

Irish Sheep Breeding – the next five years

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Introduction

Animal genetics is a powerful tool that allows farmers to select superior animals to become the parents of the next generation. Genetics involves the passing on of favourable or unfavourable genes from one generation to the next. Therefore, genetics is permanent and cumulative and allows farmers to make long term genetic gains, something that feeding or management cannot compensate for. A ram that has a genetic predisposition to lameness will continuously cause problems irrespective of treatment and more worryingly this animal has the potential to pass these unfavourable genes onto his progeny and thus the problem may persist or indeed worsen. However, the reverse is also true. For example, an animal that displays high growth rates or good conformation due to superior genetics will allow the favourable gene to filter down through your flock. Animal breeding is an underutilised tool in the Irish sheep industry, the gains that can be achieved through genetic selection are clearly evident within the dairy and beef industry. However, with the establishment of Sheep Ireland, along with new research from Teagasc and continued industry support, rapid improvements in productivity gains for important traits can be achieved. The aim of this paper is to review the current sheep breeding in Ireland and to highlight future improvements.

Current State of Play

Sheep Ireland was established in 2008 to implement a dynamic genetic improvement breeding programme for the Irish sheep industry and to help increase flock productivity and profitability. The current genetic evaluations established by Sheep Ireland focus on breeding profitable animals for commercial sheep production. The aim of the national breeding programme is to produce a low cost, easy-care sheep with good maternal characteristics, but yet will produce a quality lamb with high growth rates that will reach slaughter at a young age. Data on the traits of interest are recorded across a range of commercial and pedigree flocks and each trait is weighted based on its monetary value (€/lambs born) to farm profitability. A star rating is also assigned to each trait that allows farmers to easily visualise the ranking of animals within their breed (1 star = bottom 20%; 5 stars = top 20% of the breed).

New Breeding Objective

A comprehensive review of the Sheep Value breeding objective was undertaken in 2013 and after consultation with industry the decision was taken to split the Sheep Value Index into two overall indexes:

1. **Terminal index** - ranks animals based on their ability to produce live, fast growing terminal progeny with little lambing difficulty. This takes into account the progeny's growth rate, carcass characteristics, days to slaughter and also lamb survival and lambing difficulty.

2. **Replacement index** - ranks animals on the expected maternal performance such as milk yield, lamb survival and the ease of lambing, however it also includes some terminal traits to account for the efficiency at which animal's progeny are finished.

Table 1 provides a list of all the goal traits that are included in each index and the relative emphasis that is placed on each trait included in the index. Both indexes provide a measure of the genetic ability of the animal's progeny to generate profit at farm level for a combination of traits.

Table 1 Relative emphasis for each trait in the new Terminal and Replacement indexes.

Trait	Terminal	Replacement
Days to slaughter	40.30%	12.12%
Carcass conformation	7.80%	2.35%
Carcass fat	14.98%	4.55%
Maternal days to slaughter	-	12.36%
Maternal carcass conformation	-	2.86%
Maternal carcass fat	-	5.49%
Ewe mature weight	-	15.93%
Maternal Lamb survival	-	16.34%
Maternal Single Lambing difficulty	-	0.22%
Maternal Multiple Lambing difficulty	-	0.13%
Number of lambs born	-	14.95%
Single Lambing difficulty	1.12%	0.37%
Multiple Lambing difficulty	0.60%	0.21%
Lamb survival	35.20%	12.12%

Genetic gains to date

The rates of genetic gain are calculated annually for the terminal and replacement index to ensure that the genetic indexes are selecting genetically superior animals for the next generation. Figure 1 illustrates the annual rate of genetic gain across the terminal and replacement index achieved to date. The graph shows that

although considerable genetic gain has been achieved in the terminal traits, by comparison, little genetic gain has been achieved to-date in the maternal traits represented in the replacement index. However, with the accumulation of large amounts of maternal data and continual improvement in the national genetic evaluations there is significant scope to accelerate genetic gain across both terminal and maternal traits.

