Past, Present and Planned, the journey of the Irish sheep breed development improvement programme: Sheep Ireland

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Setting the scene

Prior to the establishment of Sheep Ireland there was an earlier breed improvement program called the Pedigree Sheep Breed Improvement Programme (PSBIP) which was run by the Department of Agriculture. Its objective was solely to achieve genetic improvement in lean tissue growth rate and muscularity in terminal sire (meat) breeds of sheep in Ireland. One of the concerns with this type of approach was that by focusing all the selection pressure on such a small number of terminal traits it would have a very negative effect on some of the other economically important traits that were not being recorded/monitored. For example, there is a negative relationship between terminal and maternal traits (Satish *et al*., 2017). This means as flocks were increasing the growth rate potential of their bloodlines, they were reducing the maternal ability of their ewes, and as there was no index for any of the maternal traits at this time, and without these it was extremely difficult to counteract this.

While PSBIP was only targeted at terminal breeds we know that ~75% (Hanrahan, 2014) of the national ewe flock is sired by terminal sires, therefore this approach had the potential to have a negative effect on the national ewe flock. In 2008 at the end of the PSBIP the number of participating flocks was declining and there were only 119 active flocks involved across six different breeds (Table 1).

Table 1. The number of flocks who participated in the PSBIB programme during its final year in 2008

Belclare	Charollais	Ile de France	Suffolk	Texel	Vendeen	Total
1	11	1	24	69	13	**119**

Another key driver to move away from the terminal only traits and breeds was the national weaning rate. The number of lambs being weaned per ewe from the national sheep flock had remained static or even decreased since the 1950's with the national average lamb output currently standing at 1.3-1.4 lambs weaned per ewe (Hanrahan and Kinsella, 2012), and it was identified that this was a key area for improvement.

Sheep Ireland established

Sheep Ireland was established in late 2008 to implement a dynamic genetic improvement breeding programme for the Irish sheep industry and increase the national flock productivity and profitability. The driving force behind this establishment was the 'Sheep Industry Development Strategy', completed in 2006 (Malone, 2006). Three of the actions from this report were directly related to improving the genetic potential of the national sheep flock using a robust breeding program with clear objectives and based on market signals. The other clear recommendations of the report were that the new "Sheep Ireland" should have very strong ties with the ICBF and Teagasc.

When Sheep Ireland was established, having a strong commercial flock influence in the program was crucial both in terms of recording large amounts of relevant and high-quality data quickly but also to demonstrate the benefits of the genetic improvement efforts to commercial farmers. To do this it was structured with three different programmes.

1. LambPlus: This was the service which provided a platform for breeders to record their flocks' performance records and to receive €uroStars in return.

2. Central Progeny Test (CPT): The purpose of the CPT was 1) to create genetic linkage between LambPlus performance recording flocks and breeds, and 2) to performance test the progeny of stock rams from pedigree flocks.

3. Maternal Lamb Producer group (MALP): MALP was set up 1) to demonstrate that the genetic indexes work and 2) as a second source of commercial data.
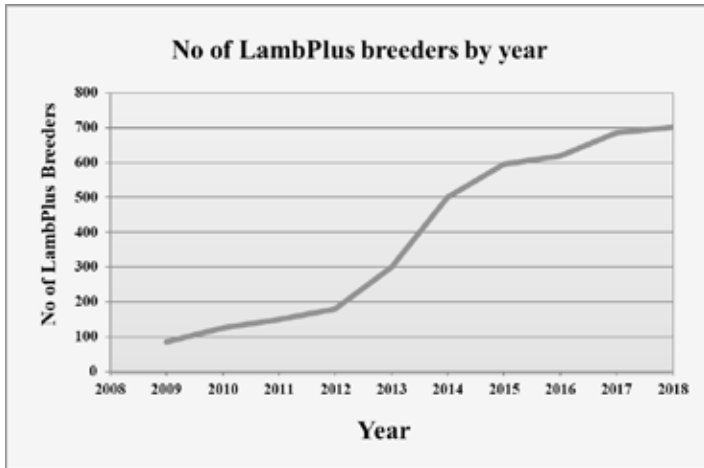
LambPlus

LambPlus is the performance recording service provided by Sheep Ireland and is available to all Pedigree ram breeders in Ireland. LambPlus aims to collect as much performance information on pedigree and commercial sheep as possible for use in the Sheep Ireland genetic evaluations.

