# Breeding strategies for low input animal production systems: a case study from Central America and Mexico

***A. Tewolde***

*Universidad Autonoma deTamaulipas, UAMAC,*
*Ciudad Victoria, Tamaulipas, Mexico*

## Introduction

Several breeding strategies and management systems have been designed in various environmental conditions and for various reasons. The reasons for such strategies have in general been associated with the problems related to the environment and challenges that they present. For example in tropical environments, specialised and high producing genotypes for meat and milk were in the past, and in some instances even today, introduced with the expectation that they would continue to produce at the same level as in their original environments. However, the adaptation problems associated with them made it impossible to achieve such desired levels of production. In the meantime, the introduction of high producing and specialised breeds to the tropical environments caused erosion, if not irreversible changes, to the genetic identity of certain local genotypes. The local genotypes, if used strategically, could have contributed to the alleviation and need for more livestock productivity in most developing country conditions in general and tropical Latin America in particular. This has created a condition where some of those genotypes, such as the criollo cattle of Central America and the Caribbean and other breeds of other species such as the local pigs known as cerdo pelon in Mexico, are at present vulnerable or at risk.

Efforts have been made to develop breeding strategies using locally adapted genotypes especially those of the bovine in certain areas such as Central America with the Criollos, which are basically *Bos taurus*. In this, the main objective was to look for alternative genotypes, like the Criollos, that can fit in low input production systems consisting of pasture grazing systems. Even though that was the case, modifications to the original breeding strategy that consisted of straight-breeding and/or up-grading were later modified to simultaneously incorporate cross-breeding systems while at the same time being capable of maintaining themselves as straight-breeds. This was the case for so many years with the Central American Dairy Crollos and the Romosinuanos. This will be dealt with in more detail later.

Some of the underlying assumptions of genetic improvement strategies include: a) the existence of sufficient genetic variance (additive and/or non-additive) for some bio-economically and environmentally important traits; b) the possibility that genetic progress is feasible even in harsh environmental conditions; c) that some or all of the genetic progress possible to be achieved can indeed be used by the producers hence better overall productivity; and finally d) that livestock policies can be influenced at national and regional levels. Observed successes or failures from such strategies have been shown to be due to any one or combination of these factors. As there have been experiences that clearly elucidate these assumptions, it seems imperative that for eventual designs and planning of breeding strategies for cost effective production systems, all negative and positive results from such programmes be considered.

In this manuscript efforts will be made to document and examine experiences as case studies in a breeding programme where the author was directly involved for ten years in Central America and later on at national level in Mexico.

## Description of the Central American programme

Since the early 1940s a breeding management programme was initiated at the Centro Agronomico Tropical de Investigacion y Ensenanza in Costa Rica with the objective of promoting the use of locally adapted genotypes that can produce in pastural conditions in the tropics and therefore achieve production objectives in beef and milk under low input production systems. Two tropically adapted genotypes of cattle, the Central American dairy Criollos and the Romosinuanos, were used as straight-breeds at the beginning and later also to produce crosses but for the same objectives. The former, as its name implies, is a dairy type while the latter is a beef type. Both were managed in pastural conditions and in experiment station conditions and can generally be referred to as though they were managed in a low input production system. The crosses in the case of dairy included first generation $F_1$ with the Jersey (Criollo x Jersey including the reciprocal crosses) as well as back crosses to the respective breeds; while in the case of the beef production systems crosses involved the mating (natural) of Romosinuano bulls to *Bos indicus* cows mainly Brahman (no reciprocal crosses were permanently produced over time even though efforts were made to introduce other European beef breeds as terminal sire breeds such as the Charolais) and the cross-bred females from this were bred back to the Romsinuano bulls.

