Breeding plan for commercial dairy goat production systems in southern Brazil


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Abstract
Commercial small dairy goat producers, exploiting European breeds and selling fluid milk, concentrate in the southeastern and southern States of Brazil. They are in need to access improved germplasm due to government regulations banning imports of living material. This paper reports the actions taken, the difficulties encountered and the preliminary results of a Dairy Goat Breeding Plan started in 2005 by EMBRAPA Goats and Sheep, the Brazilian Ministry of Agriculture, Livestock and Food and the Association of Goats and Sheep Breeders of Minas Gerais States. The plan’s objective was to address the needed access to improved germplasm claimed by farmers, through conducting progeny tests. Participatory and community work took place to organize/implement the plan. A professional milk recording institution was recruited by farmers to collect individual milk records in the associated farms where bucks are progeny-tested. Selection criteria mainly designed to respond to the market demand, focused on milk yields, lactation lengths and reproductive characteristics. Twenty bucks of Saanen, French Alpine and Anglo-Nubian breeds are being tested through artificial insemination in 22 herds. Until August 2010, the databank contained 7872 milk test days. The averages for total milk yield in a complete lactation, milk yield in 305 days of lactation, lactation length and average daily yield were 768 ± 16 kg, 676 ± 10 kg, 278 ± 4 days and 2.75 ± 0.01 kg/day, respectively. Herd effects were found important (P < 0.01) with a wide range of averages in milk production which justifies well the progeny test to suit germplasm for also a wide range of environments. Breed effects were also important in differentiating total milk yields in a complete lactation (P < 0.01) with Saanen goats having significantly greater yields than Alpine and crossbred goats. Linear and quadratic age effects were significant in changing milk yields. The establishment and implementation of the plan confronted difficulties that were not insurmountable and offered important lessons learned and recommendations for similar engagements for smallholder dairy goat production systems elsewhere. These included: (1) careful identification and involvement of stakeholders considering the enabling conditions needed and sustainability, (2) engagement,
1. Introduction

Goat milk production in Brazil is distributed in two geographical regions. Production in the first region comprises the northeastern states of Paraiba and Rio Grande do Norte and is heavily dependent on government support through a program that purchases milk production from smallholders. In contrast, a more market-oriented production takes place in the southeastern states of Minas Gerais, Rio de Janeiro, Sao Paulo, and Espirito Santo, and in the southern State of Rio Grande do Sul.

Dairy goat farmers in both regions own small herds (average herd size of 30 animals) to produce and sell fresh milk. In the northeast the production systems are semi-intensive, range-based with concentrate supplementation, and exploit crossbred goats of an unknown genetic background involving exotic breeds, mainly Saanen, Alpine and Anglo-Nubian. In the southeast and south the systems are intensive, based on silage and/or hay feeding with concentrate supplementation. These include European breeds such as the Saanen, the most widely distributed breed, followed by the Alpine and the Toggenburg. In general, farmers raise purebreds though it is not uncommon to find farms including crossbreds (Löbo et al., 2010).

Several challenges regarding the herd health, nutrition and management aspects of the more intensive southeastern and southern systems have been well addressed. In contrast, less attention was paid to the genetic improvement of the dairy goat herds which were established through the importation of improved animals and/or semen from countries with temperate climates, in particular from France, Canada and USA (Facó and Löbo, 2008). This condition introduced constraints and risks for farmers to surmount: a dependency on foreign genetic material; high costs of continued importation conflicting with national regulations to import animals, semen and embryos; and potential health risks. Furthermore, dairy production orientations in European and Brazilian systems do not correspond: whereas in Europe goat milk is largely produced for cheese making, with selection criteria focusing on protein content, in Brazil, the most important consideration is milk production per se, as the market is for fluid milk (Gonçalves, 1996). An additional concerning issue is the potential effect of genotype × environment interactions, causing that the best animals for milk production in Europe may not rank equally under the Brazilian production conditions, with detrimental effects to productivity.

