COMMUNITY BREEDING PROGRAMS FOR SMALL RUMINANTS IN THE ANDEAN REGION

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SUMMARY

Breeding programs can play an important role in promoting small ruminant production in the Andean region. Concurrent consideration of the production environment, production systems, market opportunities, producer's organization, producer participation, in addition to Government support, is decisive for establishing sound breeding programs, which are not yet well developed in the region. Native and Criollo populations have been insufficiently studied, however, population screening results suggest that potentials for exploiting specific market niches could be revealed. Open nucleus apparently fit community breeding programs well, provided that production improvement is conceived as an integrated production approach. To this end networking could be complementary.

Keywords: Breeding programs, Andean region, camelids, sheep, goats.

BASIC CONSIDERATIONS

The role of animal breeding in the development and improvement of small ruminant (SR) production has been secondary, as few organized breeding schemes have been established and have succeeded in the region. Moreover, development programs have dismissed animal breeding as unnecessary under the assumption that environmental modifications to nutrition or animal health were more critical in achieving production changes. Unfortunately, motivated by the need to show short-term results, this attitude still prevails among most international funding agencies, governments and politicians

The consideration of basic aspects connected with the design and success of breeding programs (Iñiguez *et al.*,1994), could be helpful in this review. These include:

- the production environment and production systems,
- the available local genotypes,
- market demand and environmental potentials that define breeding objectives, and
- suitable approaches for establishing sustainable and pragmatic site specific breeding programs, which also allow a permanent evaluation of the improvement process.

PRODUCTION ENVIRONMENT AND PRODUCTION SYSTEMS

The Andean region comprises a vast area of Bolivia, Peru, Ecuador, Northern Chile and Argentina, where native (llamas and alpacas) and introduced SR (sheep and goats) play important roles in rural economies. Pastoral and agropastoral SR production systems in this region develop under rather limiting environmental conditions which are summarized in Table 1. High altitude production systems include alpaca, llama and sheep. Alpacas thrive better in humid niches while llamas are found in the most marginal and dry environments. Criollo sheep and goats in the interandean valleys are raised in mixed flocks (Iñiguez *et al.*, 1994). Production levels of meat, fiber and milk are low.

Largely associated with small low-input landholdings, SR systems reflect the social and economic consequences of small holdings. SR production is based on extensive utilization of range, which is seasonally influenced, often overgrazed and not adequately managed. Land in pastoral areas usually belongs to the community as a whole and is utilized in accordance with long-standing traditions. In agropastoral regions, community grazing conflicts with intensive cropping are exacerbated by population growth and excessive land division.

Table 1. The main SR production systems and environmental conditions in the Andean region

System	Altitude	Environmental characteristics	Species
High altitude pastoral	3,600-4,600	Low temperatures, high incidence of frosts, strong winds, and low rainfall and drought in Southern Altiplano[1]. No cropping	Llamas Alpacas Sheep
High altitude agropastoral	3,200-3,800	Milder climate and better water resources allowing for cropping	Cattle Sheep
Interandean valleys agropastoral	<3,200	Dry Mediterranean climates, higher temperatures and low incidence of frosts, allowing for fairly intensive cropping	Cattle Sheep Goats

[1]The Northern Altiplano is more humid with rainfall >400 mm/yr.

All above systems have the following features in common: open grazing involving communal land; year round reproduction; and flock/herd management without separating sex or age groups. An understanding of the implications of the environment and the foregoing aspects is critical in considering breeding programs. We sustain that SR production improvement can only be approached by acknowledging that it depends not only on the genetic potentials of the animals, but also on appropriate management, nutrition, reproduction, health control, transformation and marketing interventions, to permit full expression of these potentials.

LOCAL GENOTYPES, BREEDING PROGRAMS AND VARIABILITY

Little emphasis has been placed in the past on the value and potentials of native or local adapted genotypes (Mueller, 1994; Iñiguez *et al.*, 1994; Burfening and Carpio, 1995), and on market possibilities. The trend was an indiscriminate use of exotic germplasm without appropriate breed comparisons. For example, as wool production was targeted by crossing aseasonal Criollo with seasonal Corriedale sheep, community farmers were frustrated when many of the crossbreds did not reproduce under the usual pattern and therefore did not produce lambs when lamb price was higher nor milk for highly demanded cheese, through extended lactations. While most efforts have focused on sheep and alpacas, breeding plans for goats and llamas were poorly developed.

