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SELECTION INDICES FOR IMPROVING SOME PRODUCTIVE TRAITS IN LOCAL SHEEP

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SUMMARY

Three indices were constructed to improve some productive traits in Ossimi and Rahmani sheep. Traits considered were lamb weights at 120 (W120) and 180 (W180) days of age and number of lambs born per ewe joined (LBj) .The relative economic values of increase in net income used for the traits were L.E 1.06/kg for W120, L.E 1.0/kg for W180 and L.E 15.28/lamb for LB_j .

The index utilizing combinations of W120, W180 and LB_j have shown to be the most efficient index (the accuracy on indices were 0.44 for Ossimi and 0.37 for Rahmani). The index combining W120 with LB_j was the least efficient (relative index efficiency = 0.84 and 0.54 for Rahmani and Ossimi, respectively) .

The results showed that when the index included W180 with LB_j, the expected genetic progress was moderate in both traits in Rahmani while in Ossimi it was high for W180 and very low for LB_j . Due to the negative genetic correlation between LB_j and each of W120 and W180, in Ossimi sheep it is suggested that constructing restricted selection index could be more effective in improving Ossimi sheep production .

Keywords : Sheep, lamb body weights, fertility, selection index

INTRODUCTION

Number of lambs produced per ewe and lamb growth performance constitute a major component in the profitability of sheep. Accordingly, selection objective concentrates on these traits. Selection indices have been constructed and used to improve almost all species of animals such as dairy cattle (Simm and Dingwall,1987; Khalil and Soliman 1989; Ashmawy, 1990), sheep (Abdel-Aziz *et al.*,1979; Aziz, 1988; Mavrogenis and Constantinou, 1991), rabbit (Khalil *et al.*, 1986) and poultry (Akbar *et al.*, 1984).

Ronningen (1970) summarized the properties of the selection index in the following: maximize the correlation between the true aggregate genotype and the value of the index, maximize the expected genetic gain and maximize the probability of correct ranking the individual under selection.

The objective of this study was to construct some selection indices utilizing different combinations of important sheep productive traits (W120, W180 and LB_j) in Ossimi and Rahmani Egyptian breeds.

MATERIAL AND METHODS

The variance and covariance components used in this study were estimated by Shaat *et al.* (1996) using Multiple Traits Animal Model Program (MTDFREML) of Boldman *et al.* (1993). Lambs weight at 120 and 180 days of age were measured as traits of the individual lamb and number of lambs born per ewe joined was measured as a reproductive trait on the dams of the lambs. Shaat et. al (1996) have given a detailed description of the material .

The relative economic value for the traits considered in this study reflects the expected increase in net income, in L.E , for each unit of improvement in that trait. So, additional feed, labor, veterinary and other miscellaneous items associated with increasing the production for either trait were discounted. The input and output prices frequently change in response to supply and demand conditions. So, average input and output prices were calculated from the period of 1992-1994 on the basis of field observations.

For each one kg increase in W120 or W180, gross income increased by L.E 7.5. On the other hand, an increase of one kg in W120 and one kg in W180 results in an increase in expenditure by L.E 2.72 and L.E 2.99, respectively. So, the economic value of W120 and W180 were L.E 4.78 and L.E 4.51, respectively.

Expenditure per ewe was estimated as L.E 152.6 for a period of 240 days which covers breeding, gestation and suckling periods. Feeding costs constitute 71.3% of total annual expenditure. The means of LB_j was estimated as 1.05 in Ossimi and 1.09 in Rahmani. Increasing average of LB_j from 1.07 to 2.07 lambs would result in an extra income of 152.6/1.07 - 152/2.07 = L.E 68.90 per each extra lamb born. So, the economic value of LB_j was L.E 68.90. Consequently, the relative economic values for increase in net income obtained and used in this study were 1.06, 1.0 and 15.28 for W120,W180 and LB_j, respectively .

Method of constructing the selection index depends to a great deal on the methodology of Hazel (1943), which was in the form, $I = \Sigma b_i x_i$, $i = 1$ to k where, b's were weighting factors (i.e. partial regression coefficients) and x's were the phenotypic values of k considered traits.

The partial regression coefficients for indices (b's) were computed as : $\underline{b} = P^{-1} G \underline{a}$ where, $\underline{b}$ is the vector of partial regression coefficients of the x's in the index I, P^{-1} is the inverse of phenotypic variances-covariances matrix, G is the genotypic covariance matrix, and $\underline{a}$ is the vector of relative economic values.

