ABACUSBIO LIMITED

Cost Benefit Analysis:
Genetic Improvement in the Irish Sheep Industry

Prepared for ICBF

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1 OVERVIEW

The Irish sheep industry is proposing the development of high quality genetic evaluations and breeding schemes, such as a Central Progeny Test (CPT) and Maternal Lamb Producer Group (MALP). These schemes will bring a number of advantages to the Irish sheep industry:

- Foster and improve genetic linkages throughout the Irish sheep industry.
- Demonstrate the value of genetics and how genetics can be disseminated throughout the industry by using superior rams which create cumulative benefits for commercial farmers.
- Enable an accurate evaluation of genetic progress in the Irish sheep industry over a number of years.

This document outlines the predicted genetic improvements in number of lambs born (NLB), and carcase weight (CWT) in the Irish Sheep Industry, and the likely benefits resulting from the dissemination of these benefits into the commercial producer sector. The costs of the genetic improvement and demonstration schemes are presented.

2 GENETIC PROGRESS IN THE BREEDER FLOCK

With increased performance recording of economically important traits, and accurate genetic evaluations by Sheep Ireland, breeders will be able to improve the performance of their sheep (make genetic progress) and therefore the genetic quality of the rams they sell to producer clients.

To predict genetic progress within breeders' flocks over a 5 year timeframe, we modelled ram genetic superiority and subsequent benefits for two traits; Number of Lambs born per ewe lambing (NLB) and lamb carcase weight (CWT). We modelled expected yearly gains in NLB and CWT as increasing by 0.3% and 70 grams per year over and above current rates of genetic progress. Genetic improvement is permanent and cumulative so these increase rates of genetic progress were cumulated over 5 years of the breeding program (Figure 1). These types of gains equate to a cumulative extra (over what might be achieved without them) improvement in lambing percentage of 1.5% and an improvement in carcass weight of 350 grams. A recent very extensive study of genetic trends in New Zealand demonstrated impacts of this magnitude averaged over a very large number of performance recording flocks (see Appendix 1). **The improvements in rates of gain identified are averages of a wide spectrum of performance recording flocks. The top 25% of flocks had rates of genetic progress in excess of twice the average of all the flocks considered in NZ. For this reason it is possible that with widespread**

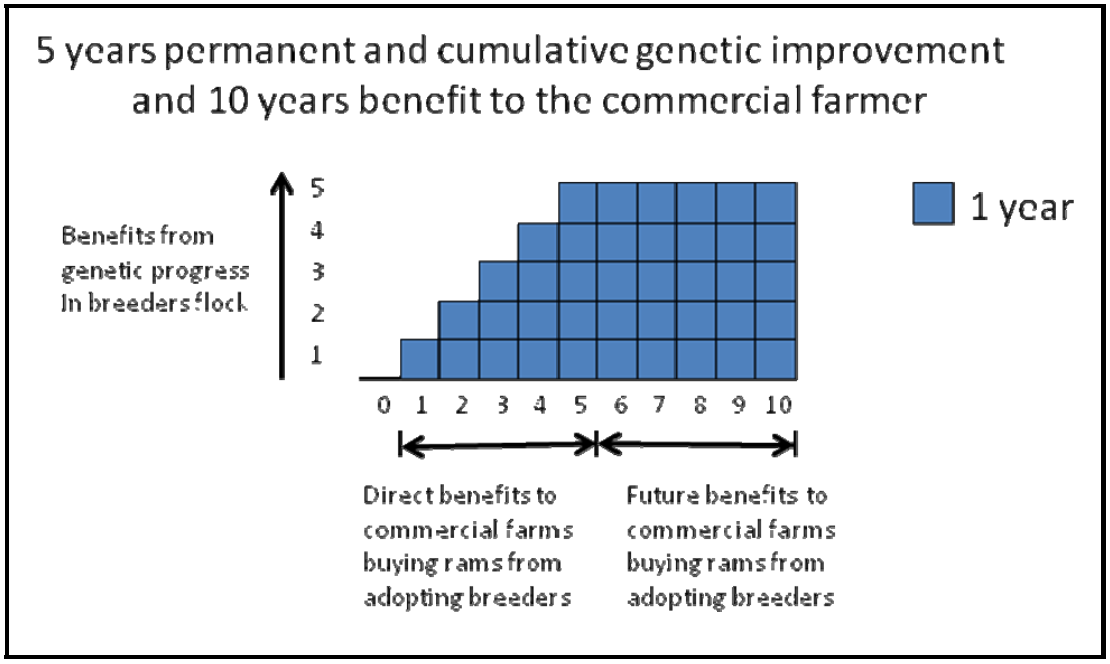
adoption by Irish ram breeders, the yearly improvements in these two profit traits could be higher and therefore the benefits obtained by the commercial sector greater.

