

Impact of the relative emphasis on growth and litter size in a maternal index for selecting sheep

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Tosh, J. J. and Wilton, J. W. 2004. **Impact of the relative emphasis on growth and litter size in a maternal index for selecting sheep.** *Can. J. Anim. Sci.* **84**: 713–715. Selection responses in sheep were predicted for a maternal index with different emphases on litter size and lamb growth to assess the need for correct economic values. Ratios of economic values for litter size relative to growth from 2 to 200 were tested. Genetic change per generation in market weight of lambs (1.75 to 0.03 kg) was sensitive, but genetic change per generation in number of lambs born (0.11 to 0.17) was practically independent of the economic values applied in the index.

Key words: Economic values, genetic improvement, maternal characteristics, selection, sheep

Tosh, J. J. et Wilton, J. W. 2004. **Impact de l'emphase relative accordée à la croissance et à la taille de la portée sur un indice maternel servant à la sélection des ovins.** *Can. J. Anim. Sci.* **84**: 713–715. Les auteurs ont prévu la réponse des ovins à la sélection grâce à un indice maternel mettant l'emphase de diverses façons sur la taille de la portée et la croissance des agneaux en vue d'établir la nécessité de valeurs économiques adéquates. Ils ont vérifié les ratios de la valeur économique pour la taille de la portée par rapport à la croissance situés entre 2 et 200. La variation génétique du poids de marché des agneaux par génération (de 1,75 à 0,03 kg) est sensible aux valeurs économiques de l'indice, mais la variation génétique du nombre d'agneaux dans la portée (de 0,11 à 0,17) ne l'est presque pas.

Mots clés: Valeurs économiques, amélioration génétique, caractères maternels, sélection, ovins

The Sheep Flock Improvement Program (SFIP) maintains databases on home-tested sheep in Ontario and conducts genetic evaluations for several economically important traits. A terminal-sire index (Tosh and Wilton 2002) was recently introduced, combining information on several traits in one criterion for selecting rams to produce market lambs. An index for selecting sheep for maternal characteristics is also needed. Maternal indexes require economic values for reproductive traits as well as growth traits. The appropriate values to apply are not obvious and depend on production and market situations. In this study, the impact on selection response from using different economic values for litter size relative to the direct component of weaning weight in a maternal index is demonstrated.

Maternal indexes are designed to improve female reproductive rate and lamb weaning weight. Increasing postweaning growth and market weight of lambs and lean content of carcasses may also be considered, because ewes contribute half the genes that control these traits. Genetic evaluations in the form of expected progeny differences (EPD) are available through SFIP for direct and maternal components of birth weight, direct and

maternal components of 50-d weight, gain from 50 to 100 d, ultrasonic fat depth, ultrasonic loin muscle depth, number of lambs born, and number of lambs weaned [Ontario Ministry of Agriculture and Food (OMAF) 2004]. Only 3% of all lambs recorded in SFIP in 2000 to 2003 were scanned by ultrasound to measure carcass characteristics (OMAF 2004). Therefore, indexes suitable for general use should disregard ultrasonically measured traits.

A maternal index was established by adding maternal components to a growth index. The growth index had been developed using the same procedures described for a terminal index (Tosh and Wilton 2002) but excluding ultrasound-measured traits. Direct components of birth weight, 50-d weight, and gain from 50 to 100 d of age formed the initial breeding goal. To this, maternal components of birth weight and 50-d weight were added, as were number of lambs born and number of lambs weaned. Thus, the complete breeding goal comprised direct components of growth, maternal components of growth, and litter size. Total aggregate genotype improved through selection using the maternal index may be written as:

Abbreviations: EPD, expected progeny difference; SFIP, Sheep Flock Improvement Program

Table 1. Assumed heritabilities (on diagonal), genetic correlations (below diagonal), and phenotypic standard deviations (bottom row)

Trait	Bwt.d	Bwt.m	Wt50.d	Wt50.m	Gain	NBorn	NWean	
Bwt.d	0.24							
Bwt.m	-0.34	0.24						
Wt50.d	0.63	0	0.16					
Wt50.m	0	0	-0.32	0.11				
Gain	0.43	0	0.45	0	0.20			
NBorn	0	0	0	0	0	0.07		
NWean	0	0	0	0	0	0.85	0.04	
SD		0.84		3.44		3.52	0.66	0.69

