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DESIGN AND IMPLEMENTATION OF A COMMUNITY-BASED BREEDING PROGRAM FOR DAIRY GOATS IN NORTHERN MEXICO

[DISEÑO E IMPLEMENTACIÓN DE UN PROGRAMA DE MEJORAMIENTO GENÉTICO DE CABRAS LECHERAS BASADO EN LA COMUNIDAD EN EL NORTE DE MÉXICO]

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SUMMARY

This paper describes the research and development process for the design and implementation of a community-based breeding program for smallholders. The emphasis of the paper is on the organisation and practical procedures of the breeding program. The selection process of young breeding bucks based on own growth performance and on mother´s milk performance is described. The sustainability of a breeding program can only be ensured when there is a long-term commitment from researchers and extension service to collaborate with farmers and support them in the decision-making process. Ownership of farmers was created by handing-over many responsibilities and decision mechanisms to them and researchers played the role of facilitators.

Keywords: dairy goat; breeding program; participatory research; Mexico.

RESUMEN

El presente trabajo describe el proceso de investigación y desarrollo para el diseño e implementación de un programa de mejoramiento genético basado en la comunidad para pequeños productores. El énfasis del artículo radica en la organización y procedimientos prácticos del programa de mejoramiento genético. Se describe el proceso de selección de los machos jóvenes prospectos a sementales basado en su propio crecimiento y el comportamiento productivo de la madre en cuanto a la producción de leche. La sostenibilidad del programa puede asegurarse solamente cuando exista un compromiso a largo plazo de investigadores y servicios de extensión para colaborar con los productores y apoyarlos en el proceso de toma de decisiones. La apropiación del programa por parte de los productores fue creada transmitiéndoles varias responsabilidades y mecanismos de decisión donde los investigadores tuvieron la función de facilitadores.

Palabras clave: cabras lecheras; programa de mejoramiento genético; investigación.

INTRODUCTION

In Mexico there are about 9 million goats (Montaldo *et al.* 2010), which are mostly kept in extensive production systems under harsh environmental conditions (Mellado, 2008, Escareño *et al*., 2012). In the arid zone of Northern Mexico more than 5 million goats are kept by 320,000 families and play an important role in their livelihoods (FIRA, 2010). In this zone goats are mainly kept for milk production,

the sale of kids at the age of about 45 days is a second important income source for farmers.

An intensive production system has recently emerged next to the traditional system of keeping smaller herds on communal pasture. This new system is high-input oriented and uses irrigated alfalfa as main fodder source, pure exotic dairy goats (often imported breeding stock from the USA) and high-tech management. Artificial lighting system is used to simulate an extended photoperiod in order to stimulate the libido of bucks from temperate climates. Male off-springs from these farms are sold to nearby smallholders at a very low price, highly subsidized by the regional government. The benefit of this approach is questionable as a possible Genotype x Environment-effect is ignored and the animals have never been tested under the conditions of an extensive system and farmers reported bad experiences with breeding bucks of exotic dairy breeds (Escareño *et al*., 2011).

Therefore, the aim of this study was the development of a community-based breeding program for smallholder farmers to make them less dependent on external supply of breeding animals, which might not fit to their prevailing production system. It was planned that farmers select the best animals of their herds and set up a scheme, which ensures that animals are exchanged across herds to avoid inbreeding problems.

Other authors (Gizaw *et al*., 2009; Haile *et al*., 2008; Mueller, 2006; Wurzinger *et al*., 2008), recently showed that this new community-based or village-centred approach in animal breeding can be used for smallholder systems as this ensures the full participation of the farmers and is more sustainable in the long term as it is less dependent from external inputs. These schemes are designed according to the needs of the farmers and the technical and logistical management is at the level which farmers feel comfortable with.

Detailed descriptions of the communication and consultative process between farmers and researchers and administrative and technical details for the implementation and execution of the breeding program are presented here.

