The perfect cow

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Summary

- A perfect cow is one that efficiently produces a large quantity of high value dairy products predominantly off grass, throughout her long lifetime with minimal intervention required.
- Breeding has proven itself to be an effective and efficient strategy to achieve rapid gains in a range of performance traits concurrently.
- Higher EBI animals are more profitable than their lower EBI counterparts.
- Research consistently highlights additional advantages in terms of performance and profit with Jersey crossbred cows in addition to that explained by EBI alone.
- A high EBI fertility sub-index will reduce the number of cows that require treatments for anoestrous and endometritis, as well as shorten the interval to pregnancy establishment after the start of the breeding period.

Introduction

Breeding was traditionally thought of as a slow process. Annual trends in performance of the national herd, coupled with the comparison of EBI strains in the *Next Generation Herd*, clearly demonstrates that the appropriate breeding strategies can, in fact, rapidly achieve high performance potential for a range of different traits. Analysis of the large e-Profit monitor database clearly shows that higher EBI herds are more profitable. The characteristics of the ideal cow have remained largely unchanged for almost two decades, but the technologies to accelerate gains in genetic potential and the management strategies to help realise this genetic potential, are improving year-on-year.

The Economic Breeding Index (EBI) – where has it come from and where is it going?

When launched in 2001, the EBI was comprised of only five traits: milk yield, fat yield, protein yield, calving interval and survival. The recognition that all traits affecting profitability should be included within breeding indexes led to the expansion of the EBI to its current format today, which now includes 18 traits. A similar trend has occurred globally, with some dairy cow indexes now containing >40 different traits. Widening the scope of breeding indexes does not, however, necessarily equate to a large reduction in performance gain in the other traits. For example, the annual rate of genetic gain in fat plus protein 305-day yield in the last 10 years in Ireland is 83% of the annual gain achieved in the 10 years before the introduction of the EBI (Figure 1). This increase in milk solids yield arose due to a combination of greater yield per se, and also due to greater composition (Figure 1). The mean genetic merit of Irish females born in the past 10 years is 0.1% greater in milk fat concentration and 0.1% greater in milk protein concentration than Irish females born in the 10 years before the EBI. In fact, the actual gains in cow lifetime yield are expected to be considerably greater in the modern-day dairy cow. This is attributable to 1) greater daily yields, 2) longer lactations, and 3) greater survival.

Genetic merit for calving interval was lengthening (i.e. getting worse) by 1.5 days per year before the introduction of the EBI (Figure 1). During the last decade, genetic merit for calving interval has been reducing, on average, by almost half a day per year. Shorter calving interval not only affects the costs of production, but also facilitates longer lactations through earlier calving.

The yield of a mature cow is 22% greater than that of a first lactation cow; hence, improving the herd age profile will help achieve the herd's genetic potential. Genetic merit for survival improved by almost 0.3% per annum in the past 10 years compared to a year-on-year disimprovement in survival before the introduction of the EBI. Based on an analysis of DairyMIS data between the years 1990 and 2001, the number of lactations achieved per cow declined by 0.1 per year (i.e. one less lactation per cow was achieved when comparing the year 2001 to the year 1990), while replacement rate increased by almost one per cent per year, equating to a 10% increase in replacement rate over the 10 year period.