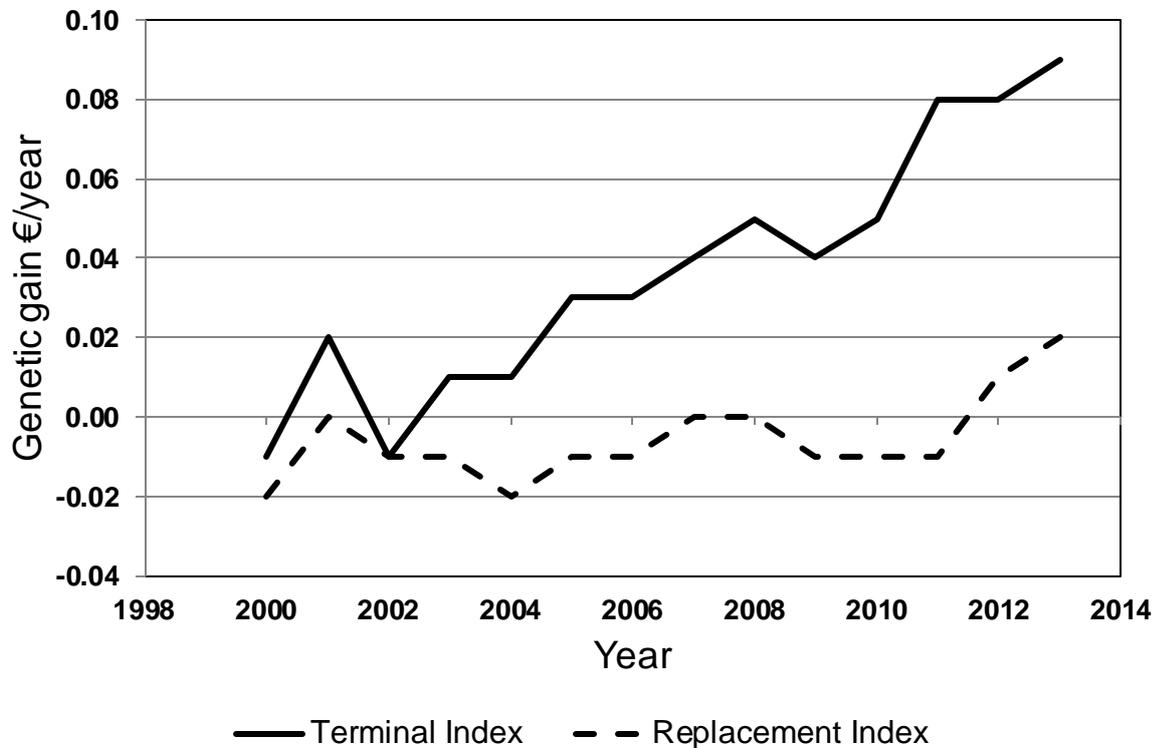


Figure 1 Annual rates of genetic gain achieved in the terminal (—) and replacement (---) index from 2000 to 2013.

Does genetics work?

National genetic evaluations provide information to aid in selection decisions to increase long-term performance of the national flock. The accuracy of the national genetic evaluations can be tested by comparing the genetic merit of a sire with his progeny's performance. A small study was undertaken to quantify the difference in animal performance in sires differing in genetic merit for the previous production sub-index (5-star versus 1-star) in 2012. Results from the study using Sheep Ireland data show that progeny 5-star rams with an accuracy of 60% or greater were average was 3.82 kg heavier at weaning compared to progeny from 1-star rams. Results from an on-going study in the Teagasc BETTER farms across a range of lowland and hill commercial flocks have also shown higher weights at weaning from the progeny of 5-star rams compared to progeny from one star rams. However, further research is required to validate all the maternal and terminal traits across different production systems and different environments.

