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Sheep Improvement Limited (SIL) - the first 10 years
Introductory remarks

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Garrick *et al.* (1992) defined the six major components of performance recording schemes designed for genetic improvement on a national scale as committed buyers, motivated breeders, database, genetic technology, animal breeding research, and extension. The major factor determining the effectiveness of a national scheme is the way that each of these components is matched to industry needs and mutually coordinated (Clarke *et al.*, 1992).

Geenty (2000) stated the aim of Sheep Improvement Limited (SIL) was to facilitate effective genetic improvement across the New Zealand sheep industry. However the existence of genetic evaluation systems does not in itself ensure genetic progress, information must be used when making selection decisions for genetic progress to be achieved. Contributors in this contract session examine the uptake and impact of SIL in the New Zealand and international sheep industries in the decade since its commencement.

Young and Wakelin (2009) review the overall impact of SIL within the New Zealand sheep industry. Amer (2009) quantifies changes in the rate of genetic progress in the sheep industry since 1990, classifies flocks on the basis of potential rates of genetic gain and discusses the implications of this for industry genetic improvement initiatives.

The establishment of a single national database provides the opportunity for national evaluations to be easily undertaken and Young and Newman. (2009) describes the development and growth of SIL-ACE, New Zealand's national evaluation. Although dairy and beef industries routinely perform international genetic evaluations, there have been few international evaluations in sheep. Young *et al.* (2009) describe trans-Tasman genetic evaluations conducted by SIL and Sheep Genetics in Australia.

SIL's responsiveness to industry changes or needs, is demonstrated in changes described by Jopson *et al.* (2009) for genetic evaluation of meat yield. SIL also has a role in research and development of new technologies which offer the means to further increase rates of genetic gain (McEwan *et al.,* 2009).

SIL – progress over a decade

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ABSTRACT

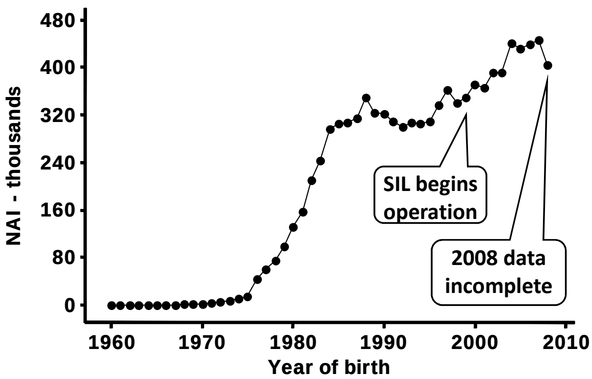
In the 10 years that Sheep Improvement Ltd (SIL) has been operational, the system has continued to develop to meet the needs of breeding flock owners and their ram buying clients. New traits have been added to the evaluation. More flocks are using across-flock evaluations, but there is the opportunity to grow this significantly. The language of SIL is well accepted by industry and offers the most likely path to integration of DNA based genetics into the sheep industry. While a large proportion of rams used by the New Zealand sheep industry come from SIL flocks, a significant section of the industry are still not comfortable with SIL figures when purchasing rams. Greater penetration into the ram buying industry and further into the meat processing industry are challenges for SIL and its collaborators. SIL must maintain and enhance its relevance to industry. This means focused research that addresses key issues and a significant extension effort to increase the proportion of industry that has confidence in using SIL and related technologies.

Keywords: genetic evaluation; SIL; sheep; improvement; across-flock; development; usage; benefits.

HISTORY OF GENETIC EVALUATION FOR NEW ZEALAND SHEEP

New Zealand sheep breeders have had access to state-of-the art genetic evaluation systems for over 40 years (Callow, 1985). The National Flock Recording Scheme, which was established in 1967, was followed by Sheeplan in 1976 (Clarke & Rae, 1977) which led onto Animalplan in 1988 (Johnson *et al*., 1989). Throughout this period, the number of breeders using this performance recording and genetic evaluation service grew (Figure 1).