Participation levels

As can be seen from the Figure 1 the level of participation in LambPlus has grown annually since its inception, from 85 breeders in 2009 to over 700 in 2018. This has been driven by several factors.

By working together with the pedigree breed societies to try and encourage participation in LambPlus for the benefit of the breeder, the breed society and the national sheep flock. Sheep Ireland also developed the functionality in its database to be able to host breed society flockbooks. Currently there are six breed societies hosting their flockbooks on the Sheep Ireland database. The benefit of this is that breeders only need to submit their data once to fulfil both breed society and LambPlus requirements, and that only one database needs to be maintained. For breeders from these six societies it is also a much easier transition to join LambPlus as their flock is already on the database and they are already familiar with the website. The final bonus is that once a flockbook is hosted in the Sheep Ireland database all the ancestry information becomes available for the genetic evaluations which ultimately lead to more accurate evaluations.

Figure 1. The number of LambPlus performance recording flocks by year

One of the other main factors that influenced the increased participation rates was the Sheep Technology Adoption Programme (STAP) which ran from 2013 until 2015. This was a Department of Agriculture, Food and Marine scheme, where by participants of the scheme were required to attend a number of discussion groups throughout the year where best practices would be discussed. Participants of the scheme also had to complete two tasks from a menu of options, one of which was to use a high index performance recorded sire. This approach worked incredibly well, as the demand for high €uroStar rams was created from the bottom up (Farmers asking breeders and not breeders telling farmers). This resulted in the majority of farmers in the program purchasing a performance recorded ram with a minimum set of criteria for the first time. It compelled them to engage with the €uroStars and to discuss €uroStars at their discussion groups which greatly helped with our early engagement and adoption. As the demand for performance recorded rams increased the number of performance recording flocks also increased.

The room for future growth in pedigree LambPlus performance flocks is limited as there is a limited number of pedigree registered flocks left to join. There is also a percentage of non-society ram breeders in the country who are not members of LambPlus as they are not capturing parentage information which is vital for a genetic evaluation. Future growth will most likely come from a steady growth in new breed society members and commercial sheep flocks who want to start performance

recording their commercial flocks in order to improve culling and replacement female selection.

Central Progeny Test (CPT)

Although sire reference schemes were established in the late nineties by a small number of Texel and Charollais breeders, the Irish sheep sector lacked a breeding scheme that evaluated all breeds together (Byrne *et al.,* 2010). In the past the breeding scheme focused on pedigree flocks and on terminal traits. Since the establishment of Sheep Ireland, the focus has shifted towards a much broader array of economically important traits at commercial level for both the terminal and maternal traits. Four Central Progeny Test (CPTs) flocks made up of approximately 2,500 ewes were established to ensure that large amount of connected data (genetic linkage) would be generated across several breeds in a short period of time that would help to identify the genetically superior animals and establish the base for a national across breed evaluation. This was done by collecting fresh semen from selected stock rams from LambPlus flocks and using it to AI the 2,500 commercial flocks.

The Irish CPT is the only one of its kind in the Northern hemisphere. What makes it unique is that sires selected for the CPT are selected based on their maternal traits, and that daughters from these rams are retained within the flock to be performance tested over their lifetime as breeding ewes. All this data feeds back to the bloodlines of some of the country's top pedigree stock rams, making their €uroStar evaluations, and their progeny's more accurate.

