Moorepark Dairy Levy
Research Update

Thursday 6th May, 2010
Ballyhaise Agricultural College

Series No. 14

Achieving Improved Herd Fertility

Moorepark Dairy Production Research Centre
Teagasc
Fermoy
Co. Cork
www.teagasc.ie

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Introduction

The dairy industry in Ireland is facing new and challenging times with the impending removal of the milk quota regime and volatility in milk price. Robust cows that will efficiently deliver high yields of milk solids from grazed grass, with consistently excellent fertility, will maximise profit regardless of future milk price volatility. Currently however, fertility performance (conception rates, survival and calving pattern) continues to be sub-optimal, eroding profit margins on Irish dairy farms and restricting the supply of high quality replacements. Data from the ICBF indicates that the average calving interval of Irish dairy herds is 389 days, with an average 6-week calving rate of 58% and 18% of cows recycled on a yearly basis. Similarly, indications are that reproductive performance on dairy farms in the northern half of the country is significantly poorer. This is a significant cost on the average dairy farm and reduces the supply of high EBI AI bred replacements thereby restricting Ireland's ability to increase milk production in the future.

There is no simple recipe to achieve good reproductive performance. Current best practice reproductive management entails (1) the use of high EBI AI sires with special emphasis on the fertility sub-index; (2) a good calf and heifer management system; (3) achieving target body condition scores; (4) the use of effective heat detection aids, and (5) the implementation of a healthy herd health programme. Improved reproductive performance will result in increased farm profitability through reduced culling, higher milk production and reduced costs, more replacement heifers born from AI and generally reduced labour requirement.

The function of the Ballyhaise college systems experiment is to provide dairy farmers in the Border Midlands West region with locally generated research information and system development technology to secure their dairy farming livelihoods post milk quotas, irrespective of fluctuations in milk prices, interest rates and inflation. The reproductive performance of the Ballyhaise herd has increased significantly in recent years through the implementation of key fertility management factors highlighted above. The objective of this event is to provide comprehensive direction to dairy farmers in improving fertility performance.

Pat Dillon,
Head, Moorepark Dairy Production Research Centre

John Donworth,
Programme Manager - Dairying

Key Factors for Dairy Farm Efficiency

Laurence Shalloo[1], Brendan Horan[1] and Donal Patton[2]
[1]Teagasc, Moorepark, Dairy Production Research Centre, Fermoy, Co. Cork
[2]Teagasc, Ballyhaise Agricultural College, Ballyhaise, Co. Cavan

Summary
- Milk price volatility will force Irish dairy farmers to place greater emphasis on business planning, incorporating risk and key performance indicators.
- Key characteristics of a successful dairy farm business in the future will be a low cost grass-based system driven by high grass utilisation, low levels of supplementation using productive and highly fertile grass-based genetics.
- Grass utilisation per hectare is the best predictor of profit per hectare.
- Farm management skills such as business planning/monitoring, grass measurement/budgeting, fertility management, breeding management and the adoption of low cost labour efficient practices are required.

Introduction
Future milk price in both Ireland and the wider EU will be increasingly exposed to substantial fluctuation over the next number of years as the supports available from CAP recede. These supports regulated EU milk price by placing product into intervention when prices were low and selling product out of intervention when prices were high, thus keeping milk price in the EU stable, to a large extent. This practice however, also had a stabilising effect on the world market price as it removed EU product from the market at times when the market was weak and reintroduced it when the price rose.

In contrast to New Zealand and Australia, milk price volatility is a new phenomenon for Irish and EU producers. There is a requirement at farm level to refocus the dairy farm business in a way that will insulate the business in an increasingly volatile environment. Every dairy farmer who remains committed to dairying for the longer term should develop a business plan that can be used to drive the farm business forward. The development and application of a business plan is the first stepping stone in the development of a thriving and successful business. In order for any business to survive and prosper long term it must constantly innovate to reduce costs and increase output. In the business plan, a review is required of resources and from this a plan for the future can be prepared. The business model that dairy farmers select for the future must be based around surviving price and weather shocks and setting up the business to capitalise when the price increases. This ultimately means producing milk at the lowest cost possible, while reducing the investment requirement by expansion through the use of low cost housing technologies.

Key components to ensure future profitability
The key components of the successful dairy farm of the future will centre around producing milk at low cost in a simple system that is sustainable for the animal and the personnel working in the system, with a cow suited to the

system in an environmentally sustainable manner. The maximum gains will be achieved where grass harvested is maximised through increased grass growth and utilisation with a dairy herd that calves compactly, at the right time of year, while maximising grass utilisation and minimising supplementary feeding. The key technologies centre around grass utilisation and having the right cow for the system. This paper is divided into two sections;

A. Components of profitability

1. *Grass utilised per hectare*
2. *Grazing season length*
3. *Fertility performance*
4. *Milk solids concentration*

B. Ballyhaise systems

1. *Background*
2. *Economic performance*

A. Components of profitability

1. Grass utilised per hectare

Grass utilised per hectare is a feature of grass grown per hectare, stocking rate, grassland management and the level of supplementary feeding that is carried out on the farm. Nationally, dairy farmers operate at a stocking rate of 1.78LU/ha (O' Donnell *et al.,* 2008) on the grazing platform. It is estimated that nationally there is approximately 7.1t DM/ha being utilised on the average specialist dairy farm. Figure 2 shows the relationship between grass utilised per hectare and net profit for 200 farms selected from the Profit Monitor System for 2008. Grass utilised is calculated based on the farm stocking rate, milk yield per cow, cow live weight and the level of concentrate feeding. Figure 1 shows that approximately 44% of the difference in net profit per hectare between farms can be explained by overall grass utilised per hectare. Carrying out the analysis over a number of years showed that the relationship was extremely robust ranging from 45% to 34% over a five-year period. The key drivers effecting grass utilised per hectare are grass growth, stocking rate and supplementation level.

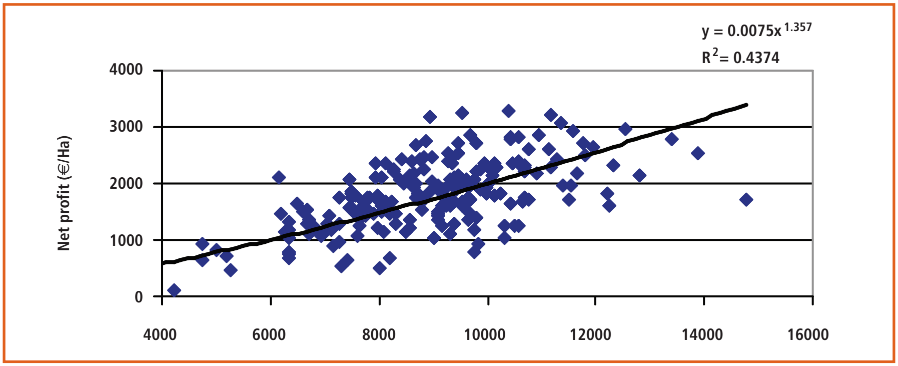


Figure 1. The relationship between estimated grass utilised per hectare and net profit per hectare

2. Grazing season length

Results from the NFS suggest that the national grazing season length is under 200 days annually. A number of studies have been carried out looking at the effect of the grazing season length on overall farm profitability. The studies have shown that milk yield and milk solids concentration are increased through earlier turnout of cows as well as sward quality and therefore intake in subsequent rotations. The feed costs are substantially reduced as there is a reduced requirement for grass silage and concentrate which are between two and three times more expensive than grazed grass. Animals outdoors have less mastitis and feet problems, require less labour and have less slurry spreading costs. Increasing the length of the grazing season has been estimated to increase profitability by over €3/cow/day. Therefore, on a 60-cow herd a 10-day increase in grazing season length is worth €1,800. As is discussed on the grassland boards, grazing season length can be extended using tools such as the rotation planner and having the correct grass varieties.

3. Fertility performance

There are significant costs associated with infertility in the national dairy herd. Data from ICBF indicates that even in the top 10% of spring-calving herds based on EBI, replacement rate (incl. recycled cows) is in excess of 30% annually with a mean calving interval of 380 days. The optimum replacement rate (balance between requirement for new genetics and cost) is estimated to be 17% in a spring-calving herd. Sub optimal fertility adds significant cost to the dairy business. Sub optimal fertility effects herd in a number of ways:

(i) Replacement rate

The cost associated with the requirement for increased replacements is a topical one. It has been estimated that it costs approximately €1,500 to rear a replacement heifer when the value of the calf and labour, land and housing costs are included, as well as the direct costs. The value of a not in-calf cull cow at the end of lactation will vary from €200 to €400 depending on year. Therefore, the cost associated with having to replace an additional 10 cows is €11,000 or €275/ha on a 40ha farm with 100 cows.

(ii) Calving date and spread

Sub optimal herd fertility will result in a spread-out calving pattern with an average calving date slipping to later and later each year. More often than not, this will result in the farmer starting to calve earlier in an effort to stop the slippage and subsequent increase in the breeding and calving seasons. This has a significant feed budget effect as some cows are then calving too early to match the supply of grass with the demand and others are calving too late to capitalise on early grass. There will be an effect on milk solids concentration as more milk is produced from grass silage. There may also be a significant milk yield effect with some cows in the herd having a significantly shorter lactation length. The national calving date has slipped by eight days over the past six years (CMMS, 2009). Nationally, the mean calving date is close to mid-March with a target of mid- to late February. This is costing approximately €300/ha/year.

(iii) Milk yield per cow

Higher replacement rates in the dairy herd result in reduced herd milk yields. This is caused because 1st, 2nd and 3rd lactation animals are only capable of producing 75%, 92% and 97% of that of a mature cow. Therefore, a higher proportion of 1st and 2nd lactation animals in a herd will result in the herd not reaching its milk production potential. A replacement rate 10% above the target of 17% will reduce a herd that has a mature cows milk production potential of 6,200l from 5,871 to 5,669l. This will reduce the potential profitability of the herd by up to €100/ha/year at a milk price of 30c/l.

(iv) Infertility treatment

It is much more difficult to quantify the costs associated with infertility treatment, with huge variation between herds. However, in herds with poor fertility, there are a greater number of straws used per calf born, increased veterinarian intervention with hormone treatments and higher levels of scanning. Good fertility versus poor fertility could account for 0.6 less straws used per cow in calf with a conception rate to service of 60% versus 40%. This will result in €12 difference between cows @ €20/straw. When coupled with additional scanning and treatments the total could amount to €30/ha.

(v) Labour

A herd with higher levels of infertility will result in the amount of dairy cows that an operator can handle being significantly reduced. Increased breeding, calving, and herd intervention reduce the number of cows that can be handled.

All of these costs result in reduced profitability and add significant pressure to the system being operated. Other costs that are more difficult to quantify are reduced potential for expansion, reduced genetic gain, inability to maintain a closed herd, drudgery factor associated with breeding and calving for a 20- week breeding season as well as the lost opportunity for the second most potentially profitable enterprise on the farm. The EBI and in particular the fertility sub index within the EBI as well as cross breeding urgently need to be explored and exploited if the costs associated with infertility are to be reduced on farm.

4. Milk solids concentration

The rate of milk composition (fat and protein) increase in Ireland is slow. Milk fat and protein concentrations have increased from 3.56% and 3.21% in 1992 to 3.83% and 3.33% in 2009 (www.cso.ie) or by 0.016% and 0.008% per year, respectively. Increasing milk solids concentration through the combination of both management and genetic selection has a significant effect on farm profitability. The recent introduction of the A+B-C system of milk payment in many co-ops and its proposed introduction in others will increase the emphasis on milk solids concentration at farm level. An increase in milk solids concentration increases the efficiency of protein and fat production within the cow due a reduction in lactose output for every additional unit of protein and fat. Increasing milk solids concentration has a significant effect on dairy farm output and inevitably farm profitability. Table 1 shows the effect of increasing milk solids concentration in incremental steps of 0.04% protein and 0.08% fat in a non EU milk quota scenario. The results show that increasing milk solids concentration will substantially increase profitability with a larger increase observed at greater milk prices. Increasing milk protein and fat concentration from 3.33% and 3.83% to 3.54% and 4.22% increased profitability by €11,600, €9,081 and €13,669 at milk prices of 27c/l, 20c/l and 33c/l, respectively, on a 40ha farm. While it is accepted that these types of increases will not happen overnight, the benefits are substantial. These benefits can be captured by focusing on improving grassland management, extending the grazing season length and grass quality as well as on the permanent effects of increasing the genetics for increased milk solids concentration.

Table 1. Effect of increasing milk solids concentration on farm profitability.