FIGURE 1: Animals on SIL database - NAI (new animal indicators – equivalent to lambs born) by year of birth. A total of 9.9 million animals were on the SIL database at the end of 2008. Not all 2008 born animals were entered on SIL at the time these data were compiled.



After this, momentum was lost when some breeders switched to rival systems such as FlockLinc from 1989 and the PC based software package, Studfax. These alternatives each had advantages, but this was a period of confusion with different systems for analyzing and presenting information to industry. Concerns that this would compromise the industry led to a common database being mooted (Garrick *et al*., 1992).

In the mid 1990s, Meat New Zealand and the New Zealand Wool Board brought the different groups together with genetics experts and provided funding to develop a common vision for the provision of performance recording and genetic evaluation services to the New Zealand sheep industry (Geenty, 2000). A range of experts were involved in design and specification of the system (Newman *et al*., 2000).

Their concept was to create a national genetic database with a single evaluation system based on multi-trait, repeated measure animal model BLUP methods to service the sheep industry. It would transparently scale from single flock evaluations to national across flock and breed evaluations. This led to development of the Sheep Improvement Ltd (SIL) system which first went live in 1999 (Geenty, 2000).

In 2004, with the formation of Meat and Wool New Zealand, SIL was brought into the new company where it operates as a service to the New Zealand sheep industry. SIL is a natural progression from earlier evaluation schemes.

DESIGN FEATURES OF SIL

From the outset, SIL was designed to be flexible to suit user needs and to be readily accessible. With the advent of more powerful hardware and software, the individual animal model BLUP method was introduced for all genetic evaluations (Newman *et al*., 2000). These were available on-demand for all but larger analyses.

A modular architecture allows system components to be separately upgraded with minimal effect on other components, as well as ensuring BLUP evaluations are conducted in a fast and efficient manner. Access via the internet means users can work from almost any location. Users interact with the SIL database where data are uploaded and checked, genetic evaluations are scheduled and reports designed to suit the needs of individual breeders or collaborating breed or flock groups. All genetic evaluations, including data transfers, writing of reports and return of these to the user through electronic mail are conducted by automated procedures.

Eight commercial bureaus around New Zealand offer the full SIL service to sheep breeders here and overseas. Effectively bureaus retail the SIL service and SIL wholesales its services to the bureaus. In addition, SIL provides industry good extension programmes and developments necessary to ensure the service is appropriately up-to-date for the sheep industry.

Initially the SIL system allowed genetic evaluations of Growth, Meat (based on carcass merit) Wool, Reproduction based on number of lambs born, Lamb Survival and Resistance to Internal Parasites (WormFEC) (Newman *et al*., 2000). Reporting of results was in a standard format and few flocks participated in across-flock genetic evaluations.

Most breeders make use of SIL selection indexes designed for Dual Purpose flocks producing wool, lambs and replacement ewes, or Terminal Sire flocks where all progeny in commercial flocks go to carcass production. There are also selection indexes for Fine Wool flocks and Mid-Micron flocks.

SIL FUNDING

SIL is funded partly by fees charged to breeders, approximately one third, while industry good funding from Meat and Wool New Zealand

(MWNZ) provides the balance to cover extension services and ongoing development. SIL has also been an industry partner in a number of externally funded research projects which have contributed to developments in the SIL system.

USAGE

Use of SIL has grown dramatically. Currently there are over 1,000 active flocks of which more than 740 are performance recording. There are close to 500 flock owners giving about 1.5 active flocks per owner (Table 1). Just over 300 flocks use the database to record pedigree only. There are close to 10 million animals on the SIL database, with about 400 thousand more added each year (Figure 1). SIL is the largest genetic database for sheep in the world as far as we know.

FIGURE 2: Distribution of Dual Purpose flock sizes in the SIL database by number of new animal indicators (NAI) in 2007.

