Evaluation of Brazilian Dairy Goat Breeding Programs

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ABSTRACT: This work aimed to evaluate the genetic and economic gains for two selection schemes for dairy goats in Brazil. Analyses were performed by ZPLAN software. The traditional scheme had no economic viability, except with high levels (>=60%) of using nucleus bucks on commercial flocks. However, this has no practical feasibility due the low use of artificial insemination in Brazil. The progeny testing of young bucks presented viability, with considerable genetic gains for the selection objective and the individual traits that make up this goal. The economic returns of the program outweighed its costs, with an investment return of 20 %. In this scheme, the trait of greater economic impact was milk yield followed by somatic cell count. The amount of using of young bucks should be up to 15 % since higher levels reduce the economic efficiency of the program.

Keywords: dairy goats; economic evaluation; genetic gain and profit; net present value

Introduction

Brazil is the 15th producer of goat milk in the world with an annual production of about 158.000 tons. The general flock's productivity is low, with elite breeders concentrated mainly in Southeast region of the country. Until 2002, there were no breeding programs for goats in Brazil, but only animal importation to use in crossbreeding to try to improve the productive indexes (Lôbo et al. (2010)). Facó et al. (2011) reported on problems related to this importation: high costs, health risks, use of animals selected for different objectives, genetic-environmental interaction, etc. Thus, in 2005, Embrapa Goats and Sheep started the Dairy Goats Breeding Program (CAPRAGENE) and established the progeny testing of young bucks and the official milk recording for structuring of a national databank for the major breeds raised for milk production (Lôbo et al. (2010); Facó et al. (2011)).

In running a breeding program, it is essential to assess its efficiency in order to verify alternative schemes (Harris et al. 1984). As in any other activity, a breeding program presents costs for its implementation and it is necessary to monitor them so that there are economic benefits from the program. The most efficient breeding program is one that maximizes return on investment. This profit is not completely proportional to the increase in production, although there are higher incomes when it produces more. Thus, economic evaluations, as well as genetic evaluations are necessary for rational and efficient management of these programs (Lôbo et al. (2000)). The objective of this study was to evaluate the viability of a national dairy goat breeding program in Brazil, comparing two schemes of selection.

Materials and Methods

Optimization of breeding plans. The economic and genetic evaluations were performed by the computer program ZPLAN Version 2008 (Willam et al., 2008). This software optimizes selection strategies using deterministic simulations. It is based on the gene flow method (Hill (1974); McClintock and Cunningham (1974)) and selection index procedures.

Population and breeding plans. A dairy goat population of 600.000 animals was used in this study. From those animals 40.000 were considered as breeding nucleus. In Brazil, there is no clear definition of multiplier flocks. So, the population was stratified only with nucleus and commercial flocks. Two breeding schemes were evaluated: the traditional scheme, which represents the general production system in Brazil, and the progeny testing of young bucks proposed by CAPRAGENE (Lôbo et al. (2010)).

Traditional breeding plan. In this scheme the nucleus is closed to upward gene-flow. The commercial flocks receive genes from the nucleus only by the purchase of bucks from the nucleus. The direct pass of does from nucleus to commercial was not considered. The selection criteria and breeding objective included milk yield, lactation length, age at first kidding and kidding interval (Lopes et al. (2012)). The index used in selection of nucleus bucks included one measurement of each of those traits from its dam and the index for the nucleus does included its own information and those from its dam for the same traits.

Progeny testing scheme. The progeny testing plan considered the same population structure presented above except that the nucleus bucks were selected by two selection pathways. The young bucks are progeny tested in the nucleus and commercial flocks by using of artificial insemination. The gene flow from nucleus to commercial was from young and proven bucks. Somatic cell count and dry milk solids were included to the traditional breeding objective currently used by the breeders in Brazil and reported above (Lopes et al. (2012)). The selection index to nucleus bucks included one measurement from its dam, two measurements from the dam of its sire and two from the dam of its dam, and one measurement of 30 their daughters for milk yield, lactation length, age at first kidding, kidding interval, somatic cell count, fat content, protein content and total dry extract content. Those same traits were used in the selection index for nucleus does with one measurement from the own individual and two measurements in its dam.

Input parameters for the breeding program. The biological and technical parameters for the simulation are presented in Table 1. These parameters were derived from a literature search, the current production system in Brazil or expert opinion, depending on their availability. The genetic and phenotypic parameters are given in Table 2 and Table 3.