Milk protein % Milk Fat %	3.33 3.83	3.38 3.90	3.42 3.98	3.46 4.06	3.50 4.14	3.54 4.22
DM Utilised (t DM/ha)	8,832	8,911	8,989	9,065	9,146	9,223
Total hectares (ha)	40	40	40	40	40	40
Milk sales (kg)	452,586	452,586	452,586	452,586	452,586	452,586
Cows calving (no.)	85	85	85	85	85	85
Stocking rate (LU/ha)	2.09	2.09	2.09	2.09	2.09	2.09
Milk solids sales (kg)	32,426	32,978	33,514	34,048	34,614	35,149
Fat sales (kg)	17,274	17,643	18,012	18,364	18,733	19,085
Protein sales (kg)	15,153	15,335	15,502	15,684	15,881	16,064
Labour costs (€)	25,732	25,732	25,732	25,732	25,732	25,732
Milk Price 27 c/litre						
Milk returns (€)	127,766	130,142	132,360	134,640	137,076	139,357
Margin per cow (€)	258	286	312	339	367	394
Margin/ kg milk (c)	4.74	5.25	5.73	6.22	6.75	7.25
Total profit/farm (€)	21,908	24,286	26,505	28,788	31,226	33,508
Milk Price 20 c/litre						
Milk returns (€)	94,531	96,363	98,109	99,904	101,822	103,618
Margin per cow (€)	-136	-114	-94	-72	-50	-29
Margin/kg milk (c)	-2.49	-2.10	-1.72	-1.33	-0.92	-0.53
Total profit/farm (€)	-11,535	-9,704	-7,960	-6/165	-4,249	-2,454
Milk Price 33 c/litre						
Milk returns (€)	156,351	159,102	161,725	164,421	167,301	169,997
Margin per cow (€)	596	629	659	691	725	757
Margin/kg milk (c)	10.96	11.55	12.12	12.70	13.33	13.91
Total profit/farm (€)	50,672	53,427	56,053	58,754	61,639	64,341

B. Ballyhaise systems

1. Background

As a result of the impending removal of milk quotas and the expected expansion in milk output (O' Donnell *et al.,* 2008), land will become a limiting factor at farm level. Therefore, the effect of significantly increasing stocking rate beyond where the milking platform is providing the forage requirement for the farm was investigated at Ballyhaise. An experiment was set up with the objective of evaluating the effect of two differing stocking rates (3.1 and 4.6 cows/ha) over a three year time period. The first two years of this experiment have now been completed. The objective was to determine the effect of a system stocked at 3.1 cows/ha, where the majority of the forage required is produced on the milking platform with purchased concentrate being minimised compared to a treatment where almost all of the grass produced on the farm is consumed as grazed grass with the vast majority of the winter feed purchased. The milk production and fertility performance over the first two years can be seen in the paper by Horan and Patton later in this booklet.

2. Economic performance

The Moorepark Dairy Systems Model (MDSM) (Shalloo *et al.,* 2004) which is a stochastic budgetary simulation model was used to analyse the first two years data. The analysis was carried out assuming that land was fixed at 40 ha. For this analysis there are four separate herds analysed based on the biological data. There are two genotypes which include the Holstein Friesian's (HF) originally selected using RBI and now being selected using EBI and a herd of Jersey/Holstein Friesian Crossbreds (JEX). These animals were compared on the closed high grass (HG; 3.1 cows/ha) and open high intensification (HI; 4.6 cows/ha) systems. The economic assumptions are included in Table 2. Full labour costs were included in the analysis at a cost of €12.44/hr. The analysis was carried out at 22 and 30c/l and the breakeven price within breed across feed systems was calculated. Differentials for the cull and male calf values between the JEX and HF were included in the analysis based on mart and factory returns.

Table 2. Key assumptions included in the economic analysis

Assumptions	
Land area Ha	40
Concentrate costs €/t	190
CAN €/t	240
Urea €/t	300
Ratio Protein : Fat	2
Low Cost Housing €/Cow	600
Replacement heifer costs €	1,400
Female calf value €	350
Male calf value HF €	80
Male calf value JEX €	30
Cull cow value HF € (Liveweight*0.45*€1.50)	367
Cull cow value JEX € (Liveweight*0.42*€1.20)	280

Table 3 shows the economic performance of genotype and feed system over the first two years of the experiment. There are substantial differences in milk sales between the HG and HI systems and there are substantial differences in milk solid sales between the two genotypes. Grass utilised per hectare ranged from 12,474 to 13,837 kg DM/ha for the HG HF and HG JEX treatments respectively with the corresponding figures of 14,078 and 14,515kg DM/ha for the HF and JEX in the HI system. Irrespective of system or genotype, high grass utilisation equivalent to twice the current national average level was achieved. Total farm costs were between 16 and 18% higher for the HF animals depending on feed system when compared to the JEX and were between 55 and 59% higher for the HI feed system depending on genotype when compared to the HG system.

As expected there are substantial differences in profitability at differing milk prices with the optimum feed systems changing at differing milk prices. At a milk price of 22c/l, the most profitable system was the JEX in the HG feed system. Both HF systems recorded substantial loses with the JEX in the HI system just recording positive profitability. At a milk price of 30c/l, the highest profitability was achieved with the JEX animals in the HI system. The HF animals were least profitable with the HI system being optimum for both genotypes. Even though the farm profitability and profit per hectare were higher in the HI system, the profit per kg of MS was lower when compared to the HG system. The milk price at which the optimum system changes between the HG and the HI system is different for the JEX and the HF genotypes. A milk price over 26.2c/l is required for the JEX and 27.4c/l for the HF animals before moving from the HG to HI systems. The JEX animals on the HG feed system produced the highest profit per kg of milk solids irrespective of price.

Table 3. The effect of feed system and genotype on the economic performance (2008 and 2009)

Feed Systems Breed Group	HG HF	HG JEX	HI HF	HI JEX
Cow numbers	124	124	180	180
Milk production kg	572,576	610,816	912,369	912,163
Fat kg	23,117	28,059	36,743	40,390
Protein kg	18,756	21,511	29,517	31,114
Grass utilised as grazed kgDM/Ha	12,474	13,837	14,078	14,515
Labour Costs €	34,716	36,336	50,394	52,745
Total Costs €	196,678	166,245	305,591	263,546
	Base Milk price 22c/l			
Farm Net profit €	-23,575	19,280	-38,329	2,358
Net profit €/Ha	-589	482	-958	59
Net Profit €/kgMS	-0.56	0.39	-0.58	0.03
	Base Milk price 30c/l			
Farm Net profit €	24,979	76,007	38,327	84,279
Net profit €/Ha	624	1,900	958	2,107
Net Profit €/kgMS	0.60	1.53	0.58	1.18
HF breakeven between feed systems (Standard Milk Price 26.2c/l)				
Farm Net profit €	1,916	-	1,916	-
Net profit €/Ha	48	-	48	-
Net Profit €/kgMS	0.05	-	0.03	-
JEX breakeven between feed systems (Standard Milk Price 27.4c/l)				
Farm Net profit €	-	57,382	-	57,382
Net profit €/Ha	-	1,435	-	1,435
Net Profit €/kgMS	-	1.16	-	0.80

Conclusion

Price volatility will be a key feature in milk production systems of the future. There is a positive future for dairy farming if a clear business focus is adopted. The objective or goals of the business should be set out and should drive the business forward. Focus should be placed on maximising grass utilisation while minimising supplementary feeding, increasing the length of the grazing season and improving the genetic status of the herd. The Ballyhaise research has shown that increasing the stocking rate to a point where there is and will be a substantial requirement for supplementary feeding within the system can increase profitability when milk price is high but exposes the business to vulnerability when milk price drops. Systems of milk production that are sustainable in the context of milk price volatility are crucial to a prospering Irish Dairy Industry. There have been significant financial investments made in facilities on farm over the past number of years and there is now a requirement for farmers to invest in their own skill set (business planning, grass budgeting) and appropriate genetics for the future. These investments will result in substantial increases in productivity and will ensure survival of the business into the future.

References

O'Donnell S., Shalloo L., Butler A.M. and Horan B. 2008. Opportunities, challenges and limitations on Irish Dairy farms. *International Journal of Farm Management.* Vol **13** (6) 419-434.

Shadbolt N. 2009. How risky your business? In Proceedings of South African Large herds conference. 23rd-25th February 2009, Champagne Sports Resort, Drakensberg. Page 155-167.

Shalloo, L., P. Dillon, M. Rath, and M. Wallace. 2004. Description and validation of the Moorepark Dairy System Model. Journal of Dairy Science 87:1945-1959.

Ballyhaise College Systems Experiments Review

Donal Patton[1] and Brendan Horan[2]
Teagasc, Ballyhaise Agricultural College, Ballyhaise, Co. Cavan
Teagasc, Moorepark, Dairy Production Research Centre, Fermoy, Co. Cork

The function of the Ballyhaise College systems experiment is to provide dairy farmers in the Border Midlands West region with locally generated research information and technology to secure their dairy farming livelihoods post milk quotas irrespective of fluctuations in milk prices, interest rates and inflation. At a practical level, a key objective of system development is to realise dairy herd reproductive performance which facilitates efficient milk production and allows dairy farmers to expand herd size post-quotas. In terms of the individual management practices, the challenge is to achieve high animal performance over a long grazing season based on a predominantly pasture diet. National statistics currently illustrate that reproductive capacity on the average Irish dairy herd is poor (average national calving date of mid–March, 58% of animals calving in six weeks after calving start date; CMMS & ICBF statistics, 2009) resulting in significant financial losses. In contrast, the reproductive performance of the Ballyhaise College herd has improved dramatically during the last four years as evidenced by the reduction in a 13-week empty rate from 35 to 17%. Against the backdrop of a requirement for increased numbers of replacement heifers to grow the dairy industry in future years and an urgent requirement to regain control of fertility on farms, adopting suitable management practices in addition to the selection of an appropriate dairy cow will provide dairy farmers with research to regain control of reproductive performance on farms based on the most up-to-date information.

Improving reproductive performance

The approach taken at Ballyhaise has been to select for a dairy cow with a lower milk production potential and excellent fertility so as to achieve high animal performance through a compact calving profile. In this regard, the initial four years of this project have been successful as empty rate during a 13-week breeding window has been halved while pregnancy rates have increased each year. This improvement in reproductive capacity has been realised by improving the genetic capabilities of the herd using the Economic Breeding Index (EBI). The basis for high animal performance from pasture is to use high EBI sires with excellent fertility sub-indices to increase the portion of cows calving compactly in the six weeks following the start of calving each spring. Over the last four years the dairy herd at the college has been transformed from an average EBI Holstein-Friesian herd (EBI = €28; fertility subindex= €0) using high EBI Friesian, Jersey and Norwegian Red sires coupled with the purchase of 30 high EBI Friesian and Jersey crossbred incalf heifers in the autumn of 2006 and a further 25 high EBI Friesian and Jersey crossbred incalf heifers in autumn 2008. The change in genetic make-up and level of reproductive efficiency of the herd between 2005 and 2009 is outlined in Table 1 below. This change has been realised through the exclusive use of high EBI sires such as UYC, RUU, CWJ, TIH and WLT over the last three years. With improving herd fertility the main breeding objective, the average empty rate for the herd was reduced from 35% in 2005 to 17% in 2009. In 2010, the average EBI of the herd is €113 with the fertility subindex contributing €66. Approximately, 25% of the 126 cows calving in 2010 are Jersey cross Holstein-Friesian. The rate of progress in genetic improvement in the herd will continue with bulling heifers with an average EBI of €123 (fertility sub-index = €70) and an average EBI of €133 (fertility sub-index = €73) for calves born in 2010. The target EBI for the herd for 2012 is €140 with the herd annually realising 1,350kg of milk solids per hectare and with 90% of the herd calving in 42 days.

Table 1. Ballyhaise College dairy herd 2005-2010

Year	Herd EBI (€)	Milk SI (€)	Fertility SI (€)	Pregnancy rate to 1st service (%)	42 day In-calf rate (%)	13-week Empty rate (%)
2005	28	28	0	36	38	35
2009	103	44	51	49	60	17
2010	113	37	66	-	-	-

(Breeding season was 13 weeks in 2005 and 12 weeks during 2009).

What are the consequences of these changes?

The strategy employed in Ballyhaise is to maximise milk solids production per hectare from within low cost systems. Table 2 below illustrates the changes in herd performance since 2004 in comparison with the target levels of performance for the herd. Overall, milk solids productivity per cow has been reduced, while milk solids production per hectare has increased from 946 kg MS to 1,135kg MS per hectare during the same period due to compact calving, increased grass utilisation and improved pasture quality. The net consequence of this change in milk productivity in association with the improved fertility performance evident in Table 1 is to increase overall farm profitability per hectare at a 30 c/l milk price from €1,000 per hectare in 2005 to €1,900 per hectare in 2009. (For further details, see “Key Factors for Dairy Farm Efficiency” paper also in this booklet).

Table 2. Key Performance Indicators for the Ballyhaise College Farm

	2005	2009	Target
Herd EBI (€)	28	103	100
Herd milk sub-index (€)	28	44	50
Herd fertility sub-index (€)	0	51	50
Stocking rate (cows/ha)	2.2	3.1	3.5
Concentrate (kg/cow)	439	750	250
Fertilizer (kg N/ha/yr)	170	242	250
Grass growth (t DM/ha/yr)	14.7	14.7	>18
Pasture OMD (%)	75	83	85
Milk solids (kg/cow)	430	367	450
(kg/ha)	989	1,138	1,600

While per cow performance has been reduced between 2005 and 2009, owing mainly to a lower herd age profile, the improvement in per hectare performance of the Ballyhaise herd during the same period has been realised through improved calving compactness as illustrated in Figure 1 below. Increasing the genetic potential of the herd for fertility has resulted in more cows calving in February and March and consequently achieving longer more productive lactations during the grazing season.