Maternal Lamb Producer Groups (MALP)

The Maternal Lamb Producer Group (MALP) flocks compromised of 22 flocks in total and were established to test the robustness of the genetic evaluations across different systems. The MALP flocks were geographically spread across a range of different land types and production systems. They were set up not just to provide data but also to provide a demonstration of the range of genetic merit among a group of rams. This was reflected in the main objectives of the MALP flocks which was to help farmers to gain an appreciation for the value of improving genetics. A review of the MALP flocks in 2015 showed that the level of recording of key traits for the genetic evaluations was sub-optimal, in addition the breed composition of these

flocks was not reflective of the of main breeds included in the genetic evaluations resulting in a large loss of potential data from the genetic evaluations. Since the MALP programme ceased, large volumes of commercial flock performance data is now being sourced from flocks involved in the Teagasc Better farm programme. They are operating a very similar programme with single sire mating practiced on these flocks, and performance records being collected. This data is now flowing routinely into the Sheep Ireland database and provides more informative data for the genetic evaluations than the MALP programme as the breeds involved are more reflective of the national flock.

The Present day

In 2017 there were 10,000 pedigree ram lambs performance recorded through the Sheep Ireland database, considering that a percentage of these ram lambs will not be sold for breeding for various reasons (e.g., not physically correct, poor breeding values) estimates suggest that 60% of these performance recorded rams go on to be used for breeding. The Irish national flock requires approximately 22,000 new breeding rams to enter the national breeding flock annually. This means that approximately 28% of the rams bought annually have been performance recorded and €uroStars available.
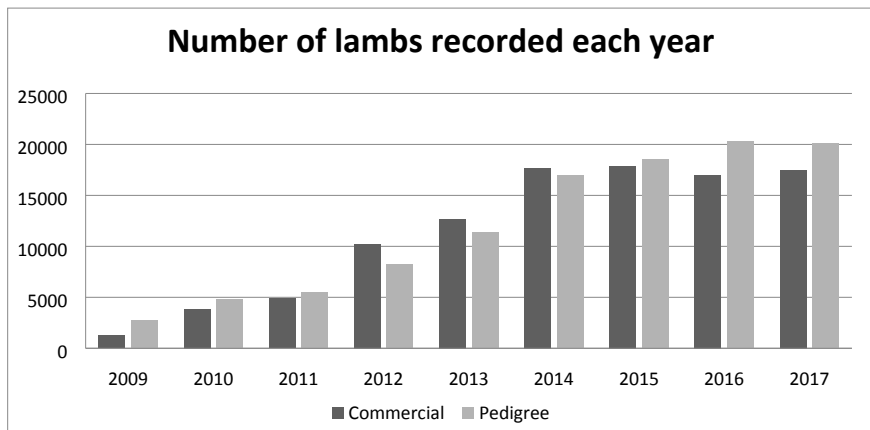

Figure 2. The number of performance recorded animals recorded on the Sheep Ireland database annually split by the source of the information (Pedigree or Commercial).

*Only lambs with a minimum of a birth weight and a Lambing difficulty score recorded are included

Genetic Gain
As previously mentioned there was no emphasis on improving the maternal aspects of the national flock in the previous breeding programme, and this is evident from Figure 3. Until 2013 the national maternal index trend was in decline as the main focus of breeders remained on the terminal traits, this in part may have been attributed to the fact that the old maternal index was not presented as clearly as it could have been. In 2013, Sheep Ireland launched two new indexes (Replacement and Terminal) to make the breeding values easier to interpret based on the purpose of the sire. Sheep Ireland also started to focus on selecting rams with superior maternal characteristics (Replacement index) to be progeny tested in the CPT, thereby increasing the accuracy of the €uroStars for these bloodlines. On the Terminal index, the industry has managed to build on the breeding goals of the previous programme and to increase the rate of genetic gain even further.
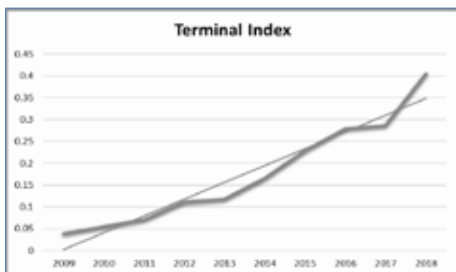
Figure 3. The rate of genetic gain on the Sheep Ireland Replacement index from 2009 to 2018
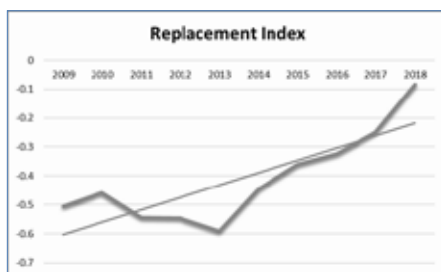
Figure 4. The rate of genetic gain on the Sheep Ireland Terminal index from 2009 to 2018

