
VOLUME 62 2002

Genetic and phenotypic relationships among flystrike indicator traits in the Earnscleugh stud Merino flock

DR Scobie[a]*, SM Hickey[b], AK Campbell[c] and DP Maslen[d]

[a]AgResearch, Lincoln, Private Bag 4749, Christchurch 8140, New Zealand; [b]AgResearch, Ruakura Research Centre, Private Bag 3123, Hamilton 3240, New Zealand; [c]Earnscleugh Station, RD 1, Alexandra 9320, New Zealand; [d]The New Zealand Merino Company Limited, PO Box 25-160, Christchurch 8024, New Zealand
**Corresponding author. Email: scobie@agresearch.co.nz*

Abstract

Increases in breech wrinkles, breech cover and dags have been shown to increase flystrike susceptibility of Merino sheep. At shearing at approximately 320 days of age in 2007, 2008 and 2009, breech wrinkle (1 to 5), dag score (1 to 5) and breech cover (1 to 5) were scored on 736, 806 and 866 yearlings that were the progeny of 31, 38 and 36 sires respectively. It was hypothesised that flystrike would become worse with an increasing score, where 5 indicated a very wrinkly, very daggy or very woolly breech. Fleece weight was recorded at shearing and fleece midside samples were collected and measured for washing yield. Breech wrinkle score ($h^2 = 0.25 \pm 0.07$), breech cover ($h^2 = 0.33 \pm 0.08$) and dag score ($h^2 = 0.10 \pm 0.04$) were found to be heritable. Breech wrinkle score and breech cover were phenotypically (0.39 ± 0.02, $P < 0.05$) and genetically correlated (0.40 ± 0.16, $P < 0.05$). Clean fleece weight was heritable ($h^2 = 0.33 \pm 0.06$) and showed a strong significant negative genetic correlation (-0.52 ± 0.14, $P < 0.001$) with breech cover. There was no evidence of flystrike during the three years of investigation, but this stud could decrease susceptibility by decreasing breech cover, breech wrinkles and dag score.

Keywords: ribby pelts; body wrinkle; breech strike; dags

Introduction

Recent literature reports have shown that susceptibility to flystrike increases with increasing severity of wrinkles on the breech of Merino sheep (James 2006; Greeff & Karlsson 2009; Scholtz et al. 2010a, b; Smith et al. 2009). Increasing dag score has also been found to increase the risk of flystrike in many breeds of sheep and in a number of environments (Leathwick & Atkinson 1995; 1996; James 2006; Scobie et al. 2002). Scobie et al. (2008) discovered that inherited breech bareness can reduce the formation of dags and Scobie & O'Connell (2010) showed these two factors could reduce the risk of flystrike. The relationship between these risk traits and flystrike have been confirmed in recent reports from Australia (Greeff & Karlsson, 2009; Smith et al. 2009). Scobie et al. (2011) reported the genetic and phenotypic relationships between flystrike risk traits and production traits from the Awapiri stud flock in Marlborough. The current report uses information from the Earnscleugh stud flock in Central Otago, to investigate these relationships in a different environment during a three year period, concurrent with the Marlborough study.

Methods

A flock of stud Merino sheep at Earnscleugh Station in Central Otago was observed across a three year period. Ewes were single-sire mated each year to 31 sires in 2007, 38 in 2008 and 36 in 2009. Across the three years, six sires were used for three years and nine others were used in two consecutive years. Lambs were identified to sire group by tagging at tail docking. Only ram lambs were recorded and measured in this flock. The number of male progeny from each sire varied from two to122 due to variable numbers of ewes mated to each sire. Small progeny groups either resulted from artificial insemination, or from 'back-up' sires. A total of 736 male progeny were recorded in 2007, 806 in 2008 and 866 in 2009. Pedigree was established from stud records. There were five major sub-flocks within this flock, which were based on fibre diameter groupings to satisfy a range of ram buying clients. Breeding stock frequently transfer between these sub-flocks on the basis of measured fibre diameter, such that the overall flock was strongly interrelated.

