pressure is placed on the existing farm's cash flows. Dairy farmers will need an increased level of understanding of business principles if dairying in Ireland is to not only survive but prosper. Every dairy farm business must use the intervening year to quota abolition to develop their farming operations in a manner consistent with the requirements of a vibrant business for the future. Upgrading skills in strategic planning, financial management (e.g. accounting, business structures), succession planning, people management, communication and negotiation, in addition to skills in technically efficient sustainable farm management will be essential. Recent studies have highlighted the important role of financial management skills in underpinning successful dairy farm businesses, as people with these skills achieve a higher level of business growth in the long-term.

A summary of the most recent results from the comprehensive dairy research programme at Moorepark are presented in this open day booklet. This open day affords dairy farmers an opportunity to see the research results underpinning the technology required to deliver high profit sustainable dairy businesses and to meet research and advisory personnel from Teagasc. The financial support for the research programme from state grants and dairy levy research funds is gratefully acknowledged. Similarly the support of FBD Trust, the overall sponsors of Moorepark'13, is greatly appreciated.

Positioning the Dairy Farm for Expansion

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Summary

- The abolition of the milk quota will provide dairy farmers with an opportunity to expand their farm business.
- Before any expansion is considered, the current farm performance should be analysed with the objective of identifying key areas to increase farm productivity and efficiency.
- The business plan should include all of the components of the expansion process including realistic performance projections and contingency for capital expenditure.
- A risk identification and mitigation management plan should be put in place to reduce the farm financial exposure.
- The combined annual cost of labour, drawings, debt and tax should not exceed €700/cow on the most efficient farms (top 10 % on profit monitor) and €400/cow on the farms operating at an average level of efficiency.
- Investment should be prioritised into areas that will give the maximum return based on current performance, investment costs and profit response.

Introduction

The business planning process is the most important component of running any business. The milk quota regime provided significant milk price support, resulting in the perception that the requirement for business planning was not important. With the removal of milk price support and the pending removal of milk quotas and the projected expansion within the dairy industry, there is an urgent requirement to focus on business planning at farm level. Expansion should only be considered if it will result in an increase in overall farm profitability. This can only be determined through the development and application of a realistic, comprehensive business plan for the farm. The business planning process will be discussed in five separate components: setting goals, farm planning, cash flow budgeting, risk management and prioritising investment.

Setting goals

The first step in the business planning process should centre around setting goals for the dairy farm business. The goals should be centred on the requirements for income from the farm now and in the future, cow numbers and hectares farmed, and how much personal/family time is required away from the farm. All of these components should be incorporated to form a vision for your future on the farm. This should be completed before any expansion is contemplated, as it is difficult to achieve a set of objectives if those objectives are not clear. The requirements for income now and in the future will change due to changes in family situations and the reduction of the real value of income due to inflation. These goals should be revisited from time to time, thus ensuring that the direction of the business is going to result in the achievement of the correct objectives.

Farm planning

The completion of a SWOT analysis (Strengths, Weaknesses, Opportunities and Threats) of the dairy business should be the next component of the farm planning process. Realistically this should provide information in relation to the opportunities to increase efficiency on farm, and should clarify whether or not expansion is going to result in increased farm profitability. It should also identify areas where there is a requirement to focus attention on the farm. This review process or "Whole Farm Assessment" should encompass both physical and financial traits. The key drivers of profitability (grass utilisation and growth, genetics, herd fertility performance, level of imported feed (forage and concentrate), herd health and milk production performance) should be included within the review process. An evaluation of data from the E Profit Monitor highlights the differences in overall profitability at farm level for 2011 in comparison to 2010 and 2009 (Table 1). The more profitable farms in 2011 produced more milk per unit land area and purchased less feed (both forage and concentrate). Differences in milk sales and purchased feed explained 53 and 73 per cent of the difference in profit between the average top and bottom 10 per cent of farmers on a per hectare basis, respectively. The top performing farms, however, had lower costs of production on a per litre basis for nearly every cost category recorded. As a result of a detailed review process it will become apparent that focusing on increased efficiency rather than expansion will be a more suitable strategy for some farmers for the foreseeable future.

Table 1. The profitability of spring calving dairy farms that completed the Teagasc Profit Monitor in 2009, 2010 and 2011

	2011 Average	2011 Top 10%	2011 Bottom 10%	2010 Average	2009 Average
Gross output (c/l)	36.15	38.48	33.61	31.00	23.75
Milk price (c/l)	35.46	36.53	34.37	30.88	23.55
Stocking rate LU/ha	2.03	2.14	1.77	2.03	2.10
Yield MS/ha	784	856	648	794	767
Variable costs (c/l)	11.22	9.04	14.10	10.54	9.96
Fixed costs (c/l)	9.71	6.84	13.18	9.09	8.96
Net margin (c/l)	15.22	22.61	6.33	11.37	4.84
Net margin (€/ha)	1,599	2,495	563	1,233	534

For those farmers that are expanding, there will be a requirement to develop a capital budget that details capital expenditure within the business plan. This capital budget should incorporate a contingency fund of up to 20 per cent of the proposed expenditure and it should be ensured that there is funding available for this component via owned resources or bank debt. The physical performance of individual components of the farm will be poorer in expanding herds. The reasons for this include the proportion of first lactation animals will be higher (milk yield ~75 per cent of a mature cow), less voluntary culling and animals are in a larger group, which will increase competition for scarce resources. These pressures could result in higher involuntary culling and mortality within the herd. All of these individual components should be factored into the business plan. The first realistic output from the plan is to evaluate whether expansion should be considered or not. Research has shown that farm profitability is maximised when productivity and milk output increases quickly, even though this may result in increased farm borrowings at the early stages of expansion. Sensitivity analysis should be considered for key factors such as milk price fluctuation, quantity and price of purchased feed, herbage production, herd fertility and herd health.

Cash flow budgeting

The expansion process will put a significant strain on scarce cash resources. Reasons include increased debt servicing costs, lag phase on farm productivity, growing stock numbers and ongoing farm development costs. This creates critical requirement to complete cash flow budgets that can be used to identify particular cash deficits within and between years, and can allow a plan to be developed around managing cash. For many farmers, this process will identify potential pit-falls during the expansion process and will provide opportunities to seek solutions. For example, seeking a moratorium on capital repayments of bank debt for the first two to three years of the expansion process could make expansion process viable and reduce the exposure to liquidity issues. Another solution would be to secure short-term finance (within year) to overcome periods of cash deficit as occurred on many farms in the spring of 2013. When negotiating bank deals, bank repayments should be set up for the months of May to October when there is significant cash being generated on the farm. Cash flow budgets should be set up at the start of the year. On at least a quarterly basis, these budgets should be compared with actual cash flow from the bank statements and any variance identified and understood. Ideally this process should be undertaken with the bank to build a strong relationship and understanding between the bank and the business. After each review process, projections should be completed for the remainder of the year to determine the new overall picture for the farm and steps should be taken if cash deficit issues are apparent.

Risk identification and management

Uncertainty is a fact of life. It creates a business environment that provides both opportunities and threats. Risk can be both positive and negative. There cannot be a business environment without risk. The important question is how much is the business "at risk", or how vulnerable is the business to the external pressures (weather, milk price, input prices etc). Risk identification and risk management determine whether the business is able to cope with changes in the external environment and changes within the business. Identifying the factors that put the business at risk should create opportunities to develop strategies to manage the key risks. There are many risks to the business. These include financial risks (milk price, feed price, fertiliser price, interest rates, etc.) and weather risks (summer 2012 and spring 2013), both of which affect the viability of the business. There may be other risks that are relevant depending on circumstance and locations. As a dairy farm expands, the risks per se do not change but their effects on the dairy business do change and the probability of these events occurring increases. The reasons include higher levels of borrowings, higher cash demands, increased animal numbers, increased grazing intensity and greater likelihood to be purchasing animals into the herd. Evaluating a risk on a farm should take into account the effect of the risk and the probability of the event occurring. For example, the coldest March since records began this spring caused a reduction of approximately 1 t DM/ha in herbage production. This has resulted in a significant shortage of fodder on many farms. In monetary terms, if replacing this feed shortage with forage and concentrate (50:50), the net cost would correspond to €265/ha. The effect of this reduction in profitability is similar to a reduction of milk price of 2.6 c/l for the average farm. The probability of an extreme milk price reduction, however, is much greater than the probability of an extreme weather event as occurred this year. The combination of a number of risky events together can create an environment that makes farm survival difficult.

When developing the farm business the focus should not be to protect against all risks, but rather to identify the key risks that put the business at risk, to identify the contributing factor that increases the likelihood of that risk affecting the business, and to develop mitigation strategies that reduce the farms exposure. A number of risks are identified and analysed for a typical Irish dairy farm in Table 2. Each farm will be different in this situation and each individual farmer should complete an exercise similar to this.

Table 2. Identification of risks, threats, contributing factors and mitigation strategies for a typical Irish dairy farm

Risk	Threat	Contributing factor	Mitigation strategy
Milk price	High	High costs High bank debt Expansion phase Approximately 90% of income	Grassland technologies Build cash reserve Milk solids concentration
Poor weather – wet	High	Impermeable soils Two weather events together Poor grazing infrastructure Stocking rates too high	Drainage Building a feed reserve Good farm infrastructure Match stocking rate to demand with feed reserve
Poor weather – low temperature in spring	High	Calving date too early Old permanent pastures Two weather events together	Building a feed reserve Develop reseeding strategy
Animal disease	High	Poor bio-security Purchasing of animals Lack of health screening	Bio-security protocols Closed herd Herd testing Vaccination
Interest rate	Low	High borrowings High use of overdraft facility	Match debt levels to efficiency Cash reserve Fix interest rates

After completing the process outlined in Table 2, the risks identified to have a high threat for the farm should be addressed. Investment should be targeted to deal with the risk, and should encompass both the contributing factor and the mitigation strategy. For farmers in both the Connacht Gold and Glanbia regions, maximising the amount of milk produced in the fixed price schemes will reduce the volatility around milk price.

Risk of over-indebtedness

The level of farm debt has to be considered in the context of the overall farm business and the repayment capacity of the farm. In addition to technical efficiency, there are a number of varying factors that should be considered when calculating repayment capacity such as the level of drawings required, the cost of hired labour, the land rental/leasing cost and the tax liability. Table 3 summarizes the range in funds available to meet these costs from farmers that completed the profit monitor over the four years from 2008 to 2011. It is obvious that the milk price variation has a significant effect on the funds available. The volatility in milk price in the last few years is likely to continue in the post-quota era. The level of variation between farms, however, is even greater than yearly milk price variation. As a general rule of thumb the combined annual cost of labour, drawings, debt and tax should not exceed €700/cow on the most efficient farms and €400/cow on the average farms after the expansion phase has been completed. With initial performance expected to be lower after expansion, the level of indebtedness should be managed to ensure viability during the early stages of expansion.

Table 3. The effect of year and level of efficiency on the funds available per cow to pay drawings, labour, debt servicing, tax and land rent

Year	2008	2009	2010	2011
Milk price (c/l)	34.41	23.58	30.88	35.43
Top 10 %	€1,310	€712	€1,123	€1,319
Average	€907	€431	€808	€927
Bottom 10 %	€445	€127	€406	€573

Prioritising investment

In order for expansion to be successful, there will be a requirement for significant investment on many farms. The available capital for this investment will be scarce as expansion happens. Therefore, it is important that investment is prioritised into areas that will give the maximum return. Investment should also be targeted at areas that increase efficiency and reduce the exposure of the business to external shocks of one form or another.

Table 4 summarizes the potential return on investment for different investments in the dairy farm business. The potential benefit and return from these investments can only be determined by measuring the performance on the farm before the investment takes place. This performance information coupled with the potential increased performance following the investment will determine overall returns from one investment or another. The most important investment will be in improving the skill set of the farmer (financial and technical) and this should then be used to prioritise further investment within the farm. The investments to be prioritised on the farm can only be determined after detailed analysis of current farm physical performance and farm infrastructure using baseline information on areas such as individual paddock yield, paddock nutrient status, etc. All planned investments should be prioritised based on current performance and expected returns. Investments that give the highest returns should be prioritised.

Table 4. Potential return on investments for various investments in the dairy farm business based on initial performance, response and investment costs

Investment	Cost	Impact	Annual Return (%)
Increase soil P & K levels	P & K application of 20 and 50 kg/ha	+1.5 t DM/ha/year herbage growth	152
Reseed full farm in eight year cycle	€650/ha	+ 1.5 t DM/ha/year herbage growth	96
Improve grazing infrastructure	€1000/ha for roads, fencing and water	+ 1.0 t DM/ha/year herbage utilisation	58
Increased supplementation to increase milk yield/cow	€280/t DM of concentrate	Additional 0.8 l milk/kg of concentrate	3.2

Conclusions

The Irish dairy industry is now approaching the end of the milk quota era. Expansion should only be planned if it is going to result in increased farm profitability and if it will improve the livelihoods of the family running the farm(s). Before any expansion is undertaken, farmers should appraise their existing business and exploit any potential for increased productivity from within existing resources. Any major expansion plan should be accompanied by a risk management strategy to limit the exposure of the business to the particular risks affecting the farm. Farmers should prioritise investment into areas that increase productivity and reduce the business exposure to risk.

Resilient Farming Systems for an Expanding Irish Dairy Industry

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Summary

- In the future, the only constant will be change! Milk price and input prices will be more variable than they have been historically.
- Existing farms and those intent on expansion will need to be resilient; this requires a solid farm system foundation (**strategic plan**) with the technical expertise to make appropriate tactical decisions (**tactical implementation**).
- Farm businesses must be business focused; they must be designed with land production capacity, soil class and rainfall in mind; they must be based on elite high performance animals, and they must be highly efficient per unit of land, labour and capital.
- Such businesses should:
    - » provide a reasonable rate of return on equity.
    - » be environmentally sustainable and animal welfare compliant.
    - » allow for an enjoyable and rewarding lifestyle.
    - » allow opportunities for training and personal development.

Introduction

"If you don't like change, you'll like irrelevance even less"

Gen. George Shinseki

The business environment for dairy farming is changing. While it has always been difficult to predict international commodity prices or foresee production risks (climate and feed availability and price), the reduction in dairy product stores in Europe and the USA and increasing wealth in previously developing countries has led to price volatility, arguably, not witnessed before. Future milk production will, therefore, be set against a backdrop of increased farm business uncertainty. As a consequence, modern dairy farming systems must be sufficiently resilient to respond positively and rapidly to change.

The imminent abolition of quotas, although providing significant opportunity for expansion, further heightens uncertainty for Irish farmers. Dairy farm expansion has risks, as the additional infrastructural investment must be financed by the existing dairy enterprise(s). Such investment increases expenses and, yet, is almost always accompanied by sub-optimal biological performance initially. This places significant additional pressure on the original farming business. While prudent use of debt is an effective part of a growing business, heavily geared farms are significantly exposed to downturns in product prices, increases in input prices, and the vagaries of climate, particularly during the developmental phase of the new business.

Fundamentally, resilient systems must have a low production-cost base to insulate the dairy farm business from price shocks and allow family-based farms to generate sufficient funds in better times to meet family requirements; this sentiment is even more correct for expanding businesses. This paper aims to improve the design of our production system against a backdrop of post-quota expansion opportunities and a more uncertain production and economic environment.

What is a resilient farm system?

Resilience denotes the capacity of a system to absorb and thrive in a changing and uncertain production environment. Resilient farm businesses must, therefore, have a plan (**strategy**) for how the farm will run in an 'average' year. Resilient businesses exploit their comparative advantage; in the dairy sector, this means that although Irish dairy farmers can produce milk more cheaply than their European contemporaries from grazed pasture or from silage and wheat, for example, the far lower cost of production from grazed pasture offers pasture-based milk producers a comparative advantage. By exploiting its comparative advantage, the business will be more profitable and financially sustainable.

Resilient farm businesses are those that are designed to utilise their comparative advantage. This requires a 'fit for purpose' system that will provide a consistent level of production at a consistent price, within the general averages of climate, input price, and milk price uncertainty. A resilient farm system will also have sufficient tactical flexibility to overcome unanticipated events that can lower short term profitability (e.g. cold wet spring, low milk price, etc), but the system principles remain the same.

Although there are many components to a successful farm system, we believe that there are four 'pillars' that define resilient farm systems in the Irish dairy farming context (Figure 1), irrespective of region, rainfall, or farming philosophy.

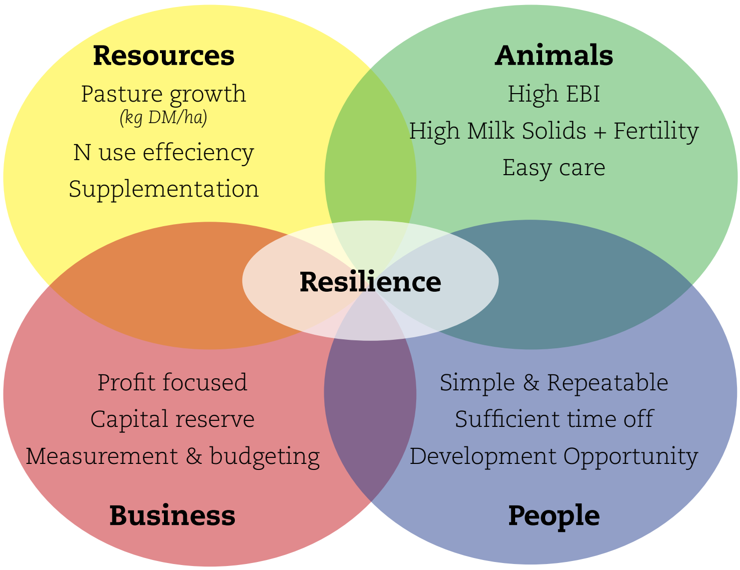

Figure 1. *The 'pillars' of a resilient farm system*

Efficient utilisation of available resources

Land-base: Although dairy farms differ in their capacity to produce and utilise pasture at different times of the year, one of the most important drivers of operating profit and, therefore, return on capital, is maximising the amount of pasture that is grown and utilised. This requires consistent monitoring and effective record keeping of pasture grown in each paddock, so that strategic decisions around drainage, fertiliser, and pasture reseeding can be made to maximise pasture grown in all paddocks. Although farmers instinctively know their best and worst paddocks, without measuring weekly pasture covers you will not accurately rank paddocks in the middle. *"You cannot manage what you do not measure".*

Total milk output from the dairy farm will increasingly be limited by pasture growth post quotas, and so the development of management practices to improve pasture production and quality will take precedence over practices informed by individual animal performance.

Grazing management will be concerned with achieving adequate soil fertility, the reseeding of underperforming swards and achieving the correct balance between grazing severity and individual animal intake. Grazing to a consistent post-grazing residual height of 3.5-4 cm maximises growth and results in consistently higher quality pasture.

Some investment in infrastructure is required to ensure maximum utilisation of pasture grown: multiple access points to paddocks and an extended network of narrow tracks will allow more efficient utilisation of pasture, even under wet conditions. Do not use wet land as an excuse for an uninterrupted six month housing period; any pasture in the diet is better than no pasture in the diet from a cost and cow welfare standpoint. However, be flexible; there will be periods when cows cannot be allowed out.

Supplementary feed: The decision to feed supplements and how much supplements should be fed each day is part of tactical management. However, the decision on how much supplements should be incorporated into the system on an annual basis is a strategic decision (i.e. an annual feed budget). This decision is based on the amount of pasture grown, the stock carrying capacity of the land, and the level of financial exposure the importation of feed creates in the business. Resilient businesses limit exposure to outside influences where appropriate. The greatest single operating expense in dairy farming businesses in Ireland is purchased feed, leaving dairy businesses heavily reliant on bought-in supplements and very exposed to the vagaries of international commodity prices. For example, we have recently seen supplement prices rise by 30-50 per cent and the requirement for supplementary feeds increase by more than 20 per cent because of wet weather and poor pasture growth.

In the UK and New Zealand, datasets analysed to determine associations between feeding and cost of production indicate that for every 1 pence (p) spent on feed, operating expenses increase by 1.3 to 1.6 p. This means that a kg of supplement must be purchased for considerably less than the cost of one litre of milk. In analysing the requirement for supplement and the risk of exposure to economic forces external to the farm gate, we propose limiting the use of supplement to less than 500 kg DM/cow (550 kg purchased) and that these supplements must be purchased for less than 2/3 of the price of milk. In other words, if milk price is projected to be 30 c/l, supplements must be sourced for less 20 c/kg DM (18 c/kg fresh) or less than €180/t delivered. Supplements used tactically to fill unexpected feed deficits can be priced according to need, but the majority of supplement must be sourced at less than €180/t delivered.

Environment: In addition to the economic and animal welfare benefits associated with grazing, Irish pasture-based milk production is highly regarded internationally for its environmental sustainability. Only 10 per cent of global dairy production originates from grassland and, in comparison with cropping, grassland is an important biological filter for reducing nutrient and chemical run off and supports biodiversity and carbon storage. Recent international studies have indicated that by virtue of our high reliance on grazing and reduced need for mechanisation, Irish milk has the lowest carbon footprint within the EU. Notwithstanding these benefits, the efficiency of Nitrogen (N) and Phosphorus (P) use within Irish pasture-based systems is variable and can potentially result in nutrient loss to water resources. In future, particularly within expanding dairy farm businesses, on-farm management practices must be tailored to achieve excellent nutrient management. Intensive production systems require grazing and nutrient management practices that increase slurry-use-efficiency, optimise fertiliser N use within allowable levels, and minimise the cultivation of grasslands and nutrient overloading associated with external feed supplementation. Evidence from both Ireland and New Zealand suggests that where intensification is fuelled by increased grazed pasture utilisation and conversion to product, intensified grazing systems will continue to deliver the highest standards of water quality even within highly vulnerable free draining soils.

The appropriate animal for the system

If we accept that the comparative advantage of dairy production in Ireland involves the efficient utilisation of grazed pasture, then the appropriate cow must be able to harvest pasture efficiently. To do this in a farm system context, she must re-calve every 365 days to ensure peak intake demand coincides with peak pasture supply, she must be an aggressive grazier, and her live weight must be no more than is required to maximise intake (i.e. big cows do not eat proportionally more than medium sized cows in grazing systems). Excellent research over the last decade has led to the production of a multi-factor, profit-focussed, breeding index (**€ EBI**) that takes the guess work out of choosing the appropriate cow for Irish dairy systems.

In addition to selection on EBI, however, crossbreeding offers significant financial reward, improving production and fertility beyond the value of the improvement in EBI. In comparison with high EBI Holstein-Friesian cows, Jersey*Holstein-Friesian crossbred cattle achieved a higher six week in-calf rate (70 vs. 56 %) and a lower 13 week empty rate (10 vs. 18 %), had greater intake per 100 kg of live weight at grazing (3.6 vs 3.3 kg/100kg live weight) and produced more milk from less feed (11.3 vs. 12.8 kg pasture/kg MS). While there have been significant improvements in national dairy herd fertility in recent years, even the top 10 per cent of dairy farms on EBI (EBI = €140 and fertility subindex of €70) are failing to achieve optimum six week calving rates (65 vs. 90 %); this metric is an important component of pasture utilisation. On the basis of these results, crossbreeding would be expected to add €180/cow/lactation (equivalent to €18,000/annum for a 100 cow dairy herd); this is in addition to the value of improved EBI. With this in mind, it is surprising that more farmers are not using crossbreeding in addition to EBI to more rapidly improve the fertility status of their herds, to develop a more efficient cow, and to increase overall farm profitability with milk quota abolition in mind.

Developing people

Dairy production systems must be simple and labour efficient, providing adequate time off and training opportunities for those working in the business. The requirement for greater labour efficiency increases the need for an easy care dairy cow and simplicity in operational protocols to minimise the requirement for additional labour. It is also essential to enable sufficient time for farm staff and owners to develop new skills that will increase the efficiency of the production system and to make farming a viable and attractive career choice relative to a 40 hour working week in town.

The need for continuous improvement can not be overstated. It will be vital that farmers are adaptable, flexible and are able to make appropriate decisions quickly. In the past, farm management was dominated by production economics, and farmer learning traditionally focussed on plant and animal husbandry rather than acquisition of broad management skills. Farmers of the future need a broader range of management skills (e.g. human resources, contract negotiation, forward contracting of milk and feed), with modern dairy farming increasing in complexity. The rapid pace of change in technologies necessitates lifelong learning and continuous education and training to ensure the viability and sustainability of the businesses.

Developing a business discipline

Dairy farmers will need an increased level of understanding of business principles if dairying in Ireland is to not only survive but prosper. Every dairy farm business must use the intervening year to quota abolition to develop their farming operations in a manner consistent with the requirements of a vibrant business for the future; upgrading skills in strategic planning, financial management (e.g. accounting, business structures), succession planning, people management, communication and negotiation, in addition to skills in technically efficient sustainable farm management will be essential. Recent studies have highlighted the important role of financial management skills in underpinning successful dairy farm businesses, as people with these skills achieve a higher level of business growth in the long-term.

Expansion will put significant additional pressures on the existing dairy farm business and should not be considered without due regard for repayment capacity and the impacts on the family unit. With excellent management, expanding dairy farms rarely achieve high levels of productive efficiency during the initial years of expansion, as new infrastructure and people, nutrient deficient soils, and immature or mixed source herds take time to reach potential; as a result of the initial 'below par' operational performance, additional pressure is placed on the existing farm's cash flows.

The total costs (incl. own labour) for the average and top 10 per cent of Irish dairy farmers compared with milk price during the last eight years are presented in Figure 2.

Figure 2. *Milk price and production costs on Irish dairy farms (2006 – 2012)*

These stark results indicate that the average dairy farmer achieves total costs of production after own labour that are equivalent to the average milk price, leaving no additional profit for re-investment in the farm business. In comparison, the top 10 per cent of dairy farmers are retaining, on average, 8 c/l (equivalent to €400/cow) as profit after full costs over the same period. This additional profit is essential to fund expansion. Consequently, while all farmers may expand by specialising in dairying at the expense of other enterprises post quotas, we conclude that only the top 10 per cent of farmers can consider making significant investments to expand their dairy farming business. Furthermore, because there are additional expansion costs associated with land leasing and further capital investment, these results also indicate that even the top 10 per cent of dairy farmers will need to reduce production costs further (by 2.5c/l or €0.30/kg MS) to achieve a similar margin per kg MS on a newly leased dairy farm.

Resilient farm systems and comparative stocking rate

In the last section we defined a resilient farm system as any system that efficiently utilises natural resources in an environmentally sustainable manner using appropriate dairy cattle genetics, thereby generating sufficient financial reward and free time to achieve lifestyle and expansion goals; this definition was predicated on continuous professional improvement and a strong business acumen. In this section, we combine these parameters to produce a 'strawman' system as an example of what we believe a resilient farm system will look like.

A resilient system needs to account for land class and usability, supplement purchases, and the type of cow being used. These factors are encapsulated in the concept of Comparative Stocking Rate (CSR).

- When most people hear the term ***Stocking Rate***, they automatically equate this with cows/ha. But this metric does not allow people to compare different land classes or regions capable of growing different amounts of pasture (e.g. the SW of Ireland has more growing days than the NE, but also has more rainfall), differences in the size of cows (e.g. 2.5 Jersey cows require less feed than 2.5 Friesian cows), or differences in the amount of supplement purchased.

- The use of the metric ***Live weight/***ha was an improvement over cows/ha, as it accounted for the different demands of different sized cows; however, it doesn't account for purchased supplements or differences in pasture grown. Considering the contribution of purchased supplement to variable expenses, failure to plan usage of supplements undermines the resilience of the system.
- *Comparative Stocking rate* is an attempt to include all of these variables in the one metric, whereby the carrying capacity of the farm is defined by the live weight of the cows, the potential of the land to produce pasture, and the amount of supplement purchased: simply put, comparative stocking rate is defined as the amount of live weight that can be fed per tonne of feed DM available (kg of live weight/tonne of feed DM available: kg Lwt/t DM).

What is the optimum stocking rate?

We already established that to limit exposure to international commodity prices, resilient farm systems should maximise the use of grazed pasture and limit planned concentrate purchases to 0.5 t DM/cow. We also established that a crossbred cow of high EBI was the most efficient cow for a grazing system. In addition to EBI and crossbreeding, however, we believe that grazing cows should average 500 kg live weight, with, arguably, no advantage to cows greater than 550 kg live weight in the herd. The relationship between cow live weight and DM intake in a grazing system is not linear. Intake increases with cow live weight up to about 500 kg, but the factors regulating grazing behaviour limit further increases in DM intake with increasing cow size in a largely pasture-based diet. Although bigger cows can eat more total DM intake and, therefore, may have some value in systems feeding higher amounts of concentrate, justifying these cows in this way leads to the greater use of concentrates, which, we believe, will undermine the resilience of the proposed system.

With these variables in mind, the results of extensive NZ farm systems research indicate that the optimum CSR for grazing systems is between 75 and 85 kg live weight/t DM. This is equivalent to offering a cow between 5.9 and 6.5 t total feed DM/year (cows producing 390-450 kg milksolids). This means that the optimum stocking rate will be different for different farms and different farm systems. In Table 1, the optimum stocking rate for farms that produce different amounts of pasture and feed different amounts of concentrate supplement are defined. For example, if a farm can grow 10 t DM of pasture on average and the system involves feeding 0.5 t concentrate DM/cow, the stocking rate should be 1.8 cows/ha. In comparison, a farm capable of growing 16 t DM pasture/ha and feeding 0.5 t concentrate DM/cow should be stocked at 3.0 cows/ha (see Appendix 1 to calculate your farm's CSR).

Table 1. Stocking rate* (cows/ha) that optimises profit on farms growing different amounts of pasture and feeding different amounts of concentrate/cow. The proposed stocking rate for a resilient system is highlighted

Concentrate (t DM/cow)	Pasture grown (t DM/ha)			
	10	12	14	16
0.00	1.5	2.0	2.3	2.6
0.25	1.7	2.1	2.4	2.8
0.50	1.8	2.2	2.5	3.0
1.00	2.0	2.4	2.9	3.2
1.50	2.2	2.6	3.1	3.5
2.00	2.4	2.9	3.3	3.9

*All of these stocking rates equate to 85kg live weight/t feed DM available.

If the actual stocking rate is less than optimum, the farm should be feeding less concentrates/cow, while more concentrates at the optimum stocking rate indicates that either pasture growth is over-estimated or that pasture grown is being wasted. Although not foolproof, the concept of CSR allows farmers to set a stake in the ground regarding the optimum stocking rate for their farm. This does not preclude the use of more supplements in poor pasture growth years or for winter milk; nor does it suggest 500 kg supplement/cow should be a target in years where pasture growth exceeds the average used in strategic planning or where milk price drops and concentrate price does not follow suit. Such decisions are tactical and must be made with all of the available immediate information. Nevertheless, it allows you to plan what the number of cows on the available land should be.

Tactical management

Tactical management involves making short-term decisions to ensure the viability of the business (i.e. tactical management is about reacting to an immediate or upcoming situation). For example, during bad weather, the need for supplements will be greater because of poor pasture growth or an inability to utilise the pasture grown, whereas when pasture growth exceeds demands, concentrate use should be less than budgeted and/or the amount of silage harvested greater.

The importance of tactical management cannot be overstated; this is where the farmer's ability and experience of their own farm come into play. ***"The difference between a good farmer and a bad farmer is a week"***. In other words, they will both do virtually the same thing; the big difference is the timing of action. The effect this has on farm profit, however, can be extraordinary.

Tactical management decisions must be made in conjunction with a cash flow budget. As an example, in years where milk price is low and concentrate price high, it would be unwise to feed all of the budgeted concentrates; as a consequence, cows will be fed a little less and will produce less milk. But the overall viability of the business will be more secure, as the expense would not have returned value. This is not a recommendation to grossly underfeed cows; it is merely a recognition that the total response to the last 1-2 kg of concentrates will not pay for the supplement. Nor will this undermine the cow's welfare, as she will reduce her milk production commensurate with the drop in energy intake and, so, negative energy balance is not greatly affected. A slight restriction will not impact reproduction. Management issues such as this cannot be planned for. However, the strategic plan facilitates a non-emotive more objective decision, ensuring business viability.

Farm performance

If a farm system is designed properly and operated by well-trained capable individuals, it should perform at close to maximum capacity. In Table 2, we outline key performance indicators for resilient farms. On average, current systems are not resilient:

- comparative stocking rate exceeds the farms carrying capacity; this places a greater reliance on purchased concentrates, exposing the farm to external forces. The primary reason for this is the low pasture growth. Resilient farms will require improvements in land productivity (i.e. drainage, soil fertility, etc) and pasture management.
- milksolids yield/cow is low. Although there is only a very poor relationship between milksolids yield/cow and profit and, therefore, it is not a reason to change a farm system, it is a key biological indicator of how the farm is performing. Low milk yield per cow indicates that cows are of low genetic merit, are not being fed well or have too few days in milk. As concentrate purchases are 50 per cent greater than we believe prudent on average, the likely reason for the low milk production is low EBI cows with short lactations (average 265 days) and a heavy reliance on silage.
- Because of the constrictive nature of milk quotas and, possibly, poorly designed farm systems, labour productivity is low. As labour is a major cost, this will have to improve to build resilience into the farm system.
- milk production costs (c/l of milk) are too high to withstand a softening of commodity prices and a fall in the price received for milk.

As a result of lower than average performance across these indicators, farm profit is insufficient to return a reasonable wage to the farmer and facilitate debt. Most farm businesses are, therefore, not in a position to avail of the opportunities that come with quota removal. There is no 'quick fix' to the inefficiencies presented. Every farmer must self-evaluate, identify the inefficiencies in their business and seek help in improving these. Without improvement, expansion will magnify these inefficiencies.

Table 2. Key performance indicators of resilient farming systems compared with current average and top 10 per cent farm performance

	Current Average	Current Top 10%	Target
Pasture growth (t DM/ha)	6 - 14	10 - 16	12 - 20
Cow live weight (kg)	550-600	550 - 600	500-550
Herd EBI (€)	100	140	250
Comparative stocking rate (kg live weight/t feed DM)	95	90	75-85
Concentrates fed/cow (kg DM)	800	700	500
Milksolids yield/cow (kg)	350	403	450
Six week herd calving rate (%)	55	70	90
Nitrogen use efficiency (%)	25	-	40
Cows/labour unit (No./LU)	50 - 80	80 - 100	100 - 150
Proportional retained earnings (%)	30 - 50	40 - 60	50 - 70
Total milk production costs (€/kg MS) (c/l)	3.75 (30)	3.10 (24)	2.90 (23)
Profit/cow (€)	0	660	750

Conclusions

"Change before you have to"

Jack Welch

The forecast for food production is bright, but there will be periods of heavy rain! Demand for dairy products and, therefore, average milk prices will, we expect, be higher than historical values, but there will also be periods when commodity prices soften and milk price drops. Successful dairy farm businesses will need to be resilient. Resilience in any business requires a solid system foundation (**a strategic plan**) with the technical expertise to make appropriate management decisions. With the imminent removal of quotas, it is an opportune time to review your system for a future of greater opportunity and greater uncertainty.

Resilient dairy farm systems must be designed with land production capacity, soil class and rainfall in mind, they must be based on elite high performance animals suited to the system, and they must be highly efficient per unit of land, labour and capital. Such business must provide a reasonable return on equity, be environmentally and animal welfare compliant, and provide an enjoyable and rewarding lifestyle for those working on the business. The key pillars of a resilient farm business are the efficient utilisation of natural resources, a 'fit for purpose' animal, a strong business acumen in management, and a policy of continuous improvement for staff at all levels of the business.

Appendix 1. *Calculating Comparative Stocking Rate (CSR; kg Lwt/ t DM)*

Step One:
Calculate kg Liveweight/ha

Total number of cows milked at peak = ... cows **a**
Farm area (effective area) = ... ha **b**
Cow liveweight (average mid-lactation) = ... kg **c**

Liveweight/ha = a ÷ b x c = ... kg LWT/ha (A)

Step Two:
Calculate t DM available/ha

i) Pasture grown on milking area = ... t DM/ha

ii) plus imported feed
. . . . . tonnes concentrate x 85%/farm area = ... t DM/ha
. . . . . bales silage x 0.25 t DM/bale/farm area = ... t DM/ha
. . . . . m^3 silage x 150 kg DM/m^3/1000/farm area = ... t DM/ha
. . . . . ha forage crop x ____t DM/ha (crop yield)/farm area= . . . . t DM/ha
. . . . . tonnes other purchased feed DM/farm area = ... t DM/ha
. . . . . days grazing off x __cows x __ kg DM/cow/1000/farm area = ... t DM/Ha

Total imported feed = ... t DM/ha

Total feed available = (Pasture grown + Total imported feed) = ... t DM/ha (B)

Step Three:
Adjustment where young stock are on the effective area
i) [. . . . . calves x 3.5 kg DM/hd/day x . . . . . days]/farm area = ... kg DM/ha
ii) [. . . . . heifers x 7.0 kg DM/hd/day x . . . . . days]/farm area = ... kg DM/ha

Total feed used by young stock ÷ 1000 kg = ... t DM/ha (C)

Step Four:
Divide kg LWT/ha by t DM/ha

kg liveweight/ha = ... (A)
tDM available/ha = ... (B)
Young stock adjustment = ... (C)
Net feed for dairy production (**B - C**) = ... (D)

Comparative stocking rate (A ÷ D) = ... kg (Lwt / t DM)

Growing More Grass

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Summary

- There are four key aspects of increasing grass growth on farms; grazing management, reducing poaching damage, managing soil fertility and increasing sward perennial ryegrass content.
- Grazing management factors that increase grass production include spring grazing, targeting the correct mid-season pre-grazing herbage mass and post-grazing sward height.
- Poaching damage needs to be minimised on all soil types; on wetter soils grass production can be reduced from 14 to 49 per cent when severely poached.
- Increasing soil pH will increase capacity for grass growth.
- In the absence of soil fertility management, soil P and K status will move from higher and more productive Index three and four to low fertility Index one and two.
- Perennial ryegrass content of swards on commercial farms is too low.

Introduction

Dairy farmers are currently utilising 7.5 t DM/ha (source: National Farm Survey) during a 210 day grazing season on a milking platform stocked at 1.8 livestock units (LU)/ha. While every farm situation is unique with varying soil types, local climatic conditions, stocking rates and farmer management capabilities, grass production is limiting on most farms. If the forecast levels of expansion on dairy farms are realised, then farm grass production will have to increase substantially from current levels to meet additional cow requirements. The optimum stocking rate for an individual farm is that which gives sustainable profitability per hectare and is dependant on the individual farm's grass growth capability. With only two years remaining to the abolition of milk quotas, dairy farmers need to focus on increasing the grass growth potential of their farms; otherwise the proposed milk production expansion will come at a much higher farm gate cost. This cost will arise from much higher use of imported feed to support increased stocking rates. This paper will focus on four key issues related to growing more grass on Irish dairy farms: i) grazing management; ii) minimising poaching damage; iii) managing soil fertility; iv) improving sward perennial ryegrass content.

Grazing management

Good grazing management practices include maintaining optimum pre-grazing herbage mass, rotation length and soil fertility. Recent grazing studies at different Teagasc locations reveal that when good grazing management practices are combined with measurements to identify and reseed underperforming swards, high annual grass yields (in excess of 14.5 t DM/ha) can be achieved, regardless of location. While these grass production levels (and even higher levels) are being achieved on some farms, too many dairy farms are producing insufficient grass. Increasing the number of grazing days is a key aspect of increasing grass production and utilisation. Targeting early turnout and high grass utilisation can increase the grass growing capacity of a farm substantially. Previous research at Moorepark has shown that grazing in spring increases sward grass growth, grass quality and utilisation.

The most important aspect of mid season (April to August) grazing management is to control grass supply. Completing a weekly farm cover and assembling the data using the 'pasture wedge' is a simple method to interpret this data and control the current grass supply (**www.agresearch.teagasc.ie/moorepark**). Grass growth is dynamic, and during the mid season it requires control, especially during periods of high grass growth.

A recent grazing experiment comparing three pre-grazing herbage masses (low – 1,000 kg DM/ha; medium – 1,500 kg DM/ha and high – 2,300 kg DM/ha) for dairy cows from April to September was undertaken (Table 1). Daily herbage allowance was 17 kg DM/cow/day (> 4.0 cm) for all three treatments. Grazing cows at low and medium herbage masses had a positive effect on milk solids yield, as well as increasing grass utilisation. Continuously grazing low herbage mass swards during the grazing season doubled the daily area required for grazing compared to grazing the high herbage mass and increased the area required by 30 per cent compared to the medium herbage mass. Short grazing rotations (<16 days) have negative effects on grass production as the sward will rarely reach the three leaf stage.

Table 1. The effect of pre-grazing yield on the performance of spring calving dairy cows from April to October

	Low mass	Medium mass	High mass
Pre grazing yield (kg DM/ha)	974	1474	2319
Pre grazing height (cm)	6.6	9.1	12.4
Post grazing height (cm)	4.0	4.2	4.3
Leaf proportion (%)	70	67	60
Leaves appearing during re-growth	1.73	2.16	2.26
Milk solids (kg/cow)	1.63	1.63	1.58
Dry matter intake (kg/cow)	15.3	16.2	16.2
Grazing time (hours)	10.8	9.3	9.3

Achieving three leaves on perennial ryegrass tillers is desirable to ensure canopy closure which stimulates high levels of growth (Figure 1). As the youngest leaf remains post grazing, both the medium and high herbage mass swards grew between two to three new leaves per tiller during the regrowth interval, while the low mass sward only grew one to 1.5 leaves per tiller in the same period. The recommendation is to **target pre-grazing yields of 1,300 – 1,600 kg DM/ha** during the mid season period (April to late August) and to graze paddocks to 4 cm. When pre-grazing yield increases above this, the paddocks should be harvested for round bale silage, closed for a main cut of silage or grazed by non lactating stock.

Poaching damage

Increasing the length of the grazing season also increases the risk of poaching damage, particularly during times of soil saturation which are more common in early spring and autumn. Recent Moorepark research has shown that when a free draining soil was badly poached in spring, DM yield was reduced by 30 per cent at the next grazing, but total annual DM yield was similar between undamaged and badly poached paddocks. On a heavy soil, cumulative annual DM yield was reduced by between 14 and 49 per cent, depending on frequency of poaching and timing. A predominantly perennial ryegrass (PRG) sward on a free-draining soil is resilient to heavy treading damage, but a PRG sward on wet soil needs careful management to avoid significant losses in DM production after poaching damage. The use of on/off grazing is vital to maintain the grass production potential of the farm. With variable weather patterns the grazing management approach needs to be flexible.

