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Breeding goals and selection criteria for intensive and semi-intensive dairy goat system in Brazil

Fernando Brito Lopes[a], Arcadio de los Reyes Borjas[a], Marcelo Correia da Silva[a], Olivardo Facó[b], Raimundo Nonato Lôbo[b], Maria Clorinda Soares Fiorvanti[a], Concepta McManus[c,*]

[a] *Escola de Veterinária e Zootecnia, Universidade Federal de Goiás, Campus II, Goiânia, Brazil*
[b] *Embrapa Caprinos e Ovinos, Sobral, Ceará, Brazil*
[c] *Universidade Federal do Rio Grande do Sul, Av. Bento Gonçalves 7712, Porto alegre, Rio Grande do Sul, Brazil*

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ABSTRACT

The aim of this study was to identify traits of socio-economic relevance for intensive and semi-intensive dairy goat production system, to derive economic weights for the breeding goals and to propose selection indices whose criteria are easily collected by dairy goat breeders. The economic value of each trait was calculated as the difference between the average profit before and after the improvement of criteria, after increasing each trait by 1%, keeping the average of other traits unchanged. Eight selection indices were proposed. Four indices (I–IV) were determined for the intensive system and four (V–VIII) for the semi-intensive system. The traits included in each index were: milk production (MP) and lactation length (LL) (I and V); MP, LL, and age at first kidding (AFC) (II and VI); MP, LL, AFC and kidding interval (CI) (III and VII); and MP, LL, AFC, CI, somatic cell count (SCC) and total solids (TS) (IV and VIII). The average profit of the semi-intensive system was higher than the intensive system, R$ 0.18 and R$ 0.14, respectively. The use of indices III and VI promoted simultaneous improvement in both productive and reproductive traits. With differential payment for better quality milk, TS and SCC levels, use of indices IV and VIII are indicated. The choice and use of these indices depend on the definition of objectives and of the measurement ease of selection criteria.

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1. Introduction

The rapid increase in the human population in tropical areas leads to an increase in demand for food. An increase buying power in countries such as Brazil has also put pressure on systems to produce more without increasing the area being farmed. It is predicted that total production of meat and milk will have to double in the next twenty years (FAO, 2007).

The goat industry, including the production of goat milk, cheeses and meat increased 66% worldwide during the last 20 years compared to only 9% for cattle (Dubeuf and Boyazoglu, 2009), with an acceleration in this tendency during the past 5 years. With the increasing human population and pressure on land use, goats are gaining importance in smallholder production systems in areas with high potential (Bett et al., 2007a).

It is therefore necessary to increase animal production efficiency for farmers to obtain economic gain in their production systems, with selection of superior animals. This involves the estimation of genetic and phenotypic parameters, choice of selection criteria for each production system and determination of economic weights for the selection

* Corresponding author. Fax: +55 51 3308 6048.
E-mail address: concepta.mcmanus@ufrgs.br (C. McManus).

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Table 1
Trait levels for intensive (S1) and semi-intensive (S2) dairy goat systems in Brazil.

Source	S1	S2	Source	S1	S2
Fertility (%)	86	82	Milk production (kg/day)	2.01	1.61
Lactation length (days)	242.37	232.04	Milk price	1.26	1.26
Total mortality (%)	7	4	Proportion male:female (%)	2	5
Kidding interval (months)	11.52	11.33	Goat shed for male (m^2/animal)	9	3
Prolificacy (offspring per birth)	1.6	1.6	Goat shed for female (m^2/animal)	3	1.2

criteria that influence profit in these livestock production systems (Chen et al., 2009; Tozer and Stokest, 2002).

Goatfarming has increased in the tropics and is important for economic and social livelihoods of the large human population in these areas, contributing meat, milk and clothing in domestic markets (Kosgey et al., 2006). The relative importance of milk varies from one region to another due to ecological, economic and cultural factors.

In 2005, EMBRAPA Goat and Sheep created the Dairy Goat Breeding Program ("Programa de Melhoramento Genético de Caprinos Leiteiros"). The program aimed to structure the dairy goat national databank and to conduct progeny tests for the main dairy breeds raised in the country. With the support of the Brazilian Ministry of Agriculture, Goat and Sheep Breeders Association of the state of Minas Gerais (ACCOMIG–CAPRILEITE) and EMBRAPA Goat and Sheep, the Official Dairy Control Test has been carried out by technicians of the Brazilian Association of Holstein Breeders (ABCBRH) with an average of 45 days between tests. Some breeders have been carrying out analysis for milk protein, fat, lactose and total solids content as well as somatic cell count. The Official Dairy Control Test has been carried out in eleven flocks in the states of Minas Gerais, Rio de Janeiro and São Paulo (Southeast region) (Lôbo et al., 2010). Descriptions of the national breeding program can be found in Facó et al. (2011) who state that current selection criteria were mainly designed to respond to the market demand, and have focused on milk yields, lactation lengths and reproductive characteristics without any formal use of selection index theory.