The progeny were not shorn as lambs but were first shorn at approximately 320 days of age when they were carrying more than 10 months of wool growth. The fleeces were weighed and fleece samples were taken and measured for fibre diameter, washing yield, staple length and staple strength.

Breech cover score, breech wrinkle score and dag score of the progeny were recorded at shearing using the methods described in Scobie et al. (2011). A breech cover score of 5 was given to a breech with wool growing in close proximity to the anus and a score of 1 indicated a considerable area of bare skin around the anal area. Note this is the opposite of breech bareness score reported in other publications (Scobie et al. 2007; Scobie et al. 2008; Scobie & O'Connell 2010). A breech wrinkle score of 1 was given to an animal with no evidence of skin wrinkling and a score of 5 to an animal that was excessively covered in wrinkles around the breech.

Table 1 Numbers of singles, twins and triplets in each breech wrinkle score group (Wrinkle score), their average dag score (Dag score) and breech cover score (Breech cover) when shorn at approximately 320 days of age. Standard deviations of dag score and breech cover within wrinkle score groupings are provided and were calculated from the raw data.

Wrinkle score	Birth rank			Dag score	Breech cover
	Single	Twin	Triplet		
1	73	191	6	1.1 ± 0.4	3.5 ± 0.8
2	297	409	14	1.4 ± 0.7	4.1 ± 0.8
3	414	395	5	1.7 ± 1.0	4.5 ± 0.7
4	124	81		1.6 ± 1.0	4.6 ± 0.6
5	19	9		1.5 ± 0.9	4.7 ± 0.6
Total	927	1,085	25		

Dag score of the progeny was also recorded at shearing according to a five point scale. A score of 1 was given to an animal with no dags, while a score of 5 was recorded for animals extensively covered in dags (Australian Wool Innovation 2007).

No animals were flystruck in this stud flock during the three year period of observations.

Heritability, as well as genetic and phenotypic correlations were estimated for clean fleece weight, fibre diameter, breech wrinkle score, breech cover score and dag score using animal-model restricted maximum likelihood (REML) procedures (Gilmour et al. 2009) with a relationship matrix including three generations of pedigree information. The fixed effects were sub-flock, birth year, mob within birth year, and birth rank (1–3). Heritabilities and correlations were obtained from a five-trait REML analysis.

An analysis of covariance was conducted to determine the effect of increasing wrinkle score on wool quality traits such as fibre diameter, staple length and staple strength. Wrinkle scores 4 and 5 were pooled for this covariance analysis.

Results

The numbers of yearlings in each breech wrinkle score at shearing are shown in Table 1 and divided on the basis of birth rank. The greatest proportion were recorded with a breech wrinkle score of 3, with very few recorded in score 5. A greater proportion of twins were recorded as having wrinkle scores of 1 or 2, while those with wrinkle scores of 3, 4 and 5 were more commonly singles. A total of 25 lambs were born as triplets with all triplets having a wrinkle score of 3 or less.

Mean breech cover score and dag score at shearing are also shown in Table 1. Although mean dag score was very low, animals with a wrinkle score of 3, 4 or 5 had significantly more dags ($P < 0.001$). Mean breech cover on the other hand was relatively high in this flock, indicating woolly breeches, but animals with less wrinkles had significantly barer breeches ($P < 0.001$).

Fleece weight and wool quality traits are presented in Table 2. Sheep with the most wrinkles about the breech produced 870 grams more greasy fleece than those with no wrinkles. However, washing yield was lower in groups with greater wrinkle score and thus the group with wrinkle score of 5 produced only 450 grams more clean wool. The animals without wrinkles had longer staples ($P < 0.001$) that were stronger ($P < 0.001$). Staple length was found to increase slightly ($P < 0.001$) with increasing fibre diameter at 1.4 mm per 1 µm change in diameter, whereas a one kilogram increase in clean fleece weight was accompanied by a 10.5 mm increase in length ($P < 0.001$). The sub-flocks were significantly different in fibre diameter ($P = 0.003$), but there was no significant difference in diameter between wrinkle score groupings within sub-flocks.

