BREEDING FOR REDUCED BREECH FLYSTRIKE AS PART OF MULTI-TRAIT SELECTION

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SUMMARY

We predicted genetic gains for reducing breech flystrike incidence (FSI) based on selection using modified MERINOSELECT indexes. Predicted genetic reductions in FSI after 10 years of selection were larger when the heritability of the trait was moderate (as in a summer rainfall environment) than when a low heritability was assumed (as in a winter rainfall environment). The relative gains between flystrike incidence and fleece weight, fibre diameter and reproductive rate and their implications for Merino breeding programs are discussed.

INTRODUCTION

General consensus within the Australian wool industry is that breeding more resistant sheep will be a critical component of programs to control breech and tail strike in non-mulesed flocks as well as reducing the risk of strike in mulesed sheep. Since 2005, a major research program has been funded to identify optimal breeding strategies for reducing breech strike resistance. Selection lines for breech flystrike were established at two research stations, Mt Barker in WA, in a winter rainfall environment (Greeff and Karlsson 2009) and at CSIRO's Chiswick property, near Armidale, NSW, in a summer rainfall environment (Smith *et al.* 2009). Results have confirmed the presence of significant genetic variability amongst sheep in susceptibility to breech strike and also identified key indirect selection criteria for improving resistance, in particular scores of breech wrinkle, dag, breech cover and urine stain (Smith *et al.* 2009; Greeff *et al.* 2014). Earlier studies (Brown *et al.* 2010; Richards and Atkins 2010) predicted genetic gains from index selection with breech wrinkle score included in the breeding objective, as a proxy for breech flystrike incidence. This paper extends those earlier findings, by predicting genetic gains in breech flystrike incidence from selection using all available breech indicator traits of breech wrinkle, dag and breech cover scores for three different breech objectives within three different environments.

MATERIALS AND METHODS

Predictions of genetic gain from within flock selection were undertaken based on the 'MTINDEX' modelling program (van der Werf 2019), using a batch code written in R. Three breeding objectives were examined, by modifying the Dual Purpose (DP+), Fibre Production (FP+) and Merino Production (MP+) indexes available from MERINOSELECT (Sheep Genetics 2018). The modifications consisted of adding Flystrike incidence (FSI, strikes/ewe/year) as a formal trait to the breeding objective associated with each index. The modified indexes, DP+FSI, FP+FSI and MP+FSI target, respectively, medium wool/dual purpose, superfine/fine wool and fine/medium wool production systems, along with reduction in FSI. The effects of using a range of FSI economic values were examined, from $0 to -$240/strike/ewe/year, to include the likely large range in the associated costs of FSI to the sheep industry across Australia. Breeding program assumptions included a flock structure of 5 ewe and 3 ram age groups, a first joining at 18 months of age, a ratio of 1 ram mated to 50 ewes, 90% weaning rate, 48% of ewe hoggets retained for breeding, a death rate in mature ewes of 4% p.a., a 30% loss

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of variance under selection (Bulmer 1971) and that 65% of selection emphasis was placed on index scores. Genetic parameters used in predictions were from Sheep Genetics, supplemented by values from Hatcher and Preston (2017, 2018) and AWI project reports (Greeff *et al.* 2016; Smith 2016).

Full records of productivity traits and pedigrees were assumed as selection criteria, as well as records of breech wrinkle, dag and breech cover scores. Predictions were conducted for 3 different scenarios (i) moderate heritability (0.20) for FSI (ii) low heritability for FSI (0.10) and (iii) low heritability for FSI (0.10) but high heritability (0.30) for Dag Score.

RESULTS AND DISCUSSION

Genetic gains in FSI (Figure 1). Under conditions where breech flystrike has a moderate heritability (scenario i), predicted gains for FSI after 10 years of selection range from -0.02 to -0.03 (2% to 3%) to a maximum of -0.19 to -0.21 (19% to 21%) strikes/ewe/year, when the economic value for FSI is increased from 0 to -$240. These predicted gains are 3 to 5 times as large as those where heritability for FSI is low (scenario ii). Gains are slightly less for the FP+FSI index and slightly more for the MP+FSI index compared to gains from using the DP+FSI index. At the highest economic value, most (80%+) selection emphasis is placed on reducing FSI (details not shown). Predicted gains scenario iii (h^2 for FSI is low, but the h^2 for Dag Score is high) are no different to the predicted gains for scenario ii, so are not discussed further.

