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Breeding Objectives and Desired-Gain Selection Index for Rayeni Cashmere Goat in Pasture System

Research Article

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ABSTRACT

The aim of this study was to define breeding goals and determine the suitable selection index in Rayeni cashmere goat using simulated data. To select animals for increased quantity of meat, milk and cashmere produced, body weight of the doe (BWD), milk weight (MW), cashmere weight (CW), weight of kids for sale (WK) and number of kids for sale per doe (NK) was used as selection criteria. Four selection indices were proposed (I_1–I_4) to compare genetic gain for all traits included in indices based on selection index. Maximum of genetic gain was calculated for 0.04 buck ratio with the full selection index (I_1). So, the most suitable selection index for this breed is index 1 which included BWD, MW, CW, WK and NK.

KEY WORDS breeding objectives, desired-gain selection index, Rayeni cashmere goat.

INTRODUCTION

Due to the increase in buying power in many countries (such as Iran), the pressure is growing on systems in order to produce more without raising agricultural area. In addition to be a major supply source of meat, milk and clothes in domestic markets, goat farming in the tropics is also important for household income in many rural homesteads (Kosgey *et al.* 2006). Because of high demands in using lands and high population pressure, goat farming is gaining importance in small farmstead systems in favorable locations (Bett *et al.* 2007). Definition of the breeding objectives is a first important step in the development of genetic improvement programs. This definition should start with consideration of all the relevant traits. Therefore, the number can be limited to a few traits of major interest. Trait priority by the producers is influenced by costs and profits of the production system, or by social reasons (Kosgey *et al.* 2004; Kosgey *et al.* 2006; Bett *et al.* 2009). Multiple traits selection using selection indices (Hazel, 1943) is the fastest and most effective method to improve the total breeding value. The relative economic value of component traits in aggregate genotype is the basic requirement of selection index. The estimation of economic value is a cumbersome process and it rapidly changes with the change in market trend. A selection index for attaining pre-determined desired genetic gain, which does not require defining aggregate genotype and estimation of relative economic values of component traits was suggested by Pesek and Baker (1969). About 20% of Iran's goats produce cashmere. After China and Mongolia, Iran is the main cashmere producer in the world. Most cashmere in Iran is produced from the Rayeni Cashmere goat (Ansari-Renani, 2013).

Rayeni Cashmere goat is one of the most important native goat breeds in Iran that mainly raised in large numbers in Kerman and Hormozgan province. These goats are mainly kept for milk, cashmere and meat production. Because of that, an optimized breeding program to improve milk, cashmere and meat production traits of this breed is required. In the absence of a national genetic improvement scheme for Rayeni Cashmere goat, achieving and monitoring genetic gain is difficult. The enforcement of a genetic improvement scheme is an important part of the development and progress of the Rayeni Cashmere goat industry in Iran, to meet product demand in the longer term (Kargar Borzi *et al.* 2017).

Notable breeding objectives and selection index have been defined for various livestock species in different countries. E.g. for indigenous chicken (Okeno *et al.* 2012), Creole goat (Gunia *et al.* 2012) wormsilk (Seidavi *et al.* 2008) and Aberdeen Angus cattle (Campos *et al.* 2014). The aim of this study was to investigate the most important breeding goals and the appropriate selection index for desired gain. This was done base on highest genetically value for the Rayeni Cashmere goat in pasture system.

MATERIALS AND METHODS

Breeding objective

The city of Baft in Kerman province were chosen to collect the information required, since it is the main Rayeni cashmere production region of Iran (Ansari-Renani, 2013). Ten farmers were accepted to take part in this study. All farmers expected to increase their economic return from their goat herds through higher meat, milk and fibre output and through reduced costs. Therefore, higher reproduction rate, higher growth rate, higher milk yield and higher cashmere weight of the goats are of main interest. Breeding objective traits should be heritable to be modified through animal breeding. Reproduction traits such as fertility, prolificacy and kid survival have low heritability (Mohammadi *et al.* 2012). Early growth traits and maternal traits such as total weight of kids weaned over a does' have also low heritability (Maghsoudi *et al.* 2009). On the contrary reproduction traits, body weights, milk weight and cashmere weight are moderately to highly heritable (Table 1) and are therefore more obvious candidates to be improved.