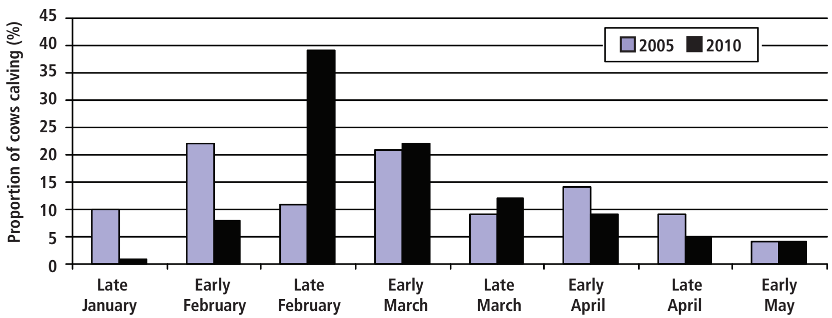


Figure 1: The Proportion of cows calving by month at Ballyhaise in 2005 and 2009

Ongoing Experimental Results 2009

During 2008, 2009 and 2010, the Ballyhaise College system experiment will compare two likely futuristic pasture-based production systems for the Northern regions. Both production systems are based on high milk solids (fat plus protein) production from within low cost systems, a long grazing season (February to Mid-November), high grass growth rates and efficiency nutrient (both fertiliser and concentrate) utilisation.

The systems compared are:

a) Low external input enclosed system: This is a low cost pasture-based system based on maximum grass production and conversion to milk (HG)
   - 3.1 cows per grazing hectare
   - 300 kg of supplement per cow
   - all winter feed produced within the farm

b) High pasture utilisation open system: This is high supplementation high intensity system based on a maximum grass conversion to milk (HI)
   - 4.5 cows per grazing hectare
   - 1,100kg of supplement per cow
   - Most winter feed produced from outside

Table 3 outlines the performance of the experimental groups during 2008 and 2009. The farm produced 15.2 and 14.7 tonnes of grass DM per hectare during 2008 and 2009, respectively. Average pre-grazing herbage mass was 1,400kg DM/hectare (10cm pre-grazing height) with post-grazing residuals averaging 3.9cm. The HI system produced more milk per cow, similar fat and protein composition and higher milk solids production per hectare.

Table 3. Effect of system of production on animal productivity (2008-2009)

System of Production	HG	HI
Stocking Rate (Cows/ha)	3.1	4.5
Concentrate to milking cows (kg/cow)	693	1,065
Silage to milking cows (kg/cow)	353	773
Milk (kg/cow)	4.630	5,023
Fat (%)	4.46	4.41
Protein (%)	3.50	3.41
Milk Solids (kg/ ha)	1,142	1,767
6week pregnancy rate (%)	51	56
Empty rate (%)	22	20
AI services (No./cow)	1.31	1.29

Table 4 below outlines the breed group effects on milk production and reproductive performance in 2008 and 2009. As evidenced from the Table, the Holstein-Friesian Jersey crossbred animals had a higher EBI and milk production and reproduction potential in 2008 and 2009, which corresponded to increased milk production and composition and superior reproductive performance during the initial two years of the experiment when compared to the pure Holstein-Friesian animals on the experiment. In addition, the crossbred animals on the study were approximately 30 kg lighter than the pure Holstein-Friesian which is advantageous for grazing on wet soils in spring and autumn.

Table 4. Effect of breed on milk production and reproductive performance (2008/2009)

Breed group	Holstein-Friesian	Jersey* Holstein-Friesian
EBI	69	100
Milk Sub-index	32	44
Fertility Sub-index	28	50
Milk Production		
Milk yield (kg/cow)	4,843	4,997
Milk solids (kg/cow)	363	411
Fat (%)	4.13	4.62
Protein (%)	3.33	3.55
Reproductive Performance		
Pregnancy rate to 1st service	34	46
6-week pregnancy rate (%)	44	65
Empty rate (%)	31	21
Average Bodyweight (kg)	544	512

Conclusions to-date

Preliminary results from this ongoing study demonstrate that considerable potential exists to increase animal productivity from pasture in the BMW region by increasing sward productivity in combination with an appropriate stocking rate and a compact calving high EBI herd.

(Weekly updates on research herds at Moorepark are available online at: www.agresearch.teagasc.ie/moorepark).

Bull Selection 2010

Frank Buckley and Donagh Berry
Teagasc, Moorepark Dairy Production Research Centre, Fermoy, Co. Cork

Summary

- The EBI is a tool to compare animals with regard to the expected profitability of their progeny based on additive genetic differences.
- Evidence from Moorepark suggests that high EBI North American Holstein genetics can survive in our system.
- Oman (OJI) is still ranked no. 1 on the ICBF Active Bull list®. On average, in Ireland his daughters have 19 days shorter calving interval and 1% greater survival compared to their herdmates.
- A review of 2009 daughter performances for the first crop of genomically selected (GS) sires is signalling that genomic selection is a more accurate predictor of genetic merit than previously used methodology.
- Research is on-going between Teagasc Moorepark and ICBF to ensure a continuous supply of high EBI sires into the future. Among the challenges being addressed is the identification of elite Irish bull dams of future high EBI AI sires.
- Crossbreeding trials at Moorepark have demonstrated substantial improvements in cow performance and consequent profitability from crossbreeding. Moorepark studies suggest hybrid vigour is worth in excess of €100 per lactation in addition to EBI.
- Analysis by ICBF, using performance data from the national data base, confirmed these findings.
- The true benefit (add profit generation) from crossbreeding will only be realised where the best available genetics (high EBI alternative breed sires) are used, thereby availing of high EBI, breed complimentarity and hybrid vigour.

Introduction

The ideal cow for Ireland, irrespective of breed, is a cow that will efficiently deliver high milk solids from grazed grass with little fuss, and continue to go back in calf year-on-year. Robust reliable cows will ensure profit generation regardless of the ups and downs that the future will present. The ongoing research at Moorepark, as well as close collaborations with industry partners such as the Irish Cattle Breeding Federation (ICBF); experimental results, and tools such as the EBI, the Active Bull list®, Genomic Selection etc., gives Irish dairy farmers the knowledge to identify the most profitable genetics for the Irish grass-based environment. Now, more than ever, there is a large choice of bulls of high genetic merit from different breeds. Irish farmers must maximise the use of superior genetics to ensure highest profit potential within their future herd.

Genetic improvement – the Economic Breeding Index

Genetic improvement for Irish dairy farmers should constitute increases in herd productivity through genetic improvement in solids output potential, and reduced costs by genetically improving reproductive efficiency/survival as well as animal health (udder health, lameness etc.). It also should be noted that improvements to calving interval and survival (fertility sub-index) will improve productivity via potentially longer lactation lengths as well as increasing the proportion of cows reaching maturity and the consequential increased production capacity that ensues. Moreover, it must be appreciated that genetic change, be it improvement or otherwise, is cumulative and permanent. The economic breeding index (EBI) has been available to Irish dairy farmers as a tool to identify the most profitable animals under average production systems. The availability of sub-indexes within the EBI allows farmers to "fine-tune" the selection of bulls to address particular issues in their herd.

EBI – ongoing developments

The economic breeding index is continuously updated to reflect expected changes in economic, social and environmental policy as well as the availability of data to estimate genetic merit. With land now the limiting factor on Irish dairy farms (imminent removal of quota) the ability to maximise milk solids output per unit land area, or per tonne of grass grown is the key to maximising profitability. To reflect this the weighting on cow liveweight has become more negative and to make this more transparent within the EBI, a new sub-index, the 'maintenance' sub-index, is now included. This in effect means that the EBI is selecting for cows with high milk solids and good fertility, and requiring less feed to do so. Upcoming changes to the EBI in the latter half of 2010 will include changes to the methodology by which fertility (calving interval) is evaluated with more emphasis being placed on insemination data. Mastitis and lameness will enter the EBI as traits themselves, replacing the current methodology whereby both traits are predicted by somatic cell count and locomotion score, respectively. Also, six-week-old calf price (based on mart data) will replace carcass traits in the beef sub-index.

Genomic selection – What is it?

Genomic selection is a new tool that facilitates the more accurate identification of high EBI animals, based on analysis of the DNA of the animal. As a technology it is being heralded as the most promising application of science in animal breeding since the introduction of AI. The basis of the technology is similar to that used by forensic scientists to solve crime or identify bodies. Both are based on the knowledge that everyone has a unique signature of genes or DNA. Also, DNA is passed on from parents to offspring. Furthermore, DNA can be measured in an individual from birth and does not change over the lifetime of the individual. It is the DNA, or genes, interacting with the management on the farm, that determine whether an animal will yield more milk solids and will go back in-calf easily.

Therefore, if we can determine what DNA is associated with the different performance traits, and we can measure the DNA of an animal at birth, then we can predict the genetic merit of the animal. This is the basis behind genomic selection. Genomic selection was launched in Ireland for Holstein-Friesian cattle in spring 2009. Ireland was the second country, after the US, to release official national proofs based on genomic selection. The implication of genomic selection is an increase in EBI reliability for younger animals, especially young bulls and cows. It has no impact on the reliability or EBI of proven bulls. Genomic selection is currently only available in Holstein-Friesians but research is underway to expand to other breeds. The accuracy of the approach will be firstly tested in beef where a multiple of sires from different breeds are proven in Ireland.

Genetic evaluations incorporating genomic information

In Ireland, the genetic merit predicted from the DNA is blended together with the old system of genetic evaluations, which for calves is just its parental average. Bulls with DNA information included in their genetic proofs are said to be "genomically selected". Here, there are four categories of bull available through AI; a) bulls with daughters milking in Ireland (DP-IRL), b) bulls with no milking daughters in Ireland but with daughters milking in other counties, thereby proven in other countries (DP-INT), c) bulls selected based on their DNA, but also with at least 50% reliability for calving difficulty in some country, meaning that they must have progeny calves somewhere in the world and are therefore known not to carry any major genetic defects observable in calves and have reliable calving difficulty information (GS), and finally d) bull calves which are genomically selected but have no or very few calves born anywhere in the world.

Impact on genomics on accuracy of identifying elite bulls

The reliability achievable for bulls evaluated, based on their DNA, is now approximately 54%, though this will vary depending on the information available from their pedigree. This is an increase of approximately 22% compared to no genomic selection being used. However, 54% reliability is still considerably less than the maximum of 99% achievable in proven (older) bulls. Nonetheless, the genetic merit (e.g., EBI) of the best genomically selected bulls is on average superior to the genetic merit of most proven bulls, available at a reasonable price. The lower reliability of genomically selected bulls can be overcome by using teams of these bulls; a recommendation is to use at least five genomically selected bulls in a team. **Use of less than five genomically selected bulls in a herd is not recommended and should never be undertaken.** The reliability of the average EBI of a team of five genomically selected bulls, each with an individual reliability of 54%, is equivalent to the reliability of the EBI of using one sire with a reliability of 91%. One option is to select a team of bulls that includes proven bulls, genomically selected bulls proven for calving difficulty, and G€N€ IR€LAND young bulls.

Are we confident that genomic selection stacks up?

Although genomic selection is a relatively new technology and has not been thoroughly proven, 35 layoff bulls that were genomically selected last year now have daughters milking. Comparing their now daughter milk production proofs (these bulls have no daughters with fertility information yet) with predicted milk proofs using genomic selection and the old traditional system of genetic evaluation, it is clear that genomic selection was the better predictor. Some bulls did change relative to their predictions but this is expected and is reflected in the range of EBI provided on the Active Bull List®.

Can high EBI North American holstein genetics be successful in Ireland?

Based on past experience it is difficult to accept that Holstein-Friesian genetics (specifically those of North American origin) will really survive in our grass-based production environment. Recent research at Moorepark, however, provides evidence that the EBI and its sub-indexes do predict animal performance. Cows of contrasting fertility sub-index but similar production sub-index were assembled. The cows in the study have either a high fertility sub-index (€51) or a low fertility sub-index (€-30), but have similar percentage of Holstein-Friesian genetics (93%) and similar values for the milk production sub-index (€40). The sires of cows with a high fertility sub-index include RUU, LBO, LLO and OJI, while the sires represented in the low fertility sub-index group include BIJ, VET, SYG and GUF. In 2008, the 36 cows were managed as one herd in accordance with the Moorepark blueprint for pasture-based milk production. The production and fertility performance of each group during Year 1 of the study (2008) is summarised in Table 1.