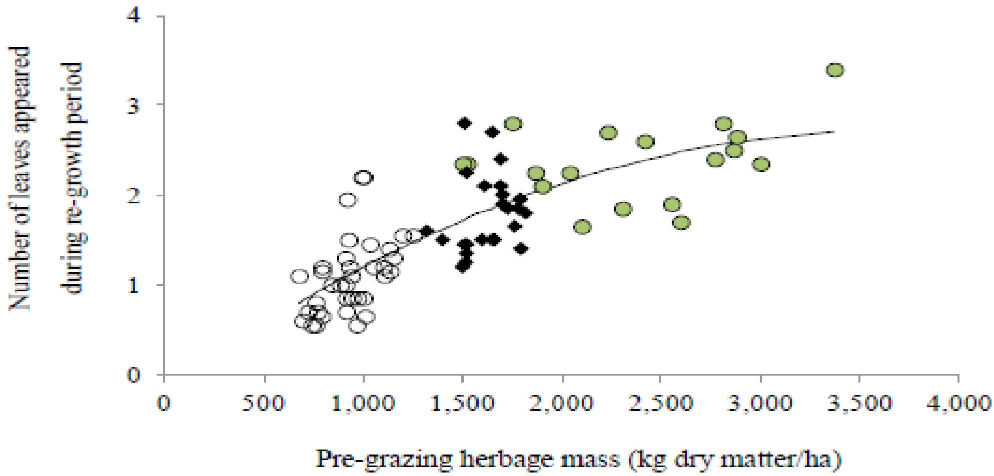


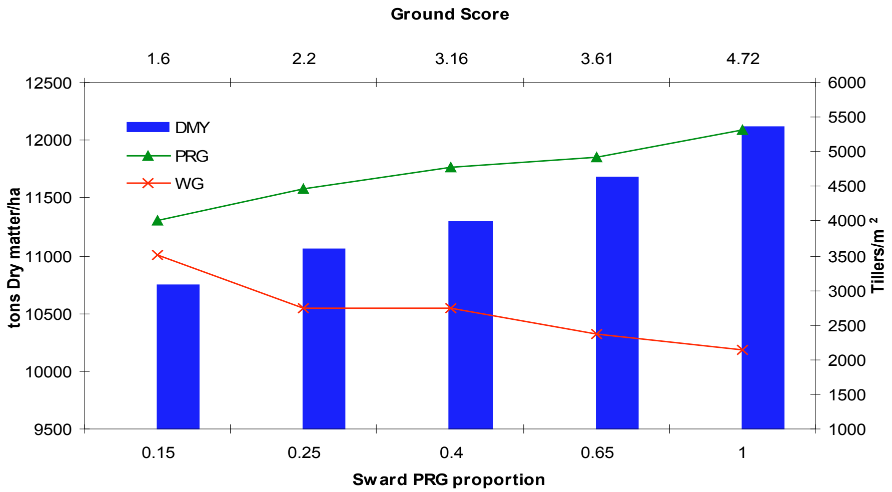
Figure 1. *Pre grazing herbage mass (kg DM/ha) and number of leaves appeared per tiller during the regrowth period that were grazed at low (○), medium (▪) and high (●) pre grazing herbage mass over a 24 week period*

Soil fertility management

In recent years, soil fertility has not received adequate attention on grassland farms. Though fertilizer costs are rising, increased grass growth rates can be achieved profitably with proper soil nutrient management. Soil pH affects the availability and uptake of both major and trace elements by crops. The ideal pH for grass is 6.3, as this allows maximum grass growth, nitrogen (N) release and phosphorus (P) and potassium (K) availability. Liming increases the soil pH and stimulates the release of N from soil organic matter. It may also increase N supply through increased growth of white clover. Applying lime to increase the soil pH will increase nutrient uptake and DM yield, and improve the long-term persistency of perennial ryegrass and clover in the sward. Recent research illustrates that 5 t/ha of lime applied to a soil with low pH (5.3) increased grass production by approximately 1.5 t DM/ha over a two year period. Only approximately 30 per cent of soils are in the agronomically optimum Index three range for P and K. Soils with poor fertility status cannot support productive grass swards. Increasing soil fertility of low Index 1 and 2 soils up to Index three is vital to maintaining high DM production across the farm. Research has shown that soils with P Index 3 will grow approximately 1.5 t DM/ha/yr more grass than soils with P Index 1. Current trends in soil P and K indicates a movement of soil Index from higher and more productive Index 3 and 4 down to low fertility Index 1 and 2. In the last four years, the proportion of Index 4 soils has decreased, while the proportion of soil samples with P levels in Index 1 has increased from 14 to 22 per cent. Soils in the Index 2 range have remained relatively stable at 25-28 per cent for the last number of years. Soil K indices show a similar pattern to P, although not as pronounced. Sulphur (S) is also a key nutrient that needs to be applied in fertilizer, especially on lighter free draining soils. Deficiency of S in swards will reduce DM yield by up to 14 per cent, and also reduces the response to N fertilizers.

Perennial ryegrass content

Only seven per cent of the land area on specialist dairy farms in Ireland is reseeded annually. Recent research has demonstrated that increasing the proportion of the farm reseeded increases total and seasonal DM production. When accompanied by an increased stocking rate, leading to increased herbage utilisation and a positive effect on profitability. The greatest gain in terms of DM yield will be achieved when the new sward is replacing a sward that is producing less grass than it potentially could. Ground score is a method to establish the level of perennial ryegrass (PRG) content in pasture. Figure 2 shows the DM production, tiller density (PRG and weed grass (WG)) and ground score (GS) (% of PRG in the sward, scale 0 to 9) in swards with different levels of PRG. As the GS and PRG percentage of the swards increased the DM yield of the swards increased substantially. The DM yield ranged from 10.7t DM/ha (GS-1) to 12.1t DM/ha (GS - 4.7). Hence, GS has a positive effect on the DM yield of a PRG sward. In 2012, as part of on farm grass variety evaluation study, >1250 paddocks on 40 dairy farms were ground scored. Mean ground score was 3.1, which ranged from paddocks scoring 0 to 6.5. It is clear from this investigation that it is necessary to increase the perennial ryegrass content in swards on commercial dairy farms.



*DMY – Dry matter yield; PRG –perennial ryegrass content; WG – Weed grass.

Figure 2 *Relationship between perennial ryegrass content, DM production and ground score in simulated grazing swards*

Conclusions

As farmers aim to produce more milk from the grazing platform in the future, pasture growth will be the first factor that limits productivity. Most farms have the capacity to grow more grass, and every effort should be made to adopt grazing management practises that ensure high annual grass DM production. Investing in soil fertility improvement and increasing sward perennial ryegrass content will be valuable investments in the coming years.

EBI to Fuel Expansion

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Summary

- The EBI is the most appropriate breeding goal for the post-quota era.
- Increased herd milk production with the EBI is achieved through each of the following:
    - » Increased genetic merit for milk solids yield/cow.
    - » Longer lactation lengths through better fertility.
    - » Achieving herd mature yields through greater animal survival.
- The additional benefit of hybrid vigour (€100/lactation in the first cross) will be maximised where the best available genetics (high EBI sires of the alternative breed) is used.

Introduction

The breeding goal for Irish dairy cows post-quota does not differ fundamentally from that here-to-fore. The appropriate breeding goal for all production systems is increased profit, achieved through greater milk solids at minimal cost. This is the objective of the Economic Breeding Index (EBI). Many studies have now clearly shown that differences amongst animals and herds in EBI are clearly reflected in differences in performance (both milk production and fertility) and, most importantly, profit. The EBI achieves a dual objective of increasing revenue (i.e., mainly milk solids output) and reducing costs (mainly fertility, survival and health).

Economic breeding index

The EBI introduced in Ireland in 2001 has always focused on identifying the most profitable animals for Ireland. Originally the EBI was designed to maximise profit under a milk quota regime but in 2007 the relative emphasis on the traits within the EBI were altered to reflect the imminent removal of milk quotas in 2015. Hence selection of the ideal post-quota cow has been in operation for the past six years.

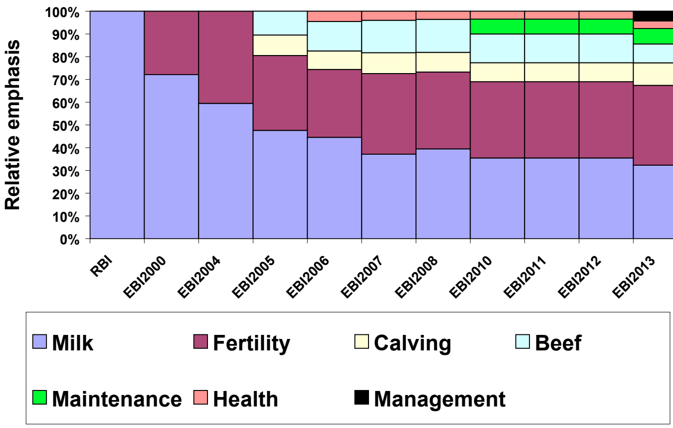

Figure 1. *Relative emphasis on the sub-indexes within the EBI since its establishment in 2001*

The EBI is evaluated annually and, where necessary, alterations are made to reflect changes in costs of production as well as projections of milk price. In 2013, following consultation with industry, two management traits, milking duration and temperament were included in the EBI. Milking duration evaluations are independent of milk yield and udder health meaning that selection for shorter milking duration will not impact negatively on milk yield or udder health. How the EBI has evolved since its introduction 12 years ago is summarised in Figure 1. The relative emphasis of traits within the EBI has not changed substantially since 2005. The relative emphasis on the milk production, fertility and survival, calving, beef, maintenance, management and health is 33, 35, 10, 9, 6, 4 and 3 per cent, respectively.

Is the EBI selecting for increased milk production?

There has recently been some (mis-informed) commentary on the lack of sufficiently "high milk bulls" on the active bulls list. This subsequently manifested itself as questioning if the EBI was selecting for increased milk solids yields and therefore its suitability to a non-quota environment.

Table 1. Average EBI, milk and fertility sub-index as well as a selection of traits for all Irish herds on the ICBF database, milk recording herds, pedigree registered herds and winter calving herds

Trait	All	Milk recording	Pedigree	Winter calving
EBI	92	91	76	62
Milk subindex	27	29	32	29
Fertility subindex	58	56	41	30
Milk kg	89	101	151	177
Fat kg	5	5.5	6.2	5.9
Protein kg	4.8	5.2	6.2	6.2
Fat %	0.035	0.035	0.014	-0.01
Protein %	0.038	0.038	0.026	0.009
Calving interval	-3.56	-3.39	-2.35	-1.7
Survival	1.31	1.27	1.05	0.82

The average genetic merit of Irish dairy herds for EBI and a selection of subindexes and traits in the EBI are in Table 1. Genetic gain will ensue if the average genetic merit of the team of bulls selected is greater than the genetic merit of the herd. Based on Table 1, it is quite clear that ample bulls exist on the active bull list that will increase the milk solids yield in Irish herds; in fact over three quarters of the bulls on the active bull list will increase milk solids yield in the average Irish herd while almost all will improve survival and calving interval. Moreover, the variation in herd average lactation milk yield for herds with an average genetic merit of +95 to +105 kg PTA for milk is quite substantial (Figure 2) varying from 4000 to 9000 kg of milk. Therefore, the genetic merit of a herd cannot be reliably undermined based on the performance alone, since management (e.g., concentrate input) has such a large influence.

There are nonetheless, three approaches to increase milk solids yield per cow: 1) improving genetic merit for milk solids yield, 2) increasing lactation yield through longer lactation length, and 3) ensuring a greater proportion of cows in the herd reach their mature yield. The EBI is improving all three.

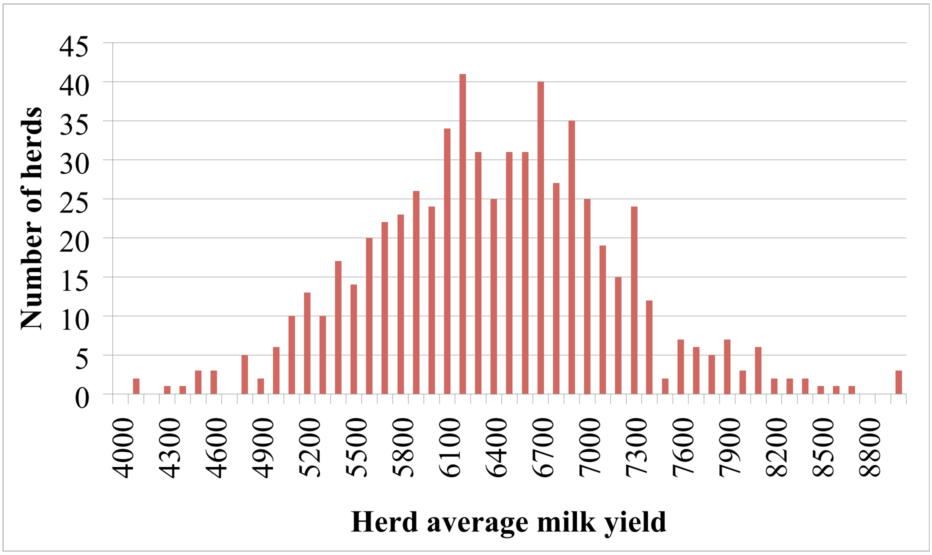

Figure 2. *Mean milk yield/cow in herds with a mean milk predicted transmitting ability (PTA) of 95 to 105 kg*

Milk solids yield. The evidence is clear that a 1 kg difference in sire PTA for milk yield, fat yield or protein yield manifests itself as, on average, 1 kg difference in progeny performance on the ground. Genetic merit for milk solids is increasing by ~1 per cent/year which is consistent with international breeding programs. Gain in genetic merit for milk solids since the introduction of the EBI is 50 per cent of what it was prior to the introduction of the EBI. This is because the EBI also includes emphasis on non-production traits, most of which are unfavourably correlated with milk production. Equivalent figures in the UK and US for genetic gain following the introduction of functional traits in national breeding objectives is 45 per cent and 65 per cent, respectively of the gains prior to the introduction of the functional traits.

Reproductive performance. National average lactation length in Ireland is 279 days, attributable mainly to a delayed calving date brought about by inferior genetic merit for fertility from decades of aggressive selection for milk production. Relative to a 305-day lactation, a cow milking for only 279 days yields four per cent less; this is equivalent to 262 litres of milk for a 6000 litre cow or 390 litres of milk for a 9000 litre cow. In a seasonal production system, achieving long lactation lengths can only be achieved with superior fertility. A one day shorter calving interval equates to a one day shorter lactation length. This is cumulative and permanent; a one unit PTA for calving interval equates to a three day longer lactation by third lactation and this has knock-on effects for heifer progeny.

Survival. A second lactation cow yields 14 per cent more than a first lactation cow while a third and greater lactation cow yields 22 per cent more than a first lactation cow. Therefore, reducing replacement rate, and therefore, the proportion of younger animals in the herd will increase herd milk solids output. Lower replacement rates (i.e., greater survival) can be achieved through selection of animals, within the EBI framework, for improved survival.

Cow production index (CPI)

The Cow Production Index (CPI) is a new index currently being developed by the research team at Moorepark in conjunction with the ICBF. It is designed to rank cows on their likely profit generation taking cognisance of both genetic and environmental factors. Despite the availability of high-quality data, there appears to be a lack of guidance and uniformity in the decision making rules at farm level when it comes to decisions about voluntary culling or retention of individual cows. To use this available data more efficiently and to save farmers money, the new CPI is being developed to help farmers identify the least profitable cows in their herds and retain the most profitable cows.

The phenotypic (actual) performance of a cow is a product of both genetic and environmental effects. Genetic effects include additive genetic effects and non-additive genetic effects. Additive genetic effects are genetic effects that are passed from parents to offspring, and are the basis of the EBI which is used as a breeding tool. Non-additive genetic effects include heterosis and recombination effects and are the cumulative effects of crossbreeding. These non-additive genetic effects will be included in the CPI as well as an effects termed permanent environmental effects which remain with the animal throughout its life but are not inherited. Examples of permanent environmental effects included management as a heifer or injury to the animal.

International models have shown that farmers that are provided with production ranking indices are in a better position to more effectively choose what cows to cull, retain or purchase, to maximise profitability. Using Irish data, the CPI will provide farmers with a means to identify underperforming cows in the herd as candidates for voluntary culling and also for purchasing cows based on production performance rankings. This new index is expected to be launched in the latter half of 2013.

Bull selection

Bull selection, irrespective of the breed, should be based on EBI. The individual sub-index values can be used to tailor the team of bulls to individual herds. For example, if a farmer wants to improve fertility and survival but not sacrifice milk production then the average fertility sub-index of the team of bulls must be (substantially) greater than the herd average genetic merit but the milk sub-index value must not be (much) less than the milk sub-index value of herd. The greater the difference in sub-index values between the team of bulls selected and the herd average, the greater will be genetic gain. Easy calving bulls can be chosen for use on heifers; bulls with a PTA for direct calving difficulty of >2 are not recommended for use in heifers.

If using genomic bulls then a minimum of four bulls should be used in a team. This is because the reliability of genomic bulls (~58 %) is less than that of traditional proven bulls (~90 %) and using a team of bulls will minimise the risk of individual bull fluctuations in proofs with the accumulation of daughter records.

If crossbreeding bear in mind that hybrid vigour is worth a further €100/lactation over and above that explained by the EBI. This benefit (additional profit) will be maximised where the best available genetics (high EBI sires of the alternative breed) is used.

Conclusions

The EBI is selecting for the idea cow in a non-milk quota environment. The EBI is increasing herd milk solids yield through 1) increased genetic merit for milk solids, 2) longer lactation lengths through improved fertility, and 3) greater cow survival thereby achieving herd mature yield.

Requirements to Achieve 90% Calving Rate in Six Weeks

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Summary

- Conduct a detailed analysis of herd fertility at the end of the breeding season.
- Calving pattern is a pivotal driver of farm profitability.
- Heifer rearing and heifer reproductive management are critical for improving calving pattern.
- Over time, shorten the breeding season to 12 weeks or less. Identify strategies to maximise both submission and conception rates during the breeding season.
- Correct management of BCS during the dry period, early lactation and breeding period is a vital component of herd nutritional and reproductive management.
- Early identification of anoestrous cows allows time to take appropriate action.

Introduction

For most spring-calving systems, the breeding season will commence sometime between mid-April and the first week of May. The primary objective must be to get as many cows and heifers pregnant as quickly as possible after the start of the breeding season. This is critically reliant on achieving high submission rates in both heifers and cows.

Heifers

Heifers should be reared with the goal of reaching puberty by 10 to 12 months of age, and cycling regularly by 13 to 15 months of age. The specific weight targets vary depending on the breed, strain and cross (Table 1). Achieving target weights at 13 to 15 months of age will improve fertility at first breeding, and achieving target weights at first calving will increase conception rates as first lactation cows. Heifers need to be weighed regularly, and light heifers should be given preferential feeding to ensure that the target weights outlined in Table 1 are met.

Table 1. Bodyweight (BW) targets for maiden heifers at breeding and for heifers pre-calving by breed/crossbreed

	HF	NZ	HF*NZ	NR	HF*NR	J	HF*J
Maiden heifer BW (kg)	330	315	330	315	330	240	295
Pre-calving BW (kg)	550	525	550	525	550	405	490

HF = Holstein-Friesian, NZ = New Zealand HF, NR = Norwegian Red, J = Jersey

There may be advantages in starting to breed the heifers 7 to 10 days before the lactating cows. The main advantages are:

- Initial heat detection and AI efforts can be focused on the heifers before the breeding period begins for the lactating herd.
- If all heifers are cycling, those that did not get bred in the first six days will respond to a single injection of prostaglandin, resulting in the majority of heifers being bred by day 10 of the breeding season.
- After calving, first lactation cows take about 10 days longer to start cycling. By calving earlier in their first lactation, extra time is allowed to increase the likelihood that they will have resumed cycling and hence achieve high submission rates at the start of the

breeding season as first lactation cows. This will increase the likelihood that they will again calve early the following year, hence lengthening their productive lifespan in the herd.

It is critical that easy calving bulls are used for breeding heifers (both AI and natural service). Dystocia (calving difficulty) will result in increased incidence of retained placenta, metritis, and delayed resumption of cyclicity after calving. Collectively, these problems are associated with reduced submission and conception rates during the breeding period. When identifying AI sires for use on heifers, choose bulls with direct calving difficulty values less than two per cent.

Lactating cows

The major factors under direct farmer control that affect fertility of dairy cows are:

- Duration calved at mating start date (MSD).
- Body Condition Score (BCS) at MSD and BCS loss from calving to MSD.
- Genetic merit for fertility traits.
- Reproductive management.
- Nutritional management.

Duration calved at MSD

The single biggest factor that influences a cow's reproductive performance during the breeding season is how long ago she calved at MSD. Cows that calve early will have resumed cyclicity, be regularly displaying strong behavioural oestrus, have completed uterine recovery, have passed peak milk production and finished losing BCS by the time the breeding season commences. As a result, early calving cows are likely to be submitted for AI during the first three weeks of the breeding season and have a high likelihood of successful pregnancy establishment. **This underlines the importance of ensuring that heifers calve down at the start of the calving period, and using replacement heifers every year to achieve improvements in calving pattern.**

BCS management

After parturition, dairy cows experience a rapid increase in milk yield and a slow rise in dry matter intake (DMI). This results in a deficit in energy intake (more energy required for maintenance + milk than energy supplied from the diet) that is generally referred to as Negative Energy Balance (NEB). The cow responds to NEB by mobilising energy from fat reserves to fill the energy deficit. While it is normal for dairy cows to mobilise fat in early lactation, it becomes a problem when cows mobilise excessive amounts of fat or when the duration of fat mobilisation is prolonged (Figure 1).

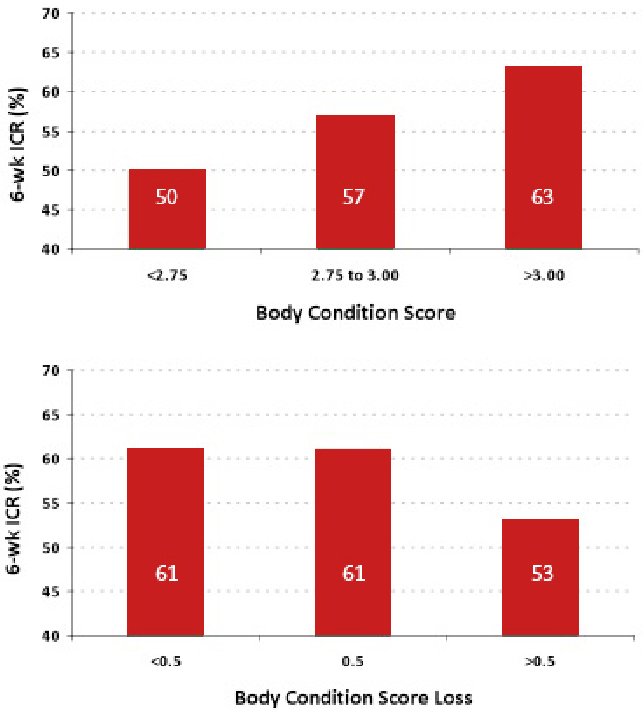


Figure 1. *Body condition score and reproductive performance.*
Top panel: *Association between body condition score (1 to 5 scale; 1 = very thin, 5 = very fat) during the breeding season and six week in-calf rate.*
Bottom panel: *Association between body condition score change from pre-calving to start of breeding and six week in-calf rate (for cows with a pre-calving body condition score of >3.00)*

Achieving the appropriate herd average **and** range in target BCS (Table 2) requires monitoring of BCS at distinct times throughout the year, not just during the breeding period. Thin cows need to be identified in advance of dry-off, allowing longer dry periods and preferential feeding to achieve target BCS at calving.

Table 2. Target body condition scores at key times of the year

	Herd average	Range
Drying off	3.00	2.75 to 3.25
Pre-calving	3.25	3.00 to 3.50
Start of breeding	2.90	2.75 to 3.25

Reproductive management
Attention to detail in relation to reproductive management will be rewarded with better herd reproductive performance. Key issues are:

- Maintain a list of all cows that had dystocia, retained placenta, metritis and metabolic problems in early lactation such as milk fever, ketosis, or displaced abomasum. These cows should be examined in advance of the breeding season and treated as appropriate.
- Use pre-breeding heat detection to identify non-cycling cows. Examine these cows early and treat them to facilitate breeding at the start of the breeding season. Ensure farm staff are fully trained to pick up signs of heat.
- If using DIY AI, take a refresher course every two to three years.

- During the period of AI use, combine heat detection aids with at least three periods of observation in the field.
- Monitor daily submission rates. By day 10, 43 per cent of the herd should be submitted for breeding. If the submission rate is markedly lower than this, consider implementing synchrony to increase submission rate.
- Ensure adequate bull power during the period of natural service (one bull per 20 cows not in-calf). Bulls should be rotated every three to four days.
- Pregnancy diagnosis for the whole herd should be carried out ~5 weeks after the end of the breeding season. Confirm pregnancy status for cows in calf to AI, and determine the stage of pregnancy for cows in calf to natural service. Compile expected calving dates, and use these dates to determine dry off strategy and dry cow nutritional management.

Nutritional management

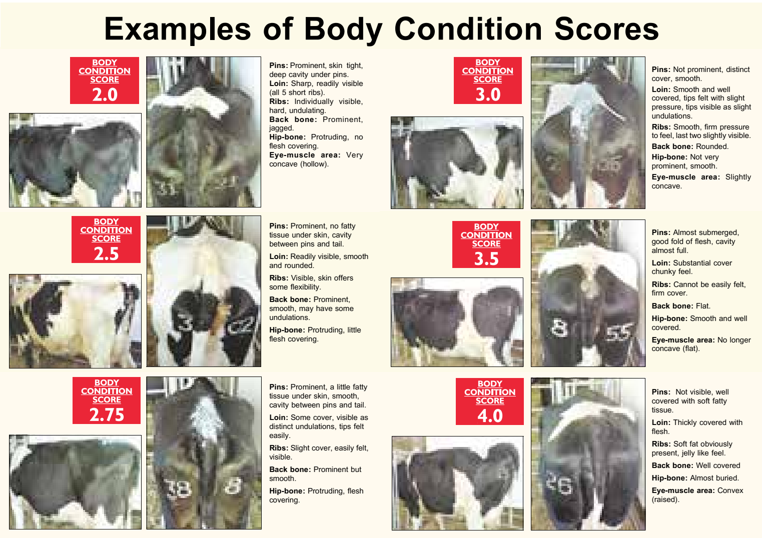
- Intervene quickly to treat any metabolic disorders that occur around calving and minimise the duration that cows have reduced intake.
- Ensure that the dry cow diet is properly balanced for energy, protein and minerals, and that the amount allocated is correct for the BCS target at calving.
- Supplement the grazing diet with the necessary minerals to prevent deficiencies or imbalances. This will require mineral testing of the grass being grazed to determine its mineral profile.
- Feed concentrates in early lactation to minimise the deficit in energy intake.

Genetic merit for fertility traits

Cows with good genetic merit for fertility traits (high fertility sub-index) have better reproductive performance than cows with poor genetic merit for fertility traits. This arises from better body condition score, earlier resumption of cyclicity, better uterine health and stronger heats. See paper by Moore and Butler on page 79 for more details.

Conclusions

The first step to improving herd fertility is to establish the fertility performance figures for your herd. Focused periods of intensive management are required during calving, the pre-breeding period and the period of AI use. Achieving a compact calving pattern is beneficial for herd management during the following spring, allows longer lactations, greater grass utilisation, and increased profitability.



Achieving a Healthy Herd

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Summary

- Know your herd health status – through good stockmanship and use of new laboratory screening tests to establish your herd health status.
- Prevent disease introduction by biosecurity – talk to your local vet about what additional tests might be useful on bought-in stock.
- Prevent disease spread by vaccination – discuss how to get maximum value out of your spend on vaccines with your local vet.

Introduction

Irish dairy farmers are moving into an unsupported and unrestricted market where milk production systems have to operate at optimal efficiency in order to withstand milk price fluctuations. For years now, the merits of grassland management, nutritional management, and management of fertility on dairy farms have been extensively promoted. Diseased animals perform sub-optimally and decrease on-farm efficiency and profitability through waste feed, labour and veterinary costs. Global markets are critically important to the Irish dairy industry as approximately 85 per cent of Irish dairy products are exported annually. Animal health is an important contributor to the international competitiveness of Irish dairy products, both as a result of the impact of animal disease on product quality, and because of the special importance of animal health in international trade. Ireland needs to move towards on-farm health planning as a means of maintaining market share, as well as improving productivity and competitiveness.

Herd health programmes employ a combination of biosecurity, vaccination and diagnostics to determine the health status of a herd. The health profile of a dairy herd will determine its success in terms of milk production, reproductive status and growth rates, i.e. the key aspects in a successful dairying operation. Biosecurity practices are now becoming substantial components of modern farming and as all herds are impacted by infectious disease, all are likely to benefit from the preparation and implementation of a biosecurity/herd health plan.

At a national level, Animal Health Ireland (AHI) is providing a framework to improve Ireland's herd health status through science-based, consensus-driven advice and recommendations. Teagasc research and advisory staff are currently actively engaged in AHI Technical Working Groups dealing with biosecurity, BVD, calf health, IBR, Johne's disease, mastitis and parasitic diseases.

Components of a herd health plan

Herd Health Plans should be kept simple, realistic, and achievable. Base them on the combined knowledge of both you and your vet with regard to the disease status of your farm and your locality.

At a minimum a herd health plan should consist of a written plan which outlines the following;

- Whether animals (including bulls and young calves) are purchased onto the farm (open herd) or the farm is operated as a closed farm (i.e. no inward movement of cattle onto the farm).
- Whether the farm has disease-proof and secure boundaries (this assessment must include any outside farm associated with the herd).
- What contractors (if any) will come onto the farm.

- Will slurry be imported (not recommended).
- Isolation procedures for sick and dead animals.
- Cleaning schedule for housing and yards.
- Additional biocontainment procedures to be introduced or maintained around the farm, e.g. clean supplementary veterinary equipment, footbaths etc.
- Disease monitoring plan for the farm, i.e. what surveillance diagnostic testing should be carried out given the open or closed status of the farm. An example of a herd monitoring plan is included in Table 1.
- A purchasing plan if stock are to be bought onto the farm. An example of what should be included in this plan is included in Table 2.
- Vaccination plan for the farm, i.e. what diseases are present in the herd that require vaccinating against; what additional diseases the farm potentially is at risk from based on purchasing strategies and neighbouring farms. Viral and bacterial diseases that should be considered include Leptospirosis, Salmonellosis, IBR, Clostridial diseases (e.g. blackleg), Rotavirus/Coronavirus, E. coli, BVD. An example of a herd vaccination plan is included in Table 3.
- Dosing plan for the farm, i.e. what diseases are present in the herd that require dosing against; what additional diseases the farm potentially is at risk from based on purchasing strategies and neighbouring farms. Parasitic diseases that should be considered include; Liver fluke, lungworm (hoose), gutworms, cryptosporidium, coccidiosis (an example is included in Table 3).

Herd health plan to achieve a healthy

There are three key steps in a veterinary herd health plan: 1) know your herd health status, 2) prevent disease introduction, 3) prevent disease spread by vaccination. In addition, it is up to you to monitor your own control programme. You are in the 'driving seat'; start the process by sitting down with your local vet and design a herd health plan together using these three simple steps to achieve a healthy herd (Figure 1).

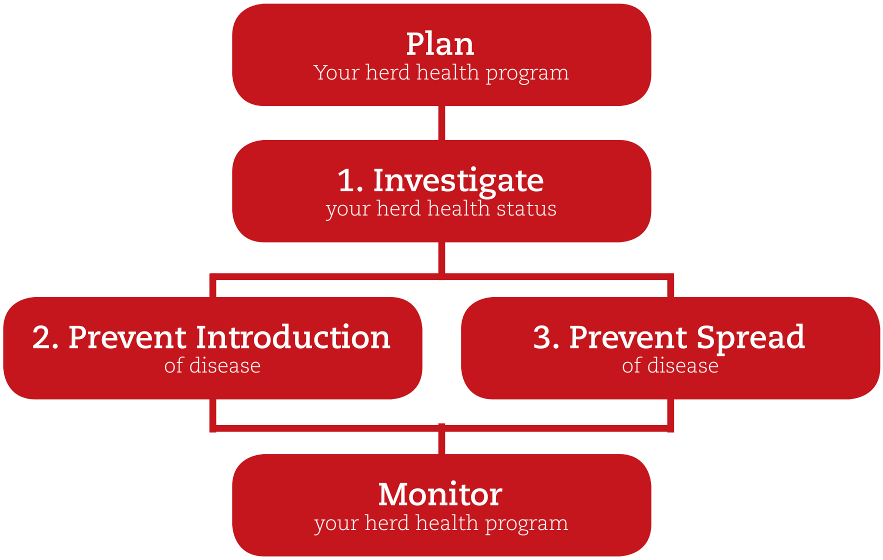

Figure 1. *Herd health plan to achieve a healthy herd*

Step 1: Investigate your herd health status

The simplest way to keep an eye on your herd health status is to herd your stock regularly for clinical signs of disease and to use your local vet to diagnose problems at an early stage. In addition, there are now new diagnostic tests that allow economical screening of herds using:

- Bulk milk testing (BVD, fluke, IBR, leptospirosis, neosporosis, salmonellosis, worms).
- Individual milk testing (BVD, IBR, leptospirosis, Johne's neosporosis, salmonellosis).
- Targeted blood sampling of weanlings (BVD, leptospirosis)
- Ear-notch testing (BVD).

These test methods can be used to give a starting point from which to decide, in conjunction with the clinical herd history, what to do next, e.g. the implementation of biosecurity and or vaccination protocols, what tests you need to do on bought-in cattle and which animals to cull based on test results. If you are using 'distance diagnostics' (test results and advice independent of your local vet) it is advisable to discuss this information with your local vet. Samples collected as part of a herd health plan in conjunction with your local vet provide the vital interpretation of the results specific to your herd health history. Table 1 shows an example of a disease monitoring plan for a farm.

Table 1. Example of a disease monitoring programme for a herd

Disease	Sample	Schedule	Vet informed of result (Yes or No)	Action Required
BVD	Ear-notch	Within 7 days of birth	Yes	All results negative. No immediate action required
BVD	Ear-notch	Within 7 days of birth	Yes	One virus positive reported. Re-test required.
BVD	Bulk milk	Quarterly	Yes	High level of exposure indicated. Discuss whole herd testing with vet.
IBR	Bulk milk	Quarterly	Yes	No IBR exposure indicated. Maintain high level of biosecurity
Johnes	Individual milk or blood	Over 90 days post-TB test	Yes	Two ELISA positives detected. Get vet to take dung sample from both.
Liver fluke	Bulk milk	Quarterly	Yes	High positive results in August. Need to dose on housing
Etc.				

Step 2: Prevent introduction of disease

With herd sizes likely to increase in the phased lead up to quota abolition, bought-in stock will become a major source of disease transmission. Currently, nine out of ten dairy farmers carry out no additional routine herd health screening when buying-in cattle. Biosecurity in its simplest form means the implementation of measures to prevent the introduction and spread of infectious diseases:

- A closed herd policy (i.e. no cattle movement, including bulls, onto the farm) will prevent the direct transmission of disease onto a farm. Ireland is currently one of the few EU Bluetongue disease-free countries; importation threatens this.
- Testing of bought-in stock should include more than TB and brucellosis. Diseases such as BVD, IBR, Johne's and Neospora should be tested. The most dangerous animal is the pregnant animal as the feotus may be infected and the dam test-negative ('Trojan animals'); the calf needs to be tested also. Non-pregnant, non-lactating cattle bought over the summer are the lowest risk. An example of a stock purchasing plan is included in Table 2.
- On-farm biosecurity measures, such as quarantine, stock and disease-proof boundaries (to prevent nose-to-nose contact and breakouts/breakins) and footbaths increase protection against the introduction of infectious diseases.

Table 2. A purchasing plan for stock purchase

No.	Action	How	Complete (✓)
1	Establish the current disease status of your herd before purchasing dairy cattle.	Use bulk milk analysis and blood sampling of young stock	
2	Buy all cattle from a single source if possible.	Use personal contacts or auctioneers to source suitable animals	
3	Speak with the seller regarding the health history of his herd and the individual animals to be purchased including their vaccination status.	Record all information supplied in writing	
4	Clean and disinfect buildings before introduction of purchased animals.	Get veterinary advice on suitable cleaning and disinfection procedures. List of approved disinfectants on **www.agriculture.gov.ie**	
5	Quarantine all newly purchased cattle, i.e. isolate for at least 30 days in an area that is at least 3 m from other cattle groups, with no sharing of feed or water troughs and no mixing of dung and urine.	Purchase animals during the grazing period to allow isolated paddocks to be used as quarantine area. Do not purchase lactating stock which will require milking unless isolated milking facilities are available.	
6	Vaccinate/test new purchases for Leptospirosis. If deemed necessary, vaccinate for Salmonellosis and IBR. Note: both Leptospirosis and Salmonellosis are transmissible to humans	Use current herd status and veterinary advice on levels of Salmonellosis and IBR in your local area to decide on vaccination strategy	
7	All purchases (including bulls) should be tested for BVD virus and exposure to IBR, Leptospirosis and Johnes Disease (antibodies). If economically feasible and if the seller's herd history suggests there may be an issue, test for Salmonella, *Neospora caninum* and *Mycoplasma bovis.*	Take a blood sample approximately three weeks after the animals arrival on farm and while they are still in quarantine.	
8	Dose all purchased animals for parasites, including lungworm and liver fluke. These parasite can also be tested for in incoming animals should your farm be negative.	Use an effective and licensed wormer and flukicide ensuring to adhere to withdrawal times.	
9	Remember that in buying an in-calf cow or heifer, you are essentially buying two animals. Test calves from newly purchased dams at birth for BVD virus.	This is now compulsory under the National BVD eradication scheme.	
10	Discuss on-going testing, vaccination and dosing strategy for infectious diseases with your vet.		

Step 3: Prevent spread of disease by vaccination

Vaccination programmes are best implemented where there is close veterinary involvement in the decisions: Whether to use a vaccine or not? Which vaccine to use? When to administer the doses? Vaccines should be viewed as a component of a herd health plan but not the sole means of disease prevention within a herd as is commonly the case. Over-reliance on vaccination without the backup of proper compliance, management and biosecurity can lead to real or apparent vaccine breakdown. If you find it difficult to remember when to vaccinate it is worthwhile designing with your vet a simple calendar of which month which animals need to be vaccinated on one sheet of paper and stick this up beside your farm files and in the dairy. Pick a date and stick to it. In addition, write these dates, and when you need to order product, into your diary each year. Linking vaccination dates to prominent calendar dates also helps, e.g. '*first lepto vaccine dose for heifers on St Valentine's Day and second dose on St Patrick's Day*'. An example of a herd vaccination plan is included in Table 3.

Table 3. Example of vaccination and dosing plan for a herd

Disease	Schedule	Vet informed (Yes or No)	Product
Liver fluke	Dose whole herd at housing and again before calving	Yes	Albendazole (Note product milk withdrawal)
Liver fluke	Dose whole herd two weeks after housing	Yes	Triclabendazole (Note product milk withdrawl)
BVD	1st March for cows and bull(s) 1st February and 1st March for heifers (Breeding start date is 1st April)	Yes	Bovilis BVD or Bovidec
IBR	6th January and 6th June Check product for booster requirements for primary vaccination	Yes	Zoetis products MSD products Hipra product
Salmonella	15th August for cows and bulls 22nd July and 15th August for heifers	Yes	Bovivac S
Etc.			

Monitor your control programme

Once you have decided to implement a control programme through a herd health plan you need to check that it is working year after year. You can do this by:

- Routine herding of stock to pick up early signs of disease.
- Monitoring of records to detect changes in performance.
- Testing/treating bought-in stock and
- Use of screening tests to detect a change in herd health status.

In addition to monitoring for disease you need to monitor the control programme itself, e.g. has the timing of your vaccination programme drifted over the years?

Disease specific information

Brief notes on a number of relevant disease to Irish dairy farms are included below including a prioritised list of measures to be implemented for prevention and control which can be used to develop your herd health plan.

Leptospirosis

Leptospirosis is a bacterial disease of cattle. It can also result in life-threatening disease in humans. A leptosprial infection can be transmitted from one animal to the next through direct contact with infected urine/water, milk or placental fluids. Infected animals often show no signs of infection but harbour the bacteria in their kidneys, shedding them intermittently into the environment. Some wildlife species (e.g. rats) also shed leptospires in urine making avoidance difficult. Transmission via semen is possible but uncommon.

Clinical Signs

- Decreased reproductive efficiency (infertility).
- Decreased milk production (milk drop syndrome).
- Abortion sometimes with retention of afterbirth.
- Stillbirths and weak calves.
- Septicaemia (blood poisoning).

Control in your herd using

- Vaccination.
- Selective treatment with high dose antibiotics.
- Rodent control.
- Fencing of wet ground and streams.
- Keeping housing clean and disinfected.
- Designing and implementing a biosecurity plan including diagnostic testing.

Infectious bovine rhinotracheitiis (IBR) *(see* **www.animalhealthireland.ie***)*

IBR is a highly contagious viral disease of cattle caused by Bovine Herpes Virus 1 (BHV-1) Direct animal contact is the most efficient method of IBR virus transmission. Stress re-activates infections in carrier animals. Nasal discharges from infected animals will contain large amount of virus. Indirect transmission can also occur although of lower risk.

Clinical Signs

- Initial outbreak
  - » Sudden milk drop and high fever.
  - » Nasal discharge – red, crusty nose.
  - » Sore and cloudy eyes.
  - » Severe pneumonia due to secondary bacterial infections.
  - » Abortions in the second half of pregnancy.
  - » Increase in calf pneumonia.

Repeat outbreak (less severe)

- Occasional abortions in second half of pregnancy.
- Pneumonia.

Eliminate from your herd by

- Vaccinating with a live vaccine in the face of an outbreak.
- Continuing to vaccinate at six-monthly intervals (note change to Zoetis inactivated

vaccine which allows annual booster interval).
- Testing to establish the level of carriers in the herd.
- Culling carriers out of the herd when economically feasible.
- Designing and implementing a biosecurity plan including diagnostic testing.

Bovine viral diarrhoea (BVD) *(see* **www.animalhealthireland.ie**)
BVD is a highly contagious viral disease of cattle caused by Bovine Viral Diarrhoea virus (BVDv). Direct animal contact is the most efficient method of BVD virus transmission. Both transient and persistently infected animals will shed virus particles in all bodily secretions, such as nasal and oral discharges, tears, milk and semen. Persistently infected animals shed significantly higher levels of virus that transiently infected animals. Indirect transmission by contaminated housing, veterinary equipment and farm visitors can also occur although of lower risk.

Clinical Signs
- Poor fertility (conception rates), having ruled out other causes.
- Poor calf health, i.e. unprecedented or undeserved level of calf scour and/or pneumonia.
- Increased number of abortions, stillbirths and/or deformities.
- Birth of weak calves.
- Occurrence of severe acute BVD.
- Occurrence of fatal mucosal disease (only possible in persistently infected animals).

Eliminate from your herd by
- Testing for and removing persistently infected animals (National BVD Eradication Scheme). Also note AHI supplementary advice on applied additional BVD testing on your farm should positive animals be identified (**www.animalhealthireland.ie**).
- Designing and implementing a biosecurity plan.
- Vaccinating.