Genetic and phenotypic parameters

Genetic and phenotypic parameters are important input variables when evaluating breeding programs. The phenotypic and genetic (co)variance matrix (Table 1) was estimated using the data of breeding station of Rayeni cashmere goat, southeast of Iran. Data were collected over a period of 28 years (1982-2009).

(Co)variance components and corresponding genetic parameters for the studied traits were achieved by restricted maximum likelihood (REML) method fitting an animal model using the ASReml computer program (Gilmour *et al.* 2006).

The required data and traits that were not available from those records were extracted from related published studies and reviews (Maghsoudi *et al.* 2009; Al-Atiyat *et al.* 2010; Gizaw *et al.* 2010; Mohammadi *et al.* 2012; Al-Atiyat and Aljumaah, 2013; Abegaz *et al.* 2014; El-Wakil *et al.* 2014; Castañeda-Bustos *et al.* 2014; Mueller *et al.* 2015; Amayi *et al.* 2016). They should be population specific, but due to lack of performance and pedigree recording in smallholder herds in particular, literature estimates have been used to evaluate breeding programs (Amayi *et al.* 2016).

Data simulation and herd structure

The real data which collected from Breeding Station of Rayeni Cashmere goat and phenotypic and genetic (Co)variance matrix and means of traits (Table 1) was used to simulate the base population. Breeding Station of Rayeni Cashmere goat located near the city of Baft in Kerman province, Iran. Simulating program was used according to R statistical software. After simulating phenotypic records of the base population, random mating between top adult bucks and does (the best parents) were considered to be obtained phenotypic records of kids (offspring). Breeding values of traits for each animal with multiple trait animal models were predicted. Top adult bucks and does were selected based on desired-gain selection index. To choose the best Parents, selection index for each animal was established. Herd size, buck ratio, number of generations, number of traits, Litter size, percentage of buck and doe in the flock, longevity of buck and doe in the flock, and age of animal maturity and mortality rate were defined like real herds (Table 2). Overlap between generations was considered. Selection indices were studied by changing the buck ratio from 4 to 6 percent.

Derivation of desired-gain selection index

Four selection indices depending on the available measurements were proposed (I_1-I_4) to compare genetic gain per generation for all traits included in indices based on selection index.

The traits included in each index were: body weight of doe (BWD), milk weight (MW), cashmere weight (CW), weight of kids for sale (WK) and number of kids for sale per doe (NK) (I_1); BWD, MW, CW and WK (I_2); CW, WK and NK (I_3) and CW and WK (I_4). Index 1 was considered as a base selection index that all traits (breeding goal) included in it. Because of low heritability of number of kids for sale per doe, index 2 was proposed.

Table 1 Estimates of heritabilities, phenotypic (below diagonal), genetic (above diagonal) correlations and genetic variance in diagonal of traits in the breeding goal

Traits	h_2	BWD	WK	NK	MW	CW
BWD (kg)	0.41	**1.84**	0.40	0.33	0.16	0.30
WK (kg)	0.22	0.42	**2.26**	0.29	0.08	0.30
NK (head)	0.05	0.09	0.10	**0.01**	0.38	0.00
MW (kg)	0.22	0.09	0.08	0.38	**1.62**	-
CW (kg)	0.33	0.30	0.17	0.00	-	**0.12**

BWD: body weight of doe; MW: milk weight; CW: cashmere weight; WK: weight of kids for sale; and NK: number of kids for sale per doe.