MATERIAL AND METHODS

Description of study area

The project was carried out in a rural community in La Comarca Lagunera Region in Northern Mexico. The climate can be characterized as semi-arid with an annual average temperature of 19ºC and an annual mean precipitation of 250 mm with a rainy season from May to July.

The selection of the study site was based on the information from INIFAP - Instituto Nacional de Investigaciones Forestales, Agrícolas y Pecuarias taking into account the importance of goat keeping for smallholder farmers and the numbers of goats in the region.

The production system can be characterized as an extensive mixed crop-livestock system, where goats are kept on pasture all year around and only supplemented with crop residuals during specific periods of the year. For further details see Escareño *et al.* (2008).

Main production aim is the sale of milk and the sale of kids (cabritos) at the age of about 45 days, directly after weaning. Milking starts immediately after weaning of the offspring.

Farmers keep a mixture of various genotypes in their herds as they practice indiscriminate crossbreeding of their local goat called Criollo with exotic breeds like Anglo-Nubian, Saanen and Alpine, depending on the availability of bucks. A phenotypic description of the population is presented in Escareño *et al* (2011).

Communication and consulting process

A series of workshops were held with farmers to design the breeding program and establish a good relationship between the different stakeholders.

A first contact between farmers and the research team was established in July 2007. A first workshop with farmers from different communities and extension workers was held at INIFAP to identify possible constraints and opportunities for dairy goat keeping in the region. Breeding practices, such as the purchase of breeding bucks, use of bucks in the herd and selection criteria were discussed. Improved milk performance of does and growth performance of young kits were identified as breeding objectives.

Based on this information a detailed questionnaire was developed and 64 farmers were interviewed. The questionnaire consisted of general information such as herd management, herd structure, use of products and socio-economic factors, hindering and encouraging factors for the establishment of a breeding program. Results of this survey are presented in Escareño *et al.* (2008).

As a next step, workshops were held in the communities, where farmers showed interest in the formation of a farmers` group and to start jointly a

breeding initiative. Researchers discussed in detail the current situation and identified possible solutions for the improvement of the current scenario.

Finally, ten farmers from one community agreed to start a breeding program and developed with the support of the research team organizational and administrative rules for the breeding program. The cooperation between participants of the breeding program was also discussed in various meetings. After a few weeks three farmers decided to leave the group and the breeders' organization continued with seven members. There were different reasons for leaving the group. One person refused to send his young bucks to a common central place, another one had health problems in his herd and one farmer sold his whole herd. Dates of regular farm visits were agreed well in advance to ensure that farmers could dedicate enough time to the data collection process.

Herd monitoring

At the beginning of the project all females of the herds were registered in a herd book. At the same time, farmers identified the best females of their herds according to their own criteria. The young bucks of these best females were also registered in the herd book and were identified as the candidates for the first selection round of breeding bucks. A final selection decision was done after the completion of the growth performance test.

Individual identification was based on ear tags used by a local program for Brucellosis prevention and complemented with a collar and a medal, which includes farm and goat number. During the identification process of females, information about age, phenotype (coat colour, absence or presence of wattles, bear, horns) and number of parities were recorded. During the follow-up visits kidding dates, litter size, body weights and sex of new born kids were documented. For the young bucks, body weight was recorded monthly.

Milk recording started after weaning, which takes place on average 45 days after kidding. Young bucks, which had been identified as selection candidates, were allowed to suckle for an extended period of 90 days before they were sent to the performance testing station. This resulted in a reduced lactation period for their dams.

Data collection started in January and continued until October 2008 and took place during the morning milking before animals were guided to the pasture. The milk yield was measured every fourteen days for each animal individually with an electronic balance. A total number of 276 does from seven herds were under the milk recording scheme, the size of herds ranged from 13 to 65 animals. Milk samples for fat and protein content were taken from 227 females five times during the lactation period.

Milk samples were taken before the milking started, a preservative was added and samples were kept cold during the transport to the milk laboratory. Milk content analysis was done with Flow Cytometrics.