The economic weights of these traits for the Irish Sheep industry have been calculated at €3.72 per increase in NLB, and €0.67 per 1kg increase in CWT (see Appendix 2 for full rationale). These weights are presented on a per ewe lambing basis, and therefore the cumulative value of improvements in these traits can be calculated according to how many ewes are mated to improved rams each year, and what proportion of these ewes actually successfully lamb.

3 BENEFITS REALISED ON THE COMMERCIAL FARM

Genetic benefits will be delivered to the commercial industry through use of genetically superior breeding rams purchased from those breeders involved in the genetic improvement program.
These benefits can be calculated according to how long the breeding program has been in place. In the first year of the breeding program, no benefit is gained by the commercial farmer because the rams have not yet had any selection pressure applied. Such "lag" occurs whenever a breeder is making genetic progress, because the commercial farmer takes some years to get improved genetics throughout their flock (especially for maternal traits). The future benefits gained by the commercial farmer from the expression of superiority in traits are discounted at a rate of 7% per year to account for this lag.
The future benefits gained by the commercial farmer are a function of the level of improvement in traits in the breeders' flock and the size of the economic benefits of these improvements (presented in section 2 above). By continuously buying better rams each year, commercial farmers can "cash in" on their breeder's genetic improvement success. As can be seen in Figure 1 the cumulative and permanent nature of genetic improvement is captured in this way. The genetic improvement in rams purchased is initially small, and then steadily builds over time with ongoing genetic selection in the breeder flock.
If a breeding program is continued for five years, then the corresponding benefits are gained in year one onwards. The purchasing horizon has been set at 10 years for the commercial farmer (Figure 1), with the benefits being counted 15-20 years later.

Figure 1: Schematic diagram showing time frame of commercial farm benefits from cumulative genetic progress in a breeders flock.



4 INDUSTRY BENEFITS

A number of assumptions have to be made about the level of uptake of improved genetics by commercial farmers in order to predict the overall industry benefit. The number of ewes in the commercial sector mated to improved rams is the key driver of the level of benefit obtained. For example, if 50% of the commercial ewes in the industry are mated to improved rams, this produces a predicted benefit of €2,035,806. This equates to an approximate 3 to 1 return on investment. Sensitivity analysis for the level of uptake by commercial farmers (proportion of ewes mated to improved rams) and the associated industry benefits, is presented in Appendix 3.

5 INDUSTRY COSTS

The cost of the CPT and MALP is predicted at €687,873. Appendix 4 presents the cost estimates discounted to present value for the development and functioning of the CPT and MALP over a 5 year period, by year, including recording, fees paid to producers, and the cost of services including DNA.

6 CONCLUSIONS

Cost benefit analyses shows:

- Industry benefits include an increase in revenue from genetic improvement in NLB and CWT; profit traits and associated value accrued through multiple generations.

- Genetic progress in breeders' flocks may be higher than those presented here, with high levels of uptake of superior genetics in the stud sector.

- Commercial farmers benefit from genetic improvement programmes outlined in this report through improved uptake of superior genetics in the sheep industry, estimated at €2,035,806, with 50% uptake.

- The combined costs of the CPT and MALP over 5 years are predicted to be €687,873.

- There is potential to see a return on investment of up to approximately 6 to 1, with high levels of uptake by commercial producers.

7 APPENDIX 1 – GENETIC PROGRESS

Sheep improving faster!