Table 1. First lactation milk production and reproductive performance

	High fertility sub-index	Low fertility sub-index	Fertility targets
Milk production (kg)	5069	5098	-
Milk solids (kg)	360	363	-
Average BCS	2.81	2.65	-
21-day submission rate (%)	83	72	90
First service pregnancy rate (%)	56	28	55-60
6-week in-calf rate (%)	72	41	>75
Empty rate (%)	11	28	<10
2008 mean calving date	15 Feb 2008	09 Feb 2008	-
2009 mean calving date	17 Feb 2009	11 Mar 2009	-

There was no difference in milk production during their first lactation. The high fertility group maintained a better body condition score (BCS) throughout lactation. This is particularly interesting, as all cows were fed and managed in a similar manner. The high fertility group had slightly better submission rates, superior conception rates, less pregnancy loss (embryo mortality) and a lower overall empty rate than the low fertility group. The differences in fertility performance resulted in the mean calving date in 2009 staying the same in the high fertility group, but slipping by 28 days in the low fertility group. This means the high fertility group had a more compact calving pattern, resulting in longer lactations at pasture, and hence a more profitable cow.

"The Oman effect"

Similarly, there is a lot of talk on how the high yielding North American bull, Oman (OJI), can have such good fertility. Unfortunately we don't know and if we did we would make more of them! However, OJI, or his sons, are topping the active bull lists of most countries around the world. OJI is currently positioned around 50th highest on breeding worth (BW) in New Zealand based on many New Zealand daughters. He loses many BW points from his heavier liveweight compared to the average herd (which includes Jersey cows) in New Zealand. His milk production sub-index in Ireland is based on 418 daughters milking in 111 Irish herds (including Moorepark). His fertility performance is still based on INTERBULL genetic evaluations but is also influenced by his 426 daughters in 112 Irish herds. On average, these daughters have 19 days shorter calving interval than their herdmates and 1% more survive to the next lactation.

The national breeding programme

Having a world-class breeding index, such as the EBI, is futile without having a constant supply of high EBI sires from different families, coming through the system year-on-year. This is the basis of G€N€ IR€LAND®. A breeding programme, first implemented by the NCBC in collaboration with Moorepark and the ICBF in 2009 is now being expanded to include other breeding organisations. The objective is to ensure that a sufficient stream of new sire and dam lines routinely come to the top of the Active Bull List®.

The selection of sires of young test sires is not very difficult, and is possible by large progeny group sizes and international genetic evaluations. Identification of elite Irish dams is, however, more challenging because of the lower EBI reliability associated with cows. The approach is to identify genetically elite Irish cows that have proven themselves under Irish grazing systems. Research at Moorepark is underway since 2007 to develop computer programmes that will screen the entire national dairy herd of milk recorded cows to identify high EBI cows that have proven themselves on the ground through high milk solids and consistently going back in calf. Genomic selection tools will be used to more accurately select within these cows. These cows will be mated to sires, of which a proportion will be of different sire lines, some with lower EBI values compared to the current high flying bulls. The hope is, with careful selection, that a proportion of progeny from lower EBI sires will themselves have higher EBI and be able to compete with bulls at the top of the Active Bull List®.

Crossbreeding

There is now also an increasing realisation that crossbreeding with high genetic merit (high EBI) alternative breed sires can offer substantial animal performance benefits with consequent improvements in profit. Much of this view is being fuelled by the findings emanating from the research at Moorepark - Jersey crossbreeding research at Ballydague and the Norwegian Red on-farm study. Since 2006, Ballydague research farm has been devoted primarily to evaluating the merit of crossbreeding with Jersey under Irish conditions. After four years of evaluation the results are consistent and very much in favour of the Jersey crossbred cows when compared to either of the two parent pure breeds. Similar findings were observed on the on-farm study with Norwegian Red×Holstein-Friesian cows.

While the Jersey×Holstein-Frieisan cows produced less milk volume compared to the Holstein-Friesian, they had improved milk composition and consequently increased milk solids yield and milk value. Production characteristics of the Norwegian crossbreds was similar to that of the Holstein-Friesian cows. As a consequence, we can in fact expect an increase in herd productivity, particularly where we use top genetics. This is due to more days in milk/more mature lactations because of improved fertility/survival. Both Jersey×Holstein-Frieisan and Norwegian Red×Holstein-Friesian cows on both studies display many other favourable practical traits that will benefit Irish dairy farmers, such as an ability to maintain better body condition, a moderate body size, and a substantial improvement in reproductive efficiency. Udder health was improved with the Norwegian Red crossbreds compared to the Holstein-Friesians.

As presented at the Teagasc National Dairy Conference last November, economic analysis conducted using the biological data generated at Ballydague showed a substantial profit benefit per lactation with the Jersey×Holstein-Friesian cows compared to pure Holstein-Friesian cows. The difference in performance equated to +€18,000 annually on a 40ha farm. This is over €180/cow/year more profit with the Jersey×Holstein-Friesian cows compared to pure Holstein-Friesian cows at Ballydague. In the same analysis, similar improvements were estimated for the Norwegian Red crossbreed (+ €130/cow annually). 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. The improved profitability is primarily attributable to improvements in milk value and the large differences in reproductive efficiency/longevity observed at Ballydague.

Whilst these results are highly significant, it should be noted that they were based on animals from an experimental research farm and that some of the difference in economic performance could be explained by EBI differences between the crossbred and Holstein-Friesian cows. These findings prompt the question as to whether similar findings would be apparent based on national data, where the number of animals are much larger.

Latest results from EBI evaluations

Recent ICBF research indicates a potential benefit from crossbreeding to other dairy breeds, of some €100/lactation in the first cross (Table 2). These results are based on an analysis of 28 commercial dairy herds (some 6,000 lactation records) that have a mixture of dairy breeds including Holstein-Friesian and Jersey.

Table 2. Breed and hybrid vigour effects for three dairy breeds under commercial farm conditions

	Milk (kg)	Fat (kg)	Protein (kg)	Calving interval	Cow profit (€)
Holstein-Friesian	5,549	233	200	371	€1,176
Jersey*	-1172	7.3	-19.6	-3.8	€25
Hybrid vigour effects**. Holstein-Friesian×Jersey	93 (1.7%)	5.7 (2.4%)	5.3 (2.7%)	-3.2 (-0.9%)	€74 (6.3%)

** Breed effect of Jersey is relative to the Holstein-Friesian.*
*** Values within brackets are percentages hybrid vigour of the phenotypic mean.*

The results indicate that, relative to the Holstein-Friesian, purebred Jerseys, produce less milk volume (4,377 kg), more fat (240 kg), less protein (180 kg) and have shorter calving intervals (367 days), with a difference in overall profit of +€25 (in EBI terms).

Looking next at the effects of hybrid vigour, indicates that first cross animals (F1) from the Holstein-Friesian and Jersey breeds, would have additional milk, fat, protein and calving interval benefits, above the average of the two parent breeds, resulting in an increase in cow profit/lactation of €74 (or 6.3% of the phenotypic mean). ***Similar hybrid vigour benefits were apparent for other breed crosses.***

It should also be noted, that the results presented only take into account the effects of milk production and calving interval and do not account for other traits within the EBI, most notably cow survival. Given the biological similarity between this trait and calving interval, ICBF are confident that inclusion of data on this trait (and other traits within the EBI index), would increase the effect of hybrid vigour to ~€100 for breed crosses, such as the Jersey×Holstein-Friesian.

These results are significant and timely. They also support the findings from the Ballydague research, with both studies indicating substantial benefits from cross-breeding. ***A figure of €100 in the first cross is now accepted within the industry.*** You should keep this figure in mind when making your breeding decisions this spring.

Sire selection for cross breeding this spring

The first and most important thing to remember is to continue to use high genetic merit (high EBI) sires. However, many of these 'alternative breed' sires still have very low reliability so it is important to 1) use a team of bulls and 2) take cognisance of proof in country of origin which will likely be of higher reliability. Based on the findings outlined above, using a Jersey or Norwegian AI sire with an EBI of €200 will result in progeny with an increased profit per lactation of €300 (i.e., €200 from the direct genetic effect, plus another €100 from the "mixing" of the genes). Similarly, using a Jersey sire with an EBI of €100 will only return an additional profit of €200, which is less than the majority of Holstein Frisian sires on the ICBF Active Bull List. Keep this in mind when making breeding decisions – otherwise the benefits of cross-breeding will be totally wiped out by using inferior sires from other breeds. Remember also that the heterosis effect (€100/lactation) does not get 'passed on' to the next generation, but may be reduced after generation one. The extent to which hybrid vigour is maintained/reduced depends on the breeding strategy of choice after the first cross.

Where to after the first cross?

There are three options with regard to the breeding strategy that can be employed when it comes to breeding the crossbred (F_1) cow. These are as follows:

1) Two-way crossbreeding. This entails mating the F_1 cow to a 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%.
2) Three-way crossing. Simply use a high EBI sire of a third breed. When the F_1 cow is mated to a sire of a third breed HV is maintained at close to 100%. However, with the reintroduction of sires from the same three breeds again in subsequent generations the HV levels out at 85.7%.
3) Synthetic crossing. This involves the use of F_1 or crossbred bulls. In the long term a new (synthetic) breed is produced. HV in this strategy is reduced to 50% initially and is reduced gradually with time.

At Ballydague, for the past two breeding seasons the Jersey×Holstein-Friesian cows have been mated to high genetic merit Norwegian Red sires (LEV, NZT, SJU, AKM) to determine the benefit of a three-way crossbreeding strategy. In conjunction with this a follow-on study to the on-farm Norwegian Red crossbreeding study has engaged a further 20 commercial farms to generate and subsequently evaluate three-way crossbred cows (both Jersey×Norwegian Red×Holstein-Friesian and Norwegian Red×Jersey×Holstein-Friesian) on a larger scale. This year, 20 three-way crossbred heifers at Ballydague (50% Norwegian Red, 25% Jersey, 25% Holstein-Friesian) will be mated to the highest EBI GS Holstein-Friesian sires available from the ICBF Active sire list. Emphasis will be placed on solids yield mostly, while obviously not neglecting the fertility sub index. In essence, therefore, maximising the benefits of EBI, breed complimentarily and hybrid vigour. The resulting calves will be 62.5% Holstein-Friesian, 25% Norwegian Red and 12.5% Jersey. These will in turn be mated to high EBI Jersey and so on.

Genomic selection and other breeds

Genomic selection in Ireland is currently only undertaken in Holstein-Friesians due to a lack of high reliability proofs on a large number of sires from other breeds; however, genomic selection is undertaken in other countries on different breeds but these are not for EBI or its constituent traits under Irish production conditions. Research is on-going, however, to evaluate the possibility to extend genomic selection to other breeds/crossbreeds in Ireland.

Conclusion

Genetic change, be it improvement or otherwise, is cumulative and permanent. Now, more than ever, there is a large choice of bulls of high genetic merit AI sires available. Farmers can choose to use high EBI black and white sires or choose to capitalise on the merits of crossbreeding – high EBI, breed complimentarily and hybrid vigour. ***If sufficient high EBI 'alternative breed' sires can be identified, crossbreeding is the logical option for all to maximise profitability.*** The right genetics is crucial for future success. Irish farmers must maximise their use of superior AI sires this season.

Getting Cows In-calf

Stephen Butler,
Teagasc, Moorepark Dairy Production Research Centre, Fermoy, Co. Cork

Summary

- Use only bulls that will improve genetic merit for fertility traits.
- Maiden heifers should be inseminated with high EBI easy-calving AI sires to increase availability of high genetic merit replacements.
- Maximising submission rates is critically important. Heat detection aids must be used.
- AI should be used for at least the first six weeks of the breeding season to increase the proportion of heifers born to high EBI sires.
- Herd synchronisation could help reverse slippage in mean calving date
- Good records of all problems/disorders around calving are essential in identifying cows with potential fertility problems during the breeding season
- Examine body condition. Thin cows are less likely to go in-calf. Take action immediately to improve fertility performance
- Nutrition has a major effect on fertility. If grass supply is inadequate, introduce buffer feeds.

Maximising submission rate

Submission rate is a key driver of fertility performance. To maximise submission rates, use heat detection aids. Moorepark research shows little difference in reproductive performance when tail paint, paint stick, checkmate mount detector or scratch cards were used as the heat detection aid. The type of aid used is a matter of preference, but after choosing an aid, use it properly for the period of AI use.

Pre-breeding heat detection

Pre-breeding heat detection should begin three to four weeks before the planned mating start date. This is a good time to improve heat detection skills, to train new staff to correctly identify cows in oestrus, or to try alternative heat detection aids. All heats should be recorded. By mating start date, you will be able to anticipate when cycling cows will next come on heat, and you will also have a list of all cows that have not yet been seen in heat. The following is a simple pre-breeding heat detection programme using tail paint, but other heat detection aids can also be used.

- Apply tail paint of one colour (e.g., red) to all milking cows 28 days before the planned mating start date. Apply red paint to late calvers as they enter the milking group.
- Check the tail paint on all milking cows weekly until mating start date. Depending on weather conditions, cows may need to be topped up with red paint.
- Record all cows that have had tail paint removed, and paint with a different colour (e.g., green).

