# The role of genetics in supporting dairy cow fertility

George Ramsbottom, Teagasc Oak Park, Carlow

## INTRODUCTION

Genetic merit is one of the four contributors to achieving high fertility performance in Irish dairy herds.

A target fertility sub-index for the next generation of dairy heifers of at least €125 is achievable on most dairy farms. Selective crossbreeding with the highest genetic merit alternative breed dairy sires is recommended on cows with low fertility sub-index (less than €50) to breed more fertile daughters.

## FERTILITY FACTORS

Four of the most important factors that affect dairy herd reproductive performance are disease, nutrition, mating management and genetics. Failure in any one area can result in sub-optimal dairy herd reproductive performance. Farm to farm variation in fertility levels are substantial – conception rate to first service ranged from 30% to 75% during last year's sexed semen trial. Much has been written in this Journal about the first three factors outlined above. In this article I will focus on the genetic aspect of dairy herd fertility.

Dairy production systems in Ireland are seasonal (Berry et al., 2006) and highly dependent on achieving high fertility levels in dairy cows (Shalloo et al., 2004). Over the 20 years prior to the year 2000, the Relative Breeding Index (RBI), which focused on genetic improvement for milk production, had delivered on its objective – to produce milkier cows. However, it underestimated the antagonistic genetic relationship between milk production and fertility resulting in a less fertile national herd (Evans et al., 2002; Berry et al., 2003). Indeed research showed that 'medium' RBI dairy cattle were more profitable than 'high' RBI stock when their higher fertility performance was accounted for (Veerkamp et al., 2000). When modelled, farm profit was most sensitive to changes in milk price followed by replacement rate (Evans et al., 2006).

Milk yield increased by over 600kg per cow over the 13-year period resulting in an increase in milk sales revenues per cow. Replacement rate also increased by 11% increasing replacement costs by €16,000 per farm. Thus, overall net farm profitability increased by only €4,000 per farm.

## THE ECONOMIC BREEDING INDEX (EBI)

The EBI of a cow is an estimate of the economic value of her genetic merit. It is comprised of six components – the two most important are the milk and fertility sub-indexes. The index is measured against the genetic 'base cow'. Economic modelling of the index at Moorepark predicted that a €1 higher EBI was expected to result in €2 more profit per cow – an advantage that was subsequently confirmed in a large scale multi-year analysis of spring-calving Irish dairy herds (Ramsbottom et al., 2012).

## HIGHER FERTILITY SUB–INDEX IN WINTER MILK HERDS

In a study of over 3,100 dairy cows in 22 winter milk herds, cows were ranked into quartiles for fertility sub-

**Table 1. Trends in milk production and replacement rate on farm net profit for 14 spring-calving dairy herds. (Evans *et al.*, 2006)**

| | Milk production | | Replacement rate | | |
|---|---|---|---|---|---|
| Year | Yield (kg/cow) | Sales (€,000's) | Rate (%) | Cost (€ ,000's) | Net Profit (€ ,000's) |
| 1990 | 5,033 | 126 | 16 | 21 | 29 |
| 1993 | 5,307 | 136 | 21 | 28 | 30 |
| 1997 | 5,629 | 145 | 25 | 34 | 32 |
| 2000 | 5,609 | 148 | 26 | 35 | 33 |
| 2003 | 5,638 | 150 | 27 | 37 | 33 |
| Change | 605 | 24 | 11 | 16 | 4 |

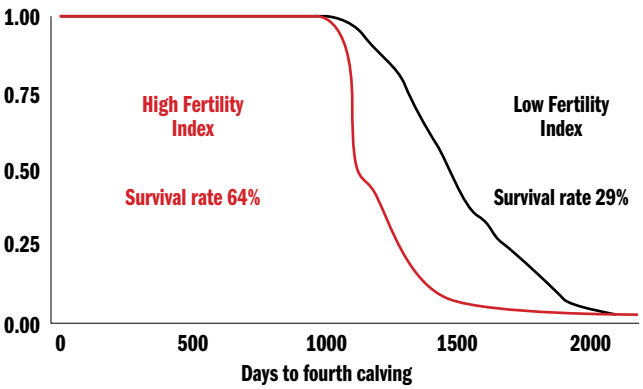


**Figure 1. Survival to fourth calving for high fertility index and low fertility index dairy cows in winter-calving herds.**

index (Ramsbottom and Patton, 2012). Figure 1 shows the survival to fourth lactation for the top 25% ranked by fertility sub-index and the lowest 25% ranked by fertility sub-index.