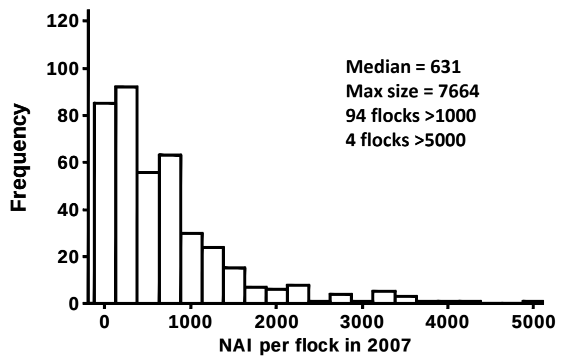


FIGURE 3: Distribution of Terminal Sire flock sizes in the SIL database by number of new animal indicators (NAI) in 2007.

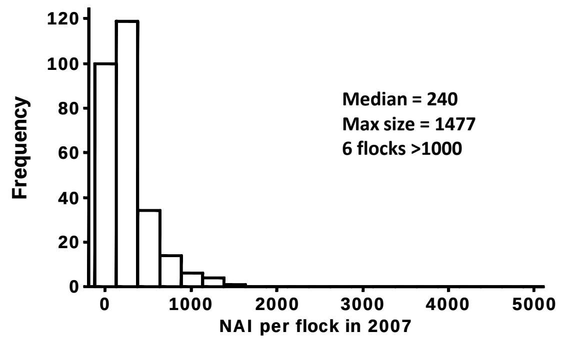
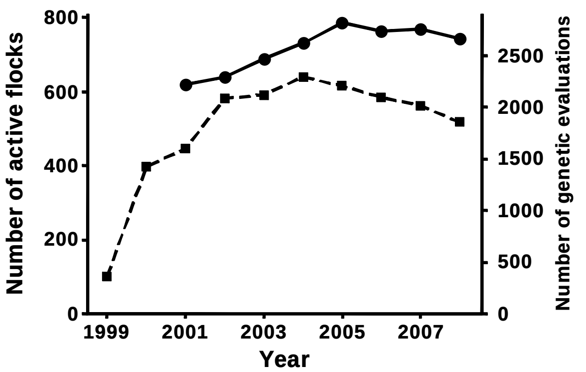


FIGURE 4: Changes in the total number of active flocks (solid line) relative to total number of genetic evaluations (dashed line) over time within the SIL database.



Average flock size is not an ideal measure of typical flock size because the distribution of flock sizes is heavily skewed (Figures 2 & 3). The median is a better measure of typical flock size (Table 1). These data show that flock size has increased since SIL started, that Dual Purpose flocks are larger than Terminal Sire flocks and that there are a few very large flocks with more than 5,000 new animal indicators (NAI), equivalent to number of lambs born, entering the flock each year.

Relative to the number of active flocks, the number of genetic evaluations has declined (Figure 4). This is because more flocks are now participating in across-flock genetic evaluations in order to compare animals across flocks. There are more than 25 across-flock groups conducting regular across-flock evaluations. Some of these groups began across flock comparisons a decade before SIL was formed such as the Wairarapa Romney Improvement Group and the Coopworth Sheep Society.

SIL-ACE is the largest across-flock evaluation regularly conducted with SIL. We believe it is the largest sheep genetic evaluation in the world (Young & Newman, 2009).

RESEARCH AND DEVELOPMENT

SIL is committed to working with others in the industry to enhance the services it can offer. This commitment ranges from aiding the collection of data through to implementing new genetic evaluation modules and updating economic selection indexes. The following enhancements to SIL system have occurred in the last 10 years.

Since 1999, SIL genetic evaluation modules for Growth and Survival have been upgraded to include maternal effects, providing estimates of genetic merit for ‘milking ability’ and ‘mothering ability’. SIL now has additional genetic evaluation modules for Wool Quality, Hogget Lambing, Twinning with more twins and fewer triplets at the same lambing percentage, Resistance to Facial Eczema, Dag Score and Resilience to Internal Parasites.

