

Utilization of Animal Genetic Resources in Brazil: Results of a 28-year Conservation Program

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1. Introduction

When the Americas were conquered, there were a few domesticated animals in the continent. The natives exploited a number of those species, such as camelids and guinea pigs. Most introductions occurred during the first years of colonization, by the Spanish and Portuguese settlers who brought animals of the main domesticated species found on the Iberian Peninsula. In 1493, Columbus unloaded a number of animal species onto the island of Santo Domingo in the Caribbean. Subsequently, the animals moved with the settlers into the mainland, Central and South America, with the exception of Brazil, where only in 1534, the Portuguese settlers began bringing their own livestock. In Brazil, those introduced species were subjected to natural selection and became adapted to one of the many environments. Today, these earlier introductions represent recognized, well adapted populations, known as naturalized breeds (Mariante et al., 2009).

At the end of the 19th century, due to the increased need for animal products, some exotic breeds, selected in temperate regions, were imported from Europe. The naturalized breeds presented lower production levels than these importations, but were adapted to the tropics and had adaptive traits, such as resistance to disease, heat, parasites and excessive humid or dry climates. A few decades later, breeders decided to import zebu cattle (*Bos indicus*) from India. The zebu cattle and their crosses, well adapted to tropical conditions, started to replace the naturalized breeds from the Southeast region northwards. These exotic breeds and their crosses almost led to the disappearance of the naturalized breeds in many areas of the country. Traditional naturalized cattle breeds, such as Caracu, Pantaneiro, Curraleiro, Mocho Nacional and Criollo Lageano, were suddenly under threat of extinction. Had it not been for the timely action of a few breeders and researchers, it is probable that not a single herd of these breeds would have remained today. Thanks to these imaginative individuals, these valuable genetic resources representing many generations of natural selection and adaptation have been saved. It should also be recognized that these livestock imported in the 20th century not only contributed to the country's animal genetic resources, as were decisive for the success of the Brazilian beef cattle industry. Imports of exotic breeds of other species had caused similar consequences, and naturalized breeds were also rescued by farmers and researchers especially horses and sheep, as shown below.

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2. Brazilian Conservation Program

The establishment of a program for the conservation of endangered livestock breeds was essential to avoid their impending disappearance. Embrapa (Brazilian Agricultural Research Corporation) has shown leadership in conserving these breeds at its various Research Centers, together with Universities and private farmers. Since 1983, Embrapa Genetic Resources and Biotechnology - Cenargen, one of the 42 Research centers of EMBRAPA, located in Brasilia, has the lead role in coordinating the program. The *in situ* and *ex situ* conservation activities and the programs for animals considered at risk include the identification of populations in an advanced state of genetic dilution, the establishment of conservation nuclei, the genetic and phenotypic characterization and the evaluation of their production potential.

In early 2009, Brazil launched an innovative structure for the conservation and sustainable use of its genetic resources, known as the Brazilian Platform for Genetic Resources, under the leadership of Cenargen, that also hosts the Regional Focal Point of Animal Genetic Resources for Latin America and the Caribbean (RFP-LAC).

This Platform is composed by four Networks. The first is responsible for the utilization and conservation of plant genetic resources; the second for animal genetic resources, and the third for microorganisms genetic resources (Figure 1). The fourth is a horizontal Network, and is composed of five research projects, that interact with the other three Networks. The first of these projects deals with the management of the Platform as a whole, while the other four research projects are responsible for subjects common to the other three networks: germplasm curatorship, documentation, exchange and quarantine.

