Response to genomic selection in the Scottish Blackface breeding programme

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Introduction The use of selection indices in the Scottish Blackface (SBF) breeding programme results in significant economic gains at farm and national levels (Amer *et al.*, 2007; Conington *et al.*, 2008). Recent developments in the ovine genome sequence have made dense marker panels available allowing for the prediction of genomic merit and the implementation of genomic selection (GS) in sheep. The prediction of genomic merit relies on establishing the associations between phenotypes and the dense marker panels in training populations. The aim of this study was to assess the impact on the response to selection of including genomic predictions in the SBF current breeding programme and in an alternative young ram programme considering different training population sizes.

Materials and methods Selection index theory was applied to predict the responses to selection for scenarios with and without the inclusion of genomic predictions. The breeding goal comprised lamb (carcass fat and lean weights and weaning weight) and maternal traits (mature size, litter weight weaned and litter size reared) and their economic values as reported by Conington *et al.* (2008). The recorded traits included the same maternal traits as in the breeding goal together with muscle and fat depths by ultrasound scanning and body weight at scanning. Phenotypic and genetic parameters were those used in the SBF national genetic evaluation (NGE). Breeding population parameters were calculated using the SBF NGE database. Two breeding program structures were considered: (i) the current breeding programme (CBP) in which young and older rams are used, and (ii) a young ram programme (YRP) which only included the new rams with no progeny information. Proportions of animals selected and generation intervals for rams and ewes are presented in Table 1. The effect of GS was considered by combining the conventional estimated breeding values (EBV) and the genomic EBV (GEBV) in the selection indices. The GEBV accuracies were calculated as a function of the heritabilities of the traits used in SBF NGE, the number of loci affecting the traits, the number of phenotypic records in the training population (TRP) and the effective population size (Ne) (Daetwyler *et al.* 2008; Goddard, 2009). In this study the effects of Ne of 300 and 500 animals and different training population sizes were evaluated. Genetic and phenotypic correlation matrices including EBVs and GEBVs were calculated based on the approach proposed by Dekkers (2007).

Results Table 1 shows the economic annual responses to GS in combination with the current strategy expressed relative to the response observed in the current program (£47/year/100 ewes). The decrease of the response in the YRP compared with the CBP can be explained by the lower accuracy of EBVs (due to less phenotypic information) but this is partially traded-off by the lower generation interval. The inclusion of GEBVs increased the responses in both CBP and YRP. For training populations of 3000 animals, the response in the YRP was very similar to the one achieved in the CBP. Larger training population sizes increase the responses and the rate of improvement depends on Ne and breeding programme structure. For a given Ne, a higher increase of the annual response was observed in the YRP with the rise in training population sizes. Higher accuracies of GEBV associated with larger training population sizes had a more significant impact on the total accuracies in the young rams because of the lower EBV accuracies compared to older rams. Although similar trends were observed for both Ne, the improvement rate of the economic response to GS was higher with a Ne of 300 animals.

Table 1 SBF breeding programme with and without genomic markers

Parameters		Current programme		Young ram programme	
Proportion selected		Rams, 0.04; Ewes, 0.50		Rams, 0.04; Ewes, 0.50	
Generation interval		Rams, 2.30; Ewes, 3.63		Rams, 1.50; Ewes, 3.63	
Relative economic annual response to selection (%)					
Method	TRP	Ne=300	Ne=500	Ne=300	Ne=500
EBV		100		87	
EBV	1000	101	100	94	91
+	2000	105	102	101	96
GEBV	3000	108	105	107	100
	4000	111	107	112	104
	5000	114	109	117	108

Conclusions The genetic improvement to farm profit by the inclusion of GS in the SBF CBP ranged between 1 to 14%. Proportionally greater increases were found with larger training populations. Optimising GS strategy should consider improved responses at national scale and training population costs, as well as the real undetermined SBF population size. Optimal genetic and economic responses using GS may imply the re-definition of breeding programmes.

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References

Amer, P.R., Nieuwhof, G.J. Pollot, G.E., Roughsedge, T. Conington, J. and Simm, G. 2007. Animal 1, 1-10.
Conington, J., Lambe, N., Amer, P., Bishop, S.C., McLean, K., Simm, G. and Bünger, L. 2008. Proceedings of BSAS, 21.
Daetwyler, H.D., Villanueva, B. and Woolliam, J.A. 2008. Plos One 10, 1-8.
Dekkers, J.C.M. 2007. Journal of Animal Breeding and Genetics 124, 331-341.
Goddard, M.E. 2009. Genetics 136, 245-257.

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