Alpacas. The region's camelids are concentrated in Bolivia and Peru. Peru has the largest population of alpacas while Bolivia the largest population of llamas (Table 2).

Table 2. Small ruminant population in the Andean region (in thousands)

Species	Bolivia[1]	Peru[2]	Argentina[3]	Ecuador[2]
Llamas	2,022	989	135	na
Alpacas	324	2,511	0.4	na
Sheep	8,580[a]	12,501	na	1,709
Goats	1,200[b]	2,301	500	2,031

[1]Rodríguez and Cardozo (1989); [2]FAO (1997); [3]Mueller (1997).
[a]60.6% of sheep are in the Altiplano; [b]Most goats are in the valleys; na: not available.

The alpaca is a producer of fiber in high demand by the textile industry because of its fineness (21-23 μm). Although husbandry technologies have been made available in nutrition, forage production, shearing and animal health, animal productivity have not reach desirable levels yet.

Breeding programs. Breeding plans are in the process of being consolidated in the region. Most past breeding improvements were achieved in Peru where production was better organized. Organized production effectively started in Bolivia only during the early 90's, with the establishment of an association of alpaca producers (AIGACAA) (Ticona, 1995).

Prior to the formulation of structured breeding plans in Peru, production improvements derived from intraflock selection that emphasized on fleece yields and elimination of colored animals, because the industry favored heavier fleeces and white fibers. Elimination of colored alpacas was successful as most of the current alpaca national flock is white, and has proven that community farmers can be also successful in applying breeding technologies. It is of interest to note that fiber diameter of unselected Bolivian alpacas, which are usually kept in flocks having mix-colored animals, is 1 to 2 μm finer than those from Peru (21 vs. 23 μm, respectively) (Gschwend, 1995). Whether this was because selection did not emphasize on fiber diameter or due to genotype x environment interactions, is not known. Moreover, this condition, which the ongoing breeding programs are attempting to correct, has been recognized as a drawback by the textile industry.

It is now felt that breeding programs should be market oriented, interacting closely with the textile industry to monitor market trends and opportunities to maximize returns (Gonzáles, 1997). Thus, in Bolivia, for example, to assure a more stable market AIGACAA made a savvy move in acquiring a plant to process tops.

Peru started its program in 1994, under the auspices of the Center for Development (DESCO), which currently serves 2,500 alpaca producers with 526,000 alpacas. The program was designed to evolve towards an open nucleus, with a central nucleus formed with 750 animals selected from different regions of the country. This is combined with a multiplier level, consisting of elite producers (average flock size 130-180 head) in each of the program's locations, that produces improved males for the base flocks (average flock size 80-120 head) (DESCO, 1996). The Bolivian incipient alpaca breeding program, serves 1,300 producers with 30,000 alpacas. Presently it only distributes animals that were selected phenotypically in the Northern Altiplano. Further steps to implement a more organized breeding program in the form of an open nucleus are underway (Ticona, 1995).

Difficulties in data recording, fiber analysis, management and data analysis, were identified as limiting factors in both Bolivia (Montero, 1997) and Peru (Gonzáles, 1997). Key problems involving data recording and animal identification arise from who records and who manages the database, assuming that a simple recording system is developed. If data is collected, managed and analyzed by different entities, as in Peru, then reliable coordination is needed.

Screening animal variability. Charcas *et al.* (1997) screened 247 animals with outstanding fiber characteristics out of 5,000 alpacas sampled in Bolivia (1.5% of the national flock). Mean fiber diameter and medullation in the screened animals were 19.1 μm (range 16.5-20.2 μm) and 7.6% (range 0-17.5%), respectively. These results, show a great potential for improving fiber traits and stress the need of production records to facilitate identifying outstanding animals for other equally important traits.

Llamas. Llamas are raised mainly for their meat. In most regions llama fiber is very coarse (31 μm) and highly medullated (76.1%), and fleece yields are ≤1 kg/yr. Llama production has not yet emerged from a subsistence orientation. In recent years IFAD and the EU established two development projects in Bolivia aimed at improving production and marketing of llama products. Neither project supports a breeding program. They declare that genetic resources just "were in place". Although breeding programs are not yet formally established, steps are being made towards their organization. Two separate programs are now being discussed in Bolivia (Iñiguez, 1995a; Rodríguez, 1997a).