These considerations prompted the need to develop a national breeding plan for dairy goats focusing on the country’s market opportunities, production context and, above all, the demand expressed by farmers for a plan that allows them to access improved animals. In response to this need, in 2005, the National Goat and Sheep Research Center of the Brazilian Agricultural Research Corporation (EMBRAPA Goats and Sheep—Embrapa G&S), under the Brazilian Ministry of Agriculture, Livestock and Food Supply (MAPA), established preliminary steps to develop a breeding plan that consolidated in 2007, with the inclusion of the Association of Goat and Sheep Breeders of Minas Gerais State (ACCOMIG/CAPRILEITE), in what is currently known as the Dairy Goat Breeding Plan (DGBP). The aim of this plan was to structure a community based dairy goat national database and conduct progeny tests for the main dairy goat breeds raised in the country. This paper reports the actions involved towards the implementation of the plan, the difficulties encountered and the preliminary results thus far obtained, with lessons learned that may be valuable for similar engagements in other developing countries.
professional base to conduct the OMR, ACCOMIG/CAPRILEITE approached the Association of Holstein Breeders of Minas Gerais State (ACGHMG), with extensive experience in data recording, and successfully negotiated the full engagement of its milk recording staff in the OMR activities, under a funding provided by MAPA. In conducting the OMR the ACGHMG staff follows Brazilian technical recording standards (BRASIL, 2010) which comply with those of the International Committee for Animal Recording (ICAR, 2007).

The progeny test was targeted to evaluate young bucks of Saanen, Anglo-Nubian and Alpine breeds. The selected bucks would be sent temporarily to a central station for semen collection to then be used in the participating herds to produce doses that would be evaluated at their first lactation for total milk, protein and fat yields; days in milk (lactation length) from kidding until the animals dry; and age at first kidding. Discusions with farmers are ongoing in relation to other traits they would like to be evaluated in the plan, e.g. udder characteristics.

It is expected that a new group ofbucks will be sent to progeny testing each year. In the choice of these animals genealogical data available will be considered, to somehow control the length of the generation interval that tends to increase under a progeny test scheme. In this regard the plan will try to maintain a 3-year generation interval and the use of semen of a given outstanding buck for no more than three years in a herd. The plan also targets to keep the levels of inbreeding rates and relationships among animals as minimal as possible.

In discussions with farmers it was agreed to initially test each year a group of 10 bucks (five Saanen, three Anglo-Nubian, and two Alpine). Each farmer agreed to provide 28–84 reproductively active females to mate the bucks to be progeny-tested. Participant farmers would receive two-cost-free doses of semen for each available female. The initial target is to evaluate 40 daughters per buck. Considering conception rates under AI, prolificacy and kid mortality until weaning, it was estimated that approximately 150 doses of frozen semen per buck will be needed to accomplish this target. Nevertheless to keep a reserve of genetic material if the program expands, the decision was to collect 300 semen doses per buck to be frozen for distribution to collaborating herds.

The collection and distribution of semen would be covered initially with resources provided by Embrapa G&S, while buck owners would be responsible for sending the bucks to a central site for semen collection. Profits would not be generated from semen since semen doses would be distributed at free-cost. However, the owners of bucks will be free to collect additional semen doses to make these available to sell to other farmers outside the plan. Farmers will not be obligated to keep their bucks until the BLUP rankings are obtained, but they will keep the AI females born until the end of the test.

Because of the small number ofbucks per breed, all bucks of a given breed will be tested in each farm producing that particular breed, so that genetic effects will be avoided. The program will build the genealogical structure of the herds to incorporate information on relatives in the analysis of the bucks that are being tested.

2.3. Record keeping, data analysis and feedback to farmers

The consortium of stakeholders agreed that the production information collected would be entered via internet into a database by technicians of ACCOMIG/CAPRILEITE, using the Management System for Livestock (MSL) software developed by Embrapa G&S. It was also agreed that each participant farmer would access the MSL through her/his own login and password in order to obtain a series of different reports on herd production that this program can output while it also prevents the possibility to alter information contained in the database.

