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Comparison of Ordinary and Restricted Selection Indices on Genetic Gain of Body Weight in Iranian Moghani Sheep

Research Article

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ABSTRACT

The effect of ordinary and restricted selection indices on body weight at different ages changes in birth weight of Iranian Moghani sheep was studied. Traits in the aggregate genotype were birth weight (BW), body weights at 3 (BW3) and 12 months of age (BW12). Two ordinary selection indices (I_1 and I_2) and two restricted selection indices (R_1 and R_2) were constructed. BW and BW3 were included in I_1 and R_1 and BW, BW3 and BW6 were included in I_2 and R_2. The ranges of expected genetic gains in I_1 and I_2 for BW, BW3 and BW12 per generation were 0.080 to 0.068, 0.210 to 0.177 and 0.546 to 0.662 kg, respectively. Increasing BW may cause a disorder in the future of breeding goal due to dystocia. Restricted selection indices were constructed to increase BW3 and BW12 while keeping genetic gain in BW to zero. Under selection by indices of R_1 and R_2 the amount of genetic gain in BW was zero, while considerable genetic gains were obtained for BW3 (0.094 to 0.062) and BW12 (0.39 to 0.60). Ordinary and restricted selection indices were then evaluated in a simulated population. Predicted genetic gains for BW, BW3 and BW12 from ordinary and restricted selection indices were similar to the predicted genetic gains. For both restricted selection indices (R_1 and R_2) predicted genetic gains for BW3 and BW12 in the simulated population increased over the generations whereas BW decreased slightly over the generations.

KEY WORDS body weight, genetic gain, Moghani sheep, restricted selection indices.

INTRODUCTION

Moghani sheep is a fat-tailed and meat type breed that is mainly raised in north western of Iran. Meat production is one of the primary objective of sheep husbandry in Iran and therefore early growth has an important role of farmer economic (Hossein-Zadeh and Ardalan, 2008). The main part of income is from the sale of lambs while milk is of secondary importance and wool is a cost itself. Birth weight, weaning weight, weight at six months, yearling weight and average daily gains are recorded in Iranian sheep breeding programs. Sheep breeding programs focused on increasing body weight because of its moderate heritability and easy measurement (Tosh and Kemp, 1994). Heritability of body weight at different ages in Moghani sheep has been reported to be low (0.05) to high (>0.50). Moderate to high direct genetic correlations have been reported between body weights and growth traits (Hossein-Zadeh and Ardalan, 2008; Jafaroghli *et al.* 2010). Hossein-Zadeh (2012) reported that direct genetic trends for body weights in Moghani sheep breed were positive and significant as they were 1.63, 69.20, 79.38, 66.83 and 110.22 g/year for body weights at birth, 3, 6, 9 and 12 months of age, respectively. The maternal genetic trends for these traits were also positively high and significant at 2.36, 49.18, 37.33, 17.73 and 9.67 g/year, respectively.

George (1976) reported the incidence of dystocia in Merino ewes to be 4.2% compared to 34% in Dorset Horn ewes. Various factors affect on incidence of dystocia in ewes such as dam age, gender of offspring, birth weight of lamb (Smith, 1977), small pelvic dimensions (Haughey *et al.* 1985) and reduced uterine activity due to hypocalaemia (Robalo Silva and Noakes, 1984). Dalton *et al.* (1980) reported that the incidence of dystocia tended to increase with increasing birth weight, whereas incidence of lamb loss due to starvation-exposure increased with decreasing birth weight. McSporran and Fielden (1979) concluded that the incompatibility in size between the maternal pelvic and the lamb birth weight is largely responsible for dystocia in sheep. Selection for large pelvic-inlet area by using external measurements was shown to be impracticable. Therefore selection should be focused on birth weight. In order to improve lamb viability and decrease dystocia in sheep breeding program, the lamb birth weight should be increased until an especial weight or intermediate weight in different sheep breeds.

Restricted selection indices for many breeds of sheep were used by many studies (Aziz 1988; Jawasreh *et al.* 2006; Oramari and Hermiz, 2011). The restricted selection indices can be used to keep birth weight at intermediate level while improve the weaning, marketing and yearling weights (Jawasreh *et al.* 2006). The objective of this study was to construct a restricted selection index in Moghani sheep breed for improving the lamb body weight but maintaining the birth weight.