Selection and rearing of young bucks

In the first year of the breeding program the selection of possible candidates as breeding bucks was exclusively based on farmers' own experience and knowledge. Selection criteria were milk yield and phenotype (body size, long legs, udder conformation) of the dam and their health status. Milk yield was assessed subjectively by farmers as there was no milk recording scheme in place. Farmers were asked to select according to their own criteria the best does from their herd to be the mothers of the future breeding bucks. The only pre-conditions set by researchers were that selected females should be above herd average, healthy and at least in their second lactation. Farmers agreed that bucks from the best does were taken to a central corral of the village at the age of 3 months.

Sixteen young bucks, two per farm, were chosen and kept in a central corral after weaning. The idea of the central corral was to have a test station where the growth performance of the young animals after weaning could be tested under the same conditions. Therefore farmers agreed to construct a central corral in their village to make the monitoring of the animals easier. Although there might be also a genotype x environment interaction between farms and test station, the research team opted for this approach. This central corral was used as an educational and demonstration tool for farmers.

The young bucks were kept in the corral for 90 days and body weight was recorded weekly. The animals were provided with a diet consisting of oat hay, maize and mineral salt.

In the second year, the selection procedure was changed and a selection index, including milk performance of the dam and own growth performance of the young bucks, was established. This selection index is based on phenotypic information. Total milk yield of the dam was used, fat and protein content was not used as there was not enough information available. As there is no information on economic values available, both traits were given equal importance and the ratio was 1:1. Milk yield was

recorded twice per month and body weight of young bucks was measured on a monthly basis.

A total number of 8 young bucks after weaning at the age of three months were brought to the central corral for evaluation of their growth performance and kept there for duration of five months.

Before the young breeding bucks were re-distributed to herds, a sanitary check was done by the veterinarian of the research team. Only animals free of parasites and brucellosis were allowed to re-enter a herd.

Data management and analysis

Finally, all records from the field were entered into a data base and the information was used for further analysis. The following data was recorded: milk yield of all females was recorded every 15 days, milk fat and milk protein from 5 milkings throughout the lactation period, body weight of young bucks in the central corral was recorded once per month.

Total milk yield was calculated according to ICAR standards (ICAR, 2009). Lactation length was defined as the milking period after weaning of the kids until drying off.

Total milk yield (TMY) was calculated by using the milk yield of one test day, multiplied by the days of the interval until the next test day and the sum was made over the whole period.

For presentation of the milk performance, a cut-off point of at least 90 days in milk was used as suggested by Valencia *et al*. (2007).

The selection index was calculated based on the total milk yield of the dam and the own growth performance of the young bucks. In a first step, dams were ranked according to their milk performance from rank 1(=best) to rank 8 (=worst). Independently a ranking was done for the young bucks based on their daily gain from best to worst. In a next step, the final index was then calculated by dividing the sum of the two ranks by two. This information was used to build the final rank of the young selection candidates.
All data analysis was performed using SAS 9.1 (SAS, 2003).

RESULTS AND DISCUSSION

Constraints and opportunities for dairy goat keeping

During the initial workshop different problems were highlighted by farmers. Limited accesses to credit system, feed shortage and volatile prices for products were frequently mentioned as hindering factors for the development of the dairy goat sector. Farmers were also concerned that breeding bucks were not easily available and they often had to buy animals without any information about dam's performance or in some cases they bought sick animals and infested their whole herd with brucellosis. Farmers also mentioned that they choose, depending on availability, bucks from different exotic breeds. Saanen and Alpine goats were seen as animals with high potential for high milk production, but one of the disadvantages mentioned was the relatively low fat content. Some farmers even reported that milk traders refused to buy milk from Saanen crossbred goats as they thought that the milk was diluted with water.