One of the agreed responsibilities of Embrapa G&S in the DGBP was to analyze the progeny testing data by using the Best Linear Unbiased Prediction (BLUP) methodology (Henderson, 1975) to rank best bucks from which semen could then be used via AI on the population targeted. An intrabreed animal model applying the MTDREML software (Boldman et al., 1995) will be used to this end. The model will include contemporary group (herd–year–season) as fixed effects, age of doe at kidding as a covariate, and a direct animal effect as random effect. Preliminary statistics reported in this paper concerning the analysis of the OMR data to visualize trends in total milk production and days in milk, were obtained by using the GLM procedures of Statistical Analysis System (SAS, 1999). The linear model involved included fixed effects of herd, year x month interaction, breed and age of doe at kidding as a covariate.

3. Results and discussion

3.1. Process leading to internalize the breeding plan into the community of breeders

The need for a system that will allow farmers to access improved bucks goes back to the time when intensive dairy goat production farms were established, as they ever since confronted problems of importing improved germplasm in Brazil. Farmers operating under less production intensification also claim lack of access to improved animals which parallel assessments made elsewhere in smallholder systems (Iniguez, 2005). Farmers were unable to solve this problem by themselves because of the lack of the enabling conditions and due technical support.

The 2005 first phase project followed a rather top-down approach with poor participatory work with the farmers’ community and engagement of key stakeholders. This resulted in a poor adherence of farmers to the proposed breeding plan. A lesson learned was that a top-down approach motivates little on the farmer’s community and environment, resulting in only few recruited breeders that join the project as most perceived that this could eventually increase their production risks. A second lesson learned was that in the implementation of a breeding plan involves a long-term process where it is crucial to carefully identify and engage different actors and stakeholders in an adequate inclusion to secure the realization of objectives. Though this approach largely failed to attain its objectives, it was successful in the structuring of a database and nurturing of a suitable interaction between farmers and Embrapa-G&S staff.

The 2007 approach promoting participatory work and a more a comprehensive stakeholder inclusion in the consortium caused a tremendous improvement. The main achievement was to establish and launch a truly decentralized breeding plan (DGBP), owned by the community and structured in a manner that each stakeholder provides its contribution: Embrapa G&S the needed technical support, orientation, data analysis, partial funding, and feedback to farmers; ACCOMIG/CAPRILEITE the responsibility of the OMR; and MAPA a main co-funding structure. Engagements of this type should avoid ignoring active stakeholders in the production context, for instance the involvement of the marketing and commercialization sectors, including the industry, will be deciding to improve an eventually outscale the plan. Moreover, these interactions will build a strong farmers’ negotiating power and help farmers to perceive the benefits of the involved technology, in line with the recommendations made by Aw-Hassan (2008).

The discipline involved in following the requirements of the plan was agreed by all stakeholders and was a crucial entry point for farmers to join the plan. As farmers develop more trust in this plan the aspects related to this issue consolidate.

3.2. Implementation of the breeding plan

The end of the 2005 and the start of 2007, when the two approaches were applied towards developing
a breeding plan, overlapped with a number of problems.

A first challenge concerned the choice of the first group of bucks to start the progeny test. Since no genealogical or production information was available, the Brazilian Goats Breeders Association (ABCC) was requested to select the bucks to be tested. The farmers’ poor understanding of the program and distrust in the ABCC participation, prevented many farmers to join the progeny test. The first group of bucks to be progeny-tested included 10 bucks from 10 farms restricted to the Minas Gerais, Rio de Janeiro, and São Paulo States. Lack of productive organization and operational difficulties, e.g. absence of AI infrastructure and technicians to inseminate, restricted the participation of breeders of other regions in that year, and above all held up the evaluation of bucks from the first group. A concomitant lesson learned was that efforts of this type require intensive participatory work with farmers in explaining all cornerstones of the plan and that organization and persons distrusted by farmers should be avoided from inception. As more production information is collected from the does of the first group of bucks, we expect that their evaluation will be concluded by 2011. Furthermore, the difficulties confronted with the first group under progeny testing held up the selection of the second group of bucks until 2009, however, the progeny testing in this group is now normally conducted.

