Animal & Grassland Research and Innovation Centre

Moorepark

Moorepark Dairy Levy Research Update

Ballyhaise Dairy Research Project Review

Moorepark Animal & Grassland Research and Innovation Centre
Ballyhaise Agricultural College

Tuesday 1st October, 2013
Series 21

Teagasc

Agriculture and Food Development Authority

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Principal's Welcome
John Kelly

Teagasc Ballyhaise Agricultural College is an estate of 220 hectares of grassland and forestry. The college provides training in agriculture and forestry and has developed close links with the local Institute of Technology in Dundalk (DKIT). Over 300 students are currently registered on courses in Ballyhaise Agricultural College. The college is also a significant Teagasc centre for advisory services as well as dairy research.

Having recently taken up the appointment of Principal, this is an exciting time to be involved in agricultural education. Demand for our courses is strong. Within Food Harvest 2020 significant potential for the industry is set out and people want to be part of this growth. The challenge for us in the college is to educate our students, giving them the skills and knowledge to maximise their potential within the industry.

Students attending Ballyhaise Agricultural College, having first completed a Level 5 Certificate in Agriculture, can choose to complete a Level 6 Advanced Certificate in Dairy Herd Management. Subsequently students can seek progression onto a Level 7 Professional Diploma in Dairy Farm Management giving them the skills required to manage the most progressive dairy farms. Our dairy students work on the college research farm giving them first-hand insight into key weekly decisions. As well as our teachers, students have access to guest lectures from Teagasc advisors, a dairy specialist and a dairy researcher who are all based in the college.

The college dairy research programme was set up in 2004 with an objective of increasing the efficiency of milk production in the region. Today's Open Day has a strong theme on soil fertility, land drainage techniques and autumn grass management. The information presented should help famers make informed choices and decisions and I am sure that everyone who attends today will take away important information and practical advice that will improve your farm business.

On behalf of Teagasc and Ballyhaise Agricultural College I welcome you here today and wish all involved a successful event.

John Kelly
College Principal

Irish Dairying- Harvesting the Potential

Pat Dillon

Teagasc, Animal & Grassland Research and Innovation Centre, Moorepark, Fermoy, Co. Cork

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. This 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 a 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 to feed 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 businesses must provide a reasonable return on equity, be environmentally and animal welfare compliant, and provide an enjoyable and rewarding lifestyle for those working within them. 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.

Ballyhaise College Systems Experiments Review

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A significant expansion in milk production in Ireland post EU milk quota abolition will require increased animal productivity from pasture. In addition to increased grass production and utilisation on existing dairy farms, additional new dairy enterprises may emerge on more marginal soil types. The Border, Midland & Western region of Ireland (BMW; www.bmwassembly.ie/) comprises thirteen counties including the six border counties with Northern Ireland and accounts for 47 per cent of national land area. Notwithstanding its scale, the region currently accounts for only 25 per cent of total national milk production. From an agronomic viewpoint, the wet mineral soils, which are characteristic of the region, impede drainage and have traditionally been associated with a shorter grazing season and lower pasture production compared to the south of Ireland. Many studies have focused on the potential of increased stocking rates (measured as cows / hectare; SR) and increased feed supplementation to increase productivity within pasture systems, however, few studies have focused on the implications of alternative grazing systems differing in SR and feed supplementation level specifically within soil types such as those found in the BMW region.

The function of the Ballyhaise dairy research project is to provide farmers in the Border Midlands Western (BMW) region with locally generated research information to increase the profitability of their farm business and to demonstrate best practice grass based milk production systems. Highly profitable grazing systems are based on productive well managed pasture, a compact herd calving pattern, high EBI dairy cows and the correct overall farm stocking rate. From it's origin in 2005 the project has focused on increasing grass growth and utilisation, improving milk solids production per hectare, improving herd fertility performance and reducing feed costs. Over the last eight years these improvements have led to a more profitable and robust system which is capable of delivering a reasonable return to farmers within a production environment characterised by increased milk and input price volatility.

Grass Production and Utilisation

An intensive reseeding programme has taken place at Ballyhaise over the past eight years as well as improvements in grazing infrastructure and soil fertility. Regular soil testing is carried out to monitor soil fertility status over time. Soil fertility is a major constraint for many farmers in the region; however soil P and K indexes at Ballyhaise have been traditionally high. Soil pH is low and 20 per cent of the farm is receiving two tons of ground limestone per acre annually. An improved road network has made it possible to graze grass during wet weather conditions while reducing the level of pasture damage by poaching. The grazing infrastructure is designed to facilitate a flexible grazing management approach. Techniques such as on – off grazing and block grazing are essential tools used to achieve a high level of grass utilisation over a long grazing season of 280 days.