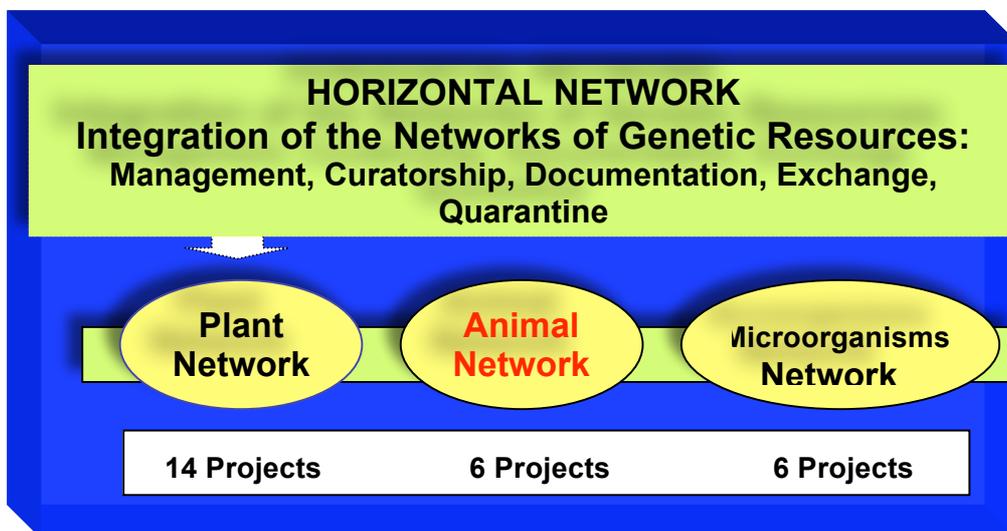


Figure 1: Structure of the Brazilian Platform of Genetic Resources

The Genetic Resources Platform, as a whole, includes 31 Research Projects and 170 Action Plans, being developed at 35 Embrapa Research Centers and 70 partner institutions, by a total of 520 researchers. Such a structure shows the high priority that the country is giving to the conservation and sustainable use of its genetic resources.

The Animal Genetic Resources Network contains the following six research projects: (1) Management of the AnGR Network; (2) *Ex situ* conservation of AnGR; (3) *In situ* conservation of AnGR; (4) Genetic Characterization of AnGR; (5) *In situ* conservation of associated herds of AnGR (herds that do not belong to Embrapa); and (6) Conservation of wildlife with economic potential. The Genetic Characterization and the *Ex Situ* Conservation projects are responsible for the characterization and the cryopreservation of genetic materials from the animals included in the Conservation Nuclei, kept on the regions where the animals have been naturally selected for centuries.

2.1. In situ conservation

In situ conservation is being carried out in Conservation Nuclei spread all over the country, and includes naturalized breeds of seven species: cattle, buffaloes, pigs, sheep, goats, horses and donkeys (poultry breeds should soon be included in the program). Each Nucleus is being maintained by government organizations as well as by private breeders, located in the environments where the animals have been naturally selected for centuries. Specific research projects have been consolidated in the Animal Network of the Brazilian Platform of Genetic Resources. In general the animals are being preserved in their natural habitats. The animal species/breed being conserved, their environment and the reasons for their conservation are presented in Table 1. In a large country like Brazil, with many climates and different agro-ecosystems, there would be little use in conserving animals in environments that vary from their natural habitat.

2.2. Cryopreservation

Following the establishment of the *in situ* program on a nationwide scale, it was decided that Embrapa should start an *ex situ* program, with emphasis on cryopreservation. This program would avoid the genetic dilution and the loss of irreplaceable genes of the naturalized breeds, and, in order to store semen and embryos from these animals, the Animal Gene Bank was established in 1983. Currently, cryopreservation activities are being carried out at Cenargen as well as in some Conservation Nuclei, when the research center where the Nucleus is located has the necessary infrastructure for the collection of semen and embryos. The selected animals are assembled at these sites and as soon as the semen and/or embryos are collected, they are immediately transferred to the Animal Gene Bank (AGB). When the infrastructure for the collection of semen and embryos do not exist, donors are temporarily transferred to Cenargen's Experimental Farm for subsequent collection. Presently, the AGB has 53,450 doses of semen and 435 embryos.

Table 1: Original environment of local livestock breeds of Brazil, their environment and reasons for their conservation.