Dr Mark Young & Dr Anna Campbell

We are often asked "How much progress are New Zealand sheep breeders making?" Previously this was difficult to measure, but we can now do so with reasonable accuracy. A recent study shows average rates of genetic gain are increasing dramatically across the sheep industry. These increases highlight how successfully breeders, and industry groups supporting them, are working together to improve New Zealand sheep genetics.

Rates of genetic gain were low and static prior to the establishment of SIL (Sheep Improvement Ltd). When SIL was introduced (1999), rates of genetic gain doubled. Since its inception, SIL has routinely produced more accurate BVs than previous systems, and drawn more traits into the evaluations to obtain more robust genetic analyses. We believe that part of the increase in rates of genetic gain is due to greater accuracy and part is due to breeders placing more emphasis on SIL figures when selecting sheep, as their confidence in the system increased.

SIL has been collaborating in the M&WNZ Central Progeny Test (CPT, previously funded by Alliance Group) and since 2004 has regularly produced SIL ACE, a large-scale, across-flock, across-breed, genetic evaluation using genetic links built by the CPT. These initiatives led to rates of genetic gain further increasing as breeders could, for the first time in NZ, fairly compare sheep for genetic merit across a large part of the breeding industry. SIL ACE allows breeders to benchmark their own progress and to identify rams from other flocks which can drive their genetic gains further.

How the data were analysed…
To successfully breed sheep there are two important requirements:

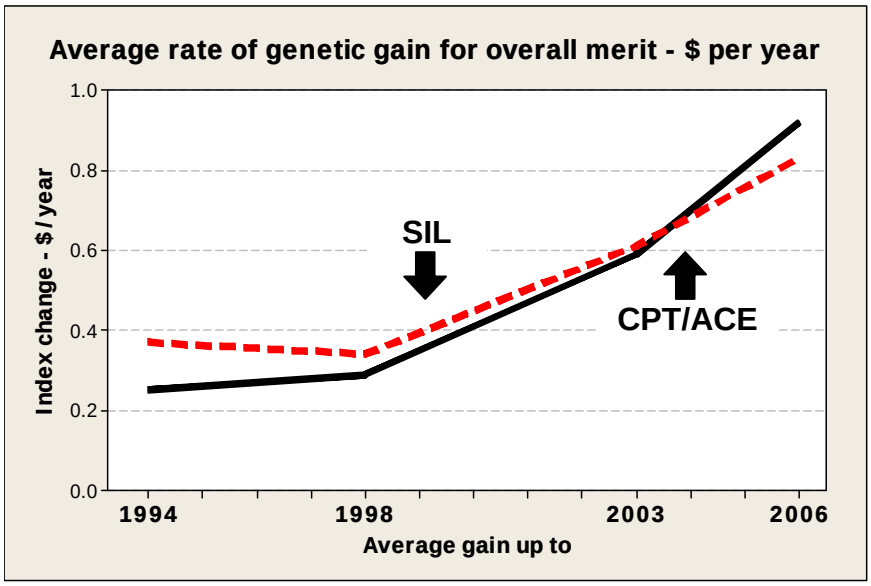
1. Performance recording (data collected by the breeder) and
2. Genetic evaluation (e.g. SIL).

Information collected on farm by the breeder is analysed by SIL to give all animals in their flock "breeding values" (BVs). BVs are essentially "best estimates" of genetic merit for key production traits where non-genetic effects that we know about are removed. Because some rams are used over several years SIL can estimate year effects. This means that changes in genetic merit over time, genetic trends, can be plotted. With many flocks now connected through use of common rams, we can study genetic trends across the industry.

To determine rates of genetic gain since 1990, Dr Peter Amer of AbacusBio in Dunedin, analysed results of the December 2007 SIL ACE run, in a study funded by **Ovita**. Of 202 ram breeding flocks studied, 140 were Dual Purpose (DP, ewe breed, evaluated for Growth, Wool & Reproduction) and 62 were Terminal Sire (TS, meat breed, evaluated for Growth and carcass merit (Meat)). Over 300 flocks are in SIL ACE but the study was restricted to those with strong genetic connections.