What are the €uroStars delivering for Irish Sheep farmers?

Rather than relying on physical appearance alone, the €uroStars enable farmers to see the expected performance in the ram's progeny. One of the main differences between the sheep sector and the dairy and beef sectors is that very few sheep farmers record the sire of the lambs at birth (71% of beef calves in 2017 had a sire recorded (ICBF, 2017)), and most flocks also tend to mob mate their ewes. This means if a farmer introduces a top performing 5 €uroStar ram into their ram team of otherwise unknown genetic potential, the increased performance of the 5 €uroStar ram's progeny is likely to go undetected. This is one reason why validation is so important, so that farmers who are not performance recording themselves, can see and believe the benefit that using 5 €uroStar rams can deliver and to give them confidence to continue bringing 3,4 or 5 €uroStar rams into their ram team.

In Table 2 we can see some of the recent validation work on the €uroStars which was carried out by Fiona McGovern, Teagasc, using the data collected on the flocks CPT in 2017. The validation compared the difference in performance of the 1 €uroStar versus the 5 €uroStar animals across some of the most important traits. While we can see that on average the 5 €uroStar animals outperform the 1 €uroStar animals across all of these traits, the differences are not so significant that they would be visually detected in a flock that was not recording.

Table 2. The physical performance of the 1 €uroStar and 5 €urostar animals in the CPT in 2017 on the Replacement and Terminal index

Replacement	Lamb Mortality (%)	10.65%	9.45%	-1.20%
	Number of lambs born	1.92	1.97	0.05
	Ewe mature weight (kg)	78.7	76.8	-1.9
Terminal	Lambing Difficulty (%)	23.06%	18.17%	-4.89%
	40 Day weight (kg)	18.1	20.2	2.10
	Weaning weight (kg)	31.9	34.5	2.60

When these results are inserted into the new Teagasc bio-economic model and simulated across a typical Irish 100 ewe flock the financial difference is substantial. The 1 €uroStar flock had an average net profit of €7/ha compared to the flock of 5

€uroStar animals that had a net profit of €217/ha. That's an €20.55 increased net profit per ewe.

Latest Developments

The genetic evaluation is broken down into four modules: Health, Maternal, Lambing and Production (growth). The health module was updated in 2017 and the lambing module has just been updated & released this spring for the first time in nine years, resulting in a genetic evaluation that can now more accurately predict which bloodlines will have decreased levels of lambing difficulty and lamb mortality. For example, with the current genetic evaluations, for every €1 increase in the sires Terminal index, lamb mortality drops significantly by 2.8%.

As Sheep Ireland is partnered so closely with the ICBF, it benefited from being able to take advantage of their years of experience in many different areas, including database infrastructure. In 2015 a new Sheep Ireland database was launched, and along with it a new suite of user friendly web screens for data recording and interactive management reports that is now being used as a template in other countries.

Sheep Ireland has built its own app to help facilitate performance recording flocks (recording lambing, weights and health data), with offline capabilities and the ability to connect via Bluetooth to EID wand readers. This app was trialled during the intense CPT lambing period in 2018 and has since been released to the app store and is now available to all LambPlus flocks. This will facilitate improved data quality and speed of data entry in to the database and potentially entice a number of commercial flocks to start performance recording also.