Farmers also explained that Saanen animals could not stand the hot weather, could not walk for long distances in the sunshine and got sick more frequently.
Anglo-Nubian was another breed which was used by farmers. This breed was associated with a lower milk yield, but much better milk fat content than the other exotic dairy breeds.

Artificial insemination was not seen as a viable way to improve production under the current situation. It was also noted that a missing recording system is another limitation for the establishment of a breeding program.

Farmers agreed that a breeding program, which will make them less dependent from external actors, would be a good opportunity for improving the goat management and also the household income. They even identified the sale of their own breeding bucks to nearby farmers as a possible new source of income.

Herd monitoring

The results of the milk recording data are presented in Table 1. The total milk yield showed a very large variation with a minimum of 52 kg and a maximum of 406 kg. This result can partly be explained by the length of the lactation period, which ranged between 90 and 248 days. It also has to be taken into account that the milk yield was only recorded after kids were weaned. In comparison, Valencia et al. (2007) reported for Sannen breed in Mexico a milk yield of 800 kg in a lactation period of 285 days, whereas Mellado *et al*. (1991) reported a total milk yield of 140 kg over 180 days in local goats. Montaldo *et al*. (1995) reported for a local Mexican goat breed a total milk yield of 299 ± 34 kg and a lactation length of 288 ± 11 days. Another study from Southern Mexico identified for local Creollo goats a production of 856 ± 28.1 kg in 100 days (Sánchez de la Rosa *et al.*,

2006). Mellado (2008) concluded that for the selection of local goats under rangeland conditions, these must produce at least 60 kg / 6 months which means 300 g/day.

The milk fat and protein content is shown in Table 2. The measured fat content was between 4.18 % and 4.96 % and the milk protein varied between 3.48 and 4%. There was no literature available from Mexico to compare with.

Selection of dams, young bucks, selection index

As a first attempt to include the important information of the dams´ milk performance the total milk yield was used. For further refinement of the breeding program it would be much better to use energy corrected milk. This would help to make better informed decisions, but this would also mean additional costs for laboratory analysis of the milk. As most of the milk is sold for processing, information on fat and protein content are essential for farmers.

Using this information might result in a re-ranking of the first two dams, but would not influence the final ranking of the young bucks (Table 3).

The daily gain of the young bucks for selection was also very heterogeneous and varied between 40 g and 168 g. Mellado (2008) reported daily gain after weaning of 75 g during the dry season, but during the rainy season daily gain can go up to 100 g.

The current used selection index is a first attempt to use recorded data instead of only subjectively assessed performance. As a next step economic values of selection criteria have to be calculated.

Table 1. Total milk yield and lactation length of all animals under recording.

		TMY			TDM		
Farm	n	Mean (kg)	SD (kg)	Min-Max (kg)	Mean (days)	SD (days)	Min-Max (days)
1	13	136	61.5	52-210	142	42.7	92-193
2	57	214	84.2	74-406	170	46.0	98-242
3	31	168	66.3	78-343	150	39.5	98-220
4	47	223	60.1	122-421	188	30.0	123-248
5	32	152	67.9	52-299	156	48.2	90-237
6	19	124	45.6	63-217	149	37.5	93-203
7	17	136	43.3	36-198	157	35.3	104-208

TMY = Total milk yield, TDM=Total days in milk, SD=Standard deviation

Table 2. Average content of milk fat (%) and milk protein (%).

		FAT			PROT		
Farm	n	Mean (%)	SD (%)	Min-Max (%)	Mean (%)	SD (%)	Min-Max (%)
1	11	4.24	0.56	3.47-4.97	3.48	0.28	2.80-3.90
2	50	4.96	0.57	2.99-8.67	3.63	0.55	1.44-4.93
3	33	4.72	0.72	3.58-6.01	3.83	0.30	3.17-5.06
4	56	4.18	1.00	2.64-8.98	3.73	0.57	2.66-5.72
5	37	4.91	1.40	2.20-8.83	4.00	0.68	2.88-6.39
6	24	4.54	0.93	3.08-6.64	3.57	0.49	2.90-4.70
7	16	4.71	0.75	3.60-5.83	3.61	0.39	2.92-4.27

FAT= average fat content (%), PROT= average protein content (%), SD=Standard Deviation

Table 3. Rank of young bucks based on selection index (milk performance of dam and own performance on growth from birth to 6 months).