- At mating start date, any cows with red paint are unlikely to have been in heat during the preceding 28 days. Cows with green paint have been in heat at least once during the same period.
- Calculate the percentage of the herd that is cycling and showing oestrus by dividing the number of cows with green paint by the number of cows with either green or red paint, and multiply the result by 100.
- The figure should be >70%. If the figure is lower than this, it may be necessary to:
  - o Improve pre-breeding heat detection;
  - o Examine calving pattern (i.e., too many late calving cows);
  - o Determine the average body condition loss after calving and current body condition score. Thin cows or cows that lost a lot of body condition after calving are at risk of anoestrus; and,
  - o Ensure that heifers have reached their bodyweight and body condition targets at calving.

If pre-breeding heat detection is carried out as outlined above, switch to a new colour paint after cows have been inseminated (e.g., blue). This allows a speedy picture of how your submission rates are progressing. Cows with blue paint have been inseminated. Cows with green paint were detected in heat before MSD and it should be known when to expect them to return to heat. Cows with red paint have not yet been inseminated and have not been observed in heat. The target three-week submission rate for efficient seasonal calving systems is 90%.

Automated heat detection

Activity meters can be useful for automated heat detection. A trial conducted at Ballydague farm in 2007 indicated that the MooMonitor activity collar had a heat detection rate of 82% when 173 cows were managed as a single group at pasture. These are encouraging results, and show that if labour is limiting the time available for heat detection, then automated heat detection should be considered.

Cow synchronisation and fixed-time AI

In 2008, a large trial was carried out on eight commercial dairy farms with lactating cows to examine the effect of different synchronisation protocols on reproductive performance. Two of the protocols evaluated utilised fixed-time AI, meaning that cows were inseminated at a designated time with no requirement for heat detection. Increased use of AI is facilitated with fixed-time AI, as you know in advance when the cow will be inseminated. Cows that calved on or before mating start date were included in the study. Treatments were carried out to facilitate AI on MSD (earliest calving cows), and again at 21 days after MSD and 42 days after MSD (for the later calving cows). All cows were at least 42 days calved at the time of insemination. The treatment protocols are outlined in Table 1. The CIDR_OBS treatment is a CIDR based oestrus synchronisation treatment, and cows had to show signs of oestrus before being inseminated. Both the CIDR_TAI and Ovsynch protocols are ovulation synchronisation fixed-time AI protocols. The fourth treatment was a control group, and these cows received no hormonal intervention.

Table 1: Hormone treatments for three different synchronisation protocols

	CIDR_OBS	CIDR_TAI	Ovsynch
Mon	GnRH + CIDR in (8 am)	GnRH + CIDR in (8 am)	GnRH (8 am)
Tue			
Wed			
Thu			
Fri			
Sat			
Sun			
Mon	PG (8 am)	PG (8 am)	PG (8 am)
Tue	CIDR out (8 am)	CIDR out (8 am)	
Wed		GnRH (5 pm)	GnRH (5 pm)
Thu	AI at observed oestrus	FTAI (10 am – 1pm)	FTAI (10 am – 1pm)
Fri	AI at observed oestrus		

GnRH = Gonadotropin Releasing Hormone; CIDR = Controlled Intravaginal Drug Release Device
PG = Prostaglandin F_{2a}; FTAI = Fixed-time AI

The fertility results are outlined in Table 2. What is immediately obvious is that the two fixed-time AI protocols resulted in the greatest submission rates. Compared with the Control treatment, CIDR_TAI had similar conception rates to first service, but combined with the greater submission rate, resulted in a shorter to calving to service interval and a shorter calving to conception interval. The results for CIDR_OBS and Ovsynch are intermediate between the results for Control and CIDR_TAI.

Table 2: Fertility results for different synchronisation treatments

	TARGET	CIDR_OBS	CIDR_TAI	OVSYNCH	Control
SR-24d	90	74.6	91.2	91.0	78.6
CRFS (%)	50-55	53.7	49.4	42.6	49.3
CSI (d)	60-70	60.0	55.4	55.1	64.1
CCI (d)	80-85	79.0	76.3	79.4	83.9

Heifer synchronisation

Synchronisation should be utilised us a management tool to maximise the number of heifers that become pregnant as quickly as possible after MSD. Appropriate synchronisation protocols for heifers are outlined in Emer Kennedy's paper in this publication.

Body condition scoring (BCS)

BCS is an excellent tool to monitor herd nutritional status. Moorepark research shows that BCS at the time of first service and the loss in body condition from calving to first service affect the reproductive performance of dairy cattle. Target scores for key times during the year have been identified and are summarised in Table 3.

Table 3: Target body condition scores at key times of the year

	Target scores	
	Herd average	**Range**
Drying off	3.0	2.75 to 3.25
Pre-calving	3.25	3.0 to 3.5
Start of breeding	2.9	2.75 to 3.25

The key points are that you want your cows to gain very little during the dry period, and hence they must be close to the desired BCS at dry-off. Excessive loss of bodyweight and body condition after calving results in anoestrus, cystic ovaries, poor expression of oestrus, decreased conception rates and increased incidence if embryonic mortality. Feed cows in early lactation to minimize BCS loss.

It can be difficult to achieve the BCS targets outlined above with cows that have been aggressively selected for increased milk yield. Feeding higher levels of concentrate to these cows results in higher milk production, but doesn't improve BCS. In the short-term, the BCS of these cows can be improved by 1) turning cows out to a high quality pasture soon after calving rather than feeding indoors on grass silage; 2) shortening the duration of the dry period from eight weeks to four weeks reduces the inherent drive to produce milk in the subsequent lactation, and hence improves BCS; 3) adopting once-a-day milking for set periods of time when necessary. In the long term, these cows are unsuitable for seasonal-calving grass-based systems of production. See the paper by Buckley and Berry in this booklet for detailed information on the most suitable cow genetics for grass-based systems of production.

Nutrition

The breeding season occurs while the cows are at pasture, and grass makes up the majority of the cows diet. Concentrate supplementation usually declines as the breeding season progresses. Research at Moorepark has indicated that increasing the total amount of concentrate fed during the lactation from 350kg - 1,500kg had no effect on reproductive performance. Diets fed pre- and postpartum should be correctly balanced for the major nutrients (protein, carbohydrate, lipid, fibre) and minerals. It is important to avoid major changes in the nutrition programme immediately prior to and during the breeding season. In situations where grass supply does not meet demand, a buffer feed or additional concentrate must be introduced. When supplementing cows with concentrate at pasture, avoid high protein concentrates (>18% CP). Spring grass is high in degradable protein, and in excess can lead to reproductive problems.

A number of minerals are essential for normal growth and reproduction in cattle. Trace mineral deficiency can be a problem in certain regions of the country. The main trace minerals associated with poor reproductive performance are deficiencies in copper, selenium and iodine. Molybdenum also plays an indirect role because high levels of molybdenum reduce the absorption of dietary copper. Supplementing with minerals where no deficiency exists can lead to toxicity problems. The requirement for specific mineral and vitamin supplements varies from region to region. Consult your advisor/veterinarian to discuss deficiency and toxicity problems in your area. A pre-calving mineral mix should be fed for the final four to six weeks of pregnancy.

Problem cows

The majority of problem cows are those that had a health problem during calving and/or early lactation, and good records will identify many of them. Records should be maintained of cows having twins, calving difficulty, retained foetal membranes, and peripartum disorders (metritis, displaced abomasum, mastitis, etc.). Cows that encounter any of these problems are at risk of reduced reproductive performance. Anoestrus is the term used to describe cows that have not resumed cyclicity after calving. Most cows start cycling by 35 days post-calving, and show heat by 45 days post-calving. High producing cows that are thin and have lost a lot of body condition (0.75 to 1 BCS units) are most at risk of anoestrus. Efficient pre-breeding heat detection will identify cows that are not cycling.

"Phantom cows" are non-pregnant cows that have been inseminated, but do not return to oestrus. Typically, these cows are not identified until examination after the end of the breeding season, and represent a major challenge to efficient reproductive performance. Phantom cows arise due to late embryonic mortality (weeks 4 and 5 post-insemination). The incidence is increased when body condition score is low, and when cows are inseminated <50 days postpartum.

Mid-Season Grazing for Efficient Milk Production and Reproductive Performance

Michael O'Donovan and Eva Lewis
Teagasc, Moorepark Dairy Production Research Centre, Fermoy, Co Cork

Summary

- Use 'pasture wedge technology' to manage and control grass supply in the main grazing season.
- Maintain pre-grazing herbage mass between 1,200-1,600kg DM/ha during the main grazing season.
- Grazing swards <1,100kg DM/ha will reduce overall grass production by 10%.
- Perennial ryegrass dominant pastures are crucial to achieving high production from pasture.

Introduction

Spring 2010 was a big challenge in terms of cow and grass management. While grass production was reduced by nearly 50% in the first grazing rotation, grass growth has recovered well in the second and third rotations. The objective on all dairy farms for the remainder of the grazing season should be to produce milk as profitably as possible. The month of May is a crucial month on spring-calving farms as this is generally when peak milk production occurs. However, it is also the period when the herd is being rebred for the next year. This paper discusses the grazing and nutritional management aspects which need to be considered during the main grazing season.

Controlling grass supply mid season

During the main grazing season (April to September) the objective is to achieve high cow performance from an all grass diet. This will be achieved by allocating an adequate quantity of high quality pasture (pre-grazing herbage mass 1,200 -1,600kg DM/ha) and grazing to a post-grazing residual of approximately 4 - 4.5cm. Research at Moorepark has shown that adopting a strategy of grazing pastures at 1,500kg DM/ha compared to 2,500kg DM/ha has a clear advantage in terms of milk output per cow and per hectare. **Research work in 2009 shows that grazing swards <1,100kg DM/ha is not desirable.** Continuous grazing of low covers can reduce herbage production by 10% (1t DM/ha) compared to grazing swards at 1,500kg DM/ha. Furthermore, cow grass DM intake was reduced by 0.6kg DM/cow/day with this grazing regime. Optimum rotation length is between 18-21 days during the mid season period. Where pre-grazing herbage mass is maintained between 1,200 - 1,600kg DM/ha and paddocks are grazed to a post-grazing residual of 4 - 4.5cm, pasture topping can be minimised.

The net result of operating this grazing management regime will be well-fed, highly productive, cows at grass. This will result in extra milk output, which can generate an extra €150/ha compared to operating a grazing management regime using higher pre-grazing herbage masses. **During the mid-season period the farm must be walked weekly and a farm cover completed.** This information should then be used to make critical decisions regarding the quantity of feed available to the herd. The 'pasture wedge' is a simple method of interpreting this data. The amount of grass in each paddock (cover) is drawn onto a graph, starting with the highest. The target pre-grazing yield is calculated using the following equation:

Grass intake × Stocking Rate = Herd Demand

Herd Demand × Rotation length + Residual = Pre Grazing Mass Target

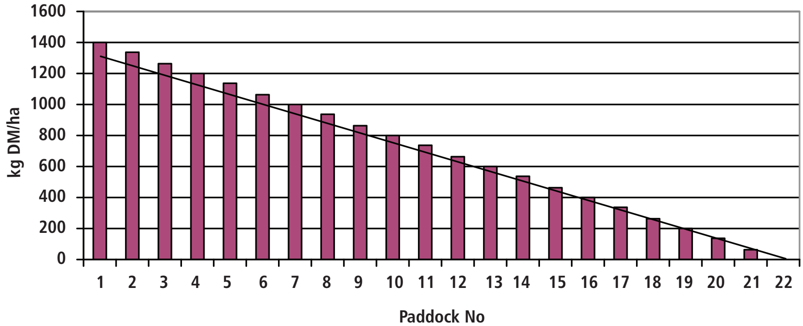
Example:

Herd Demand (16 kg DM/cow/day × 4 cows/ha) = 64kg DM/cow/day)

64kg DM/cow/day × 20 days + 100kg DM/ha residual
= 1,380kg DM/ha (target pre grazing yield)

A line is drawn from the target pre-grazing yield to the target residual (using the example 1,380kg DM/ha to 100 kg DM/ha). The pasture wedge visually illustrates the breakdown of the pre-grazing herbage mass distribution on the farm. If the paddocks are above the target line there is surplus grass on the farm. If they are below the line there is a deficit and grass is in short supply on the farm. The amount of grass in kg DM/cow can be calculated by dividing farm cover by stocking rate. Figure 1 represents a farm which is on target with its pre-grazing herbage mass profile, as the paddocks have a stepped profile and are almost all on the pre-grazing target line.

Figure 1. Ideal grass wedge with growth equaling demand



Nutritional management for high fertility

The targets for reproduction include:
- 90% submission rate in first three weeks
- 60% conception rate to first service
- 90% of cows calved within six weeks
- 365 day calving interval
- empty rate of <10%

Approaching the breeding season, it is important to ensure that cows are in the correct body condition. Body condition score (BCS) is an objective assessment of a cows body reserves. Values range from 1 (extremely thin) to 5 (obese). Moorepark research shows that the reproductive performance of dairy cows is associated with BCS at first service and with BCS loss from calving to first service. The target BCS for cows at the start of the breeding season is a herd average of 2.90. Individual cow BCS should not be <2.75. Cows should not lose >0.5 of a BCS between calving and breeding.