The second challenge concerned the needed funding to organize participatory workshops, and support the AI process. In both cases in this period Embrapa G&S stood along with farmers and had a proactive role in providing technical backstopping and the needed financial support for the AI activity. Farmers and their association simply did not have the financial capacity to support this start. This act of solidarity was another determining fact for more farmers to join the plan with trust and enthusiasm. A lesson learned was that to gain farmers’ trust the institutions promoting a technological change should stand with farmers under the more critical periods confronted by them, without discontinuing in these conditions a solid backstopping and open discussions on the plan’s requirements and discipline, which is in line with Iñiguez et al. (2010). The long-term projection of the plan and consideration of potential strategies to achieve the plan’s sustainability is now a central issue for Embrapa G&S, the producers and their associations.

According to the market opportunities Embrapa G&S and farmers agreed on the plan’s selection objectives and criteria. Considering that in Brazil the market pays only on fluid milk basis and not on quality, the selection objective was agreed to focus on milk yields and days in milk in addition to age at first kidding. But, this situation is changing as more markets are paying for new farms due to the strategic changes made resulting in a continued improvement of the OMR practices. This increase was due to the incorporation of about 95% in comparison to early 2009. Similarly, in 18 months the number of complete lactations increased by 87% (Table 1). At the start of 2009 the databank for Saanen and Alpine goats contained complete lactations from 410 does involving 467 lactations, while in August 2010 this number increased to 646 does, involving 873 lactations. This increase was due to the incorporation of new farms due to the strategic changes made resulting also in a continued improvement of the OMR practices. In addition, milk yield in 305 days of lactation averaged 673 kg/doe/lactation. About 84% of these results came from Saanen goats, 10% from Alpine goats and 6% crossbreed goats.

Negotiations between ACGHMG and ACCOMIG/CAPRILEITE, led to an operational agreement in that the ACGHMG technicians, at an average interval of 45 days between milk tests, will perform the OMR. This is considered a fundamental and innovative achievement considering that data recording is one of the pillars of any breeding plan (ICARDA, 2005). Besides the traits now being measured by the OMR, the consortium is considering the inclusion of other traits that farmers deem as important in the plan, since dismissing them as unnecessary could be detrimental to the success and sustainability of the plan, as also pointed by Iñiguez et al. (2010).

The farmers’ first reaction to join the DGBP was mixed: some were convinced and agreed with the plan though most refused it. Consequently, only a few herds have joined the breeding plan at the start. The new strategies applied, with a closer partnership among MAPA, EMBRAPA, and ACCOMIG/CAPRILEITE facilitated by participatory work with the community gradually attracted more interested breeders and expanded the OMR to other farms: thus far, the OMR encompasses 18 herds in the states of Minas Gerais, Rio de Janeiro, São Paulo and Espírito Santo. This also led to obtain additional financial resources to support the DGBP. With these improvements in 2009, a second group of 10 bucks (including 5 Saanen bucks, 2 Alpine bucks and 3 Anglo-Nubian bucks) were chosen for progeny testing on the basis of the milk yield of their dams. The semen collected from the second group of bucks (total of 3000 doses at an average of 300 doses per buck) is now being distributed among collaborating herds for the progeny test). Currently the DGBP is gathering the third group of bucks for progeny testing based on the information available in the databank.

Starting in 2010, a group of four Anglo-Nubian breeders from Bahia State joined the DGBP so that the plan was expanded to operate with 22 herds. It is noteworthy that the collaboration of Agricultural Development Company of Bahia State (ADCBS) was crucial for this expansion. The expansion to other states of the Federation will largely depend on the presence of other partners to ensure financial and, mainly, human resources.