MATERIALS AND METHODS

Genetic parameters and economic values

Genetic parameters used in this study (Table 1) for birth weight (BW) and body weights at 3 (BW3), 6 (BW6), 9 (BW9) and 12 (BW12) months of age in Iranian Moghani sheep were as reported by Naderi *et al.* (2007). The selection indices (Table 2) were constructed using the economic values of the mentioned traits reported by Abdollahy *et al.* (2012).

Breeding objective and selection indices

The aggregate genotype of BW, BW3 and BW12 were weigheted by their corresponding economic value (V_i) as follows:

$$H= (V_1 \times BW) + (V_2 \times BW3) + (V_3 \times BW12)$$

Ordinary selection indices

According to this breeding objective (*H*), the following selection indices were constructed:

$I_1= (b_1 \times BW) + (b_2 \times BW3)$

$I_2 = (b_1 \times BW) + (b_2 \times BW3) + (b_3 \times BW6)$

Where:

b_1, b_2 and b_3: index weights.

Selection index weights were derived as follows:

$$b= P^{-1}Gv \qquad \text{Equation 1}$$

Where:

b: vector of index weights.

P: phenotypic variance-covariance matrix between the traits in the selection index.

G: genetic variance-covariance matrix between traits in the selection index and traits in the aggregate genotypes.

v: vector of economic values.

Restricted selection indices

In order to restrict genetic gain in BW to zero, a restricted selection index method that was described by Cunningham *et al.* (1970) was used. For deriving index weights of the restricted selection indices, a column of matrix G that related to a restricted trait (BW) as zero in the final position was added as row and column (G_j) to matrix P, adding a dummy variable (b_d) to the vector b and a row of zero to matrix G as follows:

$$\begin{bmatrix} \mathbf{P} & \mathbf{G_j} \\ \mathbf{G_j'} & \mathbf{0} \end{bmatrix} \begin{bmatrix} \mathbf{b} \\ \mathbf{b_d} \end{bmatrix} = \begin{bmatrix} \mathbf{G} \\ \mathbf{0} \end{bmatrix} [\mathbf{v}] \qquad \text{Equation 2}$$

Equation 2 was solved for b and b_d using equation 1. Genetic gain in trait *j* (ΔG_j) in the aggregate genotype were predicted as follows:

$$\Delta G_j= (G_j' \, b/\sigma_I) \times i, \quad \sigma_I= \sqrt{(b' \, P \, b)}$$

Where:

G_j: j^{th} column of matrix G.

σ_I: standard deviation of the index.

i: selection intensity, which was assumed to be one in this study.

Simulated genetic gains

The ordinary and restricted selection indices were then used to select animals of a simulated population. Pedigree and performance data for BW, BW3, BW6 and BW12 of 50 ram and 50 ewes were simulated in the base population. Selection was done for six generations. Finally, 70 percent of ewes and 20 percent of rams were selected based on index values.

For computing the mean genetic value in each generation, 50 replications were done.

Table 1 Additive genetic variance (diagonal), genetic covariance (above diagonal), phenotypic covariance (below diagonal) and phenotypic variance (last row) of birth weight (BW) and body weights at 3 (BW3), 6 (BW6) and 12 (BW12) months of age[1]

	BW	BW3	BW6	BW12
BW	**0.062**	0.116	0.073	0.228
BW3	0.652	**0.527**	0.348	1.712
BW6	0.743	10.681	**1.919**	3.114
BW12	0.510	7.044	13.852	**5.787**
σ_p^2	0.362	11.916	22.917	25.457

[1] From Naderi *et al.* (2007).

Table 2 The absolute economic value ($/ewe/year) of birth weight (BW), weaning weight (WW) and 12 months body weight (BW12)[1]

Traits (kg)	Absolute economic value
BW	-0.08
WW[2]	1.48
BW12	1

[1] From Abdollahy *et al.* 2012.
[2] Weaning weight was at 4 months age, this economic value was used for economic value of 3-month body weight (BW3).

Observed genetic gains were computed of the difference between mean breeding value of the population in the sixth generation and base population.