Land type undoubtedly has a significant impact on grass production and utilisation. Recent studies at Ballyhaise have reported high grass growth and utilisation at the site in normal growing seasons. Grass production increased steadily from 12 tons DM/ha in 2008 to 15.2 tons in 2011. More recently, poor weather during 2012 and during spring 2013 have provided a stark reminder of the high production costs associated with poor grass growth on wetter soils during inclement weather. Grass growth reduced to 11 tons DM/ha in 2012. Concentrate feed inputs consequently increased by 36 per cent in 2012 to 850 kg per cow and based on higher concentrate prices, resulted in total concentrate feed costs of €240/cow compared to €130/cow in 2011. The overall costs of poor weather and reduced grass growth also required that an additional €140/cow was spent on winter feed purchased from outside the grazing block during autumn 2012. It is evident that even with excellent grass management farmers operating on heavy soils need to have a substantial reserve of forage available for use during wet years where growth will be severely impacted. Despite the poor growth during 2012, the college farm has recovered to grow 9.5 tons DM/ha up to the beginning of September 2013.

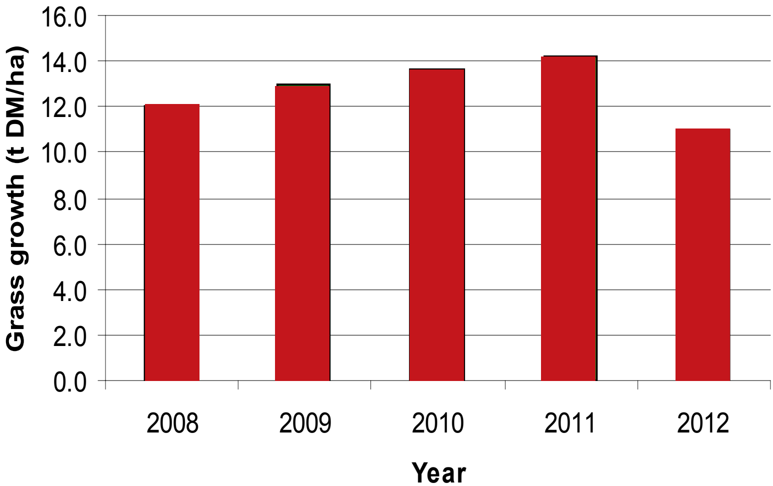

Figure 1. *Grass growth at Ballyhaise (tons DM / ha)*

Compact calving and Herd Reproductive performance

Poor fertility performance is a major issue for many dairy farmers in the region leading to reduced profitability and restricting their ability to grow herd size in a post quota environment. A compact spring calving pattern is essential to maximise the production of high quality milk solids from grazed grass. There is significant scope to improve the calving pattern on farms in the BMW region to increase animal performance from grazing (Figure 2). In comparison with Ballyhaise college where in excess of 80 per cent of the herd calve during the 42 days after planned start of calving, only 50 per cent of cows on BMW dairy farms have calved during the same period. The reproductive performance of the Ballyhaise herd has improved steadily each year as herd Economic Breeding Index (EBI) has increased. The overall herd empty rate has decreased from 36 per cent in 2005 to 9 per cent in 2013 (Figure 3), while the critical six week calving rate has increased from 56 per cent to 83 per cent during the same period. In addition to producing additional higher value milk from grazed grass, in each of the last 2 seasons, the college have also sold surplus dairy stock and are now reaping the numerous financial benefits from a healthier more robust high EBI grass based dairy herd.

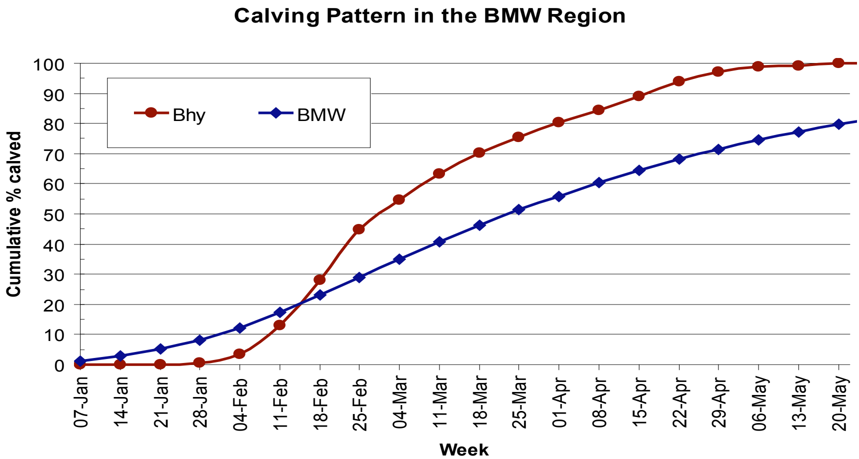

Figure 2. *A comparison of the compactness of the Ballyhaise herd with dairy farms in the BMW region.*