Estimates of the genetic parameters are presented in Table 3. Breech cover and wrinkle score were moderately heritable in this flock while dag score was poorly heritable. Breech cover increased as wrinkle score increased both genetically (0.40 ± 0.16) and phenotypically (0.39 ± 0.02). Clean fleece weight was genetically (-0.52 ± 0.14) and phenotypically (-0.14) correlated with breech cover. Increasing breech cover was associated with increasing dag score both genetically (0.26 ± 0.02) and phenotypically (0.34 ± 0.22).

Fibre diameter was highly heritable in this flock (0.69 ± 0.09). There was a significant genetic correlation between fibre diameter and breech cover (-0.36 ± 0.14), but not between fibre diameter and wrinkle score or fibre diameter and dag score. There was a strong positive phenotypic correlation between clean fleece weight and fibre diameter (0.33 ± 0.02). These traits were also genetically correlated (0.46 ± 0.11).

Discussion

The estimated heritability of breech wrinkle score in the Earnscleugh stud flock in central Otago (0.33 ± 0.08) was lower than that reported by Scobie et al. (2011) for the Awapiri flock in Marlborough (0.51 ± 0.11). Indeed, this estimate is lower than international

Table 2 Number of progeny (n) and mean ± standard deviation, by breech wrinkle score (Wrinkle score) for greasy fleece weight (GFW), washing yield (Yield), clean fleece weight (CFW), fibre diameter (FD), staple length (Length) and staple strength (Strength) of wool at yearling shearing.

Wrinkle score	n	GFW (kg)	Yield (%)	CFW (kg)	FD (µm)	Length (mm)	Strength (N/ktex)
1	270	3.3 ± 0.7	72 ± 4	2.4 ± 0.5	16.4 ± 1.8	80 ± 12	44.9 ± 11.8
2	720	3.4 ± 0.8	72 ± 5	2.4 ± 0.6	15.7 ± 1.6	77 ± 12	43.6 ± 12.5
3	814	3.5 ± 1.0	71 ± 4	2.5 ± 0.7	15.4 ± 1.6	73 ± 15	39.2 ± 12.7
4	205	3.9 ± 1.1	70 ± 5	2.7 ± 0.8	15.6 ± 1.7	70 ± 16	35.5 ± 11.6
5	28	4.2 ± 1.0	68 ± 5	2.8 ± 0.7	16.2 ± 1.6	67 ± 14	36.3 ± 9.9

Table 3 Heritability estimates ± standard error (in bold) and correlations ± standard error of production traits, clean fleece weight (CFW) and fibre diameter (FD), with flystrike indicator traits of breech cover score (Breech cover), breech wrinkle score (Wrinkle score) and dag score (Dag score). Phenotypic correlations are above the diagonal and genetic correlations below the diagonal.

Trait	CFW	FD	Breech cover	Wrinkle score	Dag score
CFW	**0.33 ± 0.06**	0.33 ± 0.02	-0.16 ± 0.02	0.03 ± 0.02	-0.11 ± 0.02
FD	0.46 ± 0.11	**0.69 ± 0.09**	-0.15 ± 0.03	-0.04 ± 0.03	-0.06 ± 0.02
Breech cover	-0.52 ± 0.14	-0.36 ± 0.14	**0.33 ± 0.08**	0.39 ± 0.02	0.26 ± 0.02
Wrinkle score	0.14 ± 0.18	-0.27 ± 0.17	0.40 ± 0.16	**0.25 ± 0.07**	0.29 ± 0.02
Dag score	-0.09 ± 0.23	0.01 ± 0.22	0.34 ± 0.22	0.05 ± 0.25	**0.10 ± 0.04**

reports which range from 0.36 to 0.69 (Greeff et al. 2009, Smith et al. 2009; Scholtz et al. 2010a; Brown et al. 2010b). The current estimate was similar to that reported for ribby pelts (0.34 ± 0.18), which are caused by wrinkles on the body and breech of slaughtered lambs (Scobie et al. 2005a). Ribby pelts incur price penalties (Scobie et al. 2005a), while other factors such as longer time taken to shear wrinkly sheep (Scobie et al. 2005b) and slower growth rates of wrinkly yearlings (Scobie et al. 2011) contribute to lower production or higher costs associated with wrinkly sheep. Selection against breech wrinkles would therefore seem wise in the flock studied here, regardless of the lack of flystrike challenge.