Johnes disease (Paratuberculosis) *(see* **www.animalhealthireland.ie**)
Johnes Disease or Paratuberculosis is a bacterial disease of cattle caused by ***Mycobacterium avium*** subspecies ***paratuberculosis***. This bacterium is shed in faeces by infected animals. Young calves are most at risk of infection and become infected when exposed to infected dung, particularly when nursing from an udder contaminated with infected faeces or from ingestion of infected colostrum and/or milk. ***M. avium*** subspecies ***paratuberculosis*** can also cross the placenta; however the most common route of infection is through ingestion of the mycobacterium. An apparently normal animal can silently shed mycobacteria in the herd. This bacterium remains viable in the environment for lengthy periods (> 1 year).

Clinical signs
- Chronic, eventually fatal, weight loss in cows despite treatment.
- Progressive wasting despite a good appetite.
- Persistent and severe diarrhoea.
- Clinical signs rarely seen in animals less than two years of age.

Control in your herd by:
- Immediately isolating and culling of infected animals.
- Continuous testing to identify high-risk animals, which should be culled if/when economically feasible.
- Implementing a calf management system to avoid infection i.e.
  - » separate newborn calves from all adult animals immediately after birth until at least 12 months of age and preferably until two years of age.

    - feed colostrum from cows either negative or low-risk for Johnes.
    - rear calves on milk replacer until weaned.
- Maintaining a clean and disinfected environment in order to reduce faecal contamination, especially in calf housing and on equipment coming into contact with calves. An approved disinfectant should be used.
- Designing and implementing a biosecurity plan including diagnostic testing.

Fascioliasis (liver fluke) *(see* **www.animalhealthireland.ie**)
Liver fluke is parasitic disease of cattle, sheep and humans caused by Fasciola hepatica. Liver fluke eggs are shed in pasture, move through a number of developmental stages which includes a second snail host and are then ingested by other individuals. The larvae subsequently develop with immature and mature fluke residing in the liver of infected individuals. Both immature and mature flukes cause significant liver damage leading to both obvious clinical signs and sub-optimal production in infected cattle. Wetter farms tend to be at increased risk although a dry farm is no guarantee against a fluke infestation.

Clinical signs
- Chronic sub-optimal production.
- Bottle jaw.
- Anaemia.
- Poor coat.
- Lack of appetite.

Control in your herd by:
- Testing herd or individuals to establish herd status.
- Dosing using an appropriate product at an appropriate time of year (usually over the dry period in Irish dairy cows).
- Minimising access to areas of snail habitat (muddy areas).
- Designing and implementing a biosecurity plan including diagnostic testing.

FEEDING THE DAIRY COW AT PASTURE

Appropriate Stocking Rates for Irish Grazing Systems

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Summary

- Stocking rate (SR) is the main driver of milk production in grazing dairy systems.
- The ideal SR for any farm will facilitate high grazed grass utilisation rates in addition to relatively high levels of milk production per cow and per hectare.
- With long term farm profitability in mind, the ideal overall farm stocking rate should be closely aligned with the growth capacity of the farm. As a general rule, the farm must grow 4.5 to 5 tons of DM/ha for each one cow/ha. At SR's that exceed the farms growth capacity, little additional profitability will be yielded from these extra animals in the longer term.
- At higher SR's, the ability to produce enough winter feed will be a key limitation and consequently excellent grazing management and feed budgeting practices are essential to realise the full benefits of higher SR.

Introduction - the importance of stocking rate and calving date in grazing systems

Post milk quota abolition, farmers wishing to expand herd size and increase milk production, will be limited by the grass growth capability of land around the milking parlour (i.e., the grazing platform). Increasing stocking rate (SR) in order to facilitate increased milk production will place additional feed supply pressures on dairy farm businesses. Increasing overall farm stocking rate must not result in a significant reduction in either the length of the grazing season, the proportion of grass in the dairy cows diet or individual animal lactation lengths as these effects would likely increase milk production costs and reduce overall farm system profitability. Achieving high levels of milk production from grazed grass with minimal supplementation will occur where the appropriate mean calving date and distribution of calving is achieved in conjunction with the optimum SR to align herbage supply to herd demand (Figure 1). Stocking rate, traditionally defined as the number of animals per unit area of land (livestock units (LU)/ha), is acknowledged as the main driver of milk production from grazing systems due to its impact on milk and milk solids production per hectare and on the amount of grass that is utilised (eaten) per hectare. The ideal SR is best considered as a balance between the available feed supply (the amount of grass grown plus supplements imported) and overall herd demand (the number of cows needed to eat the grass grown). It is therefore recommended that the overall SR of the farm is closely aligned to the individual farms grass growth capability. The optimum stocking rate should allow relatively high individual animal performance but also relatively high grazed grass utilisation to be achieved.

Calving date is also an important factor in grass-based milk production systems and influences both the milk productivity of the dairy herd (lactation length) and also the requirement for supplementation at grazing. In general, the herd should be calved as early as possible, provided that it can be fed adequately from a predominantly grazed grass diet throughout the lactation. While highly dependant on the individual farm characteristics, the optimum herd mean calving date will allow high individual animal performance, with minimal requirement for supplementation at grazing, to be achieved by aligning animal feed requirements with spring grass growth. At a given SR, the correct calving date will maximise animal performance by increasing the length of lactation as well as having a high level of production per day of lactation. Calving too early, in particular at higher SR's, will lead to underfeeding or a requirement for increased supplementation as grass growth rates will be unable to match herd demand in early spring. A spread out calving rate or delayed calving date will lead to reduced grass utilisation as insufficient numbers of animals are available and grass is wasted in spring. While there is no ideal mean calving date that will be appropriate to every farm (due to differences in ground conditions, grass growth rates, SR's, etc.), a mean calving date of February 15th to 25th with 90 per cent of the herd calved in 42 days appears to be generally appropriate for most Irish dairy farms in comparison to the current average mean calving date of March 15th. The current average national SR (1.9 LU/ha) and mean calving date (MCD = March 15th) of Irish dairy farms differs considerably from dairy research herds (SR = 2.5 – 3.3 LU/ha and MCD = February 15th) and is indicative of the lower grass growth and utilisation capacity of Irish dairy farms when compared to research targets. Consequently, where improved grassland management practices together with optimum soil fertility, predominantly ryegrass swards and appropriate grazing infrastructure (water troughs, roadway access, etc.) are developed on dairy farms, research results indicate that there is considerable scope to increase productivity on Irish dairy farms post quota.

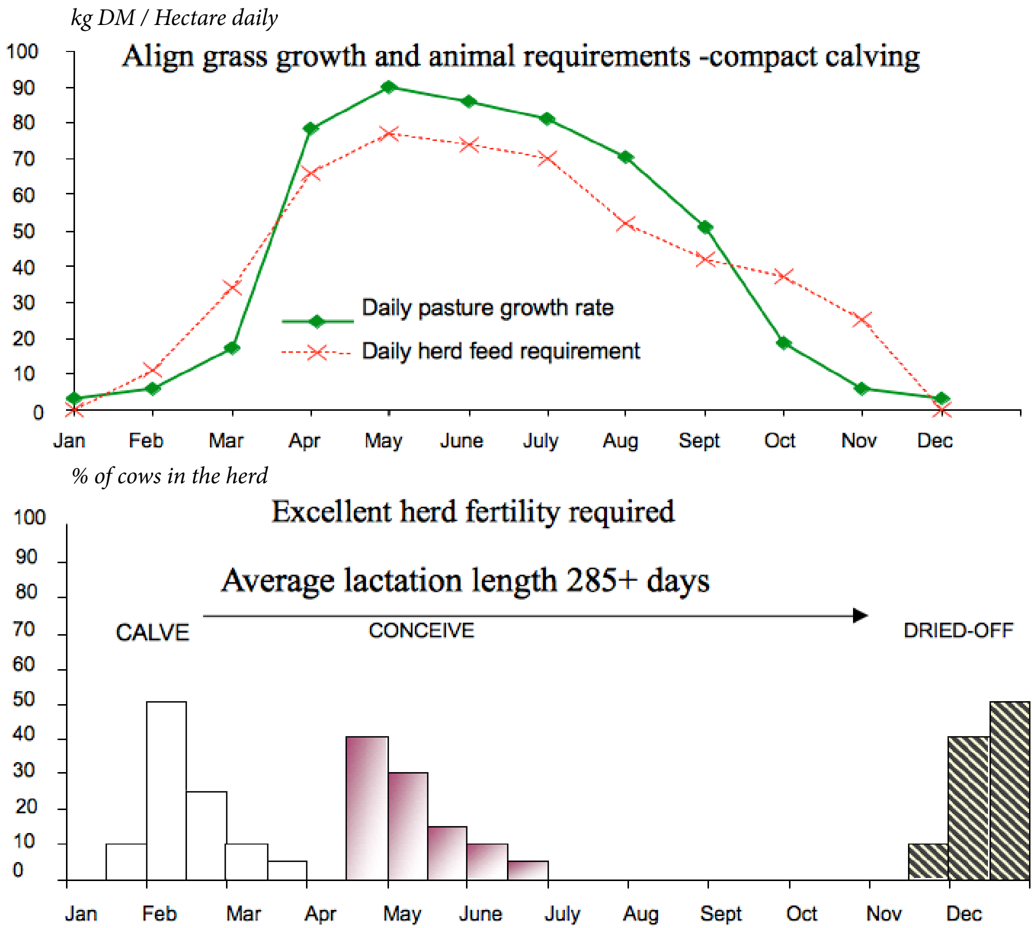

Figure 1. *The importance of calving rate and stocking rate to the overall design of highly profitable grazing systems*

Curtin's farm stocking rate and calving date experiment

Recent research at Curtin's Farm has investigated the productivity of a range of SR systems (Low: 2.51 LU/ha; Medium: 2.92 LU/ha and High: 3.28 LU/ha) within two compact herd mean calving dates (February 14th and March 1st) over the last 4 years. The overall study objective was to identify the optimum overall farm SR and mean calving date combination to maximise the efficiency of grass-based milk production post quotas. The low SR treatment had a target post-grazing residual sward height 4.5 to 5.0 cm whereas the medium and high SR treatments had target post-grazing residual sward heights of 4.0 to 4.5 cm and 3.5 to 4.0 cm, respectively. The overall milk production performance of each of the three stocking rate treatments was consistent over the four year study period and the results are presented in Table 1 below.

Table 1. Milk and herbage production performance of the Curtin's Farm herd (2009-2012)

Calving group	Early			Late		
Stocking rate	*Low*	*Med.*	*High*	*Low*	*Med.*	*High*
Lactation length (days)	293	290	290	281	274	276
Milk yield (kg/cow)	5,811	5,434	5,110	5,862	5,416	5,265
Milk solids yield (kg/cow)	457	426	408	460	418	415
Milk yield (kg/ha)	14,589	15,978	16,803	14,817	15,921	17,275
Milk solids yield (kg/ha)	1,144	1,249	1,338	1,162	1,227	1,359
Grazed grass utilised (t DM/ha)	8.8	9.5	9.8	9.0	9.2	9.8
Silage produced (t DM/ha)	2.8	2.3	2.2	2.8	2.3	2.2
Total grass utilisation (t DM/ha)	11.6	11.5	12.0	11.8	11.5	12.0
Winter feed deficit (t DM/ha)	0	0.6	1.1	0	0.6	1.1

Stocking rate had a significant effect on milk and milk solids yield per cow and per hectare over the four years whereas calving date had little effect. The low SR treatment produced the greatest amount of milk and milk solids yield/cow but the lowest amount of milk and milk solids/hectare. In contrast, the high SR produced the lowest amount of milk and milk solids/cow but the highest amount of milk and milk solids/hectare, with the medium stocking rate being intermediate. The results of the study indicate that although, having only a small effect on total feed utilisation and resulting in a shortage of winter feed, increasing SR increased grazed grass utilisation and improved overall grass quality. More detailed sward analysis also indicated that increasing grazing severity to a consistent post-grazing residual height of 3.5 to 4 cm over the entire season resulted in swards with consistently higher grass growth based on higher concentrations of green leaf and digestible nutrients and less senescent material.

Conclusions

As farmers increase SR, total milk output from the dairy farm will increasingly be limited by grass growth and so the development of grazing management practices to improve grass production and quality will be critical. Grazing (and nutrient) management to support higher SR post milk quotas will be concerned with achieving adequate soil fertility, reseeding under-performing swards and grazing intensity. Consequently, further research in this area must focus on grazing strategies to further increase grass DM availability and utilisation on each hectare of farmland available for milk production.

Exploiting the Potential of White Clover

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Summary

- Including white clover in grass swards receiving up to 250 kg N/ha can increase total annual herbage production by 1.1 t DM/ha.
- Sward white clover content varies across the year; it is lowest in spring, increases to a peak in late summer, and then begins to decline during autumn.
- Annual milk solids production can be increased by up to 12 kg milk solids/cow when average annual sward white clover content is 23 per cent.
- Frequent tight grazing (4 – 4.5 cm above ground level) of grass-clover swards will encourage clover persistence in grazed swards.

Introduction

The Irish dairy industry relies on Nitrogen (N) fertilised perennial ryegrass swards to provide feed for dairy cows for most of lactation. White clover is not widely used on dairy farms. Currently there is increased interest in white clover as the cost of N fertiliser continues to increase, and application rates are limited under the Nitrate Directive. Clover fixes atmospheric N and makes it available for grass growth. Some of the previous research in this area has shown that including clover in grass swards can increase milk production, particularly in the latter half of lactation. Clover growth is very seasonal, and therefore its contribution to sward herbage mass varies across the year. It is lowest in spring, peaking in late summer and declining during autumn. A number of experiments at Moorepark are examining the role of clover in intensive grass based milk production systems.

Including white clover in fertilised grass swards

Poor clover persistence in N fertilised swards is one of the main reasons why clover is not widely used on dairy farms. However, good grazing management (18 to 21 day rotations mid-season; 4 – 4.5 cm post grazing sward height) is likely to benefit clover persistence. A three year plot (8 m × 8 m) grazing experiment was undertaken at Moorepark from 2010 to 2012. The experiment had two sward types (grass only and grass-clover), and five N fertiliser application rates (0, 60, 120, 180 and 240 kg N/ha). Swards were grazed 9 times in 2010 and 10 times in 2011 and 2012. Pre-grazing herbage mass and sward clover content were measured prior to each grazing.

Results

Herbage production was, on average, 2 t DM/ha greater on the grass-clover plots compared to the grass only plots, regardless of N application rate. At low N input, the increase in herbage production was greater with clover inclusion than at high N input, but even at 240 kg N/ha herbage production was 1.1 t DM/ha greater on the grass-clover treatment compared to the grass only treatment (Figure 1). Average annual sward clover content was 34 per cent on the 0 and 60 kg N/ha treatments, 28 per cent on the 120 kg N/ha treatment and 22 per cent on the 180 or 240 kg N/ha treatments. These results indicate that including white clover in grass swards can increase herbage production, regardless of N fertiliser application rate.

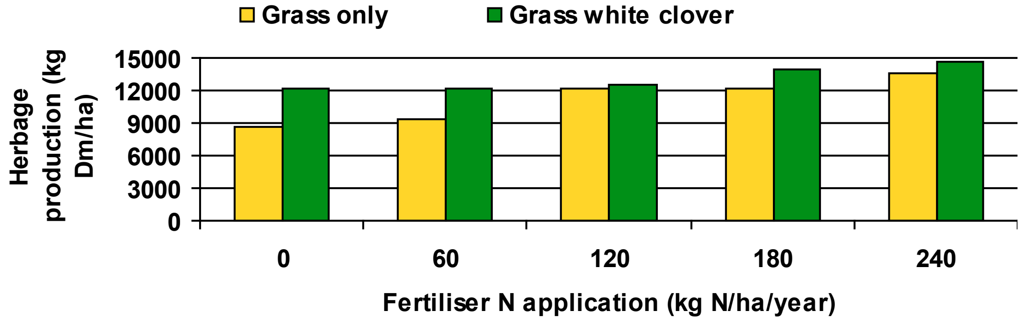

Figure 1. *Average annual herbage production (kg DM/ha) on grass only and grass clover swards receiving 0, 60, 120, 180 or 240 kg N/ha*

Influence of clover inclusion in grass swards on milk and herbage production

Milk and herbage production were compared in 2011 and 2012 from a grass only sward (37 kg/ha of a 50:50 Astonenergy and Tyrella mix) and a grass-clover sward (same grass plus 5 kg/ha of a 50:50 Chieftain and Crusader mix) each receiving 250 kg N fertiliser/ha. Fifteen and 20 cows grazed each treatment in 2011 and 2012, respectively. Daily herbage allowance was 17 kg DM/cow/day.

Results

Milk production was similar for each sward in 2011. In 2012 cows grazing the grass-clover treatment had higher milk and milk solids yields than cows grazing the grass only treatment (Table 1). Milk production on the grass-clover swards increased from mid-June onwards when sward clover content was increasing and the digestibility of grass declining due to heading. Herbage production was similar in 2011, and approximately 1.1 t DM/ha greater on the grass-clover sward compared to the grass only sward in 2012 (Table 1). Average annual sward clover content was 18 per cent in 2011 and 23 per cent in 2012. Research by other groups has found that sward clover contents of greater than 20 per cent are required before milk production benefits are observed. Sward clover content increased across the grazing season from <10 per cent in February to a peak of 25 per cent in October in 2011, and a peak of 29 per cent in June in 2012. Sward clover content remained high (22 % to 27 %) after the peak until the end of each grazing season.

Table 1. Daily milk yield and milk solids production from cows grazing grass only and grass-clover swards in 2011 (April to October) and 2012 (February to October) and total herbage production on grass only and grass-clover swards

	2011 (Apr. - Oct.)		2012 (Feb. - Oct.)	
	Grass only	*Grass-clover*	*Grass only*	*Grass-clover*
Milk yield (kg/cow/day)	19.0	19.8	17.0	18.6
Milk solids yield (kg/cow/day)	1.52	1.47	1.41	1.53
Herbage production (t DM/ha/yr)	13.5	13.6	13.6	14.7

Conclusions

These experiments show that including white clover in grass swards receiving high fertiliser N input can increase herbage production, milk yield and milk solids production. Tight and frequent grazing is beneficial to clover maintenance in a sward as it facilitates the penetration of sunlight, therefore optimising clover growth. Research examining the role of white clover in high stocking rate systems is on-going.

Growing More Grass with Soil Fertility Management

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Summary – Five targets for soil fertility on your farm

- Soil test the whole farm to know soil fertility levels.
- Apply lime to acidic soils to increase the pH.
- Use the soil Index in each field to guide fertiliser P and K and slurry application.
- Use slurry to maximise its nutrient value.
- Use bagged fertilisers that are correctly balanced in N, P, K and S for the needs of each field.

Introduction

Productive soils are the foundation of any successful farm. The demand within intensive grazing systems for high grass growth rates over an extended grazing season represents an increasing demand on soil fertility levels. The ability of soils to maintain a supply of nutrients in the appropriate quantities for grass growth is a key factor in determining how productive a field or farm can be. Fertiliser costs account for approximately 15-20 per cent of the total variable costs on dairy farms, but can provide good value for money when used correctly. However, fertiliser application rates that are either too low, too high, or not in balance with other soil fertility factors will give lower responses. With soil phosphorus (P) and potassium (K) levels declining on many farms in recent years, the importance of soil fertility management has increased.

Soil fertility management – five steps to follow

1) Soil test

A soil test will indicate the background soil fertility levels of pH, P and K and also Mg and trace elements where required. The role of soil analysis has taken on a new dimension in recent years within the Nitrates regulations, with soil testing now being associated more with bureaucracy and regulation than with good farming practice. However, it is important to remember that the primary function of soil testing on the farm should be to improve soil fertility information and to plan fertiliser applications.

Have soil samples taken for the whole farm. It can be organised through your local Teagasc advisor at a cost of €25/sample. Unless you know what is in the soil, it is impossible to know how much fertiliser it needs. Therefore, by taking soil analysis and using the results, the fertiliser programme can be tailored to the needs of the soil and the farm. Repeating soil analysis over time is also critical to monitor soil fertility.

2) Apply Lime

Soil pH is the first thing to get correct. The release of nutrients from the soil and the response to applied fertilisers will be reduced where the soil pH is low (or too high). Apply lime as required based on the soil test result to increase soil pH up to the target pH, which is 6.3 for grassland. It is important not to apply more than 7.5 t/ha of lime in a single application, as it can affect trace element availability in soils if applied in excess. Apply 7.5 t/ha immediately and the remainder after two years where more than 7.5 t/ha is required.

3) Target Index 3 for P and K
Soil analysis is designed to estimate the proportion of P and K that is present in the soil in a plant-available form. Aim to have soil P and K fertility levels of Index 3 in all fields. High fertility soils (Index 4) are a resource and should be utilised. Low fertility soils (Index 1 or 2) need to be nurtured. For soils in Index 3 the fertiliser program should be designed to replace the nutrients being removed, thus maintaining the soil fertility level. Advice for P and K for dairy grassland is shown in Table 1. Note that the advice for both P and K shown includes P and K from both chemical fertiliser and slurry sources. The P advice rates should also be adjusted to account for the P coming onto the farm in concentrate feeds. Each tonne of concentrate feed is assumed to contribute 5kg of P.

Table 1. Simplified P & K requirements of grazed and cut swards for dairy farms

Soil Index	Grazed Swards				Silage Swards	
	Farm Stocking Rate (LU/ha)				Cut Once	Cut Twice
	< 1.5	1.5-2.0	2.0-2.5	>2.5		
P advice (kg/ha)						
1	30	34	39	43	+20	+30
2	20	24	29	33	+20	+30
3	10	14	19	23	+20	+30
4	0	0	0	0	0	0
K advice (kg/ha)						
1	85	90	95	100	+120	+155
2	55	60	65	70	+120	+155
3	25	30	35	40	+120	+155
4	0	0	0	0	0	0

4) Slurry
Slurry is a valuable source of P and K. On many farms, chemical P fertiliser is not permitted within the Nitrates regulations, resulting in slurry being the only source of P available to the farmer for distribution. Cattle slurry typically contains 0.6 kg m^{-3} of P and 4.3 kg m^{-3} of K. The P and K fertiliser values of slurry can be highly variable, usually due to dilution with water. While slurry can be more difficult to mange than chemical fertiliser, it can be a very cost effective resource to increase fertility levels. Use slurry on the farm as efficiently as possible, and top up with fertiliser as required. Target slurry applications to fields that have high P and K requirements (fields with P and K Index 1 or 2). Apply in cool and moist weather conditions (e.g. in spring) to maximise N recovery.

5) Fertiliser products that give a balanced nutrient supply
Make sure the fertiliser compound is supplying nutrients in the correct balance for the crop, the soil, and to complement other fertilisers being applied. If one nutrient is deficient, no amount of another nutrient will overcome this. For example, if a field is deficient in K, then excess N application will not be fully utilised. Consider straight K or NK fertilisers where P usage is restricted. Other nutrients such as Sulphur can play a very important role in a balanced fertiliser programme and should also be applied on lighter soils that are freely drained and have lower organic matter contents.

Conclusions
Implementing these simple steps for soil fertility management will go a long way to ensuring that the production potential of the farm is being realised, and that fertiliser inputs are being utilised as efficiently as possible.

Grass as a Feed for Dairy Cows

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Summary

- Grass dry matter intake is low at the start of lactation but increases as lactation progresses.
- Good quality grass is a highly nutritious feed.
- In a grass deficit, low crude protein, high energy concentrate should be offered.
- In a severe grass deficit forage, as well as concentrate, must be offered.
- The total diet should meet requirements for phosphorus and other minerals.

Introduction

Cows must ingest sufficient quantities of high quality feed to ensure good performance and health. Grazed grass is highly digestible, high in crude protein and has adequate fibre, making it an excellent feed. In periods of grass deficit a supplementary feed, complementary to grass, must be chosen.

Grass dry matter intake

Dry matter intake (DMI) is possibly the single most important factor influencing dairy cow milk production. The ability to take in feed is called intake capacity. In early lactation intake capacity is low (Figure 1). In the first week of lactation a heifer eats just 8 kg DM grass and a mature cow 10 kg. As lactation progresses, this increases. Cows reach peak intake at 10-12 weeks post-calving, when heifers eat 13-14 kg DM grass and mature cows eat 17-18 kg. Other factors also affect grass DMI, such as breed and size of cow, grass chemical composition and supplementary feed. Teagasc Moorepark have evaluated and developed models to predict cow grass DMI; future work will see better prediction of grass DMI across alternative nutritional strategies.

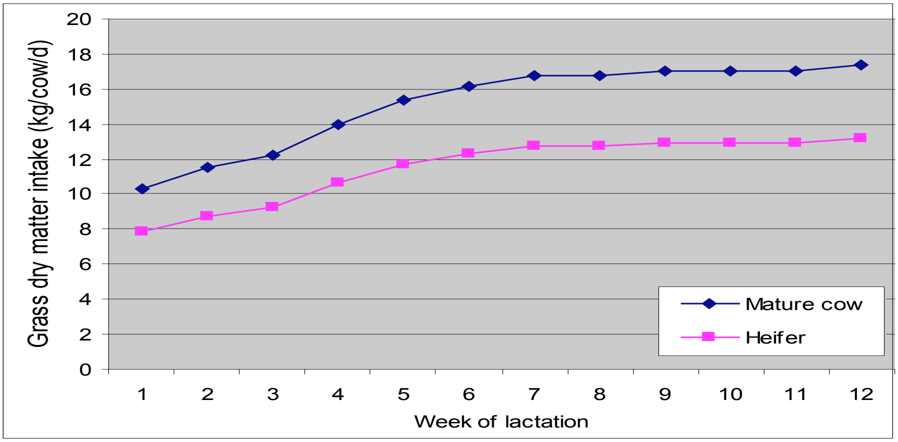

Figure 1. *The grass dry matter intake of cows in early lactation*

Grass nutritive value

Animal performance depends on DMI, but also on high feed digestibility. Highly digestible grass has a high energy concentration. Feed energy value is measured in UFL. One UFL is the energy contained in 1 kg of air dry standard barley. Data from Teagasc Moorepark, indicate that on average spring grass is 1.04 UFL/kg DM grass. Grass digestibility is measured by organic matter digestibility (OMD). High grass OMD is critical to high animal performance. Research has found that higher grass OMD was significantly associated with higher milk protein concentration. Other research highlighted that Jersey cows had a higher OMD than Holstein-Friesian cows and that low pre-grazing herbage mass swards had significantly higher OMD than did high pre-grazing herbage mass swards. Research will continue to evaluate parameters such as grass cultivar, grass moisture content and sward clover content; also more rapid methods to measure grass OMD will be developed.

Dietary fibre concentration is important to maintain rumen health and animal production performance. High diet digestibility may be associated with low dietary fibre concentration giving rise to low rumen pH and low milk fat concentration. Research conducted at Teagasc Moorepark identified that although rumen pH is low in cows on grass-based diets, the associated negative effects, such as lameness and milk fat depression, are not apparent. Further work will re-define the guidelines for rumen pH in the grazing dairy cow specifically.

Supplementary feeding

If there is insufficient grass available to meet demand, or if access to grazing is limited, supplementary feed must be offered.

In low to moderate feed deficits, a low crude protein supplementary feed should be offered. Grass is high in crude protein. Further crude protein added to the diet results in increased milk urea nitrogen concentrations and increased urinary N excretion, both of which are undesirable. Teagasc Moorepark research indicated no difference in milk yield or milk solids yield when grazed grass was supplemented with high, medium or low crude protein concentrate feeds. Low crude protein feeds should be highly digestible, high in energy concentration to maximise milk production performance.

Supplementing grazed grass with a low phosphorus feed resulted in animal blood phosphorus falling below the recommended level. It is important to identify low mineral concentrations, especially in “straight” feeds, and to ensure that the mineral levels in the total diet meet recommendations.

When animals have a low intake capacity (e.g. early lactation) concentrate feeds should be offered. Concentrate feeds have a low fill value, which gives rise to a low substitution rate. When supplementary feed is offered, grass DMI is reduced, which is known as “substitution”, because the supplement is substituting for grass. Forages have a high fill value, because they are usually less digestible and are slowly degraded in the rumen leading to greater gut fill, lower grass DMI i.e. a high substitution rate.

In a severe grass shortage, forage, as well as concentrate, should be offered, in order to maintain adequate dietary forage fibre levels, which preserve rumen function. Forages should only be offered when absolutely necessary as both milk yield and milk protein concentration can suffer when silage is included.

Conclusions

Grass is a highly nutritious feed with high crude protein and energy concentrations and fibre concentrations sufficient to maintain rumen function. With a low to moderate grass deficit a low crude protein high energy supplement should be offered. In a severe grass deficit it is also necessary to add in supplementary forage. Care should be taken that animal requirements for phosphorus and other minerals are met.

The Grass Economic Index

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Summary

- The Grass Economic Index applies monetary values to a grass cultivar based on its seasonality of dry matter production, quality, persistency and silage dry matter production.
- The generated sub-indices within the Grass Economic Index will identify the most suitable cultivars for individual systems.
- The Grass Economic Index with rankings for individual cultivars will be released in 2014.

Introduction

Evidence of reranking of cultivar performance when compared under simulated grazing protocols and intensive silage protocols in Moorepark trials has highlighted the need to evaluate and select cultivars adapted for their target end use. This has resulted in the inclusion of a frequent cutting management in the DAFM grass evaluation trials, in addition to the two-cut silage management protocol. The seasonal nature of ruminant production in Ireland influences the traits of importance for grass-based production systems. Cultivars that provide higher dry matter (DM) production in spring and autumn support the extension of the grazing season. As a result, the costs of production are reduced. There is a greater economic benefit to these cultivars compared to those which provide higher DM yields during the main grazing season, when there is already surplus grass available.

Development of the grass economic index

The Grass Economic Index, developed by researchers at Teagasc Moorepark to rank perennial ryegrass cultivars based on their economic contribution to the farm system. The index applies economic values to the traits of importance for Irish grass based production systems. These traits are spring, mid-season and autumn DM production, grass quality (April to July, inclusive), persistency and 1st and 2nd cut silage DM production. Economic values were derived by simulating a physical change for each trait using the Moorepark Dairy Systems Model. The difference between the net margin per hectare in a dairy system before and after the change was simulated, was divided by the change in the trait of interest to calculate the economic value for a unit change in that trait. Table 1 presents the calculated economic value for each of the traits within the Grass Economic Index. These economic values are then applied to the performance of individual cultivars to determine the total economic merit of a cultivar and allow ranking of cultivars based on their economic merit.

Application of the grass economic index

Annually, DAFM evaluate over sixty perennial ryegrass cultivars in their Recommended List Trials across five sites in Ireland. Economic values will be applied to data generated within the DAFM trials to calculate the total economic merit of a cultivar. The performance of each cultivar relative to a base yield of 9 t DM/ha will be determined.

Table 1. Economic values (€/ha/year) of traits within the Grass Economic Index

Seasonal DM yield[1]			Quality[2]				Persistency[3]	Silage[1]	
Spring	Mid Season	Autumn	April	May	June	July		1st Cut	2nd Cut
0.15	0.03	0.10	-0.001	-0.008	-0.010	-0.009	-4.96	0.03	0.02

[1]per kg DM increase; [2]per unit change in DMD; [3]per 1% change in persistency

The base yield was selected to quantify the benefit which can be achieved by selecting cultivars based on their economic merit relative to the mean performance of grass swards at farm level. The base values for silage DM yield and quality were selected from the average performance of all 63 cultivars in the DAFM data across two years (2011 and 2012). The economic merit of a cultivar for each trait was calculated by determining the difference between the performance of each cultivar and the base value of each trait. This was then multiplied by the economic value for that trait. Table 2 presents the ranking of 12 cultivars which have had the economic values applied and the resulting total economic merit and overall ranking. The sub-indices present the opportunity to select cultivars for specific purposes. For example, if selecting a cultivar for intensive grazing, the emphasis would be placed on seasonal DM yield and quality with less importance placed on the silage performance. If selecting a cultivar specifically for silage production, then greater emphasis would be placed on the performance of that cultivar within the silage sub-index. The relative emphasis on each trait was as follows: DM yield (49 %), quality (10 %), silage (16 %) and persistency (25 %). This indicates the weighting the index is placing on each trait or the importance of each trait within the index.

Table 2. Economic ranking of 12 cultivars within the sub-index, the total economic merit and the overall ranking based on total economic merit

Cultivar	Rank within sub-index				*Total Economic Merit (€ per ha/yr)*	*Overall Rank*
	Seasonal DM yield	*Silage DM yield*	*Quality*	*Persistency*		
A	6	2	3	3	146	1
B	5	7	2	6	138	2
C	4	9	1	7	131	3
D	2	1	8	8	126	4
E	7	10	5	4	92	5
F	10	11	4	1	89	6
G	9	6	7	9	59	7
H	12	5	6	2	52	8
I	8	12	10	10	42	9
J	11	3	11	5	28	10
K	3	8	9	11	21	11
L	1	4	12	12	10	12

Conclusion

The Grass Economic Index provides the opportunity to select cultivars based on their economic contribution to farm performance. The sub-indices allow farmers select cultivars for specific purposes. The Grass Economic Index will be used in 2014 to rank cultivars economically.

Grassland Reseeding

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Summary

- Reseeding is one of the most cost effective on-farm investments.
- There is little difference between reseeding methods.
- With spring reseeding there is no loss in dry matter (DM) production in the establishment year compared to permanent pasture.
- Management after reseeding is just as important as decisions made at sowing.

Introduction

The past year has presented huge difficulty for farmers challenging grassland management to the limit. In 2013, a large number of farms have damaged swards that need to be to repaired and re-established as productive pastures. Economically pastures with a low proportion of perennial ryegrass are costing farmers up to €300/ha/year due to a loss of dry matter production and reduced nitrogen use efficiency during the growing season. If the cost of reseeding is estimated at approximately €700/ha, the increased profitability of the reseeded pasture would cover the cost in just over two years. This means reseeding is one of the most cost effective on-farm investments.

Reseeding methods

How paddocks are prepared for reseeding comes down to soil type, amount of underlying stone and machine/contractor availability. There are essentially two methods of preparing the seedbed. The most common method is ploughing; however in many areas this is not possible because the ground is too stony, soil too shallow or topography is too steep. Recent technological advances, such as minimal cultivation techniques, enable reseeding to be carried out without ploughing. Studies have taken place at Moorepark in recent years investigating the effect of method of reseeding on herbage production. Four methods of reseeding were compared, namely 1) direct drilling, 2) discing followed by one pass, 3) onepass with powerharrow, and 4) ploughing. One of the main aims of the studies was to evaluate alternative grassland reseeding methods in terms of their effect on DM production, sward establishment, and sward persistence. While all having different modes of action, each of the full sward renewal methods evaluated performed satisfactorily. It can be concluded that, on balance, all sward renewal methods evaluated are equally as effective as the conventional method of grassland reseeding. The length of the study (2.5 years) may be too short to fully evaluate the lifetime performance of the swards, but after 24 months of establishment, prevailing grazing management is more likely to influence DM production than the reseeding method.

Timing of reseeding

Most reseeding in Ireland is completed in the autumn. This may make sense from a feed budget point of view but it does have some negative consequences. Conditions deteriorate as autumn progresses – lower soil temperatures can decrease seed germination and variable weather conditions reduce the chances of grazing the new sward. The opportunity to apply a post-emergence spray for weed control is also reduced as ground conditions are often unsuitable for machinery to travel. With this in mind if planning to reseed, the spring period should be considered for at least a proportion of the area, with all reseeding completed as early as possible in the autumn. As part of the studies investigating reseeding methods described above the effect of reseeding timing was investigated over a two year period. Swards were established in both autumn and spring. The autumn sown reseed in its first year of production out yielded an old permanent pasture control sward by 958 kg DM/ha (11,326 versus 10,368 kg DM/ha), in Year 2, this difference increased to 2,410 kg DM/ha (12,749 versus 10,339 kg DM/ha). For the spring sown reseed there was virtually no difference in DM production in the establishment year (swards yielded 9,700 kg DM/ha), while in Year 2 this difference increased to 2,033 kg DM/ha in favour of the reseeded swards. A key finding from this study was that there was no loss of production in the establishment year when reseeding in the spring period. It could be concluded from the study that irrespective of timing of reseeding the swards required time to settle, allow perennial ryegrass hierarchy establish and then the advantage to reseeding became apparent.

Management of reseeds

When reseeding, ensure that grass varieties from either of the Irish (Republic or Northern) recommended lists are used; these varieties have been trialled and tested under Irish conditions. Teagasc recommendations are to sow 14 kg seed/acre (35 kg/ha) to ensure good establishment of the sward. It is also advised to sow a minimum of 3 kg of each variety within a mixture. Prior to reseeding, the old sward should be killed off using glyphosate. It is vitally important that soil fertility is at recommended levels to ensure high performance from reseeded swards. Soil samples should be taken from the freshly cultivated soil for analysis to gauge the level of nutrients required. The best time to control docks and all other weeds is after reseeding. By using a post emergence spray, seedling weeds can be destroyed before they properly develop and establish root stocks. The post emergence spray should be applied approximately six weeks after establishment just before the first grazing takes place. Care needs to be taken when grazing newly reseeded swards. The sward should be grazed as soon as the new grass plants roots are strong enough to withstand grazing (root stays anchored in the ground when pulled). Early grazing is important to allow light to the base of the plant to encourage tillering. Light grazing by animals such as calves, weanlings or sheep is preferred as ground conditions may still be somewhat fragile depending on establishment method used. The first grazing of a new reseed can be completed at pre grazing yields of 600-1,000 kg DM/ha. Frequent grazing of the reseeds at light covers (<1,400 kg DM/ha or less than 10 cm) over the first year post establishment will have a beneficial effect on the sward. The aim is to produce a uniform, well tillered, dense sward. If possible newly reseeded swards should not be closed for silage in their first year of production as the shading effect of heavy covers of grass will inhibit tillering of the grass plant resulting in an open sward which would be liable to weed ingress.

Conclusion

The timing of reseeding will be influenced by feed budgets and weather conditions. There is little difference between reseeding methods once a firm, thrash free seed bed is established. Many management factors affect the success of newly sown swards. Good management after sowing is just as important as decisions around timing and methods.

PastureBaseIreland-National Grassland Database

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Summary

- PastureBaseIreland is a new online grassland management application which stores grass data recorded by farmers in a centralised grassland database.
- PastureBaseIreland includes a user-friendly decision support tool to increase the precision of grassland management.
- It is anticipated that PastureBase Ireland will result in the development of more robust grass growth models, more accurate grass cultivar evaluation and an increased understanding of the factors affecting grass growth at farm level.
- PastureBaseIreland is designed to allow the transfer of data from commercial software providers.

Introduction

The future of an efficient low cost milk production system will depend on the conversion of a low cost feedstuff in the form of grazed grass to milk. On many dairy, beef and sheep farms some form of grassland measurement is being completed. Currently this immensely valuable information is not being centrally collated and stored in a way that it could be used for research. The development of PastureBaseIreland (PBI) which incorporates both a decision support tool to increase the precision of grassland management and a database to store all of the grassland data in a standard format is an important step to advance the progress of grassland research, with an ultimate aim of developing grassland technologies that are more robust for the future. The data captured through this process will significantly increase the understanding around the factors affecting grass growth, grass utilisation, cultivar evaluation and numerous other grassland related components.

Pasture Base Ireland

PBI was launched in January 2013 with an extension, advisory, training and research focus. The database stores all grassland measurements in a common structure. This will facilitate the quantification of grass growth and DM production (total and seasonal) across different enterprises, grassland management systems, regions and soil types using a common measurement protocol and methodology. PBI has a number of reports that allow farmers to make day to day management decisions (grass wedge, rotation planners and budgets) and allows farmers to evaluate medium to long term performance from the farm (distribution of growth and paddock summary reports). The reports can also be used to benchmark farms across enterprises and regions. The background data such as paddock soil fertility, grass cultivar, aspect, altitude, reseeding history, soil type, drainage characteristics and fertiliser applications are also recorded. PBI will also for the first time link grass growth on farms to local meteorological weather data.

Both nationally and internationally there is a lack of historical national data on grass growth. This has had implications for grassland research adoption at farm level and resulted in a poor understanding of grass growth at farm level in many countries. Many grass growth models are based on limited data and are in affect limited on their ability to predict grass growth at farm level.

Grass variety evaluation

A long term on-farm grass cultivar trial has been setup by Teagasc Moorepark. There are currently 70 farms on the trial, however over the coming years it is hoped over 100 farms will participate in the trial (The project is funded by Germinal Ireland and UK, Goldcrop, Barenbrug, Dairygold and Glanbia). Adopting on-farm grass cultivar evaluation will quantify the life time performance of the grass cultivar. Data from commercial farms is required for the development of the grass economic index. Pasture persistency and longevity are key traits within the index; the measurement of these traits needs to be over a long term period in grass evaluation protocols. The development of PBI will give researchers immediate access to the performance of cultivars on commercial farms.

Advisory and educational requirements

The Teagasc Agricultural colleges are using PBI as a grassland management decision support tool for both their dairy and dry stock enterprises. This will ensure that there is a common use of decision support tools across all Teagasc farms. Advisors for the first time will have direct access to grassland data from all Teagasc research farms. This innovation will provide reliable grass growth rates to the advisory service across soil types and regions. Advisors will have easier access to their clients grazing data, as they will be fully integrated users on the system, which allows them to generate grassland reports for individual farms and larger reports to include all farms in a discussion group.

Compatibility with commercial company software

Over the past number of years the number of commercial grassland management grassland decision support packages has increased dramatically. It is anticipated that in the future PBI will have the capability to accept data entered on these packages. Incorporating this data will increase the value of the database and will ensure that all potential data sources are being used to increase the sustainability of grass based dairy beef and sheep farmers. Teagasc in conjunction with the commercial software providers is currently developing strategies to facilitate the flow of data into PBI.

Conclusion

The development of PBI both as a decision support tool and a grassland database is a hugely significant step for the future of grassland production systems in Ireland. PBI has the potential to add significant value to the data collected by individual farmers and will ultimately result in significant advancement towards gaining a greater understanding around grass growth in Ireland.

Filling a Deficit in Winter Feed Supply

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Summary

- Early planning of the winter feed budget is a key component of limiting the cost of imported winter feed.
- There is no single option that will suit all farmers in filling the deficit in silage stocks. The cheapest option on paper is not necessarily the cheapest option in practice.
- Risk factors that must be considered include yield and quality potential; storage and handling facilities needed, labour requirement and the cost of nutrient balancing.

Introduction

A deficit in winter feed, either planned or unplanned, will incur additional feed costs. The options to fill that gap are more numerous and cost effective the earlier the planning begins. Short term planning will address an immediate shortage, but long term planning is required to ensure that the grass growing capacity of the farm is maximised, particularly at high stocking rates, before exposing the farm business to expensive imported feeds. There is significant volatility in the feed market and limiting exposure to these markets will be important for future profitability.

Farm Case

A spring calving herd of 100 cows carrying 30 replacement units with a four month winter will have a demand for 1,086 tonnes (t) of silage, including a buffer of 200 t of silage to be used at the shoulders of the year. The 33 ha milking block and 27 ha out-farm is capable of growing 830 t of silage. This leaves a deficit of 256 t of silage or 40,000 units of energy (UFL) or 400 UFL/cow on the farm. What is the most cost effective option to fill that gap?