The variance of the index (σ^2_I) is obtained by $\sigma^2_I = \underline{b}' P \underline{b}$, where, P is the phenotypic variances-covariances matrix and $\underline{b}'$ is the transpose of $\underline{b}$ vector.

The variance of the aggregate genotype (σ^2_H) can be obtained by this formula (in matrix notation) as $\sigma^2_H = \underline{a}' G \underline{a}$

The amount of genetic progress to be expected from the selection, based on a particular index, is proportional to the correlation between the index and the aggregate genotypic value (r_{IH}).

The r_{IH} was estimated as $r_{IH} = \underline{b}' G \underline{a} / \underline{a}' C \underline{a}$, i.e. simply dividing of σ_I by σ_H, where: $\underline{a}'$ is the transpose of $\underline{a}$ vector, and C is the squared matrix of genotypic variances-covariances of the traits in the aggregate genotype (H).

The expected genetic progress in each trait (ΔG) is achieved by multiplying the standard deviation of the index (σ_I) and intensity of selection (i) which is defined as, Z/b where, Z is the height of ordinate of the unit normal distribution at the point of truncation and b is the fraction of the population selected or saved, and the regression of each trait on the index (b_{XI}), i.e. $(\Delta G) = (\sigma_I)\ (i)\ (b_{XI})$.

The relative efficiency of the index (RE) was defined as:

$$r^*_{IiH} \ / \ r_{IiH}$$

where r_{IiH} is the correlation between the aggregate genotypic value and the index which included all of the three traits, and r^*_{IiH} is the correlation between the index I_i, $I \neq 1$, which included only two traits and the aggregate genotypic value.

The correlation coefficient of the index and each trait (r_{IX}) was calculated as:

$$r_{IX} = b' G_i \ / \sqrt{\ (\sigma^2_I)\ (C_{ii})}$$

where, C_{ii} is the diagonal element of C matrix.

The regression coefficient of the trait on the index (b_{XI}) was obtained as

$$b_{XI} = \underline{b}' G_i / \sigma^2_I$$

where, $\underline{b}'$, G_i and σ^2_I were as mentioned before.

RESULTS AND DISCUSSION

Tables 1 and 2 show the genetic and phenotypic variances and covariances for all studied traits in Ossimi and Rahmani breeds of sheep after Shaat *et al.* (1996).

The b's coefficients in each index was divided by b_1. The calculated selection indices for Ossimi and Rahmani were,

Table 1. Estimates of genetic (g) and phenotypic (p) variance and covariance of 120-day (W120), 180-day (W180) weights and number of lambs born per ewe joined (LB_j) used in the construction of the selection indices in Ossimi sheep.

Traits	W120 , kg	W180 , kg	LB_j
W120	4.53^g	4.72^g	-0.14^g
	17.33^p	17.47^p	-0.15^p
W180		5.89^g	-0.003^g
		24.34^p	-0.26^p
LB_j			0.05^g
			1.61^p

Table 2. Estimates of genetic (g) and phenotypic (p) variance and covariance of 120-day (W120), 180-day (W180) weights and number of lambs born per ewe joined (LB_j) used in the construction of the selection indices in Rahmani sheep.

Traits	W120 , kg	W180 , kg	LB_j
W120	1.35^g	1.96^g	0.03^g
	10.22^p	7.60^p	0.02^p
W180		3.90^g	0.01^g
		15.27^p	-0.16^p
LB_j			0.13^g
			1.46^p

For Ossimi breed:

I_1 = - W120 + 5.74 W180 + 4.61 LB_j, r_{I_1H} = 0.44.
I_2 = W120 + 2.26 LB_j, r_{I_2H} = 0.23
I_3 = W180 + 1.92 LB_j, r_{I_3H} = 0.33.

For Rahmani breed:

I_1 = W120 + 3.63 W180 + 13.74 LB_j, r_{I_1H} = 0.37.
I_2 = W120 + 7.28 LB_j, r_{I_2H} = 0.31.
I_3 = W180 + 4.82 LB_j, r_{I_3H} = 0.34.