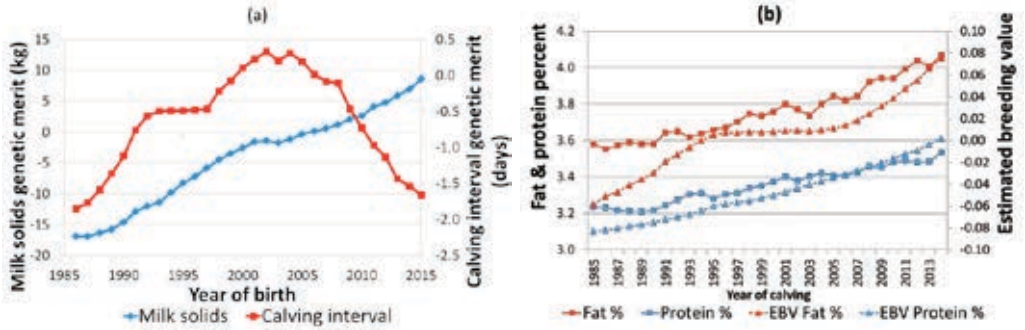

Figure 1. *a) Trend in genetic merit for milk solids yield and calving interval by year of birth in Ireland, and b) mean annual bulk tank fat and protein concentration (continuous line) and the genetic merit (i.e. EBV) of the contributing cows*

The EBI is, therefore, achieving gains in cow productivity by improving several different aspects of performance. Although the annual gains may seem small, the key point is that it is cumulative and permanent: the parents of each generation benefit from the gain of previous generations.

Further evidence that selection for EBI is delivering, is the findings from Teagasc's *Next Generation Herd*, which compares high EBI Holstein-Friesian cows against Holstein-Friesian cows representative of the national average. A detailed performance summary is provided later in this booklet. The results of the study are extremely encouraging. Cow performance, both in terms of productivity and fertility/longevity, and as a consequence predicted profitability, are consistent with expectations based on EBI and its sub-indices.

The EBI, like all national breeding indexes, is constantly being scrutinised to identify improvements. With the current traits in the EBI, simply maintaining fertility levels (i.e. no improvement) would allow the relative emphasis on calving interval to be reduced by only seven per cent. Therefore, it is unlikely that the economic weight on calving interval will change any time soon. Three suites of traits under active research for consideration in future versions of the EBI include feed efficiency, milk quality and more detailed health traits. Over 70% of feed efficiency is already implicitly assumed within the EBI through the simultaneous inclusion of both milk production and body weight. Even at the same milk energy output and body weight, however, differences in feed intake among progeny of sires exist. Given the importance of high value export markets, having consistently high quality and nutritious dairy products is vital to command a premium price. As fertility in the Irish dairy herd continues to improve year-on-year, animal health is likely to become the next biggest limiting factor to a cow achieving its genetic potential. This is especially true as the average cow age increases with improved survival. Animal health is poorly represented within the EBI, primarily due to a lack of routinely available data that can be used to derive genetic evaluations and identify genetically elite parents of the next generation.

Developments will also occur in the genetic evaluations themselves. Two large areas of research are the evaluation of alternative and more pertinent measures of fertility in the EBI as well as other approaches to modelling lactation yield. The Irish fertility genetic

evaluations were last updated over 10 years ago, while the milk production evaluations were last updated 15 years ago. The current genetic evaluations for milk production are based on a standard milk lactation profile for a given lactation number by calving date; no consideration is given to variability in the shape of lactation profiles among cows. In fact, the actual shape of milk lactation profiles is under strong genetic control. This implies that the daughters of some bulls peak higher than the daughters from other bulls, but there are also differences in the persistency of daughter lactation profiles between bulls. Although computationally more demanding, such a development, termed a test-day model, will more accurately evaluate cows and bulls based on their true lactation profile.

Does crossbreeding still have a role?

Crossbreeding with high EBI Jersey offers a rapid approach to deliver a type of cow that is ideally suited to seasonal, pasture-based dairying: high yields of milk fat and protein, moderate size, excellent fertility, high intake capacity relative to their moderate size, and high productivity per unit area. The Jersey breed is highly complementary to our high EBI Holstein-Friesian. Because of the large genetic distance between the breeds, potential gains from hybrid vigour are maximised, in addition to breed complementarity. Research findings consistently identify advantages in terms of greater performance and greater profit with Jersey crossbred cows, typically in the order of an additional €100 to €150 per cow per lactation, over and above that explained by EBI (see more detail later in this booklet). Despite the modest gains in EBI with the currently available Jersey sires, crossbreeding with Jersey still offers advantages to the Irish dairy industry in the short to medium term, at least. Long term, the opportunity to exploit the Jersey breed and its proven synergy with our intensive seasonal pasture-based production system may require a proactive futuristic approach to deliver a continued supply of high EBI Jersey genetics. One such initiative is the recent establishment of an elite nucleus herd of Jersey cows by Teagasc (NextGen Jersey).