The horizontal axis shows the interval from first to fourth calving while the vertical axis shows the proportion of cows remaining to calve for the fourth time. Cows with the highest fertility sub-index had a survival rate to fourth lactation of 64% and an interval of 1,215 days between

**Table 2. Summary of the milk production, lactation number, and genetic merit of cows by month of calving.**

| Month of calving | January | February | March | April/May |
|---|---|---|---|---|
| Average calving date | 25th Jan | 15th Feb | 16th Mar | 22nd Apr |
| No. of cows | 88 | 975 | 493 | 258 |
| Milk production | | | | |
| Milk solids yield (kg/cow) | 426 | 398 | 355 | 322 |
| Days in milk | 292 | 276 | 245 | 197 |
| Lactation number | 3.2 | 2.9 | 2.8 | 3.8 |
| Genetic merit | | | | |
| EBI | €132 | €125 | €124 | €109 |
| Milk sub-index | €14 | €30 | €29 | €25 |
| Fertility sub-index | €102 | €85 | €86 | €78 |

first and fourth calving which were 36% higher and 279 days shorter respectively than the cows in the lowest fertility sub-index. In other words, twice as many cows in the higher fertility sub-index category survived to fourth lactation and they did so on average nine months earlier than the cows in the lowest fertility sub-index category.

Fertility sub-index and milk production in spring-calving herds

A study of the milk production, calving and genetic data for 1,800 spring-calving cows in 18 spring-calving herds operating a medium input: medium output systems of milk production is presented in Table 2.

Cows calving in January had the greatest milk yield. Surprisingly they were of similar parity to the February- and March-calving cows but had lower milk sub-index than all other groups of cows. The main reason for their greater milk yield was because the earlier calving cows spent longer in milk. The April/May calving cows had the lowest yields and lowest fertility sub-index. In summary, for every day later cows calved, they spent approximately one day less milking. This is because the date on which cows are dried off in spring calving herds bears little relationship to when the cow calves.

Further analysis of a subset of over 300 spring-calving British and Holstein Friesian cows from this database was carried out. The strength of the association between fertility sub-index and calving interval in the study was low (5%). However, as discussed earlier, it's only one of the four factors affecting fertility performance in dairy herds. Despite this however higher fertility sub index cows tended to have a shorter calving interval. The study showed that a fertility sub index of €125 was associated with a calving interval of 365 days. The expected calving interval and associated fertility sub-index from this analysis are presented in Table 3.

**Table 3. Range in herd average fertility sub-index and expected calving interval range.**

| Herd average Fertility sub-index range | Expected calving interval range |
|---|---|
| <€50 | > 377 days |
| €50 - €100 | 369-377 days |
| > €100 | < 369 days |

Teagasc's recommendation is to breed herds of cows with high fertility sub-index – preferably in the €120 to €140 range to support improvements in national dairy herd fertility from a genetic perspective.

## IMPROVING GENETIC MERIT FOR FERTILITY NATIONALLY

Increasing herd genetic merit for fertility was never easier. Irish breeding companies have rapidly increased the

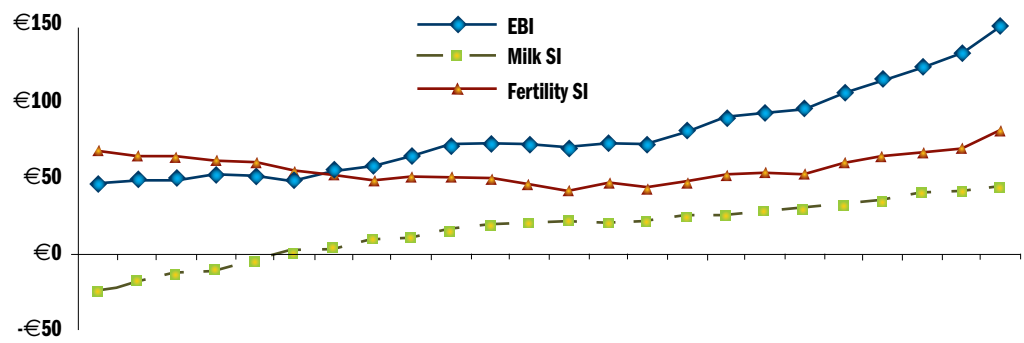


**Figure 2. Trends in EBI, milk sub-index and fertility sub-index of dairy replacement heifers by year of birth since 1990.**

average EBI of the sires available especially since the arrival of genomic testing methodologies. Nationally half of inseminations are currently bred to such sires. Improved awareness of the influence of superior genetics for fertility is contributing to the improvement in the fertility sub-index observed in the national dairy herd as presented in Figure 2.