Table 1. Biological and technical parameters used in the simulation for the goat breeding program

	Nucleus		Commercial
Trait	**Trad**	**PT**	
Bucks HL, yr.	7	-	6
Proved bucks HL, yr.	-	5	
Young bucks HL, yr.	-	4	
Does HL, yr.	8	8	6
Bucks ABF, yr.	1.5	-	2.5
Proved bucks ABF, yr.	-	4	
Young bucks ABF, yr.	-	1.5	
Does ABF, yr.	1	1	1
Survival, %	96	96	93
Kidding interval, yr.	0.80	0.80	0.90
Parity rate, %	87	87	85
Litter size	1.49	1.49	1.49
Availability, %	87	87	87
Does per buck	40	40	40
Artificial insemination, %	-	50	10[&]
Nr. doses semen buck/year	-	1.200	-
Nr. services per conception	-	1.18	-

Trad: traditional plan; PT: progeny testing plan; HL: herd life; ABF: age when born first kid; Availability: young does available for selection.
[&]Only for progeny testing

Table 2. Economic value (V), trait average (A), standard deviation (s_p), repeatability (r) and heritability (h^2) used in the breeding program

	V, US$[&]	A	s_p	r	h^2
MY, kg	0.016	768.00	351.67	0.36	0.19
LL, day	0.011	676.00	73.20	0.43	0.07
AFK, day	0.0004	376.89	80.57		0.21
KI, day	0.004	312.06	148.68	0.06	0.06
SCC	-0.024	1,340,000	700	-	0.24
DS, %	0.010	11.4	2.36	0.18	0.16
PROT, %	-	3.1	0.44	0.63	0.54
FAT, %	-	3.7	0.78	0.60	0.52

[&]The values presented here were converted (Lopes at al. (2012)) to American dollars (US$ 1 = R$ 2.35 / Dec 03 2013)
MY: milk yield; LL: lactation length; AFK: age at first kidding; KI: kidding interval; SCC: somatic cell count; DS: dry milk solids; PROT: milk protein content; FAT: milk fat content.

Table 3. Genetic (above diagonal) and phenotypic (below diagonal) correlations used in the simulation for the goat breeding program

	MY	LL	AFK	KI	SCC	DS	PROT	FAT
MY	-	0.66	0.05	0.35	0.12	0.00	-0.38	-0.16
LL	0.76	-	-0.24	-0.001	-0.01	-0.001	-0.001	-0.001
AFK	-0.14	-0.09	-	0.64	0.00	0.00	0.00	0.00
KI	-0.17	-0.07	0.07	-	0.00	0.00	0.00	0.00
SCC	0.00	0.05	0.00	0.00	-	0.00	-0.13	-0.20
DS	0.00	-0.01	0.00	0.00	0.01	-	0.40	0.60
PROT	-0.28	-0.005	0.00	0.00	0.01	0.50	-	0.01
FAT	-0.18	-0.005	0.00	0.00	0.01	0.70	0.01	-

MY: milk yield; LL: lactation length; AFK: age at first kidding; KI: kidding interval; SCC: somatic cell count; DS: dry milk solids; PROT: milk protein content; FAT: milk fat content.

Investment parameters and costs. The investment period considered was 20 years, using 8 % and 6 % of discount rates for returns and costs, respectively. The annual fix costs of the program were estimated in US$ 196,042.98 (average time to occurrence 1.5 yr. for the traditional scheme and 2 yr. for the progeny testing). The fixed costs referred to the outlay of a breeders association. The variable costs considered were: a) monitoring the flocks and pedigree recording per animal – US$ 15.38 (average time to occurrence 1.5 yr.); b) daily milk yield recording per animal – US$ 5.53; c) measurement of total milk yield per lactation – US$ 37.49 (average time to occurrence 1.84 yr.); d) measurement of lactation length – US$ 0.85 (average time to occurrence 1.84 yr.); e) measurement of age at first kidding – US$ 0.42 (average time to occurrence 1.0 yr.); f) measurement of kidding interval – US$ 0.42 (average time to occurrence 1.80 yr.); g) measurement of milk quality – US$ 8.36 (average time to occurrence 1.84 yr.); h) collecting semen dose – US$ 2.00 (average time to occurrence 0.8 yr.); i) semen storage – US$ 0.21 (average time to occurrence 0.8 yr.); j) annual semen collection for proven bucks – US$ 1,276.59 (average time to occurrence 3.5 yr.); k) semen collection of young bucks – US$ 297.87 (average time to occurrence 0.8 yr.).