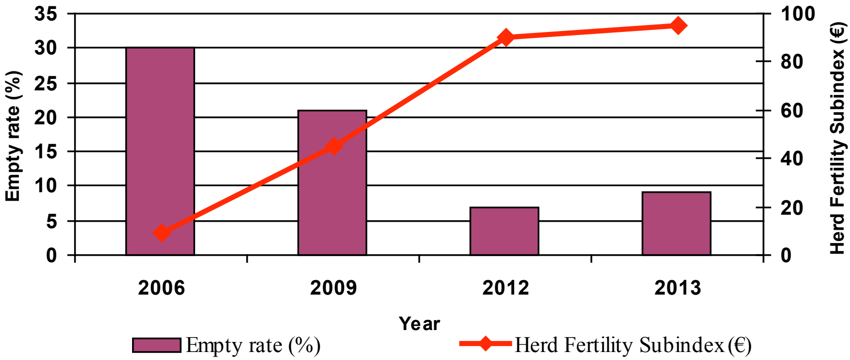

Figure 3. *Ballyhaise College Herd Empty rate and Herd fertility sub-index (€)*

Profitability

Profit monitor data collected from farms in the BMW region show that average farm output in the region is 900 kg of milk solids (MS; fat plus protein) per hectare with a concentrate input of 890 kg/cow. In contrast, and by virtue of improved grazing management and a more fertile and compact calving dairy herd, MS production/ha at Ballyhaise has increased from 950 kg in 2005 to 1,250 kg in 2012. The top 10 per cent of producers in the BMW region achieved a very high level of output and profitability per hectare during a difficult year which demonstrates the scope which exists to increase milk solids output and profitably at farm level even during periods of inclement weather. The highest profitability producers in the BMW region are attaining this high level of profit per hectare via high milking platform stocking rates (3.19 cows / ha), moderate levels of feed inputs and consequently through a high level of grazed grass utilisation, similar to Ballyhaise college.

Table 1. Profit monitor data for the BMW region during 2012

	Average	Top 10%	Ballyhaise
Whole farm SR (cows / ha)	2.00	2.35	3.0
Milking Platform SR (cows / ha)	2.34	3.19	3.0
Milk solids (kg / ha)	900	1,370	1,250
Gross Output (€/ha)	3,800	5,900	5,300
Feed costs (€/ha)	650	850	1,100
Total Variable Costs (€/ha)	1,500	2,000	2,450
Net Profit (€/ha)	1,200	2,400	1,800

New Experiment 2013 -2016

With the abolition of milk quotas, some dairy farmers may consider commencing calving earlier to increase total lactation length and milk production / cow post quota. This strategy is likely to increase supplementary feed requirements and result in a reduction in the proportion of the animal diet achieved from grazed grass. Consequently, the current experiment at Ballyhaise is comparing two herd mean calving dates: an early spring (15th February) herd average calving date and a late spring (March 10th) calving date using both high EBI Holstein-Friesian and Holstein-Friesian Jersey crossbred dairy cattle. The objective of the project is to identify the optimum combination of herd mean calving date and animal genotype for the BMW region post milk quotas.

Lifting Milk Protein- Lessons from the Lakeland Joint Programme

Martina Moran[1] and Joe Patton[2]

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Introduction

With less than 600 days remaining until abolition of EU milk quotas, discussion among dairy farmers is understandably dominated by expansion plans, new investment and of course speculation on future milk price. The story is no different in the Lakeland Dairies catchment area. Recent survey work here shows scope for up to 40 per cent expansion among established milk suppliers. Potential for new milk from start-ups in the region is considerable.

In all cases, good technical efficiency and sound business planning are needed to make expansion worthwhile. This principle underpins the recently established Teagasc/Lakeland Dairies joint advisory programme. From the outset the programme team identified three main areas for technical improvement among Lakeland suppliers - milk protein content, grass utilisation and herd fertility. To-date the focus has been improving milk protein. The team have delivered key messages to farmers through a series of invited workshops, on-farm consultations, and public events.

Why focus on milk protein?

Protein is the key element driving milk price for Lakeland suppliers. Under the A+B-C payment structure, the value of 1kg protein was 2.6 times greater than that of 1kg milk fat in 2012. The range in milk solids content within the supplier base is large (Table 1). In financial terms, moving from the average to top 10 per cent for milk solids is worth €88 per cow, or €6,100 in extra milk revenue for a typical 70-cow herd.

Table 1- Lakeland herd performance 2012

	Bottom 10%	Lakeland Average	Lakeland Top 10%
Protein %	3.15	3.29	3.43
Fat %	3.75	3.98	4.2
Milk Price C/L	31.2	32.9	34.7

Improving milk protein- what does research tells us?