The Options

There is no single option that will meet the demands of all farmers that are short of winter feed and must import feed. The options include:

Feed restricted roughage and meals

Some of the deficit in silage stocks can be filled by buying some silage (€33/t @ 70 DMD) and feeding restricted silage, e.g. feeding 75 per cent of the normal forage requirements of the animal, plus 2 kg meals for a period of time. Assuming ration is costing €300/t, this option works out at €214/1,000 units of energy (UFL).

Rent silage ground

Renting silage ground, fertilised or unfertilised, may be an option for building silage stocks. Assume a yield potential of 25 t fresh weight of utilisable yield/ha of good quality silage (70 % DMD). The energy cost of such a crop of silage per 1,000 UFL varies from €142 for silage ground @ €100/acre (€250/ha) to €238 when silage ground costs €250/acre (€618/ha).

Surplus grass

Surplus grass baled as silage during periods of rapid grass growth in the main grazing season is a high value product on any farm. It is a vital tool for good grassland management and is an alternative method of utilising home grown forage. Surplus bales are costing approximately €190/1,000 UFL. Surplus bales are usually a bonus and should not be relied on to fill a winter feed deficit.

Purchase alternative forages

Alternative forages such as maize silage, whole crop cereal silage and fodder beet could be used to bridge the gap in supply and demand. Issues to watch include variability in nutritional value, handling and storage facilities required and estimation of yield at the time of harvest. Fodder beet is worth c. €34/t and maize silage (25 % starch) is worth c. €44/tonne, relative to rolled barley at €200/t. Every €25/t increase in barley price will increase value of beet and forage maize by €5/t. These feeds must be balanced for protein and minerals.

Forage crops

Forage crops grazed *in situ* provide an option for some farmers on dry land to reduce winter feed costs. Yield and efficient utilisation will have a major impact on any potential cost saving with these crops. Issues to consider include variability in yield, quality and cross compliance. The production cost associated with brassica crops is €184-236/1,000 UFL, assuming ploughing, tilling and sowing the crop. Given the low yields of rape, min-till or no-till may be more cost effective than ploughing.

Table 1. Options for filling the gap in silage stocks

		Feed cost €/1,000 UFL	Feed cost €/Cow[5]
Restricted silage + meals[1]		214	85
Soya Hulls	€240/t	260	104
Surplus bales		190	76
	Land Rental Charge		
Land rental[2] (1st cut, fertilised)	€150/acre	174	70
	€250/acre	238	95
Forage crops[3]	Kale	160	70
	Rape	236	94
Maize silage[4]	€44-49/t	180-204	72-82
Fodder beet[4]	€34-39/t	160-183	64-73

[1]Buying silage @ €33/tonne and meals at €300/tonne; [2]Assumes utilisable yield of 25 tonnes fresh weight/ha; [3]Home grown; [4]Grown on contract; [5]Assumes a silage deficit of 25%

The future

Securing adequate winter feed as stocking rate increases will be a challenge. Greater output from increased stocking rate must come primarily from growing and utilising more grass on the home block rather than simply increasing silage and concentrate imports. Greater reliance on imports increases exposure to the volatility in the feed markets and puts farm profitability under increased pressure, particularly in a low milk price scenario.

Farmers need to take a critical look at the grass growing capacity of the farm, relative to stocking rate. This requires an examination of the sward quality, grassland management skills and, in particular, soil fertility. Recent figures suggest silage harvested from a low nutrient status field will cost an extra €20/t of utilised dry matter relative to silage from an index 1 field. The cost of substitute feeds purchased to replace a silage deficit caused by low soil fertility could be multiples of this.

What is the Ideal Post-Grazing Height?

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Summary

- Target 3.5 cm post-grazing height during the first rotations to ensure:
  - High milk and milk solids production per cow.
  - High grass utilisation and excellent quality grass in the following rotations.
- Main grazing season: increase post-grazing height to 4 – 4.5 cm.

Introduction

In anticipation of quota abolition, herd expansion has already started on many farms across Ireland. Given the increase in the cost of concentrate and silage production, the extra milk output must come from grazed grass to maintain farm profitability. Early spring turnout of the spring-calving dairy cow is a strategy to maximise the use of grazed grass in the diet. However, spring grass growth can be extremely variable, as has been the case for the past number of years. Grazing pastures to a low post-grazing height can create greater herbage availability during this period. Recent research at Teagasc Moorepark investigated the effects of different post-grazing heights on dairy cow milk production.

Spring grazing: target post-grazing height = 3.5 cm

Post-grazing heights of 2.7, 3.5 and 4.2 cm were compared over a 10-week period from mid-February to mid-April. During the 10-week period all cows were offered on average 4 kg of concentrate DM/cow/day. To achieve the post-grazing heights of 2.7, 3.5 and 4.2 cm cows were offered grass allowances of 8, 10, and 12 kg DM/cow/day, respectively. At the end of the 10-week period cows grazing to 4.2 cm had a similar cumulative milk and milk solids yield when compared to cows grazing to 3.5 cm (Table 1). Grazing to a post-grazing residual of 2.7 cm significantly lowers cumulative milk solids yield (-13 %) and milk yield (-10 %) during 10-week period. Grazing to 4.2 cm reduced grass utilisation which also meant that a larger grazing area per day was needed to achieve this height. This can be problematic when shortages in early spring grass supply are considered. Greater bodyweight and body condition score losses were also found when grazing to 2.7 cm (Table 1).

Table 1. Effect of post-grazing height on cow production during early lactation: mid-February – start of breeding season

	Post-grazing height		
	2.7cm	*3.5cm*	*4.2cm*
Milk yield, kg/day	22.0	23.6	24.6
Fat content, %	4.49	4.72	4.68
Protein content, %	3.34	3.43	3.43
Cumulative milk solids yield, kg (10 weeks)	104	119	121
Cumulative milk, kg (10 weeks)	1354	1491	1534
Bodyweight at week 10, kg	444	456	463
Body condition score at week 10	2.71	2.80	2.85

Mid-season and total lactation performance

From the start of the breeding season (mid-April) until drying-off, cows that grazed to 2.7, 3.5 and 4.2 cm, were subsequently grazed to either 3.7 or 4.7 cm. A higher grass utilisation was achieved on pastures grazed to 3.7 cm (94 %) than on pastures grazed to 4.7 cm (81 %). Grazing to a post-grazing height of 3.7 cm during the main grazing season reduced MS yield by 22 kg/cow compared to grazing to 4.7 cm; and the indications are that the reduction was greater where cows grazed to 2.7 cm during spring as apposed to either 3.5 or 4.2 cm.

Over the total lactation the lowest milk production (386 kg MS/cow) was achieved where cows grazed to 2.7 cm in spring and subsequently grazed to 3.7 cm during the main grazing season. The highest total lactation milk production (431 kg MS/cow) was achieved where cows were grazed to either 3.5 cm in spring and 4.7 cm subsequently or grazed to 4.2 cm in spring and 4.7 cm subsequently. However, when grass utilisation is considered the optimum grazing strategy would be to graze to 3.5 cm in spring and subsequently graze to 4.7 cm. The results also indicate that milk production of cows that are grazed to a low post-grazing height in spring (2.7 cm), recover somewhat subsequently when grazed to a higher post-grazing height (4.7 cm); however not totally. Targeting pre-grazing yields between 1300 and 1600 kg DM/ha help achieve high grass utilisation.

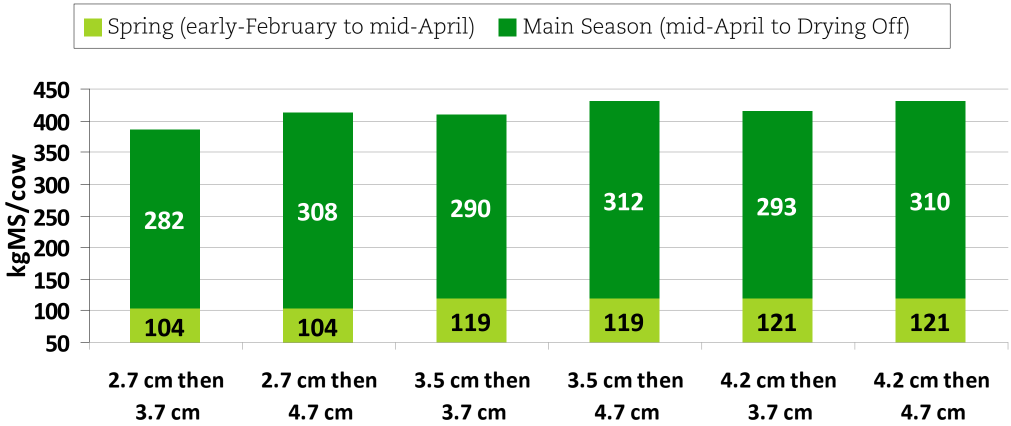

Figure 1. *Effect of post-grazing height on milk solids production*

What about sward quality?

From April onwards swards grazed to 3.7 cm in spring were leafier with less stem and dead material than swards grazed to 4.7 cm. This did not reduce milk solids production of the cows grazing to 4.7 cm because they did not graze into the lower quality material mainly present below their grazing height. Also, it was found that all cows consumed grass of equivalent nutritive value during the main grazing season.

Conclusions

A target post-grazing height of **3.5 cm** is recommended during the first grazing rotations to achieve high milk and milk solids production in early lactation as well as high grass utilisation. It will also guarantee excellent pasture quality for subsequent grazing rotations. From mid-season onwards post-grazing height should be increased to 4 - 4.5 cm to achieve adequate animal performance while maintaining good pasture quality.

New Developments in Grass Cultivar Evaluations

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Summary

- Sward structural differences between cultivars can impact animal performance.
- Leaf and stem proportion influence sward digestibility and therefore milk production.
- Compared to diploids, cows grazing tetraploid cultivators produced four per cent higher milk yield and five per cent higher milk solids yield.
- On-farm evaluation trials will quantify long term yield and persistency of cultivars.

Introduction

The grassland research programme at Moorepark continues to focus on the identification of perennial ryegrass cultivars which will support increased stocking rates and improved animal performance. The traits of importance which are crucial to supporting these objectives include seasonal sward production, grass quality and persistency. Understanding the impact of sward structural traits which are affecting intake and animal production is an important aspect of the research in this area.

Effect of sward structure on animal performance

Sward structure is known to influence animal performance. Individual grass cultivars have different sward structural attributes even under a similar management regime. Increased leaf proportion in the sward will increase the overall quality of the feed being offered, however an increase in stem proportion will reduce nutritive value and also act as a barrier to intake as it is physically more difficult for animals to graze. Research is ongoing to examine the effect of sward structure on animal intake and milk performance.

Trial 1

In 2010 and 2011, four cultivars were sown as monocultures (single cultivar per paddock) to determine what sward structural traits were important from a grazing perspective. The four cultivars were AberMagic (diploid), Spelga (diploid), Bealey (tetraploid) and AstonEnergy (tetraploid). Cultivars were grazed by four groups of cows from April to September of both years. Cows were offered 17 kg DM/cow/day. Table 1 presents the effect of cultivar on milk yield and milk solids yield. Milk yield was highest (25.8 kg/cow/day) on the two tetraploids, Bealey and AstonEnergy, compared to 25 kg (Spelga) and 24.5 kg (AberMagic).

There were large differences in the sward structure of these cultivars between the reproductive and vegetative growth phases. Sward structure influenced milk yield during the reproductive growth phase; AberMagic maintained larger stem proportions during this period which led to reduced animal performance. As the swards returned to the vegetative stage, the digestibility of the cultivars became a key driver of milk yield, with higher digestibility values in the tetraploid compared to the diploid swards.

Trial 2

Following on from this work, four new cultivars were sown as monocultures in 2011. The cultivars were AstonEnergy (tetraploid) (which was a control from the previous study), Delphin (tetraploid), Glenroyal (diploid) and Tyrella (diploid). In 2012, four groups of cows grazed these cultivars from April to September. On average, milk yield was 1.1 kg/cow/day higher on the tetraploid cultivars compared to the diploid cultivars. This work is currently ongoing to further investigate the effect of structure on animal performance. Milk performance and post grazing sward height are shown in Table 1.

Table 1. Milk yield, milk solids yield and post grazing sward height results from two experiments investigating the effect of cultivar on animal performance

	Tetraploids		Diploids	
Trial 1	**AstonEnergy**	**Bealey**	**AberMagic**	**Spelga**
Milk yield (kg/cow/d)	25.8	25.8	24.5	25.0
Milk solids yield (kg/cow/d)	2.0	2.0	1.9	1.9
Post grazing height (cm)	4.0	4.0	4.2	4.2
Trial 2	**AstonEnergy**	**Delphin**	**Glenroyal**	**Tyrella**
Milk yield (kg/cow/d)	21.2	20.8	19.9	19.9
Milk solids yield	1.7	1.7	1.6	1.6
Post grazing height (cm)	4.0	4.1	4.1	4.0

Throughout both trials, the post grazing residual was lower on the tetraploid swards, despite animals all being offered a similar daily herbage allowance. This agrees with other work in Moorepark which has shown lower post grazing residuals in tetraploid cultivars indicating higher utilisation of tetraploid compared to diploid swards under grazing.

On-farm grass cultivar evaluation

In 2010, an on-farm research study began with 18 commercial dairy farms to evaluate the performance of cultivars at farm level across a range of managements, locations and soil types. The objective of this study was to develop a greater understanding of the DM yield performance, growth rates and persistency of cultivars at farm level and to increase the information available on Recommended List cultivars. Cultivars are sown as monoculture with one single cultivar per paddock. One common control cultivar is sown on every farm and each farm also has between one and seven other cultivars sown as monocultures. The number of farms involved has increased each year and there are currently almost 70 farms testing a total of eight cultivars. A target of 100 farms is hoped to be involved by 2014. All farms are linked to the PastureBaseIreland grassland database, where the seasonal and total DM production is quantified along with paddock history and sward longevity.

Conclusion

Animal performance studies will identify the important traits influencing intake and milk or meat production, thus ensuring grass breeders can select those traits which are most desirable for a grazing system. Results from Moorepark are indicating improved animal performance can be achieved from tetraploid cultivars due to their increased leaf proportion, higher digestibility and increased utilisation compared to diploid cultivars.

Teagasc Grass and Clover Breeding Programme

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Summary

- Teagasc has been breeding grass and clover varieties for Irish farm systems for over 50 years.
- Our goal is to breed varieties of perennial ryegrass and white clover that offer high yields of quality forage over a long grazing season.
- Twenty-three perennial ryegrass and nine white clover varieties have been commercialised to date.
- Teagasc has entered into a new partnership with Goldcrop Ltd. to support the programme and commercialise all new varieties that emerge from the programme.

Introduction

Grassland is Ireland's greatest renewable feed resource, and provides the main feed for ruminant livestock. Genetic improvement of grass and clover swards offers a cost effective mechanism to increase the profitability and reduce the environmental impact of animal production from grassland. Grass and clover have been subjected to very little formal breeding. There is no sign that the genetic progress achieved during the past 50 years of forage breeding will not continue for at least the next 50 years. Genetic variation within and among populations is still extremely high, showing no signs of decreasing. Harnessing the power of modern technologies such as genomic selection may accelerate genetic improvement. The potential of forage breeding is limited only by human imagination, ingenuity and available funding.

History

The science of forage breeding in Teagasc began in the early 1960's at the Oak Park Research Centre, Carlow. Initially, there was a broad remit including (i) research on breeding methods, (ii) agronomic evaluation of species, varieties within species and mixtures (at the time there was no organised trial system in Ireland in which all new varieties were assessed) and (iii) breeding new varieties. In the mid-1980's major changes were made to the programme. It was decided that the programme would concentrate on the breeding of new varieties, and that the programme would become commercially orientated. An exclusive commercial agreement with DLF-Trifolium of Denmark to propagate and market all new Teagasc varieties was entered into in 1992. To date, the programme has bred and commercialised 23 perennial ryegrass varieties and 9 white clover varieties.

In 2013, the Teagasc breeding programme entered a new chapter in its history signing a new 10 year commercial agreement with Goldcrop Ltd., an Irish seed and inputs company with headquarters in Carrigtwohill, Co. Cork. Goldcrop offer financial and technical support to the programme. In return, Goldcrop have exclusive world-wide rights to commercialise and market all new varieties that emerge from the programme.

Breeding goals

Our emphasis is on breeding improved varieties of perennial ryegrass and white clover for Irish farmers. Our goal is to increase the profitability and sustainability of animal production from grassland in Ireland. The main plant traits for genetic improvement are: (i) spring and autumn growth; (ii) quality, particularly during mid-season; (iii) sward persistency and density; and (iv) disease resistance. The perfect variety would provide sufficient yield to match the animal feed demand curve over the entire season. In other words, it would offer significantly higher spring and autumn yields than is currently achieved. It would also provide additional yield during the mid-season that could be conserved for use during the winter when grazing is not possible. We want a grass variety that heads only once in a compact period of time. The variety must head if we are to produce seed for resale. For the rest of the year we want a leafy, highly digestible sward. We want a variety that produces a dense sward with no bare ground and that will persist indefinitely. Finally, we want a variety resistant to rust. Rust is not a major disease problem in Ireland at present but it is predicted to become a bigger problem in the future.

Varieties

In 2013, farmers may choose from nine perennial ryegrass and three white clover varieties bred by Teagasc for reseeding. All varieties are included on the Grass and Clover Recommended List Varieties for Ireland 2013. Teagasc varieties include: ***KINTYRE***, best yielding late perennial ryegrass variety on the Recommended List; ***GLENVEAGH***, late diploid with best sward density of all recommended perennial ryegrass varieties; MAJESTIC, late diploid perennial ryegrass variety with excellent all round performance; CARRAIG, highest spring yielding intermediate tetraploid on the Recommended List; ***SOLOMON***, intermediate diploid with the best spring growth of all recommended perennial ryegrass varieties; and ***CHIEFTAIN*** and ***AVOCA***, best yielding medium leaf size white clover varieties on the Recommended List.

The Grass and Clover Recommended List Varieties for Ireland 2013 is available at the following website: **www.agriculture.gov.ie/publications/2013/**

Forthcoming Teagasc varieties currently undergoing seed increase and with predicted release date in 2014-2015 include ***GLENROYAL*** (late diploid perennial ryegrass), ***BUDDY*** (medium leaf white clover) and ***IONA*** (medium leaf white clover).

Conclusions

The Teagasc forage breeding programme continues to develop improved varieties of grass and clover for Irish farmers. Farmers may currently choose from nine perennial ryegrass and three white clover varieties bred by Teagasc for reseeding. A number of other new varieties are currently undergoing seed increase for future release.

NEXT GENERATION BREEDING AND REPRODUCTION

Developments in EBI

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Summary
- The EBI has evolved since its introduction in 2001 to remain pertinent to the Irish production systems.
- Suites of traits under investigation for possible inclusion in the EBI include:
  - Milk quality.
  - Environmental footprint and feed intake.
  - Animal health, disease and welfare.

Introduction
The Economic Breeding Index (EBI) has been in existence for 12 years. Like any tool, the EBI must be constantly questioned and challenged, and where appropriate, revisions and subsequent improvements made. The EBI has undergone many (slight) revisions since its inception in 2001. The most recent of these revisions was the inclusion of the two management traits, milking duration and temperament in 2013.

A plethora of studies has clearly and unequivocally shown that improved profit ensues from selection on EBI. Genetic merit for milk solids continues to increase and genetic improvement for fertility is improving year on year. By the year 2020 the genetic merit for fertility of the Irish national dairy herd will be back to 1989 levels; however the cow of 2020 will produce 60 per cent more milk solids than the cow of 1989. Scrutiny of the EBI, nonetheless, suggests at least three suites of traits that are either explicitly neglected or can be improved. These include 1) milk quality, 2) environmental footprint including feed intake, and 3) health, disease and welfare.

Milk quality
Ireland exports 90 per cent of its dairy products and therefore production of consistently high quality milk is paramount. Although the milk, fat and protein are included in the EBI, fat and protein alike can be decomposed into their individual components. Milk fat is an accumulation of saturated and unsaturated fatty acids. Preliminary analysis suggests that the concentration of saturated fat in the milk fat of Irish dairy cows is naturally lower, likely attributable (in part) to our grazed grass diet. Lower saturated fatty acid concentrations are important because of their apparent unfavourable impact on human health. Therefore Ireland already has a natural competitive advantage in our milk fatty acid profile. Furthermore, the level of conjugated linoleic acid (CLA) is, on average, greater in grazing cows; CLA is an anti-carcinogenic.

Researchers in Moorepark, as part of an international collaboration, developed the necessary methodology to accurately predict saturated fatty acid content of routinely collected milk samples from milk recording schemes. Considerable genetic differences exist among animals; the heritability of milk fatty acid content is 0.20 to 0.40. The cost of generating the data is negligible and because the data are available on each milk recorded animal, genetic evaluations for milk fatty acid is possible. Once the extent of the genetic variation is known, research on how best to include this measure of milk quality in the EBI will commence.

Research has also begun on quantifying the genetic variation present in milk protein and mineral profiles, as well as the functional characteristics of milk. These properties are all important contributors to cheese quality and yield. If ample genetic variation exists and improving these properties add value to the milk then their inclusion in future revisions of the EBI must be considered.

Environmental footprint and feed intake

Although no direct financial incentive currently exists for improving individual cow environmental footprint, this may not always prevail. Traits describing the environmental load of an individual animal include methane emissions and nitrogen excretion. Irrespective, the excretion of such wastes usually also imply inefficiency in the production system. Methane emissions account for approximately six per cent of energy loss, therefore, reducing emissions assuming no deleterious consequences on performance could be beneficial. Feed accounts for up to 80 per cent of the variable costs in Irish dairy production systems, thus improving the efficiency could yield considerable benefits. There is some scope to reduce feed intake per animal through breeding without compromising milk production, however the main efficiency goal is that of the entire system. Milk production and live-weight, both included in the EBI account for a large proportion of feed efficiency, while fertility, health and survival account for a major proportion of the remainder. Therefore, the EBI is indirectly selecting for improved efficiency.

The main reason for not including environmental footprint and feed intake in the EBI is the cost associated with collection of the data. However, developments in biosensors and other tools to predict these traits are currently under investigation to generate the necessary data for genetic evaluations.

Health, disease and welfare

Although a health sub-index currently exists within the EBI it includes only udder health and lameness and does not include other infectious and metabolic diseases or resistance/resilience to parasites. The relative emphasis on health in the EBI is low because the impact of compromised health on performance such as reduced milk production, inferior fertility and decreased survival is already captured through inferior genetic merit of the animal for these traits. Inclusion of a trait in the EBI requires accurate estimates of the genetic differences among sires which in turn require large quantities of data. Farmers know which animals were sick and the facility already exists to upload such information into the ICBF database. This information can be used to identify which family lines have compromised health. More importantly, inclusion of such information in the EBI will improve the overall health status of the national herd similar to how the EBI is currently improving the fertility status. The onus is on farmers to record these data. Initiatives are also underway to collate the data from abattoirs and other sources. The applicability of non-expensive biosensor technology to measure health characteristics of an animal for use in genetic evaluations is under way.

Conclusions

The EBI has evolved since its introduction in 2001. It now includes seven main sub-indexes, milk production, fertility & survival, calving performance, beef, cow maintenance, health, and management. Research is underway to ensure the EBI remains relevant to the futuristic Irish production systems.

Genomic Selection, Past, Present, Future

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Summary

- Genomic selection uses DNA information to supplement pedigree information to more accurately identify genetically elite animals.
- Retrospective analysis of genomic predictions since 2009 show that genomic selection is 10 to 20 per cent more accurate than using pedigree alone and this improvement in accuracy is improving with time.

Introduction

DNA is the building blocks of life and what makes us all different. Similarly the DNA of a cow, in combination with the environment, dictates the performance of that cow. The DNA present in all the cells of an individual is identical and stays the same throughout an animal's life. DNA can be extracted from hair follicles. If we knew how each piece of DNA affected each performance trait, then, by taking a hair sample from a calf we could predict how well that animal will perform several years hence. This is the basis behind genomic selection.

The past

Genomic selection was launched in Ireland in February 2009, making us the second country in the world to do so. The average reliability of the genomic proofs of young animals was 48 per cent but genomics was not available to purebred Friesians because the DNA genotype for Friesians differed to that of the Holsteins. In the following years, the numbers of AI bulls used to determine the optimal DNA genotype for Ireland increased from 945 in 2009 to 5,500 in 2013. This resulted in an annual incremental increase in the reliability of genomic to 58 per cent in 2013; genomic predictions are now available for Friesians. Greater reliability of genomic proofs is being achieved in other international Holstein-Friesian populations, due to larger populations of animals available to estimate the best DNA genotype for that country.

Table 1. Percent of inseminations to different bull proof types[1] and the mean EBI of the bulls used since the introduction of genomic selection in 2009

	2009		2010		2011		2012	
Proof	Use	EBI	Use	EBI	Use	EBI	Use	EBI
DP-IRL	37%	€120	25%	€146	29%	€143	30%	€177
DP-INT	29%	€133	34%	€155	24%	€155	22%	€180
GS	34%	€179	40%	€218	47%	€218	48%	€215

[1]DP-IRL=bulls with daughters producing in Ireland; DP-INT= bulls with no daughters in Ireland but producing in a foreign country; GS = genomic bulls

A paradigm shift in cattle breeding in Ireland has occurred since the introduction of genomic evaluations; farmers are now using teams of (genomically selected) bulls rather than individual proven bulls. Teams of bulls are recommended since the reliability of the genomic bulls is still only ~58 %. The usage of genomically selected bulls in Ireland for the past few years is summarised in Table 1. Usage has increased due primarily to a considerably higher EBI of the genomic bulls relative to the daughter proven bulls. This is consistent with trends observed internationally.

The present

DNA technology has been used for parentage testing in Ireland for several years. This DNA technology is based on the use of microsatellite technology. The DNA technology used for genomic selection is based on single nucleotide polymorphisms (SNPs). In 2013 a new genotyping platform, the international dairy & beef (IDB) chip, was developed to reduce the cost of acquiring a genotype without compromising the information generated. The IDB also allows the SNP technology to "talk" to the microsatellite technology meaning that the back-pedigree of animals are not required to be re-genotyped. Many countries, like Ireland, are now moving parentage testing to SNP technology as it is lower cost and more reliable. The IDB genotyping chip also includes other known genetic mutations (e.g., A1A2 beta-casein) and as other mutations are discovered they will be added to the chip. The advantage of the IDB is that only one hair sample is required, thereby reducing the cost and inconvenience of the service. This Irish chip will be constantly improved.

Bulls sold as genomic AI bulls several years ago now have daughters milking with many entering fifth lactation. Comparing the genomic predictions made several years previously to their daughter-based proofs now show that the genomic technology is 10 to 20 per cent superior than the previous pedigree-based approach in the identifying the genetically elite animals. There was a slight overestimation in the EBI of the genomic bulls which has since been adjusted. The accuracy of genomics is improving year-on-year.

The future

Based on the current algorithms used, the benefit to related un-genotyped animals is minimal. Disseminating the benefits of genotypes for related un-genotyped animals is an area of active research. Research on generating genomic proofs for other breeds is underway. The cost of developing a genomic program for other breeds is ~€150,000/breed.

One of the main benefits in the future of genomic technology will be its use in mating programs design. Genomic technology can be used to identify matings with the best probability of achieving genetically elite progeny while minimising the inbreeding. Genomics can more accurately quantify relationships among animals. For example, theoretically, the mating between two full sibs can result in a progeny that are not inbred; this is because each sib receives a random sample of DNA from each parent and theoretically at least each of the two half sibs could receive a very different half. Every animal and human are thought to be carriers of at least six lethal recessive mutations. Many more genetic mutations with deleterious effects will be detected in the future and rather than simply culling animals based on their genotype (as was undertaken for CVM and BLAD), mating programs can be designed to ensure carriers are not mated.

Conclusions

Genomic technology is used in most developed international dairy cow populations to identify the genetically elite animals. All other countries, with the exception of New Zealand, have consistently shown greater accuracy of selection with the use of genomic technology, corroborating our experience of the technology in Ireland.

Crossbreeding to Increase Profit

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Summary

- Studies at Moorepark have demonstrated considerable animal performance benefits with crossbred cows.
- Economic analysis undertaken using biological data generated from research studies indicate superior profit generating potential with a herd of first cross Jersey×Holstein-Friesian and Norwegian Red×Holstein-Friesian cows compared with their contemporary Holstein-Friesian cows, equating to approximately €18,000 and €13,000, respectively, based on a 40ha unit.
- Independent research undertaken by ICBF has indicated a potential benefit from cross-breeding of some €100/lactation in the first cross over an above that explained by EBI. Note, this added performance is not reflected in the EBI values of either bulls or cows. It is due to additional performance benefits.
- Heterosis alone will not guarantee success in a crossbreeding programme. The key must be to utilise the best available genetics (high EBI) to maximise the benefit and ensure genetic improvement.

Fundamentals of crossbreeding

The two primary reasons to crossbreed are: 1) introduce favourable genes from another breed selected more strongly for traits of interest, and 2) to capitalise on what is known as heterosis or hybrid vigour. The first point relates to additive genetic differences between breeds e.g. breed differences pertaining to milk yield, milk composition, size, beef merit, fertility, mastitis resistance, intake capacity, feed efficiency etc. Heterosis or hybrid vigour refers to the phenomenon that occurs when an animal is heterozygous (different) at a particular locus (gene), resulting in synergies that mean crossbred animals perform better for certain traits than that expected based on the average of their parents. In practice additive genetic differences must be considered, having particular relevance subsequent to the first cross. A major portion of success will result from additive genetic merit for different traits that bulls and cows transmit to their offspring (long term genetic gain). Heterosis alone will not guarantee success in a crossbreeding programme.

Estimates of heterosis vary in magnitude depending on the trait being examined, and the genetic distance between the breeds being crossed. Heterosis for production traits such as milk yield or liveweight/growth rate is usually in the range 0 to 5 per cent, whereas heterosis for traits related to fertility is usually in the range 5 to 25 per cent. Milk composition is not influenced by heterosis and therefore improvements in solids yield is due to the influence on milk volume. Heterosis will generally be higher in traits related to fitness and health i.e. traits which have lower heritabilities. In New Zealand for example crossbred cows (Jersey×Friesian) survive 227 days longer (almost 1 lactation more) compared to the average of the parent breeds. This equates to almost 20 per cent hybrid vigour. This benefit is further highlighted by the fact that at current rates of genetic gain for longevity (9.5 days/year) it will take 24 years of selection before a similar rate of survival is reached with cows within the straight breeds. Traits relating to udder health will generally not be affected by heterosis per se either but more influenced by breed effects or changes to yield potential.

Summary of Moorepark research results

The performance data generated at Ballydague (Jersey) and on the large on-farm study (Norwegian Red) has been impressive and demonstrates that crossbred dairy cows are capable of production levels per cow at least similar to their Holstein-Friesian contemporaries on low cost systems, but fertility and survival levels are markedly improved, e.g. six week in-calf rates were increased by over 10 percentage units with crossbreds in both studies. Extrapolated to a conventional herd basis (e.g. allow age profile to change/mature due to fertility differences etc) the research results from Ballydague show that a herd of Jersey×Holstein-Friesian cows to be 10 per cent more productive than a herd of straight Holstein-Friesian cows (Table 1). Crossing with Jersey is the most prudent means to collectively maximise solids production per hectare, increase survival, reduce maintenance costs (due to a reduced size), and particularly complementary to the multiple component milk payment system (A+B-C). Mating Holstein-Friesian cows with Norwegian Red sires will typically result in a cow very similar in general appearance and production characteristics to the Holstein-Friesian. However, improved fertility, udder health and body condition can be expected. Thus, it is certainly an option for those wishing to avail of the benefits of crossbreeding but wanting to retain a Holstein-Friesian type cow, i.e., similar colour, size, weight, production characteristics, calf value etc.

Economic analysis using the biological data generated from these studies has highlighted a substantial profit benefit per lactation with the Jersey×Holstein-Friesian and Norwegian Red×Holstein-Friesian cows (Table 2). The difference in performance, based on economic analysis generated over three years ago, equated to over €18,000 and €13,000, respectively, annually on a 40 ha farm. Base milk price was taken as 27 c/l. This implies over €180 and €130 more profit/cow/year, respectively. This economic analysis was very detailed, taking into account differences in production characteristics, body weight differences, replacement rates/survival, cull cow and male calf values etc. A reanalysis conducted during the summer of 2012 taking cognisance of the changes to both milk and beef/ calf values showed an advantage of over €130/cow/year more profit for both Jersey and Norwegian Red crossbreds compared with straight Holstein-Friesians. The improved profitability is primarily attributable to improvements in milk revenue and the large differences in reproductive efficiency/longevity observed with the crossbred herds.

The economic performance of the Norwegian Red×Holstein-Friesian is for the most part what is expected if the Holstein-Friesian cows had similar fertility performance/ replacement rates to the Jersey×Holstein-Friesian cows. So the benefits from the Jersey×Holstein-Friesian is more than that accounted for by improvements in fertility.

Sensitivity analysis showed that at a milk price of 20 c/l, farm profitability ranges from unprofitable to lowly profitable. The economic loss was greater for the Jersey compared to the Holstein-Friesian. At a higher base milk price of 33 c/l the higher milk solids concentration of the Jersey×Holstein-Friesian results in increased profitability compared to Holstein-Friesian, Norwegian Red and the Norwegian Red×Holstein-Friesian cows. When the value of protein to fat is increased from 2.6 to 1 to 3.3 to 1 the difference in profitability between the Jersey×Holstein-Friesian and the Holstein-Friesian is reduced by €447, while the difference between the Jersey and Holstein-Friesian increased by €1,185. Increasing the cost of replacements increases the difference in profitability between the Holstein-Friesian and the more fertile groups (€1,580, €1,651 and €1,681 for the Norwegian Red, Jersey×Holstein-Friesian and Norwegian Red×Holstein-Friesian, respectively).

Table 2. Physical and financial components of Holstein-Friesian (HF), Jersey (J), Jersey×Holstein-Friesian (JX), Norwegian Red (NR) and Norwegian Red×Holstein-Friesian (NRX) cows on a 40 ha farm					
	Breed group				
	HF	J	JX	NR	NRX
Annual milk yield (kg)	543,916	480,087	510,032	542,073	555,302
Milk sales (kg)	532,713	466,845	498,773	530,599	544,135
Milk protein (kg)	18,607	18,837	19,397	18,562	19,034
Milk fat (kg)	21,943	24,875	23,817	21,843	22,030
Milk protein (%)	3.49	4.03	3.88	3.49	3.49
Milk fat (%)	4.12	5.32	4.77	4.05	4.05
No. of cows	96.3	113.8	96.7	98.6	95.9
Land area (ha)	40	40	40	40	40
Stocking rate (LU/ha)	2.28	2.70	2.34	2.38	3.32
Milk price (c/l)	30.68	38.12	35.47	30.52	30.52
Labour cost (€)	27,760	32,811	28,463	29,005	28,230
Concentrate costs (€)	5,953	7,037	6,442	6,564	6,389
Livestock sales (€)	28,675	22,696	21,674	26,097	26,401
Replacement costs (€)	38,904	45,982	26,935	27,447	26,715
Total costs (€)	149,852	167,089	137,786	139,708	137,268
Milk price 27c/l					
Milk returns (€)	158,675	172,816	171,790	157,226	161,223
Profit/kg milk solids (€)	0.92	0.65	1.29	1.09	1.23
Profit/ha (€)	938	711	1,392	1,090	1,259
Profit farm (€)	37,499	28,423	55,678	43,615	50,356

Independent research undertaken by ICBF has indicated a potential benefit from cross-breeding of some €100/lactation in the first cross over an above that explained by EBI. This means that heterosis adds in excess of €100/lactation in the form of added performance in the first cross.

Where to after the first cross?

Performance of the first crosses will please even the most critical. First crosses tend to tick all the boxes: display full hybrid vigour, are productive, fertile and tend to be uniform in appearance (colour, size etc). For traits displaying a lot of hybrid vigor e.g. fertility and longevity, subsequent generation performance may decline, depending to varying extents on the additive genetic contribution of the follow on sires selected. For obvious reasons self-propagation of crossbred replacements is mandatory and any crossbreeding strategy should be viewed as a long term proposition. A common question among dairy farmers considering crossbreeding is "where too after the first cross?" Several schemes are available for creating replacement animals via crossbreeding. The three most common are as follows:

- Two-way crossbreeding. This entails mating the F1 cow to a high EBI sire of one of the parent breeds used initially. In the short term HV will be reduced but over time settles down at 66.6 per cent.
- Three way crossing. Uses high EBI sires of a third breed. When the F1 cow is mated to a sire of a third breed HV is maintained at 100 per cent. However, with the reintroduction of sires from the same three breeds again in subsequent generations, for example Holstein-Friesian etc, the HV levels out at 85.7 per cent.

- Synthetic crossing. This involves the use of high EBI crossbred bulls. In the long term a new (synthetic) breed is produced. HV in this strategy is reduced to 50 per cent initially and is reduced gradually with time.

Evaluation of three-way crossbreeding

The positive outcome of the on-farm Norwegian Red study prompted the use of Norwegian Red sires on the Jersey crossbred cows at Ballydague, to generate three-way crossbred cows. The theoretical advantages of a three-breed rotational crossing system are clear, but data to recommend it in practice is very limited. The advantage in theory lies in the maximisation of hybrid vigour, averaging 86 per cent for full heterosis in advanced generations. The cows generated at Ballydague now form part of a new research study has been established at Clonakilty Agricultural College with the aim of comparing three genotypes (Holstein-Friesian, Jersey×Holstein-Friesian, and Norwegian Red×Jersey×Holstein-Friesian cows) across pasture treatments comprising a range of grass/clover combinations. While it is too early to draw conclusions the initial performance results for the three-way crossbred cows, both at Clonakility and at commercial farm level, are very favourable.

In addition, a follow-on study to the Norwegian Red on-farm crossbreeding study engaged 18 commercial farms to generate three-way crossbred cows (both Jersey×Norwegian Red×Holstein-Friesian and Norwegian Red×Jersey×Holstein-Friesian). Numbers are small but the oldest cows have now completed second lactation. Preliminary performance analysis, based on data collated during 2012, shows that Jersey sired three way crossbred cows (Jersey x (Norwegian Red x Holstein-Friesian) were highly productive recording 14 kg more milk solids or 3.5 per cent higher 305 d yield of milk solids compared to their Holstein-Friesian contemporaries. Norwegian Red sired three-way crossbreds (Norwegian Red x (Jersey x Holstein-Friesian) were slightly less productive at 16 kg less or four per cent lower yield of milk solids compared to the Holstein-Friesian cows. Reproductive efficiency (measured as in-calf rate) was excellent across all breed categories. Cows with Norwegian Red genetics (including the Norwegain Red three-way crossbreds) had particularly high in-calf rates, averaging 97 per cent pregnant across all farms.

Conclusions

Going forward crossbreeding must make an even greater contribution on Irish dairy farms than it currently does in light of current and expect policy and the consequent drive by the industry to maximise output/profit per ha and reduce costs. While not everyone's 'cup of tea' it is very clear from the research at Moorepark that crossbreeding in the dairy herd can very quickly improve traits such as fertility and herd productivity, thus having significantly favourable effect on profit generating ability.

The Effect of Genetic Merit for Fertility Traits on Uterine Health in Dairy Cows

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Summary

- Uterine infection reduces cow fertility.
- Moorepark research indicates that cows with good genetic merit for fertility traits have a quicker recovery from uterine infection after calving compared with cows with poor genetic merit for fertility traits.
- Selecting sires with a high fertility sub-index will improve uterine health and reduce the requirement for treating 'dirty' cows.

Introduction

After calving, the uterus is exposed to bacteria and uterine infection develops. Most cows will resolve this infection without treatment. However, persistence of the infection results in cows with clinical (purulent vaginal discharge) and sub-clinical endometritis. Even when cows are identified and treated, endometritis has negative effects on subsequent fertility. Production costs are increased due to veterinary intervention costs and slippage in calving pattern associated with poorer reproductive performance.

Study comparing cows with high and low fertility sub-index

In 2008, a study was established at Moorepark to investigate the reproductive efficiency of two strains within the Holstein-Friesian breed that had similar genetic merit for milk production, but either good (Fert+) or poor (Fert-) genetic merit for fertility traits. These animals were representative of the top 25 per cent of the national herd in genetic merit for milk production. The Fert+ and Fert– groups represented the top 20 per cent and bottom 5 per cent of the national herd for calving interval, respectively.

Animals were managed as one herd in accordance with the Moorepark blueprint for pasture-based milk production. During their first and second lactations, mean milk solids production tended to be greater in the Fert+ cows compared with the Fert- cows (436 vs. 424 kg). During the breeding season, the Fert- cows had poorer submission rates (72 % vs 83 %) and poorer conception rate to first service (33 % vs. 56 %), and as a result required 28 days longer to become pregnant compared with the Fert+ cows. In 2012, a study was undertaken to monitor the uterine health of the Fert+ and Fert- cows after calving. The aim was to examine if differences in uterine health contributed to the differences in reproductive performance between the Fert+ and Fert- cows. All cows were managed as one herd with similar nutrition, housing and general health management. Uterine health was assessed in two ways:

- Weekly scoring of vaginal mucus (Figure 1). This is reflective of the level of bacterial contamination;
- Conducting a cytology exam of the cells within the uterus to determine the proportion of immune cells. A high proportion of immune cells indicates an on-going uterine infection.

From the second week after calving onwards, the Fert- cows had greater vaginal mucus scores, indicating a slower clearance of bacterial contamination compared with the Fert+ cows. A similar proportion of Fert+ and Fert- cows were classified as having endometritis (~80 %) based on immune cell population at week three after calving. By week six, 75 per cent of Fert- cows were classified as having endometritis, compared with 25 per cent of

Fert+ cows. Mean milk solids production (1.88 vs. 1.67 kg/day) and body condition score (2.98 vs. 2.75 units) were greater in the Fert+ than the Fert- cows. The superior uterine health status of the Fert+ cows may be explained by their greater dry matter intake (19.2 vs. 16.8 kg/day) and more favourable metabolic status (greater blood glucose and IGF-I) compared with the Fert- cows during the first few weeks after calving.