The use of selection indices, through defining economic weights of important traits for the dairy goat production system, is important as the use of these indices can be promote improvement of groups of traits, simultaneously pondering both breeding value and economic weight. Thus, the study was undertaken to identify the traits that have greatest socio-economic importance for the intensive and semi-intensive dairy goat production systems in Brazil, derive economic weights for selection goals and propose selection indices that can be easily used by dairy goat farmers.

2. Material and methods

2.1. Data simulation and herd structure

In this study, productive and economic indices for intensive and semi-intensive dairy goat system from Brazil (Table 1) were collected from national literature (Barros et al., 2005; Medeiros et al., 2006; Rodrigues et al., 2006; Queiroga et al., 2007; Gonçalves et al., 2008; Vieira et al., 2009). Herds were composed of 100 females and were based on intensive and semi-intensive dairy goat systems. The number of breeding females in each age class was determined by:

$$HS = \frac{a \times (1-r)^n}{1-r},$$

where HS, herd size; r, survival rate; a, number of animals; and, n, number of years in the system.

The semi-intensive system is characterized by a mixed farming system. The animals are grazed and supplemented with crop residues and mineral salt. In the intensive system, the animals do not graze. They are kept housed and fed forage, mineral salt and concentrate. All food is provided in the trough and their production levels are generally higher than in semi-intensive systems.

2.2. Economic analysis

A deterministic and static bio-economic model was used in the herd simulation. Microsoft Excel spreadsheets were used to estimate productive and reproductive performances as well as of the costs and revenues. The systems, production costs and revenues, profit equation and derivation of the economic values were estimated as described by Moav and Hill (1996), Harris (1970), Bittencourt et al. (2006), Yáñez et al. (2006), Deminicis et al. (2008), Vieira et al. (2009). The sources of variation that influence the costs and revenue are presented in Table 2.

The economic indicators included: effective operational cost (EOC); production costs (PC); total operating cost (TOC), sum of the EOC and operating costs (i.e., durable asset depreciation); total cost (TC): sum of TOC, interest and remuneration; average cost (AC): division of TC and total production; total gross income (TGI): revenue of the total production in the agricultural year; gross margin (GM): difference between the average production and the EOC; net margin (NM): difference of TGI with TC; profit (P): TGI minus TC; average profit (AP): division of P and final production; profitability (Pa): division of TGI and EOC.

The economic values (EV) for the traits were obtained by difference between average profits (AP) before and after improvement (EV = AP′ − AP), where AP′ is the average profit after 1% increase in the traits, keeping other traits unchanged (Ponzoni, 1992).

Table 2
Sources of variation for costs and revenue in dairy goat production in Brazil.

Source	Trait
Revenue	
Milk	Milk production, lactation length, kidding interval, total solids, somatic cell count, fertility
Young males and females in reproduction	Prolificacy, fertility, mortality
Bucks and does	Adult weight, mortality
Cost	
Nutrition	Prolificacy, fertility, mortality, milk production, food consumption, adult weight
Housing	Prolificacy, fertility, mortality and milk production
Labor	Prolificacy, fertility, mortality and milk production
Health	Prolificacy, fertility, mortality, milk production and disease resistance

Table 3
Estimates of phenotypic (below diagonal), genetic (above diagonal) positive defined covariance and genetic and phenotypic variance for dairy goat production in Brazil.

	MP	LL	AFC	CI	SCC	TS
Structure of genetic and phenotypic covariance matrix						
MP		211.50	−470.02	−649.49	−3.71	552.57
LL	1337.79		−237.44	−1.62	−0.29	1.80
AFC	1816.58	1532.35		−835.11	2.15	−13.23
CI	2213.19	−1.62	4630.86		1.84	−11.36
SCC	−27.12	−0.35	2.18	1.81		−2.04
TS	2819.65	1.79	−13.22	−11.37	−1.91	
Genetic and phenotypic variance						
σ_a^2	1019.47	691.42	1407.56	2154.36	1.62	854.28
σ_p^2	6034.62	3561.42	7296.88	15013.36	7.26	4153.78

σ_a^2, direct additive genetic variance; σ_p^2, phenotypic variance; MP, milk production; LL, lactation length; AFC, age at first kidding; CI, kidding interval; SCC, somatic cell count; TS, total solids.

Table 4
Traits in selection indices for intensive (I–IV) and semi-intensive (V–VIII) dairy goat systems in Brazil.

Index	Selection criteria					
I and V	MP	LL				
II and VI	MP	LL	AFC			
III and VII	MP	LL	AFC	CI		
IV and VIII	MP	LL	AFC	CI	SCC	TS

MP, milk production; LL, lactation length; AFC, age at first kidding; CI, kidding interval; SCC, somatic cell count; TS, total solids.

2.3. Structure of (co)variance matrix

The phenotypic and genetic (co)variance matrix (Table 3), positive defined (Van Der Werf, 1999), was estimated using the phenotypic and genetic parameters from national and international literature (Butcher et al., 1966; Barillet and Bonaïti, 1992; Soares Filho et al., 2001; Berry et al., 2003; Pimenta Filho et al., 2004; Legarra and Ugarte, 2005; Lôbo and Silva, 2005; Corbet et al., 2006; Eknæs et al., 2006; Andrade et al., 2007; Bagnicka et al., 2007; Barillet, 2007; Queiroga et al., 2007; Riggio et al., 2007; Valencia et al., 2007; Toshniwal et al., 2008; Afolayan et al., 2009; Ahuya et al., 2009; Torres-Vásquez et al., 2009; Zhang et al., 2009).