The revenue benefit of improving milk solids content is clear. Fortunately, projects in Moorepark and Ballyhaise have also shown that methods for increasing milk protein are not expensive, giving a positive effect on overall profit. The three main factors identified by research are:

- Breeding: genetic merit (EBI) for protein explains over 60 per cent of the difference in milk protein between herds, and over 80 per cent of the difference between cows within a herd (Figure 1).
- Feeding: plane of nutrition accounts for up to 30 per cent of the difference in milk protein between herds. The main factors are the amount and quality of grazed grass in the diet.
- Management: making up the remaining 10 per cent of difference in milk protein between herds is a combination of calving pattern, dry cow and heifer management.

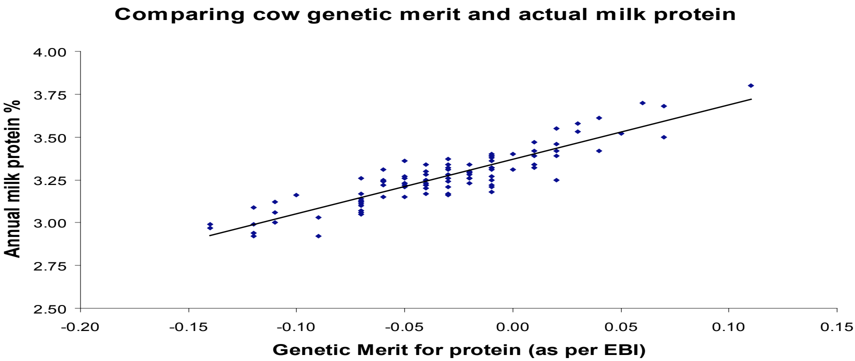

Figure 1. *Genetic merit and actual milk protein %*

What is affecting milk protein at farm level? Lessons from farm visits

Farmers who attended a protein workshop were offered a follow-up consultation with a joint programme advisor, to look at the specific factors affecting milk protein for their herd. Each farmer visited then received a concise plan for improving milk solids over the next five years. Examining the issue in this way has helped to build a good understanding of the situation 'on the ground'. So what did the programme advisors find as the main reasons behind lower milk protein across the farm visits?

- Bull selection: In line with the research, breeding was seen to have a huge effect in milk protein on farms. The highest protein herds had used generations of high EBI AI bulls while lowest protein herds were dominated by high milk volume genetics with little focus on EBI or milk solids. Without doubt, a major problem is the use of low EBI stock bulls and it was clear from checking stock bull figures that most were extremely high in volume and negative for protein and fertility.

- Calving pattern: A spread out calving pattern, with a high percentage of cows calving from late April through July, was common for low protein herds. The full potential for high protein milk from grazed spring grass, and high protein milk in late lactation, is being missed as a result. The problem largely reflects low fertility genetics. Higher protein herds had tighter control on calving pattern.
- Replacement heifer management: It may not directly affect herd milk protein content, but there was a tendency for low protein herds to calve heifers at 30 to 36 months, instead of the optimum 24 months seen on the higher protein herds. In many cases this was due to a perception that heifers were too small for bulling at the 350kg target weight. The result is over-grown first lactation heifers with poorer lifetime performance.
- Grass management: Managing grass quality throughout the main season was found to be a major issue on farm visits. The common difficulty with low protein herds is that not enough paddocks are removed as silage in good growth conditions. The consequence is cows grazing stemmy poor energy covers throughout high growth periods. When growth rates are poor, meal/silage is not included in time to hold rotation length. In contrast, higher milk protein farms regularly monitor the quality and quantity of grass ahead of cows.
- Reseeding and soil fertility Soil fertility (P, K and lime) status was unknown on many farms; some high as well as low milk protein. A major grassland issue on the lowest milk protein farms though is a lack of reseeding and in some situations 70-100 per cent of the farm was in need of reseeding due to a lack of ryegrass in swards.
- Silage quality (DMD) is important where farms are producing some of their milk on silage-based diets. Poor silage in combination with a spread calving pattern is a disaster and we have noted some herds spending three months below 3.00 per cent protein in winter due to low DMD silage. The highest protein herds produce a smaller proportion of their milk from silage diets but carry a reserve of high quality (usually baled) material for this purpose. Silage quality is strongly influenced by reseeding and soil fertility and a significant problem is cutting out-farms and rented land that has not been reseeded.

Summary

Clear messages on milk protein have emerged from the work completed under the Teagasc/Lakeland joint programme to date. Shifting the breeding focus to EBI and milk solids/fertility must be a priority for low protein herds. This should be done through AI but should also be remembered when purchasing stock bulls. In terms of feeding, the key areas for attention are soil fertility, reseeding and managing mid-season grass. Progress may be slow, but focus on these areas makes lifting milk protein predictable, cost-effective and very worthwhile.

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 impending 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.

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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.