RESULTS AND DISCUSSION

Expected genetic gains per generation in traits of the aggregate genotypes in the ordinary selection indices (Table 3) were 0.08 to 0.068, 0.210 to 0.177 and from 0.546 to 0.662 kg from I_1 and I_2 for BW, BW3 and BW12, respectively. Heritability of I_1 (0.116) was similar to heritability of I_2 (0.098). Increases in BW are associated with increases in dystocia and lamb viability. Results obtained by (Sawalha *et al.* 2007) indicated that viability had a cubic relationship with BW and estimated breeding value of birth weight. In that study mean mortality rate at intermediate BW (3.5 to 4.0 kg) was lower than mortality rates for lighter and heavier lambs as the lambs of lighter BW having the highest mortality rate. There is a positive unfavorable relationship between mortality rate and breeding value of birth weight. Lambs with a higher breeding value for BW had a higher mean mortality rate than lambs with a smaller predicted breeding value. In Iranian Lori-Bakhtiari sheep the total rate of lamb loss up to seven days postulation was 1.94% (Vatankhah and Talebi, 2009). A quadratic relationship has been reported between BW of lamb and mortality rate at all ages in Iranian Lori-Bakhtiari sheep (Vatankhah and Talebi, 2009). Therefore in sheep breeding program, lamb mortality and dystocia should be considered. One of the easiest ways to do this is to keep the BW in optimum range and avoid increasing of BW. In selection using R_1 and R_2, the predicted genetic gain in BW was zero but considerable genetic gains were obtained for BW3 and BW12 (Table 4). Amount of genetic gains in BW3 and BW12, heritability and accuracy of indices in restricted selection indices were lower than those obtained in ordinary selection index.

The accuracy, heritability and expected genetic gain for BW12 in second restricted selection index were higher than the first selection index. Amount of predicted genetic gain for BW3 from the ordinary selection indices was higher than response from the restricted selection indices; this difference is about three times but difference in expected genetic gain for BW12, heritability and accuracy of selection indices in ordinary and restricted selection indices were low, especially between I_2 and R_2. Except for BW3, expected genetic gain obtained for BW12, heritability and accuracy of selection index in R_1 were lower than those in R_2. Therefore the second restricted index was better than the first restricted selection index; but using R_2 need more information to record (BW6) that can increase the cost and generation interval. Restricted selection index were reported in several sheep breeds. Restricted selection indices for increasing 50 and 100-day weights whille keeping the birth weight at a certain level using a stepwise procedure were constructed for Suffolk and Dorset breeds (Aziz, 1988). Restricted selection index for growth traits of Awassi sheep in Jordan was reported to increase yearling, marketing and weaning weights while keeping birth weight at a certain level (Jawasreh *et al.* 2006). Restricted selection index to increase six-monthand weaning weights with constructing the BW of lambs to zero were constructed in Karadi sheep in Iraq (Oramari and Hermiz, 2011). The results obtained in this study confirmed that it is possible to improve BW3 and BW12 without any changes in BW. Ordinary and restricted selection indices that were constructed in Tables 1 and 2 were used to select animals in a simulated population (Figure 1). The predicted genetic gains for BW, BW3 and BW12 in that population had a similar pattern of expected genetic gains. Only genetic trends of BW and BW3 were shown in Figure 1 because trend for BW12 were similar to BW3 but amount of observed genetic gain in BW12 were higher than that of BW3.

Table 3 Ordinary selection indices, expected genetic gains for birth weight (BW) and body weights at 3 (BW3) and 12 (BW12) months of age,heritability (h^2) and accuracy of indices

Index	Index weights	BW	BW3	BW12	h2	Accuracy
I_1	(0.793×BW) + (0.164×BW3)	0.080	0.210	0.546	0.116	0.245
I_2	(0.746×BW) + (0.0815×BW3) + (0.0958×BW6)	0.068	0.177	0.662	0.098	0.265

Table 4 Restricted selection indices, expected genetic gains for birth weight (BW) and body weights at 3 (BW3) and 12 (BW12) months of age, heritability (h^2) and accuracy of indices

Index	Index weights	BW	BW3	BW12	h^2	Accuracy
R_1	(-0.303×BW) + (0.162×BW3)	0	0.094	0.39	0.028	0.153
R_2	(-0.249×BW) + (0.057×BW3) + (0.121×BW6)	0	0.062	0.602	0.063	0.201