2.4. Selection index

Hazel (1943) defined the aggregate genotype, H, for a given individual as the sum of its genotypes for several traits (assuming a distinct genotype for each economic trait), each genotype being weighted by their predicted contribution to the increase in the overall objective. This contribution is determined by so-called cumulative discounted expressions and economic values. The cumulative discounted expression of a trait reflects time and frequency of the future expression of a superior genotype originating from the use of a selected individual in a breeding program (Brascamp, 1978). Multiplying the economic value by the cumulative discounted expression gives the discounted economic value. The following equations illustrate the principles used:

$$H = a_1\text{BV}_1 + a_2\text{BV}_2 + \ldots + a_i\text{BV}_i$$

where BV_i is the breeding value for trait; and, a_i is the discounted economic value for trait i. The discounted economic value is $a_i = c_i \times v_i$ where, c_i is a cumulative discounted expression for trait i; and, v_i is the economic value of trait i.

Once a linearized breeding goal has been developed and economic values of economic traits have been estimated, selection index theory (Hazel, 1943) can be used to derive a linear selection index, which predicts the breeding goal as accurately as possible, given the information that is available in the form of EBV for individual traits:

$$I = b_1\text{EBV}_1 + b_2\text{EBV}_2 + \ldots + b_i\text{EBV}_i$$

where EBV_i is the estimated breeding value for trait i; and b_i is the index weight on EBV_i.

The MTINDEX program (Van Der Werf, 1999) was used to estimate the indices weight. The gene flow discounted was given by GFLOW program (Brascamp, 1975; Hill, 1974).

The selection indices were created for both systems (intensive and semi-intensive). Eight indices were proposed (Table 4): four indices (I–IV) for intensive system and four indices (V–VIII) for semi-intensive system. The traits included in each index were: indices I and V: milk production (MP) and lactation length (LL); indices II and VI: MP, LL, and age at first kidding (AFC); indices III and VII: MP, LL, AFC and kidding interval (CI); and Indices IV and VIII: MP, LL, AFC, CI, somatic cell count (SCC) and total solids (TS).

2.5. Sensitivity analysis

The parameter values and assumptions of any model are subject to change and error. Sensitivity analysis (SA), broadly defined, is the investigation of these potential changes and errors and their impacts on conclusions to be drawn from the model (Baird, 1989). Herd structure was changed by ±25% (increasing and decreasing in 25% the quantity of half-sibs and full-sibs); phenotypic and genetic parameters (heritability, repeatability, phenotypic and genetic correlation) and (co)variance components (phenotypic and genetic (co)variance). After increasing and decreasing in 25% these parameters, the percentage changes on the original indices were estimated.

3. Results

3.1. Breeding objective and selection criteria

Breeding goals and selection criteria (Table 5) include actual and possible traits. The differences between these

Table 5
Breeding goals and selection criteria for dairy goat systems in Brazil.

Breeding goals	Selection criteria
Actual	
Milk production	Milk production (kg) and lactation length (days)
Precocity	Age at first kidding (days) and kidding interval (days)
Possible	
Total solids	Total solids (g/100 g)
Mastitis resistance	Somatic cell count (ud)

Table 6
Economic indicators for intensive and semi-intensive dairy goat system in Brazil.

Economic indicator	System		
	Intensive (I)	Semi-intensive (SI)	(I/SI) × 100
Gross margin (R$)	46,171.84	46,227.41	100
Net margin (R$)	31,666.01	33,108.29	96
Profit (R$)	17,442.52	21,396.82	82
AOC (R$/kg of milk)	0.45	0.38	118
ATOC (R$/kg of milk)	0.57	0.49	115
ATC (R$/kg of milk)	0.68	0.59	114
Average profit (R$/kg of milk)	0.14	0.18	76
Profitability (%)	179	200	90

AOC, Average Operating Cost (OC/kg of milk); ATOC, Average Total Operating Cost (TOC/kg of milk); ATC, Average Total Cost (TC/kg of milk).

are: (i) actual includes traits currently recorded and paid by cooperatives for milk production in Brazil; and (ii) possible breeding goals, not used at present but possible for selection of dairy goats in Brazil.

To select animals for increased quantity of milk produced, milk production and lactation length was used as selection criteria. Age at first kidding and kidding interval were included to select early maturing animals. MP and LL as well as AFC and CI are positively correlated (Lôbo and Silva, 2005). Total solids and somatic cell count were included as selection criteria. Thus, it would be possible to select animals for increased total solids production as well as for resistance to mastitis (Sørensen et al., 2009; Vallimont et al., 2009).

3.2. Economic analysis

In general, the economic indicators showed similar results for both systems, with a slight advantage for the intensive system (up to 10%). Profit in both systems was practically the same, but average profit was better for the semi-intensive system (Table 6).