In both the dairy and beef production systems in pastural conditions, it is important to emphasise that the objective was to develop low input production systems using improved local genotypes via selection and cross-breeding in relatively harsh environmental conditions. While doing so the number of breeder females in both the beef and dairy herds oscillated between 125 to 180 and 85 to 120, respectively. Breeder males were generally produced in the herds except the pure bred Jerseys that were

introduced from external markets via artificial insemination, for example, semen was bought from commercial companies who in turn imported it from foreign countries. Therefore, genetic improvement through selection was primarily directed towards these two nuclei in Costa Rica even though the advantage of cross-breeding was also considerable. Right from the beginning of the programme individual records on milk traits such as milk, fat and protein yields, fertility and growth traits measured at birth and weaning, were kept. Thus, the importance of the programme in terms of its capacity to have developed a strong and continued database for tropically adapted animals in tropical environments is absolutely evident. In general, milk yield per lactation, which was generally of 270 days, in the dairy Criollo and Jersey, was the selection criterion while in the Romosinuano the selection criterion was consistently the weaning performance of the animals. In the Romosinuano cattle and their crosses with the Brahman, other growth traits such as post weaning growth traits were also noted but were not consistently recorded in that they were taken only during a certain number of years and then interrupted for different reasons.

During the years that these herds were managed, closed nuclei efforts were made to avoid breeding schemes that could otherwise result in high levels of inbreeding. Several research papers were published showing the existence of genetic progress and variance for at least the traits that were being used as selection criteria and for which cross-breeding was undertaken as described above. Such studies confirmed some of the underlying assumptions on which a breeding strategy should be based for herds in tropical environments. However, these results were mainly based in experimental station conditions and were not checked or validated in producer conditions with whom the programme may have had established relationship and cooperation.

This is because, and it should be emphasised here, that most of the selection and cross-breeding work carried out with the dairy Criollos and Romosinuanos was mainly in experiment station conditions and there was little participatory collaboration of producers in any one of the countries in the region. The most that took place was that Romsinuano and Dairy Criollo sires, from the nuclei in Costa Rica, that had positive genetic potential for weaning and milk yield, respectively, were either distributed (mostly sold) as sires or in the form of semen. In the case of the Romosinuanos most sires ended up in Costa Rica, the USA and Panama while dairy sires were also used in Costa Rica but their semen was distributed in several countries such as the Dominican Republic, Paraguay, Mexico and Honduras among others. Improved females were not generally distributed to any country. Even though there was modest distribution of the genetic material, no follow-up and monitoring of the performance of such genotypes in relation to that of the main nucleus was undertaken. From the beginning, this was the main flaw of the programme as the need to promote, at producer level, the use and follow-up of such improved

local genetic material that can sustain low input production systems in real world conditions was never incorporated into its operation. In future designs of breeding management where low input production systems are the main target and where they can be served by the incorporation of genetic improvement, then the participation of the producers becomes not only desirable but a necessity.

It is also important to note the input level under which these genetic resources have produced ranges between low to medium input. This is because there were records (production, growth and reproduction records) maintained throughout the time that these animals were in the station, group breeding with defined breeding and weaning season in the case of the Romosinuanos as well as artificial insemination in the case of the dairy Criollos, was satisfactory. Also good health management practices were also in place including rotational grazing on improved pastures.

As previously indicated, the formal and collaborative programme with producers never really existed. However, significant training activities were undertaken directed to the producers of the Central American region and also formal graduate students from all over Latin America who did their thesis work using the data generated from the station. Training was probably the most important impact this programme had in the decades that it was operational. Along these lines, it should be recognised that there were very few producers who started up-grading their herds towards the Romisnuano without any formal relations with the central programme. The same can be said for those dairy producers who used sires from the Central American dairy Criollo. It should be noted that these producers did not start because the programme had an outreach activity to promote these breed types. Instead most of the producers started on their own and based their activities on informal communications with other producers or with the people who managed these herds at the experiment station in Costa Rica. An exception was the existence in Nicaragua of the Dairy Criollo managed in a dual purpose production system that contributed towards the formation of the Costa Rican dairy Criollo herd. The important issue to emphasise here is that there was no outreach activity inherently tied to the programme.