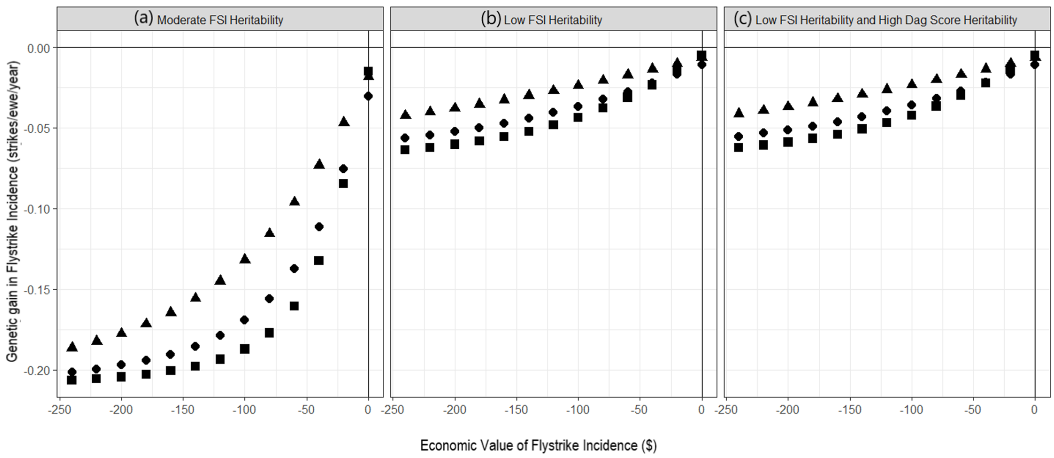

Figure 1. Predicted 10-year genetic gains in Flystrike Incidence (FSI, strikes/ewe/year) assuming (a) moderate FSI heritability (b) low FSI heritability and (c) low FSI heritability and high Dag Score heritability, with economic values from 0 to -$240 for FSI. Results are shown for 3 indexes, Dual Purpose+FSI (DP+FSI ●), Fibre Production+FSI (FP+FSI ▲) and Merino Production+FSI (MP+FSI ■)

When compared to breech flystrike incidence in unmulesed, crutched young sheep in a winter rainfall environment at Mt Barker, WA (from 4% to 9.5% or 0.04 to 0.095 strikes/ewe/year, Greeff *et al.* 2016) and at Chiswick, near Armidale, NSW in a summer rainfall environment (average of 18.1% or 0.181 in weaners and 7.6% or 0.076 in yearlings, Smith 2016), our predicted genetic gains suggest that after 10-15 years of index selection, FSI could be reduced in unmulesed sheep (of average genetic merit for FSI) to low levels (<0.02 or 2%) in average years, given sufficient selection emphasis is given to the trait. Reducing FSI to zero is almost impossible in all years as environmental (and possibly non-additive genetic) variation remains, despite selection effects to reduce incidence. Further, it is important to balance potential gains in reducing FSI with the predicted impact on genetic gains for other important traits, shown below.

Genetic gains in key production traits. Predicted genetic gains for Clean Fleece Weight (CFW), Fibre Diameter (FD) and the Number of Lambs Weaned/Ewe Joined (NLW) are listed in Tables 1 to 3, respectively, listed by economic value for FSI. With increasing economic value for FSI, gains in CFW decrease gradually when the heritability of FSI is low, but decrease more rapidly when the heritability of FSI is moderate, particularly for the DP+FSI and MP+FSI indexes. However, even for the largest economic value for FSI examined (-$240), genetic gains for CFW remain positive.