Results and Discussion

The annual genetic gain for the breeding goal in the traditional scheme was lower (US$ 0.94) than that estimated for the progeny testing scheme (US$ 1.09) (Table 4). The progeny testing scheme also presented higher genetic profit (US$ 8.44). One of the factors that promoted the higher genetic gain in the progeny testing was the genetic correlations of milk yield and lactation length with the trait dry milk solids. In the traditional scheme this last trait was not considered and the selection emphasized fluid milk. This is reinforced by observing that the genetic response to milk yield in the traditional plan (55.03 kg/yr.) was higher than in the progeny testing scheme (39.90 kg/yr.).

Table 4. Results for the two selection schemes evaluated for the Brazilian goat breeding program

	Traditional		Progeny Test	
Variable	**ΔG**	**GP (US$)**	**ΔG**	**GP (US$)**
Breeding goal	US$ 0.94	1.255	US$ 1.09	8.445
Milk yield	55.03 kg	1.193	39.90 kg	4.970
Lactation length	2.21 days	0.033	3.48 days	0.302
Age at first kidding	2.45 days	0.010	1.85 days	0.046
Kidding interval	4.97 days	0.018	5.32 days	0.118
Somatic cell count	-	-	-37.94	3.008

Dry milk solids, %	-	-	-0.002	0.000
Generation interval	4.48 yr.		5.38 yr.	
Fixed costs	US$ 1.06		US$ 1.06	
Variable costs	US$ 2.47		US$ 4.76	
Total costs	US$ 3.53		US$ 5.83	
Total genetic profit	US$ 1.25		US$ 8.45	
Net present value	US$ - 2.28		US$ 2.61	

ΔG: annual genetic response; GP: genetic profit/doe;

The genetic gain for goat milk yield estimated with field data in Brazil ranges from -0.81 kg/yr. to 1.05 kg/yr. (Gonçalves et al. (2002); Lôbo and Silva (2005)). Montaldo and Manfredi (2002) reported genetic gain of 13 kg/yr. for milk yield in France. It is important to highlight that the higher values presented in this study, superior to real data, came from a deterministic simulation without considering variation in the parameters in an optimized situation. In real situations, many factors contribute to reduce the possibility of optimization and maximization of theoretical genetic gains.

Milk yield represented 95 % and 60 % of the genetic profit for the breeding goal in the traditional and the progeny testing plans, respectively. This was expected, as milk yield is the main trait in the dairy goat productions systems in Brazil and it has a high economic value. Studies with dairy cattle also observed the higher importance of milk yield (Balaine et al. (1981); Harder et al. (2004); Kahi et al. (2004)). In the progeny testing scheme, the somatic cell count was the second most important trait. Indeed, this trait is responsible for reduced milk yield due to mastitis cases. De Cremoux et al. (1999) reported a reduction by 21.2 % in the milk yield in lactations with more than 1,600,000 cell/ml in comparison to lactations with less than 200,000 cell/ml.

The traditional scheme presented negative net present value (US$ - 2.28; Table 4), i.e., it did not cover the costs for its execution. This scheme does not justify the maintenance of the physical and human infrastructure to implement a program of goat breeding in Brazil. The traditional scheme only presented positive return if 60 % of the bulls on commercial flocks came from nucleus flocks. In this situation, the net present value was US$ 0.34 doe/yr. and the genetic profits per doe for milk yield, lactation length, age at first kidding and kidding interval were US$ 3.69, US$ 0.10, US$ 0.03 and US$ 0.05, respectively. However, that situation would be unviable in practice since the using of artificial insemination in Brazil is very low, making the use of those bucks by natural mating impossible in a large country with concentration of nucleus flocks in a limited area and without multiplier flocks.

In contrast, the progeny testing presented 20 % of return to investment. Other studies have demonstrated the viability of the breeding programs, with return on investment ranging 15 % to 235 % (Hill (1971); Nitter et al. (1994); Lôbo et al. (2000)). It was observed that the use of young bulls must be ranged between 10 % and 15 % since the lower usage reduces the genetic gain and the net present value of the scheme and the higher usage implies a reduction of using proven bucks also decreased the possibilities of improvement.

Conclusions

Results indicate that the traditional scheme of selection and usage of the bucks from nucleus flocks did not present economic viability, not covering the costs of a breeding program. In contrast, the progeny testing proposed by CAPRAGENE resulted in a return of investment of 20%, with milk yield the trait with higher importance followed by somatic cell count.

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