Profitability was 179% and 200% for the intensive and semi-intensive dairy goat system, respectively (Table 6). These meant that for each R$ 1.00 of operating cost, not investments considering, these systems had an average profit of R$ 1.79 and R$ 2.00 for the intensive and semi-intensive system, respectively.

3.3. Economic values

The economic values for breeding goals in the intensive system were larger than in the semi-intensive system (Table 7), because of the higher effective operating cost for the intensive system. At present, milk production, lactation length, kidding interval and age at first kidding are used for selection purposes by dairy goat breeders in Brazil. However, only milk production and lactation length showed high economic values. In Brazil, only a single dairy industry pays for better quality milk (somatic cell count and total solids). These traits showed relatively high economic values when compared with milk production.

3.4. Selection index

The selection index weights for the intensive (I–IV) and semi-intensive (V–VIII) dairy goat production systems showed high accuracies for all traits (>0.90 – Table 8). The importance of milk production decreased as an increase in the number of index traits. AFC was positive when only MP and LL were in the index but negative when quality traits were included. CI and SCC had negative weights while other traits were positive. In general weights were higher for the intensive system compared to the semi-intensive system.

The response to selection (Table 9) predicted for each trait using the selection indices (Table 7) showed mean increase of R$ 27.07, 18.57, −14.45, −13.22, −0.73 and 22.01 for intensive system and mean increase of R$ 23.21, 14.82, −10.44, −9.97, −0.41 and 17.24 for semi-intensive system, per generation for MP, LL, AFC, CI, SCC and TS, respectively. Higher increases were found for milk traits in indices without reproduction traits in both systems (intensive and semi-intensive).

3.5. Sensitivity analysis

The sensitivity analysis (Table 10) showed low variability in the index weights. In both systems, the mean sensitivity for milk production, lactation length, age at first kidding, kidding interval, somatic cell count and total solids were 8.71, 8.65, 10.43, 8.25, 4.61 and 1.68%, respectively.

In general, the sensitivity was lowest 15%. This is indicative that the selection indices are reliable and that possible changes in genetic and phenotypic parameters as well as in structure of the herd would not cause major changes in the selection index weights.

Table 7
Economic values (R$ – Brazilian reais) for actual and possible breeding objectives in dairy goats in Brazil.

Trait	System	
	Intensive	Semi-intensive
Milk production (kg/animal)[a]	3.77	3.14
Lactation length (days)[a]	2.63	2.47
Age at first kidding (days)[a]	0.97	0.68
Kidding interval (days)[a]	0.87	0.81
Somatic cell count[b]	−2.37	−2.20
Total solids (g/100 g)[b]	1.94	1.79

[a] Actual breeding objective.
[b] Possible breeding objective.

Table 8
Selection indices and their accuracies (r_{HI}) for intensive and semi-intensive dairy goat systems in Brazil.

System	Index	Traits						r_{HI}
		MP	LL	AFC	CI	SCC	TS	
Intensive	I	11.23	7.92					0.93
	II	9.88	7.01	1.37				0.92
	III	6.91	7.35	−2.46	−1.11			0.93
	IV	3.40	7.89	−2.99	−1.94	−17.67	46.96	0.95
Semi-intensive	V	8.44	6.97					0.92
	VI	8.83	5.83	1.09				0.91
	VII	7.99	6.77	−1.99	−0.63			0.93
	VIII	3.21	6.94	−2.17	−1.15	−14.99	44.22	0.95

MP, milk production; LL, lactation length; AFC, age at first kidding; CI, kidding interval; SCC, somatic cell count; TS, total solids; r_{HI}, accuracy of selection index.

Table 9
Response to selection for selection criteria in dairy goat systems in Brazil.

System	Index	Trait					
		MP	LL	AFC	CI	SCC	TS
Intensive	I	27.91	18.99				
	II	26.73	18.71	−14.91			
	III	26.74	18.97	−13.88	−15.02		
	IV	26.88	17.59	−14.56	−11.42	−0.73	22.01
Semi-intensive	V	23.97	15.13				
	VI	22.91	14.99	−10.11			
	VII	22.75	15.06	−9.98	−11.91		
	VIII	23.21	14.11	−11.24	−8.03	−0.41	17.24

MP, milk production; LL, lactation length; AFC, age at first kidding; CI, kidding interval; SCC, somatic cell count; TS, total solids.

4. Discussion

Economic weights for productive and reproductive traits are necessary to objectively select animals with superior genotypes (Togashi and Lin, 2009; Wolfová et al., 2009). To select an animal for precocity that produce high volumes of milk, for example, it is necessary to obtain accurate predictions of breeding values for selection criteria such as milk production, length lactation, age of first kidding and kidding interval.

Some traits may not have an economic impact on livestock production or some breeding goals may have many indicator traits. The choice and estimation of correct selection criteria (Table 5) can be among the most important decisions made by dairy goat breeders (Queiroz et al., 2005; Bett et al., 2007b).