A number of factors can affect BCS. One important factor is dry matter intake (DMI). The DMI capacity of dairy cows in early lactation is low. As lactation progresses the DMI of the animals will increase by approximately 1kg per week of lactation, up to week 10-12. The demand for feed by the lactating spring calved cow is ~16-18kg DM/d throughout the grazing season.

The availability of grass should be the first consideration in a feeding budget and grass availability should dictate the type and level of supplementation offered. Well managed high quality grazed grass is an excellent feed. It is highly digestible and has a high energy and protein value. Well managed high quality grazed grass will meet cow requirements, ensuring high energy intake and minimising negative energy balance. This is key to achieving good reproductive performance, as it is important to have cows in a state of positive energy balance at the start of the breeding season. Moorepark research shows that there are no beneficial effects of offering supplementation on reproductive performance when adequate amounts of high quality grass are available.

In the unlikely event of a grass shortage during the breeding season, supplementary feeding may need to be considered. Purchased concentrate should have a minimum UFL value of 0.95. The UFL value and/or ingredients in the concentrate must be checked to ensure the quality of the concentrate. The type of concentrate required depends on the levels of grass available. The more grass that is available the lower the crude protein concentration in the concentrate needs to be. Concentrates that are high in digestible fibre (e.g., citrus pulp, beet pulp, brewers grains, soya hulls) are preferable to starch/sugar-type feeds (e.g., cereals grains, molasses) for supplementing pasture, especially when fed at moderate to high levels. This is because the feeds high in digestible fibre are slowly degraded in the rumen. In contrast, feeds high in sugar/starch are rapidly degraded in the rumen and this can lead to reduced rumen pH, reduced feed digestibility and reduced DMI. Grass silage should only be introduced if very low levels of grass are available for grazing. In this scenario, the grass silage maintains adequate forage fibre levels in the diet. Grass silage is less digestible and has a lower energy and protein value than grass and is a poor feed for maintaining milk protein concentration.

It is important to ensure that adequate mineral levels are present in the total diet offered. Different options are available for providing minerals. These include fixed rate concentrate feeding, carrier concentrate, pasture dusting, drinking water and boluses. The requirements for minerals are very much dependent on individual farm factors and so your own particular situation should be considered before a decision is made to offer minerals or not. The main trace mineral deficiencies associated with poor reproductive performance are copper, selenium and iodine. Molybdenum can also play a role as it can reduce the absorption of copper. In relation to the use of Calmag to aid in the prevention of grass tetany, it is important to be certain that the Calmag levels in the concentrate are suitable for the feeding rate you are employing. Levels of Calmag that are too high will cause scour and levels that are too low will not provide enough magnesium to prevent grass tetany.

Perennial ryegrass pastures

Many farms in Ireland now have swards that are unable to recover quickly from the poor winter growing conditions. These swards have high levels of unsown species that will not be capable of recovering grass growth until late April/early May. The lack of growing capacity is due to a number of factors but primarily the absence of perennial ryegrass (PRG) tillers in swards. Currently, in Ireland, only 25% of dairy farmers have a planned reseeding program. Reseeding pastures makes a lot of sense for a number of reasons: (i) Reseeded swards have the capacity to provide grass in the shoulder periods, especially early spring (ii) PRG swards are 25% more responsive to nitrogen than permanent pasture (iii) PRG swards have higher sward quality and re-growth ability (iv) PRG swards can carry higher stocking rates. Investment in PRG swards is rewarding. The opportunity loss of old permanent pasture is about €300/ha, and so, with full reseeding costs of €500/ha, the cost of a successful reseeding program is returned within two years. There are huge developments being made in the area of grass and clover breeding, and reseeding swards with the best varieties will allow farmers to harness these developments.

Increasing the availability of replacement heifers

Emer Kennedy, Stephen Butler and Frank Buckley
Teagasc, Moorepark Dairy Production Research Centre, Fermoy, Co Cork

Summary

- Well bred heifers should represent the highest genetic material in the herd and have the capacity to improve herd calving pattern and farm profit.
- Currently only 26 dairy bred heifers per 100 are produced per year, when calving pattern and mortality levels are factored in this indicates insufficient numbers to grow the national dairy herd.
- Target liveweights at 6, 15 and 24 months of age should be identified as part of the heifer rearing programme and achieved.
- Once-a-day feeding reduces the labour requirement of the pre-weaned calf.
- Out-wintering heifers on kale can improve weight gains and result in superior fertility performance.
- Weight gains can be significantly increased by turning heifers out to grass six weeks pre-mating start date.
- Synchronisation is a management tool to maximise the number of heifers that become pregnant as quickly as possible after mating start date.

Introduction

Well bred and well reared maiden heifers have the potential to substantially impact upon herd profitability in that: 1) they should represent some of the highest genetic material in the herd in terms of potential profit, 2) if calved early they have a capacity to significantly improve herd calving pattern, 3) if mated to high EBI sires will provide a (further) source of early-born high genetic merit replacement heifers for the future, and 4) they may be a source of extra income from sale of surplus heifers. In order to capitalise on these benefits however high levels of husbandry and management will be required.

The scarcity of heifers is a major limitation to expansion

In a recent survey almost 50% of farmers indicated that they intend to expand their dairy enterprise over the coming years. The potential to expand post quota will be dependant on the availability of well bred, high EBI replacement heifers. Increasing numbers of replacement heifers generated will provide the opportunity to benefit from improved herd performance or capitalise on the increasing demand for replacements from those choosing to expand. This necessitates the number of replacement heifers to be greater than the number of dairy cows that are removed from the herd due to culling and death. In Ireland, while progress has been made in recent years we are struggling to achieve this objective. Furthermore, since the introduction of milk quotas the Irish dairy herd has contracted by over 1% per year which is partly being compensated by an equivalent increase in milk yield per cow. The Irish CMMS data reveals that the proportion of dairy bred females born to the dairy herd has risen somewhat in the last three years from 21 per 100 cows to 26 per 100 cows. On the face of it this may appear acceptable. The reality is that when issues such as: 1) the pattern of births nationally (only 68.6% of these are born during the months of January to March), and 2) the expected losses from birth to lactation (over 10%) are considered, it is clear this level of supply is not sufficient to sustain the current national herd, let alone facilitate expansion. Irish dairy farmers are minimising the cost of current performance by recycling cows; estimated at 18% nationally in spring calving herds (10% in the top 10% of spring calving herds based on EBI). Secondly, of 268,000 dairy heifers born in 2009 it is estimated that only 55.6% were sired by an AI bull.

There are clear issues with regard to the quantity and quality of replacement heifers available to service the national herd going forward. The trend is in the right direction but pace of change needs to be accelerated. Between 2008 and 2012 Ireland's milk quota will increase by approximately 6% and it is likely that in the final two years of the quota there will be further adjustments made towards complete devaluation. Unless we get an increase of greater than 20% in the number of cows bred to dairy AI bulls in 2010 we are unlikely to ever fill our national quota again.

Rearing the pre-weaned calf

Specific liveweight targets have been established aimed at optimising the balance between lifetime performances and rearing costs. Frequently, the heifer rearing component of the overall dairy system is overlooked despite important long-term effects on subsequent milk production performance. The rearing of high quality replacement heifers starts from the day the heifer is born. Calf mortality rates are high during the first six weeks of life (50% of all mortalities in year 1) so extra care and attention needs to be given during this period. Ensuring that all calves receive 2 – 3l of colostrum within the first six hours of life is essential to maximising calf health.

Table 1. Effect of calf feeding system on daily labour input, calf weight and weight gain

	Automatic Feeder	Once daily with teats	Twice daily with teats	Twice daily with trough
Total calf care time incl. vet. time (sec/calf/day)	38	23	36	27
Calf weight at 77 days (kg)	95.0	94.8	93.2	90.5
Calf weight gain per day (kg)	0.70	0.79	0.80	0.65

To reduce labour requirements once-a-day feeding can be implemented – once feed is offered at the same time daily it can be carried out at any time during the day. However, if feeding calves once-a-day they will still need to be checked twice daily and will need *ad-lib* access to fresh water and solid food (e.g., hay, meal, grass). Experiments conducted at Moorepark have shown that once a day feeding requires the least labour input (23 sec/calf/day). In addition, calf weight at 77 days is not adversely affected (Table 1). When weaned, calves need to be offered low covers of high quality grass throughout the grazing season. When calves are six months old they should achieve a target weight of about 30% of their mature liveweight.

Over-wintering options

There are options available when over-wintering weanling heifers that will enhance growth at a lower cost. In a Moorepark trial during the winter of 2008/2009 heifers were assigned to three diets to assess if winter feeding treatment affected the attainment of target weight at mating start date. The three treatments were: i) indoors offered grass silage (65% DMD), ii) 70% kale and 30% (66% DMD) baled silage and iii) 100% kale. As shown in Figure 1, the 70% kale and 100% kale heifers were significantly heavier (311kg) than the grass silage heifers (294kg) at mating start date (April 16). This difference in liveweight remained for the rest of the year – on 15 September 2009, the grass silage heifers weighed 435kg while the 70% kale and 100% kale heifers weighed 454kg. There was no difference in BCS at mating start date (average of all treatments = 3.10). This difference in liveweight was reflected in superior fertility performance of the heifers over-wintered outdoors on kale as a greater proportion of these animals are pregnant and are expected to calve, on average, seven days earlier than the grass silage heifers. This concurs with the data from the large Teagasc on-farm Norwegian Red study which commenced in 2005. In that study, greater liveweight and BCS were associated with a greater proportion of animals cycling pre-mating start date.

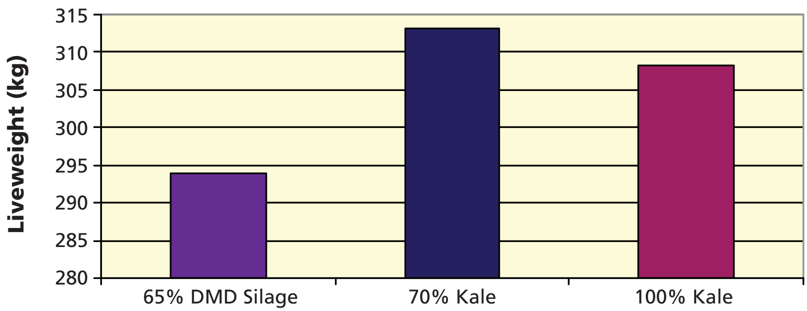


Figure 1. Effect of over-winter feeding treatment on heifer weight at the start of the breeding season (16 April 2009)

The study was repeated this winter (2009/2010) – there were five different treatments: i) 70% kale and 30% grass silage, ii) 100% kale, iii) indoors offered grass silage only, iv) indoors offered grass silage and 1.5kg concentrate and v) out-wintering pad offered grass silage and 1.5kg concentrate. The weight of the five treatments on 8 March 2010, 12 days after turnout were: 70% kale – 269kg; 100% kale – 264kg; indoors (grass silage) – 245kg; indoors (silage and

1.5kg concentrate) – 264kg; pad (silage and 1.5 kg concentrate) – 275kg. The silage offered this year was 71% DMD and 28% DM. The weight gains and fertility performance of these heifers will be monitored over the coming year.

Liveweight targets

Previous research indicates that heifers should be 25 - 30% of mature liveweight at six months old, mated at 55 - 60% of mature liveweight and should calve at 85 - 90% of mature liveweight. Recommended mature liveweights vary considerably between countries due to large breed variations. For example, in the US mature liveweight for Holstein cows is deemed to be 650kg. In New Zealand, however, this is 100kg less. By calculating target weight as a proportion of mature weight breed differences can be overcome.

In practice on many Irish dairy farms heifer rearing receives low priority and achieving target weights is not an issue of concern to farmers. As a result potential milk production is unlikely to be realised. Reduced levels of management will result in a lesser profit, as heifers may calve later than 24 months and produce less milk compared to better managed heifers. Well bred heifers, if calved early, have a capacity to significantly improve herd calving pattern and when mated to high EBI sires will provide a source of early-born high genetic merit replacement heifers for future herd development.

Heifers that become pregnant late in the breeding season are at risk of leaving the herd after their first lactation, as they may not have sufficient time during the short breeding period to recover from calving and become pregnant again. In addition, a late calving date reduces the length of the lactation, leading to reduced production potential. Hence, it is imperative that heifers conceive at the beginning of the breeding season to give them a good chance of surviving in the herd for many years. Thus, it is critical that heifers reach weight and BCS targets outlined in Table 2 to ensure they are cycling prior to the spring mating start date. Often the problem of heifers being too light is realised in March or April, by which time it is too late. Heifers should be examined and a representative sample weighed 4 – 6 months before the planned start of breeding. Growth rates of 0.6 to 0.7 kg/day should be anticipated if heifers are managed correctly (*ad*-lib high quality grass in autumn, early turnout after first winter) and will need to be realised if heifers are to reach the liveweight targets set out in Table 2. If not, then they will need to be supplemented with concentrate to ensure they reach these target weights. This supplementation can begin from autumn onwards. Weight gain from spring grass can be over 1kg/day, significantly higher than when indoors so it is important to target an early turnout date.