Sheep Ireland launched a Data Quality Index (DQI) in 2016 as a way of helping LambPlus breeders identify the areas of performance recording they should work on improving the most and to rank breeders based on the quality, quantity and timeliness of their data recording. The DQI algorithm was updated this spring to reflect changes in the programme. Ireland was the first country to develop such an index and it is now being considered for adoption in three other countries.

LambPlus breeders can now request and pay for genotypes online, this starts the automatic process of sending the breeder a tissue collection kit. This sample gets returned to Sheep Ireland before getting sent to the lab for analysis. Based on the

latest analysis of parentage results, on average 13.8% of recorded sires and 8.7% of recorded dams are incorrect. At the current rate of genetic gain, this incorrect information is costing the industry €60,000 per year in lost genetic gain. What happens next is covered in the following section.

Next Steps for the national breeding programme

The Maternal and Production modules of the genetic evaluation are scheduled to be updated by April 2019. As well as updating the existing modules, it is planned to add new traits as well. Sheep Ireland has been collecting data for new traits over the past three years on Mothering Ability, Ewe Milk, Lamb Vigour, Carcase Weight, Carcase Confirmation and Carcase Fat. Other traits that Sheep Ireland and Teagasc have plans to start collecting data on with the intention of trying to develop them into breeding values include feed intake, ewe longevity and faecal egg count resistance.

One of the biggest barriers to performance recording in commercial flocks is the inability to assign sires/parentage to lambs as single sire mating or AI is not feasible. Next year a project called OviData (run by Sheep Ireland and Teagasc) will commence on 5 commercial flocks. All of the lambs will be tagged at birth with a tissue collection tag and parentage of all the lambs will be assigned via DNA assignment. This is a 5-year project and approximately 13,000 lambs will be performance recorded over this period, and feed back to the national genetic evaluations. Additionally, this project will aid the direction for a future model that allows a greater number of commercial flocks to performance record.

As mentioned previously, parentage errors have been identified and are currently running at 13.8% for sires and 8.7% for dams. Sheep Ireland plans to build a process that will help LambPlus flocks to identify the correct parentage where they too have been genotyped, and dramatically reduce the percentage of parentage errors in the genetic evaluations.

Currently all the €uroStar evaluations are within breed, meaning that the breeding values for two rams of different breeds cannot be compared. The next step to this is to develop an across breed evaluation which would allow farmers to pick a ram with the best breeding values that meets their needs, regardless of breed. This type of approach would allow a commercial farmer to increase the rate of genetic gain in their flock as they will not be restricted by breed choice.

Genomic evaluations are now routinely used in the Irish dairy and beef breeding programmes as a way of increasing the reliability of the breeding values. The amount of information that can be extracted from a new born dairy calves genotype is the equivalent to the information that would be collected on 15 of their progeny. Again, this is one more method that will be exploited to make the €uroStars as accurate as possible for both pedigree breeders and commercial sheep farmers.

Discussion

Breeding programmes are a medium to long term approach to increasing the performance of a national flock, but the advantage is that the financial gain from genetics is permanent, cumulative and easy to exploit on a national basis. As Sheep Ireland nears its 10-year anniversary it is starting to emerge from the early era of setting up and developing breeding programmes, developing a top-quality genetic evaluation and indexes, and building up a bank of data to influence future breeding decisions; therefore it finds itself in a relatively strong position. None of this would be possible without the continued financial support of the DAFM and the Irish sheep farmers who pay the Sheep Ireland levy.

Sheep Ireland's ambitions for the future are big as we want to help Irish Sheep farmers position themselves in the most competitive position possible to compete on the global market, via increased productivity and sustainability, and we believe an integral part of making this happen is to have a world class breed improvement programme that delivers a superior return of investment.

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