Bwt = birth wt (kg), direct and maternal; Wt50 = weaning wt (kg), adjusted to 50 d of age, direct and maternal; Gain = postweaning gain (kg), from 50 to 100 d of age; NBorn and NWean = number of lambs born and weaned.

$$T = -0.403 g_{Bwt.d} + 1.703 g_{Wt50.d} + 2.323 g_{Gain} \\ - 0.806 g_{Bwt.m} + 3.406 g_{Wt50.m} \\ + (m \times 1.703) g_{NBorn} + (m \times 1.703) g_{NWean}$$

the sum of weighted genotypic values. The weights are relative economic values in phenotypic standard deviation units, which emphasize each constituent part relative to others on the observed (phenotypic) scale accounting for different variances. The relative economic values for direct components of growth are from the growth index. Maternal components of growth were given twice as much relative emphasis as the direct components to compensate for the generation lag to expression. Many different economic values were applied to the litter size traits. The factor m assigns the amount of emphasis on litter size relative to direct weaning weight (50-d weight); values from 2 to 200 were tested.

Indexes consist of estimates of genotypic values, which are EPD in this case. Selection index weights for the EPD were calculated from the relative economic values (implied by the total aggregate genotype) and phenotypic standard deviations, taking into account that an EPD is an estimate of half the genotypic value. The resultant maternal index is:

$$I = -0.96 EPD_{Bwt.d} + 0.99 EPD_{Wt50.d} + 1.32 EPD_{Gain} \\ - 1.92 EPD_{Bwt.m} + 1.98 EPD_{Wt50.m} \\ + (m \times 5.16) EPD_{NBorn} + (m \times 4.94) EPD_{NWean}$$

When twice as much emphasis is put on litter size relative to direct weaning weight, the index weights for EPD of number of lambs born and number of lambs weaned are 10.32 and 9.88, respectively.

Changes in genotype expected in one generation from selection based on the maternal index were predicted. Assumed parameter values are in Table 1. For litter size traits and maternal components of growth traits, the parameters are an amalgamation of estimates from the review by Fogarty (1995) and our own unpublished work. For direct components of growth, the parameters are those used in developing the growth and terminal indexes (Tosh and Wilton 2002). Selection intensity was ignored in the calculations, which is equivalent to setting it to 1 (as in selecting the top 5 to 6% of males and applying no selection to females). Results for other situations may be obtained by multiplying by the appropriate level of selection intensity.

Genetic changes are illustrated for simplicity by three lines in Fig. 1. Genetic change in the number of lambs

weaned (not shown) followed very closely, though slightly below due to a slightly lower heritability, the change in number of lambs born. Combined changes in direct and maternal components give the overall genetic change in birth weight. Genetic change in 100-d weight is the sum of changes in direct and maternal components of 50-d weight and gain from 50 to 100 d.

Increasing the relative emphasis on litter size had little impact on the expected genetic change in number of lambs born. In Fig. 1, the applicable line is very flat. Genetic change in number of lambs born was 0.11 for twice as much emphasis on litter size relative to direct weaning weight, but was 0.17 for both 10 and 200 times as much relative emphasis. Genetic improvement is severely limited by the low genetic variance of number of lambs born. The small difference in genetic change between relative emphases of 2 and 10 would be even less in most practical situations because selection intensity usually is below the assumed value of 1.

As the relative emphasis on litter size increased, genetic change in overall birth weight declined (Fig. 1). Birth weight is a component of weight at older ages; thus, genetic change decreases when selection pressure on body weight at another stage of life eases off. With twice as much emphasis on litter size relative to direct weaning weight, genetic change in overall birth weight was 0.09 kg; 0.03 kg for 10 times as much relative emphasis, and no change for 200 times as much emphasis. Genetic change would be less appreciable with lower selection intensities.

The relative emphasis on litter size had greater effect on 100-d weight than on number of lambs born (Fig. 1). This is a consequence of the contrasting genetic variances: 217 times larger for 100-d weight than for number of lambs born. With two times as much emphasis on litter size relative to direct weaning weight, genetic change in 100-d weight was 1.70 kg, but substantially less with 10 times as much emphasis (0.51 kg), and negligible with 200 times as much emphasis (0.03 kg).