Table 1. Predicted genetic gain in Clean Fleece Weight (%) after 10 years of index selection, by economic value for Flystrike Incidence (FSI)

h^2 FSI/Index	Economic Value for FSI ($/strike/ewe/year)						
	0	-40	-80	-120	-160	-200	-240
Low h^2							
DP+FSI	2.69	2.50	2.27	2.03	1.80	1.59	1.39
FP+FSI	2.69	2.59	2.48	2.30	2.20	2.06	1.92
MP+FSI	6.04	5.58	4.92	4.22	3.59	3.06	2.63
Moderate h^2							
DP+FSI	2.69	2.07	1.46	1.01	0.70	0.48	0.32
FP+FSI	2.69	2.37	1.97	1.59	1.26	1.00	0.80
MP+FSI	6.04	4.34	2.77	1.84	1.29	0.92	0.67

Table 2. Predicted genetic gain in Fibre Diameter (μ) after 10 years of index selection, by economic value for Flystrike Incidence (FSI)

h^2 FSI/Index	Economic Value for FSI ($/strike/ewe/year)						
	0	-40	-80	-120	-160	-200	-240
Low h^2							
DP+FSI	0.01	-0.03	-0.07	-0.11	-0.14	-0.16	-0.18
FP+FSI	-0.78	-0.80	-0.81	-0.81	-0.81	-0.80	-0.79
MP+FSI	-0.36	-0.42	-0.44	-0.45	-0.44	-0.44	-0.43
Moderate h^2							
DP+FSI	0.01	-0.10	-0.17	-0.21	-0.23	-0.25	-0.26
FP+FSI	-0.78	-0.81	-0.79	-0.75	-0.70	-0.66	-0.62
MP+FSI	-0.36	-0.45	-0.43	-0.40	-0.38	-0.37	-0.36

When the heritability of FSI is moderate, there are small genetic reductions predicted in FD with increasing FSI economic value using the DP+FSI index of up to 0.26μ after 10 years of selection. There are also slightly lower genetic gains in FD with increasing FSI economic value using the FP+FSI index of up to 0.16μ. However, in general there is little impact predicted on genetic gains for FD when also selecting for reduced FSI as part of index selection. Predicted genetic gains for NLW when also selecting for reduced FSI are impacted much less than those for CFW. Relative to gains when FSI has no economic value, there are modest declines of up to a maximum of 31% in NLW gains using the MP+FSI index and up to 45% using the DP+FSI, at the largest economic value for FSI examined (when h^2 for FSI is moderate).

Table 3. Predicted genetic gain in the Number of Lambs Weaned/ewe after 10 years of index selection, listed by economic value for Flystrike Incidence (FSI)

h^2 FSI/Index		Economic Value for FSI ($/strike/ewe/year)						
		0	-40	-80	-120	-160	-200	-240
Low h^2	DP+FSI	0.08	0.08	0.08	0.07	0.07	0.07	0.06
	FP+FSI	0.02	0.02	0.02	0.02	0.03	0.03	0.03
	MP+FSI	0.04	0.04	0.04	0.04	0.04	0.04	0.04
Moderate h^2	DP+FSI	0.08	0.07	0.07	0.06	0.05	0.05	0.04
	FP+FSI	0.02	0.02	0.03	0.03	0.03	0.03	0.03
	MP+FSI	0.04	0.04	0.04	0.03	0.03	0.03	0.03

CONCLUSIONS

Useful reductions in breech flystrike from 0.05 to 0.08 strikes/ewe/year up to 0.19 to 0.21 strikes/ewe/year in a summer rainfall environment were predicted after 10 years of index selection for breeding objectives relevant to the Australian wool industry. For a winter rainfall environment in WA, with a lower heritability for FSI, smaller gains were predicted, from 0.01 to 0.02 up to 0.04 to 0.06 strikes/ewe/year. Predicted gains using a FP+FSI index were less than gains from using MP+FSI or DP+FSI indexes. It is unnecessary to use very high economic values for FSI to achieve significant reductions in the trait. For example, when the heritability for FSI is moderate and the trait is given an economic value of -$80, 62% of the highest genetic gain for FSI predicted (when the economic value is -$240) is obtained with the FP+FSI index, with higher gains of 78% and 86% being obtained with the DP+FSI and MP+FSI indexes, respectively. At that economic value for FSI (-$80), between 46% to 73% of the genetic gains for CFW and between 84% and 125% of the genetic gain for NLW are being retained, with no significant impact on gains in FD. In the absence of formally-derived economic values, -$80 for FSI appears to be a reasonable upper limit to use in Merino breeding programs to achieve a balance between genetically lowering flystrike incidence whilst obtaining competitive genetic gains in productivity traits as outlined above.

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