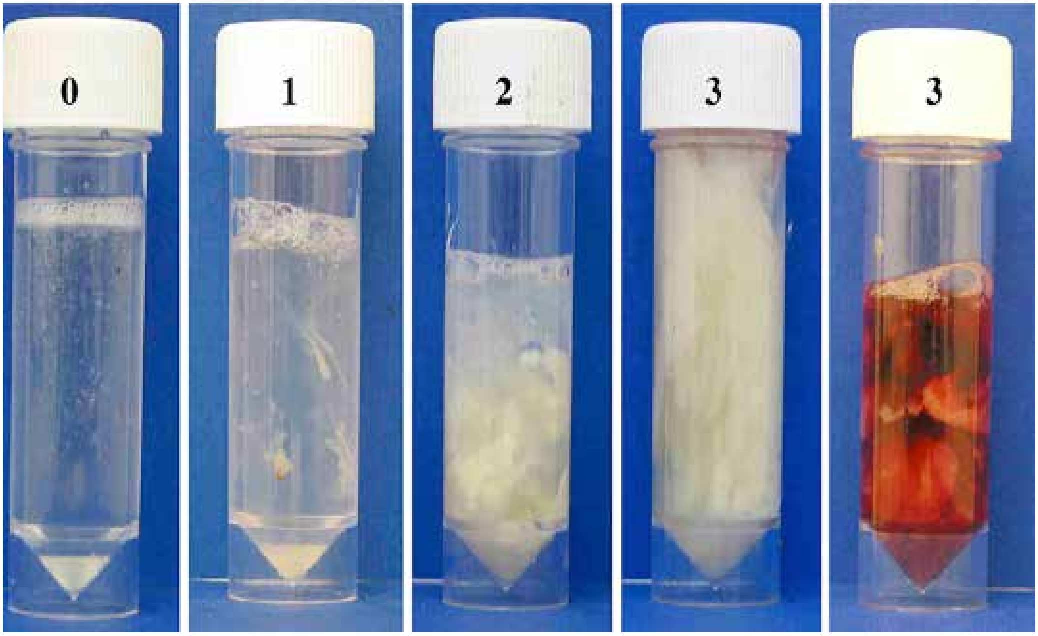

Figure 1. *Vaginal mucus score scheme used to identify cows with uterine infection. Clear mucus = 0; mucus with flecks of pus = 1; mucus containing <50 % pus = 2; mucus containing ≥50 % pus (sometimes bloody) = 3*

Conclusion

Cows with a high fertility sub-index have a faster recovery from uterine infection after calving. The need for veterinary intervention can be reduced and fertility improved by selecting sires with a high fertility sub-index to generate replacement heifers with superior genetics for fertility traits. Assessing vaginal mucus is a quick and convenient method to identify cows with uterine infection.

Sexed Semen – Has it a Role in Ireland?

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Summary

- Sexed semen is usually sorted to 90 per cent purity (i.e., 90 % heifers, 10 % bulls).
- Conception rates with frozen sexed semen are reduced compared with conventional semen.
- Evidence from other countries indicates that fresh sexed semen has a smaller reduction in conception rate compared with frozen sexed semen.
- Economic modelling indicated faster and more profitable expansion using sexed semen.
- A major field trial was conducted in spring 2013 to determine the performance of fresh and frozen sexed semen in Irish dairy herds.

Introduction

With conventional semen (fresh or frozen), the likelihood of a heifer or a bull calf is roughly equal at 50 per cent. Sexed semen (90 % X-sorted) will alter this ratio to 90 per cent heifer calves and 10 per cent bull calves. There is, however, a reduction in conception rates using frozen sexed semen to approximately 75 to 80 per cent of those achieved with conventional semen. A study in NZ using *fresh* sexed semen indicated conception rates were approximately 94 per cent of those achieved with conventional semen. For example, if conception rates with conventional semen were 60 per cent, expected conception rates with sexed semen would be 56 per cent (fresh) and 45 per cent (frozen).

Economic modelling

A model was developed to examine the effects of sexed semen use on rate of herd expansion and farm profitability in Irish dairy production systems. Expansion from a herd size of 100 cows to 300 cows was modelled over a 15-year simulation period, using either conventional, fresh sexed or frozen-thawed sexed semen. The sexed semen was used in virgin heifers for the first two AI and in lactating cows for the first AI. Sexed semen use (either fresh or frozen) generated greater numbers of replacement heifers, and facilitated faster rates of herd expansion (Figure 1). This resulted in greater levels of farm profitability over the 15-year simulation period. The rapid expansion, however, increased the financial pressure on the farm business, particularly at times of low milk price.

Further benefits of sexed semen use

In addition to the projected increased rate of herd expansion, use of sexed semen may also reduce the incidence of calving difficulty (heifer calves are lighter than male calves), and improve biosecurity by allowing farmers to increase herd size while maintaining a closed herd. Use of sexed semen will reduce the number of low-value male dairy calves born, and hence could make Jersey cross-breeding more attractive. After adequate heifers have been generated at the start of the breeding season, use of Y-sorted semen (male offspring) from easy-calving short-gestation beef bulls provides an opportunity to increase the value of beef output from the dairy herd.

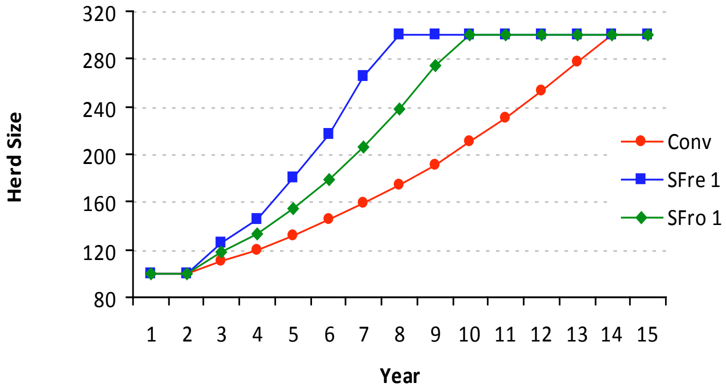

Figure 1. *Rate of herd expansion over a 15-year simulation period using conventional (Conv), fresh sexed (SFre) or frozen-thawed sexed semen (SFro) for the first two AI in virgin heifers and for the first AI in lactating cows.*

Field trial

To date, there has been limited use of frozen-thawed sexed semen in Ireland, and fresh sexed semen has never been used. A field trial was carried out in Ireland during the 2013 breeding season to evaluate the use of fresh and frozen sexed semen. Over 15,000 inseminations on 394 farms were carried out on lactating cows and virgin heifers as outlined in Figure 2.

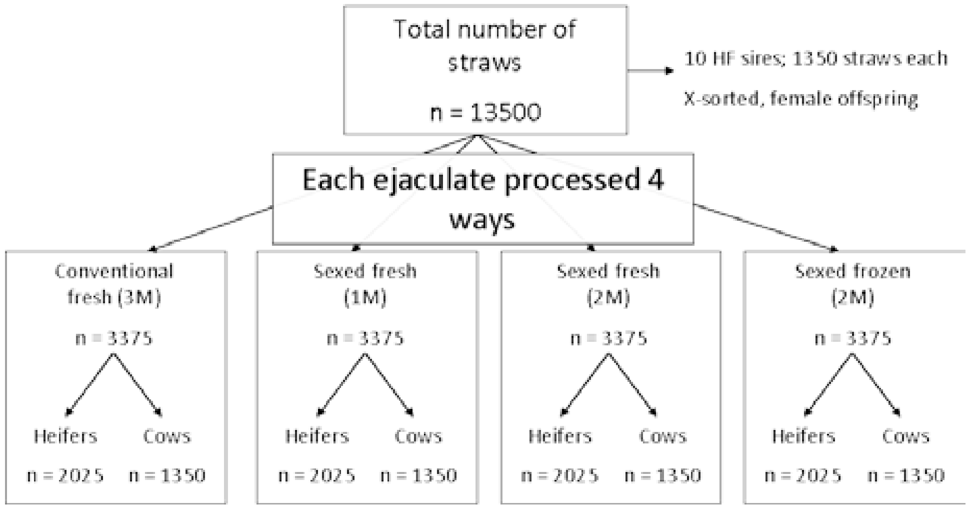

Figure 2. *Experimental design of the sexed semen field trial conducted during the 2013 breeding season. Two fresh sexed semen treatments and one frozen sexed semen treatment were compared against a conventional fresh treatment.*

The field trial will provide important information on the performance of both fresh and frozen-thawed sexed semen under Irish conditions. This information will be used to provide guidelines on the use of sexed semen in Irish dairy herds. Initial results from the trial will be presented at the Moorepark'13 Open Day, with full results confirmed after the cows involved in the trial calve down in February 2014.

Conclusions

Data generated from economic modelling work indicates faster, more profitable expansion using sexed semen compared with conventional. The field trial data will be used to develop a number of different strategies for sexed semen use to increase the efficiency and profitability of dairy herds.

The Next Generation Herd

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Summary

- The establishment of a *Next Generation Herd* represents a futuristic national herd, and a strategically important resource providing a "forward view" of the implications of high EBI herds under varying grazing intensities.
- The *Next Generation Herd* will allow the impact of selection for EBI on traits not currently included in the EBI to be quantified. This will further enhance the EBI, and provide more precise direction for sustainable genetic gain in the future.

Introduction

Exploiting genetic gain to achieve maximum profit will improve efficiency and competitiveness post-quota. Analysis of commercial farm data has shown that each €1 increase in herd EBI results in a €2 increase in profit/cow/lactation. The rate of increase in EBI has risen from €5/cow/year in the mid 2000's to €11/cow/year in 2011. By-passing the need to wait for daughter proofs, genomic selection has provided the industry with the potential to exploit genetic gain at a faster rate. The EBI of individual sires on the active bull list now exceeds €300, and this trend is set to continue.

With the EBI increasing at such a pace, we need to be confident that we are driving the EBI in the right direction. What will be the implications of a national herd EBI of €200? Will a €400 EBI sire provide progeny of true profitable advantage post quota? Will other economically important traits be compromised, e.g., environmental impact, milk quality, feed efficiency etc? In the past, intense selection for milk yield alone had disastrous consequences for fertility, due to the neglect of other traits of importance. To avoid repeating this mistake, we need to continually monitor and challenge the EBI, and to ensure continual long term genetic gain in a sustainable manner.

Teagasc's *Next Generation Herd* (NGH) has been established at the Dairygold Research Farm in Kilworth. The ELITE heifers will be compared to a group of heifers that represent the national average EBI (for heifers born in the same year, 2011). The research will involve detailed observations on genotype by stocking rate for routine performance traits such as milk production and composition, milk quality (somatic cell count and mastitis), fertility measurements, body-weight and body condition score as well as difficult to measure traits concerning milk processability, feed intake, energy balance, and methane emissions.

Next generation herd set up

The herd was assembled during 2012, with the purchase of maiden heifers, in-calf heifers and heifer calves from commercial dairy herds around the country, and animals from within Teagasc dairy herds. The primary goal is to validate the association between selection for EBI and animal performance (profit). For this reason the herd is made up of heifers of two distinct genetic groups: ELITE (extremely high EBI) and CONTROL (national average) heifers. The ELITE heifers makeup two thirds of the herd and have an average EBI of €234, putting them firmly inside the top one per cent in the country. Prominent sires represented within the ELITE group include SOK, IRP, WHS, BHZ and WGM. CONTROL heifers, have an average EBI of €116, in line with the average of heifers born in 2011. Commonly used sires represented within the CONTROL group include UPH, RXR, BYJ and WMZ. ELITE heifer calves purchased in late 2012 currently have an average EBI of €252; again, this is considerably higher than the average of €128 for dairy females born in 2012. The genetic merit of both lines in the *Next Generation* study herds is summarised in Table 1.

Table 1. Summary statistics of the NGH

Genotype	EBI	Sub-Indices						
		Milk	*Fert*	*Calving*	*Beef*	*Maint*	*Health*	*Manag*
ELITE	234	57	138	35	-12	13	0	2
CONTROL	116	38	59	28	-9	4	0	0

Heifers born in 2011, of appropriate genetic merit and genetic diversity (of varied ancestry), were identified from the ICBF national database. The ELITE heifers were required to have parent average EBI of greater than €175. The CONTROL heifers were identified on the basis of EBI approximating 'national average', with a production sub-index of approximating €40 (+/- €20) and a fertility sub-index approximating €60 (+/- €20), as per the national average for dairy heifers born in 2011. Owners were contacted and farms were visited. The heifers were visually inspected, genotyped and blood sampled to determine health status for a range of common infectious diseases. These included IBR, BVD, Salmonella, Neospora, Johnes and Leptospirosis. Only heifers with a negative disease status were purchased.

It was vital to maintain genetic diversity to allow the EBI to be disentangled from sire line effects. For example, of the 95 ELITE heifers on trial, 42 sires, 83 paternal grandsires and 27 maternal-grandsires are represented. Maintaining genetic diversity will also impact on the sire selection policy going forward. Unlike a commercial herd, a slightly unorthodox approach is employed to meet the somewhat conflicting criteria of maximising EBI while maintaining genetic diversity. A larger team of bulls than would ordinarily be recommended has been identified for use on the *Next Generation Herd*. The Sire Advice programme offered through the ICBF HerdPlus package has been used to assist with the process of allocating sires to each of the individual females in the herd. Common AI sires will be used on both lines to avoid any potential bias in fertility performance that could arise due to potential differences in semen quality.

Treatment groups

The *Next Generation Herd* is being evaluated across three seasonal grass-based management systems. The treatments are: 1) CONTROL SYSTEM with a target post grazing residual of ~4.5 cm, and a concentrate supplementation level of ~350 kg/cow, 2) HIGH CONCENTRATE SYSTEM with a similar post grazing residual and a higher concentrate supplementation level of ~1200 kg/cow, and 3) HIGH STOCKING RATE with a target post grazing residual of ~3.5 cm, with concentrate supplementation level similar to the CONTROL SYSTEM.

Early Results

Mean calving date in year one of the study (first lactation) is February 12. Early milk production data indicate differences in performance in line with that predicted by the breeding values. The indications are that milk volume, lactose concentration and live weight are similar for both genotypes, while both milk fat and protein concentrations are higher for the ELITE animals, resulting in higher milk solids output. The ELITE animals are also exhibiting a definite propensity to maintain higher body condition score.

Conclusions

The *Next Generation Herd* is a fundamental industry good research project that will provide clear and precise indications of the compatibility of the EBI with future management conditions. The herd will be valuable for collating new information on traits that will be of key interest in the future.

Replacement Heifer Rearing

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Summary

- Achieving target weight is critical in any successful heifer rearing programme.
- Heifer weight needs to be continually monitored to ensure they achieve target weight.
- Large variations in weight gains from different winter feeding diets exist.
- Higher weight gains are achieved from grass thus early turnout is a critical component in achieving target weight at mating start date.

Introduction

The cost of rearing a replacement heifer is €1,486. This includes a cost for an initial value of the calf and a charge for land and labour. When these costs are excluded the cost is €805. A substantial investment is required to ensure that the next generation of the lactating herd are reared to achieve target weights at key time points such as breeding and pre-calving. Heifers that do not reach their target weight tend not to achieve their potential milk production when they join the lactating herd.

Target weights

Bodyweight (BW) and body condition score (BCS) are of greater importance at mating start date (MSD) than age. Recently a Moorepark study gathered BW and BCS information at MSD from over eight hundred and seventy Holstein-Friesian (HF) heifers on 48 farms across the country. It was clear that age (i.e. calving at <24 months) does not effect calving date, survivability or subsequent milk production performance. Heifers that achieve target weight at MSD were more productive and are more likely to survive to second and third lactation and ultimately result in greater profitability. Thus, ensuring maiden heifers achieve target weight at MSD is of critical importance. Every heifer rearing program should have a target BW or proportion of mature BW at MSD. At Moorepark studies have shown that heifers should be mated at 55 to 60 per cent of mature BW should calve at 85 to 90 per cent of mature BW. A further target of 30 per cent of mature BW at six months of age can also be set. Based on this research target BW at three critical periods are outlined in Table 1 for the more popular dairy breeds.

Table 1. BW targets for maiden heifers at 6 months, breeding and pre-calving

	HF	NZFR*HF	NR*HF	J*HF
Six month BW (kg)	170	170	170	150
Maiden heifer BW (kg)	330	330	330	295
Pre-calving BW (kg)	550	550	550	490

HF = Holstein-Friesian, NZFR = New Zealand Friesian, NR = Norwegian Red, J = Jersey

Achieving target weights

The weight of replacement heifers needs to be continually monitored from weaning onwards. When heifers are brought back to the yard for dosing every six – eight weeks their size and if possible weight gain should be observed. Some lighter heifers may require concentrate during the summer months to ensure that they maintain similar weight gains to the rest of the herd. Prior to housing weanling heifers should be weighed and if necessary a group of the smaller animals can be assembled and given preferential treatment to ensure that they reach target weight at breeding the following spring. It is too late to discover that your heifers are below target weight four – five weeks before the start of the breeding season.

Table 2. Effect of diet on weight gain at different periods (kg/heifer/day)

(kg/heifer/day)	Silage only	Silage + 1 kg conc	Silage + 2 kg conc	70% kale + 30% baled silage	100% kale
Winter weight gain	0.30	0.44	0.65	0.47	0.48
Weight gain from turnout to breeding	0.82	0.68	-	0.89	0.88

Experiments at Teagasc Moorepark have shown that considerable variation exists in the weight gain achieved from different diets offered over the winter (Table 2). Kale has a high feeding value (1.05 UFL – similar to early spring grass), consequently heifers can achieve high levels of weight gain at a relatively low cost. There is no difference between kale, rape and a hybrid of kale and rape in terms of heifer weight gain over the winter period. However, forage crops are only suitable for drier soil types. Similar levels of weight gain can be achieved with grass silage and concentrate diets. Silage only diets support weight gains of approximately 0.30 kg/heifer/day. Therefore, if silage only is to be offered during the winter period heifers should be well ahead of target at housing as 0.30 kg/day is insufficient weight gain to achieve target weight at mating start date for heifers that commence the winter period at or below target weight.

Early turnout

Regardless of diet offered over the winter similar weight gains are achieved when heifers are turned out to grass in spring. As can be seen from Table 2 the weight gains achieved post-turnout are higher than that achieved during the winter. This clearly shows that heifers should be turned out to grass as soon as possible, as they can gain up to 1kg/day at grass compared to <0.70 kg/heifer/day while on their winter diet. Consequently heifers have a greater chance of attaining their target weight with early turnout.

Conclusions

Heifer weight gain should be continually monitored. Diet offered over the winter should be carefully chosen so that the anticipated over winter weight gain is sufficient to ensure that heifers will achieve target weight at the start of the breeding season. Heifers should be turned out to grass as soon as possible in spring to maximise weight gain prior to the start of the breeding season.

Rearing Healthy Calves

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Summary

- Feeding sufficient high quality colostrum to calves is vital to ensure they remain healthy and survive.
- Colostrum quality is greater:
  - » In cows in their third or greater lactation.
  - » When the interval between calving and milking is short (<9 hours).
  - » In early calving cows (January/February/March).
  - » In lower yielding cows (irrespective of lactation number).

Introduction

The 2013 spring calving season has finished and it is now time to assess where the weaknesses in your calf rearing system lie. It is an extremely important exercise to establish the number of calves that died and also what type of illness the calves suffered from and at what age these illnesses occurred. This will help indicate where improvements can be made in the calf rearing system for future years. On-farm studies have shown that calf mortality rate in Ireland, during the first six months of life, is approximately 10 per cent. In contrast, the mortality rate in Norway is only 3.7 per cent. This shows that there is considerable scope for improvement within Irish herds. Unfortunately, there is no quick fix solution; it's a case of doing the simple things correctly.

Colostrum management

Once a calf is born it is essential that it ingests sufficient colostrum (biestings), ideally from its own mother, within the first two hours of life to develop their immune system. The average 35 kg calf needs three litres of colostrum within two hours. It is also important that the colostrum the calf receives is of high quality. Good quality bovine colostrum is defined as colostrum which has an IgG or antibody concentration of greater than 50 g/L. A recent study completed at Teagasc Moorepark investigated the quality of colostrum produced by Irish cows. Samples were taken from 704 cows including spring and autumn calvers and cows of different breed (Holstein Friesian, Jersey, Norwegian Red, Jersey X Holstein Friesian cross breeds and Norwegian Red X Holstein Friesian cross-breeds).

The average IgG concentration was 112 g/L. Samples ranged from 13 to 256 g/L. In total, 96 per cent of the samples contained >50 g/L IgG. Only the colostrum collected at the first milking post-calving should be fed to newborn calves as this is when the IgG content of colostrum is greatest. In fact the IgG content of the colostrum or transition milk (i.e. milk collected after the very first milking) is over 50 per cent lower by the second milking and by the third milking the level of IgG is similar to that present in saleable milk.

Factors that affect colostrum quality

Lactation number

Heifers and second calvers had lower quality colostrum than cows in their third or greater lactation. Older cows are more likely to be exposed to a greater number of illnesses in their lifetime, which is the likely explanation for the increase in colostral IgG with increasing lactation number. However, only 10 per cent of the colostrum samples obtained from heifers were below the threshold of 50g/L. Therefore, on the basis of our findings, we would advise Irish farmers to disregard any previous recommendations to automatically discard colostrum from first lactation heifers, as it may be of high quality.

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Time interval from calving
Cows should be milked as soon as possible after calving to ensure high quality colostrum is collected. Colostrum quality is lower in cows calved over nine hours compared to freshly calved cows. The IgG concentration of colostrum collected between nine and 12 hours post-calving was reduced by 14 per cent to 106 g/L IgG compared to that of colostrum collected in the first three hours post-calving, while IgG concentration of colostrum collected between 18 and 21 hours post partum was reduced to 95 g/L IgG.

Month of calving
Spring-calving cows that calved in April produced lower quality colostrum than cows calving in the earlier spring months (Jan – Mar). Autumn calving cows also produced high quality colostrum. In general, the cows that calved in April had a longer dry period than cows that calved earlier and tended to become excessively fat. Having cows over-conditioned at calving has a negative effect on the immune system which may have been a factor in reduced colostrum quality in April calving cows.

Quantity of colostrum produced
Generally the more colostrum produced the lower the quality – the IgG concentration decreases by 1.7 g/L with each kilogram increase in yield of colostrum. This is possibly due to a dilution effect as colostrum volume increases as time from calving increases.

Feeding colostrum to the newborn calf
The following guidelines are a simple way of ensuring that absorption of the antibodies (or IgGs) from colostrum is maximised and the calf's immune system has the best chance of developing satisfactorily.

- Only use the **first** milk collected from the cow
- Feed within **two** hours of birth
- Feed **three** litres of colostrum

As explained above the first milking has the highest concentration of IgGs. The ability of the calf to absorb IgGs from colostrum starts to drop two hours after birth so the earlier the calf receives colostrum the better; by the time the calf is 24 hours old its ability to absorb IgGs has ceased completely. Three litres is the ideal amount of colostrum for a Holstein Friesian calf weighing 35 kg at birth - this should be reduced for smaller calves such as Jersey x Holstein-Friesian (8.5 % of birth weight is a quick rule of thumb to ensure calves receive a sufficient volume of colostrum).

Calf Mortality – Latest Results from Moorepark Research

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Summary

- The primary causes of calf deaths are problems at calving, not before or after calving.
- The main calving problems currently contributing to calf losses are prolonged calvings, malpresentation calvings and hard calvings, in that order.
- There was a surprisingly high incidence of abnormal calves in this three-year study.

Introduction

There have been no recent studies on why calves are dying in our dairy herds. This paper presents salient results from a recent large scale research study at Moorepark on calf losses in commercial dairy herds. It was conducted before the appearance of Schmallenberg virus in Ireland; see separate paper in this booklet on the effects of this virus on calf losses.

Recent research work at Moorepark

This is a collaborative study with the Department of Agriculture, Food and the Marine (DAFM) Vet Labs in Cork and Backweston and with UCD. The work involved thirty Munster dairy farmers submitting all calves which died within two days of calving for examination at the Post-Mortem Laboratory in Moorepark. Over 650 calves were examined during the three years. This is the largest study of this type internationally.

Study results

This research project has diagnosed numerous individual different causes of calf death, as every calving is different so every calf dies under different circumstances. However, these many causes were reduced into a smaller number of categories; these are listed in detail in Table 1. These results highlight the fact that calves no longer die just because of hard calvings as in the past when more beef sires were used in dairy herds. Some 85 per cent of the calves which died around calving were alive at the start of calving; much of this loss is preventable. The majority of calves (80 %) died within one hour of calving. When the largest, combination cause of death category (Table 1) was disaggregated, the two most frequently diagnosed categories of calf death were calving problems (49 % of calf deaths) and anoxia at normal calvings (13 %). This brief paper will focus on the results for these important causes of calf loss.

Calving problems

When the most common cause of death category, calving problems, was examined further it was found that the most prevalent factors were prolonged calvings, malpresentation calvings and traumatic calvings, in that order. In slow calvings the calf died during the prolonged calving due to lack of oxygen and not due to traumatic injuries. The second most common calving problem was calvings where the calf or calves was/were presented wrongly. The most common malpresentation was one or both fore legs back (48 % of cases). The third most common calving problem was hard calvings where there were significant injuries to the calf, e.g. 10 per cent of calves had fractured ribs. Interestingly, fewer calves were born at difficult calvings (33 %) than at unobserved (39 %) calvings. The fact that hard calvings contributed to less calf loss than prolonged calvings is a surprising finding and reflects a change in management practices within dairy herds today. In difficult calvings involving a deformed calf the latter may have been very large at birth (e.g. 'waterbelly' calves) or were so deformed that they were difficult to extract. The high incidence (24 %) of abnormal calves in this study was a surprising finding. Hence current research at Moorepark with colleagues in Grange, DAFM, ICBF and UCD is examining the causes of congenital defects in Irish calves with the ultimate aim of developing a national register so that genetic defects can be identified early.

Table 1. Causes of calf mortality around calving; results from a three year study of 680 calves

Cause of death (alphabetical order)	2010	2011	2012	Total	Rank*
Accident	1	0	3	4	9
Combination of causes	81	89	94	264	-
Congenital defect	9	4	5	18	5
Dystocia	57	63	63	183	1
Eutoxia	13	16	11	40	2
Haemorrhage or anoxia	6	11	3	20	3
Hypothermia	0	0	1	1	10
Infection	8	7	5	20	3
IUGR	2	2	3	7	7
Iodine imbalance	3	3	0	6	8
Premature placental separation	9	6	4	19	4
Prematurity	2	8	5	15	6
Unexplained	26	37	20	83	-
Total	**217**	**246**	**217**	**680**	**-**

*excludes combination of causes and unexplained cases

Anoxia at normal calvings

In cases of anoxia (suffocation) at normal calvings the early stages of calving may have been disturbed and delayed, the placenta may have begun to separate early or the umbilical cord may be twisted, entangled or compressed for an unduly long time during an apparently normal or unobserved calving. A typical sign of hypoxia during calving was meconium staining of the hair coat, present in 18 per cent of calves.

Conclusions

Calf losses occur even on well run dairy farms. The most common causes of death in this study involved problems at calving, not before or after calving. This research indicates that the main calving problems causing calf losses on dairy farms today are prolonged calvings, difficult calvings and anoxia at normal calvings, in that order. A surprisingly high incidence of abnormal calves was detected in this study.

Schmallenberg Virus and Calf Mortality

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Summary

- Schmallenberg virus (SBV) was first detected in Ireland in October, 2012.
- The virus causes abortions and deformities in calve.
- A survey of Munster dairy herds in spring 2013 found that the majority of the deformed calves were malpresented and this caused serious calving problems.
- The most common deformity was arthrogryposis (fused leg joints) and the most common malpresentation was calves presented backwards at calving.

Introduction

The focus of this paper is on Schmallenberg virus (SBV) and its effects on calf mortality. The virus was first identified near the town of Schmallenberg in Germany in November, 2011. It very rapidly spread across Europe and was first identified in Ireland a year later in Cork in October, 2012. The virus is transmitted by insects; biting midges and mosquitos, which are currently thought to be active from April to November. In non-pregnant cattle the impact is limited; fever, off feed, reduced milk yield or scour. However, if cows are infected during early or mid pregnancy they may abort or give birth to a deformed calf. It is estimated that the critical period for infection during pregnancy is between 40 and 120 days.

Signs of SBV infection

The affected calves may have skeletal or brain abnormalities. Skeletal defects include bent legs with fixed joints (arthrogryposis), stiff or wry neck (torticollis), curved spine (scoliosis) and shortened lower jaw (brachygnathia). These deformities may cause calving problems. Brain defects include a small brain (cerebral or cerebellar hypoplasia or hydranencephaly) and nervous system signs, e.g. 'dummy' calves, blindness, poor balance, unable to rise or suck and sometimes fits.

Moorepark SBV survey

During the spring calving season of 2013 a survey was carried out on some 5,500 calves born on 35 dairy farms in Munster. All calves which died around birth in these herds were examined post-mortem. Diagnosis was made on the basis of laboratory testing and calves with two or more of the lesions characteristic of SBV infection: arthrogryposis, torticollis, scoliosis, cerebral or cerebellar hypoplasia or hydranencephaly and brachygnathia. A total of 251 calves which died around calving were examined.

A third of the farms (31 %) had at least one affected calf. The number of affected calves per farm was small (1-4). It is estimated that less than 0.5 per cent of all calves born were affected but approximately 7 per cent of all calves which died were affected. These calves were born around full-term (270-304 days of gestation) between February and April. This indicates that they were conceived in May-July and probably infected in July-November, 2012. Over half of the calves (55 %) were from stock bulls. All ages and breeds of cows and both singles and twins from numerous sires were affected.

Problems at SBV calvings

Even though the affected calves were much smaller than normal (on average, 19 kg, 9-33 kg), the majority of their calvings needed assistance (83 %) and in two thirds of cases a difficult calving resulted. The primary reason for this was the skeletal abnormalities and the very high incidence of malpresentations at calving (72 %). In particular, an unusually high incidence of calves coming backwards was detected (61 %). These problems resulted in severe traumatic injuries (fractured ribs, legs, and spine) in two-thirds of affected calves due to hard calvings.

SBV deformed calves

The most common deformity was arthrogryposis (fused leg joints). This was seen in all affected calves and in the majority of cases (83 %) involved all four legs. The next most common deformity was torticollis (bent neck), seen in 78 per cent of cases. The neck was bent back, to the side and up, back and to the side, to the side only or upwards only. Approximately three quarters of calves (72 %) had rotated legs, usually inwards. Deviations of the spine were seen in two thirds of calves, usually upwards but sometimes upwards and to the side. Internally, the most common defects were an underdeveloped brain in two thirds of calves, a small hind brain in 61 per cent of calves and underdeveloped lungs in 44 per cent of cases. All of these defects are lethal.

Figure 1. *Deformed calves due to SBV infection are more likely to be malpresented at calving*

Implications

The results of this survey suggest a relatively high percentage of herds in Munster were infected last summer/autumn but that in infected herds the number of affected calves was small. If these results are replicated nationally, the very high number of malpresented calves indicates the need for close monitoring of calvings in infected herds to avoid further welfare problems and losses due to calving difficulties.

Control of SBV

Now that the world's first vaccine against SBV infection has just become available in Ireland (Bovilis SBV), discuss its use in your herd to prevent infection in your cattle with your local veterinary surgeon.

HARVESTING HIGH QUALITY MILK

Guidelines on Using Cleaning Products and Avoidance of Harmful Residues in Milk

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Summary

- Ineffective cleaning or issues with chemical residues in milk can occur if the detergent is not mixed at the recommended levels.
- The cleaning product chosen should be based on the washing procedure applied.
- Cleaning solutions containing chlorine (detergent-steriliser) should be rinsed from the milking system immediately after the main wash cycle, while the stain of non-chlorine cleaning solutions should be left in the plant between milkings.
- Powder detergent or liquid detergent-steriliser solutions may be reused on one occasion.
- Higher product usage rate is required with cold cleaning.
- Use at least 14 litres/unit (3 gals) to rinse out both milk (before the main wash) and detergent (after completion of the main wash).

Introduction

Proper cleaning of the milking machine is crucial to producing milk with satisfactory TBC (10,000 -15,000 cells/ml in the bulk tank at milk collection). Furthermore, there is a direct link between milking machine cleaning procedures and chemical residues. Products chosen for use on dairy farms should be labelled with the following information (i) identity and content of active substances; (ii) instructions on usage; (iii) manufacturer details; (iv) date of manufacture; and (v) PCS number. To legally distribute a steriliser product in Ireland the product must be registered with the Department of Agriculture Food and Marine. Using unregistered products for cleaning equipment may have implications for farmers in a cross compliance check. The compositional ingredients, usage rate and water temperature used with that product, with sufficient rinsing of equipment are the most important parameters in maintaining a high hygiene equipment standard with absence of residues.

Composition of cleaning products

Hot wash cleaning

Liquid detergent-steriliser products used for cleaning milking machines and bulk tanks contain varying levels of caustic, chlorine, surfactants and sequestrants. Caustic (sodium hydroxide) acts as the cleaning/detergent agent and chlorine (sodium hypochlorite) acts as the steriliser. Surfactants and sequestrants are wetting agents and an aid to water softening which are added to all detergent and detergent-steriliser products. The levels added to cleaning products can influence the effectiveness of individual cleaning products, especially in hard water situations. The products chosen for cleaning should be determined by the washing procedures in place.

A review by the International Dairy Federation has indicated a normal caustic working solution in detergent/sterilizers as between 200 and 800 ppm. Therefore, it could be expected that products containing less than 10 per cent caustic will be within this range and give satisfactory cleaning where hot water (65 – 75^{0}C) is used for the main wash cycle, the solution is not re-used for a subsequent wash or if combined with daily acid cleaning. A relatively high concentration of caustic (>15 %) in a detergent-sterilizer product will allow for lower usage rate while still achieving effective cleaning. Typical usage rates of such a product in New Zealand (200 ml/50 litres) are considerably lower than the rate generally applied in Ireland (400 ml/45 litres); however, hot water is used twice daily and detergent is not recycled for the subsequent milking. Therefore, lower product usage rates can be applied when hot water is used as part of the cleaning process. The preferred chlorine content within a detergent-steriliser product is <3.6 per cent, and this will adequately give working solution strength of 200ppm chlorine which is considered sufficient for satisfactory cleaning. Non-chlorine powder products which were traditional used for cold cleaning are very effective when used with hot water. Use of night rate electricity is a cost effective way of heating water for equipment cleaning.

Cold wash cleaning

While detergent-steriliser products are most effective when used with hot water, if intended to be used in a cold water solution and/or recycled at the next cleaning time then a product containing greater than 10 per cent caustic (working solution >800 ppm) would be required. However, increasing the usage rate of low caustic detergent-steriliser products to achieve the correct caustic working solution will automatically increase the working solution of chlorine in the wash solution and this can have a negative effect on chlorine residues. In situations where powder or liquid caustic only based detergents (non-chlorine) products are used, a working solution greater than 2000 ppm is recommended for cold caustic cleaning. The addition of chlorine to an existing detergent-steriliser wash solution is considered unnecessary or the inclusion of chlorine in a pre-milking rinse should be avoided to reduce the possibilities of residues. A higher working solution of chlorine (300ppm) may be required when cold water is used daily. However, chemical residues are more likely to occur if high working solution strengths of chlorine are used, in particular where inadequate rinsing is carried out (a minimum of 14 litres/unit rinse water). The product usage rate (working solutions) required with cold cleaning is approximately double that as compared to when hot water is used for cleaning.

Washing routine guidelines

Regardless of the composition of cleaning products or the wash routine chosen, if the detergent is not mixed at the recommended levels then ineffective cleaning or issues with chemical residues in milk can occur. Adequate post-milking rinsing (14 litres/unit) to remove all traces of milk from the plant is critical to avoid milk coming into contact with the wash solution as this contact can render the detergent ineffective and increase the likelihood of residues. Similarly, rinsing of the cleaning solution is equally important from the point of view of residues. Choosing a routine that does not include chlorine will reduce the likelihood of chlorine residues. Liquid non-chlorine products contain much lower levels of caustic (<27 %) than powder products (76 %). In situations where liquid caustic only products are used, more regular acid cleaning and no recycling of the solution are advised. Four milking equipment wash routines used in Ireland have been defined. The routines include: Hot Detergent-steriliser cleaning; Cold cleaning; Non-chlorine cleaning; Hot Detergent-steriliser/acid cleaning.

Conclusions

Teagasc has analysed a wide range of products used for the cleaning of milking equipment. The chemical content, working solutions and registration status of these products are available on the Teagasc dairy webpage. In addition to this list, guidelines on the effective use of cleaning products, washing procedures and a video link on good herd milking management practise and are also available. **http://www.agresearch.teagasc.ie/moorepark/milkquality**.

Labour Efficient Milking

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Summary

- The milking process is a function of the interaction of three key elements - cows, people and facilities and all three elements must interact well.
- Choices of alternative milking infrastructure depend on herd size, preferred pre-milking routine, desired milking time, and available capital for investment.
- Greater throughput in larger parlours is associated with a decrease in operator idle time.
- Milking parlour output can vary from 42 to 129 cows/hour (1-2 operators) depending on the efficiency of the milking equipment, pre milking routine, and operator ability.
- Over-milking should be limited to two minutes, which has implications for milking management in large parlours.

Introduction

Milking the dairy herd is the most time consuming task on pasture-based dairy farms and requires 33 per cent of total labour input. As herds expand, efficient milking parlour performance is critical to permit increased farm labour efficiency. Yet, to-date there has been limited field evaluation of parlour efficiency. The most common type of milking parlour in pasture-based systems is the swing-over herringbone, accounting for 91 per cent of the milking parlours in Ireland. The swing-over herringbone is popular due to its lower investment costs relative to other parlour types (e.g. double-up herringbone, rotary) and for ease of adding extra units in the future. However, all milking parlours represent a significant capital investment, and therefore, careful consideration is required when selecting the appropriate number of milking units.

Recent research studies conducted at Moorepark

Factors influencing milking performance

The effect of milking cluster number, pre-milking routine and stage of lactation on milking row time, over-milking and operator idle time were measured. As cluster number increased, row time and duration of over-milking increased while operator idle time was reduced. The type of milking routine practiced largely dictates the number of clusters one operator can manage and the overall efficiency of the milking operation. When clusters were attached to cows with minimal teat preparation, one milking operator could manage 22 milking clusters without experiencing over-milking of longer than ~2 minutes in the absence of automatic cluster removers (ACRs). The presence of ACRs would allow 26 clusters to be managed due to the ACRs eliminating over-milking especially in late lactation. Alternatively, when a full pre-milking routine (spray, strip, wipe and attach clusters) was applied throughout lactation, milking cluster numbers of 14 (early lactation) or less (late lactation) may be operated without experiencing over-milking of longer than ~2 minutes in the absence of ACRs. While ACRs would prevent over-milking with increased milking cluster numbers, such additional units in this scenario would not allow significantly greater cow numbers to be milked within a specified time of ~2 hour, as the pre-milking routine is the limiting factor. While minimum unit numbers reduce capital investment, guidelines have indicated that it is increasingly difficult for the operator to remain focused if milking more than 10 rows of cows per milking.

Effect of over-milking on teat-end hyperkeratosis during late lactation

The effect of over-milking for various durations on teat condition, as indicated by hyperkeratosis was examined in late lactation. This was achieved by assessing the effect of four end of milking criteria on 181 spring calving, mixed age Holstein-Friesian cows, at on average 217 days post-calving, over a six week period. The four treatments were: 1) remove cluster once milk flow rate fell to 0.2 kg/minute plus 5 (0 minute over-milking); 2) plus 120 (2 minute over-milking); 3) plus 300 (5 minute over-milking); 4) plus 540 (9 minute over-milking). Teat-end hyperkeratosis score was assessed at week 0, 3, 5 and 6 of the study. At week six, mean teat-end hyperkeratosis score of the two minute over-milking treatment was similar to that of the zero minute over-milking treatment, whilst that of five minute over-milking was worse than two minute over-milking, and nine minute over-milking was worse than both five minute over-milking and two minute over-milking. Milk production and SCC were nonetheless not different between treatments. Results indicated that in order to minimise changes in teat-end condition, over-milking should be limited to two minutes, which has implications for milking management in large parlours not fitted with ACRs.

Evaluation of milking efficiency in commercial farms with swing-over herringbone parlours
Milking data were collected to evaluate milking efficiency over a range of parlour sizes (12-32 milking units). Data were collected from 19 Irish farms equipped with electronic milk meters and herd management software that recorded data at individual milking sessions. Cow throughput per herd and milking performance increased with increasing parlour size (12 to 32 units), with throughput ranging from 42 to 129 cows/hour and milking performance from 497 to 1,430 kg of milk/hour (1-2 operators) (Table 1). Greater throughput in larger parlours was associated with a decrease in operator idle time. Operator efficiency varied between farms and depended on milking routines in use. Both milking routines and operator idle time require consideration when sizing parlours so high levels of operator efficiency as well as cow throughput can be achieved simultaneously.

Table 1. Milking efficiency values of 19 farms with swing-over herringbone parlours of different sizes

	Parlour size (units)					
	12	16-18	20	22	24	30-32
Average herd size	45	91	115	86	237	169
Cow throughput (cows/hr)	42	82	94	88	106	129
Operator efficiency (cows/operator/hr)	43	72	71	88	76	95
Milking performance (kg/hr)	497	950	1098	1187	1231	1430
Operator milking efficiency (kg/operator/hr)	521	833	810	1187	880	1031

Conclusion
Over-milking should be limited to two minutes, which has implications for milking management in large parlours not fitted with ACRs. Milking parlours are run most efficiently when the milking equipment and labour are balanced. The milker should not be waiting for the milking equipment (e.g. cluster) to become available and the equipment should be fully utilised, not idle and waiting for the milker to catch up.

CellCheck-the National Udder Health Programme

Finola McCoy
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- Poor udder health will restrict opportunities for expansion in Ireland.
- CellCheck is a multidisciplinary and collaborative programme, involving all relevant industry bodies.
- CellCheck is providing the knowledge, tools and support to enable farmers to take control of mastitis in their herds.
- CellCheck is not new science, but allows existing science to be used in a new way.

The expected abolition of milk quotas in 2015 will offer Irish farmers an opportunity for expansion. However it will also result in Irish dairy farmers facing a less regulated global trading environment with more price volatility than before, and an ever-increasing demand for higher standards of milk quality. Superior animal health and milk quality has an important role to play in ensuring competitiveness, meeting consumer demand and improving profitability. Previous research in Ireland, such as the €uroMilk pilot mastitis control programme, identified inconsistent advice, a lack of a coordinated or "joined up" approach to mastitis control and a "normalisation" of high herd SCC as some of the obstacles at farm level, to improving udder health. A coordinated approach to improving udder health, such as that provided by CellCheck, will provide many benefits for the Irish dairy industry, and individual farmers. The overall objective of the CellCheck programme is to enable the dairy industry to maintain a national average bulk milk somatic cell count of 200,000 cells/mL or less by 2020. The programme has the following objectives:

- setting goals
- building awareness
- establishing best practice
- building capacity
- evaluating change

The CellCheck programme is delivering on these through a range of activities, as follows:

Monthly articles

Monthly articles appear in the Irish Farmers Journal on the first Thursday of every month, building awareness of the CellCheck programme and the value of improved udder health, as well as providing key practical advice. The articles are also available through the Teagasc Management Notes, co-op newsletters, vet clinic newsletters and the CellCheck website.

CellCheck Farm Guidelines for Mastitis Control

The ***CellCheck Farm Guidelines for Mastitis Control*** contain independent, evidence-based information, providing clear, consistent messages. They are a practical management and advisory tool for farmers and service providers alike, based on national and international scientific research and best practice in mastitis control. They are available to purchase from your local co-op or veterinary clinic for €15.