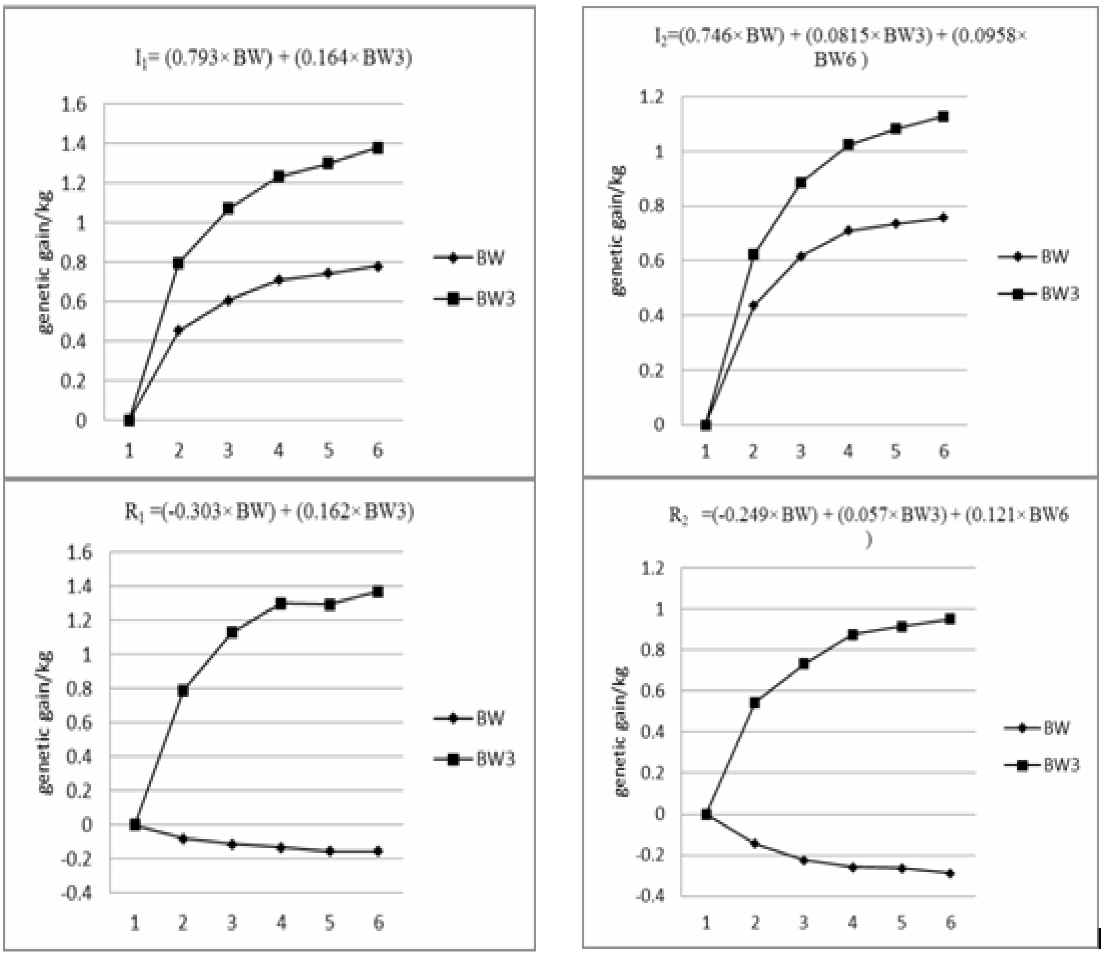

Figure 1 Observed genetic gains for birth weight (BW) and body weight at 3 months of age (BW3) by using ordinary selection indices (I_1 and I_2) and restricted selection indices (R_1 and R_2) in six generations

Using ordinary selection indices BW and BW3 were increased over the generations. Observed genetic gains for BW and BW3 were lower than expected genetic gains. Amount of observed genetic gains for both BW and BW3 in I_1 were higher than I_2 that were similar to the result obtained in expected genetic gains. In both I_1 and I_2 amount of genetic gain for BW was higher than BW3. The rate of genetic gains for both BW and BW3 in early generations in I_1, I_2, R_1 and R_2 were higher than those of later generations.

As a result shown in Figure 1, by using restricted selection indices (R_1 and R_2) BW3 was increased over the generations but the expected genetic gains for BW was not exactly zero.

The observed genetic gains for BW was decreased over the generation but the amount of decrease in BW was negligible. Amount of genetic gains in BW3 in R_1 was somewhat higher than that in R_2 that had a similar patern in expected genetic gains.

CONCLUSION

Applying ordinary selection indices in a sheep breeding program caused considerable increases in the body weights at 3, 6 and 12 months of age as well as birth weight. Predicted genetic gains and responses in a simulated population confirmed that maintaining birth weight unchanged while increasing body weights at late ages direction restricted selection index can be used.

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