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# BRIEF COMMUNICATION: Genetic evaluation for milking performance in a large flock of milking sheep in New Zealand

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## Introduction

Over the last two decades, the New Zealand sheep industry's traditional exports have been under continuing competitive pressure for land, capital, and talent from the dairy cattle industry. In response to the underlying growing global demand for dairy products, a number of sheep enterprises commenced the development of sheep milking and processing operations over the last decade. One of the goals of the emerging New Zealand milking-sheep industry is to grow export receipts from sheep dairy products to over $200 million by 2030. One way to achieve this goal is to improve the genetic merit of animals for milk production, which requires a system of genetic evaluation and a selection programme to identify parents of future generations. The purpose of this report is to describe the early stages of a milking – sheep genetic-improvement programme.

## Materials and methods

This report describes the farm system, structure, and early progress in the Blue River Dairy Limited Partnership (Blue River) dairy-sheep genetic improvement programme. Blue River, which commenced operations in 2004, is a fully integrated large-scale sheep-milking, processing, and marketing enterprise based in and near Invercargill, Southland (McMillan et al. 2014).

Animal numbers expanded rapidly from a base of 2,500 ewes, with minimal culling of ewes for dairying performance to date. Many ewes are East Friesian cross, although their true breed composition is unknown and pedigree information, although limited, is growing. Most rams are home-bred East Friesian cross with a proportion of purchased straight-bred East Friesians. Until recently, there has been no selection for dairying performance in rams.

Ewes mate to lamb first between 14- and 20-months of age, and lambing takes place all-year-round following synchronised mating. Daily milk recording commenced in June 2009 and the analysis comprises over 8 million daily milk records in 26,603 ewes. Animals are usually withdrawn from milking when 7-10 day average daily milk yield is between 0.2 and 0.3 litres. However, animals may be withdrawn at higher daily milk yields for management reasons unrelated to milk production. This occurs more frequently for animals that are more than 5-6-months into their lactations. The main culling criteria for ewes include low milk production due to very short lactation length, failure to lamb, and unsatisfactory animal health. This report relates to data recorded from June 2009 to 31 January 2014 for lactation length, and milk yield to day 180 of lactation (MY180). The analysis includes daily milk records between 0.10 and 5.0 litres (less than 3% of daily records excluded) in all ewes, and excludes the limited data beyond day 210 of lactation.

Estimated breeding values (BV) for accumulated yield of milk to day 210 is the sum of daily values. BV for daily yield of milk is from a random regression test-day model including:

- Fixed effect of contemporary group defined as the group of ewes lambing in the same year, flock, and month of lambing.
- Fixed effect of age at lambing measured in semesters.
- Fixed effect of suckling period. Some ewes suckled lambs for some days before commencing milking.
- Fixed effect of the number of lambs present at pregnancy scanning.
- Fixed effect of day of lactation modelled with a Legendre polynomial of order 3.
- Random effect of additive genetic effect of an individual ewe for each day of the lactation modelled with a Legendre polynomial of order 3.
- Random effect of permanent environment of ewe for each day of the lactation modelled with a Legendre polynomial of order 3
- Residual or temporary environmental effects with heterogeneous variance, with different residual variance for each of the 7 months of lactation.

Breeding value for lactation length is from a mixed model including the fixed effects of contemporary group, lactation number, and age at lambing, and the random effects of animal additive genetic and permanent environmental ewe effects and residual effects. Mean BV is arbitrarily set at zero.

Within the ram breeding flock of up to 800 autumn-mated ewes, the genetic index for selection of sires and dams of sires includes a prototype index arbitrarily combining MY180 and lactation length. Sire and dam parentage verification in the ram breeding flock is through DNA analysis, with no parentage recording in the remaining ewes.

The 2009- and 2010-born rams are sons of a random cohort of high-index ewes lambing in the spring, but their sires are unknown. The highest index rams mated selected high-index ewes in autumns 2012-2014 to generate future sires. Most of the high-index ram-fathers mated to selected high-index ewes in autumn 2013 and 2014 were born in 2012 and 2013, respectively.

## Results

Considerable variation exists in BV for lactation length and MY180 in ewes (Figure 1). Ninety per cent of lactation length BVs are between -61 and +48 days, and respective values for MY180 are -46 and +57 litres. The correlation between lactation length and MY180 BV is low and positive (r-squared = 0.24, P<0.001). Mean lactation length and MY180 BV for the 100 highest-ranked ewes based solely on lactation length are +137 days and +23 litres, respectively. Mean lactation length and MY180 BV for the 100 highest-ranked ewes based solely on MY180 are +29 days and +121 litres, respectively.