Between 1990 and 2000, the rapid improvement in genetic merit for milk production was counterbalanced by the decline in genetic merit for fertility. Since the introduction of EBI in 2000, a more moderate but continued improvement in genetic merit for milk production has been sustained nationally. Improvement in genetic merit for fertility has been observed since around 2002 with rapid increases observed in the last two-three years as genomic technologies and their widespread adoption by dairy farmers occurred.

## ASSESSING THE GENETIC MERIT OF A DAIRY HERD

When assessing the genetic merit of a dairy herd, use the most recent ICBF herd EBI report.

Check to see that most if not all of the cows are included in the EBI averages – the number of cows included in the EBI average is listed as is the number missing an EBI evaluation. If greater than 50% of the cows are missing an EBI evaluation, the average herd EBI won't be that accurate.

Next look at the overall EBI of the dairy cows – the higher the better. The national herd average is €121. Yearling and weanling replacement stock should have a considerably higher average EBI than the mature cows. Teagasc promotes the use of the highest EBI AI sires available. The 2015 born replacement heifers can average over €200 EBI if such AI sires were used across the herd. Focus then on the fertility sub-index.

## BREEDING FOR HIGH FERTILITY SUB–INDEX

The fertility sub-index of 2012-born heifers is €69 which is the same as that of heifers born in 1990. This will contribute to the continued improvement in the reproductive performance of the national dairy herd. This figure is however much lower than the Teagasc target of breeding replacement heifers with an average fertility sub-index of €125. Calculating the fertility sub-index of teams of AI sires required to breed dairy replacement heifers with a sub-index of €125 in herds of differing sub-indices is presented in Table 4.

**Table 4. Target average fertility sub-index of AI sire teams to achieve fertility sub-index of €125 in the replacement heifers born to herds of different fertility sub-index.**

| Herd average fertility sub-index | €25 | €50 | €75 | €100 |
|---|---|---|---|---|
| Bull team average fertility sub-index | €225 | €200 | €175 | €150 |
| Expected heifer fertility sub-index | €125 | €125 | €125 | €125 |

The data in Table 4 shows that the lower the herd fertility sub-index, the higher the fertility sub-index of the team of bulls required. Ranked by fertility sub-index, the current (Jan 2014) Active Bull List, the list of the most widely available high EBI sires, lists 10 British and Holstein Friesian sires with an average fertility sub-index of €196. So, for many herds rapid improvement can be made within the black and white breed. With herds, or more especially among cows within herds of low fertility sub-index, finding sires of high fertility sub-index will however remain a challenge. So what can be done to substantially improve the genetic merit for fertility in the daughters of such cows?

An alternative approach to rapidly improving genetic merit for fertility is to crossbreed. Over 10 years' of research at Moorepark has confirmed the role of hybrid vigour at improving the fertility performance of dairy herds. A three-year trial at Ballydague Research Farm showed that first cross Holstein Friesian X Jersey cows had 21% higher conception rate to first service and 8% lower empty rate compared with the 'typical' Holstein Friesian cow at that time (Prendiville et al., 2011). A recent analysis from the Irish National data base (Buckley et al., 2014) has confirmed that first cross dairy cows have shorter calving intervals and superior survival. Taking both breed and heterosis factors into consideration, compared with pure Holstein Friesian cows, his analysis illustrates that 19% more of both the first cross Jersey X Holstein and

Norwegian Red X Holstein dairy cows are surviving to the start of the sixth lactation. In addition, their calving intervals are eight and six days shorter respectively. From my perspective, farmers with cows of fertility sub-index less than €50 should crossbreed with high EBI sires of either breed to exploit the advantage of hybrid vigour for fertility in the next generation of heifers.