Fertility characteristics of the perfect cow

With growing herd sizes, and hence less time available per cow, inherently fertile cows are a valuable resource. A highly fertile cow goes in-calf early during the breeding period, and hence calves early during the calving period, year after year. These cows produce more milk, reflecting longer lactations (>280 days) and greater survival (>5.5 lactations). A cow has many hurdles to overcome after calving before she is capable getting pregnant again. All farmers are aware that anoestrous cows (i.e. non-cycling cows) and cows with endometritis (i.e. dirty cows) represent problem cows in a herd; they require treatment, which costs time and money, and they will have poorer fertility during the breeding season than the cows that do not have these problems. Will selecting heavily for EBI fertility sub-index reduce (and eventually eliminate) problem cows?

Taking advantage of the substantial genetic variation for fertility traits that existed in the early 2000's in Ireland, a study was initiated at Moorepark to identify fertility phenotypes under genetic control. Cows with similar genetic merit for milk production traits, but either very good (Fert+) or very poor (Fert-) genetic merit for fertility traits were identified and assembled as a single herd of animals. With a similar environment (nutritional management, health protocols, winter housing, etc.), the divergence in fertility phenotypes recorded in these two groups of animals was astounding. Despite calving at similar BCS and having approximately similar milk production, Fert+ cows had earlier resumption of cyclicity, more rapid recovery of uterine health after parturition, greater BCS during lactation, more favourable blood indicators of bioenergetic status, stronger oestrous expression, a larger ovulatory follicle (and greater circulating estradiol concentrations) that subsequently resulted in a larger corpus luteum (and greater circulating progesterone concentrations). In addition, Fert- cows were more likely to have either silent heats (i.e. ovulation occurred, but there were no behavioural signs of heat) or to have anovulatory heats (i.e. the cow did display signs of heat, but failed to ovulate). Obviously, there can be no pregnancy establishment while cows have either silent heats or anovulatory heats.

The key phenotypes that differ between Fert+ and Fert- cows during the early postpartum period and at the time of breeding are summarised in Table 1.

Table 1. Summary of the physiological mechanisms responsible for greater fertility in Fert+ cows compared with Fert- cows

Early postpartum (parturition to Week 7)	At breeding (Weeks 8–16 postpartum)
Higher dry matter intake	Stronger oestrus expression
Greater body condition score	Fewer silent heats
Earlier resumption of cyclicity	Less ovulation failure after oestrus
Superior uterine health	Greater circulating progesterone
More favourable metabolic status	More favourable uterine environment
	More favourable metabolic status

These detailed measurements collectively impacted the reproductive performance during the breeding period, with the Fert- cows failing to achieve fertility targets and survive in seasonal calving systems. The collective results from this investigation highlighted the importance of selecting for fertility traits, and for the first time identified the fertility phenotypes under genetic control in lactating dairy cows. It is interesting to note that all of these differences in fertility phenotypes were captured by selecting cows based on differences in calving interval. In the day to day management of a dairy herd, problem-free cows are good cows. For fertility management, having high fertility sub-index cows will allow a more compact calving pattern, reduced requirement for interventions, and a lower proportion of non-pregnant cows at the end of the breeding period. These are all key drivers of farm profitability.

Conclusions

The EBI has stood the test of time with overwhelming evidence that higher genetic merit animals, either on a trait-by-trait basis or on the EBI as a whole, translate to greater performance and profitability, respectively. In addition, research consistently highlights further advantages in terms of performance and profit with Jersey crossbred cows in addition to that explained by EBI alone. High fertility is a key driver of profit, suitable genetics is essential to optimise performance.