

New Zealand Society of Animal Production online archive

This paper is from the New Zealand Society for Animal Production online archive. NZSAP holds a regular annual conference in June or July each year for the presentation of technical and applied topics in animal production. NZSAP plays an important role as a forum fostering research in all areas of animal production including production systems, nutrition, meat science, animal welfare, wool science, animal breeding and genetics.

An invitation is extended to all those involved in the field of animal production to apply for membership of the New Zealand Society of Animal Production at our website www.nzsap.org.nz

[View All Proceedings](#)

[Next Conference](#)

[Join NZSAP](#)

The New Zealand Society of Animal Production in publishing the conference proceedings is engaged in disseminating information, not rendering professional advice or services. The views expressed herein do not necessarily represent the views of the New Zealand Society of Animal Production and the New Zealand Society of Animal Production expressly disclaims any form of liability with respect to anything done or omitted to be done in reliance upon the contents of these proceedings.

This work is licensed under a [Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International License](https://creativecommons.org/licenses/by-nc-nd/4.0/).



You are free to:

Share— copy and redistribute the material in any medium or format

Under the following terms:

Attribution — You must give [appropriate credit](#), provide a link to the license, and [indicate if changes were made](#). You may do so in any reasonable manner, but not in any way that suggests the licensor endorses you or your use.

NonCommercial — You may not use the material for [commercial purposes](#).

NoDerivatives — If you [remix, transform, or build upon](#) the material, you may not distribute the modified material.

<http://creativecommons.org.nz/licences/licences-explained/>

Lessons to NZ sheep breeders from other species and other countries

L. R. PIPER AND R. BANKS¹

CSIRO Livestock Industries, F D McMaster Laboratory, Locked Bag 1, Armidale, NSW 2350, Australia

ABSTRACT

The SIL system for genetic improvement of productivity in the New Zealand sheep flock has been reviewed. It is technically well designed, and provides first rate genetic information to a range of breeder users. However, the availability of such a system for performance recording and genetic evaluation does not guarantee that it will be fully utilised by industry to achieve high rates of genetic gain for economically important breeding objectives. Ways of maximising participation by the nucleus sector and of maximising the choice among genetically comparable rams for the commercial sector need to be pursued.

Key words: sheep; genetic improvement; new technologies.

INTRODUCTION

In approaching this task, we have restricted our focus to animal breeding matters and have not attempted to deal with other issues of major importance to animal production industries such as animal husbandry, animal health, industry regulation, product marketing and development and competition from land use alternatives.

In common with agricultural industries around the world, New Zealand sheep breeders face declining terms of trade for their products (e.g., Geenty, 2000) and must become more efficient in order to remain viable. This usually means increasing the productivity of their enterprise by increasing the volume and/or quality of product per ha, by reducing costs of production per ha and in some cases, by increasing the scale of the enterprise or adopting marketing or enterprise diversification strategies to minimise risk. New Zealand sheep breeders will be very familiar with these scenarios and recent productivity trends suggest that many have successfully risen to the challenge (Davison, 2000).

Sheep breeding in New Zealand

The main features of the structure and organisation of sheep breeding in New Zealand were reviewed in several papers at the 2000 meeting of the New Zealand Society of Animal Production. I have assumed that these papers remain a good reference point for assessing the status of sheep breeding in New Zealand but there will have been developments that I have overlooked, which will be highlighted by other speakers in this symposium.

The structure of the sheep industry in New Zealand has been described by Garrick *et al.* (2000). It consists of a nucleus or ram-breeding sector comprising 1-2% of the breeding ewes and a commercial sector, accounting for the balance of the breeding ewes, which sources flock ram replacements from the ram-breeding sector. Under this structure, the rate of genetic improvement in the ram-breeding sector determines the rate of genetic improvement in the whole industry. Fine tuning the proportion of ewes in the ram breeding sector has only marginal effects on the rate of genetic improvement for the whole industry, but increasing the proportion in that sector increases the costs of the genetic improvement program (Garrick *et al.*, 2000).

Widespread use of open nucleus schemes has the potential to increase rates of genetic gain for the whole industry but costs associated with animal recording would also increase. The net benefit from increased gains against increased costs is marginal and other impediments to movement of animals between flocks such as the risk of disease have reduced the interest in such schemes. For wool breeds, where the additional costs of measuring young commercial-sector ewes for fleece weight and fibre diameter can often be recovered through superior performance of those animals for the rest of their lifetime (Piper & Swan, 1999), such schemes may be more attractive.