## Breeding design planned versus followed

The improvement strategy planned included the production of breeder males from the same herd. A closed nucleus breeding management was considered to the extent that mating between closely related individuals was avoided. This policy was continually implemented from the inception of the programme. Families (five and four families were established in the Romosinuano herd and the dairy Criollo herd, respectively) that consisted of 25-35 breeder females were constituted and males were identified from one group to serve in another group in such a way that high level of inbreeding was avoided. From 1954 to 1991 the cumulative inbreeding in the Romosinuano herd reached 17 percent. Inbreeding was found not to

be negatively influencing any of the traits of importance including fertility for which these animals, as are the dairy Criollos, are very well known in the tropics. Additional males were identified, again based on their genetic potential for growth and maternal influence in addition to ensuring the absence of any anatomical defects in the case of the Romosinuanos and milk yield per lactation in the case of the dairy Criollos. These sires were used in cross-breeding with the Brahman in the case of the Romosinuanos even though all males who served for two years in the nucleus herd were also used in the cross-breeding programme of the system. The same was done in the dairy Criollo herd. Therefore, these herds were indeed capable of producing sires for cross-breeding while at the same time they maintained themselves as pure breeds. This is one important feature of breeds of any species that can warrant its identity while still contributing towards the efficiency of the production system and should be looked at very critically while deciding on the management of such genotypes including the genetic improvement strategy. In general, it can be said that the design planned closely followed what really took place in reality. During the last four years the population size of the dairy Criollo has decreased to less than 80 while that of the Romosinuano decreased to approximately one hundred. However, there are sub populations of the dairy Criollos in Nicaragua that can reach up to 300 and a few in Mexico while that of the Romosinuanos can amount to 250 mainly in Cost Rica even though there are also other herds in Florida USA, Paraguay and Panama.

The improvement strategy followed with these animals had no relationship with that practised by the producers who mainly relied on up-grading their Bos indicus based herds and no records were kept on them. However, there were at least some similarities in the production systems as the producers also ran their cattle in pastoral, mostly unimproved, conditions.

## Basis for the genetic improvement of these herds

Ever since the inception of the programme genetic improvement was established based on growth traits for the Romosinuano and milk yield in the case of the dairy. In both cases it was recognised that they had merits for fertility that later became one of the most important and unique traits for which such genotypes were in demand from some organizations. As stated above, most studies undertaken in the experiment station conditions showed that there was indeed sufficient additive genetic variation for some traits such as weaning weights in the Romosinuano cattle; milk, fat and protein yields in the dairy Criollo cattle. Also characteristics and parameters related to lactation curves and total productivity were duly investigated and results showed that significant additive and non-additive genetic variation existed for such traits too.

In the case of cross-breeding effects, it was clear that there was some advantage in crossing the dairy Criollo with the Jersey-Jersey as on average the $F_1$s produced more than the breed average of the two breeds (28 percent

more). Also when the Romsiunao were crossed with Bos indicus some advantage was achieved in growth up to weaning. Fertility of the cross-bred females in both cases became closer to the dairy Criollo and the Romosinuano hence emphasising the utility of these genotypes in tropical environments. In the case of the dairy Criollos-Criollos and Jersey-Jersey crosses, approximately 77 percent fertility was achieved in the first two inseminations while in the Romosinuano Brahaman crosses, approximately 85 percent fertility was constantly obtained per 100 cow exposed to a bull in natural mating per year. Corresponding levels of fertility of the respective pure bred Romosinuano and dairy Criollo was similar to that observed for the crosses in similar management conditions in the station.