In addition maiden heifers should have a minimum BCS of 3.25 to ensure at least 90% are cycling at mating start date. It is imperative that only easy calving sires are used on the heifers, i.e., sires with direct calving difficulty PTA values of 1.7 or less (consult figures provided by ICBF).

Table 2. Liveweight targets for maiden heifers at breeding and pre-calving

	HF	NZFR*HF	NR*HF	J*HF
Maiden heifer LW(kg)	330	330	330	295
Pre-calving LW (kg)	550	550	550	490

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

Synchronisation for heifers

Synchronisation should be utilised as a management tool to maximise the number of heifers that become pregnant as quickly as possible after mating start date. The most popular and cost-effective synchronisation protocols for heifers involve intramuscular injections of prostaglandin (e.g., estrumate, lutalyse, enzoprost etc.). Prostaglandin synchronisation protocols work very well for heifers that have started cycling, but will not work in non-cycling heifers. The following protocol works well:

- Tail paint all heifers, and inseminate following observation of oestrus during the first six days of the breeding season.
- All heifers not inseminated in the first six days receive a prostaglandin injection on day seven, and are inseminated following observation of oestrus in the next 3 – 5 days.
- Heifers that failed to come into heat following the first injection of prostaglandin receive a second injection 10 days later.
- Heifers are again inseminated at a standing heat, or receive fixed time AI at 72 and 96h after the second injection.

This protocol generally results in submission rates close to 100% and conception rates to first service of 70%. If it is desired to reduce costs and use less prostaglandin, the first injection of prostaglandin can be delayed until day 10, and the second injection would then be given on day 20. Alternatively, if it is not possible to dedicate time to daily heat detection (e.g., heifers on an outside block), all heifers could be injected with prostaglandin 12 days before MSD and again two days before MSD. With this protocol, most heifers will be in heat in the first three days of the breeding season, and those not seen in heat could receive fixed time AI at 72 and 96 h after the second injection. However, the cost will obviously be much higher due to the greater amount of prostaglandin required (two injections for all heifers). If possible, all heifers, regardless of protocol, should be observed for repeat heats and inseminated to a high EBI easy-calving AI bull, and a stock bull introduced to “mop up” five to six weeks after the start of the breeding season.

Chemical analysis of detergent-steriliser products and guidelines for their effective use for cleaning milking equipment

David Gleeson and Bernadette O'Brien
Moorepark Dairy Production Research Centre, Fermoy, Co. Cork

Important guidelines to achieve maximum benefit from a detergent steriliser product and to avoid leaving harmful residues in milk

- Select detergent steriliser products labelled with the manufacturer's name and recommendations for use.
- For daily cleaning use either detergent or detergent sterilisers products- do not use steriliser only products for daily cleaning.
- Mix at the recommended usage rate-READ INSTRUCTIONS AND MEASURE.
- Use in hot or cold water as recommended for the product.
- Products containing chlorine should be rinsed from the milking system immediately after the main wash cycle.
- Use at least 14litres/unit (3 gals) to rinse out both milk (before the main wash) and detergent (after completion of the main wash).
- Do not re-use detergent solutions more than once.
- The expiry date should not be exceeded. For detergent sterilisers this is normally six months from the date of manufacture.
- The chemical composition of some detergent-sterilisers available in Ireland is not optimum for efficient cleaning of milk equipment i.e., the level of caustic relative to chlorine is too low.
- Increasing the usage rate of a detergent-steriliser (by either manufacture or milk producer) to compensate for a low caustic content will also increase the chlorine content and can result in chlorine residues in milk.
- Milk producers should avoid adding additional chlorine to the detergent-steriliser wash solution as this will also lead to chlorine residues in milk.

Introduction

Ireland is a major global producer, processor and exporter of milk (worth €2.2bn in exports in 2008). The production of high quality milk is of central importance to maintaining/expanding this market. Premium milk quality means (a) perfect hygiene status and (b) absence of residues. Microbial composition is a key indicator of milk quality and is most frequently assessed as a total bacterial count (TBC). Proper cleaning of the milking machine is crucial to producing milk with satisfactory TBC (10,000 -15,000 cells/ml in the bulk tank at milk collection). Regarding residues, there are a number of quite strict export regulations in place for specific dairy products. One such regulation is the content of trichloromethane (TCM). Presently, Irish dairy processors are experiencing difficulty in producing products that meet the TCM regulation of the importing country. There is a direct link between milking machine cleaning and chemical residues. While chlorine is a very economical antimicrobial, it is also very effective in removing protein deposits and as a steriliser of the machine. However, it can result in TCM residues in milk if (i) the machine is not rinsed sufficiently before and after the main wash cycle and (ii) an incorrect detergent steriliser product type or volume is used. The key to good hygiene with absence of residues is to use a reputable product at the recommended usage rates together with sufficient rinsing. A reputable product should be labelled with the following information (i) identity and content of active substances (caustic and chlorine), (ii) clear instructions on usage; (iii) manufacturer details; and (iv) date of manufacture.

List of products

The success of any detergent product in giving satisfactory cleaning of a milking plant will be determined by: (i) the chemical composition of the detergent; (ii) the correct temperature of detergent/water mix; (iii) the correct usage rate; (iv) milking system design; (v) the correct use of the product, and (vi) water hardness.

Teagasc analysed a wide range of detergents used for cleaning of milking equipment. The results of the chemical analysis of the liquid detergent-steriliser products are given in Table 1. Columns 1-3 show the product name and recommended usage rates per volume of water, for cold and hot solutions as indicated on the specific detergent-steriliser container. Columns 4 and 5 show the percentage composition of caustic and chlorine as measured, respectively, in the detergent steriliser. Columns 5-9 show the working strength of the caustic and chlorine components as calculated (using percentage composition and usage rate data), for both cold and hot solutions of the detergent-sterilisers, respectively. Products are listed in order of decreasing caustic content, since this is a main determinant of product effectiveness.

Detergent steriliser products

Composition and water temperature

Liquid detergent steriliser products contain varying levels of caustic, chlorine, surfactants and sequestrants and are now widely used for cleaning milking machines and bulk tanks. Caustic (sodium hydroxide) is necessary as the cleaning/detergent agent and chlorine (sodium hypochlorite) acts as the steriliser. Surfactants are wetting agents which can influence the effectiveness of a cleaning product and some types may have additional benefits over others. Sequestrants act as an aid to water softening. The compositional ingredients and the usage rate are the two most important parameters of any cleaning product and both have a significant impact on price.

As observed from Table 1, caustic and chlorine concentrations range from <1 to 25 % and <1 to 9 %, respectively, in the detergent-steriliser products currently available on the Irish market. **A detergent-steriliser product of minimum working solution strength 800ppm caustic and 300ppm chlorine used with cold water is necessary for satisfactory cleaning, while working solution strength of 200-800ppm caustic and 200ppm chlorine is sufficient when used with hot water.** A relatively high concentration of caustic (>800 ppm) in a detergent-steriliser product will allow for lower usage rate if used with hot water, while still achieving effective cleaning. Detergent-sterilisers with relatively high chlorine and low caustic contents often do not give satisfactory cleaning. This may lead to even more chlorine being added to the detergent-steriliser solution by the milking operator, in an attempt to achieve more effective cleaning. A working strength of 800ppm may also be achieved by using a product containing lower caustic levels at a higher usage rate. Increasing the usage rate to achieve the correct caustic working solution will automatically increase the working solution of chlorine in the wash solution and this can have a negative effect on chlorine residues. Products containing less than 10% caustic may be cheaper to manufacture, but may only give satisfactory cleaning if used with hot water, at least once daily. A large proportion of farmers do not use hot water daily while most detergent sterilisers are recommended to be used with hot water (700C) at least once daily. Thus, while products containing high levels of caustic (10 to 18%) may be used effectively with hot or cold water, it will be necessary to use hot water to achieve satisfactory cleaning with products containing lower caustic levels. Typical liquid detergent sterilisers used in New Zealand contain 15% caustic and 5% chlorine. These concentrations are close to those previously recommended by Teagasc i.e., 18 - 21% caustic and 3.5 - 4.5% chlorine.

Usage rates

Regardless of the composition of products if the detergent is not mixed at the recommended levels then ineffective cleaning or issues with chemical residues in milk can occur. The usage rate of similar product types can range from 100 mls to 450 mls per 45 litres water. So while a drum of detergent may appear cheaper than a competitor the usage rate required may be double.
The use of the alkaline detergent-steriliser in hot water (9 litres/unit, 70 - 80^{0}C) for the morning wash and reused for the afternoon wash provides adequate cleanliness provided that pre-rinsing has been done correctly. Traces of milk remaining after inadequate rinsing will neutralise the chlorine in the solution and render the detergent ineffective. For detergent steriliser products the expiry date is normally six months from the date of manufacture. Some products can crystallise or become more viscous if stored over a long period and may result in a lower level of the product being drawn through the milk lines for washing.

TCM residues

All products containing chlorine should be rinsed from the milking system after circulation cleaning. Products containing high working strength solutions of chlorine will lead to the problem of high TCM residue levels in milk if not used correctly followed by sufficient rinsing. With automatic bulk tank cleaning in particular, there is a tendency to minimise the rinse water usage rate for the purpose of energy and time saving; however there is also an increased risk of residues in milk. Indicators of inadequate bulk tank rinse water would be a strong chlorine smell from tank after the final rinse.

Detergents

Detergent only products contain caustic only, are generally only available in powder form and are used as a cold circulation wash. For maximum cleaning benefit of this product the stain of the detergent wash should be left in the milking system between milkings.

Sterilisers

Sterilising milking equipment prior to milking using steriliser products is carried out in situations where caustic only products are used for the daily cleaning of milking equipment and where water quality is not satisfactory. Steriliser only products (which contain high chlorine levels) should never be used for the daily cleaning (main wash) of milking equipment. Steriliser products contain approximately 8 - 11% chlorine and are effective against a range of bacteria and certain viruses and spores. The recommended levels of chlorine (14 mls/45litres) used in these situations is critical to avoid residues in milk. Alternatively, peracetic acid (which is toxicologically safe) may be used in this situation instead of chlorine.

Acid rinse (descale)

The purpose of a descale acid wash is to remove mineral deposits such as calcium, magnesium, iron, and manganese. Mineral deposits on pipelines will result in biofilm formations where Thermoduric bacteria grow. The descale acid wash should be carried out weekly especially in hard water situations and is used in conjunction with both cold and hot cleaning.

Conclusion

In conclusion, the range of products tested and reported on in this article may not include all of the products on sale in Ireland for the purpose of cleaning milking plants and it is not intended for use as a 'recommended list' of products. Neither is it an indication of the products regulatory status as required by DAFF. It is anticipated that this study will assist dairy farmers to make an informed decision on which products are most suitable for the task required and are the best value for money. The detergent-steriliser product range tested will be amended and updated as new products are introduced, as manufacturers modify the chemical content of their products and as the product registration status is established. Caustic detergent powder products are still commonly used and give satisfactory cleaning. Powder detergent products and steriliser products have also been analysed and only marginal differences have been observed in chemical composition. These results will be made available through the Teagasc Advisory Service. Manufacturers/distributors should ensure that the labelling of detergent-sterilisers should include name of manufacturer; PCS number, identity and content of active substances (caustic and chlorine); directions for use; optimum temperature of usage; equipment for which the product is suitable; health and safety information; and expiry date and batch number.