Table 2 Overview of the assumed values of the input variables of the model

Variables	Value	Variables	Value
Flock structure		Mature weight of does (kg)	36
Conception rate (%)	90	Weight of kids sold (kg)	20
Twining rate (%)	11	Weight of kids yearling (kg)	29
Number of kid per birth	1.11	Milk weight in year (kg)	27
Doe survival (%)	94	Cashmere weight in year(kg)	0.55
Replacement survival (%)	91	**Management variables**	
Pre-weaning survival (%)	90	Weaning age of kids (months)	4.5
Post-weaning survival (%)	95	Age of kids sold (months)	6.5
Replacement rate (%)	30	Age of selection replacement (months)	8
Culling rate of doe (%)	21	Age at first mating (months)	18
Culling rate of buck (%)	2	Age at Mature weight (months)	18
Production variables		Age at culling of doe (year)	6
Birth weight (kg)	1.8	Age at culling of buck (year)	4
Weaning weight (kg)	18	Proportion of bucks in flock (%)	5
Mature weight of bucks (kg)	48	-	-

Now milk weight and body weight of doe are not measured so index 3 was proposed. Finally index 4 was proposed included cashmere weight and weight of kids for sale with moderate heritability and available measurements. Since the choice of parameters used influences the index weights, the expected outcome from their use had to be analysed with care. Selection is made on the basis of the index:

$$I= b'X \qquad (1)$$

Where:
X: phenotypic record and b is the selection index coefficient (or weight) for traits.

Selection index coefficient was computed as equation (2):

$$b= G'Q \qquad (2)$$

Where:
G: genetic covariance matrix for traits in selection index.
Q: desired gain (Table 3) for the traits included in the index (Lwelamira and Kifaro, 2010).

Genetic gain for breeding goal was obtained from equation (3) (Dekkers *et al.* 2004):

$$S_H= \sqrt{b' \times P \times b} \qquad (2)$$

Where:
b and P: selection index coefficient for traits and phenotypic covariance matrix for traits in selection index respectively.

Genetic gain for traits was obtained from equation (4) (Dekkers *et al.* 2004):

$$S_g= (b'\times G) / (\sqrt{b'\times P\times b}) \qquad (4)$$

RESULTS AND DISCUSSION

Breeding objective and selection criteria

To select animals for increased quantity of meat, milk and cashmere produced (breeding objective), body weight of doe, weight of kids for sale and number of kids for sale per doe, milk weight and cashmere weight (selection criteria) was used as selection criteria respectively. These traits are easy to measure. The breeding objectives of this production system were obtained from economic analysis and the discussion with each farmer. The traits included in the breeding objective were close to the traits desired by farmers. Economic increase comes from higher meat, milk and cashmere output as well as costs reduction in goat herds. Hence, higher reproduction and growth rate, milk yield, and cashmere weight are essential. Some traits may not have an economic effect on production system or some breeding goals may have many indicator traits. The choice of correct selection criteria can be among the most important decisions made by farmers (Bett *et al.* 2007).

Amayi *et al.* (2016) for dairy goats in Kenya, have defined breeding goal included milk yield, daily weight gain , live weight, does mature weight, number of kids weaned per doe and survival rate of the does that most of them like this research. Rayeni cashmere goats produce meat, fibre and milk (Ansari-Renani *et al.* 2013). The breeding goals for the Rayeni Cashmere goat system in Iran and Europe are different. In Europe, dairy goats are used for cheese and milk derivate production. In these countries dairy production is based on protein and fat content, and not for only amount of milk produced (Lopes *et al.* 2012). On the other hand, in Iran, milk production is based in fluid milk and the fluid milk volume is more important, because no money pay for milk contents. Similar results were found by Lopes *et al.* (2012) for dairy goat production in Brazil, that have defined breeding goal included milk production, lactation length, Age at first kidding and kidding interval. Mueller *et al.* (2015) for cashmere goat have obtained fleece weight, down yield, down weight, down diameter, weaning weight, yearling weight and adult weight as breeding objectives. They reported that, at present there is no local fibre analyses laboratory providing sample analyses services to nomades. Thus, design breeding program may require operating without fleece sample analyses.

Construction of selection indices

Change of genetic gain with different buck ratio in selection indices from I_1 to I_4 were compared (Table 4).