The heritability of dag score was estimated to be low (0.10 ± 0.04) in the flock at Earnscleugh. Scobie et al. (2011) reported a similarly low estimate for the Awapiri flock (0.08 ± 0.07) and suggested that this may be a consequence of very few daggy animals. Although the proportions of animals with dag scores of 3, 4 or 5 were small at Earnscleugh, there were still reasonable numbers due to the size of the flock. Smith et al. (2009) gave a similar estimate (0.09 ± 0.06) for a flock in Armidale, New South Wales. Greeff & Karlsson (2009) on the other hand reported a much higher estimate (0.55 ± 0.30) from Western Australia. Given the two low estimates for Merinos in New Zealand, less emphasis on selection against dag score is suggested.

It is not surprising that there were significant differences between interrelated sub-flocks for fibre diameter. This stud has a range of clients who demand rams across a range of fibre diameters. The 'Poll' sub-flock, reflects the impact of some recently introduced genotypes from Australia to get rid of horns. These have brought with them slightly higher fibre diameter (16.7 µm), than in the 'Fine' (16.3 µm), 'Superfine' (15.2 µm) and two 'Ultrafine' (14.2 and 13.8 µm) sub-flocks. Though not statistically significant, the 'Poll' sub-flock had less wrinkles with a mean score 2.1 ± 0.8, than all other sub-flocks of between 2.6 ± 0.7 and 2.8± 0.7.

The present report only includes information from ram lambs that survived to shearing at 320 days. No data were collected on the total number of lambs born or the number of ewes present at joining and lambing. Table 1 indicates that triplets and twins made up a greater proportion of the groups with low wrinkle score. This was also noted in the Awapiri flock (Scobie et al. 2011) and previously reported in New Zealand Merinos by Scobie et al. (2005a). South African Merinos selected for increased fertility were less likely to be flystruck on the breech than a line selected for reduced fertility run in the same flock (Scholtz et al. 2010a). An analysis of litter size data from the Earnscleugh flock in conjunction with wrinkle score would be interesting, because greater fertility and lower flystrike risk would be good reasons to select against wrinkles.

The genetic and phenotypic correlations reported here suggest that increasing breech wrinkle score is not associated with increasing clean fleece weight. This was also noted in the Awapiri flock (Scobie et al. 2011). This is quite the opposite of the beliefs of Merino breeders. Considering the fact that animals without wrinkles were more likely to have been born a twin, and twins produce less wool as yearlings than those born as singles (Scobie et al. 2011), we begin to see where breeders may have been misled. Wrinkly singles tend to produce more wool, and though not reported for Earnscleugh, also had heavier live weights at Awapiri. In the absence of information on birth rank or rearing rank, selection probably favoured bigger sheep with heavier fleeces, without acknowledging the potential for lower fertility and more wrinkles.

Favourable genetic and phenotypic correlations were observed between all the traits which reduce flystrike risk, with the exception that breech wrinkle score and dag score were not genetically correlated. In practice, Earnscleugh should be able to select for decreased wrinkle score, decreased breech cover or greater breech bareness, and reduced dag score without detrimental interactions between these traits. With regard to production traits, breech cover was favourably correlated with clean fleece weight because barer breeches were associated with greater fleece weights, however there will likely be some detrimental effect on fibre diameter, due to the negative association with breech cover. The improvement of length and strength of the wool produced from animals with lower wrinkle scores (Table 2) provides more compelling evidence to select for plain bodied sheep.

Although no flystrike was observed on Earnscleugh, these traits will more than likely improve the flystrike resistance of sheep in the flocks of their ram buying clients. This will probably improve the proportion of twin lambs weaned.