Sheep Improvement Limited (SIL), a joint-venture company of the New Zealand Meat and Wool Boards, has the responsibility for developing and maintaining a national system for genetic improvement of productivity in the New Zealand Sheep industry. It also has wider information-broker and technology-adoption roles and product-development, differentiation and quality assurance functions (Geenty, 2000). The essential elements of the SIL system for genetic improvement of productivity in the New Zealand Sheep industry are the same as for any well-organised breeding program for any livestock species and have been described by Newman *et al.* (2000). These elements include a national database of individual sheep production and pedigree records (where available) and a genetic engine that uses measurements on a range of predictor traits to provide BLUP-based estimated breeding values for individual breeding objective traits in a comprehensive set of goal trait groups (growth, meat, wool, reproduction, survival and disease). The rationale behind goal trait grouping is to enable implementation of multivariate BLUP animal models for estimation of breeding values within goal trait groups and to facilitate ease of upgrading of each goal trait module. The modular structure also allows for a continuous improvement strategy of adding new modules as new technologies (gene marker information) and traits become available to clients of the SIL system.

The national database and the genetic engine are located on different computers that interface through the Internet. Estimated breeding values can be combined into three overall indexes (Dual Purpose, Terminal Sire, Fine

¹ MLA, Department of Animal Science, University of New England, Armidale, NSW 2351, Australia

Wool) or into goal trait group indexes calculated as the sum of the trait breeding values within goal trait groups times the appropriate relative economic weights. There is flexibility to add new indexes to the system and for breeders to specify customised indexes for their own enterprise. This allows for genetic specialisation and market differentiation and it may be interesting for SIL to undertake an analysis of the expected long-term outcomes from the current range of customised breeding objectives.

Studies reported by Geenty (2000) indicate that annual rates of genetic improvement of 2% are achievable for performance-recorded dual-purpose flocks. However, such rates of progress do not appear to be being achieved across the New Zealand sheep industry as indicated by analyses of national rates of change in traits such as fleece weight and, to a lesser extent, lambing percentage (Geenty, 2000). Interpretation of trends in such data is difficult because changes in management environment, breed composition of the national flock, and rate of genetic improvement all affect the overall trend. Analyses by Davison (2000) do indicate substantial changes in lambing percentage and in slaughter weight over the period 1986-87 to 1999-00. However, much of that gain in productivity is ascribed to non-genetic factors (improved management and feeding of sheep, wide-scale adoption of scanning to identify dry ewes and those carrying twins, mating of hogget ewes) and to breed substitution.

With the availability of a first-rate genetic improvement system such as SIL, why does the rate of genetic improvement in the New Zealand sheep industry appear to be lower than is achievable and lower than is being achieved in other livestock and crop industries? What lessons can be learned from other industries and other countries?

Uptake of new breeding technologies

For the intensive poultry and pig industries, a small number of major multi-national companies control the breeding programs that determine the rate of genetic gain for the whole industry. In many cases, these companies are vertically integrated through to retail product and they employ high quality in-house genetics expertise to design and control breeding programs. The latest technological advances are evaluated and, if assessed as beneficial, incorporated into breeding programs of the company-controlled tiers and sectors of the relevant industry. Uptake of new technology is rapid and depends only upon the assessment of whether it will add value to the operations of the company. Genetic progress in both these industries has been rapid and sustained, as consumers of modern broiler chickens can easily judge.

In the dairy industry, genetic progress has also been rapid, especially since the advent of widespread availability of AI, and, more recently, because of increasingly sophisticated genetic evaluation technologies, use of multiple ovulation and embryo transfer (MOET) and world-wide semen movement, which facilitates comparisons of the genetic merit of dairy sires across the industry on a global basis. Again, by comparison with the beef, sheep and goat industries, there

is a relatively small number of breeding companies globally and, with some variations from country to country, a readiness to adopt new genetic technologies that will add shareholder/investor value. The Dutch dairy breeding program is a good example of rationalisation and optimisation to increase uptake and adoption of improved breeding technologies. Previously existing AI Cooperatives merged into a single organisation called CR-Delta, which includes the national livestock recording system and a breeding division called Holland Genetics (<http://www.cr-delta.co.nl>). Out of this new structure, a national breeding program with rates of genetic gain as high as any in the world has been developed. As a result, the Dutch dairy industry has become a net exporter of dairy semen.