Genetic gain was decreased as males to females mating ratio increased, and best genetic and economic response was related to buck ratio of 0.04 (Table 4). These results are in accordance with the results obtained by Kosgey *et al.* (2003), Bett *et al.* (2007), Abbasi and Savar (2015), Talebi *et al.* (2011) and Kasarda *et al.* (2014). A reduction in buck percent will accelerate genetic progress because of the high selection intensity (Falconer and Mackay, 1996). According to the results (Table 4), in the selection index 1 (I_1) where all the five traits included in the index, the highest amount of genetic gain (16.808) was obtained. Like this result, Abbasi and Savar (2015) for Afshari sheep, reported that the most suitable selection index is full index with ewe body weight, annual wools weight and total weaning weight for each exposed ewe.

In index 1 genetic gain for traits were 0.539 kg, 0.621 kg, 0.169 head, 0.296 kg and 0.058 kg for BWD, WK, NK, MW and CW respectively. In the selection index 2 (I_2), genetic gain were varied between 15.760 to 15.750 respectively (Table 4).

The lowest values of genetic gain, were obtained by using selection index 3 (I_3) and 4 (I_4) (Table 4). Highest increase for genetic gain was found for weight of kids for sale in index 4 (0.707 kg per year), but Bett *et al.* (2007) for Kenya dual purpose goat was found it for milk production (0.737 kg). Importance of weight of kids for sale decreased as an increase in the number of index traits. Similar results were reported by Lopes *et al.* (2012) for milk production.

Table 3 Observed and desired mean and desired gain of different traits

Traits	Observed mean	Desired mean	Desired gain
BWD (kg)	38	39	1
WK (kg)	20	21	1
NK (head)	0.90	1	0.1
MW (kg)	27	28	1
CW (kg)	0.55	0.6	0.05

BWD: body weight of doe; MW: milk weight; CW: cashmere weight; WK: weight of kids for sale; and NK: number of kids for sale per doe.

Table 4 Genetic gain per generation by different selection indices

Buck ratio	Index	Trait					Genetic gain
		BWD	WK	NK	MW	CW	
0.04	I_1	0.539	0.621	0.169	0.296	0.058	16.808
	I_2	0.551	0.640	-	0.293	0.061	15.760
	I_3	-	0.704	0.103	-	0.051	7.535
	I_4	-	0.707	-	-	0.052	7.285
0.05	I_1	0.532	0.619	0.164	0.291	0.052	16.798
	I_2	0.547	0.631		0.287	0.059	15.754
	I_3	-	0.699	0.101	-	0.048	7.531
	I_4	-	0.694	-	-	0.045	7.280
0.06	I_1	0.524	0.613	0.152	0.284	0.050	16.523
	I_2	0.539	0.625		0.281	0.051	15.750
	I_3	-	0.691	0.098	-	0.041	7.521
	I_4	-	0.687	-	-	0.040	7.271

BWD: body weight of doe; MW: milk weight; CW: cashmere weight; WK: weight of kids for sale; and NK: number of kids for sale per doe.

Highest progress for Body weight of doe and cashmere production were found 0.551 and 0.061 kg per year respectively in index 2. In the selection index 1 (I_1) the highest amount of genetic gain for number of kids for sale per doe and milk production were obtained (Table 4). Genetic gains for all traits were obtained to be positive under all selection indices. Bett *et al.* (2007) predicted that annual genetic gains for average daily milk yield, live weight and number of kids weaned ranged between 0.047 and 0.737 kg, 0.037 and 0.591 kg and 0.009 and 0.144 respectively, under different pathways selection. Higher genetic gains were obtained for each trait with higher selection intensity, which is in agreement with the results obtained in the present study. Genetic gain of traits was not changed largely in different selection indices, because of its positive genetic correlation between traits. Genetic gain of traits in multi-trait selection depended on heritability and correlation structure of traits. For a production system and genetic resource, response to selection modified by manipulating economic value and varying the information sources used, the first is powerful than the second (Talebi *et al.* 2011).

CONCLUSION

This selection index can apply for Rayeni Cashmere goat and should be very helpful for more efficient selection strategies. Results of this study indicated that for the genetic improvement of Rayeni Cashmere goat populations, index I_1 with five traits of body weight of doe (BWD), Milk weight (MW), cashmere weight (CW), weight of kids for sale (WK) and number of kids for sale per doe (NK) Can be used. The choice and use of the index depend on the objectives definition.

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