Species	Breed	Original Environment	Conservation Environment	Reasons for Conservation
Cattle	Caracu	Central and South Brazil (from tropical to temperate)	Central Brazil	High production and widely used for crossbreeding.
	National Polled	Central and South Brazil (from tropical to subtropical)	Central Brazil	Only polled local cattle breed.
	Criollo Lageano	Southern Brazil (highlands, cold winter)	Southern Brazil	High production and adapted to the coldest region of the country
	Pantaneiro	Pantanal (swampy region)	Pantanal of Brazil	Adapted to region liable to flooding, rustic, and high fertility rate.
Horses	Lavradeiro	Northern Brazil savannas	Northern Brazil	Survival on very poor Savanna diet, tolerant to parasites.
	Pantaneiro	Pantanal (swampy region)	Pantanal Brazil	Adapted to region liable to flooding, tolerant to Equine Infectious Anemia.
Donkeys	Northeastern	Northeastern region of Brazil (semi-arid)	Northeastern Brazil	Widely used for transport and draft by low income population
Buffaloes	Carabao and Tipo Baio	Amazon region of Brazil	Amazon region, Brazil	Well adapted to the Amazonian region
Sheep	Morada Nova and Santa Ines	Northeastern region of Brazil (semi-arid)	Northeastern Brazil	Hair type, adapted to the semi-arid region
	Criollo Lanado	Southern Brazil and Uruguay (temperate climate)	Southern Brazil and Uruguay	High fertility, precocity and resistant to internal parasites
Goats	Azul, Canindé, Marota, Moxotó, Marota, and Repartida	Northeastern region of Brazil (semi-arid)	Northeastern region of Brazil (semi-arid)	Responsible for most of the meat and milk production in the region.
Pigs	Nilo, Canastra, Caruncho, Piau, Moura and Pirapetinga	Scattered all over Brazil	Central and Southern Brazil	Resistant to diseases, important for small holders.

For some breeds included in the Brazilian program, there are less donor bulls than the 25 donors per breed with 100 doses/bull recommended by FAO. When the cryopreservation program began, some of the breeds did not have this number of males. Therefore, more than the recommended number of doses per bull has been collected when the number of bulls is limited. As the Conservation Nuclei are increasing in size and animals or new herds are identified, the intention is to collect genetic material from the greatest possible number of animals, thereby increasing the genetic variability in the AGB.

2.3. Genetic characterization

The study of molecular markers with Brazilian local adapted livestock species had started after the implantation of a DNA Bank in 1998. Today, this Bank has more than 14,000 DNA and tissue samples of livestock breeds and native Brazilian species with socio-economic potential or effective importance. Figure 2 shows the evolution and utilization of some markers in seven livestock species already studied in the country. The main objectives in the beginning of the genetic characterization efforts were to quantify the genetic diversity within and among breeds of the same species in order to identify the patterns of genetic structure as well as to estimate the influence of commercial/specialized breeds in the local adapted stock. Today the goals to achieve are towards the management of the herds kept in the Conservation Nuclei and selection of germplasm donors to for the Animal Genome Bank. With the development of high-throughput platforms of SNPs markers, the future goals will be, among others: (1) development of customized SNP panels for traceability and genetic management of the herds; and (2) insertion of breeds with higher effective numbers in breeding programs, when wild genome selection actions will start.

3. Sustainable Utilization (Success stories)

One of the best ways to increase the interest in the naturalized breeds has been the creation of Breeders Associations. Many such experiences have been successful, but it is also known that this is not enough. Traits of economic value must be identified to convince breeders to continue raising that specific breed. During its 28 years of existence, the Brazilian Program for Use and Conservation of Animal Genetic Resources has been responsible for several success stories that are highlighted below.

3.1. Caracu cattle

The Caracu has the most successful story among all Brazilian naturalized breeds in Brazil. In the 1970's, even though this breed was threatened with extinction, some breeders insisted in placing some animals on the Weight Gain Test, that was held every year by the Instituto de Zootecnia de São Paulo, exclusively for zebu breeds. Surprisingly, some Caracu bulls won the test, amazing the same zebu breeders that in the past had replaced the breed by exotic ones. All of a sudden, breeders decided to use Caracu semen in their herds. At that time, Artificial Insemination Centers did not maintain Caracu semen in their catalogs. Due to demand by those breeders, the AI centers started collecting and selling Caracu semen, but a long waiting list of breeders formed. Nowadays, Caracu is being widely used, not only for crossbreeding with zebu and European breeds, but as purebreds. The Caracu has a very strong Breeders Association with increases in population estimates of up to 65,000 head.