Farm	Number of dam	TDM (days)	TMY (kg)	Ranking of dam	Daily gain (g)	Rank of young buck	Index	Overall rank
4	10	168	249	1	142	2	1.5	1
5	2	167	219	5	168	1	3.0	2
4	9	168	228	3	133	5	4.0	3
3	27	145	247	2	101	7	4.5	4
5	9	145	225	4	126	6	5.0	5.5
3	43	167	202	6	134	4	5.0	5.5
6	7	126	76	8	138	3	5.5	7
6	5	126	84	7	40	8	7.5	8

TDM= Total days in milk, TMY=Total Milk Yield

Organisation of breeding program

Farmers set up their own rules for their breeding program. In principal, they agreed that they would allow new members in their association, but they have to agree to follow their rules and procedures. One important point was that the mating period should not be too long as this would lead to kiddings over a longer period and as a further consequence milking would be shifted towards the dryer months with more problems of feed shortage. This was one criterion for a farmer to be allowed to enter the group.

The members also agreed that a person, who has left once the association, was not allowed to join again. The members decided to take turns in taking care of the young bucks in the central corral. At the initial stage feed costs were met by the research team, but farmers thought that a given percentage of income from sale of bucks could be kept in the future to cover the costs themselves.

Farmers also developed a simple mechanism for the selection of the young bucks. Firstly, a person was not allowed to take back his own buck to his herd. Farmers, who had provided a buck to the central corral, had the right to choose first. By drawing lots, the winner of the first round was allowed to choose an animal. The winner of the second round was then allowed to select and this procedure was repeated until everybody had a breeding buck. The remaining breeding bucks were put for sale to non-members.

After the first experiences farmers convinced INIFAP to take the young bucks and raise them on the experimental station. This was more convenient for them as they could "out-source" the daily care and fodder supply, which would mean also additional costs for them. The partners of INIFAP agreed to take over this responsibility in order not to jeopardize the initiative. The only condition was that they only take bucks from does with milk records. This was seen as an option to stimulate the recording scheme.

Communication process

Interaction between farmers and investigators was easy, because there were no language barriers. This ensured a free and direct exchange of ideas and suggestions, which is usually more difficult when communication has to be done through a translator. Regular visits of the research team in the study site ensured that farmers gained trust. The role of the researchers was more to act as facilitators in the process and to give scientific back-up support when important decisions had to be made. This constant communication process ensured that farmers gained ownership in the breeding program. The low number of only seven farmers at the beginning of the program made the communication and decision process easier as everybody had the possibility to express concerns or bring forward new ideas. As the group will continue to grow in the near future, a new form of organisation might be necessary like the election of board members of the organisation etc.

Interventions like milk recording were organized in such a way that the daily routine of farmers was not disturbed.

The research team started simultaneously a communication with policy makers to create more awareness of the needs of smallholder farmers.

Way forward

At the moment farmers are paid by the volume of milk sold. It might happen that the dairy factories change their price policy and pay farmers based on energy corrected milk. In this case it would be important that farmers include in their milk recording scheme regular analysis of milk fat and protein

content. A drawback at the moment is that there is no laboratory nearby that offer this service on a routine basis.

New organisational structures have to be developed as new farmers are interested to join.

CONCLUSIONS

Farmers were open-minded, creative in problem-solving and interested to participate in a community-based breeding program. To ensure that farmers develop ownership of the program, the management of the program has to be designed according to the level of expertise and willingness of farmers to cooperate.

A community-based breeding program can work, but needs some technical support to get started and a continuous follow-up by technicians, which can decrease over time, is essential.

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