The beef and sheep industries around the world are characterised by large numbers of small- to medium- sized business enterprises and, typically, a 2-3 tier breeding structure with the herds/flocks controlling genetic progress across the industry located in the top tier. In most countries, including Australia and New Zealand, the number of genetically influential breeding herds and flocks is still relatively large and there is a wide spectrum of attitudes to modern breeding technology adoption. There is some vertical integration of breeder and commercial enterprises, which in some cases extends to processors and marketers of their meat and fibre products. There is also some group-breeding-scheme activity. But for the majority of sheep and beef cattle breeds, the norm is independent entrepreneurial breeders seeking to sell breeding males to the commercial and/or multiplier sector. The availability of new and comprehensive genetic improvement schemes, such as SIL, does not guarantee that these services will be used effectively by the majority of breeders. Provision by such schemes of breeding objectives customised for individual breeders may increase uptake. In Australia the incorrect perception that Woolplan was forcing breeders to accept a very limited range of scientist-determined breeding objectives for Merino sheep is said to have contributed to its reduced industry acceptance.

The task is to convince the majority of the top-tier breeders to adopt and effectively utilise modern performance recording and genetic evaluation technologies to increase the rate of genetic improvement in flock productivity by selecting for economically important traits. In western economies, coercion is not an option and incentives of various guises have been employed in different countries. In Australia, for the meat sheep sector, breeders cannot get within-flock estimated breeding values from LAMBPLAN. This reflects the high degree of pedigree linkage between flocks and a deliberate decision to improve clarity of market signals regarding genetic merit. For the Merino sector, the newly created Australian Sheep Genetics Agency (name not yet finalised) has been established to utilise a distributed national database to provide across flock estimated breeding values for a wide range of production traits in Merino sheep. Initially, it may also provide within-flock estimated breeding values where appropriate genetic links do not exist, but they will be badged differently to

distinguish them from the national across-flock estimated breeding values. The availability and effective utilisation of across-flock and across-breed estimated breeding values for meat sheep breeds in Australia has led to increased rates of genetic gain and to increased semen sales from elite rams (Ball, 2001). It remains to be seen whether the LAMBPLAN experience is mirrored in the Merino industry when national across-flock estimated breeding values become available through the Australian Sheep Genetics Agency.

In New Zealand, across-flock estimated breeding values are available for some groups of breeders, but they are not universally available across the ram breeding sectors within or across the breeds in the dual-purpose, terminal-sire and fine-wool sections of the industry. The ram breeders are competing to sell flock rams or semen to clients who do not have widespread access to reliable across-flock or across-breed estimated breeding values and who may not have ready access to sheep breeding extension advice. The SIL infrastructure is available to ensure that rapid rates of genetic progress can be achieved by ram breeders if they performance record, take advantage of the SIL system for genetic evaluation and select for economically important traits. Providing the commercial sector with reliable across-flock or across-breed estimated breeding values to facilitate choice of the best genetics for their individual enterprises may be the way to increase rates of genetic gain across the whole industry.

Systems of selection and mating

The SIL system utilises all of the latest BLUP genetic evaluation tools to provide high-quality estimated breeding values and selection indexes for ram breeders. However, the use of BLUP technology to estimate breeding values does not identify the optimal animals to select and mate in order to maximise rates of genetic gain while holding rates of inbreeding to specified desired levels. Optimal systems of selection and mate allocation have been developed in recent years using algebraic solutions (Meuwissen, 1997) and dynamic tactical decision systems (Kinghorn *et al.*, 2002). Dynamic tactical decision systems for animal breeding applications provide mate allocation procedures which seek to optimise predicted progeny performance one or more generations down the track. Since they focus on desired outcomes, they need to be set up and evaluated in direct consultation with the breeders involved. This interaction gives the breeders greater ownership of the outcomes and assists in recognising and dealing with the impacts of the many practical issues that must be considered in the design and implementation of an effective breeding program. The end result is a table of suggested selection and mating plans which can take account of a range of issues including:

- alternative trait value weightings
- threshold traits and threshold limits to progress in particular traits
- time scale of selection goals
- breeding value accuracies
- breed effects and heterosis