Current Limitations of sheep breeding in Ireland

Low Accuracy. One of the main hindrances to the current genetic evaluations is low accuracy associated with the indexes which can result in large movements in an animal's estimated breeding value. Low levels of accuracy indicate that there is a low level of confidence associated with the published breeding value due to limited data or poor genetic linkages. At high levels of accuracy there is a large amount of data available across different management systems which results in a higher confidence level behind the breeding value. High accuracy levels will, therefore, reduce fluctuations in the published breeding values and, therefore, increase farmer's confidence in the genetic evaluations.

Missing traits. Access to large quantities of accurately recorded data is another obstacle to accurate genetic evaluations in Ireland. Traits such as health (lameness, mastitis, susceptibility to parasites and fly strike), meat quality, lamb vigour and feed intake are economically important but in order to include such traits within the genetic evaluations, tools must be developed to facilitate the accurate recording of the pertinent data at farm level.

Parentage information. Genetic evaluations rely on the availability of accurate phenotypic information but also on the collection of pedigree or parentage information for each animal. Without this information genetic evaluations are simply not possible. Another large hindrance for sheep genetic evaluations in Ireland is the availability of pedigree information on animals especially on the commercial ewe population. Currently, in order to collect parentage for lambs, commercial farms in Sheep Ireland are asked to operate on single sire mating basis. However, this is not a viable option for many commercial sheep farmers. An alternative method for the accumulation of parentage information involves the use of DNA information to retrospectively identify parents. The process involves the genotyping of all offspring and potential parents. The current cost of such technologies (~€30 per sample), prohibits its wide-scale use within the industry. However, as the cost of such technologies continues to fall rapidly genotyping of commercial animals may become a viable option in the near future.

Validation of the index. Although validation of the old production sub-index has been undertaken through data accumulated through Sheep Ireland and through the Teagasc BETTER farms, controlled experiments for animals divergent for genetic merit must also be undertaken. Such experiments would involve the segregation of groups of animals based on genetic merit (i.e. high and low). Animal performance and differences in profit would be compared to the expectation based on predicted genetic merit.

Future Improvements

Superior genetic evaluations: Constant re-evaluation and improvements in the genetic evaluations are required to ensure that genetics continues to deliver favourable results for the industry. As more commercial and pedigree data is accumulated, research will focus on the development of superior statistical models that

reflect the underlying biology, and accounts for non-genetic effects (i.e. environmental or management factors) to ensure that the true genetic merit of an animal is reflected in their breeding values.

As more data becomes available to Sheep Ireland it is expected that the levels of accuracy for all traits will continue to increase, however there are a number of other methods that the levels of accuracy can be improved including:

- ***Improving genetic linkage*** - good genetic linkage allows for the relativity of breeding values produced between years or flocks to be established. Without genetic linkage year-to-year or flock-to-flock differences cannot be accurately accounted for in the genetic evaluations.
- ***Use of rams in the Central Progeny Test*** – the CPT plays a vital role in creating genetic linkages between flocks and breeds in the genetic evaluations. Information on the progeny managed in a commercial environment feeds back into the genetic evaluations and provides predictions of the genetic merit of the pedigree rams used and also his relatives, thereby, increasing accuracies.
- ***Use of predictor traits for difficult to measure traits*** – this is already used for carcass traits but could also be considered for a variety of other traits such as vigour scored at birth as a predictor of lamb viability, weight bands used as predictors of birth weight and farmer scored traits as predictor of performance traits.
- ***Development of genomic selection*** (see below).

New economic values: In Ireland all traits included in the terminal and replacement index are of economic importance to Irish production systems and are optimally weighted within the indexes. Bio-economic models through the modelling of whole farm systems play an important role in identifying the pertinent inputs and outputs at farm level that have the largest impact on farm profitability. Such models have been developed for dairy and beef cattle in Ireland; however, to date no bio-economic model has been developed for the sheep sector. Research is on-going in Teagasc into the development of an Irish sheep bio-economic model to generate economic values and these will be implemented into the national sheep genetic evaluations in the near future.