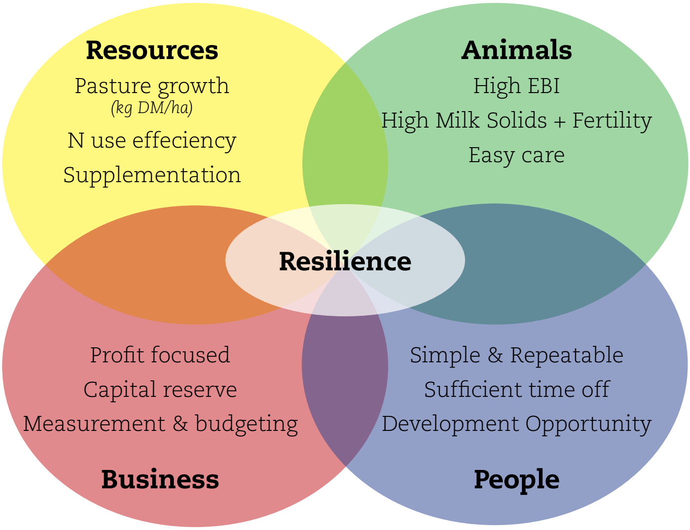


Figure 1. *The 'pillars' of a resilient farm system*

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

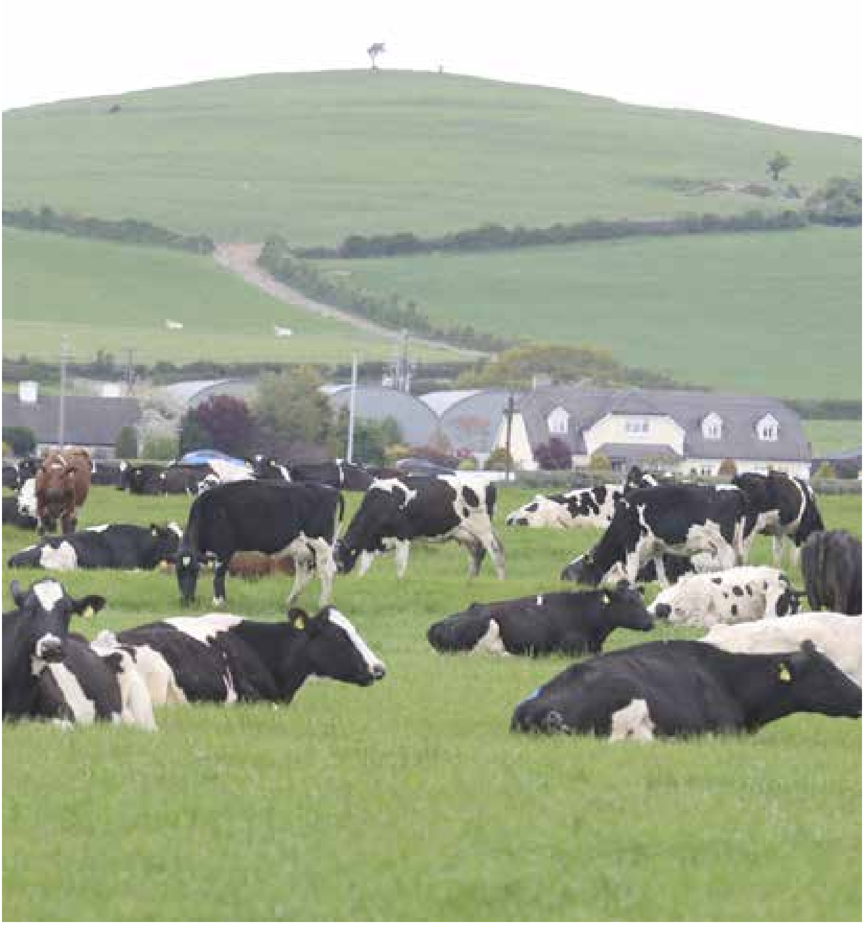
	Current Average	Current Top 10%	Target
Pasture growth (t DM/ha)	6 - 14	10 - 16	12 - 20
Cow live weight (kg)	550-600	550-600	500-550
Herd EBI (€)	100	140	250
Comparative stocking rate (kg live weight/t feed DM)	95	90	75-85
Concentrates fed/cow (kg DM)	800	700	500
Milksolids yield/cow (kg)	350	403	450
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.

