Current issues and future directions for sheep breeding in New Zealand

Published in Primary Industry Management 2010 (June) ***14:*** *37-40*

Peter Fennessy, Peter Amer, Neville Jopson, Jude Sise, Tim Byrne and Simon Glennie[1]

AbacusBio Limited, PO Box 5585, Dunedin 9058

Background

Genetic improvement is a major contributor to the ongoing improvement in productivity in the New Zealand sheep flock. From the late 1980's, the productivity of the New Zealand ewe measured as the weight of sheep meat per ewe increased at a compound rate of around 3% per year over about a 20 year period. This improvement in productivity was due to advances in both genetics and management. Our estimates indicate that both contributed about equally.

While genetic gain can appear to be quite slow, providing that it is focused on economically-important traits, the benefits are cumulative. Thus a reasonable genetic gain of 2.5% per year represents a doubling of genetic merit in less than 30 years. Before considering some of the current issues and then looking at possible directions in genetic improvement, there are several issues that require clarification.

Clarifications

Assessment of genetic merit: Effective genetic improvement requires that we can estimate the proportion of an animal's superior performance that is due to genetic factors (its **genotype**). In essence, superiority is due to a combination of genetic and environmental factors plus the interaction of the animal's genotype with its environment. The **phenotype** of an animal refers to its actual performance.

For example, an animal that is born earlier in the season has an advantage over one born later, and a single has an advantage over a twin or triplet – these are environmental factors. If an animal has superior genetic resistance to internal parasites, but never gets challenged because it is routinely treated with anthelmintics, it cannot reveal this superiority. However if the animal is not treated or there is drench resistance within the flock, the individual's own genetic resistance can be expressed. These are examples of genotype by environment interactions.

Genetic evaluation schemes: In New Zealand, Sheep Improvement Ltd (SIL) operates a genetic evaluation scheme – this produces *Breeding Values* for rams – a BV simply expresses the superiority of one ram over another in terms of the particular trait such as *Live weight gain* or *Resistance to parasites*.

Generally these traits are combined and expressed as an economic index, which is an estimate of the overall economic breeding merit of an individual animal as a parent. The economic value of a trait depends on the production system. Therefore SIL uses a number of indices to describe different systems. For example, the terminal sire index (TSO) describes a system where all progeny are slaughtered. The dual purpose index (DPO) describes a system where ewe lambs are retained as replacements for breeding. All SIL indexes are expressed as cents per ewe lambing.

Select for genetic improvement but cull for productivity: Selection of rams is the most effective means of ensuring genetic gain – this is because one ram can easily settle a hundred or more ewes and hence rams can be very highly selected. In contrast, in a practical flock situation, a farmer can make little genetic impact by selecting ewes, as the vast majority are required to maintain flock numbers. However at the flock level, culling of poor performing ewes or culling of replacements on bodyweight can have a major immediate impact on productivity and profitability.

Genetic improvement is not simple: The operation of an effective genetic improvement plan is non-trivial. The most effective schemes internationally involve large populations which are well-connected genetically so that the performance of an individual male in one flock can be compared with that of another male in another flock. Such genetic connectedness between flocks is required to be able to validly compare the genetic merit of animals born in different flocks and run under different conditions and is achieved through the sharing of rams (link sires) within and between years.

[1] Correspondence: Peter Fennessy, pfennessy@abacusbio.co.nz; www.abacusbio.co.nz

Hence this requires that breeders invest in schemes that enable the analysis of the performance of individuals within the flock to produce robust estimates of genetic merit including across-flock comparisons; in the case of sheep in New Zealand, this is managed by SIL which is supported by levy funds and user fees. SIL also provides data for genetic trends which show how successful breeders have been in making improvement.

Current issues

The major issue for genetic improvement in the New Zealand sheep industry is to increase the rate of genetic gain to improve profitability. The most effective means of increasing genetic gain in the national flock are to:

- increase the uptake and utilisation of superior genetics by farmers,
- increase selection pressure in ram breeding flocks,
- focus genetic improvement on traits that are going to continue to make a difference financially,
- ensure that superior animals are capable of performing in the commercial environment, and
- capitalise on the genetic variation present within the national flock (due to the diversity of breeds).

Increasing uptake: The benefits of genetic improvement are much more difficult to grasp for sheep farmers than for dairy farmers – the latter have a history of seeing the benefits of genetic improvement through the use of artificial insemination so that the superiority of AI sires is evident in terms of production of individual cows. The superiority is readily apparent because of the very high selection pressure on bulls that is enabled through the use of AI and progeny testing, along with the immediacy of feedback that is evident when the production of cows is recorded regularly.