- effects of inbreeding
- value of indicator traits
- multi-stage selection
- introductions from outside flocks
- extended use of individuals as parents

DNA pedigreeing, marker-assisted selection and e-sheep

The advent of DNA pedigreeing, electronic eartags and computer-based recording has the potential to increase rates of adoption of performance recording and to increase the availability of pedigree records. If adopted widely, these developments could lead to greater rates of genetic progress through the involvement of a higher proportion of the ram breeding nucleus in advanced breeding programs and through more accurate genetic evaluations based on the DNA pedigree information. Widespread adoption of electronic ear tags and computer-based recording systems by commercial flocks may provide large volumes of data which could add to the accuracy of across flock evaluation.

In Australia and New Zealand, there is substantial investment occurring in the process of mapping and discovering the functions of genes underlying the variation in traits of economic importance. Results are beginning to be discussed and it is clear, that for many traits of economic importance, there are genes (commonly called Quantitative Trait Loci or QTL) with moderate to large effects (0.3 – 1.0 phenotypic standard deviations) being discovered in QTL mapping experiments. Such QTL can be used in Marker-Assisted (MAS) or Genotype-Assisted (GAS) Selection programs which combine molecular and quantitative genetic approaches to increase rates of genetic gain through increased accuracy of genotype evaluation. The investment in mapping the QTL in Australia and New Zealand has been considerable and the investment to discover the corresponding actual genes and their function will be at least of the same order. Investment in these molecular genetics and genomics activities comes at the expense of investment in other aspects of genetic improvement programs and hard decisions have to be made on achieving the appropriate balance.

CONCLUSIONS

SIL is an advanced system for performance recording and genotype evaluation. Used effectively by ram breeders, it creates the potential to achieve rates of genetic gain for breeding objectives incorporating economically important traits, of at least 2% *pa*.

Ways of maximising the proportion of the nucleus sector utilising the SIL system to achieve high rates of genetic gain for economically based breeding objectives, need to be pursued. The advent of dynamic tactical decision systems, DNA pedigree technology, electronic tagging, computer-based recording systems and of molecular markers for traits that are difficult to improve using standard quantitative genetics approaches, should contribute to this outcome.

Ways of maximising the availability to the commercial sector of rams whose genetic merit can be directly

compared from flock to flock and perhaps from breed to breed within the broad, dual-purpose, terminal-sire and fine-wool groupings also need to be investigated if gains in the nucleus sector are to be translated into productivity gains for the New Zealand sheep industry as a whole.

ACKNOWLEDGEMENTS

LRP is grateful to the New Zealand Society of Animal Production for the opportunity to attend its annual meeting and to participate in the discussions of this vitally important area. The authors are also grateful to a number of people who have helped with ideas for this paper. The mistakes are our responsibility.

REFERENCES

- Ball, A. 2001: Technologies that drive Australian ram breeding businesses. *Proceedings of sheep farmer conferences held in conjunction with the 14th conference of the Association for the Advancement of Animal Breeding and Genetics, Queenstown, New Zealand, July-August 2001*. pp5-9
- Davison, R.M. 2000: Genetic improvement and importance to sheep and beef farming. *Proceedings of the New Zealand Society of Animal Production 60*: 184-188
- Garrick, D.J.; Blair, H.T.; Clarke, J.N. 2000: Sheep industry structure and genetic improvement. *Proceedings of the New Zealand Society of Animal Production 60*: 175-179
- Geenty, K.G. 2000: Sheep industry vision and SIL. *Proceedings of the New Zealand Society of Animal Production 60*: 180-183
- Kinghorn, B.P.; Meszaros, S.A.; Vagg, R.D. 2002: Dynamic tactical decision systems for animal breeding. *Proceeding of the 7th world congress on genetics applied to livestock production. Communication No. 23-07*
- Meuwissen, T. 1997: Maximising the response of selection with a pre-defined rate of inbreeding. *Journal of animal science 75*: 934-940
- Newman, S.A.; Dodds, K.G.; Clarke, J.N.; Garrick, D.J.; McEwan, J.C. 2000: The Sheep Improvement Limited (SIL) genetic engine. *Proceedings of the New Zealand Society of Animal Production 60*: 195-197
- Piper, L.R.; Swan, A.A. 1999: Measurement can be used to increase profit in commercial fine wool flocks. *Merinotech Australia news 4*: 3-4