The proper balance of emphasis to apply is the ratio of true economic values, which could be estimated for specific situations. Sensitivity of the outcome to the amount of emphasis used is shown in Fig. 1. Effects of errors in the values used can be seen as shifts along the horizontal axis. Within the range of 2 to 10 for the relative emphasis of litter size compared with direct weaning weight, small errors have a dramatic effect on market weight of lambs: genetic response markedly differs for small changes in relative

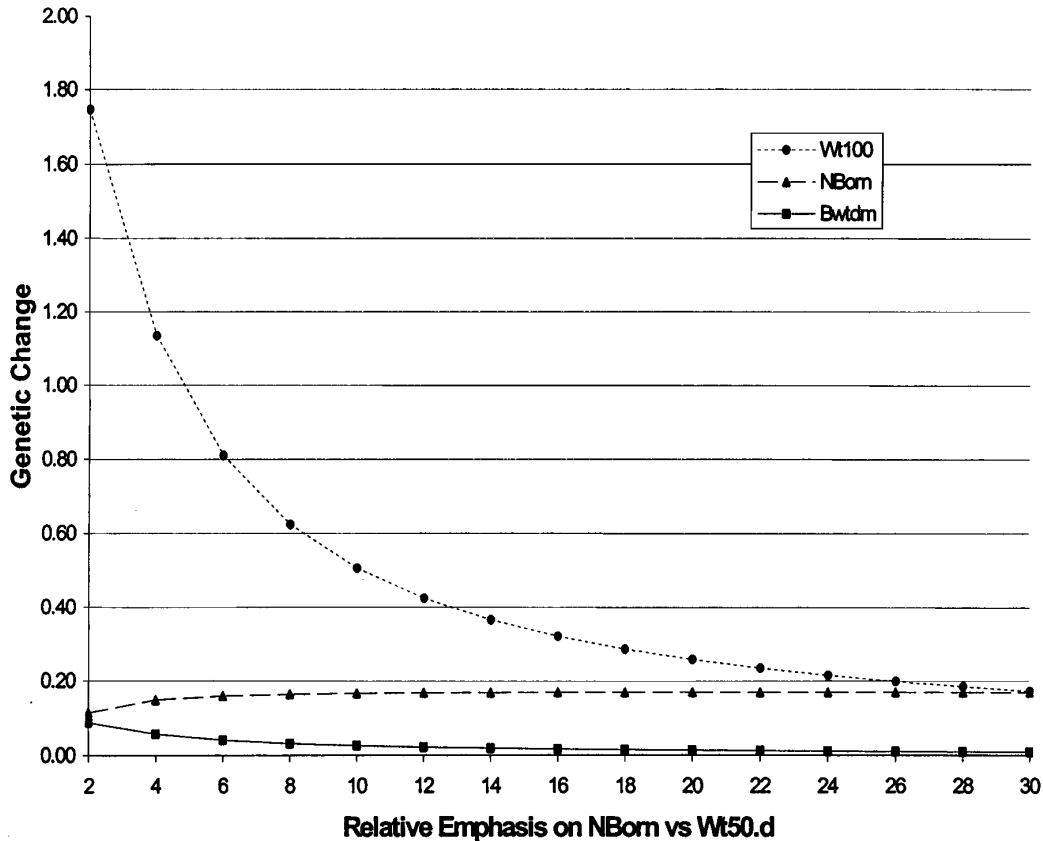


Fig. 1. Genetic response to selection using the maternal index, for different levels of relative emphasis on litter size compared with direct weaning weight. NBorn = number of lambs born; Bwtm = birth weight (kg), direct plus maternal; Wt50.d = direct component of weight (kg) at 50 d of age; Wt100 = weight (kg) at 100 d of age.

emphasis. Errors have less impact when the relative emphasis is greater than 10, because genetic response is more consistent. For litter size, genetic response is very stable regardless of the economic values.

In summary, genetic response from using different amounts of emphasis on litter size relative to lamb growth in a maternal index have been illustrated. Changes in market weight were substantially affected by the relative emphasis applied. Highly accurate economic values will be necessary for selection to succeed with regard to growth. Changes in litter size were essentially independent of economic values. Limited by low genetic variance, litter size will be very difficult to improve regardless of the amount of emphasis applied.

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