Annual increases in mean (± standard error of mean) lactation length and MY180 BV in rams born in the nucleus are 3.1 ± 0.63 days (P<0.05) and 9.3 ± 0.84 litres (P<0.001), respectively (Table 1). Mean lactation length and MY180 BVs for ram fathers mated in 2014 are +22 days, and +60 litres, respectively.

**Figure 1** Distribution of estimated breeding values, between -110 and +10 litres, for cumulative milk yield to day 180 of lactation (MY180). Mean estimated breeding value = 0 litres, N=26,603 ewes.

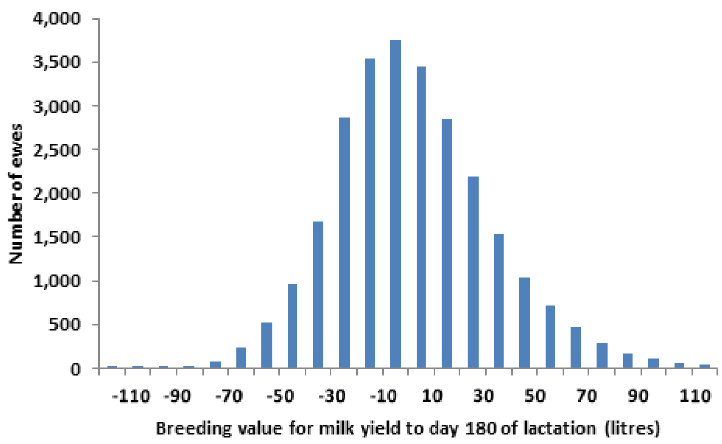


**Table 1** Lactation length and 180-day milk yield estimated breeding values (BV) in rams born from 2009-2014. Annual (± standard error of mean) increases in mean lactation length and 180-day milk yield BV in rams born between 2009 and 2014[1] are 3.1 ± 0.63 days (P<0.01) and 9.3 ± 0.84 litres (P<0.001), respectively (P<0.001).

| Birth Year | Number of rams | Lactation Length BV (days) | 180-Day Milk Yield BV (litres) |
|---|---|---|---|
| 2009 | 203 | 12 | 22 |
| 2010 | 147 | 15 | 31 |
| 2012 | 307 | 22 | 41 |
| 2013 | 383 | 22 | 54 |
| 2014[1] | 250 | 27 | 63 |

[1] Provisional at mating time based on mid-parent BV

## Discussion

The results demonstrate highly promising early genetic progress in rams, especially for MY180 where annual gain to date is 30% of the standard deviation for BV MY180. There are a number of rams with a BV exceeding +100 litres, as well as ewes approaching +200 litres. This small group of high-genetic-merit ewes and rams will support high annual genetic progress in the ram-father and ram mother pathways. Over the next few years, continuing annual increases in the numbers of animals with pedigree information will likely support higher future rates of genetic gain, as will the expansion in animals and flocks in the programme.

At this early stage, progress in the main ewe flock is somewhat limited by synchronised mating requiring a 10% ram to ewe ratio, and a lack of sufficient numbers of high-index ram fathers. This in turn requires more ram-mothers, ram-fathers, and therefore lower selection intensities, leading to lower rates of genetic gain. This situation will change over the next year or two with the generation of more high-index ram fathers. Nevertheless, the continued use of a 10% ram to ewe ratio will limit genetic progress in the main ewe flock.

The low correlation between lactation length and MY180 BVs is consistent with the published report of a low genetic correlation between the two traits (El-Saied et al., 1998), suggesting minimal progress in MY180 when selecting on lactation length, and vice versa.

On-going developments include progeny testing dairy-cross and straight-bred East Friesian rams, which commenced in 2013. Genetic linkages across flocks commenced in 2014, with extension to across-country linkages planned in the future. Of importance amongst additional traits for consideration at this stage is live weight, to allow for selection of biologically efficient parents. Given the high imperative to increase milk yield per lactation, it is unlikely that milk composition traits will be included in the short term. Other traits for future consideration include once-a-day milk yield, somatic cell counts, and udder characteristics. Further developments include an economic index, which will require construction of a bio-economic model and economic weights, as well as estimating genetic correlations between important traits. Finally, a low-cost, simple, and minimally invasive system for artificial insemination is required to facilitate progeny testing, genetic linkage of flocks, and widespread dissemination of proven sires.

In summary, a breeding programme for the emerging New Zealand sheep-milking industry is underway, early estimates of genetic merit are promising, and there is potential to increase substantially the rate of genetic gain.

## Acknowledgements

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