The b's coefficients of the index, the correlation of an index with the aggregate genotypic value (r_{IH}), the expected genetic progress in each trait (ΔG), the relative efficiency of the index (RE), the correlation coefficient of the index and each trait (r_{IX}), the regression coefficient of each trait on the index (b_{XI}) and the standard deviation of the index (σ_I) are shown in Tables 3 and 5 for Ossimi and 4 and 6 for Rahmani sheep. In the first index (I_1), a negative partial regression coefficient was obtained for W120 in Ossimi sheep (Table 3) due to the negative genetic correlation between this trait and LB_j trait. Number of lambs born had the largest absolute numerical value of the b's in all indices for both studied breeds. Generally, low value of (b) were obtained for W120 in all indices.

The expected genetic progress (ΔG) of W120 and W180 were higher in Ossimi (.87 and 1.15) than in Rahmani (.40 and 0.71), respectively. The heritability of LB_j was very low and little genetic progress is therefore expected for this trait. If selection was applied on two traits only, the expected genetic progress in lamb weight would be reduced as compared to including the three traits together and the reduction was more pronounced in the Rahmani breed.

The little expected genetic progress for LB_j , which was more pronounced in Ossimi, may be due to the negative genetic correlation between LB_j and each of W120 and W180, as suggested by James (1981) and Falconer (1983) who stated that negative genetic correlations between traits could be a limit to the expected genetic progress from selection. However, restricted selection index can solve this problem and enhance the opportunity to improve LB_j by selection.

Table3. Selection indices (I), value of the coefficient of the index being the partial regression coefficient (b), expected genetic progress in each trait (Δ_G), correlation of the index with each individual trait (r_{IX}) and regression of each trait on the index (b_{XI}) for W120, W180 and LB_j in Ossimi sheep.

Index		Traits		
		W120	W180	LB_j
I_1				
	b	-0.0896	0.5145	0.4133
	Δ_G	0.87	1.15	0.02
	r_{IX}	0.41	0.47	0.06
	b_{XI}	0.38	0.51	0.01
I_2				
	b	0.1563		0.3540
	Δ_G	0.84		-0.01
	r_{IX}	0.40		-0.04
	b_{XI}	1.08		0.01
I_3				
	b		0.2453	0.4707
	Δ_G		1.09	0.01
	r_{IX}		0.45	0.07
	b_{XI}		0.82	0.01

The standard deviations of the indices (σ_I) ranged from 0.78 for I_2 to 2.27 for I_1 in Ossimi sheep (Table 5), while they ranged from 1.73 for I_2 to 2.33 for I_1 in Rahmani sheep (Table 6). According to the correlation between the indices and the aggregate genotypic value (r_{IH}), (presented in Tables 5 and 6), the first index (I_1) was the most accurate one, while I_2 was the last one in both Ossimi and Rahmani breeds. This finding agrees with Abdel-Aziz *et al.* (1979) who found that ignoring birth weight, four month weight and yearling weight reduced efficiency of the index by 1.5, 5.5 and 7.1 %, respectively. The advantages of including all economically important traits in the index was confirmed by Giedrem (1972) who concluded that such traits never decrease, but would frequently increase the total genetic gain when selection is applied. Moreover, the r_{IH} was higher in Ossimi, being 0.44, than that in Rahmani being 0.37 for the first index (I_1).

The amount of expected genetic progress using selection indices is proportional to r_{IH}. Then the value of r_{IH} was chosen to be the main criterion for comparing the studied indices. Comparing the three indices for each breed, previously constructed, with a perfect index (r_{IH}=1), the indices constructed in this study permit from 23 to 44 percent, for both breeds, as much gain as could be made with the perfect index, being the limit of what could be achieved if the genetic constitution of each animal was completely known.

Correlation coefficient between the indices constructed and each individual trait in the aggregate genotype (r_{IX}) are presented in Tables 3 and 4 for Ossimi and

Rahmani sheep. In general, correlation coefficient between index and each body weight trait (W120 and W180) were higher in Ossimi than those obtained in Rahmani. While, higher correlations between each index and LB_j trait were obtained in Rahmani than those observed in Ossimi. In general, all the correlation coefficients ranged between -0.04 to 0.47. The regression coefficients of each trait on the index (b_{XI}'s) ranged from 0.01 to 1.08 in Ossimi (Table 3). While they ranged from 0.03 to 0.30 in Rahmani (Table 4).