Acknowledgements

The Ministry of Agriculture and Forestry supported this work through the Sustainable Farming Fund. Merino New Zealand Incorporated and Jon Manhire are acknowledged for sourcing this funding. The assistance of the Campbell family from Earnscleugh in collecting the data is gratefully acknowledged. Chikako van Koten was very helpful with the biometrical analysis.

References

Australian Wool Innovation 2007. Visual sheep scores. Australian Wool Innovation Ltd, Sydney, NSW, Australia. 56 pp. http://images.wool.com/pub/Visual_Sheep_Scores.pdf [Accessed 29 March 2012]

Brown DJ, Swan AA, Gill JS 2010. Within- and across-flock genetic relationships for breech flystrike resistance indicator traits. Animal Production Science 50: 1060–1068.

Gilmour AR, Gogel BJ, Cullis BR, and Thompson, R 2009. ASReml User Guide Release 3.0, Hemel Hempstead, VSN International. www.vsni.co.uk

Greeff JC, Karlsson LJE 2009. Opportunities to breed for resistance to breech strike in Merino sheep in a Mediterranean environment. Proceedings of the Association for the Advancement of Animal Breeding and Genetics 18: 272–278.

James PJ 2006. Genetic alternatives to mulesing and tail docking in sheep: a review. Australian Journal of Experimental Agriculture 46: 1–18.

Leathwick DM, Atkinson DS 1995. Dagginess and flystrike in lambs grazed on *Lotus corniculatus* or ryegrass. Proceedings of the New Zealand Society of Animal Production 55: 196–198.

Leathwick DM, Atkinson DS. 1996. Influence of different proportions of *Lotus corniculatus* in the diet of lambs on dags, flystrike and animal performance. Proceedings of the New Zealand Society of Animal Production 56: 99–102.

Scholtz AJ, Cloete SWP, van Wyk JB, Kruger ACM, de K van der Linde TC 2010a. Influence of divergent selection for reproduction on the occurrence of breech strike in mature merino ewes. Animal Production Science 50: 203–209.

Scholtz AJ, Cloete SWP, van Wyk JB, Misztal I, du Toit E, de K van der Linde TC 2010b. Genetic (co)variances between wrinkle score and absence of breech strike in mulesed and unmulesed Merino sheep, using a threshold model. Animal Production Science 50: 210–218.

Scobie DR, O'Connell D, Bray AR, Cunningham P 2002. Breech strike can be reduced by increased area of naturally bare skin around the perineum of lambs. Proceedings of the Australian Society of Animal Production 24: 201–204.

Scobie DR, Young SR, O'Connell D, Eythorsdottir E 2005a. Skin wrinkles of the sire adversely affect Merino and Halfbred pelt characteristics and other production traits. Australian Journal of Experimental Agriculture 45: 1551–1557.

Scobie DR, Young SR, O'Connell D, Gurteen S 2005b. Skin wrinkles affect wool characteristics and the time taken to harvest wool from Merino and Halfbred sheep. New Zealand Journal of Agricultural Research 48: 177–185.

Scobie DR, O'Connell D, Morris CA, Hickey SM 2007. A preliminary genetic analysis of breech and tail traits with the aim of improving the welfare of sheep. Australian Journal of Agricultural Research 58: 161–167.

Scobie DR, O'Connell D, Morris CA, Hickey SM. 2008. Dag score is negatively correlated with breech bareness score of sheep. Australian Journal of Experimental Agriculture 48: 999–1003.

Scobie DR, O'Connell D 2010. Breech bareness reduces flystrike in New Zealand crossbred sheep. Animal Production Science 50: 599–602.

Scobie DR, Hickey SM; Maslen DP, Black GM. 2011. Heritability of flystrike indicator traits in a stud Merino flock. Proceedings of the New Zealand Society of Animal Production 71: 251–256.

Smith JL, Brewer HG, Dyall T 2009. Heritability and phenotypic correlations for breech strike and breech strike resistance indicators in Merinos. Proceedings of the Association for the Advancement of Animal Breeding and Genetics 18: 334–337.