In contrast sheep farmers are dependent on very indirect evidence of genetic progress – increases in lambing percentage, faster rates of weight gain, and the ability to grow lambs to heavier weights without becoming over-fat, as well as evidence provided by breeders and SIL. Therefore accepting statements that breeders are making genetic progress involves an act of faith. However in some situations farmers can readily see the evidence in traits that have a profound effect on phenotype – two good examples are the muscling genes and bare points[2]; consequently farmers will readily accept that these traits will provide benefits.

Increasing selection pressure: The major opportunities lie in increasing the size of ram breeding flocks, improving the genetic connectedness between ram breeding flocks, and better use of technology. Increasing the size of flocks enables much greater selection pressure on sires[3].

The SIL Advanced Central Evaluation (SIL-ACE) evaluations are made possible by genetic links between breeds generated by both breeders and the Alliance Central Progeny Test (CPT). Thus the Meat & Wool NZ and Alliance Group investments in the CPT scheme have facilitated much improved genetic connectedness between flocks[4].

Other technological opportunities include the use of CT scanning which has been used by Landcorp Farming through *Innervision* to select for carcase and growth traits since 1996[5]; a number of other breeders are now adopting this technology. The use of *Animate*[6], a software tool developed by AbacusBio, to minimise inbreeding is a simple yet effective means to maintain high rates of genetic gain. The application of genetic marker technology, developed by Ovita (a research consortium with

---

[2] Scobie (2006): Breeding sheep with bare breech and belly. Meat & Wool New Zealand R&D Brief No 116.

[3] The assessment of genetic merit involves statistical approaches; the accuracy of estimation of an individual's merit is much less than the accuracy of assessment for a group of individuals; therefore genetic progress through using a group of sires is much more reliable than that that would be achieved by using a single sire; in addition, larger flocks enable much higher ram to ewe ratios as the risks of sire failure are much less important.

[4] SIL-ACE is New Zealand's national across flock and breed evaluation to identify the best rams for economic traits. Ram breeders provide permission for their flock to be included, and the flock also has to satisfy specified criteria. This includes recording on SIL, and having appropriate genetic links. External rams are listed if they have been used in SIL-ACE flocks and have sufficient progeny evaluated (www.sil.co.nz).

[5] The evidence of its value is apparent in the ranking of Landcorp sires in SIL-ACE.

[6] Animate (www.abacusbio.co.nz)

AgResearch and Meat and Wool NZ) and commercialised by Pfizer Animal Genetics[7], offers considerable benefits, especially for specific traits such as muscling (MyoMax and LoinMax). However the greatest impact to date has been in the use of *Shepherd*, a DNA-based scheme to define parentage. Importantly this has enabled breeders to greatly increase the scale of their operations as it has eliminated the need for shepherding to record dam-offspring relationships. The development of the SNP-chip technology will offer greater gains in the future[8].

Focus on important traits that will make a difference financially: The importance of a focus on valuable traits cannot be underestimated, as dilution of effort in genetic improvement programs is inevitably a costly exercise. Hence the focus should be on traits that are both economically important and responsive to selection; that is, they are sufficiently variable and the heritability is sufficiently high – or in other words, the traits have a high genetic variance.

One important group of traits are those that reduce costs; for example, a reduction in costs of inputs, such as animal health costs, or a reduction in animal wastage and hence a reduced requirement for replacements. Another important group of traits are those that increase animal performance or productivity; for example, increased weight gain or improved lambing. A further group includes those that impact on product quality, such as reduced fatness or increased muscling. In respect of animal performance, a valid question is how far can or should we attempt to increase ewe fecundity, especially considering the fecundity/survival conundrum?

Ensure that superior animals are capable of performing in the commercial environment: The selection of a ram breeder is a decision that is far more important than the selection of an individual ram from within a breeder's flock. The track record of the performance of a particular breeder's rams on a farm provides the best evidence of their ability to perform in that environment.

Capitalising on genetic diversity: The New Zealand sheep population is relatively diverse with a range of breeds and a relatively large number of sires in use (especially when compared with the dairy cattle population). The value of that diversity has been especially evident in the development of the composite sheep strains, where the Texel, East Friesian and Finnish Landrace breeds have all contributed specific characteristics along with contributions from the traditional NZ ewe breeds such as the Romney, Coopworth and Perendale.