Table 4. Selection indices (I), value of the coefficient of the index being the partial regression coefficient (b), expected genetic progress in each trait (Δ_G), correlation of the index with each individual trait (r_{IX}) and regression of each trait on the index (b_{XI}) for W120, W180 and LB_j in Rahmani sheep.

Index		Traits		
		W120	W180	LB_j
I^1	b	0.1018	0.3693	1.3984
	Δ_G	0.40	0.71	0.07
	r_{IX}	0.33	0.36	0.22
	b_{XI}	0.17	0.30	0.03
I^2				
	b	0.1848		1.3461
	Δ_G	0.17		0.10
	r_{IX}	0.14		0.29
	b_{XI}	0.10		0.06
I^3				
	b		0.2835	1.3670
	Δ_G		0.57	0.10
	r_{IX}		0.29	0.25
	b_{XI}		0.29	0.05

Hazel (1943) reported that the confusing effects of environment, dominance and epistasis results in phenotypes being unlike genotypes and this is the reason for the losin accuracy. The relative loss in accuracy is due to the relative efficiency (RE) in genetic gain, considered as r^*_{IH} / r_{IH} was also used to compare the present indices (Tables 5 and 6). The indices I_2 and I_3 for both breeds studied permit from 53 to 92 percent as much genetic gain as could be made with the first index (I_1).

Table 5. Standard deviations (σ_I) for the indices constructed, correlation of the index with the aggregate genotypic value (r_{IH}) and the relative efficiency (RE) of the index in Ossimi sheep.

Item	Index		
	I_1	I_2	I_3
σ_I	2.27	0.78	1.33
r_{IH}	0.44	0.23	0.33
RE to I_1	100.00	53.50	75.00

Table 6. Standard deviations (σ_I) for the indices constructed, correlation of the index with the aggregate genotypic value (r_{IH}) and the relative efficiency (RE) of the index in Rahmani sheep.

Item	Index		
	I_1	I_2	I_3
σ_I	2.33	1.73	1.96
r_{IH}	0.37	0.31	0.34
RE to I_1	100.00	83.50	92.00

CONCLUSION

Selection index including W120 and W180 and LB_j had higher genetic progress than selection for W120 or W180 with LB_j. Due to the negative genetic correlation between LB_j and each of W120 and W180, in Ossimi sheep it is suggested that constructing restricted selection index could be more effective in improving Ossimi sheep production.

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أدلة انتخابية لتحسين بعض الصفات الإنتاجية في سلالات الأغنام المحلية

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أستعملت تقديرات المعالم الوراثية والمظهرية لصفات وزن الجسم عند ١٢٠ يوم (س١)، ١٨٠ يوم (س٢) و عدد الحملان المولودة لكل نعجة قدمت للكباش للتلقيح (س٣) لحساب ثلاث أدلة انتخابية لكل من أغنام الاوسيمى والرحمانى. و لقد أحتوى الدليل الأول (د١) على الصفات الثلاثة بينما كانت الأدلة المختزلة (الثانى و الثالث) تحتوى على صفتين فقط س٣ مع س١ (د٢) و س٣ مع س٢ (د٣). و لقد كانت القيمة الاقتصادية النسبية لهذه الصفات ١,٠٦ جنيها لكل كجم من س١ ، ١,٠ جنيها لكل كجم من س٢ ، ١٥,٢٨ جنيها لكل حمل من س٣.

و لقد أوضحت نتائج الدراسة تفوق الدليل د١ (حيث كانت دقة الدليل تساوى ٠,٤٤ للأوسيمى و ٠,٣٧ للرحمانى) ، بينما كان الدليل د٢ أقلهم كفاءة (حيث كانت الكفاءة النسبية للدليل تساوى ٠,٨٤ للرحمانى و ٠,٥٤ للأوسيمى). و لقد أظهرت النتائج أنه عند الانتخاب لـ س٢ مع س٣ في الأغنام الرحمانى كان العائد الوراثي المتوقع مناسبا فى كلا الصفتين. بينما فى الأغنام الأوسيمى كان العائد الوراثي المتوقع عال فى س٢ و منخفض جدا فى س٣.

و نظرا لأن معاملات الارتباط الوراثي بين س٣ و كلا من س١ ، س٢ سالبة فى الأغنام الاوسيمى فينصح باستعمال دليل انتخابى مشروط لا يسمح بتدهور س٣ عند تحسين س١، س٢ .