Developments for new ways to describe carcass merit using VIASCAN (Jopson *et al.*, 2009) or CT scanning (Kvame *et al.*, 2004) are being implemented in SIL for wider usage.

TABLE 1: SIL flock statistics for Dual Purpose and Terminal Sire breeds and usage by year. Animal numbers per flock are represented by new animal indicators (NAI) which is equivalent to lambs born. These statistics are based on flock-year cohorts of greater than 20 NAI.

Year of birth	Number of active flocks	Number of flock owners	Number of flocks per owner	Dual Purpose (NAI/flock)			Terminal Sire (NAI/flock)			Number of genetic evaluations
				Mean	Median	Maximum	Mean	Median	Maximum	
1999	*Not all bureaus on SIL*			676	495	5820	197	133	1528	360
2000	*Not all bureaus on SIL*			713	524	5499	225	160	2400	1426
2001	620	447	1.39	691	483	5885	247	171	2381	1597
2002	639	459	1.39	756	530	7129	276	211	1957	2089
2003	689	474	1.45	754	524	7848	277	212	2049	2118
2004	731	497	1.47	856	603	8532	302	227	1935	2293
2005	788	529	1.49	861	620	8019	310	229	2110	2204
2006	764	529	1.44	877	633	8188	304	223	2250	2097
2007	769	524	1.47	873	631	7664	312	240	1477	2013
2008	743	498	1.49	854	592	7919	299	212	2037	1853

Ongoing research work is examining ways to breed sheep without wool on areas of the body where it can be a problem such as on the breech to reduce dags, to improve our recording and evaluation of Lamb Survival data and to breed sheep to reduce greenhouse gas emissions per unit of product.

SIL has been a major partner in the MWNZ Central Progeny Test (CPT) and formerly Alliance Central Progeny Test. This initiative has led to the development of new ways to characterize genetic merit for sheep meat production as well as fostering genetic connections between breeds that would not normally occur. The CPT provides a resource that can be used for a variety of developments.

SIL is actively involved with other groups conducting research for the sheep industry. SIL provides the obvious path to the commercial delivery of many developments coming from applied research. Collaborations with groups such as Landcorp have led to the implementation of new services such as CT scanning for assessing carcass merit and the validation of existing services such as Lamb Survival.

A number of gene tests have been developed as a result of Ovita investment. Ovita is a sheep genomics consortium of which MWNZ is a shareholder. SIL flock data were critical to the development of these tests which are marketed by Pfizer Animal Genetics, formerly Catapult Genetics. These tests include Shepherd® (parentage testing as a part of pedigree and performance recording), MyoMAX® and LoinMAX® (two tests of carcass muscling), i-Scan® (presence of a recessive gene for blindness in Texel sheep), Inverdale® (increased fecundity in heterozygote animals) and WormSTAR™ (reduced faecal egg counts and increased production). Inverdale® gene test results can be used within SIL as part of a modified 'Marker assisted selection' genetic evaluation for reproductive rate in sheep carrying the Inverdale fertility gene.

SIL has also developed its operating system to help breeders and their bureaus to work more efficiently while directly addressing their breeding goals. SIL has a suite of data auditing tools to help breeders and breeding groups optimize the design of their breeding programmes and enhance the quality of data they collect, in particular to characterize genetic connectedness between contemporary groups. A powerful Report Writer tool is now used that allows results of genetic evaluations to be reported in almost any way that a breeder wants, including the ability to implement custom indexes.

Growth of across-flock evaluations has led to SIL setting up the Across Flock Report Manager (AFRM) system. AFRM are affiliated to bureaus, and take responsibility for regular running of across-flock evaluations and production of group reports for participating flocks.