CostCheck

Based on recent Teagasc economic research, this interactive mastitis cost calculator allows the farmer to see the financial benefits of lower SCC by quantifying the financial gain that can be achieved by reducing SCC from current levels to a given target level. ***CostCheck*** can be found on **www.cellcheck.ie** and **http://www.agresearch.teagasc.ie/moorepark/**.

Regional coordinators
To date, seven co-op representatives are working with CellCheck as regional coordinators. Their role is to be a local point of contact and information on the CellCheck programme, and to coordinate CellCheck Farmer Workshops, along with local service providers. They are based in the following locations:

- **PAUL CULLINAN** *(Connacht Gold)* Mayo/Sligo/Galway
- **TOM DOWNES** *(Lakelands Co-op)* Longford/Monaghan/Louth/Meath
- **BRENDAN DILLON** *(Glanbia)* Kilkenny/Laois/Kildare
- **TOM STARR** *(Arrabawn Co-op)* Tipperary/Limerick
- **PADDY COYLE** (*Connacht Gold)* Donegal
- **JOE MORIARTY** *(Kerry Agri-business)* Kerry/Limerick/Clare
- **SINEAD TREANOR** (*Carbery Group)* West Cork

Contact details are available on **www.cellcheck.ie**

Service provider training
CellCheck is providing training opportunities for all service provider groups – vets, farm advisers, dairy co-op milk quality advisers and milking machine technicians – to work together to provide farmers with a consistent and complete approach to mastitis control. Over 220 people have attended Stage 2 training, designed to enable service providers to effectively deliver workshops, as part of a multi-disciplinary team.

CellCheck Farmer Workshops
The objective of these workshops is to explore the causes of mastitis and highlight how making simple changes in everyday milking routines can improve and maintain lower SCC levels in your herd. The workshops are delivered by teams of four trained local service providers-a farm advisor, a vet, a milking machine technician and a co-op milk quality advisor. Each workshop is three hours in duration; it is a farm-based workshop with a mixture of interactive, classroom-style learning, practical workstations and group discussion. Group sizes are small (max 15 farmers), and the cover charge of €30 per farmer contributes to the cost of delivery. To participate in a CellCheck Farmer Workshop, contact your farm advisor, vet or milking machine technician. Alternatively, contact the regional coordinator for your area for details of regular workshops being held around the country throughout 2013.

CellCheck Farm Summary Report
The ***Farm Summary Report*** has been developed by ICBF and members of the CellCheck Technical Working Group. This milk recording report provides you with a clear overview of how your herd is performing in the area of mastitis control and udder health. It shows if a herd is on, above, or below target. It highlights the areas of excellence, and directs you towards areas that may require further attention.

Reducing Dairy Energy Costs

John Upton[1] and Tom Ryan[2]

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Summary

- The average cost of electricity measured on 22 commercial dairy farms was 0.51 cent per litre of milk produced. There is large variation in energy costs on dairy farms, from 0.26 cent/litre up to 0.89 cent/litre.
- The main drivers of energy consumption on dairy farms are milk cooling (31 %), the milking machine (20 %) and water heating (23 %).
- The average farm in this study could save €1,800/year through a combination of altered management strategies and energy efficient technology.

Introduction

Efficient use of energy is one way to improve the cost competitiveness of the Irish dairy sector. At this moment, electricity costs on Irish farms are around four per cent of milk production variable costs, but they are expected to increase in the short to medium term due to rising global energy prices. Understanding and reducing electricity costs will have the potential to reduce overall energy use and reduce production costs.

On-farm energy audit results

Energy audits carried out as part of the Dairyman project on 22 commercial dairy farms over 12 months in 2011 provide an insight into the main areas of electricity use. These are milk cooling (31 %), the milking machine (20 %), water heating (23 %), other equipment (18 %), water pumping (5 %), and lighting (3 %). The average cost of electricity for the farms in this study was 0.51 cent/litre, with the minimum being 0.26 cent/litre and maximum 0.89 cent/litre. The average herd size was 118 cows but the study included farms ranging from 47 to 290 cows (see Table 1).

Table 1. Electricity consumption per litre of milk on 22 farms including cost of electrical energy and tariff distribution profile by percentage of day rate tariff usage

	Electricity consumed (Wh/L) [1]	Cost of electricity (€ c/L) [2]	% day tariff [3]
Milk cooling	13.02	0.16	60
Water heating	9.83	0.11	45
Milking	8.44	0.11	71
Lighting	1.37	0.02	89
Other	7.54	0.10	69
Water pumping	2.13	0.03	38
Total	**42.34**	**0.51**	**62**

[1] Wh/l = Watt hours/litre, [2] € c/l = Euro c/l of milk [3] Percentage of electricity consumed from 9 am to 12 midnight

Assessing energy costs and energy tariffs

A simple calculation can be made to approximate on-farm electricity costs. Firstly add up the total electricity charges over a year excluding standing charges, VAT and PSO levy, these figures can be found on the electricity bill. Multiply by 100 to convert from euro to cents. Next add up the total number of litres of milk sold to the processor over the same period. Dividing the electricity cost in cents by the number litres will give the cost in cent per litre. The average three bedroom house in Ireland uses approximately 5,000 units of electricity per year, this could be deducted to account for domestic usage if the dwelling house in on the same meter as the farm.

Checking your pricing and tariff structure against the best available rates can also yield significant savings. This can be done using a pricing comparison website such as **www.bonkers.ie**. All you need is information about your present tariff, annual usage and night rate usage in order to make comparisons and calculate possible savings. If you decide to switch suppliers it is important to read the small print. Check the standing charges and termination charges.

Potential for reducing costs

Energy costs can be reduced in two ways. Firstly by using more night rate electricity (from 12 midnight to 9 am) or moving electricity supplier to avail of lower unit rates.

Analysing the results of the Dairyman audits showed that the average farm in the study could save €500/year by moving to the most competitive supplier and €170/year by adjusting the night rate timer correctly. There is no investment cost involved in these changes.

The second way of reducing energy costs is to reduce total electricity consumed through the use of energy efficient technology. By implementing energy efficient technologies on the milk harvesting equipment substantial savings can be realised because 80 per cent of all electricity consumed on the farm is used in the milking parlour. However an upfront investment cost will be incurred to purchase and install the energy efficient equipment. The time taken to recover this cost is an important factor in deciding whether or not to invest. The simple payback method is a useful tool to quantify the length of time taken (in years) for the energy efficient technology to pay for itself through the resulting energy savings.

Good examples of these energy efficient technologies are: 1) the application of a Variable Speed Drive (VSD) on the vacuum pumps of the milking machine which would save €460/year, with a payback of seven years, 2) a solar thermal system for preheating water would save €350/year with a ten year payback, 3) improving the efficiency of the milk cooling system by increasing the milk to water flow ratio of the plate cooler from 1:1 to 2:1 would save €350/year with a seven year payback.

By making all of the changes described above, a permanent saving of €1,800/year could be achieved, recovering all investment costs in six years.

Conclusion

This study identified a number of areas where improvements can be made to reduce energy costs through simple management changes and through the application of suitable energy efficient technologies. Total farm energy costs can be calculated without specialised equipment. Farms with high energy costs have more to gain by improving their energy efficiency.

Reducing Thermoduric Bacterial Counts in Milk

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Summary

- Thermoduric bacteria are organisms capable of surviving pasteurisation which can carry over into product causing quality defects.
- Thermoduric bacteria are widespread in the farm environment, e.g. soil/faeces.
- The major routes of entry of thermoduric bacteria into milk are dirty cow teat surfaces, poor parlour hygiene, and poorly washed milking machine equipment.
- Milk payment penalties are applied when thermoduric counts exceed 1,000 cfu/ml.
- Thermoduric levels in milk may be minimised by: presenting clean cows for milking, replacing cracked milking machine rubberware, using correct equipment cleaning products, regular plant hot washes (75-80ºC), and weekly equipment acid descale.

Introduction

Production of high quality milk is essential, to produce premium dairy products with minimum bacterial contamination to meet customer specifications. Although most bacteria in raw milk are non-pathogenic and are generally destroyed by pasteurisation, a specific group of bacteria know as thermoduric bacteria have the capability to survive pasteurisation. Thus, close monitoring of thermoduric bacteria is crucial to maintain consumer confidence in the quality of milk produced and is of increasing interest to milk purchasers and processors. Thermoduric bacteria can limit the shelf life of milk, can produce off flavours, and pose a significant threat to the processing of infant feed formula. Reducing the initial count of thermoduric bacteria on-farm is essential as reducing the thermoduric counts at processing level is costly and can cause further defects to the finished product due to the severity of the heat treatment required.

Sources of thermoduric bacteria

Silage, faeces, used animal bedding and soil contain large numbers of thermoduric bacteria and are the most important sources of thermoduric bacteria in raw milk. It is impossible to exclude them completely from milk, but the challenge however, is to keep numbers entering raw milk to a minimum. On pasture the main source of contamination is soil while when housed the main source of contamination is poor-quality silage, faeces and used bedding. Cubicle bedding material, in particular sawdust has been identified as a significant source of thermoduric bacteria. Cows subsequently walking or sitting on the bedding material will become contaminated. Maintaining clean cubicles and passageways, and feeding good quality silage are absolute requirements.

Transfer of thermoduric bacteria into milk

Teat surfaces contaminated with thermoduric bacteria mean that these bacteria can be readily transferred to the milk during milking. Recent trials at Moorepark have shown that teats can be become contaminated with ***Bacillus cereus*** when cows rest on bare pastures or walk on soiled roadways especially during periods of wet weather. Thus, the first and most important step is to ensure cow teats are clean prior to cluster application. This can be achieved through good husbandry i.e regular clipping of tails and good pre-milking teat preparation practises. Washing teats alone is not effective in controlling contamination of milk with thermodurics, and in fact may lead to increased contamination due to mobilisation of deposits from the teat surface into the milking cluster. Washing teats with water and drying with individual paper towels has been demonstrated at Moorepark to be the minimum treatment required in order to prevent significant contamination of milk with thermodurics. Pre-milking teat disinfection with a registered product, followed by drying with individual paper towels, has also been shown to be effective in reducing a range of bacteria on teat surfaces.

Contamination via milking machine and prevention steps
Milk contamination with thermoduric bacteria from teat surfaces will, in turn, contaminate milking machine clusters, milk receivers, milk pipelines and bulk tank. Biofilm formation on pipelines due to inadequate plant cleaning and disinfection will contribute to high bacterial counts in subsequent milkings. Contamination will build-up on equipment surfaces, particularly in hard to clean areas, such as pipeline joints and dead ends. Acid descalers should be used to prevent any build up of mineral deposits on equipment surfaces as these deposits facilitate the growth of thermoduric bacteria. At minimum a weekly acid wash should be carried out for milking equipment including the bulk milk tank. In recent trials at Moorepark the lowest thermoduric counts were observed in bulk tank milk where hot water (75-80ºC) and acid cleaning was carried out daily. Water itself can be a source of contaminating bacteria, and water used in any part of the milking process must be of bacteriologically potable quality. The inclusion of a disinfectant such as peracetic acid to an additional plant rinse has been shown to be effective in reducing bacterial levels in milk when used at least one hour before milking. It is especially beneficial where the microbial count of a farm water supply is considered unsatisfactory.

- Other factors that can influence the levels of thermoduric bacteria in milk:
  - Washing of clusters, while still attached to teats.
  - Washing down the cow platform/while cows are still present.
  - Transferring unclean clusters from cow to cow at milking.
  - Not replacing old rubberware.
  - Incorrect equipment cleaning procedures.
  - Unclipped cow tails with dirty flanks and udders.
  - Slow cooling of milk and extended storage time.
  - Uncovered parlour feed bins.

Conclusions
Thermoduric bacteria are widespread in the farm environment and major routes of entry into milk are: Dirty cow teat surfaces, incorrectly cleaned milking equipment, contaminated water supplies, and poor parlour hygiene. Therefore greater care is required to ensure hygienic milking conditions especially in the late summer and the housing period so as to obtain thermoduric numbers within specification of less than 1000 cells per ml of milk.

Reducing Chemical Residues in Milk

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Summary

- Higher specifications for milk quality parameters including residue concentrations are required by export markets.
- Trichloromethane (TCM) levels in butter must be ≤ 0.03 mg/kg for export markets.
- Milk iodine levels must be ≤ 250 μg/l milk in order to meet specifications in specific product export markets.
- Up to 90 per cent of flukicide residue can be transferred from milk to milk powder during processing.
- The risk of quaternary ammonium compounds (QAC) residue in dairy products require further investigation.

Introduction

Dairy products must meet the quality standards required by customers, e.g. supermarket chains and export markets. The source of concern with regard to residues may be human health, export regulations or interference with the manufacturing process where, for example, yoghurt and cheese starter cultures are inhibited. The residues receiving most attention at present are TCM, iodine, flukicides and QAC.

Trichloromethane (TCM)

Trichloromethane is a chemical residue that can occur in milk and maximum levels are specified for products, such as butter. An industry-funded project at Teagasc has addressed this issue in recent years and significant progress in reducing TCM levels in butter has been achieved. There has been a gradual reduction of TCM in butter from 0.07 mg/kg in 2007 to the target of 0.03 mg/kg in 2011 and this level has been maintained in 2012 and 2013. This was achieved through farm visits to identify incorrect practices allied with a vigorous advisory campaign through Teagasc and the dairy companies and, most importantly, an intensive analysis programme. Routine screening for TCM is now conducted on up to 25,000 tanker and individual supplier milks annually.

TCM is derived from a reaction between chlorine in the detergent used to wash milking equipment and milk stain remaining on the machine or bulk tank. The TCM develops within the detergent solution and accumulates as the detergent is re-used in the machine/bulk tank wash cycles. Traces of the TCM remaining on the milking plant surface will be transferred to the milk at the subsequent milking. The critical points for controlling TCM are as follows:

- Adequate rinsing of milking plant after milking (14 litres of water/milking unit)
- Use of a suitable product for milking plant cleaning (Teagasc guidelines: **http://www.agresearch.teagasc.ie/moorepark/milkquality/**).
- Correct use of the detergent steriliser product (as recommended by the manufacturer).
- Not re-using the detergent steriliser solution more than once.
- Adequate rinsing of milking plant post-detergent cycle (14 litres of water/milking unit).
- Not using chlorine for cluster dipping (peracetic acid is an affective alternative).

Iodine

Iodine is an essential trace element for humans and animals. Milk and dairy products are important sources of iodine intake. It has been shown that milk iodine levels are dependent on iodine intake of the cow: 30-40 per cent of iodine taken in from concentrate feed is transferred to milk. Recently both German and US studies have documented iodine requirements of cows to be 0.5 mg/kg DM. Cow iodine intake in Ireland may be higher in some instances. So caution needs to be exercised in relation to milk iodine levels in order to ensure that dairy products will meet the specifications imposed by countries importing dairy products, e.g. a limit of 250 μg/l.

Average iodine level in Irish milk during the main grazing season is 227 μg/l. Moorepark studies showed that supplementing cows with 30 mg of iodine/day resulted in an increase of 200 per cent in milk iodine levels compared to non-supplemented cows. Furthermore, milk iodine levels increased by 65 per cent and by 180 per cent, when cow teats were disinfected post-milking and pre- and post-milking, respectively. With a requirement to maintain iodine levels in milk at <250 μg/l, there is little flexibility for iodine inclusion at different points along the milk production process. Thus, concentrate feed needs to be chosen based on iodine content and iodine removed from teats before milking cluster attachment.

Flukicides

Veterinary drugs are necessary to control liver fluke in dairy cows, and if not properly used, residues of these drugs may exist in milk. As a consequence of a lack of a maximum residue limit (MRL) for most active ingredients of flukicide products, many effective flukidide products have been banned for use in dairy cows. In order to assist in setting MRLs, studies are currently being conducted at Moorepark on the milk withdrawal period required following flukicide treatment and on the migration of residue during dairy product manufacture. One specific study determined if residues of nitroxynil, levamisole and oxyclozanide in milk transferred into skim milk powder during processing. On separation of cream and skim milk, >90 per cent of the residues remained in the skim milk portion. During powder processing, the residues were not degraded, with almost 90 per cent of the residue detected in the powder. This poses a serious challenge for industry and indicates that recommendations for use and withdrawal periods need to be adhered to at all times.

Quaternary ammonium compounds

Quaternary ammonium compounds are disinfectant compounds used to minimise bacterial growth on equipment surfaces. Thus, these compounds may be used inadvertently at farm level or at processing level to maintain a high standard of plant hygiene. The current MRL for QACs in food is set at 0.01 mg/kg. However, adjustment of this MRL is being considered at EU level and this may have implications for Irish dairy products, in particular infant formula. Department of Agriculture, Food and Forrestry are obliged (by EU regulations) to assess the risk of QAC residue in products (including dairy products) in Ireland and this is currently ongoing. Milk is not presently being tested for QAC but may be in the future.

Conclusions

It is clear that milk production methods have very significant implications for unwanted residues in milk. Thus, a comprehensive understanding is required of the relationship between farm management practices and implications for milk and subsequent dairy product quality. Production practices must ensure that all milk meets the specified requirements or limits of residue content.

Increasing the Value of Milk

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Summary

- Milk payment systems should evolve over time to account for market demands, product portfolios and overall industry profitability.
- To maximise returns milk payment systems should reflect (i) the components of milk that add value, (ii) milk processing costs (iii) and supply profile.
- Dairy farmers have a significant ability to increase the value of the milk they supply by increasing milk solids concentration, producing milk with an optimum supply profile with low somatic cell count (SCC).
- Future changes to milk payment systems could potentially include more focus on SCC levels in milk, inclusion of lactose in the payment system and differentiating between the protein components of milk.

Introduction

As world dairy markets open up in a post quota environment more external forces will affect the value of milk. Therefore there is a need to focus on maximising the value of milk domestically, at farm and processor level, to help withstand these forces. Milk payment systems in the future should reflect 1) the components of milk that add value, 2) when the milk is required and 3) milk processing costs. Over the past 30 years milk payment systems have evolved from a volume based payment to the current A+B-C system; this change process must continue into the future. These changes should be incorporated in the dairy cow breeding programs as they are developed, similar to the A+B-C system of milk payment in the current EBI breeding programme. Dairy farmers must be encouraged to react to these changes to ensure they maximise returns.

Factors affecting the value of milk

A milk processing sector model, which simulates milk processing and ultimately calculates the component values of milk, was developed to evaluate the affect of various factors on milk value (summary results Table 1).

Genetics Examining national average Holstein Friesian (HF), Jersey (J) and high composition Holstein Friesian (HHF) milk showed that across a year there are gains to be made of up to 25 per cent in milk price by improving milk solids composition through breeding.

Milk supply 1 Examining the national milk pool, a herd with a mean calving date of mid-February relative to mid-March generated a value per kg of milk solids that was 0.9 per cent higher, worth a potential milk value increase of €18 million euro.

Milk supply 2 Moving away from the current national spring calving model to herds with a split 50 per cent spring and 50 per cent autumn calving system resulted in milk values per kg of fat being six per cent lower, values per kg of protein being 10 per cent higher and overall milk price being seven per cent higher when applied to the national milk pool. However, when account was taken of the increased costs at farm level of a split calving system, at industry level (farmer and processor) the spring calving system was more profitable than the split calving system by €83 million / annum or 1.6 c/l.

Animal Health High somatic cell count milk has a higher proportion of non-usable protein and lower protein recovery rates. An increase in SCC from <100,000 cells/ml to >400,000 cells/ml has been shown to reduce the value per kg of milk solids by three per cent.

Table 1. Milk price and component values of milk for breed, milk supply and SCC				
Analysis	System	Milk price (€)	Fat value (€/kg)	Protein value (€/kg)
Genetics	HF	0.25	3.07	4.17
	J	0.31	3.79	3.27
	HHF	0.27	3.01	4.62
Milk supply 1	Mid-February	0.30	2.23	6.30
	Mid-March	0.30	2.26	6.28
Milk supply 2	Spring calving	0.28	2.47	5.49
	Split calving	0.30	2.31	6.06
SCC	<100,000 cells/ml	0.30	3.03	5.99
	>400,000 cells/ml	0.29	2.99	5.75

Future milk payment systems

Milk pricing systems evolve as market demands and processing requirements change, therefore some milk pricing changes should be expected in the future.

Lactose Milk lactose value has trebled since 2005. As a result lactose is now a valuable commodity with milk processors beginning to incorporate it into their payment system (Synlait, New Zealand) and FrieslandCampina proposing to include lactose in the payment system in the near future. The value per kg of lactose in both Synlait and FrieslandCampina is relatively small when compared to protein and fat values. In Synlait and FrieslandCampina the value per kg of lactose is 5.6 and 10 times lower than the protein value, respectively. Preliminary analysis for the Irish situation suggests that if lactose was introduced into the Irish milk payment system the relative value would be over 10 times less than the value of protein with the ratio very dependent on the product portfolio and product market values. The inclusion of lactose in the payment system would result in a reduction in the value of fat and protein as the available money will be spread out over three components.

Protein The protein component of the payment system could also be modified in the future. Protein is generally made up of approximately 80 per cent casein and 20 per cent whey, with the economic value of both changing dramatically in the past number of years. In the past whey was viewed as a waste product and now is considered a valuable by product of cheese processing. Alternatively, similar to France the payment system may differentiate between total protein (true protein + non protein nitrogen) and true protein, where non protein nitrogen is a non usable protein. Milk is currently paid for based on kgs of protein and fat, in the future a better reflection of the protein component of milk may be based on either of these systems. Modifying the payment system to differentiate casein and whey from other milk proteins or to differentiate between total and true protein may be more profitable for both processor and farmer.

Somatic Cell Count Elevated SCC due to mastitis infection has detrimental effects on raw milk composition, cheese processing and cheese composition. At processor level an increase in SCC from 100,000 cells/ml to >400,000 cells/ml in the national milk pool showed a reduction in the volume of product produced and reduced net revenue by €51.3 million/annum. A milk payment system that captures the negative impact of SCC should be incorporated right across the industry in Ireland.

Conclusion

Milk payment systems evolve over time and must respond to the external market changes. Farmers should ultimately be paid for the components of their milk that add value less the components that add costs. While the implementation of the A+B-C system was initially slow, building on that system to incorporate the valuable components of milk should be encouraged over time.

Robotic Milking from Pasture

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Summary

- Automatic milking (AM) is becoming an accepted new technology for milking cows across Europe.
- Cows decide when they come for milking, are normally milked one at a time, and the milking of the herd is therefore distributed over a 24 hour period.
- Practical challenges to integrating AM and grazing include (a) initiating cow movement to visit the AM unit; (b) queuing of cows for milking; (c) achieving high utilisation of the AM unit to minimise capital costs; (d) seasonal calving pattern - peak milk yields.
- AM could represent a suitable milking management system for Irish dairy farmers
- Successful integration of AM into a pasture system was achieved at Moorepark in 2012.
- Significant questions remain relating to the ability to manage pasture, changes to farm infrastructure and capital investment.

Introduction

During recent decades, new milking management systems have been introduced, of which development of AM systems is a significant step forward. AM has become an established management system, considered as an alternative to conventional manual milking methods, particularly in Western Europe. This trend is increasing and it is envisaged that up to 20 per cent of cows in Europe will be milked by AM systems by 2020. Additionally, studies in New Zealand and Australia have shown that AM can be successfully incorporated into both all-pasture systems and pastoral dairying systems incorporating moderate levels of supplementary feed. This system offers possibilities for precision management of individual cows in a herd, freeing up labour and allowing the cow greater control of her activities.

Of the 18,000 dairy herds in Ireland, many are milked in herringbone parlours by owner operators who have been farming for many years. Some of these parlours will require updating in the coming years and owners will also consider their future regarding maintaining their dairy operation and the possibility of reducing the dairy labour requirement. Thus, is automatic milking an option? Automatic milking is a new technology for Irish dairy farmers and information is required on how AM could be integrated within Irish farming systems.

What is automatic milking?

The principle of an AM system requires a significant change in approach to herd and farm management (compared to milking in a conventional system) for two main reasons: (i) cows volunteer themselves for milking (where grass or meal is a motivator) and are normally milked one at a time, and (ii) milking is distributed over a 24 hour period.

Is AM technology relevant to Irish dairy farms

The concept of AM could be very relevant to dairy farming in Ireland. An increase in national milk production by 50 per cent is anticipated in the coming years. However, land as a resource is limiting, farm fragmentation is an issue and the quantity and quality of skilled labour are in increasingly short supply. If AM is to be considered as a serious alternative to conventional milking in Ireland, then it has to operate with a similar cow nutritional strategy as a conventional milking system and focus on cow utilisation of grass. This is the challenge posed. An additional consideration for an AM farm is production per AM unit or system. Increasing the number of cows milked and reducing the individual cow milking frequency can increase milk production per AM system. This approach (as opposed to maximising milk production per cow) is more suited to a pasture–based system.

AM at Moorepark

An opportunity to research AM at Moorepark was provided by the Fullwood Company who recently installed a Merlin AM unit at the Dairygold Farm, Teagasc Moorepark. There were 72 cows (36 Friesian, 16 Jersey Friesian cross and 20 Norwegian Red) on the AM system during 2012. The farm-let consisted of a 24 hectare milking platform. The land area was divided into three grazing sections, which were further divided into 1ha paddocks (Figure 1). Grass allocation is critical to optimal cow visits to the AM unit. Cows move between and graze the defined areas or portions of each of the three grazing sections during each 24 hour period. A visit to the AM unit is integrated into the cow movement from one grazing section to the next. Cows grazed to an average post-grazing sward height of 4.4 cm. All cows received ~1.4 kg concentrate feed per 24 hour period during most of the lactation.

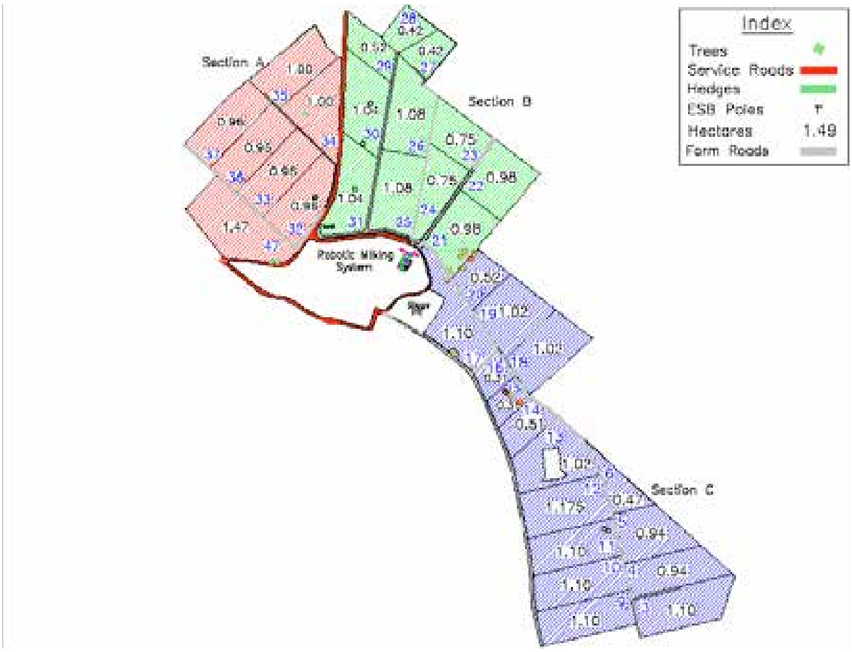

Figure 1. *Map of AM farm incorporating grazing sections A, B and C*

Production data

An average milk yield of 4,500 litres and milk solids (MS) yield of 351 kg/cow lactation was achieved. Total milk volume and MS produced by the AM unit was 284,592 litres and 22,834 kg, respectively. The average number of milkings/day was 108, ranging from 125 to 80/day in the March-May and October/November periods. Average number of milkings/cow/day was 1.8, ranging from 2 to 1.5 in the March-May and October/November periods, respectively. Each milking averaged seven minutes duration. Average milk somatic cell count (SCC) of the herd was 133,000 cells/ml and herd average total bacterial count (TBC) was 18,000 cells/ml.

Conclusion

Successful integration of AM into a grass system was achieved in the study conducted at Moorepark, however the economic viability of AM will determine how widely the technology will be adopted.

PLANNING FOR POST – QUOTAS

Increasing Productivity of Heavy Soils

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Summary

- Approximately 30 per cent of milk produced in Ireland originates from farms classified as having heavy soils.
- Increased herbage production should be the central focus on farms challenged with heavier soils
  - » Soil Fertility - pH, P and K indices need to be at optimum levels.
  - » High levels of ryegrass to increase productivity on milking platform and out farm.
  - » Farm infrastructure – good paddock access, roadways and wintering facilities essential.
- Match stocking rate to grass production capacity
  - » Taking a three year cycle.
  - » Risk management requires building silage reserves in good grass growing years.

Introduction

A large proportion (approximately 30 %) of milk produced in Ireland originates from farms where the soils that can be classified as heavy. Heavy soils add complexities to the production system that are aggravated by inclement weather conditions like experienced in 2012 and spring 2013. To ensure a robust sustainable system of milk production on heavy soils herd fertility, soil fertility, ryegrass levels and farm infrastructure all need to be at optimum levels. Stocking rate has to be based on the farm's grass growing capacity over a three year cycle.

The data shown in this paper was generated from farms in Macroom, Kishkeam, Castleisland, Listowel, Athea, Rossmore and Doonbeg. All are participants in the Heavy Soils Programme their can be followed on: **http://www.teagasc.ie/heavysoils/**.

Factors effecting productivity

Table 1. The level of grass production, utilisation and ryegrass ground cover on the farms in the heavy soils programme for the years 2011 and 2012

	2011	2012
Gross Production (tonnes DM/ha)	10.6	7.8
Gross Utilisation (tonnes DM/ha)	8.1	5.4
Ryegrass ground cover %	28	17

Table 1 shows the reduction in grass production in 2012. This baseline data was generated from weekly grass measurement The ryegrass ground cover is shown at 28 per cent in 2011 (range 17–34). In 2012 ryegrass cover was 17 per cent (range 15–22). Reasons for the decline in ryegrass cover in 2012 included reduced re-seeding levels, a drop in soil fertility and some paddocks suffered reductions from poaching damage. Increasing productivity to a target of 12.5 tonnes/ha requires grown ryegrass content needs to increase to 50 per cent ground cover.

The continuing downward trend in soil fertility nationally is also evident on the heavy soils programme farms with recent soil analysis showing suboptimal results. In the year 2013 results (2010 results in brackets) were pH 5.73 (5.54), Phosphorous 4.16 mg/l (5.54 mg/l) and Potassium 84.04 mg/l (116 mg/l) To establish and maintain good ryegrass swards soil fertility has to be at optimal levels.

The Heavy soils farms calved 75 per cent of the herd in six weeks in 2013 with a range of 60-91 per cent. The continuing emphasis on the herd fertility sub-index (€79) is vital in increasing lactation length and cow survival critical components for increased productivity from heavy soils farms.

Increased ryegrass content, high soil fertility status and highly fertile dairy herds are all important components to improving farm income. Net profit per hectare in 2012 was €895 (range €483-€1,281) with a target of €1,300/ha net profit achievable when these components are in place on these farms.

Table 2. Stock carrying capacity on 40ha milking platform (excl replacement stock)

* Potential grass growth tonnes/DM ha	Stocking rate with 0.5 tonne DM/cow reserve LU/ha	No. of cows on 40 ha milking platform	Stocking rate with 0.5 tonne DM/cow reserve–silage out sourced Lu/ha	No. of cows on 40 ha milking platform
6	0.96	43	1.07	52
8	1.28	57	1.42	69
10	1.60	71	1.78	86
12.5	2.00	89	2.22	108
13.5	2.16	96	2.40	117

* Calculations based on potential grass DM production which are achievable in two years of a three year cycle with the reserves built up in those two years being depleted in the third year.

Table 2 stocking rate calculation is based on 4.5 tonnes of forage DM/cow plus a reserve of 0.5 tonnes DM conserved/cow in two out of the three years (and fed back in year three) with a grass utilization of 80 per cent averaged over the three years. The forage requirement where silage is outsourced from the milking platform has been increased by 0.2 tonnes of silage DM/cow to allow for a shorter grazing season due to a higher stocking rate on the milking platform (grass in the Autumn will run out faster).

The feed requirement of replacement stock is a considerable additional strain on heavy farms. Sufficient productive lands or off farm rearing arrangements need to put in place so that target weight gains are achieved to improve herd performance.

Conclusions

Increased productivity on heavy soils requires clear management decisions that mitigate the risks in farming such land. The capacity to grow adequate quantities of grass in a three year cycle is dependant on high utilisation of productive ryegrass and the provision of adequate silage reserves (at least 0.5 tonne DM/cow). Stocking rates must be matched to the grass growth and utilisation capacity of the farm. Based on potential grass grown of 12.5 tonnes DM/ha with all winter feed requirement conserved within the farm (including reserve) the optimum stocking rate is 2 LU/ha.

Infrastructure for an Expanding Dairy Farm

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Summary

- Achieving acceptable milking times is important. In expanding herds examine carefully if the existing milking facilities can be extended or if a new milking parlour is required. Avoid cost overruns with new milking parlours.
- Existing cattle housing can be cheaply converted to winter cow accommodation. Where new accommodation is required, costs vary from €550 to €1,500/cow/place.
- Adjust paddock sizes for three grazings, ensure road network is appropriate for herd size and soil type and upgrade water supply to paddocks.

Milking facilities

The main considerations when designing a new or expanding an existing parlour are; the number of cows to be milked, expected or acceptable milking time, number of milkers available, the predominant pre-milking routine; the level of automation desired and the capital expenditure required/available.

Time spent milking is already too long on many farms. The cut off point for most farms is around 8-10 rows of cows/milking or around a maximum of 1½ hours/milking e.g. 96 cows for a 12 unit parlour.

Altering existing milking parlours is proving difficult on many farms. The dimensions, falls and general condition of old parlours are usually unsuitable. Room is often limiting, particularly for the expanded collecting yard, exit yards and dairy where a larger bulk tank is required. The location of an existing parlour in relation to the expanded grazing area is the most important factor. Where one or more of the above issues are compromised, it may be more appropriate to build a new milking parlour. Approximate costs for building a brand new milking parlour are:

- €4,000-5,000/unit for constructing the parlour (milking shed, collecting yard with tank and dairy)
- €2,000-€7,500/unit for the plant depending on the level of automation e.g. ACR's, diversion lines, feeders, auto id
- €1.75-€2.50/litre for the bulk tank-base capacity on three day collection at peak.

Itemised quotations and careful budgeting are necessary to avoid costly overruns.

Accommodation

Firstly consider how much accommodation you have and how much you require and do likewise for silage and slurry storage. A variety of different forms of accommodation may be suitable for dairy cows (guidelines costs for new accommodation are shown on Table 1). Preference generally is for cubicle housing where cows are milked at some stage during the housing period. The conversion of existing sheds to cubicle will provide a relatively cheap form of accommodation:

- Guideline costs are approximately €250 to €350/cubicle bed constructed in an existing straw bedded or slatted shed.
- The cost of adding a new cubicle shed to an existing slatted shed costs approximately €500 to €600/cow place.

Table 1. Guideline costs for new accommodation and slurry storage

	Costing breakdown /cow place	Total /cow place
Cubicle shed + slatted tank	€1,000 + €500	€1,500
Topless cubicle + lined lagoon	€400 + €300	€700
Lined wintering pad + lined lagoon	€250 + €300	€550

Paddocks

The size of the paddock should be based on three grazings of the planned number of cows post-expansion. The guideline paddock area is 1.8 ha/100 cows for three grazings (with a target pre-grazing cover of 1,400 kg DM/ha). For a 21 day rotation in mid-summer this means that 14 such paddocks are required. Additional grazing area will be available before and after silage is harvested.

Ideally, paddocks should be square to rectangular in shape with the depth no more than three times the width. As a general rule the distance from the roadway to the back of the paddock should be between 60-100 m on heavy land, 100-170 m in medium land and 170-250 m on light land. The upper limits are more applicable to larger herds. Provide a few small paddocks near the parlour for lame/sick cows. Use multiple gateways to paddocks on heavy land and during wet weather.

Roadways

Design and construction of farm roadways have a big impact on cow flow, walking speed and herd health. Assess your current road structure.

- Does it service all of the potential grazing areas?
- Is the roadway in good condition?

If the current roadway system is inadequate it needs to be upgraded, extended and/or made more intensive. Essential elements of a good roadway are adequate width, a smooth surface, a crossfall to shed water, raised above the grazing area and sweeping bends at corners and junctions. The main roadway should be wide enough for good cow flow e.g. 100 cows - 4 metres wide, 200 cows - 5 metres.

Construction costs can vary, from €15 to €30/m, depending on the cost of materials, the width, depth of material and the method of construction. Cow tracks are a cost effective way (€6 to €8/m) to improve access to grass, particularly on heavy land.

Water system

Access your current water supply to the paddocks

- Are pipe sizes adequate?
- Are water troughs big enough and correctly located?
- What quantity of water is provided per cow per hour?

A flow rate of 0.2 litres/minute/cow and a trough volume of 6 litres/cow is recommended e.g. a flow rate of 20 litres/minute and 600 litre troughs/100 cows. A ring main is a cost effective way to enhance water flow rates and pressure to troughs. Main pipe sizes would typically be 25 mm, 32 mm or 40 mm and branch pipe sizes would be either 20 mm, 25 mm or 32 mm (internal diameter). Use full flow ballcocks in all new troughs. Position troughs to minimise walking distances to water, to avoid unnecessary smearing of grass and away from gaps and hollows. Troughs on roadways will slow cow movement and make roadways dirty.

Winter Milk Production-Key Drivers of Profit

Joe Patton[1] and Aidan Lawless[2]

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Summary

- In a post-quota environment, winter milk systems could be employed to adjust overall milk supply profile if product processing requirements dictate. The viability of such an approach would depend on any additional market value of product exceeding increased farm-level and processing costs.
- Purchased feed and labour account for most of the cost differential between winter and spring calving systems. However, there is also a large range in profitability within each category.
- Increasing grass utilised per hectare, and milk produced from forage, are very important drivers of profit for winter milk herds.
- Tight control of calving pattern and herd calving interval are essential for profitable winter milk production. A high EBI sub-index for fertility and good management of submission rates are required.

Introduction

For most dairy farms, the most sustainable model for post-quota milk expansion will be compact calving in spring with a seasonal milk supply profile. This reduces exposure to cost fluctuations and improves labour efficiency within the farm gate. However, depending on market conditions and product mix, there may be a requirement for a supply of early lactation milk during the winter months.

Winter milk systems generally operate off a higher cost base, with Teagasc eProfit Monitor data (2009-2012) showing higher annual cost/litre of approximately 2.5 cents for winter versus spring milk farms. Feed and labour costs account for over 90 per cent of this differential. The long term viability of winter milk for the individual farm will depend on any additional market value added to the milk pool returning a sufficient price premium to exceed these additional production costs. Nonetheless, there is considerable variation in total costs and profit for spring and winter milk herds alike, indicating potential for improved efficiency within each system. Two of the main focus areas in this context are grass utilised and herd calving interval.

Increasing grass utilised and milk from forage

Cashing in on grass is not the sole preserve of spring calving herds! There is also great scope for milk production off pasture from February to November with autumn calving cows. Teagasc eProfit Monitor data shows that nearly two thirds of the difference in profit between winter milk herds can be explained by how much grass is consumed per hectare annually. Similarly, while milk yield per cow is a poor predictor of profit for winter milk herds, the amount of milk produced from forage is strongly linked to profit.

The need to focus on forage drives decisions for the Teagasc winter milk research herd in Johnstown Castle. This 60:40 autumn:spring calving Holstein-Friesian herd averages 7100 kg milk (540 kg solids) per year for a concentrate input of 1.2 tonnes. The three-year average for grass utilised is 11.3 tonnes DM/ha with 4,300 litres/cow produced from forage. The principal forage management steps employed to improve grass utilised are i) good soil fertility status, ii) reseeding 12-15 per cent of the grazing block annually, iii) using available grass budgeting tools i.e. spring rotation planner, grass wedge and autumn budget and iv) making high quality (>74 DMD) grass silage for first and subsequent cuts. In combination, these factors increase the supply of quality pasture, reduce purchased feed requirements, and improve milk solids production.

Calving interval and calving pattern

For many winter milk herds, the option to recycle or 'roll over' cows between one breeding season and the next is viewed as an advantage to the system, particularly where lax autumn and spring calving seasons are in place. The result is that replacement rate may be reduced in the short term but herd calving interval is extended. However, there is a major hidden cost to reduced fertility and extended calving intervals for winter milk herds. Longer calving intervals reduce annual milk sales per cow due to more days spent in late lactation and longer dry periods. This occurs for both high- and lower yielding herds (Figure 1). Breeding for greater yield will not offset these losses, and indeed could further reduce milk revenue if fertility is adversely affected.

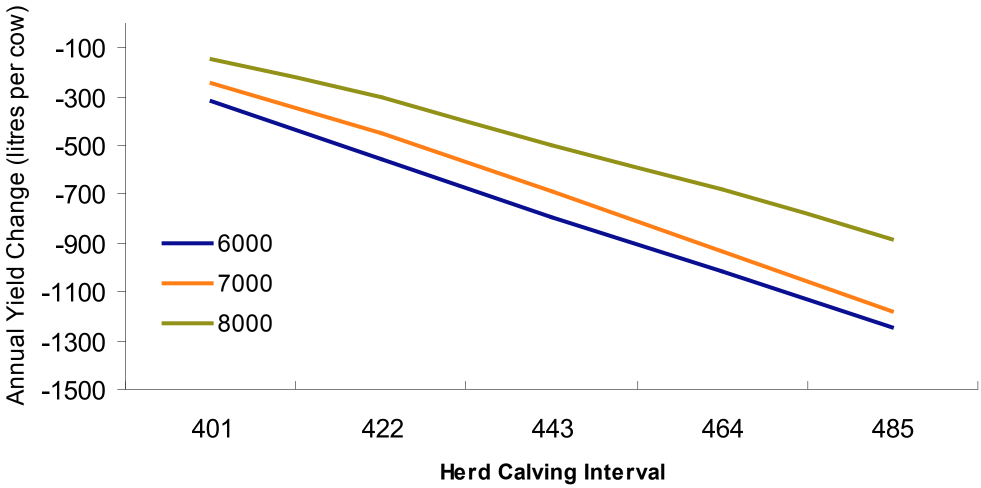

Figure 1. *Change in annual milk yield per cow due to herd calving interval, relative to a 375-day herd average, for herds with 305-day yield potential of 6000, 7000 and 8000 litres*

Reduced fertility for winter milk herds also means extension of the calving season and fewer calves born/cow/year. Economic analysis has estimated the cost of a 443-day herd calving interval to be €220-€260/cow in the herd relative to a 375-day calving interval for a 7000-litre herd (net of short-term savings on culling rate). This highlights the requirement for focus on fertility in a winter milk context.