In general, the economic indicators showed similar results, with a slight advantage for the intensive system (up to 10%). Profit in both systems was practically the same, but average profit was significantly better for the semi-intensive system (R$ 0.14 and R$ 0.18 for the intensive and semi-intensive systems, respectively) (Table 2). Similar results were found by Dal Monte et al. (2009) for goat production in Brazil, emphasizing that larger profit margins occurred in less technified production systems. This was because nutritional costs were significantly lower in the semi-intensive systems, with little differences in production levels. These costs were 46.49% and 36.78% of the total production costs for intensive and semi-intensive systems, respectively.

Nutritional management accounted for more than 60% of operational costs. Similar results were reported by Dal

Table 10
Sensitivity of selection index coefficients (as a % of index) to change (±25%) in genetic and phenotypic parameters and herd structure.

System	Index	Change (%)	Sensitivity (%)					
			MP	LL	AFC	CI	SCC	TS
Intensive	I	±25	5.27	7.67				
	II	±25	11.44	10.39	12.63			
	III	±25	10.31	11.67	10.11	5.16		
	IV	±25	12.09	6.83	10.57	12.47	5.17	2.02
Semi-intensive	V	±25	3.01	5.03				
	VI	±25	6.72	10.88	10.17			
	VII	±25	9.78	10.74	9.13	3.91		
	VIII	±25	11.03	5.98	9.99	11.44	4.05	1.34

MP, milk production; LL, lactation length; AFC, age at first kidding; CI, kidding interval; SCC, somatic cell count; TS, total solids.

Monte et al. (2009): working with goat and sheep in Northeastern and Vieira et al. (2009): working with dairy goats in Southeastern of Brazil. Nutritional management that ensures low feed wastage has the potential to result in an increase in economic return of the dairy goat production system.

Multiple traits selection using selection indices (Hazel, 1943) is the fastest and most efficient manner to improve the aggregate breeding value. As many traits are used in the selection index to produce a single value, which is used to predict the economic genetic merit for the animals in selection (Queiroz et al., 2005; Lambe et al., 2008; Cunningham and Tauebert, 2009).

The selection criteria vary between different dairy goat systems (Gonçalves et al., 2008; Ahuya et al., 2009; Vieira et al., 2009). In Brazil, the dairy goat selection has is based on milk production and early breeding females (Lôbo and Silva, 2005). Thus, eight selection indices (Table 8) are proposed to facilitate better animal selection. These selection indices can be used in accordance with the breeding goals of each dairy goat breeder.

Some farmers cannot select for traits such as total solids and/or somatic cell count, due to the prohibitive cost of measuring and recording these traits. However, to facilitate the management of the animals, many dairy goat breeders carry out control of milk production as well as reproductive traits. Thus, these breeders have information on milk production (MP), lactation length (LL), age at first parturition (AFC) and parturition interval (CI) (Barros et al., 2005; Lôbo and Silva, 2005; Medeiros et al., 2006). For these breeders, we created selection indices whose criteria (MP, LL, AFC and CI) are easily collected (Table 8). The selection index accuracy was high (Table 9), indicating a high correlation between the selection index and the breeding goal. Thus, results of this study showed that the selection indices are reliable.

The negative weights for age at first kidding and kidding interval in indices III, IV, VII and VIII can result in selection for early developing animals (Table 8). Likewise, the indices II and VI resulted in negative response to selection, because the zero or negative correlation estimates between the productive and reproductive traits were reported by some authors (Andersen-Ranberg et al., 2005; Verceci Filho et al., 2007; David et al., 2008). The indices III and VII showed greatest reduction in age at first kidding and kidding interval, than indices VI and VIII CI (Table 9).

In general, total solids and somatic cell (SCC) count are considered important traits for milk production. Some authors have proposed the use of somatic cell count as a mastitis indicator (Heringstad et al., 2008; Rupp et al., 2009). In dairy goat systems the quality of milk production is very important. The results showed that the use of SCC as breeding goals decreased the somatic cell amount as expected. This can improve the mastitis resistance, because there is high correlation between the somatic cell count and occurrence of mastitis (Sørensen et al., 2009; Vallimont et al., 2009).

The sensitivity analysis showed that there is a low percentage of variability for the production (MP, LL and TS), reproduction (AFC and CI) and mastitis (SCC) traits (Table 10). The use of the selection indices can simultaneously improve a group of traits as well as facilitate the ranking and choice of better animals selected to be parents of future generations. Thus, it is possible to increase selection intensity and select more profitable animals for a group of traits (Shook, 2006).

In Table 10 we observed a low variability in selection indices to variations (±25%) in genetic and phenotypic parameters and herd structure. In other words, the increase or decrease in parameter estimates or herd structure would not result in significant modification in index weights.

The breeding goals for the dairy goat system in Brazil 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 (Tabbaa and Al-Atiyat, 2009). On the other hand, in Brazil, dairy goat production is based in fluid milk. Thus, in Brazil, the fluid milk volume is more important, because the dairy industry does not pay for milk contents, as protein and fat (Shook, 2006). However, it may be important to select for these traits when the breeding goal is not only amount of milk produced. If there existed government and private incentives, as well as a demand for dairy products such as cheese, yogurt and total solids (including protein and fat contents), the selection using these indices can be an excellent alternative to improve the productivity of dairy goat systems (Miglior et al., 2005; Shook, 2006; Cunningham and Tauebert, 2009).