SIL has developed links with third party service providers so that more can be made of the data held by SIL. This includes the Animate® (AbacusBio, New Zealand) mating management software which optimizes genetic gain while minimizing inbreeding, and ram sale tools such as RamFocus® (AbacusBio, New Zealand).

STATISTICAL GENETICS AND DNA TESTS

Perhaps one of the greatest benefits of the SIL system has been in its ability to provide robust data for research in the genomics area. The depth and breadth of the data produces stable phenotypes, a critical requirement of genomic research. Ovita investment in this field would not have been as successful without access to such data.

The most significant development from this area that SIL has worked on is the integration of DNA test information into genetic evaluations to determine parentage, the Pfizer Animal Genetics Shepherd® service. This is part of an iterative procedure using BLUP methodology to produce 'conventional' breeding values (BVs). This means pedigree sheep can be farmed under commercial conditions, without disturbing ewes and lambs at lambing time, while still providing robust estimates of genetic merit (Dodds *et al.*, 2005).

There are still challenges ahead. The prospect of Genome Wide Selection using SNP chip technology will be addressed elsewhere (McEwan, 2009). This exciting new development promises much, especially for traits we cannot measure easily, or that are manifest later in life.

BENEFITS TO INDUSTRY IN LAST 10 YEARS

SIL has been successful in a number of ways, perhaps most noticeably in its association with dramatic increases in the rates of genetic gain achieved by SIL flocks (Amer, 2009). These are partly attributable to improvements in SIL technology, to more flocks being on SIL and to breeders using SIL genetic information more effectively as their confidence in and understanding of SIL increases.

Over the life of SIL, there has been a marked growth in the use of across-flock genetic evaluations. Many breeders now do not use within-flock evaluations. Across-flock evaluations provide a powerful way to identify the top genetics in a flock group and increasing rates of genetic gain seen in the sheep industry have been attributed to greater use of these (Amer, 2009).

Since 2003 SIL has been routinely producing a large-scale, across-flock genetic evaluation called SIL-ACE. This has grown to currently include data from over 300 flocks and more than 3 million animals. Young and Newman (2009) describe features of this and exciting new developments that make this genetic information more accessible to industry. Some SIL breed groups now routinely share data across countries (Young *et al*., 2009). In time we expect national evaluations to become the default for most, if not all, breeders.

Of major significance is the implementation within SIL of genetic evaluation modules for traits with great economic importance such as facial eczema. Breeders working on this can now incorporate all their important economic traits into routine SIL evaluations.

EXTENSION

During the initial years of SIL, much effort was devoted to extension with SIL breeder clients. This work aimed to show how SIL features could provide robust information on which to base valid selection decisions. SIL evaluations were significantly more accessible, more accurate and the reporting more flexible, than previous genetic evaluation services.

Industry extension continues to be a major focus of SIL although increasingly effort is devoted to commercial ram buyers. Useful information is readily available on the SIL website and regular articles on the genetic evaluation of sheep are presented in the rural press. SIL advisers are available to talk to groups of commercial farmers and breeders.

Many SIL breeders and their ram buying clients are comfortable with SIL figures for genetic merit. However, there is a significant proportion of the industry that still has reservations. A major challenge for SIL is to gain greater penetration into the sheep industry, from ram buyers through lamb buyers, meat processors, wool processors to retailers and consumers of sheep products.

WHAT NEXT?

We are in a period of change for genetics with new genomic technologies promising much. The strong phenotype data that SIL can produce is fundamentally important to the quest for more robust, and cheaper, genomic solutions to the characterization of genetic merit.

Perhaps SIL's most significant challenge is maintaining relevance to an industry that continues to evolve. It must continue to focus on end-users, both the ultimate customer buying the product and the groups that directly use the outputs from our genetic evaluation methods, ram breeders and ram buyers. Between these two extremes of the market place, there is the need to bridge the gap and get a common genetic language used at all levels of the sheep industry. SIL must grow the respect it currently has to cover a greater proportion of the industry.

The next ten years promise to be even more exciting than the last ten!

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