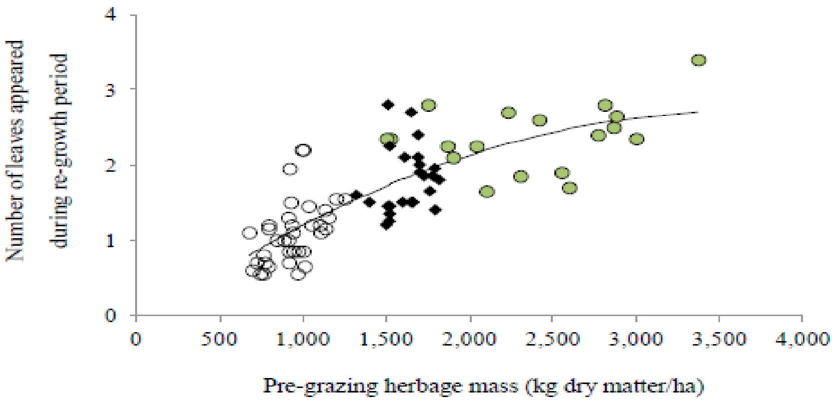


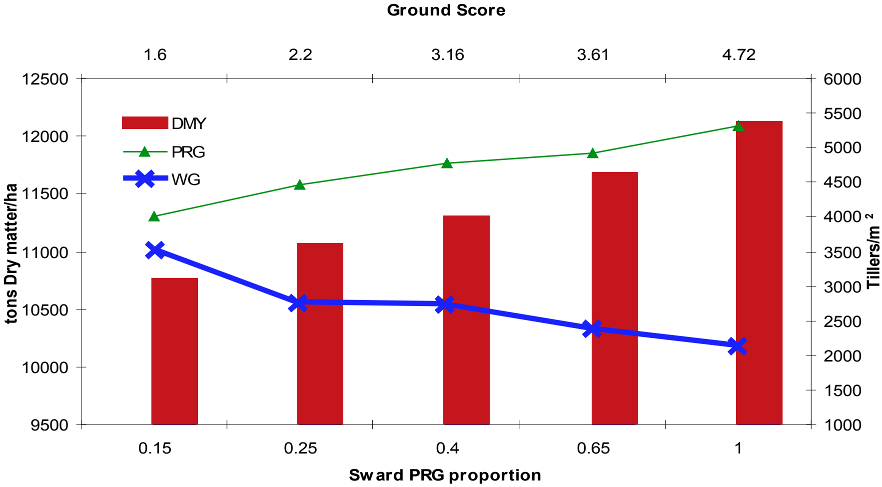
Figure 1. *Pre grazing herbage mass (kg DM/ha) and number of leaves appeared per tiller during the regrowth period that were grazed at low (○), medium (▪) and high (●) pre grazing herbage mass over a 24 week period*

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.

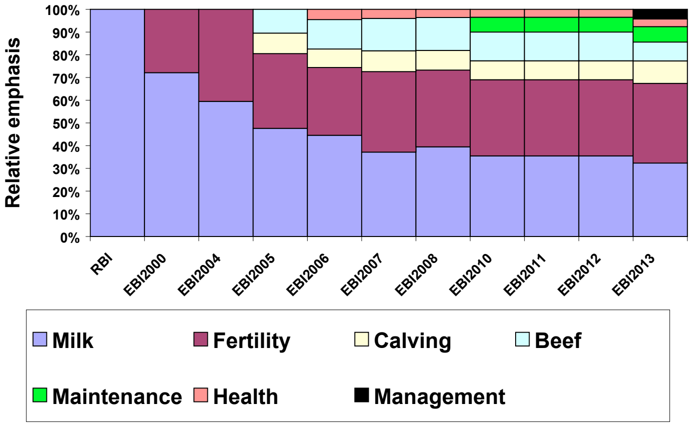

Figure 1. *Relative emphasis on the sub-indexes within the EBI since its establishment in 2001*

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.

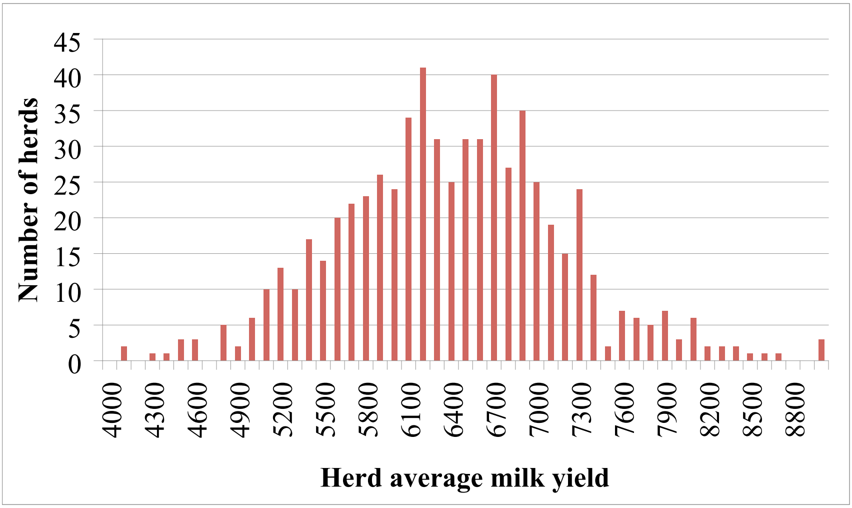

Figure 2. *Mean milk yield/cow in herds with a mean milk predicted transmitting ability (PTA) of 95 to 105 kg*

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).