Screening animal variability. Llamas having short and highly medullated fleeces (K type), woolly fleeces with fine fibers (T type) and intermediate fleeces between those of K and T (I type), are found in Bolivia and Peru. The genetic basis for this variation is not yet known. Mean fiber diameter of T llamas is 21.2 μm (range 17.8-28.2 μm) and medullation is 50% lower than that of K llamas (38.8% vs. 79.8%). A population dominated by T and I was recently studied in Southern Bolivia (Iñiguez *et al.*, 1996). The distribution of T, I and K in this population was 47, 42 and 11%, respectively, contrasting remarkably with a reverse pattern pertaining to most llama producing regions, 8, 31 and 61%, respectively. It is estimated that nearly 400,000 llamas in Bolivia have the potential to produce good quality fiber (types T and I) and compete in international markets. These facts, in addition to the feasibility of industrial dehairing, opened new opportunities for marketing llama fiber.

Loayza and Iñiguez (1995) screened 249 outstanding animals out of 9,680 sampled Bolivian llamas, with an average body weight of 109.1 kg (range 103.5-124.5 kg),. This group will be part of an open nucleus. More is to be learned on the basis of llama production, a context to be undertaken by sound research efforts.

Sheep. Community sheep production is based on Criollo sheep. Reproduction takes place year round with two lambing peaks occurring in June-July and December-January. This allows for extended lactations favoring production of cheese, which is sold at attractive prices. Local markets also demand mutton and lamb. Although accelerated lambing fits these opportunities well, seasonality of forage production requires special management.

Wool from Criollo sheep is coarse (carpet wool) and fleece yields are ≤1 kg per animal/yr. Wool prices are low (US$ 0.20/kg), making shearing of animals economically unjustified. Live weights average 20.5-21.8 kg (Alem and Iñiguez, 1995). Fertility is remarkably high, so that levels ≥85% under range are not uncommon (Rodríguez and Cardozo, 1989). It was estimated that nearly 20% of the flock's females produce twice a year and very likely 3 lambs/2 years (Rodríguez, 1997b). In contrast lamb mortality is high due to nutritional causes. Production potentials are not well studied in the various contrasting environments that sheep are raised and considering particular market demands they can respond to.

Sheep breeding programs and population screening. Breeding programs are not yet well structured. Earlier programs involved crossing Criollo sheep with improved breeds. Their aim was to improve wool production, overlooking the market, traits and production of Criollo sheep that have a major place in the producer's economy, for example, accelerated lambing and extended lactations for cheese production. Improved germplasm was not appropriately evaluated in breed comparisons in the region and introduction was based on the merit of germplasm in the place of origin. Little information on the adaptation of breeds was therefore obtained (Alderson *et al.*, 1983; Burfening and Carpio, 1995).

Peru lead the way in developing improved sheep during the 50's, when the Junin sheep was formed (Burfening and Carpio, 1995). Government efforts to increase wool and meat production on a seasonal reproduction basis started in the late 60's in Bolivia. Some Government agencies and NGO's are still engaged in the distribution of purebred rams, particularly Corriedale, to grade Criollo/Mestizo sheep. To maintain purebred stocks, the breeding schemes very often import sheep from different countries ignoring genotype x environment interactions and without conducting appropriate genotype comparisons. In addition, neither production recording nor evaluation of the breeding process are implemented.

In a recent screening of sheep populations from higher interandean valleys in Bolivia (Alem and Iñiguez, 1995), 243 outstanding Criollo animals with an average live weight of 29.5 kg (range 26.9-36.9 kg) were identified. The outstanding group, that reflects the potential for genetic improvement, has been already acquired by the national agricultural research institute (IBTA) and will constitute the basis of an open nucleus in the near future.

Goats. Goat production and breeding are the least developed compared to other SR. Although most goats are still Criollo, some degree of crossing with Saanen and Anglo Nubian was promoted by isolated and unstructured breeding programs. Again, exotic germplasm was inappropriately evaluated, and adaptation and production traits of criollo goats were overlooked (Mueller, 1994).

In 1988, the Argentinean Agricultural Research Institute (INTA) developed one of the region's few innovative and successful breeding programs for Angora goats by integrating, in an open nucleus, research, technology transfer and, most importantly, producer participation, processing and marketing (Manazza, 1994).