Across breed comparison: The fundamental mechanism of genetic evaluation is the genetic comparison of animals based on their phenotypic records and ancestry. Genetic linkage is of critical importance to allow for an accurate comparison of animals in the genetic evaluations. Genetic and environmental (farm, year, sex, level of feeding) effects can be disentangled, and accuracy can reflect this. Across breed genetic evaluations facilitates comparisons of animals regardless of their breeds. To do so, the genetic evaluation, model must correct for breed differences. Research conducted to date has shown that the current data structure doesn't yet allow for an accurate across breed genetic evaluation, especially for maternal traits. However, as more

information becomes available on crossbred animals, the feasibility of producing accurate across breed breeding values will increase, thereby, allowing farmers to rank different breeds on the same index.

New traits: The feasibility of breeding for any trait is dictated by the availability of data, either for the trait itself or a genetically related trait. For a trait to be included in a breeding objective it must be: 1) important (economically, socially or environmentally), 2) under genetic control, and 3) measurable or genetically correlated with a heritable trait that can be measured. Future research will continue to focus on evaluating state-of-the-art technologies and statistical methodology to identify “easy to implement tools” to predict traits of economic importance in breeding goals. This research will involve close collaboration with Sheep Ireland, Teagasc and the BETTER Farm Programme. Examples of new traits include: meat quality traits, lamb vigour scored at birth, ewe fertility and ewe longevity and disease traits.

Validation of Irish genetics: Genetic indexes, like all new technologies, will have to be demonstrated to deliver results on commercial farms before there will be large scale industry buy-in. A new genetically elite flock is currently being established in Athenry to aid in evaluating the replacement index to ensure that animals deemed to be of high genetic merit for maternal traits are generating more profit at flock level. A further objective of this flock is to determine the suitability of New Zealand genetics for Irish grass based production systems. As part of this study a nucleus sheep flock, comprising of elite Suffolk and Texel females, representing the top genetic merit animals in the Irish and New Zealand genetic evaluations across a range of maternal traits will be evaluated. A third group of national average genetic merit Irish ewes will also be established to assess the rates of genetic gain achievable under the current replacement index. This flock will assess the biological and economic efficiency between the Irish and New Zealand genetically elite animals and monitor the relationship between the animal’s genetic merit and the phenotypic performance.

Genomic Selection: Genomic selection is the new breeding technology that uses genetic markers associated with genes to predict breeding values. This genetic marker information along with performance records allow for more accurate estimates of the genetic merit of the sheep. This allows young animals to achieve higher accuracy’s at a younger age before large amounts of information are collected on the animal, thereby, providing more accurate genetic evaluations for farmers. Studies in cattle suggest the rate of that genetic gain can be increased by 50% with an appropriate genomic selection breeding programme. The expected response to selection from genomic selection may actually be greater in Irish sheep since the current accuracy levels are low, and therefore, the potential scope for improvement is considerable greater than incattle. To help prepare the Irish sheep industry for genomic selection DNA samples are currently being collected from rams with many progeny and high accuracy’s and stored in a biological bank. However, a prerequisite for a successful genomic selection programme is accurate genetic evaluations to exploit the technology. Therefore, most research in the short to medium term will focus on getting the basics right!

Conclusions

Genetic evaluations are a powerful tool for sheep farmers that enable them to make more informed breeding decisions and potentially increase productivity and profitability at farm level. To-date in sheep breeding it remains a relatively underutilised tool. However, with the continual improvement of the genetic evaluations rapid gains can be achieved over a comparatively a short period of time for the Irish sheep sector. The future holds significant new possibilities for accelerated genetic improvement of the sheep population. This will require significant buy-in from breed societies and commercial farms. A significant amount of additional recording will be required. However, the pay back for this will be more productive flocks, with higher lamb growth rate, requiring lower levels of assistance at lambing, reduced lamb mortality and healthier lambs and ewes. It is incumbent on all the stakeholders to grasp the emerging opportunities and deliver for the industry. This will improve the profitability and competitiveness of the sheep industry.