### 3.3. Record keeping, data analysis and feedback to farmers

By August 2010 the OMR was considered to be fully operational and accumulated 7872 test day records (Table 1), this representing an increase in information of about 95% in comparison to early 2009. Similarly, in 18 months the number of complete lactations increased by 87% (Table 1). At the start of 2009 the databank for Saanen and Alpine goats contained complete lactations from 410 does involving 467 lactations, while in August 2010 this number increased to 646 does, involving 873 lactations. This increase was due to the incorporation of new farms due to the strategic changes made resulting also in a continued improvement of the OMR practices. In addition, milk yield in 305 days of lactation averaged 673 kg/doe/lactation. About 84% of these results came from Saanen goats, 10% from Alpine goats and 6% crossbreed goats.
The results of Table 1 are in agreement with Gonçalves et al. (2008) though somewhat higher than the values reported by Vieira et al. (2009) for dairy goats from southeastern Brazil, though their estimates involve only a small number of herds and observations. In evaluating Alpine and Saanen goats, in the USA and South Africa, Wiggans and Hubbard (2001) and Olivier et al. (2005), respectively, reported higher milk yield averages than our results. This may reflect more stable environmental conditions (climates) and better management practices in both countries in relation to southern Brazil, though not necessarily a better genetic potential of the does involved in these evaluations.

Herd effects in milk yield in 305 days of lactation were very important \( (P < 0.001) \) with a wide range found in least square means between herds, from 280 kg to 1242 kg. It is felt that this reflects the great diversity of environments under which the herds produce and variation in the genetic potential between herds. This interesting result justifies well the projected progeny test, which will allow the testing of bucks in a variety of environmental conditions characterizing the extended area where dairy goats are produced on a commercial basis in Brazil, where a genotype × environment interaction effect is expected.

As expected breed differences were also important \( (P < 0.01) \) with Saanen goats having larger average milk production than Alpine and crossbred goats. The significant linear and quadratic effects of age of the doe on their milk production yields confirm a known trend observed in goats, with increasing values until goats reach 3–4 years of age to then decrease at older ages (Escaréno-Sánchez, 2010).

The MSL program allowing farmers to access the information of their herds is simple to use. However, there are only few farmers that used this tool to obtain information. Only few farmers own computers in their farms and others have little experience in the use of the software. More action in this direction is expected to occur as the DGBP progresses, bucks are progeny-tested and farmers are trained to use this suitable supporting tool.

In addition to the progeny test and OMR actions, the DGBP is developing studies using molecular markers to identify pedigree errors in the progeny test; estimate the genetic diversity within and between herds; and assess the potential of SNPs markers in predicting animals with high genetic merit. Moreover, research is being done to improve AI efficiency and expand its use; and to produce estimates of economic weights associated with the production variables targeted by the plan.

### 4. Conclusions

The DGBP has responded the demand for a system to allow small dairy goat producers to access improved germplasm, in view of strict regulations that limit importation of living materials from abroad. It has been developed on a community based approach, with the involvement of some key stakeholders and in a manner that farmers feel ownership of the plan, and focuses on the market opportunities. The finding of a large variability between herds is compatible with the conditions of the southeast region of Brazil and justifies the use of a progeny test approach that could suit improved germplasm for a range of environmental conditions. The organization and implementation of the plan posed difficulties which were not insurmountable; however it requires a long-term commitment that will not be possible without the needed funding support from government sources and the technical backstopping of research. Key lessons learned and associated recommendations that could be useful to similar engagements involving smallholder production systems elsewhere include: (1) consider identification and involvement of key stakeholders particularly to secure sustainability and the improvement of the negotiating power of farmers or their organizations, (2) engage, whenever possible, an organized and trusted system for data collection with a long-term projection, backed up by government funding. This is crucial if the technology proposed is to be outscaled. Avoid organizations/persons distrusted by farmers as this will hamper the whole process, (3) consider the sustainability of the plan from inception and engage continuous discussions with all stakeholders, in particular farmers and their organizations, on this topic. The participation of the government and if possible the development of supporting policy in this regard is fundamental, and (4) while designing the selection objectives and criteria, consider not only traits that respond to market trends, but also traits that farmers judge as important.

### Conflict of interest

None of the authors has a financial or personal relationship with other people or organisations that could inappropriately influence or bias this paper.

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