Table 1. Chemical analysis of liquid detergent and detergent-steriliser products

Product Name [1]	Usage rate per volume of water (ml)		Volume of water (litres)	% Caurstic w/w	% Chlorine w/w	Working solution strength (parts per million)			
						Caustic		Chlorine	
	Cold	Hot				Cold	Hot	Cold	Hot
P3-MIPCIP[2]	450	300	45	25.25	0.0	2525	1683		
Quantum x L[2]	*[3]	100	40	22.33	0.0	*	558	*	*
Alkadex Forte[2]	*	200	40	20.55	0.2	*	1028	*	10
Alkasan	*	200	40	20.29	8.36	*	1015	*	418
Hydrosan Liquid	450	300	45	18.67	3.11	1867	1245	311	207
Kilosan	420	420	45	17.47	4.46	1631	1631	416	416
Parlorsan	360	360	45	17.14	3.68	1371	1371	294	294
Turbosan-S (new)[4]	400	360	45	16.71	3.48	1485	1337	309	278
Avalksan	400	350	45	16.54	3.49	1470	1286	310	271
Multisan-S (new)	320	320	40	16.42	3.43	1314	1314	274	274
Kleensan	360	320	40	16.31	3.31	1468	1305	298	265
Ultrasan	400	400	45	16.06	5.18	1428	1428	460	460
Universan-S (new)	360	320	40	15.94	3.49	1435	1275	314	279
Hypal SP2	*	400	45	15.88	0.0	*	1412	*	*
Agrisan extra	*	240	40	15.81	3.64	*	949	*	218
Univsan Liquid	450	300	45	14.55	4.66	1455	970	466	311
Liquid Gold	375	312	45	14.35	3.80	1196	995	317	263
Aquasan	400	400	45	14.03	3.01	1247	1247	268	268
Crysosan liquid	450	300	45	13.79	5.99	1379	919	599	399
Unisan	450	300	45	13.15	5.69	1315	877	569	379
Mueller xtra strength	375	375	45	11.50	2.64	958	958	220	220
Vanorinse	*	125	40	11.23	4.69	*	351	*	147
Buyrite	420	350	45	10.38	1.81	969	807	169	141
Vanosan	*	200	40	9.99	3.23	*	500	*	161
C-Alka	*	225	45	9.89	3.12	*	495	*	156
TC86	200	200	40	9.30	3.71	465	465	185	185
Chlorodex	200	200	40	9.30	3.08	465	465	154	154
DeLaval super	*	320	40	8.95	2.84	*	716	*	227
Hyproclo ED	*	250	45	8.75	4.49	*	486	*	249
Chlorodex	200	200	40	8.68	3.6	434	434	180	180
Sanagard	*	200	40	8.56	0.79	*	428	*	40
Specscan (extra strong)	*	250	40	7.14	4.15	*	446	*	259
Turbosan	400	360	45	6.52	3.65	580	522	324	292
Delaval ultra	400	200	40	6.36	2.55	636	318	255	128
Universan	360	320	40	6.17	4.19	555	494	377	335
Multisan	320	320	40	6.07	4.59	486	486	367	367
Circopower AFM	*	140	40	5.43	6.13	*	190	*	215

Table 1. Chemical analysis of liquid detergent and detergent-steriliser products

Product Name [1]	Usage rate per volume of water (ml)		Volume of water (litres)	% Caurstic w/w	% Chlorine w/w	Working solution strength (parts per million)			
						Caustic		Chlorine	
	Cold	Hot					Hot	Cold	Hot
Gascosan	no mix rate supplied	no mix rate supplied	no mix rate supplied	4.93	4.07	no mix rate supplied	no mix rate supplied	no mix rate supplied	no mix rate supplied
CO-OP Source parlosan	400	360	45	4.87	3.14	433	390	279	251
Dairycleanse	*	280	45	4.32	3.04	*	269	*	189
Liquid dairygold hot wash	250	300	40	3.90	7.57	244	293	473	568
Supersan	284	284	45	3.69	7.53	233	233	475	475
Rinsan	*	250	40	3.30	5.52	*	206	*	345
Galvisan	*	125	40	2.84	9.35	*	89	*	292
BFS hot wash	*	300	45	2.10	9.59	*	140	*	639
Specsan	*	250	40	1.62	5.33	*	101	*	333
Delex H	250	250	40	0.84	6.68	53	53	418	418
Supersan D	no mix rate supplied	no mix rate supplied	no mix rate supplied	0.29	5.41	no mix rate supplied	no mix rate supplied	no mix rate supplied	no mix rate supplied

*[1]In order of decreasing caustic content. [2]Liquid detergent products (no chlorine). [3]*Not recommended by the manufacturer to be used as a cold wash solution. [4]New = Modified product*

Appendix 1. Ballyhaise College Dairy Herd Details 2010.

Jumbo	DOB	Lact No	Sire	EBI€	Milk€	Fert€	Calv€	Beef€	Maint€	Health€
16	12-FEB-07	2	SBH	148	29	105	32	-30	18	-6
24	15-FEB-07	2	HZO	149	53	93	15	-30	21	-4
55	18-FEB-07	2	SBH	184	50	112	38	-39	25	-2
91	03-MAR-07	1	CSJ	85	49	23	28	-23	11	-5
94	15-FEB-07	2	HZO	104	46	55	13	-14	3	2
98	17-FEB-07	2	SBH	138	55	76	31	-28	10	-6
100	15-MAR-07	2	HFL	150	52	76	29	-19	14	-3
118	20-FEB-07	1	SBH	143	54	70	35	-23	11	-3
120	20-FEB-07	2	HZO	132	44	87	12	-20	11	-2
123	17-FEB-07	2	SBH	132	49	74	32	-28	10	-5
148	08-FEB-97	12	LPH	81	22	47	15	-17	13	-1
150	20-FEB-07	2	SBH	121	11	101	35	-28	11	-9
205	11-FEB-07	2	HZO	154	46	96	22	-23	13	-1
206	09-FEB-02	7	LBO	92	13	59	12	-7	13	2
222	14-MAR-07	1	CXD	119	66	37	24	-26	15	3
237	25-FEB-07	1	SBH	123	38	80	25	-24	10	-5
239	20-FEB-07	2	SBH	141	37	95	29	-17	3	-6
248	23-FEB-07	2	RUU	164	47	94	30	-17	7	2
270	22-FEB-07	2	SBH	143	45	86	24	-20	8	-1
272	13-FEB-07	2	SBH	135	24	95	31	-26	15	-5
276	21-FEB-07	1	HZO	90	54	49	-2	-15	5	-1
288	16-FEB-07	2	SBH	92	39	61	14	-19	2	-6
293	02-MAR-07	2	SBH	143	37	97	28	-33	16	-2
344	21-MAR-02	7	JNM	117	74	35	17	-22	9	4
357	26-FEB-03	5	ANN	48	16	36	-2	-5	5	-2
379	27-FEB-04	5	S304	62	-11	70	16	-28	13	3
380	17-FEB-03	6	ILZ	71	14	58	-1	13	-11	-3
382	08-MAR-04	3	S304	49	-21	59	3	-14	18	5
386	22-FEB-03	6	GMI	106	41	42	21	-9	9	4
402	12-FEB-05	4	SAC	-36	14	-43	5	-3	-2	-7
406	07-MAR-05	4	RUU	88	14	65	18	-5	-6	1
407	12-MAR-05	3	NHS	51	14	48	9	-11	-2	-7
409	15-MAR-04	5	S307	112	12	84	17	-10	9	1
410	18-MAR-04	5	ULK	102	-26	103	9	1	4	11
412	16-MAR-04	5	S303	92	-4	75	10	-2	4	9
413	01-MAR-04	4	S307	123	-6	104	17	5	2	2
414	19-FEB-04	5	S302	82	-14	90	6	-5	3	2
416	20-MAR-04	4	S307	102	-10	104	16	1	1	-9
418	22-FEB-04	5	S302	91	4	78	15	-7	4	-2
420	21-JAN-06	2	RUU	55	7	43	21	-7	-9	0
421	21-JAN-06	3	RUU	60	-4	54	20	6	-15	-1
424	31-JAN-06	2	DXA	59	21	51	0	-16	1	1

Appendix 1. Ballyhaise College Dairy Herd Details 2010 cont.

Jumbo	DOB	Lact No	Sire	EBI€	Milk€	Fert€	Calv€	Beef€	Maint€	Health€
426	02-FEB-06	3	BWZ	126	50	58	25	-8	3	-2
428	03-FEB-06	3	BZG	87	-3	71	15	5	-4	3
431	12-FEB-06	2	HZO	68	24	55	4	-27	12	0
433	17-FEB-06	3	BWZ	138	41	77	30	-10	2	-2
439	01-MAR-06	3	FJD	114	38	50	23	-2	1	4
445	11-MAR-06	3	UYC	93	32	59	20	-27	13	-3
449	21-MAR-06	2	HGZ	120	24	68	21	-8	11	3
451	01-APR-06	2	IEN	116	41	57	21	-13	10	0
456	04-MAR-05	4	WAS	137	41	83	27	-49	41	-5
457	05-MAR-05	4	HZO	125	6	110	16	-17	14	-3
458	06-MAR-05	4	CJY	146	49	79	17	-32	29	4
459	06-MAR-05	4	HRZ	107	38	60	11	-12	9	1
461	08-MAR-05	4	WAS	141	67	69	17	-56	49	-4
464	11-MAR-05	4	BWZ	155	70	64	25	-4	3	-2
466	12-MAR-05	4	HRZ	111	44	57	16	-21	15	0
469	27-MAR-05	4	HRZ	112	56	49	8	-20	20	-1
470	28-MAR-05	4	BWZ	152	34	101	25	-21	20	-6
471	28-MAR-05	4	HZO	126	30	87	10	-16	13	1
472	28-MAR-05	3	HZO	99	14	76	15	-20	14	1
473	28-MAR-05	4	CJY	176	70	93	15	-39	37	1
474	28-MAR-05	4	HRZ	89	65	22	13	-22	13	-2
475	28-MAR-05	4	HZO	139	51	78	13	-25	19	2
476	29-MAR-05	3	HZO	129	35	89	11	-31	23	2
477	29-MAR-05	4	HRZ	90	27	52	13	-22	18	2
480	30-MAR-05	3	WAS	145	53	79	16	-32	30	-1
482	30-MAR-05	4	BWZ	140	38	82	21	-1	4	-3
483	30-MAR-05	3	HZO	120	37	85	5	-32	21	4
486	03-FEB-07	1	RUU	89	37	40	23	-3	-7	-2
488	02-FEB-07	2	NHS	86	66	15	20	-8	-2	-6
490	05-FEB-07	2	RUU	95	45	44	18	2	-13	1
491	07-FEB-07	2	RUU	123	29	68	24	1	-4	4
493	09-FEB-07	2	SLW	120	48	62	18	-15	8	-1
494	10-FEB-07	2	RUU	139	59	59	31	1	-9	-1
495	13-FEB-07	2	RUU	75	-2	56	33	-10	-4	2
497	20-FEB-07	2	NHS	48	53	0	5	-5	2	-6
498	25-FEB-07	2	BWZ	152	55	76	27	-19	14	-2
499	25-FEB-07	1	RUU	113	42	61	21	-3	-8	0
501	27-FEB-07	1	NHS	72	58	22	3	-5	-3	-3
502	28-FEB-07	2	MKU	131	49	72	12	-49	43	3
503	02-MAR-07	2	MKU	151	55	88	13	-45	41	-1
507	09-MAR-07	2	UYC	93	47	47	17	-21	10	-6
509	10-MAR-07	2	NHS	76	51	27	6	-8	4	-5

Appendix 1. Ballyhaise College Dairy Herd Details 2010 cont.

Jumbo	DOB	Lact No	Sire	EBI€	Milk€	Fert€	Calv€	Beef€	Maint€	Health€
512	19-MAR-07	2	MKU	153	63	80	18	-49	43	-1
514	20-MAR-07	2	RMW	85	41	38	23	-18	8	-6
515	23-MAR-07	1	NHS	86	48	31	16	-12	7	-5
518	13-APR-07	2	UYC	76	44	30	20	-22	8	-4
519	21-APR-07	2	UYC	104	54	43	15	-21	16	-3
539	17-FEB-08	1	CWJ	123	61	53	25	-28	17	-5
544	22-APR-07	2	UYC	110	75	27	21	-19	11	-4
546	25-FEB-08	1	UYC	144	64	66	22	-28	21	-1
548	01-MAR-08	1	CJY	140	53	70	18	-36	32	3
555	26-MAR-08	1	HGR	114	40	49	18	0	8	0
556	27-MAR-08	1	CJY	133	49	70	11	-35	35	3
525	06-FEB-08	1	CWJ	124	27	82	24	-18	11	-2
526	08-FEB-08	1	CWJ	112	46	55	26	-27	15	-3
527	09-FEB-08	1	UYC	151	73	59	27	-17	13	-3
529	11-FEB-08	1	CWJ	132	47	77	21	-27	18	-3
530	13-FEB-08	1	UYC	106	46	56	11	-9	6	-4
531	14-FEB-08	1	CWJ	125	26	84	20	-22	15	1
532	14-FEB-08	1	CWJ	133	23	98	26	-21	14	-8
533	14-FEB-08	1	CWJ	132	23	98	25	-21	14	-8
534	15-FEB-08	1	CJY	149	44	86	18	-34	31	5
535	15-FEB-08	1	CWJ	140	53	75	26	-25	14	-5
536	16-FEB-08	1	CWJ	123	29	82	21	-22	14	-1
537	17-FEB-08	1	CJY	126	14	94	15	-37	36	5
538	17-FEB-08	1	CWJ	126	42	73	24	-32	22	-2
540	17-FEB-08	1	CWJ	142	40	82	28	-23	18	-2
541	17-FEB-08	1	CWJ	86	28	47	23	-21	13	-3
542	20-FEB-08	1	CJY	118	44	72	6	-32	29	-1
545	23-FEB-08	1	UYC	116	45	59	22	-18	8	-2
549	01-MAR-08	1	TIH	79	27	52	11	-14	6	-3
550	14-MAR-08	1	TIH	139	31	93	18	-25	24	-1
553	20-MAR-08	1	TIH	116	27	70	20	-12	13	-2
557	27-MAR-08	1	TIH	85	7	74	10	-14	11	-2
558	29-MAR-08	1	HGR	129	48	51	11	9	7	3
559	04-APR-08	1	HGR	72	49	15	0	20	-13	1

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