CONCLUSIONS AND SUGGESTIONS

With few exceptions, community SR breeding programs are not yet well developed in the Andean region. Considering the large numbers of SR and the existing market opportunities, well structured site specific breeding programs can play an important role in promoting production. Bottlenecks identified here, constraining the implementation and/or success of breeding schemes, include:

- Limited production organization and producer participation
- Market considerations and production incentives neglected
- Weak funding and program management leading to program discontinuity
- Unreliable data recording and lack of recording aids
- Lack of integration with non-breeding programs aiming at improving production
- Little research on local genotypes, and lack of appropriate breed comparisons
- Limited linkages and information exchange between regional breeding programs

The reviewed experiences have proven that organized production and community farmer participation are decisive factors in successful program establishment, even if the program is still incipient (Gonzáles, 1997; Ticona, 1995). Because community producers were not adequately involved, most programs only lasted while funding was available or Government commitment remained unchanged.

The decision for farmers to participate in a breeding program will derive ultimately from better market incentives (prices) and/or demonstrated potential for income gains. Thus, breeding objectives must match market opportunities/needs and environmental potentials. Then site specific programs could benefit more from local adaptations, providing a diversified national strategy that will cope better with a changing market and agriculture. It is crucial to identify market niches in which native and criollo populations may have a comparative advantage. For instance, it is very unlikely that criollo wool production will compete with that of fine wool sheep, which is produced more efficiently in the Southern part of South America, but the carpet wool market could be accessible. Marketing live animals, in the case of camelids, could also render important benefits.

A breeding program is costly and may not be sustainable, particularly if it serves poor community farmers. Under such circumstances the role of the State in promoting production improvement cannot be ruled out. The Government must support technical assistance and at least partially finance the costs of data processing, storage and analysis. The lack of a suitable combination of continuous funding and farmer participation has been in the past the main cause of program discontinuity and loosing valuable germplasm. Management of the program, thus, must involve the community. In promoting awareness of the benefits of a long term breeding program and the negative impact of program discontinuity, international livestock centers and the FAO could be instrumental.

In order for farmers to participate in the recording process, they need to be adequately trained so as to assure quality information. If the data is only collected and does not return to farmers as processed information for them to make breeding decisions, the whole operation will have little perceived value. It is therefore critical to demonstrate its usefulness. Thus, it is equally important to train farmers to understand and use the processed information. Centralization of databases in a single unit, rather than disperse management, will permit better data systematization and utilization of costly hardware/software, and cost effectiveness when hiring highly qualified people in data processing, management and analysis. If the plan involves many parties a smaller, modest, but well controlled site specific program, would be preferable.

Data recording often requires that objective measurements be made by costly equipment (e.g. fiber measurements). The closer the program to the industry the greater its chances to have access to specialized equipment. This also underscores the need for Government support.

The traditional well-established community organizations are seen as suitable candidates to handle breeding schemes, provided that a sound market-oriented research and technical assistance integrates management, nutrition, health and transformation. An open nucleus appears to fit community organizations and the integrated improvement approach better. Within this framework, community producers have been also considered for *in situ* germplasm conservation. This is true to the extent that new production alternatives or inappropriate programs could eventually lead to erosion of genetic resources. For example, irrigation changed production so dramatically in the Mizque Valley, Bolivia, that intensive out-of-season onion production caused about 60% reduction of the SR stock in less than 5 years. Inappropriate breeding programs introduce even more risks if managed by disqualified personnel. Unfortunately, many NGO's development programs delegate the responsibility of their breeding components to sociologists or poorly trained technicians in animal production.

Research needs to focus more on the potential of local and native SR, understanding their production context and market opportunities. Breed comparisons with exotic germplasm should be adequately conducted on the basis of contemporary performance, through at least 3 parturitions, of observed females. Population screening for traits with high market value should be followed by analysis of their genetic control, including searching for presence of major genes. In this context available technologies, including AI/embryo transfer, could be considered if utilization costs are lowered.

Information on ongoing breeding plans in the region is scarce and often unavailable. This suggests that some programs are developing in isolation. Networking should be stimulated; in particular promoting regional studies on the potentials of local populations and breed comparisons. This can also promote sharing information and key resources.

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