Dr Amer's findings are shown for overall merit ($), carcass weight (kg) and number of lambs born (%) in Figures 1-3. These clearly show that the flocks studied are increasing their rates of genetic gain. After SIL was established in 1999, genetic gains almost doubled from that previously achieved for both DP and TS flocks. A further lift occurred after 2004, when SIL ACE was introduced using genetic links created by the CPT, and rates of genetic gain were close to three times that achieved prior to SIL.

Figure 1. **Average rate of gain in SIL overall indexes** for Dual Purpose (ewe breed – solid line) & Terminal Sire (meat breed – dashed line) sheep. These are rates of gain so increases illustrate accelerating rates of genetic gain. Times that SIL & CPT/ACE were established are indicated.



Cumulative gains over the years studied were greater than $8 for overall index, with more than $5 of this coming after 1999. Equivalent figures for carcass weight were 1.4kg (more than 900g coming after 1999), and for number of lambs born were greater than 5% (most coming after 1999).

Figure 2. **Average rate of gain for carcass weight** (predicted from liveweights collected on farm) for Dual Purpose (ewe breed - solid line) & Terminal Sire (meat breed – dashed line) sheep. Note these are rates of gain so increases illustrate accelerating rates of genetic gain. Times that SIL & CPT/ACE were established are indicated.

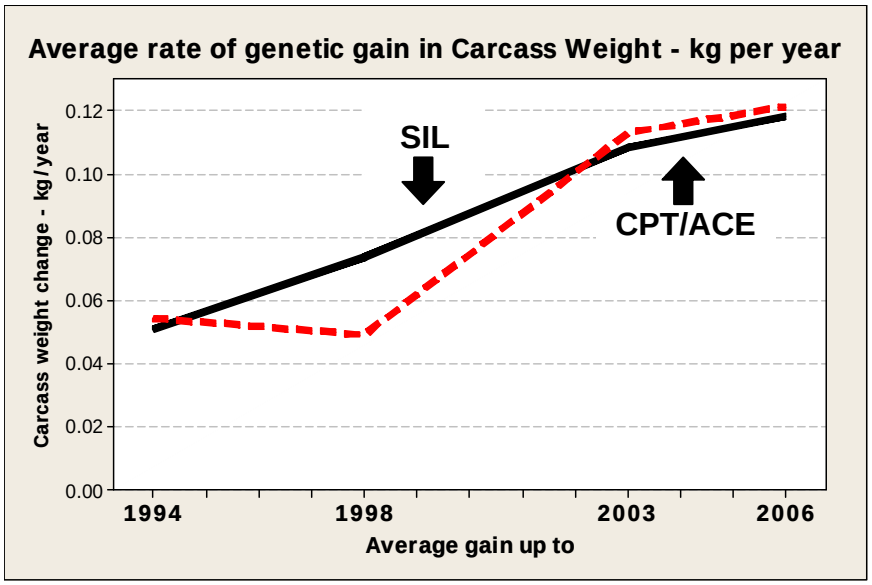
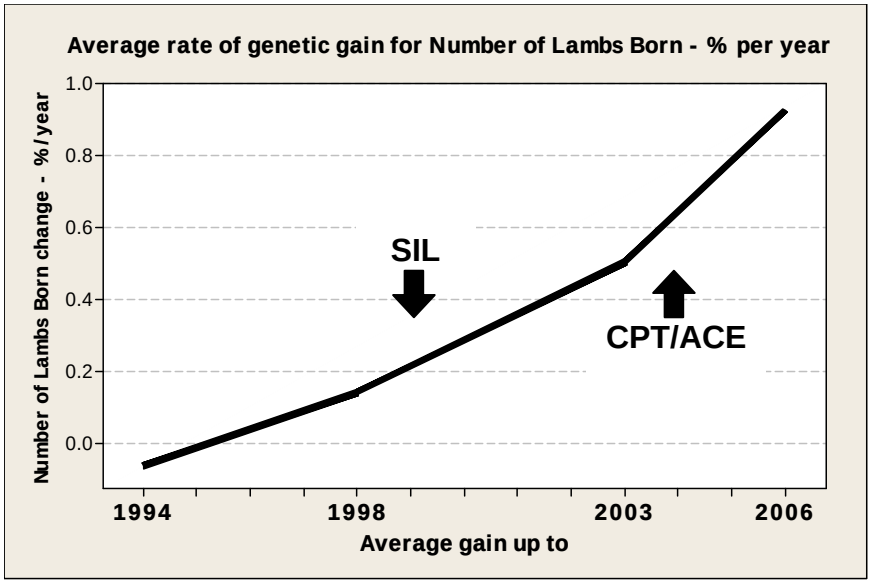