That diversity is also being exploited in the use of terminal sires where both the specific breed contributions (such as specific muscling genes and higher growth rates) and hybrid vigour (for example in terms of its impact on lamb survival) contribute to a positive outcome. However arguably terminal sires are underused by NZ farmers as they tend to over-mate ewes to dual purpose breeds to produce replacement ewe lambs.

The recent importation of Ile de France (with an extended breeding season) and the Charollais (with high growth rate and yet another muscling mutation) offer further opportunities to devise effective ways of exploiting this genetic diversity.

Directions

Despite the improving productivity, the New Zealand sheep industry cannot survive except by extracting a larger proportion of the value achieved in the market. Lamb is already a premium product so that we are unlikely to see higher prices in many markets. However this premium status and the extraction of a higher proportion of the final value will not endure because we need it – rather it requires that consumers continue to want the product and the supply chain can be modified to return a larger share to the farmer probably via a more direct supply route. Should this occur, we can expect a much greater focus of genetic improvement on meeting specific market demands although we will not be able to neglect the major productivity drivers. Therefore the following are some directions and factors that we believe will influence our approach in the future:

- a focus on both productivity and the market,
- less control of the commercial farm environment, and
- the need for data.

A focus on both productivity and the market: While one aspect of the focus of genetic improvement is expected to move to factors that are important in the market, productivity cannot be neglected.

---

[7] Pfizer Animal Genetics

[8] SNP - Single Nucleotide Polymorphism;

Market factors include consistent quality (especially with respect to flavour and tenderness), and a product that meets consumer expectations with respect to farming practices (e.g. carbon footprint, animal management, environmental management). In this respect, aspects of the carbon footprint and animal management are amenable to genetic approaches. Increasingly on the international scene, genetic improvement schemes are looking at approaches that will reduce the carbon footprint associated with meat and milk production. In New Zealand, resistance to internal parasites (which enables a reduction in chemical use) has been a selection target for many breeders for almost two decades.

Many traits are relevant to both a productivity and market focus. For example, larger carcasses provide meat processors with more options, while also potentially improving productive efficiency, so long as the feed supply can be managed without significant increases in cost. Given the need for lambs to be less than a defined age at slaughter and a need for year-round supply for some markets, there is a demand for sheep with a longer breeding season. Hence some breeders are now pursuing selection for out-of-season breeding. In this respect, the recent importation of the *Ile de France* breed offers new possibilities.

Less control of the commercial farm environment: Sheep farming can only maintain market supply in the face of an ever-expanding dairy industry and increasing cost pressures through greater productivity and intensity in farming areas where control of feed is often challenging.

Potentially extreme weather conditions in the winter and at lambing also contribute to a need for sheep that are robust (they both survive and thrive) as much as they are productive. Coopworths, traditionally the most progressive and highest performing sheep breed and, more recently, some of the high performing composite sheep breeds have not enjoyed the market share that might have been expected based on productivity alone. These breeds continue to have an important role where farm management can be adapted to their requirements.

However, there is a lesson for the breeding industry that adaptability and robustness have an important role to play in the commercial sheep farming environments of the future, but the question remains – how do we identify the animals that are performing in large-scale commercial operations to provide guidance to our breeders? Recent developments where some large-scale breeding operations are focusing their breeding programmes in more rugged farming environments reflect recognition of the importance of this robustness.

The need for data: The focus on new traits that can only be measured on slaughtered animals is driving approaches to collect data at the processing plants, and even in the market. At present this requires full product tracking with animals identified on farm through the processing plant and potentially right through to the market, which is a very complex task. However new developments in electronic identification (Ultra High Frequency - UHF tags) and rapid developments in software and logistics systems mean that the barriers will be overcome. The fundamental problem of defining the genetics of the individual remains and at present this must be integrated with the identification system.

In the longer term with reductions in the price of DNA technologies, it will be possible to reconstruct genetic relationships or pedigree on any individual animal – thus large-scale genetic of evaluation or progeny testing of rams would become feasible under commercial farming conditions. While this will be of considerable value for productivity traits, it will provide the opportunity for direct feedback from the market to the processor to the farmer to the breeder to become a practical reality.

Conclusions

The New Zealand sheep industry is in a very difficult situation with relatively low prices and increasing costs. Genetic improvement is fundamental to improving productivity but increasingly market demands will focus genetic improvement more directly on factors that are important in the market. This will require a much more integrated system to enable the simple collection of relevant data.