## REFERENCES


1. Berry, D.P., Buckley, F., Dillon, P., Evans, R.D., Rath, M. and R.F. Veerkamp 2003 genetic parameters for body condition score, body weight, milk yield and fertility estimated using random regression models. Journal of Dairy Science 86, 3704-3717.
2. Berry, D.P., O'Brien, B., O'Callaghan, E.J., O'Sullivan, K. and W.J. Meaney 2006 Temporal trends in bulk tank somatic cell count and total bacterial count in Irish dairy herds during the past decade. Journal of Dairy Science 89, 4083–4093.
3. Buckley, F., Begley, N., Pabiou, T., Pierce, K.M. and R.D. Evans 2014 Breed and heterosis effects for a range of traits reflecting productivity, reproductive efficiency and udder health. Journal of Dairy Science (submitted).
4. Evans, R.D., Buckley, F., Dillon, P. and R.F. Veerkamp 2002 Genetic parameters for production and reproduction of spring-calving upgraded Holstein-Friesian dairy cows in Ireland. Irish Journal of Agricultural and Food Research 41, 43-54.
5. Evans, R.D., Wallace, M., Shalloo, L., Garrick, D.J. and P. Dillon 2006 Financial implications of recent declines in reproduction and survival of Holstein-Friesian cows in spring-calving Irish dairy herds. Agricultural Systems 89, 165-183
6. Prendiville, R., Shalloo, L., Pierce, K.M. and F. Buckley 2011 Comparative performance of Holstein-Friesian, Jersey and Jersey X Holstein-Friesian cows under seasonal pasture-based management. Irish Journal of Agricultural and Food Research.50, 123-140.
7. Ramsbottom, G., A. R. Cromie, B. Horan and D. P. Berry. 2012. Relationship between dairy cow genetic merit and profit in commercial Irish spring calving dairy farms. Animal 6:1031-1039.
8. Ramsbottom, G. and D. Patton 2013. Relationships between genetic merit, calving interval and survival rates on Irish winter milk dairy farms. Agricultural Research Forum Tullamore, 11th - 12th March 2013, p. 76.
9. Shalloo, L., Dillon, P., Rath, M. and Wallace, M. 2004. Description and validation of the Moorepark Dairy Systems model Journal of Dairy Science 87, 1945–1958.
10. Veerkamp, R.F., Meuwissen, T. H.E., Dillon, P., Olori, V., Growen, A.F., van Arendonk, J.A.M. and Cromie, A.R. (2000) Dairy Breeding Objective and Programs for Ireland : Final Report. Available Online at ICBFhttp://www.icbf.com/publications/files/Final_RBI_report_25_11_2000.pdf


# Reader Questions and Answers

**WHICH ONE OF THE FOLLOWING IS THE LIST OF THE FOUR MAIN FACTORS AFFECTING FERTILITY IN THE DAIRY HERD?**

a) Disease, nutrition, mating management and genetics
b) Disease, nutrition, genetics and leptospirosis
c) Disease, nutrition, meal feeding and genetics
d) Disease, nutrition, mating management and tail painting

**LIST THE TWO MOST IMPORTANT COMPONENTS OF EBI:**

a) Milk and maintenance;
b) Milk and fertility;
c) Milk and health;
d) Milk and calving difficulty.

**IN THE STUDY ON MILK PRODUCTION BY MONTH OF CALVING, THE JANUARY CALVERS PRODUCED THE MOST MILK BECAUSE:**

a) They were the oldest group of cows;
b) They had the highest milk sub-index and were the oldest group of cows;
c) They had the highest fertility sub-index and the highest milk sub-index;
d) They spent the longest number of days in milk and the highest fertility sub-index.

**WHAT IS THE TEAGASC TARGET FOR FERTILITY SUB-INDEX OF DAIRY CATTLE TO SUPPORT THE ACHIEVEMENT OF A 365 DAY CALVING INTERVAL:**

a) €85;
b) €105;
c) €125;
d) €145.

**COMPARED WITH PURE HOLSTEIN FRIESIAN COWS, A RECENT STUDY HAS SHOWN THAT MORE FIRST CROSS JERSEY X HOLSTEIN AND NORWEGIAN RED X HOLSTEIN DAIRY COWS ARE SURVIVING TO THE START OF THE SIXTH LACTATION IN IRELAND. WAS THE SURVIVAL RATE:**

a) 13% higher;
b) 19% higher;
c) 23% higher;
d) 29% higher.

ANSWERS: XXXXXXX