Figure 3. **Average rate of gain for number of lambs born** for Dual Purpose (ewe breed) sheep. Note these are rates of gain so increases illustrate accelerating rates of genetic gain. Times that SIL & CPT/ACE were established are indicated.



Not just genetics…
Actual flock performance is not a good indicator of genetic merit since non-genetic effects generally make a greater contribution to flock performance than do genetic effects. Feeding and environment always greatly influence farm performance. The best farm performance will be achieved with a combination of good management and good genetics.

It is interesting to think back to farming practices over a decade ago. Most farmers could name many changes in the way they do things now. Genetic improvements since then have paralleled changes in farm management.

Overall performance of the sheep industry has improved over the time period studied here. M&WNZ Economic Service information shows that carcass weight increased by 2.5kg (14.4 to 16.9) and average lambing percentage by 16% (101.6 to 117.9). While these changes are greater than the genetic improvement for carcass weight (1.4kg) and lambing percentage (5%) they clearly indicate that genetics have made a significant contribution to increases in industry performance.

Other sources of genetic gain…
Increased rates of genetic gain have also come from sources other than use of SIL, CPT and ACE information. Breed substitution, or "blending" has occurred in some flocks so "breed" composition of the industry has changed. Exotic breeds imported into NZ in the last few decades brought new genetics into the mix. However, SIL ACE results clearly show that many sheep with exceptional, high genetic merit are from "traditional" breeds.

Dr Amer found major differences between flocks in rates of genetic gain. While the average flock gained close to $1/year on index from 2004 to 2006, some flocks gained more than $1.50/year and others gained less than 50c/year. His work provides compelling evidence that breeders with a long-term commitment to using modern genetic improvement methods are making very good gains and can produce sheep with performance equal to the more exotic new composites.

This study considered traits common to most SIL flocks (for DP, Growth + Wool + Reproduction and for TS, Growth + Meat). If your breeder is selecting on other traits as well (e.g. Resistance to disease or Survival), their economic gains for an overall index can be greater still.

Some of these genetic gains made by breeders have not yet got out to the national flock. Older ewes are from sires born earlier in the period studied. Such "lag" occurs whenever a breeder is making genetic progress because the commercial farmer takes some years to get improved genetics throughout their flock. By buying better rams each year, commercial farmers can ride on the coat tails of their breeder's genetic improvement success.

Clearly, genetic gains made by breeders have contributed to lifts in performance of our sheep industry. Together with improved management (e.g. pasture management, stocking rate), genetic improvement has helped the industry produce more lambs per ewe and heavier lamb carcasses. Some argue that such genetic gains in performance come at a lower cost than equivalent gains from changed management.

8 APPENDIX 2 – ECONOMIC WEIGHTS

8.1 NLB

The value of NLB is highly sensitive to current lambing percentage, as this has an influence on the number of ewes having singles, twins, and triplet in the flock. At the current average lambing percentage in the Irish Sheep Industry (approximately 155%), the value for each additional lamb born is relatively low for several reasons:

- Above 150% average lambing the proportion of ewes having triplets increases markedly. This results in a higher average mortality in lambs due to lower survival of lambs born and reared as multiples.
- The relative return from each birth rank lamb also influences the value of an increase in number of lambs born. With increasing numbers of triplet lambs the relative return per lamb decreases. This is associated with increasing costs per lamb to finishing (smaller triplet lambs require more feed and have higher health costs than single lambs or twin lambs).