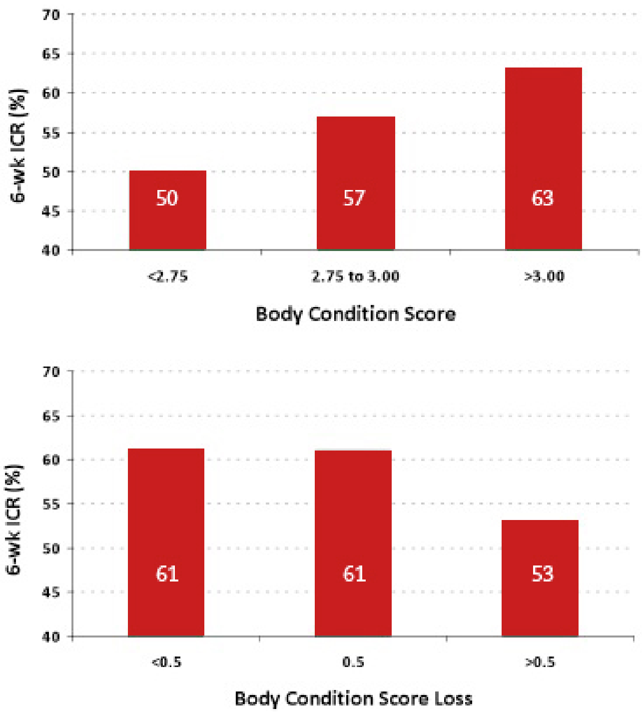


Figure 1. *Body condition score and reproductive performance.*
Top panel: *Association between body condition score (1 to 5 scale; 1 = very thin, 5 = very fat) during the breeding season and six week in-calf rate.*
Bottom panel: *Association between body condition score change from pre-calving to start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

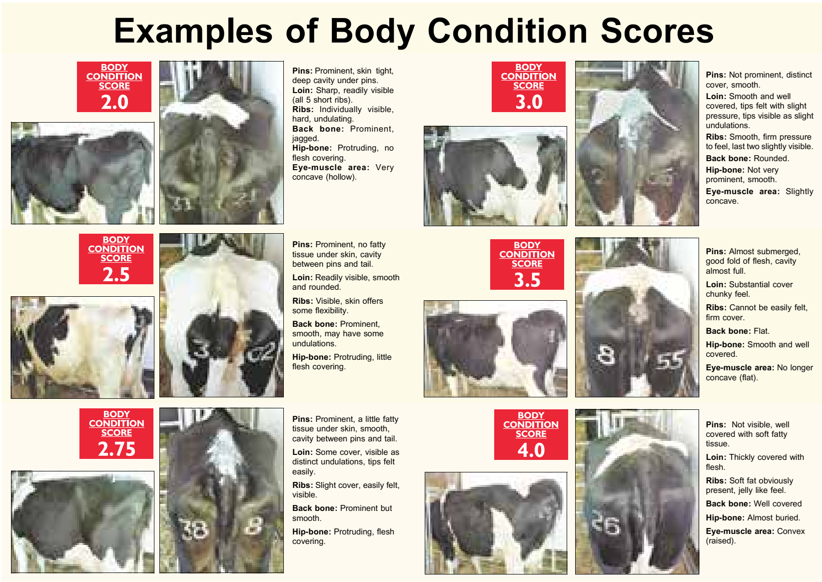
- Maintain a list of all cows that had dystocia, retained placenta, metritis and metabolic problems in early lactation such as milk fever, ketosis, or displaced abomasum. These cows should be examined in advance of the breeding season and treated as appropriate.
- Use pre-breeding heat detection to identify 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.



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).

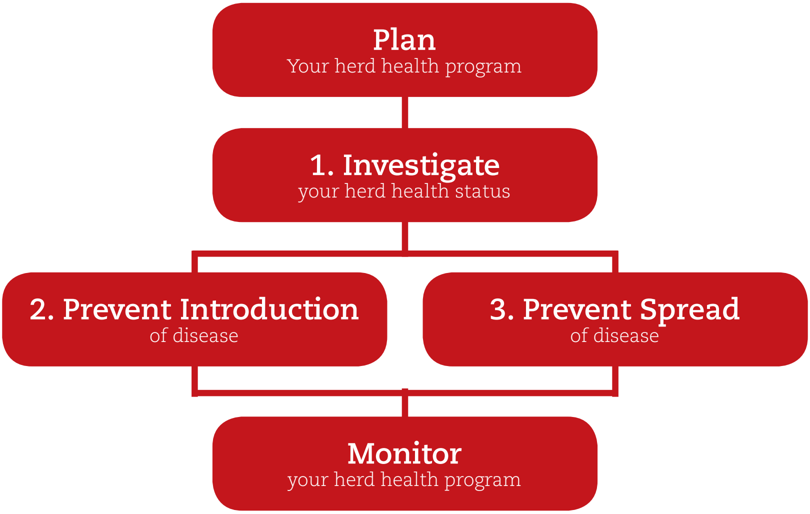

Figure 1. *Herd health plan to achieve a healthy herd*

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.

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.