Management decisions for the Johnstown Castle research herd are strongly influenced by herd fertility targets. Firstly, herd sires are selected for fertility EBI sub-index of €120 + to improve herd genetics. Second, breeding seasons are restricted to 11 weeks for autumn and spring, and a 90 per cent submission rate in the first three weeks of each season is targeted. Fewer than 10 per cent of cows are recycled between calving seasons annually. Finally, replacement heifers calve at 22-24 months. Current herd calving interval is 384 days (target 375 days), with six-week calving rates of 70-75 per cent/season.

Conclusions

Winter milk systems incur higher production costs than their spring calving counterparts; however viable winter milk production models may be necessary where milk processing and product mixes dictate. Central to this viability will be a focus on high grass utilisation and maximising milk from forage, selecting high EBI fertility genetics, and strict management of herd calving intervals.

Milk Production Systems in the BMW Region

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Summary

- Farms in the BMW region are capable of high levels of grass utilisation.
- Flexible grazing management must be adopted during wet weather conditions.
- Good grazing management coupled with high EBI genetics and compact calving will yield high levels of milk solids output per cow and per hectare.
- Aggressive selection for high fertility sub-index will improve fertility performance over time.

Introduction

The Ballyhaise college dairy project was undertaken in 2005 to investigate the profit potential of dairy production systems within the BMW region. At the outset of the project the main issues identified as hampering the profitability of dairy farms in the region were the growth and utilisation of grazed grass, farm fragmentation and poor herd fertility. The Ballyhaise dairy unit was identified as a suitable site to carry out this study as it is representative of dairy farms within the region in terms of soil type and topography. The soils are heavy clay drumlin soils which have poor drainage characteristics and are susceptible to poaching damage during inclement weather. The ability to grow and utilise more grazed grass on the milking platform is a key driver of profit on Irish dairy farms. High levels of utilisation will only be achieved when the farm is appropriately stocked with high genetic merit animals that are capable of producing high levels of milk solids while simultaneously achieving a compact calving pattern.

Grass production and utilisation

While land type has a significant impact on grass production and utilisation potential, recent studies at Ballyhaise have identified the potential to grow and utilise large quantities of high quality grass within such constraints. Grass production increased from 12 tons DM/ha in 2008 to 14.5 tons DM in 2011. An aggressive reseeding programme has taken place as well as the adoption of more flexible grazing strategies, such as on-off grazing, which have increased the grass production potential of the farm. Investments in improved grazing infrastructure have also helped to improve utilisation. However, the 2012 growing season provided a stark reminder of the limitations of such soil types with grass production dropping to 11 tons DM/ha (24 % decrease).

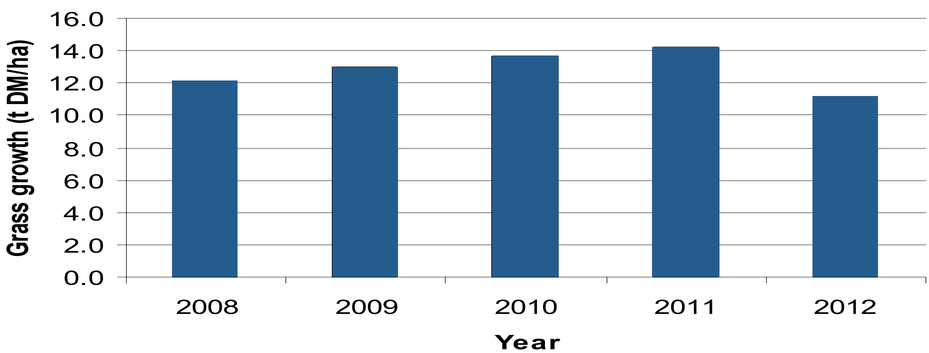

Figure 1. *Ballyhaise annual grass production*

Increased feed costs 2012

As a direct result of the poor growth rates achieved in 2012 increased levels of purchased concentrates were used to maintain animal performance. Concentrate feed inputs increased by 36 per cent to 850 kg/cow. Increased concentrate usage coupled with increased concentrate cost per tonne in 2012 led to a doubling of concentrate feed costs from €130/cow in 2011 to €240/cow in 2012. In addition to this, an additional €140/cow was spent on winter feed which had to be purchased from outside the grazing block.

Milk solids production

The performance of the Ballyhaise herd demonstrates the potential for farmers in the region to increase their output of milk solids (MS) from the milking platform in a post quota environment without increasing feed inputs per cow. Profit monitor data collected from farms in the BMW region shows an average output of 900 kg MS/ha with a concentrate input of 890 kg/cow. The production per ha at Ballyhaise has increased from 950 kg MS/ha in 2005 to 1250 kg MS/ha in 2012. Production per cow is however only moderate at 400 kg MS/cow which is well below the target of 450 kg MS/cow. Historically poor fertility performance has reduced the yield potential of the herd through short lactation length, reduced voluntary culling and high replacement rates.

Fertility performance

The fertility performance of the Ballyhaise herd has improved steadily over the course of the project. Overall empty rates have decreased from 36 per cent in 2005 to seven per cent in 2012, while six week calving rate has increased from 56 per cent in 2005 to 83 per cent in 2012. Although encouraging, it is important to highlight the fact that this is after seven years of aggressively breeding for high fertility sub-index and high culling rates of empty cows. The EBI of the herd is €170 with €90 coming from fertility sub-index.

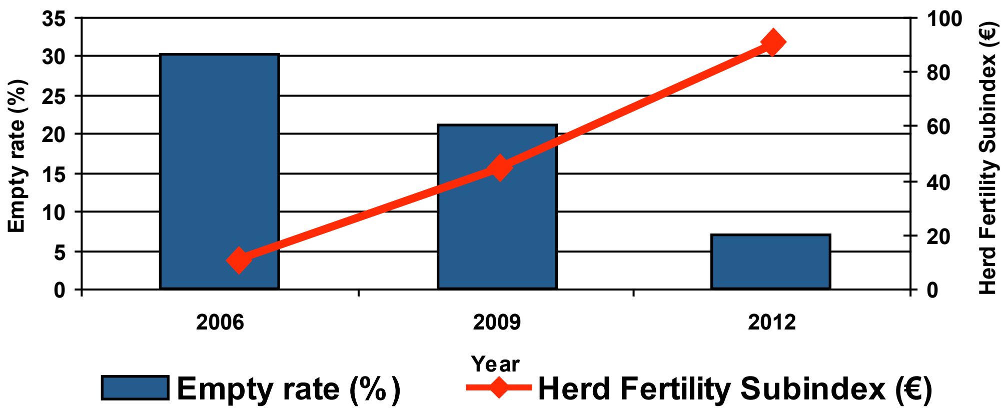

Figure 2. *Effect of EBI improvement on the Ballyhaise dairy herd empty rate over a 13 week breeding season*

Conclusions

The lowest risk expansion strategy for dairy farmers in the BMW region will be to increase output of milk solids/hectare on the milking platform through improvements in both grass utilisation and herd fertility performance. High genetic merit cows with a high fertility sub-index will be required to achieve a compact calving pattern and provide surplus young stock to fuel further expansion.

Farming on Wet Ground at Solohead

James Humphreys[1], Paul Phelan[2], Pat Tuohy[1] and Daniel Barrett[1]

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Summary

- Wet soil conditions due to high rainfall have a negative impact on grass growth and profitability.
- Soil surface deformation associated with poaching damage reduces herbage production by 20 to 40 per cent.
- Lighter Jersey-crossbred cows caused as much soil surface deformation as Holstein-Friesian cows. The Jersey-crossbred offers little advantage in terms of lowering poaching damage on wet soil.
- Herbage production can be increased by reducing poaching damage through drainage, on-off grazing and zero grazing on fragmented farms.

Introduction

The predominant soils at Solohead Research Farm are poorly drained gleys with a clay loam texture and low permeability. There is a shallow water table that varies from being at the soil surface (ponding) down to 2.2 m below ground level depending on rainfall. A number of ditches (2 m below ground level [BGL]) and tile and plastic pipe underground drains (1.8 m BGL at spacing of 25 m) were installed between 1960 and 1995 across the farm to artificially lower the water table. Nevertheless, much of the farm is waterlogged in winter and following periods of high rainfall at other time of the year. Annual rainfall has a major impact on pasture productivity and farm profitability (Figure 1).

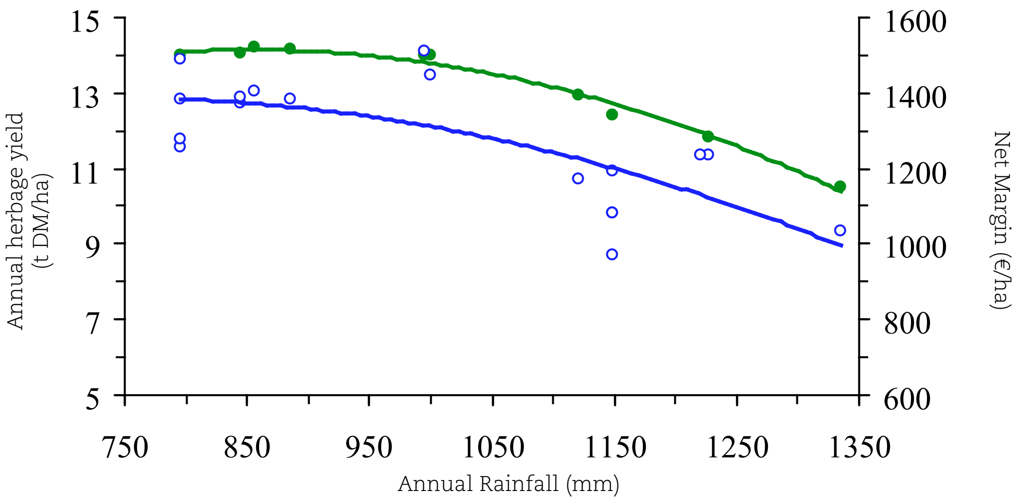

Figure 1. *The impact of annual rainfall on annual herbage yields (●) and net margin per ha (○) at Solohead between 2001 and 2010*

With the same level of inputs (fertilizer N etc.), there was substantially lower herbage production (up to 25 %) and net margin per ha in wetter compared with drier years. In heavy soils, herbage production is lower under high rainfall because the water fails to drain away naturally and air is driven from the spaces between the soil particles in the rooting zone (top 30 cm) by the rising water table. Every 1 cm of rainfall at the surface of an impeded soil will raise the water table by around 15 cm. Lack of air prevents root growth and nutrient uptake and this has a direct knock-on impact on above-ground herbage production.

Profitability is related to grazing days per year. In relatively dry years (2003 to 2006) when average annual rainfall was 963 mm, there was an average of 255 grazing days per year. In relatively wet years (2007 to 2009), average rainfall was 1173 mm and there was an average of 232 grazing days. There were 198 grazing days in 2012.

Poaching damage

Another consequence of soil wetness is damage by grazing livestock. Research at Solohead has shown that soil surface deformation has a very negative impact on herbage production (Figure 2), with knock-on impact on herbage utilization by grazing cows. Under the high rainfall and wet soil conditions in 2012, herbage yield under grazing was only two-thirds of where swards were harvested by cutting only.

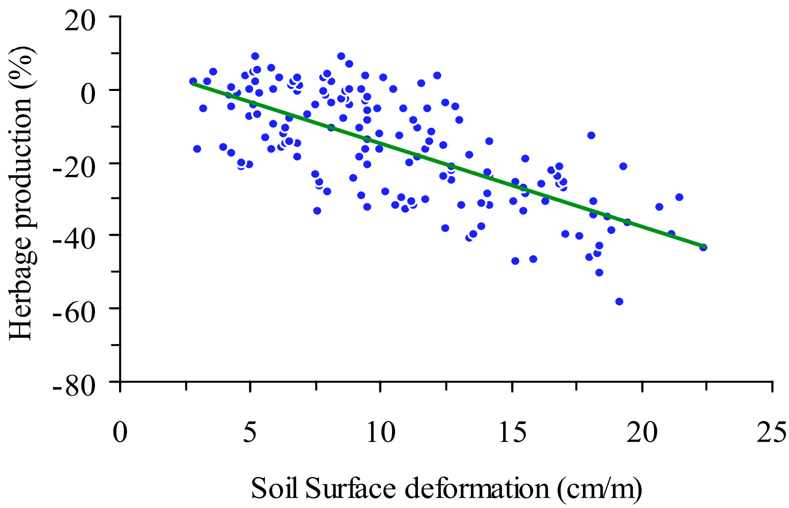

Figure 2. *The impact of soil surface deformation and herbage production relative to undamaged ground*

We also examined the impact of cow weight and stocking density on soil compaction and herbage production, comparing Holstein-Friesian (HF) and HF x Jersey (JX) cows at two stocking densities (2.5 and 2.75 cows/ha). At the start of the experiment in 2010, herds were equal in terms of EBI, age profile, calving date etc. The main difference was liveweight. The HF cows averaged 580 kg per cow compared with the JX average 506 kg per cow (Table 1).

Differences in cow liveweight did not affect soil-properties or poaching damage. Although the JX are lighter, they also have smaller feet and hence exert the same static pressure at the soil surface. There was higher poaching damage under the higher stocking densities of both breeds, which had a negative impact on herbage production.

Table 1. Mean live-weight, hoof surface-area and static surface loading pressure					
Breed	Hoof Depth (mm)	Deformation (cm/m)	Live-weight (kg)	Total hoof area (cm2)	Static pressure (kPa)
Holstein Friesian	38.4	10.6	580	273	214
Crossbred Jersey	37.5	10.7	506	234	218

Minimising poaching damage

Increasing herbage production on wet soil can be achieved by minimising poaching damage. Installation of a well designed and effective system of drains will lower the water table and poaching damage (Figure 3).

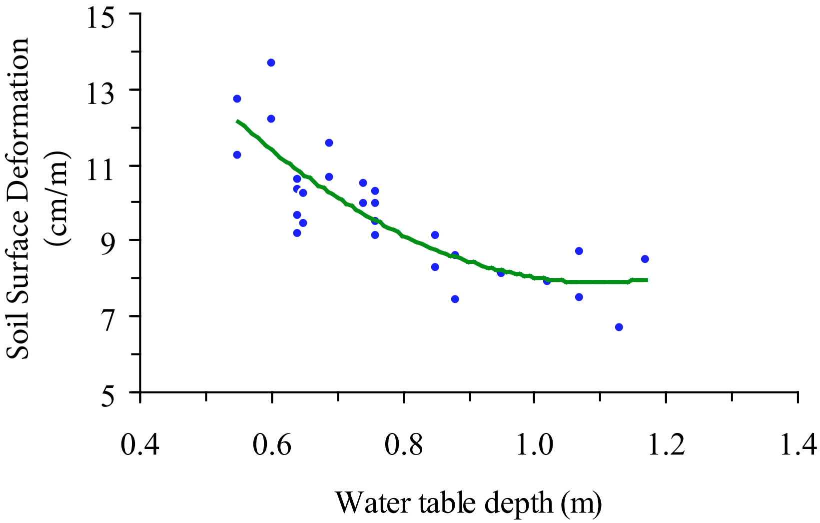

Figure 3. *The relationship between water table depth and soil surface deformation*

Drainage is expensive to install. Minimising poaching damage through practices such as on-off grazing has potential to cost-effectively increase herbage production on wet farms. Zero grazing may also have potential, particularly on fragmented farms. Making sure that soil lime, P and K status are up to requirements is important to help swards recover rapidly and thicken up after poaching damage. It also helps to maximise yields of herbage, which is particularly important this year.

Conclusions

Producing milk from grazed grass is an important part of the Irish Economy. Wet soil conditions are the most important factor limiting the utilization of grazed grass on Irish farms. It has been projected that most of the increase in milk production after the abolition of the milk quota will come from existing dairy farms, many of which are on heavy soils in traditional dairying areas in higher rainfall parts of the country. There are clear productivity gains to be made by solving the problem of wet soil by artificial drainage once it is done cost effectively. Best management practices for increasing the productivity of grassland on heavy wet land need to be identified.

Update on Greenfield Kilkenny Dairy Farm Performance 2010-2013

Abigail Ryan[1] and Michael Long[2]

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Summary

- The Greenfield farm is now in year four of a 15 year lease, milking 325 cows on 113 hectares. 2012 was the first year where both capital and interest repayments were made on the farm.
- The 2012 not in calf rate (NIC) was 11 per cent after a 13 week breeding season. A high replacement rate with heifers calving early helped improve overall fertility performance (71 % calved in six weeks in 2013). The three-week submission rate for cows was 78 per cent in 2013, 10 per cent below the industry target.
- Milk solids production has increased by 18 per cent up to the 30th April this year compared to 2012. This is mainly due to an earlier and more compact calving pattern and also an increase in spring supplementation. Over 95 per cent of the increase in milk solids came in February and March.
- Lameness was a problem this spring, with many cows diagnosed with drops in their hooves due to soft feet on rough roads. A decision was taken to resurface the farm roads at a cost of €16,000 plus VAT for 2km of roadway.

Introduction

This is an update on the Greenfield dairy farm performance from 2010 to 2013 covering the financial performance, grass and milk production, herd fertility and herd health. Some key financial figures are summarized in Table 1.

Table 1. Physical and financial figures for Greenfield Kilkenny Farm

	2011	2012
Cow numbers	295	294
Grazing area (ha)	113	113
Milk solids sold/cow (kg/cow)	388	398
Milk solids sold/ha (kg/ha)	961	982
Butterfat/protein (%)	4.41/3.52	4.61/3.57
SCC (cells/ml)	169	235
Milk price (c/l)	37.70	35.50
Meal fed/cow (kg/cow)	307	300
Total Sales-milk and stock (€)	567,323	573,666
Milk sales (€)	501,329	467,060
Stock sales (€)	65,994	101,107
Total cash expenses (€)	463,989	553,541
Net profit (€)	81,433	38,847
Borrowings at end of the year (€)	849,370	785,628
Cash left over at the end of the year (€)	103,334	20,125

The cash flow for the farm is examined every quarter, updated and compared to the cash flow budget prepared at the start of the year. Sales have increased since 2010 as the number of cows milked gradually increased from 265 (Year 1) to 320 in 2013 (Year 4). Milk sales decreased by €34,269 from 2011 to 2012, as a result of reduced milk price, even though production of milk solids increased. The total net profit and the net profit per hectare decreased from 2011 to 2012 by €42,586 or by €377/ha. 2012 was the first year that both capital and interest were paid. Costs were higher because more stock were contract-reared (94 calves and 116 in-calf heifers for 2012), higher farm maintenance costs and higher labour costs.

Grassland management, soil fertility and stocking rate

The Greenfield dairy farm (113 ha) was converted to grass from tillage in 2009 and 2010. Greenfield farm grew 13 tonnes DM/ha in 2012. There are 28 paddocks with a single variety (monoculture) in each paddock. The annual rainfall in 2012 was 790 mm. Due to poor late autumn and winter growth in 2012, the opening cover was 620 kg DM/ha in 2013, less than the target of 700 kg DM/ha. The first paddocks for the spring were closed on the 1st October. The farm grew 1.8 tonnes DM/ha to the 1st May this year compared to 2.8 tonnes DM/ha to the same date last year. This equates to 113 tonnes DM less than last year. Milking cows were on grazed grass and 3 kg meal per day from the start of calving until the 26th February when silage and hay were introduced to the diet until the 17th of April. From the 5th of March, cows were only getting 25 per cent of their diet from grass. Milking cows consumed 56.1 tonnes silage DM and 135 tonnes of concentrate this spring. The current feed budget suggests the farm will only produce 43 per cent of the winter feed requirement this year.

Milk production

Milk solids production increased by 18 per cent this year to the end of May compared with 2012. This was a result of earlier compact calving and more meal fed per cow. Individual cow samples have identified Staph aureus as the main bacteria causing infection. Strategies identified to reduce the S. aureus problem in 2013 include pre- and post-milking teat-spraying, milk recording earlier in lactation, more milk recordings per year, early culling of repeat high cell count cows, and keeping high SCC cows in a second herd and milking them last.

Fertility performance and herd health

In 2012 more emphasis was placed on pre-breeding heat detection, keeping records, and scanning cows that hadn't shown heat before start of breeding. The NIC rate for cows in 2012 was 11 per cent after a 13 week breeding season (reduced from 15 weeks in 2011). The six week in-calf rate for lactating cows improved from 56 per cent in 2011 to 60 per cent in 2012. The heifers were synchronised in 2012, resulting in an increase in the heifer six week calving rate from 67 per cent in 2011 to 90 per cent in 2013. Calving a large percentage of the herd as heifers (116) improved the compactness of the calving in 2013.

This year, mating start date (MSD) for the heifers and cows was the 23rd April and the 24th April, respectively. Maiden heifers were on target for live weight (308 kgs) and were cycling well (99 % were submitted in the first three weeks). Sexed semen was used on the heifers. No synchronisation was used. The EBI of the herd is €144.

Due to the very heavy rain in 2012, farm roadways had become very wet causing the surface to become very rough resulting in lameness problems. On inspection cows had 'drops' in their hooves. The decision was made to re-surface the main farm roadway (2.0 km) at a cost of approx €16,000 (excl. VAT). Since the resurfacing, there has been no new lameness in the herd. Lessons learned from lameness issue were: (1) if possible keep cows, especially first calving heifers, on the closer paddocks to the parlour after calving; (2) regular visits by the hoof parer required; (3) don't delay in making a decision to re-surface roadways if required.

Conclusion

Total farm output is largely dependent on milk output and milk price changes. Costs are monitored carefully and checked against the budget prepared at the start of the year. A €90,000 deposit fund has been created from surplus cash created during the first four years of operation. If the Greenfield farm is to carry a higher stocking rate, it will have to produce more grass.

Shinagh Dairy Farm: A Greenfield Experience

John McNamara[1] and Kevin Ahern[2]
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Summary

- Shinagh dairy farm was set up in autumn 2010 to demonstrate the potential of a well run spring calving dairy herd to adequately remunerate all of the resources employed; land, labour and capital.
- Because of tight economic constraints, the management focus is on generating cash surpluses.
- The farm is in it's third year of production and is currently ahead of the original business plan in terms of cash surplus and stock numbers.
- The farm was stocked with all first lactation animals in 2010. This led to low milk production in the first year, but excellent fertility and survivability.
- The lessons learned to-date:
  - » Planning and developing a new or significantly expanded dairy farm takes at least 18 months.
  - » Cash is very tight in a new or expanding dairy business as stock numbers are increasing and regular cash flow management is critical.
  - » A well managed, compact spring calving grass-based dairy farm can remunerate all of the resources employed.

Background

A 77.8 ha farm was leased for 15 years in Bandon Co. Cork in late 2010. The farm comes with no single farm payment. The farm was converted from a beef farm in the autumn and winter of 2010 for a cost of €780,000 of which €520,000 was borrowed from Ulster Bank over 15 years with the first two years interest only. The farm has one full time labour unit and employs casual relief in spring and for holidays. The profits from the dairy farm have to fund the capital repayments (~€45 k/year), land rent (~€36 k/year) and full labour costs (~€70 k/year).

Farming objective

The Business plan is to maximise profit from spring milk production grass based technologies while keeping the capital investment required low. This plan is based around maximising the amount of grass grown and utilised per hectare to ensure the business is robust enough to cope with milk price fluctuations and adverse weather. The key components of this are:

- Fertile ground (optimum lime, P and K status) with ryegrass swards.
- Fertile cows with a compact calving pattern, calving to grass.
- Breeding policy to produce replacements to suit the system.
- Excellent grassland management to ensure high grass quality and utilisation.

Stock

One hundred and ninety nine heifers were bought in autumn 2010, and they started calving in the spring of 2011. The stock were sourced on the basis of the EBI index with at least half of their EBI coming from fertility. The final herd had an EBI of €104 with €35 for milk and €60 for fertility. The purchasing plan was to purchase from as few herds as possible and all stock had to pass tests for Johnes, neospora, BVD, brucellosis and TB before delivery. The investment in bio-security and fertility at the time of stock purchase has paid dividends with low animal mortality, no outbreak of any infectious disease and high fertility performance each year.

Breeding policy

AI sires are selected on EBI to achieve €125 targets at EBI for fertility in the heifer calves, 20 kg of milk solids, +0.1 per cent fat and +.05 per cent protein with calving difficulty less than three per cent for use in cows and less than 1.5 per cent for use in heifers. Bulls selected are Friesian, Jersey and Norwegian Red to maximise hybrid vigour. Heifers are observed and AI bred for seven days and those not bred get an injection of prostaglandin and are AI bred to the subsequent heat. After this, Jersey bulls are run with the heifers. Cows are bred to AI until sufficient straws are used to give the required number of heifer calves (5.5 straws needed to produce a heifer milking in the herd). After that stock bulls are used to allow a total breeding season of 13 weeks. The breeding season duration will be reduced to 12 weeks in 2013.

Farm performance to-date

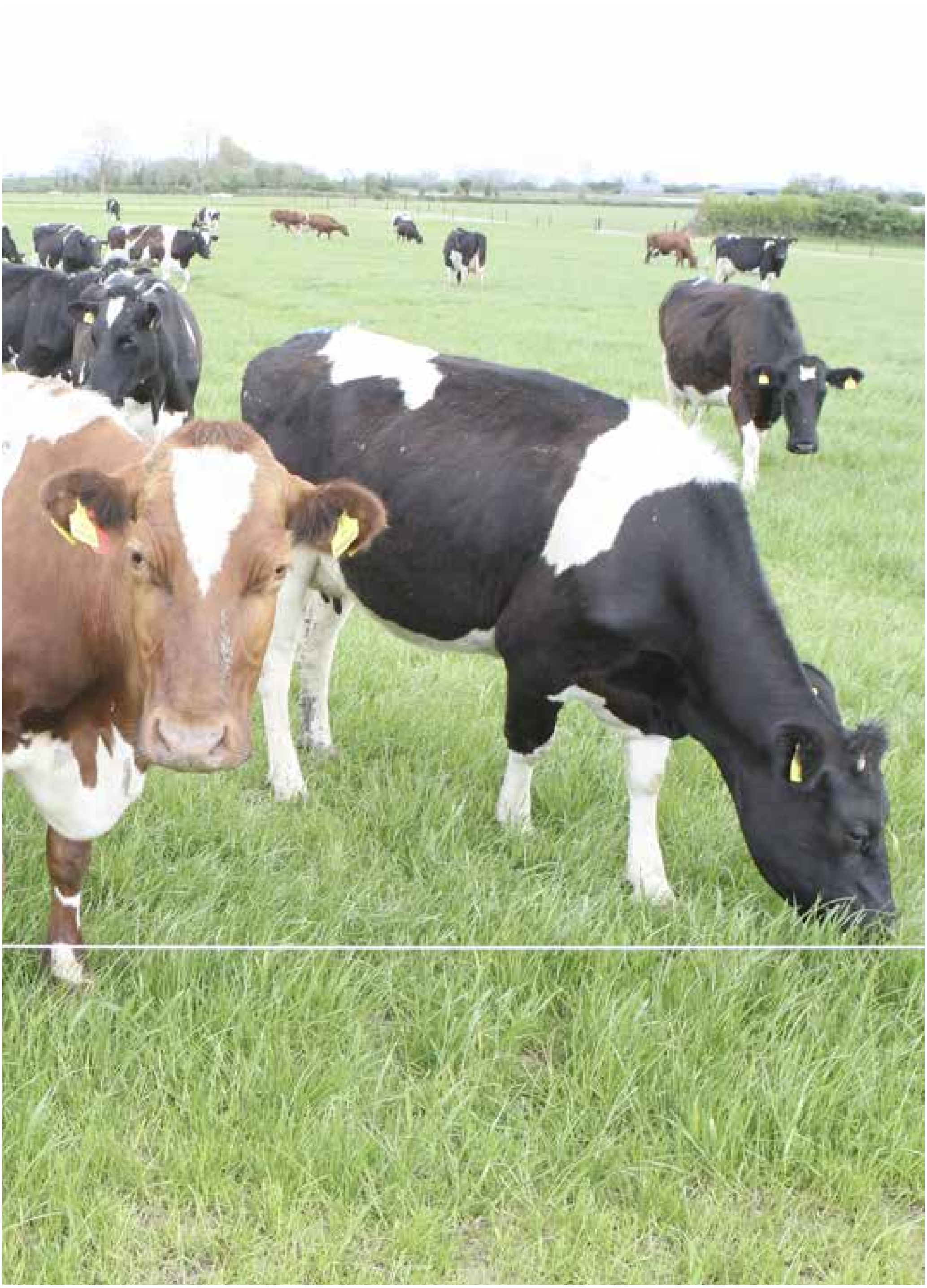
The farm is achieving the financial targets in the business plan (Table 1). Milk output has been lower than planed as all first lactation animals were bought, but herd fertility, animal mortality, and herd health costs have also all been lower than planned. Combined with a higher than planned milk price, the farm has been achieving the financial targets in the business plan. 2013 is forecast to be the most challenging year from a cash flow perspective. This is the first year the farm will have capital repayments on the farm loan; prior to this it was interest only. This is included in the annual budget for 2013, and with the current milk price the farm accounts will show a cash surplus this year after all payments.

Table1. Key performance figures to-date and projected figures for 2013

	2011	2012	2013
Cows milked	195	197	225
Stocking rate (LU/ha)	3.12	2.84	2.89
Kg MS/cow	265	326	345
Kg MS/ha	817	921	1000
Grass grown (t DM/ha)	12.25	11.53	
Grass utilised (t DM/ha)	10	9.5	
6 week calving rate %	58	62	78
Mean calving date	28-Feb	22-Feb	16-Feb
Empty rate (13 weeks breeding) %	13	7	
SCC (year average)	142,000	108,000	
Fat %	4.24	4.27	
Protein %	3.52	3.57	
Milk price (cents/litre Nett)	37.61	36.40	
Total sales (€)	268,986	319,416	395,565
Total costs (€)	246,221	317,643	355,999
Surplus cash (€)	22,765	1,779	39,657

Financial budgeting

The initial business plan forms the basis of the operation. In addition, an annual budget for the following year is prepared each winter. This is refined and updated until an accurate budget is in place the start of each year. The actual finances are monitored on a quarterly basis relative to this budget and any adjustments are made as necessary. This is essential to the running of any business.



Planning for Expansion

Tom O'Dwyer[1] and Fintan Phelan[2]

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Summary

Planning will allow dairy farmers to:

- Clarify the future direction for their farm business while anticipating changes in the outside world (strategic plan).
- Identify what needs to happen and improve the decision-making process (operational plan).
- Forecast the future cash flows and identify funding requirements (financial plan).

Ultimately, planning will allow dairy farmers prepare for the future.

Introduction

We are presented with opportunities (chances for progress or advancement) on a daily basis; some we take up and act on, others we decline. The removal of EU Milk Quotas in March 2015 is one such opportunity for the Irish dairy sector. Many dairy farmers are preparing for this opportunity but only those who create strategic, operational and financial plans will realise the full potential of this opportunity.

The three levels of planning

Strategic, operational and financial are the three levels of planning needed by a dairy farmer. Strategic and operational planning involves two different types of thinking. Strategic decisions are directional and over-arching whereas operational decisions primarily affect the day-to-day implementation of strategic decisions. Think of your strategic plan and operational plans answering the 'where do I want to get to?' and the 'what do I need to do to get there' questions, respectively. Your financial plan is a one-year or multi-year forecast of sales, production costs and other expenses; it will project your monthly cash flows and indicate whether your working capital is adequate and indicate the reward for your increased effort and risk. These three stages of planning should not be treated as stand alone entities but rather as interrelated steps in the overall planning process.

Table 1. The differences between strategic, operational and financial plans

	Strategic plan	Operational plan	Financial plan
What?	Sets overall direction and suggests strategies to be followed	Provides information to allow for the day-to-day running of the business	Presents a financial forecast taking account of both the operational and strategic plans
Time frame	Three to five year time frame	One year time frame	One year or multi-year time frame
Questions answered	Where to? What to be achieved?	How? What actions needed?	How much?
Who?	Farm owner plus key stakeholders	Farm owner	Farm owner plus financial adviser
Other	Addresses risk	Addresses control	Identifies reward

You should consult with key stakeholders (e.g. family members, Teagasc Adviser, bank manager, vet) to your farm business in preparing your strategic plan. You (as the owner of the business) are best placed to create your operational plan(s) as you know how your business functions. While the financial plan will be developed from your insights, you will need to consult with your Teagasc Adviser/agricultural consultant/financial planning professional to crunch the numbers and make recommendations in the development of your financial plan. The financial plan must only be created once the strategic plan and operational plans are completed. Many dairy farmers look to advisers to create financial plans to secure funding for on-farm investment without having fully thought through the strategic and operational decisions needed for their farm business. This is a mistake.

What is strategic planning?

Strategic planning is about identifying how to get from where you are now to where, after careful planning, you want to be some years from now. A strategic plan is a written document describing your overall direction and purpose, and the strategies, goals and action plans you will implement over the next three to five years in order to move towards your preferred future. Defining your future destination (your vision) and then planning out the steps to achieve (or a roadmap) your desired future is the essence of strategic planning. The planning process will allow you to prioritise the work to be done and will facilitate making short-term decisions (the operational plan) based on long-term implications.

How do you create a strategic plan?

Table 2 lists the three big strategic planning questions to which a fourth, “Why do you want to get to your new destination?”, can be usefully added. By answering these questions, you will be well on the road to creating a strategic plan for your business.

Table 2. The three big strategic questions

Where are you now?	Benchmarking
Where do you want to get to?	Vision, setting future direction
How will you get there?	High level action plan

Why is it important?

Individual dairy farmers need to spend time thinking about what they really want; they need to be totally clear about their future direction. The removal of EU Milk Quotas in 2015 will provide opportunities for many dairy farmers. But expansion will not be the right move for all dairy farmers. For some, improving on-farm efficiency will be a necessary first step <u>before</u> expansion (increased herd size) is contemplated. Without being absolutely clear on the answers to the key strategic questions, the necessary focus and commitment will not be applied to farm development. Lack of clarity and direction will also result in poor decisions, procrastination (delayed decisions) and increased risk. Now is the time to complete your strategic plan for your farm; the operational and financial plans can follow.

What tools are available?

Teagasc already has a range of tools to assist dairy farmers with operational planning e.g. summer wedge, fertilizer tracker app and financial planning e.g. Teagasc eProfit Monitor, Teagasc Cost Control Planner, Teagasc Farm Business Planner. Teagasc has launched its new strategic planning workbook today and plans to roll out strategic planning workshops later in the year.

Conclusion

Successful business growth requires strategic, operational and financial planning. You can think of it as the three links in a chain. Irish dairy farmers have some experience at creating operational plans but more attention must be paid to strategic and financial planning. In future, being a top-class ‘operations manager’ will not be enough; you will also need to be able to think and plan strategically and financially.

New Dairy 2020: New Entrants to the Irish dairy industry

Roberta McDonald and Brendan Horan

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Summary

- The majority of new entrants to dairying are motivated by the potential to secure the longer term financial position of the family farm and reduce their reliance on Single Farm Payments.
- The average new entrant has a farm of 58 hectares, plans to milk 70 cows and produce over 360,000 litres of milk/annum and has significant potential for further expansion in the future.
- Most new entrants are located in the southeast of Ireland, with over 50 per cent converting from a beef enterprise.
- Dairy farm expansion will protect the future profitability of the farm business, when based on low capital investment costs, using high EBI dairy cattle and where the majority of the milk is produced from a grazed grass diet.

Introduction

In advance of EU milk quota abolition in 2015, the Irish government has decided to allocate ¼ of the annual one per cent increase in milk quota between 2009 and 2015 on a permanent basis to new entrants to dairying. Over four hundred new entrants will have successfully received 200,000 litres of milk quota from the start of the scheme in 2009 to 2014 when it ends. This group of new dairy producers represent the initial evolution of the dairy sector in Ireland post EU milk quotas, and provide a unique opportunity to examine the characteristics of new dairy producers entering the industry post-EU milk quotas.

What are the characteristics of new entrant dairy businesses?

The results of this study indicate that a young and highly educated group of new farmers (Table 1) are using the New Entrant Scheme to enter the Irish dairy industry with the majority converting from beef and mixed enterprise farms. The vast majority (81 %) of new entrants to dairying are located in the south of Ireland (Figure 1), indicating that quota abolition may result in an increased regional bias of milk production. The average land available to a new entrant is 58 ha with a plan for 70 cows, allowing significant potential for milk production expansion on these dairy farms in the future.

Table 3. General characteristics of the average new entrant dairy farmer over the next five years; from the successful application forms of 2009 - 2011 applicants

	Average
Age (yr)	36
Total land (ha)	58
Cow numbers (no.)	70
Stocking rate (LU/ha)	1.74
Milk solids/cow (kg MS/cow)	381

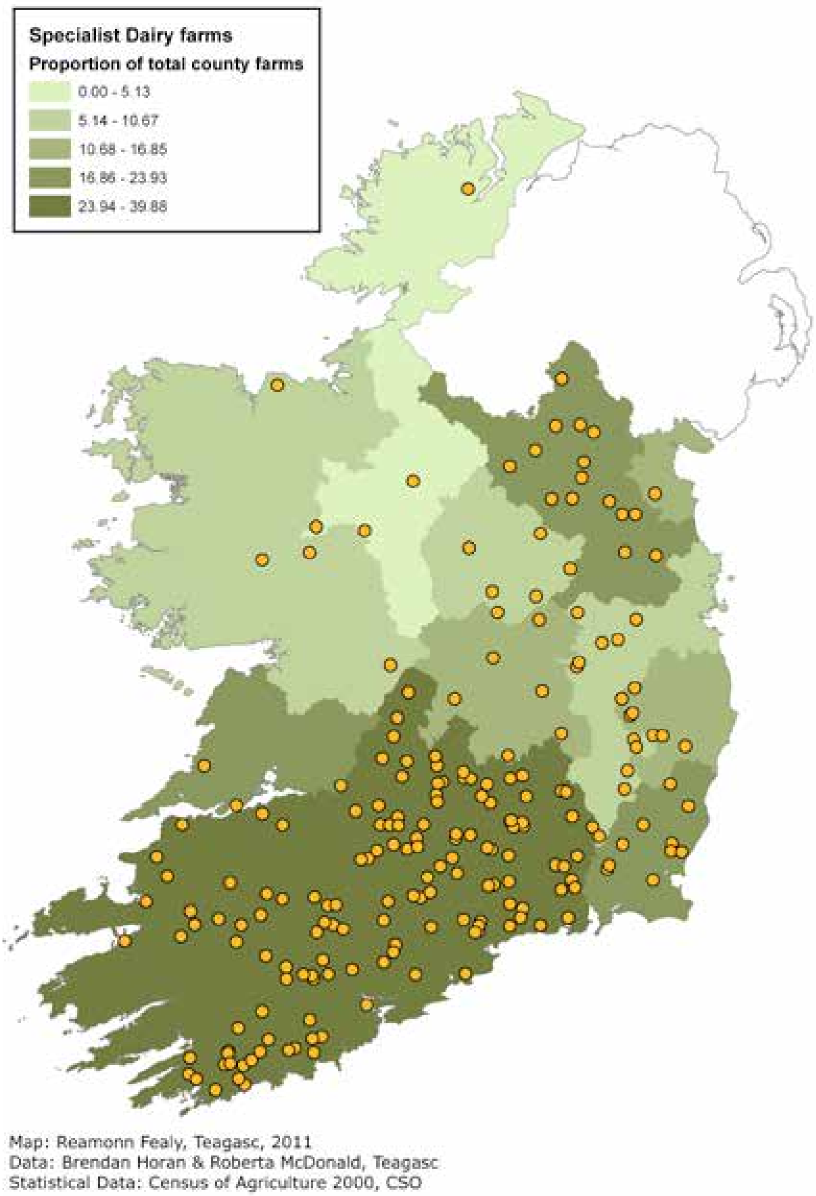

Figure 1. *Geographic distribution of new entrant dairy farms in Ireland during 2009, 2010 and 2011 in relation to the proportion of national specialist dairy farms*

Why should you consider entering dairying?

For the vast majority of new entrants to dairying, this significant decision is motivated by the potential to secure the longer term financial position of the family farm and reduce their reliance on Single Farm Payments. Dairying is the most profitable agricultural enterprise in Ireland today. Irish dairy farms achieved an average net margin per hectare of €478 from 2008-2011 excluding direct payments. In comparison, the net margin per hectare on beef suckler, beef finisher, sheep, tillage and mixed farming enterprises was -€186, -€152, -€122, €9 and €95/hectare, respectively (Figure 2, NFS, various years).

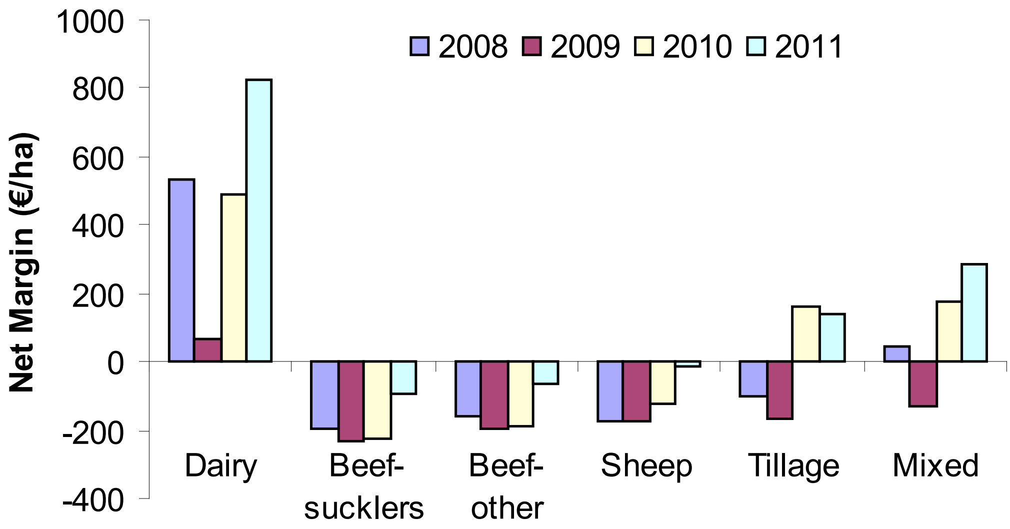

Figure 2. *Net margin/hectare achieved in each enterprise in Ireland from 2008-2011 (National Farm Survey, various years)*

Looking ahead, the overall outlook for the dairy sector is positive based on our profitable grass based milk production model, the opportunity for expansion afforded by milk quota abolition and more generally by the increased international demand for dairy food products. The traditional Irish grass based system provides dairy farmers using best practice grass-based technology with a distinct advantage over international competitors and so new entrants can confidently develop profitable new businesses within the post quota production environment.

The initial performance of new entrant dairy farm businesses

Although resulting in increased business risk and initial cash flow deficits, dairy farm expansion will protect the future profitability of the farm business. As with any new business start up, the initial capital investment outlay to create a new dairy farm is significant and profit margins during the initial years of the infant business can be low. Milk production performance on new dairy farms is generally low, as newly established herds are usually immature and farmers adapt new grazing management skills. Notwithstanding these challenges, the financial performance results from 2012 indicate that these new dairy farms are highly profitable with a net farm profit of nine cents per litre (c/l) achieved (equivalent to an overall farm profit of approx €30,000 excluding Single Farm Payments).