5. Conclusion

The use of selection indices with milk production, lactation length, age at first kidding and kidding interval promoted simultaneous improvement in the productive and reproductive traits. Having differentiated payment for milk of better quality, including total solids and somatic cell count levels, we suggest the use of indices IV and VIII. The choice and use of these indices depend on the objectives definition and of the measurement ease of selection criteria. However, the fact that the breeding objective also considers future productions as well as the marketing circumstances should be highlighted and failure to include a criteria today does not necessarily mean it should not be included in future evaluations.

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References

Afolayan, R.A., Fogarty, N.M., Morgan, J.E., Gaunt, G.M., Cummins, L.J., Gilmour, A.R., 2009. Preliminary genetic correlations of milk production and milk composition with reproduction, growth, wool traits and worm resistance in crossbred ewes. Small Rumin. Res. 82, 27–33.

Ahuya, C.O., Ojango, J.M.K., Mosi, R.O., Peacock, C.P., Okeyo, A.M., 2009. Performance of Toggenburg dairy goats in smallholder production systems of the eastern highlands of Kenya. Small Rumin. Res. 83, 7–13.

Andersen-Ranberg, I.M., Heringstad, B., Klemetsdal, G., Svendsen, M., Steine, T., 2005. Heritabilities, genetic correlations, and genetic change