8.2 CWT

The value of CWT is based on a number of factors including:

- The seasonal premium captured by increasing growth rate and therefore achieving carcase weight target at an earlier date (contributes €0.56). Analysis of price schedule data from the past 10 years revealed an 11 week period during the year when a premium can be captured. By calculating the increase in value per day over this period (increasing schedule) and the number of days required to put on 1 kg of carcase weight the value in seasonal premium per kg of carcase weight can be obtained.
- The feed cost saving associated with lambs finishing earlier and therefore consuming less feed (contributes €1.68). The reduction in the number of days required to reach target carcase weight (i.e. faster growth rate) reduces the feed intake per kilogram of carcase weight.
- The increase in mature weight associated with selection for increases growth rate (contributes -€1.57). There is a relationship between growth rate and mature weight, with faster growing animals generally reaching higher mature weight. It is for this reason that the value of increased carcase weight is adjusted to account for the increase in mature weight (and hence maintenance costs) that occurs with selection for growth rate.

Calculation of adjustment for increasing mature weight

Below is the calculation of the increase in mature weight associated with increasing carcase weight. The regression of mature weight on carcase weight:

$b(y.x) = \mathrm{Cov}(y,x) / \mathrm{Var}(x)$

$b_{(MW, CWT)} = (rg_{MW} \sqrt{h^2_{MW} * \sigma P^2_{MW} * h^2_{CWT} * \sigma P^2_{CWT}}) / h^2_{CWT} * \sigma P^2_{CWT}$

Where:

rg_{MW}	=	0.7
h^2_{MW}	=	0.4
σP^2_{MW}	=	56.25 kg
h^2_{CWT}	=	0.25
σP^2_{CWT}	=	8.78

The resulting increase in mature weight per 1 kg increase in carcase weight is 2.56 kg.

9 APPENDIX 3 – SENSITIVTY ANALYSIS - BENEFITS

Sensitivity analysis for the level of uptake by commercial farmers (proportion of ewes mated to improved rams) and the associated industry benefits**.**

Proportion of ewes mated to improved rams	**Benefit CWT**	**Benefit NLB**	**Total benefit**
12.5%	€ 411,123	€ 97,828	€ 508,952
25.0%	€ 822,247	€ 195,656	€ 1,017,903
37.5%	€ 1,233,370	€ 293,484	€ 1,526,855
50.0%	€ 1,644,494	€ 391,312	€ 2,035,806
62.5%	€ 2,055,617	€ 489,140	€ 2,544,758
75.0%	€ 2,466,741	€ 586,969	€ 3,053,709
87.5%	€ 2,877,864	€ 684,797	€ 3,562,661
100.0%	€ 3,288,987	€ 782,625	€ 4,071,612

10 APPENDIX 4 – CPT AND MALP COST

Cost estimates discounted to present value for the development and functioning of the CPT and MALP over a 5 year period.

Year	Number of ewes (& properties)	Minimum number of rams	Recording		Indicative costs		Total discounted cost
			Lambs	New ewes[1]	Producer Fees	Services (including DNA)	
Central Progeny Test (CPT)							
2009	2100 (3)	38 + 2 links	2900		€95K	€9K	€104,000
2010	2100 (3)		2900	(1150 lambs)	€(95 +4)K	€9K	€100,935
2011	2100 (3)		2900	1150 +1150 lambs	€(99 +4)K	€9K	€97,825
2012	2100 (3)		2900	2300 +1150 lambs	€(103 +4)K	€9K	€94,691
2013	2100 (3)		2900	2300 +1150 lambs	€(107 +4)K	€9K	€91,547
Maternal Lamb Producer Group (MALP)							
2008	1000 (3 to 4)	20	1400		€8K	€(4 + 48)K	€60,000
2009	1000 (3 to 4)	17 + 3 links	1400	(230 lambs)	€(8 + 1)K	€(4 + 28)K	€38,318
2010	1000 (3 to 4)	17 + 3 links	1400	230 + 230 lambs	€(8 + 1)K	€(4 + 28)K	€35,811
2011	1000 (3 to 4)	17 + 3 links	1400	460 + 230 lambs	€(8 + 1)K	€(4 + 28)K	€33,468
2012	1000 (3 to 4)	17 + 3 links	1400	460 + 230 lambs	€(8 + 1)K	€(4 + 28)K	€31,279
Total present value of costs aggregated over 5 years							**€687,873**