Table 2. A comparison of the profitability of the national average, top 10 per cent and new entrant dairy farmers based on 2012 financial performance			
2012	Average	Top 10%	New Entrants
Cow numbers (No.)	91	99	76
Milk solids1 (kg/cow)	386	403	369
Gross output (c/l)	35	37	33
Fixed costs (c/l)	13	10	12
Variable costs (c/l)	10	7	12
Net Profit (c/l)	12	19	9

Milk solids[1] = fat plus protein yield

What are the challenges and lessons from expansion?

Setting up a new dairy farm or expanding the farm business is not without its difficulties. Based on our work with new entrants, the following experiences were reported by the new dairy farmers;

- Rapidly expanding dairy farms require a significant working capital reserve to alleviate financial risk during these early development years.
- The large capital investment required necessitates that low cost options (such as upgrading old sheds for animal accommodation, wintering pads, etc.) are used.
- The project management aspect of setting up a new dairy farm adds a significant workload burden while continuing with other work both on and off-farm. These new projects should be planned well in advance and professional help should be sought to avoid expensive mistakes.
- Many new dairy entrants are surprised by the immediate and long term impacts of grassland management on animal performance and so learning the key skills to maintain healthy good quality grazing swards is essential.

Land Drainage Design and Installation

Pat Tuohy[1], Owen Fenton[2] and James O'Loughlin[1]
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[2]*Teagasc, Johnstown Castle, Environment Research Centre, Wexford*

Summary

- The first step of any drainage works is a detailed investigation into the causes of poor drainage using soil test pits.
- Two main types of drainage system exist: a groundwater drainage system and a shallow drainage system. The design of the system depends entirely on the drainage characteristics of the soil.

Introduction

The objective of any form of land drainage is to remove excess water from the soil, to lower the water table, and to reduce the period of waterlogging. This lengthens the growing season, the grazing season, the utilisation of grazed grass by livestock and the accessibility of land to machinery. A number of drainage techniques have been developed to suit different soil types and conditions. Broadly speaking, there are two main categories of land drainage:

- **Ground water drainage system:** A network of deeply installed piped drains exploiting permeable layers.
- **Shallow drainage system:** Where the permeability (the ability of the soil to allow water to move through it) of the soil is low at all depths and needs to be improved.

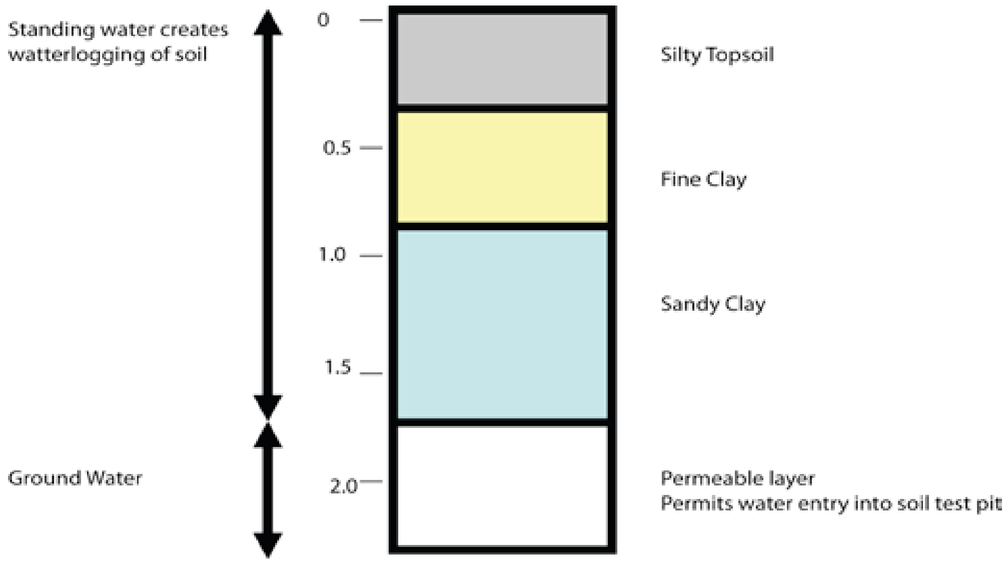

Figure 1. *A typical heavy soil profile. If a free draining layer (called "permeable layer" here) is present at any depth then a ground water drainage system is the most appropriate solution, if not then a shallow drainage system is required*

A number of test pits (at least 2.5 m deep) should be excavated within the area to be drained. The test pits should be dug in areas that are representative of the area as a whole. As the soil test pits are dug, the faces of the pits are observed, soil type should be established and the rate and depth of water seepage into the soil test pit (if any) recorded. Visible cracking, areas of looser soil and rooting depth should be noted as these can convey important information regarding the drainage status of the different layers. The depth and type of the drain to be installed will depend entirely on the interpretation of the characteristics revealed by the test pits.

Groundwater drainage system

In soil test pits where there is strong inflow of water or seepages from the faces of the pit walls, layers of high permeability are present. If this type of scenario is evident on parts of your farm it would be best to focus on these areas first as the potential for improvement is usually very high. Under these circumstances the use of a piped drainage system is advised. The installation of a piped drain at the depth of inflow will facilitate the removal of ground water assuming a suitable outfall is available. Conventional piped drains at depths of 0.8 to 1.5 m below ground level have been successful where they encounter layers of high permeability. However, where layers with high permeability are deeper than this, deeper drains are required. Deep piped drains are usually installed at a depth of 1.5-2.5 m and at spacings of 15-50 m, depending on the slope of the land and the permeability and thickness of the drainage layer. Piped drains should always be installed across the slope to intercept as much groundwater as possible, with open drains and main piped drains running in the direction of maximum slope.

Shallow drainage system

Where a test pit shows little ingress of water at any depth a shallow drainage system is required. These soils with no obvious permeable layer and very low hydraulic conductivity are more difficult to drain. Shallow drainage systems are those that aim to improve the capacity of the soil to transmit water by fracturing and cracking it, these include mole drainage and gravel mole drainage. Mole drainage is suited to soils with high clay content which form stable channels. Mole drains are formed with a mole plough comprised of a torpedo-like cylindrical foot attached to a narrow leg, followed by a slightly larger diameter cylindrical expander. The foot and trailing expander form the mole channel while the leg creates a narrow slot that extends from the soil surface down to the mole channel depth.

The success of mole drainage depends on the formation of cracks in the soil that radiate from the tip of the mole plough at shallow depth. Gravel filled moles employ the same principles as ordinary mole drains but are required where an ordinary mole will not remain open for a sufficiently long period. This is the case in unstable soils having lower clay content. The mole channel is formed in a similar manner but the channel is then filled with gravel which supports the channel walls. The gravel mole plough carries a hopper which controls the flow of gravel. During the operation the hopper is filled using a loading shovel or alternatively a belt conveyor from an adjacent gravel cart. Gravel moles require a gravel aggregate within the 10-20 mm size range to ensure they function properly.

Land drainage booklet launched today

A new practical guide to grassland drainage is being launched today. Please call to the land drainage or heavy soils group board for a copy. It will also be accessible via the Teagasc website, **www.teagasc.ie/publications**.

Implications of Expansion for Lameness and the Welfare of Dairy Cows

Laura Boyle
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Summary

- Cow welfare is an important component of sustainable dairying.
- Cows in pasture based systems have welfare problems related to exposure to inclement weather, the variability of grazed grass as a feedstuff and poor over wintering conditions/ infrastructure.
- Cow welfare problems are commonly reflected in lameness which causes considerable pain.
- Expansion poses additional threats to cow welfare which could exacerbate lameness.
- Improving underfoot conditions to maximise cow comfort while walking, standing and lying will protect cow welfare during expansion thereby minimising lameness and the associated time and money spent on cow care.

Introduction

Scientific evidence suggests that there are advantages and disadvantages to dairy cow welfare associated with both pasture based and year round confinement systems of milk production. However, consumers perceive pasture based systems as 'natural' and therefore better for cow welfare than confinement systems. This offers a marketing advantage to Irish dairy products. Irish systems of milk production will also have an advantage over countries in which milk is primarily produced from confined cows should legislation protecting cow welfare be passed in the EU. It is speculated that such legislation would ensure that all dairy cows have some outdoor access. Such advantages could be threatened by expansion in the Irish dairy industry because of associated risks to cow welfare. The culmination of a variety of welfare problems for dairy cows is often reflected in lameness. In Northern Ireland the average prevalence of lameness is 33 per cent, while the prevalence in southern Ireland is lower at 20-25 per cent, this is still too high. The European Food Safety Authority compiled an influential set of reports on dairy cow welfare in 2009. They concluded that 10 per cent is the maximum acceptable prevalence irrespective of the way milk is produced. One of the main constraints on achieving this is that farmers typically underestimate the scale of the problem as well as its impact on cow welfare and farm finances. Lameness is the main welfare concern for dairy cows because of its high prevalence and the associated pain. Lameness also reduces fertility and milk yield. Economic losses could be as high as €200/lameness case if such productivity losses are taken into account.

Risk factors for lameness associated with walking and milking

The main impact of larger and often more fragmented herds is that cows must walk longer distances to and from milking. In general exercise is beneficial for cow welfare and walking *per se* is not a risk factor for lameness provided that cows are allowed to walk at their own pace, on appropriate roadways and in dry conditions. However, time and labour pressures in large herds means that cows are often rushed during herding by the use of dogs/quads etc. such that they 'bunch up' and cannot avoid stony or water logged sections of the road which are detrimental to hoof health. Even during years of relatively 'normal' weather patterns, early turnout in the spring and extended grazing in the autumn means that cows are at pasture during periods of high rainfall. Moisture causes softening of the skin of the foot and of the claw horn making both regions more susceptible to penetration by foreign bodies while walking (as well as to bacterial infections leading to problems such as foot rot). High rainfall also makes it very difficult to maintain farm roadways in optimal condition for high volumes of cow traffic which further compounds the problems outlined above. Concrete flooring is also a major risk factor for lameness because it disturbs blood circulation in the foot and places unnatural strains on the claw horn. In spite of short housing periods in some parts of the country, cows at grass still spend a considerable amount of time every day standing and moving around on concrete. The 2001 Teagasc labour study showed that milking (cluster on/off) takes between 1.5 and 2.5 hr. This time will not change much with expansion as larger herds are usually matched with efficiencies in the milking process. However, this means that the last cows to enter the parlour, which are often the lame animals, could be standing on concrete for up to 5hr/day combined with long walking distances. The labour study also showed that 40% of cows were held at the parlour, often on concrete, after milking. Therefore even those cows which are milked early will spend a considerable amount of time standing on concrete. Finally hurrying large groups of cows into position for milking can cause injury through slips/falls on concrete.

Solutions

Many cases of lameness could be prevented simply by improving conditions underfoot. This requires that the farm infrastructure is improved such that cow comfort while walking, standing and lying is maximised. Rubber flooring in handling/milking areas acts as a shock absorber and reduces pressure on the sole which may even speed up the healing process in lame cows. Strategic positioning of rubber can also encourage cows to move from the collecting yard into the parlour which speeds up milking. Farm roadways are often designed more with the needs of the farm machinery, rather than the animal, in mind. There is growing interest in the use of 'cow tracks' made from rubber, recycled tyres or woodchips which offer better protection to the foot. Providing shelter at pasture would not only offer cows protection from inclement weather, but would also ensure dry areas for lying and standing such that the hooves are not continuously wet. Routine preventative paring of all cows in the herd at least once p.a. is crucial to managing lameness. The Farm Relief offers an excellent hoof paring service. Although producers must aim to keep production costs low, the financial returns from improved hoof health will far outweigh the costs associated with this service. Early detection of lameness is compromised in larger herds particularly as the ratio of cows to stockpeople is high. Monthly locomotion scoring helps to identify lameness which when treated promptly will have a much lower impact on cow welfare and milk production. Finally, genetics and technologies such as automatic methods of lameness detection and automatic milking, which reduces the amount of walking done by cows at pasture, could also have a role to play in addressing lameness problems in larger herds.

Conclusions

In an era of increasing consumer concerns about food quality, safety and integrity, cow welfare is an important component of sustainability. Lameness is a threat to the sustainability of expanding pasture based systems of milk production because diseases causing pain in farm animals are increasingly unacceptable to consumers. This threat can be addressed by taking proactive steps to improve/protect the welfare of dairy cows in expanding herds.

SUSTAINABLE INTENSIFICATION

Reducing Greenhouse Gas Emissions from Dairy Systems

Donal O'Brien and Laurence Shalloo

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Summary

- Ireland's non emission trading sector, which includes agriculture, is committed to reducing greenhouse gas (GHG) emissions by 20 per cent by 2020 relative to 2005 levels.
- Dairy producers can reduce GHG emissions/unit of milk without incurring extra costs and increase milk output by improving the genetic merit of their herd, extending the grazing season and increasing N use efficiency.
- Grass-based dairy systems emit less GHG emisssions/unit of milk than confinement systems.

Introduction

In contrast to most developed countries, with the exception of New Zealand, milk production is an important source of Ireland's national GHG emissions (≈ 10 %). A key goal of the Food Harvest 2020 report is to increase milk output by 50 per cent by 2020 compared to the 2007-09 average. It is projected that without adopting measures to reduce GHG emissions, achieving this target will in part cause Irish agricultural GHG emissions to be seven per cent higher in 2020 relative to 2010 levels. However, Irish agriculture is part of the EU non emission trading sector, which is committed to reducing GHG emissions by 20 per cent by 2020 relative to 2005. Thus, there is a need to apply measures to mitigate GHG emissions per unit of milk at farm level.

Assessing GHG mitigation measures

Several studies have investigated the potential to reduce GHG emissions. Examples of strategies that have been reported to reduce GHG emissions include supplementation of livestock diets with oils, and improving grassland management. Nevertheless, most studies only assess the effect mitigation strategies have on a single source of GHG emissions, which may increase emissions from other sources, thereby resulting in a net increase in GHG emissions from dairy systems. Thus, a dairy farm GHG model is required to evaluate the effect mitigation measures have on all major GHG emissions generated by a dairy farm: these include carbon dioxide (CO_2), nitrous oxide (N_2O), and methane (CH_4). A GHG model was developed to evaluate mitigation strategies using both the Life cycle assessment and the Intergovernmental Panel on Climate Change methods. The model quantifies the effect mitigation measures had on annual GHG emissions in kg of CO_2 equivalent per kg of milk solids (MS) for both methods.

Mitigation potential

The evaluation of GHG mitigation strategies demonstrated that improving the efficiency of production increases profitability and reduces GHG emissions/kg of MS. The key farm strategies that can be readily applied to reduce GHG emissions are improving genetic merit via the Economic Breeding Index (EBI), extending the length of the grazing season and increasing N use efficiency. The analysis showed that for every €10 increase in EBI, GHG emissions/kg of MS declined by two per cent. Increasing the EBI of a dairy herd improves genetic herd traits for fertility and survival, which reduces costs and GHG emissions from replacements required to maintain the herd. Extending the grazing season by one day reduces GHG emissions by 0.14-0.17 per cent/kg of MS by reducing GHG emissions from energy use and manure storage and reduces the proportion of grass silage in the diet, which improves overall feed digestibility. Improving the digestibility of feed increases animal productivity and reduces the proportion of dietary energy lost as methane. Improving N use efficiency by increasing the utilisation of slurry; synchronising slurry and fertiliser application with grass growth, and incorporating clover into the sward reduces GHG emissions from artificial N fertiliser. The GHG model showed that increasing N efficiency via decreasing the farm N surplus by 10kg/ha reduces GHG emissions/kg of MS by one per cent.

Grazing versus confinement

International reports by the FAO documented that grass-based dairy systems in temperate regions emit the lowest GHG emissions/unit of milk. In addition, the EU Joint Research Commission reported that Irish dairy systems emitted the joint lowest GHG/unit of milk in the EU. However, such reports have only considered the average performing farm of a nation or region. Thus, the GHG model described previously was used to assess emissions from a high performance Moorepark grass-based dairy farm and top performing UK and USA confinement dairy farms (Table 1).

Table 1. Physical performance and greenhouse gas (GHG) emissions of a high performance Irish grass-based dairy system, UK and USA confinement dairy systems

Item	Unit	Irish	UK	USA
Milk production	kg milk/cow/yr	6,262	10,892	12,506
Milk fat	%	4.47	3.95	3.58
Milk protein	%	3.55	3.14	3.17
Length of lactation	Days	305	351	358
Cull rate	%	18	34	38
Average BW	kg	543	613	680
GHG excluding sequestration	kg CO_2-eq/kg ECM	917	898	920
GHG including sequestration	kg CO_2-eq/kg ECM	804	883	884

ECM = Milk corrected to 4 per cent milk fat and 3.3 per cent milk protein

The comparison showed there was little difference between dairy systems GHG emissions when carbon removal (sequestration) was excluded, but including sequestration resulted in the confinement dairy systems emitting 10 per cent greater GHG emissions/unit of milk. This was because a large proportion of the feed of the confinement dairy systems was derived from arable land that does not remove carbon. However, the carbon removal capacity of grassland is variable and requires research.

Conclusions

Grass-based dairy systems emit less GHG emission/unit of milk than confinement dairy systems. Measures can be implemented by grass-based dairy farmers to further reduce GHG emissions while facilitating increased milk output and profitability.

Auditing the Carbon Footprint of Milk Production Systems

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Summary

- Internationally, the Intergovernmental Panel on Climate Change (IPCC) method is used to assess compliance with national greenhouse gas (GHG) targets, but life cycle assessment (LCA) is the preferred method to audit GHG emissions/unit of milk (carbon footprint).
- A comparion of the methodologies showed that they disagreed on ranking of the carbon footprint of dairy systems, because the IPCC method does not quantify all GHG emissions associated with milk production.
- Research results imply that reducing emissions to comply with International policy and accounting requirements might actually result in an increase in global emissions.

Introduction

The FAO report "Livestock's Long Shadow" in 2006 highlighted that globally livestock systems emitted a similar volume of GHG emissions as the transport sector. This subsequently stimulated concerns amongst some consumers, which led to initiatives by major retailers such as Tesco to determine the carbon footprint of all of their products. However, there are substantial differences associated with systems of dairy production and the methodologies used to calculate their emissions and carbon footprint, globally. In the International literature auditing methodologies follow two clear paths, Life cycle assessment (LCA) method, and the Intergovernmental Panel on Climate Change (IPCC) method. The objectives of this study were to compare the IPCC and LCA auditing methods to estimate the carbon footprint of grass-based and confinement dairy systems.

Carbon auditing

A model was developed to audit the carbon footprint of dairy farms. The model estimates the main GHG emissions: carbon dioxide, nitrous oxide, and methane using both the LCA and the IPCC methodologies. The IPCC method is a national approach used to evaluate compliance with GHG reduction targets. The methodology only considers GHG emissions from on-farm sources. In contrast, the LCA approach quantifies all emissions associated with dairy production up to the point milk is sold from the farm e.g. includes emissions from fertiliser manufacture. The model converts annual GHG emissions of a dairy system to a standard unit known as carbon dioxide equivalents (CO_2-eq) and expresses the carbon footprint in kg of CO_2-eq/kg of milk solids. The carbon footprint in the model was allocated between milk and meat using a physical allocation approach developed by the International Dairy Federation, where impacts were related to the cow's use of energy to produce milk and meat.

Dairy systems

This model was applied to evaluate the carbon footprint of grass-based and confinement dairy systems located in Moorepark. Spring-calving Holstein-Friesian cows were grouped based on genetic merit, parity, expected calving date, body condition score and predicted milk yield and assigned randomly to either the grass or confinement system**.** Grazed grass was the main feed offered in the grass-based system. Grass silage and concentrate were offered when pasture growth was unable to meet requirements. Total mixed ration was fed in the confinement system. The total mixed ration offered during lactation consisted of (g/kg DM) maize silage (267), grass silage (223), molasses (55), barley straw (20) and concentrate (436).

Influence of GHG accounting method

The comparison of grass-based and confinement dairy systems showed that the carbon footprint per kg of milk solids was eight per cent lower for the confinement system when compared using the IPCC method (Figure 1), but the LCA comparison show that the confinement system emitted a 16 per cent higher carbon footprint. The dominant sources of GHG emissions in the grass-based system according to the IPCC method were methane from cattle (55 %), emissions from manure storage and from urine excretion by grazing cattle (31 %), and emissions from mineral fertiliser application (13 %). Methane from cattle (58 %) and emissions from manure storage (33 %) were the main contributors to the carbon footprint of the confinement system. The LCA results showed that the main contributors to the carbon footprint of the grass-based system were methane from cattle (44 %), emissions from manure storage and manure excreted by grazing cattle (25 %), and emissions from mineral fertiliser application and manufacture (21 %). The main contributors to total GHG emissions in the confinement system, based on the LCA approach, were methane from cattle (36 %), emissions from the production of concentrate (29 %), and emissions from manure (24 %).

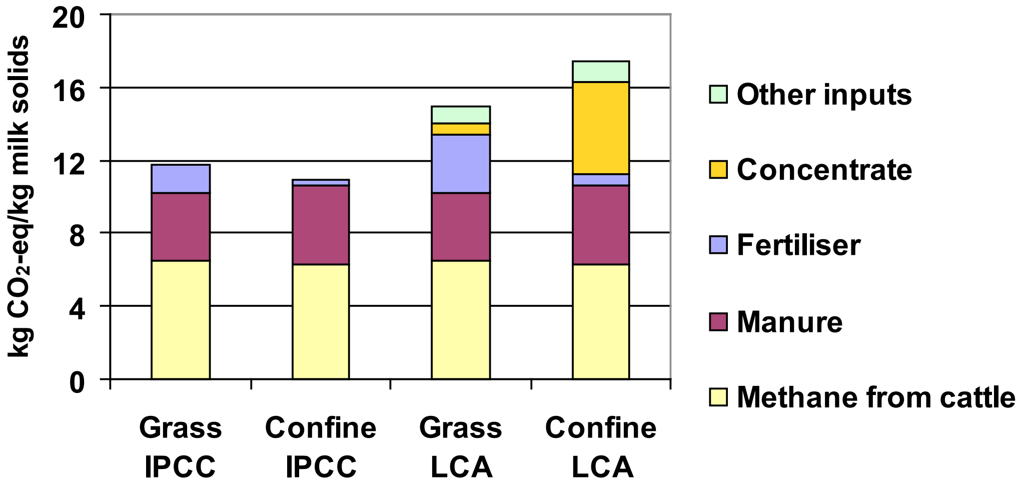

Figure 1. *The carbon footprint per kg of milk solids of a grass-based and a confinement (confine) dairy system calculated using Intergovernmental Panel on Climate Change (IPCC) method and life cycle assessment (LCA)*

Conclusion

This study highlights that it is incorrect to consider only components of the dairy system relevant for policy reporting such as that used by IPCC when estimating the carbon footprint of dairy produce. Instead, LCA methods which consider on and off-farm GHG emissions should be used. Thus, reform of the present policy framework is needed to ensure that mitigation strategies result in reduced global emissions and not just national emissions.

Sustainable Nutrient use Efficiency on Dairy Farms across NW Europe

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Summary

- The objective of the DAIRYMAN project (**www.interregdairyman.eu**) was to improve resource use efficiency on dairy farms in 10 regions of North West Europe (NWE).
- Fertiliser N use in Ireland of approximately 200 kg ha^{-1} was higher than other regions in the study due to our high reliance on grass production as feed for cows.
- The N surplus (N imports – N exports) on 21 Irish dairy farms was 170 kg ha^{-1}, which to close to the average of pilot farms in other regions in the study.
- Average P surplus on pilot farms across the NWE ranged between 4 and 17 kg ha^{-1}, however there was a deficit of P on the Irish farms of approximately -2 kg ha^{-1}.
- The deficit of P on Irish farms can be attributed to the relatively low levels of concentrates fed per cow and very restrictive P fertilisation of grassland.

Introduction

Dairy production is an important economic activity in North West Europe (NWE). Climate and soils are suitable and there is a large affluent local market for dairy products. In the past two decades there is increasing pressure stemming from various EU Directives to reduce dairy farm emissions to water and to the atmosphere and to improve other aspects of the environmental footprint. In addition to these environmental pressures, dairy farmers are coping with increasingly volatile milk price and input costs, high investment costs (in slurry storage, for example) and narrow profit margins.

DAIRYMAN is a project part-funded by INTTERREG aimed at improving resource use efficiency on dairy farms in NWE. The objective is to compare the performances of the pilot farms in the 10 regions (Table 1). On-farm data collection took place over a three year period from 2009 to 2011.

Table 1. Pilot farms involved in the Dairyman Project

Code	Country	Region	No. of pilot farms	Annual milk output (L per farm)
BF	Belgium	Flanders	13	778,464
BW	Belgium	Wallonia	20	520,553
FB	France	Brittany	11	469,338
FL	France	Pays De La Loire	10	584,018
FN	France	Nord Pas de Calais	7	556,635
GE	Germany	Baden-Württemberg	14	887,616
LU	Luxembourg		6	453,948
IN	United Kingdom	Northern Ireland	9	806,849
IR	Ireland		21	512,815
NL	The Netherlands		16	1,094,714

N balances on farms

Inputs of fertiliser N, which averaged approximately 200 kg ha^{-1} in Ireland and Northern Ireland, were consistently greater than the other regions in the study. This reflects the greater reliance in Ireland on grassland as feed for cows compared with the other regions. In the other regions there was higher reliance on maize silage, which has a reduced requirement for N than grassland, and higher input of concentrate feed. Therefore, although fertiliser N input was relatively high on Irish farms, relatively low imports of concentrate and other feeds resulted in surplus N on Irish farms (170 kg ha^{-1}) being close to the average of the regions in the study (Figure 1).

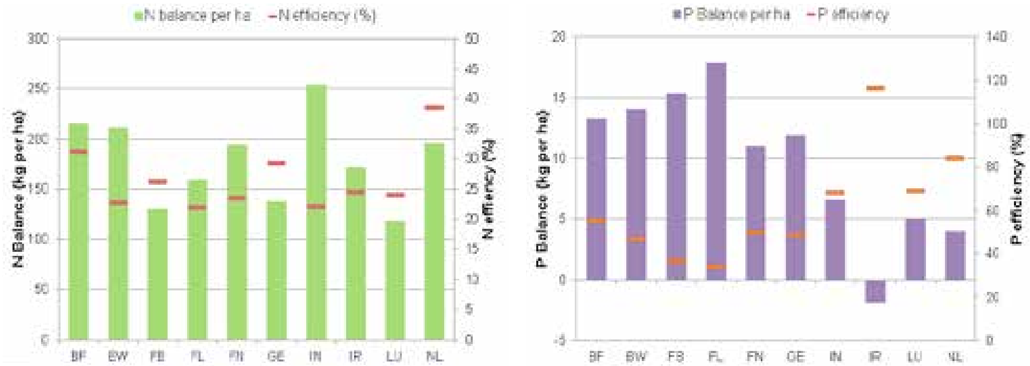

Figure 1. *N and P balances and N and P use efficiency on pilot farms*

P balances on farms

The Irish farms stood out very clearly in terms of P balance and P use efficiency (Figure 2). Whereas, average P surplus on farms typically ranged between four and 17 kg ha^{-1} in the other regions, there was a deficit of P on the Irish farms; more P was being exported from Irish farms than imported onto Irish farms. The reason for the relatively higher surpluses in the other regions can be largely attributed to the import of concentrate and other feeds as well as the absence of export of manure. The deficit of P on Irish farms can be attributed to the relatively low levels of concentrates fed per cow and low P fertilisation of grassland. Low P fertilisation of grassland is attributable to the very restrictive regulations governing P fertilisation of grassland in Ireland and the sharp increase in the cost of artificial fertiliser P in recent years.

Economic performance

The Irish farms had the second lowest milk price; the lowest was Northern Ireland. The Irish farms had the lowest costs and the highest family farm income and was the least vulnerable to low milk price in 2009 and to rising concentrate costs in recent years compared with the pilot farms in the other regions.

Conclusions

Low costs on Irish farms tended to protect farm income compared with European counterparts, particularly in the context of rising concentrate costs. Although fertiliser N use was higher, N balances on Irish farms was close to average across the regions in NWE involved in DAIRYMAN. The P deficit on Irish farms can be, in part, attributed to the very restrictive legislation governing P fertilisation of grassland in Ireland. Nutrient management and particularly management of P, K and lime was identified as an important weakness on Irish pilot farms in this study.

Managing Soiled Water on Dairy Farms

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Summary

- Dairy soiled water is water collected from concreted areas, hard stand areas and holding areas for livestock that has become contaminated by livestock faeces or urine, and parlour washings and must be managed in compliance to the Nitrates Directive.
- On average 10,000 litres (10m^3) of dairy soiled water are produced per cow per year, with an average nutrient content of 0.6 kg/m^3 nitrogen (N), 0.08 kg/m^3 phosphorus (P) and 0.6 kg/m^3 potassium (K).
- Economic savings can be made by reducing the quantity of dairy soiled water produced, while utilising low cost storage and application methods combined with strategic application during the growing season for optimum nitrogen utilisation and grass growth response.

Introduction

In Ireland, the future increase in cow numbers on farms will lead to the production of greater volumes of wastewater, which will require effective and economically optimum management strategies. In addition to herd size, the dairy production system will affect the optimum choice around dairy soiled water management. Dairy soiled water is water collected from concreted areas, hard stand areas and holding areas for livestock that has become contaminated by livestock faeces or urine, and parlour washings and must be managed in compliance to the Nitrates Directive.

Quantity produced and nutrient content

Soiled water is legally defined in Ireland as having a five day biochemical oxygen demand (BOD) of < 2,500 mg/litre, < 1 % dry matter (DM). It has a minimum storage requirement of 10 days and can be applied all year round based on the Nitrates Directive (SI No.610, 2010). On Irish dairy farms, approximately 10,000 litres (10m^3) of dairy soiled water are produced per cow per year. The average nutrient content of dairy soiled water is 0.6 kg N, 0.08 kg P and 0.6 kg K/m^3 (Table 1). At a stocking rate of 2.5 cow/ha, the dairy soiled water produced on farm could supply approximately 17.2 kg of N, 2.3 kg of P and 15.8 kg K/ha across the farm annually.

Table 1. Mean dairy soiled water nutrient concentrations and annual production

Nutrient	Mean Concentration (kg per m^3)	Kg per cow per year
Total Nitrogen (N)	0.6	6.9
Total Phosphorus (P)	0.08	0.82
Potassium (K)	0.6	6.3

Grass growth response and economic value of dairy soiled water

The N in dairy soiled water can achieve 80 per cent of the grass growth response as CAN fertiliser (Figure 1). Applying dairy soiled water at rates of 30-45 m^3/ha per application (22 kg N/ha per application), from May to August will produce an additional 5 tonne of DM/ha/year compared to no fertiliser being applied. This is equivalent to a grass growth response of approximately 22 kg of DM/kg of N applied. Assuming costs of €330 a tonne for CAN, €450 a tonne for muriate of potash (50% K) and €425 a tonne for superphosphate (16% P). Based on a stocking rate of 2.5 cow/ha, this is an average total cost saving of €32/ha/year.

Managing dairy soiled water

In Ireland, all farmers are obliged to have adequate slurry storage capacity in compliance to the Nitrates Directive. Where livestock excreta and soiled water are mixed in a collecting yard tank or slurry tank, this material is characterised as slurry and cannot be spread during the closed period. The economic costs associated with dairy soiled water management are, the costs associated with storage and application. While savings can be obtained from dairy soiled water by utilising the nutrients within it as a fertiliser. The main factors influencing storage cost is the type of storage used and the quantity of storage required. This is a reflection of the quantity produced and storage period. Likewise the main factors influencing application cost, is the method of application and the quantity to be applied. Economic savings can be attained by reducing the quantity of dairy soiled water produced while using low cost storage and application methods. Combing these with strategic application during the growing season for optimum grass DM response, will generate the greatest economic savings. In spring calving grass based dairy systems, extending the grazing season length and allowing dairy soiled water to be stored with slurry, reduces the costs associated with dairy soiled water storage. As dairy soiled water is utilising un-used on farm slurry storage, reducing the need for separate dairy soiled water storage. This emphasises the importance of proper facilities for managing slurry and soiled water to reduce costs while protecting the environment and maximising the nutrient value.

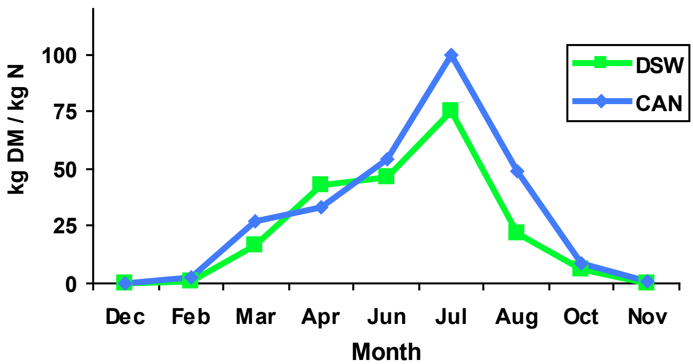

Figure 1. *The average grass growth response (kg DM/kg N) from dairy soiled water (DSW) and CAN fertiliser (CAN)*

Conclusion

When dairy soiled water is managed correctly, greater savings can be attained by reducing the quantity of dairy soiled water produced while using low cost storage and application methods. Combing these with strategic application during the growing season will achieve optimum grass DM response and greatest economic savings.

TEAGASC FOOD RESEARCH PROGRAMME

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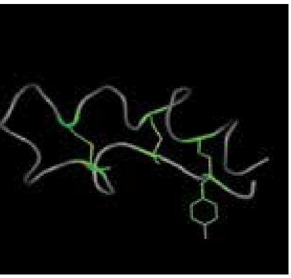

1. Food Biosciences

Introduction

The core objective of the Food Biosciences Department is to engage in advanced research and technology development in support of the Irish Agri-Food industry sector. Activities are organised into three research areas: an extensive Food for Health sub-programme; a Cheese Microbiology and Biochemistry sub-programme and a Milk and Product Quality sub-programme.

The Food Biosciences Department is a partner in the Alimentary Pharmabiotic Research Centre (www.ucc.ie/research/apc), Food for Health Ireland (www.fhi.ie), NutraMara (www.nutramara.ie) Eldermet (http://eldermet.ucc.ie), and the Irish Phytochemical Food Network (www.ipfn.ie).

The objectives are:

- To extract and/or modify food components and provide bio-functional molecules, as food solutions to address key societal diet related health concerns including gut health, cardiovascular disease, obesity, diabetes and infant nutrition.
- To exploit micro-organisms, microbial metabolites and bacteriophage as agents to control deleterious or pathogenic organisms in food systems or the gastrointestinal tract.
- To focus on the application of micro-organisms and their enzymes to impact on the sensory, textural, techno-functional properties and health benefits of a range of foods, with particular emphasis on cheese.

Food for Health: Research on the key societal diet related health concerns focuses on:

- Extraction and isolation of bioactive components from a range of food grade biological sources (milk, meat and marine origin).
- Extraction of phytochemicals from fruits, vegetables and cereals.
- Application of high throughput bioassays to screen for putative bioactive compounds
- Identification and structural characterisation of bioactives.
- Elucidation of the physiological mechanism(s) of action of bioactive molecules.
- Assessment of bioavailability
- Understanding the relationship between gut microflora and health status, and the potential of food to programme a healthy gut microflora.
- Biocontrol agents (bacteriocins and bacteriophage) for spoilage/pathogen control.

Cultures and flavour analysis: Research focuses on the:

- Application of micro-organisms and enzymes to the manufacture and ripening of cheese.
- Selection, identification and production of novel starter cultures of commercial interest.
- Investigating approaches to control and modulate the key sensory properties of cheese.
- Demonstration of the natural health benefits of cheese and application of novel approaches to enhance such benefits.

Milk Quality: While milk produced in Ireland is highly regarded there is an ongoing need to ensure that quality standards are maintained. Milk quality research is a cross departmental activity in the Food Programme and performed in association with AGRIP and focuses on:

- The microbial quality of raw milk.
- The growth of spore forming bacteria in milk processing streams.

2. Food Chemistry and Technology

Introduction

The Food Chemistry & Technology Department is located at both the Teagasc Food Research Centres, with dairy science carried out primarily in Teagasc Moorepark and meat and cereals research at Teagasc Ashtown.

Dairy research focuses on cheese, infant formula and dairy-based ingredients. Meat research focuses on quality, whole chain management and recovering value from meat processing streams. Cereals research is focused on product quality and innovation in the bakery industry.

The objectives are:

- To understand proteins, minerals and other ingredient interactions in food systems.
- To understand the impact of ingredient composition, processing and storage conditions on micro- and macro-structural properties, and how this impacts the quality of dairy, meat and cereal products.
- To facilitate product modification and process optimisation through intelligent process design.
- To extract value from meat processing waste streams and by-products.
- To add value to an expanding milk pool.

Ingredient development and Infant formula/ nutritional beverage research focuses on:

- The design of 'SMART' protein based ingredients in dehydrated form suitable for export *via* understanding of protein chemistry and the effects of thermal processing.
- Investigating the control of protein aggregation, mainly by understanding self aggregation of whey proteins and interaction with casein.
- Studying the interactions of proteins, carbohydrates and minerals in concentrated colloidal systems through optimisation of formulation and processing conditions.

Cheese research focuses on:

- Developing non-cheddar table cheeses and cheeses/cheese ingredient products for food service.
- Investigation of structure/function relationships and physical properties (e.g. macrostructure, rheology, functionality, opacity) by controlling protein-protein interactions, protein-mineral interactions, and product structure *via* alteration of milk composition, milk treatments, process modifications, type/level of added ingredients, and/or storage conditions.
- The development of 'SMART' processes for cheesemaking.
- Cheesemaking efficiency/component recovery and influence of stage of lactation and manufacturing process.

Meat research focuses on:

- Meat quality from a whole-chain meat management perspective.
- The application of genomic, proteomic, metabolomic and imaging technologies to elucidate underlying post-mortem molecular mechanisms and structural characteristics involved in regulating meat quality and the identification of biological markers of quality.
- Investigating food matrix properties, for the generation of targeted food systems which deliver consistency in product quality.
- Identifying physico-chemical parameters which influence sensory performance and technological functionality of processed meats.
- Strategies for recovery of value through generation of higher value functional products from the meat processing chain.

Cereals research focuses on:

- The development and transfer of enabling science and technology to support the bakery industry's needs and requirements for product quality and innovation.
- Fundamental and applied research on the links between food/ingredient structure and functionality.

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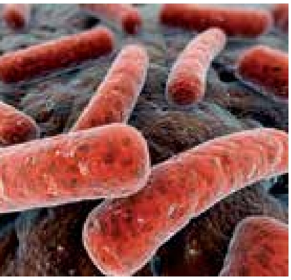

3. Food Safety

Introduction

The safety and the integrity of food is fundamental to the sustainability and continued development of the Irish Agri-food sector and a 'risk based total chain approach' to food safety management is essential to reduce level of food borne illness.

The objective of the Food Safety programme is to provide the science to underpin a total chain risk based approach to food safety focusing on microbial and chemical contaminants in the "farm to fork" food chain.

The objectives are:

- To understand the transmission, behaviour, virulence potential of key and emergent microbial pathogens and to a lesser extent, spoilage organisms in Irish food.
- To develop predictive microbial models and quantitative risk models which can be used to assess and manage microbial risk.
- To develop novel controls for microbial pathogens and spoilage organisms.
- To develop state of art methods to detect and monitor for chemical contaminants including residues from veterinary drugs, environmental contaminants and natural toxins in the food supply.
- To develop quantitative risk models and exposure models for key chemical contaminants in the Irish food supply.

The Microbiology Programme addresses key food bacterial pathogens and specific food spoilage issues along the complete "farm to fork" chain with the main focus on zoonotic pathogens. The research areas addressed include:

- Pathogen transmission and tracking using molecular epidemiological tools.
- Pathogen behaviour and survival in the food chain including adaptation to stresses and resistance to antibiotics and biocides.
- Pathogenicity, virulence and its molecular basis.
- Development of predictive modelling and quantitative risk assessment models.
- Development of novel interventions, strategies, particularly biocontrols.
- Specific issues related to microbial spoilage (packaged meat) and quality (milk) that are of concern to the Irish food industry.
- Some of the main issues being addressed are verocytoxigenic *E. coli* in meat and dairy sectors; *Salmonella* in pigs and pork, *Listeria* monocytogenes in dairy and ready to eat foods, *Campylobacter* in poultry, and pathogen resistance to antibiotics and biocides.

Chemical contaminants: The research on chemical contaminants focuses in particular on veterinary drug residues, and includes research on environmental contaminants and natural toxins in the food supply. The research includes:

- Development of state of art methods to detect chemical contaminants using mass spectroscopy and biosensor technologies.
- Investigation of the fate of residues during processing.
- Application of the technologies as part of the national residue monitoring plan.
- The data and technologies underpin a quantitative risk based approach to the control and management of chemical residues in the food.

4. Food Industry Development

Introduction

Irish food businesses face constant challenges to be competitive, sustain existing and new markets and comply with a demanding regulatory environment. Teagasc, working in conjunction with other national development agencies, provides a comprehensive support service for the food processing industry with a particular focus on supporting Small and Medium sized Enterprises (SME) and start up food businesses.

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The objectives are:

- To provide technology development and problem solving supports for the food SME sector, food start up businesses and related stakeholders, through specialist technical training courses and seminars, company specific consultancy, product development and testing, and a technical information service.
- To support research knowledge and technology transfer to industry and other stakeholders, through specific research dissemination activities, and interactions with industry in training, consultancy, product development and technical information.

Technical Training Courses and Seminars

Specialist technical training courses and seminars are provided in key areas of emerging technologies, legislation, and outputs from the food research programmes. Topics encompass food safety, quality management systems, food processing, ingredient and packaging innovations.

Product Development Supports

- This includes technical advice, access to modern food processing plant and product testing in microbiological, chemical, physical and sensory analysis.

Consultancy, Food Assurance Standards

- Provides support, usually in-company, in the development, implementation and maintenance of industry and regulatory food assurance standards.

Pilot Plant facilities

- A wide range of modern food processing facilities and equipment are available to food businesses at both Teagasc Ashtown and Teagasc Moorepark. An ultra modern pilot plant, Moorepark Technology Ltd., containing the most up-to-date and versatile pilot scale processing equipment exists on the Moorepark campus. MTL has a wide range of capabilities in general food and food ingredient development and is arranged in a modular structure of self-contained processing areas which guarantees single client access and total confidentiality.
- At Teagasc Ashtown the Meat Industry Development Unit encompasses a pilot scale meat facility incorporating a licensed abattoir, production units for processing and packaging of meat under controlled refrigeration systems and a cooked meats facility.

Technical Information Service

- This service is provided for food businesses relating to problem solving or requests for information on new product development, commercial or regulatory requirements for food production.

Food Market Research Unit

- This unit located on the Teagasc Ashtown campus is part of the Teagasc Rural Economy and Development Programme. In addition to undertaking strategic research to understand key drivers of consumer behaviour, market developments and innovation processes, it underpins the activities of the Food Programme. Specifically, it collaborates on many projects within the Food Programme to ensure that technical outputs are market-oriented and developed based on an understanding of consumer requirements.

Notes