for female fertility and protein yield in Norwegian dairy cattle. J. Dairy Sci. 88, 348–355.
Andrade, L.M., Faro, L.E., Cardoso, V.L., Albuquerque, L.G., Cassoli, L.D., Machado, P.F., 2007. Efeitos genéticos e de ambiente sobre a produção de leite e a contagem de células somáticas em fêmeas holandesas. Rev. Bras. Zootec. 36, 343–349.
Bagnicka, E., Wallin, E., Lukaszewicz, M., Adnøy, T., 2007. Heritability for reproduction traits in Polish and Norwegian populations of dairy goat. Small Rumin. Res. 68, 256–262.
Baird, B.F., 1989. Managerial Decisions Under Uncertainty: An Introduction to the Analysis of Decision Making. Wiley, New York.
Barillet, F., Bonaïti, B., 1992. Les objectifs et les critères de selection: La production laitière des ruminants traits. Prod. Anim., hors série, 117–121.
Barillet, F., 2007. Genetic improvement for dairy production in sheep and goats. Small Rumin. Res. 70, 60–75.
Barros, N.N., Silva, F.L.R., Rogerio, M.C.P., 2005. Efeito do genótipo sobre a produção e a composição do leite de cabras mestiças. Rev. Bras. Zootec. 34, 1366–1370.
Berry, D.P., Buckley, F., Dillon, P., Evans, R.D., Veerkamp, R.F., 2003. Genetic relationships among body condition score, body weight, milk yield, and fertility in dairy cows. J. Dairy Sci. 86, 2193–2204.
Bett, R.C., Kosgey, I.S., Bebe, B.O., Kahi, A.K., 2007a. Genetic improvement of the Kenya dual purpose goat: influence of economic values and prospects for a practical breeding programme. Trop. Sci. 47, 105–119.
Bett, R.C., Kosgey, I.S., Bebe, B.O., Kahi, A.K., 2007b. Genetic improvement of the Kenya dual purpose goat. II. Estimation of economic values for production and functional trait. Trop. Anim. Health Prod. 39, 467–475.
Bittencourt, T.C.C., Lôbo, R.B., Bezerra, L.A.F., 2006. Objetivos de seleção para sistemas de produção de gado de corte em pasto: ponderadores econômicos. Arq. Bras. Med. Vet. Zootec. 58, 196–204.
Brascamp, E.W., 1975. Model calculations concerning economic optimization of A.I. breeding with cattle. The economic value of genetic improvement in milk yield, 846 p. Doctoral Thesis – Centre for Agricultural Publication and Documentation.
Brascamp, E.W., 1978. Methods on economic optimization of animal breeding plans. Report B-134, Research Institute for animal Husbandry "Schoonoord", Zeit.
Butcher, K.R., Sargent, F.D., Legates, J.E., 1966. Estimates of genetic parameters for milk constituents and yields. J. Dairy Sci. 50, 185–193.
Chen, J., Wang, Y., Zhang, Y., Sun, D., Zhang, Y., 2009. Estimation of economic values for production and functional traits in Chinese holstein. J. Anim. Vet. Adv. 8, 2125–2132.
Corbet, N.J., Shepherd, R.K., Burrow, H.M., Prayaga, K.C., Van Der Westhuizen, J., Bosman, D.J., 2006. Evaluation of Bonsmara and Belmont red cattle breeds in South Africa. 2. Genetic parameters for growth and fertility. Aust. J. Exp. Agric. 46, 213–223.
Cunningham, E.P., Tauebert, H., 2009. Measuring the effect of change in selection indices. J. Dairy Sci. 92, 6192–6196.
Dal Monte, H.L.B., Costa, R.G., Filho, E.C.P., Júnior, E.H., Rodrigues, A., 2009. Mensuração dos custos e avaliação de rendas em diferentes sistemas de produção de leite caprino nos Cariris Paraibanos. As ações do Banco do Nordeste do Brasil em P&D na Arte da Pecuária de Caprinos e Ovinos no Nordeste Brasileiro. Fortaleza: Banco do Nordeste do Brasil 4, 93–130.
David, I., Astruc, J.M., Lagriffoul, G., Manfredi, E., Robert-Granié, C., Bodin, L., 2008. Genetic correlation between female fertility and milk yield in lacaune sheep. J. Dairy Sci. 91, 4047–4052.
Deminicis, B.B., Vieira, H.D., Knifis, A.L., Ponciano, N.J., Sousa, P.M., Blume, M.C., 2008. Análise econômica de sistemas de produção de leite de cabra no Estado do Rio de Janeiro. Arch. Zootec. 57, 377–380.
Dubeuf, J.-P., Boyazoglu, J., 2009. An international panorama of goat selection and breeds. Livest. Sci. 120, 225–231.
Eknæs, M., Kolstad, K., Volden, H., Hove, K., 2006. Changes in body reserves and milk quality throughout lactation in dairy goats. Small Rumin. Res. 63, 1–11.
Facó, O., Lôbo, R.N.B., Gouveia, A.G., Guimaraes, M.P.S.L.M.P., Fonseca, J.F., Santos, T.N.M., Silva, M.A.A., Villela, L.C.V., 2011. Breeding plan for commercial dairy goat production systems in southern Brazil. Small Rumin. Res. 98, 164–169.
FAO, 2007. Livestockĭs Long Shadow: Environmental Issues and Options , Rome, Italy.
Gonçalves, A.L., Lana, R.P., Vieira, R.A.M., Henrique, D.S., Mancio, A.B., Pereira, J.C., 2008. Avaliação de sistemas de produção de caprinos leiteiros na Região Sudeste do Brasil. Rev. Bras. Zootec. 37, 366–376.
Harris, L.L., 1970. Breeding for efficiency in livestock production: defining the economic objectives. J. Anim. Sci. 30, 860–865.
Hazel, L.N., 1943. The genetic basis for constructing selection indexes. Genetics 28, 476–490.
Heringstad, B., Sehested, E., Steinet, T., 2008. Short communication: correlated selection responses in somatic cell count from selection against clinical mastitis. J. Dairy Sci. 91, 4437–4439.
Hill, W.G., 1974. Prediction and evaluation of response to selection with overlapping generations. Anim. Prod. 18, 117–139.
Kosgey, I.S., Baker, R.L., Udo, H.M.J., Van Arendonk, J.A.M., 2006. Successes and failures of small ruminant breeding programmes in the tropics: a review. Small Rumin. Res. 61, 13–28.
Lambe, N.R., Bünger, L., Bishop, S.C., Simm, G., Conington, J., 2008. The effects of selection indices for sustainable hill sheep production on carcass composition and muscularity of lambs, measured using X-ray computed tomography. Animal 2, 27–35.
Legarra, A., Ugarte, E., 2005. Genetic parameters of udder traits, somatic cell score, and milk yield in latxa sheep. J. Dairy Sci. 88, 2238–2245.
Lôbo, R.N.B., Silva, F.L.R., 2005. Parâmetros genéticos para características de interesse econômico em cabras das raças Saanen e Anglo-nubiana. Rev. Cienc. Agron. 36, 104–110.
Lôbo, R.N.B., Facó, O., Lôbo, A.M.B.O., Villela, L.C.V., 2010. Brazilian goat breeding programs. Small Rumin. Res. 89 (April (2–3)), 149–154.
Medeiros, L.F.D., Vieria, D.H., Rodrigues, V.C., Barbosa, C.G., Scherer, P.O., 2006. Características de reprodução, peso ao nascer e mortalidade de caprinos Anglo-nubianos, nomunicípio do Rio de Janeiro. Rev. Bras. Cienc. Vet. 13, 37–43.
Miglior, F., Muir, B.L., Van Doormaal, B.J., 2005. Selection indices in holstein cattle of various countries. J. Dairy Sci. 88, 1255–1263.
Moav, R.V., Hill, W.G., 1996. Specialized sire and dam lines. IV. Selection within lines. Anim. Prod. 8, 375–390.
Pimenta Filho, E.C., Sarmento, J.L.R., Ribeiro, M.N., 2004. Efeitos genéticos e ambientais que afetam a produção de leite e duração da lactação de cabras mestiças no estado da Paraíba. Rev. Bras. Zootec. 33, 1426–1431.
Ponzoni, R.W., 1992. Genetic improvement of hair sheep in the tropics. FAO Animal Production, Bletchley, and Health Paper, 101: 162 pp.
Queiroga, R.C.R.E., Costa, R.G., Biscontini, T.M.B., Medeiros, N.A., Madruga, M.S., Schuler, A.R.P., 2007. Influência do manejo do rebanho, das condições higiênicas da ordenha e da fase de lactação na composição química do leite de cabras Saanen. Rev. Bras. Zootec. 36, 430–437.
Queiroz, A.S., Pelicioni, L.C., Silva, B.F., Sesana, J.C., Martins, M.I.E.G., Sanches, A., 2005. Índices de seleção para um rebanho Caracu de duplo propósito. Rev. Bras. Zootec. 34, 827–837.
Riggio, V., Finocchiaro, R., Van Kaam, J.B.C.H.M., Portolano, B., Bovenhuis, H., 2007. Genetic parameters for milk somatic cell score and relationships with production traits in primiparous dairy sheep. J. Dairy Sci. 90, 1998–2003.
Rodrigues, L., Spina, J.R., Teixeira, I.A.M.A., Dias, A.C., Sanches, A., Resende, K.T., 2006. Produção, composição do leite e exigências nutricionais de cabras Saanen em diferentes ordens de lactação. Acta Sci. Anim. Sci. 28, 447–452.
Rupp, R., Bergonier, D., Dion, S., Hyonenq, M.C., Aurel, M.R., Robert-Granié, C., Foucras, G., 2009. Response to somatic cell count-based selection for mastitis resistance in a divergent selection experiment in a divergent selection experiment in sheep. J. Anim. Sci. 92, 1203–1219.
Shook, G.E., 2006. Major advances in determining appropriate selection goals. J. Dairy Sci. 89, 1349–1361.
Soares Filho, G., McManus, C., Mariante, A.S., 2001. Fatores Genéticos e Ambientais que Influenciam Algumas Características de Reprodução e Produção de Leite em Cabras no Distrito Federal. Rev. Bras. Zootec. 30, 133–140.
Sørensen, L.P., Mark, T., Madsen, P., Lund, M.S., 2009. Genetic correlations between pathogen-specific mastitis and somatic cell count in Danish holsteins. J. Dairy Sci. 92, 3457–3471.
Tabbaa, M.J., Al-Atiyat, R., 2009. Breeding objectives, selection criteria and factors influencing them for goat breeds in Jordan. Small Rumin. Res. 84, 8–15.
Togashi, K., Lin, C.Y., 2009. Economic weights for genetic improvement of lactation persistency and milk yield. J. Dairy Sci. 92, 2915–2921.
Torres-Vásquez, J.A., Valencia-Pesadas, M., Castillo-Juárez, H., Montaldo, H.H., 2009. Genetic and phenotypic parameters of milk yield, milk composition and age at first kidding in Saanen goats from Mexico. Livest. Sci. 126, 147–153.
Toshniwal, J.K., Dechow, C.D., Cassell, B.G., Appuhamy, J.A.D.R., Varga, G.A., 2008. Heritability of electronically recorded daily body weight and correlations with yield, dry matter intake, and body condition score. J. Dairy Sci. 91, 3201–3210.
Tozer, P.R, Stokest, J.R., 2002. Producer breeding objectives and optimal sire selection. J. Dairy Sci. 85, 3518–3525.
Valencia, M., Dobler, J., Montaldo, H.H., 2007. Genetic and phenotypic parameters for lactation traits in a flock of Saanen goats in Mexico. Small Rumin. Res. 68, 318–322.