## Farmer/producer and government involvement

The programme previously discussed did not have decisive and participatory Government and producer involvement. Several factors contributed towards this situation. Firstly, the herd belonged to a regional centre and not to a specific Government or producer organization. Secondly, appreciation for other breeds in the countries played against such genotypes in that no policy at country level was ever made or developed as a result of the different studies, evaluation and improvement strategies that were being made on experiment stations. Thirdly, from the very beginning the programme did not include the participation of the producers in its operation, however small a group these were. Finally, the international agenda in this matter was not strong enough to warrant it significant and continued support. Therefore, the financial support to maintain both nucleus in the management systems described was generated mainly from the same herds, from sales of their own produce and culled animals as well as sale of germplasm. Lack of funds and other previously mentioned reasons later became the causes for reducing the size of the conservation part of the programme and hence endangering the genetic identity of the two nuclei. Efforts should be made in order that such nuclei of herds do not disappear.

## The programme in perspective

The programme described represents one of the few programmes that has lasted long enough with little changes in the breeding goals and objectives over the years. At the same time it has maintained some of the animal genetic resources that have unique traits in tropical foot and mouth disease free environments. Also, genetic variation in the respective herds was continually conserved. At a time when the need for sustainable production systems are being emphasised, such genetic resources should and can indeed be considered as potential gene sources. At present, this can greatly be enhanced thanks to the biotechnological advances taking place.

Most importantly, genetic and non-genetic evaluations have been made for the productive and reproductive traits of the Romosinuanos and the dairy Criollos in that their potential contribution to low input livestock

production systems can be determined a priority. Also they have contributed towards the generation of founder herds in other countries such as the USA.

The most important lesson learned from this programme however, is the fact that any breeding strategy and management such as this should go hand in hand with management practices at producer level with their active participation as long as there are external and local funds available to enable this. This will allow a simultaneous validation and therefore facilitates the transfer of significant genetic improvement that can be achieved in the nucleus herds.

## The case of Mexico

Recently Mexico involved itself in the development of a national programme of animal genetic resources in view of the economic, social and ecological importance that livestock has in the country's economy. In the process of the development, some of the previously mentioned lessons, both successful or otherwise, were duly taken into account. The first thing that was clear was that the producer or breeder major stakeholders of all the programme, had to be directly involved in the deliberations and discussions involving all animal genetic resources in the country. As such organizations of beef cattle breeders, dairy cattle breeders, sheep producer associations, poultry producer associations and equine as well as swine producer associations, had full and active participation in all the four forums that took place during the two years. This was a very important step to take even when the process was being sponsored by the Government with the cooperation of the technical educational and research institutions in the country.

After very detailed discussions and deliberations a national programme on animal genetic resources was developed and is now being implemented. The important thing here is the fact that from the very beginning the producers have consistently taken an active part and thus every phase of the implementation considers such participation. In fact, the implementation phase is presided over by a producer representing the producer organizations in the country and with technical support from the national educational and research institutions via the National Commission on Animal Genetic Resources that was recently founded for the first time in the country.

The national programme of animal genetic resources consists of four main programme activities. These are:

a) establishment and maintenance of a database by species that will not only allow the definition of breeding strategies to be applied by the producers of each species in different production systems as long as they are cost effective but also to determine the status of most of the animal genetic resources the country possesses;

b) conservation of valuable genetic resources applying, when appropriate, molecular techniques;
c) strategic use of the genetic resources including evaluation and production controls; and
d) promote training programmes directed to producers and technical staff within the scope of the programme.

To summarise, breeding strategies for low input production systems have been designed and implemented as described above and different types of results have been obtained. It should be highlighted that the main result that should be emphasised from the Central American herds was their ability to produce cross-breds while still providing for their own genetic identity. On the other hand, strategies such as those described for the Criollos and the Romosinuanos should have had outreach activities tied up to them since the inception of the programme. Such results, negative or positive, have contributed in part towards establishing breed and breed type evaluation programmes in some countries while in others, have directly or indirectly contributed towards the definition of a national programme. An example of the latter is the one described for Mexico. Finally, one should bear in mind that any programme or breeding strategy associated with low input production system requires the necessary budgetary allocation by any entity if such a programme is to be part of a policy that an organization or Government pursues.