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.

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.

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

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).

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.

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.

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.

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.

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

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.

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.

Farming on Wet Ground at Solohead

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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).

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.

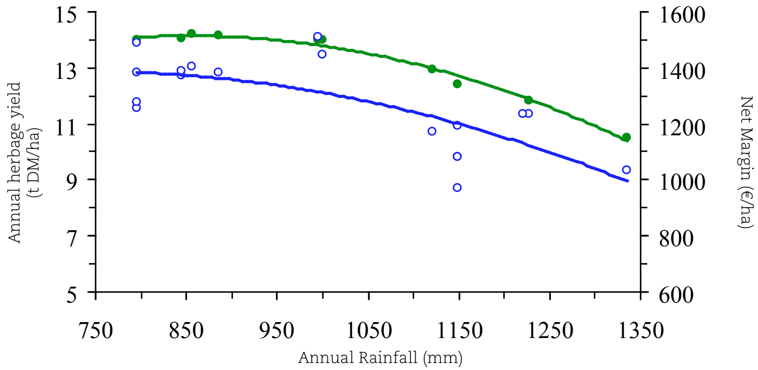

Figure 1. *The impact of annual rainfall on annual herbage yields (●) and net margin per ha (○) at Solohead between 2001 and 2010*

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.

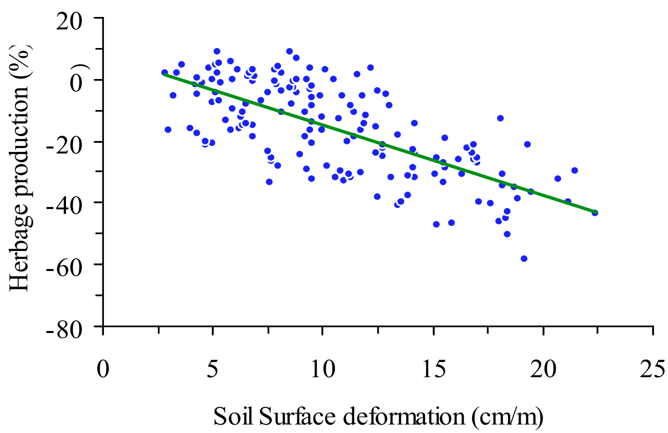

Figure 2. *The impact of soil surface deformation and herbage production relative to undamaged ground*

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).

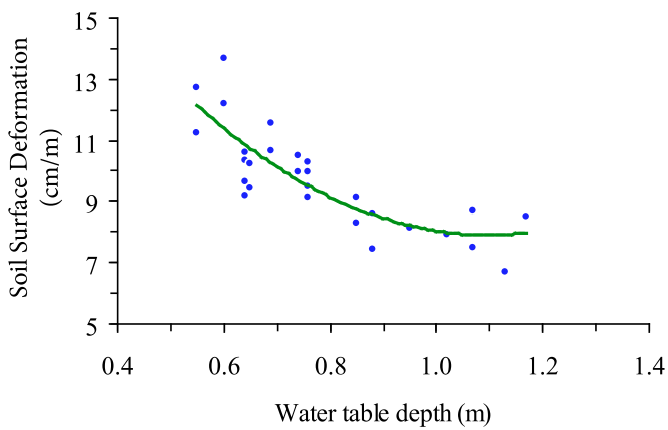

Figure 3. *The relationship between water table depth and soil surface deformation.*

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.

Land Drainage Design and Installation

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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.

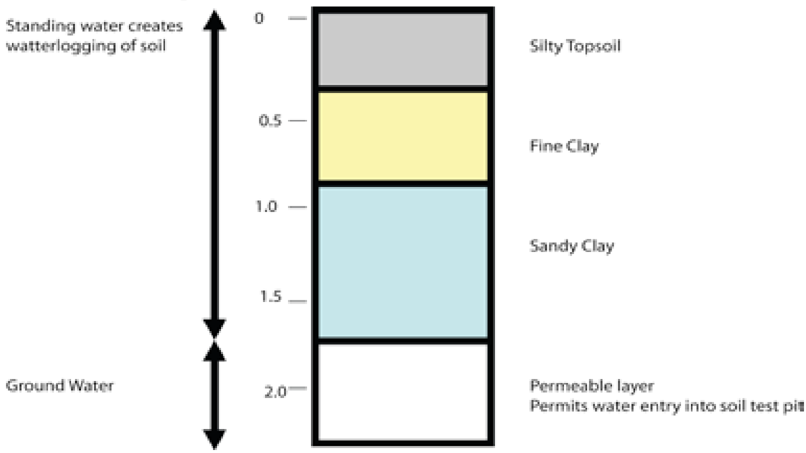

Figure 1. *A typical heavy soil profile. If a free draining layer (called "permeable layer" here) is present at any depth then a ground water drainage system is the most appropriate solution, if not then a shallow drainage system is required*

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.

Notes

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