Vallimont, J.E., Dechow, C.D., Sattler, C.G., Clay, J.S., 2009. Heritability estimates associated with alternative definitions of mastitis and correlations with somatic cell score and yield. J. Dairy Sci. 92, 3402–3410.
Van Der Werf, J., 1999. Software MTINDEX – Multiple Trait Selection Index 20Trait Version [online]. The University of New England, Armidale, Australia.
Verceci Filho, A.E., Madalena, F.E., Albquerque, L.G., Freitas, A.F., Borges, L.E., Ferreira, J.J., Teodoro, R.T., Faria, F.J.C., 2007. Parâmetros genéticos entre características de leite, de peso e a idade ao primeiro parto em gado mestiço leiteiro (*Bos taurus* x *Bos indicus*),. Arq. Bras. Med. Vet. Zootec. 59, 983–990.
Vieira, R.A.M., Cabral, A.J., Souza, P.A., Fernandes, A.M., Henrique, D.S., Corte Real, G.S.C.P., 2009. Dairy goat husbandry amongst the household agriculture: herd and economic indexes from a case study in Rio de Janeiro, Brazil. Rev. Bras. Zootec. 38, 203–213.
Wolfová, M., Wolf, J., Krupová, Z., Kica, J., 2009. Estimation of economic values for traits of dairy sheep. I. Model development. J. Dairy Sci. 92, 2183–2194.
Yáñez, L., Aranguren-Mendez, J., Villasmil-Ontiveros, Y., Rojas, N., Chirinos, Z., Ordóñez, J., 2006. Modelo Bioeconómico de Simulación para Orientar la Definición del Objetivo de Selección en el Sistema Doble Propósito. Rev. Cient. 16, 315–324.
Zhang, C.Y., Chen, S.L., Li, X., Xu, D.Q., Zhang, Y., Yang, L.G., 2009. Genetic and phenotypic parameter estimates for reproduction traits n the Boer dam. Livest. Sci. 125, 60–65.