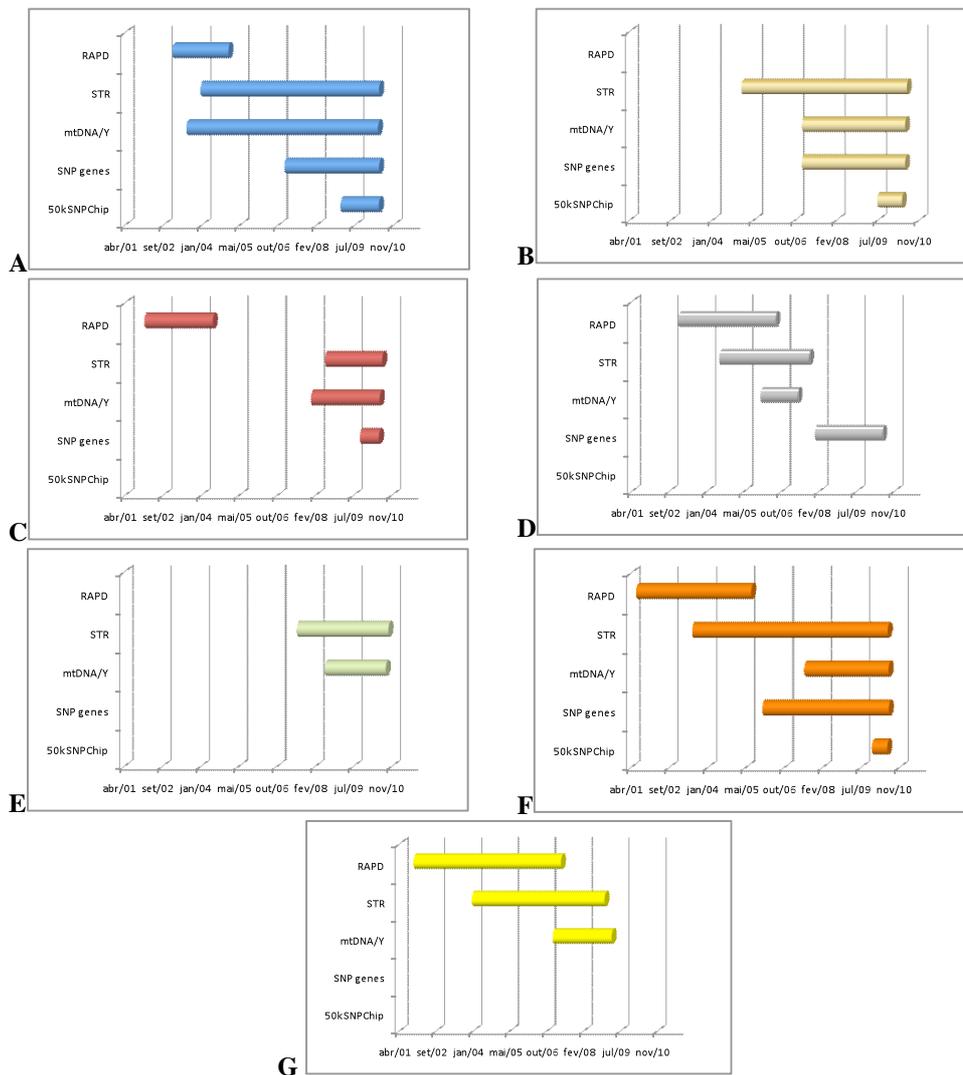


Figure 2: Brazilian Genetic Characterization Program using Molecular Markers (2001-2010). A=sheep; B=pigs; C=goats; D=buffaloes; E=donkeys; F=cattle; G=horses.

3.3. Pantaneiro horse

The Pantaneiro horse is a naturalized breed from the Pantanal Matogrossense of Brazil. The Pantanal is located on the border with Bolivia, that is flooded at least six months of the year. This horse breed had its probable origin from Iberian horses introduced by Spanish settlers, especially in the 16th and 17th centuries, and by Portuguese settlers in the 18th century. As a consequence of natural selection for more than two centuries, with little or no human

interference, this breed became well adapted to the environment. At the end of the 19th century, the population was severely reduced due to Trypanosomiasis. Later, other menaces appeared, mainly indiscriminate crossbreeding and more recently Equine Infectious Anemia. This genetic resource was saved from extinction by the creation of the Brazilian Association of Pantaneiro Horse Breeders (ABCCP), in 1972. The breeders of this region consider the Pantaneiro horse as the most important tool for managing cattle, which is the principal economic activity in the region, and breeders consider the Pantaneiro horse as their main work tool. More recently, the breeders have become interested in selection and improvement of the breed, principally in its body conformation and use in tournaments and rodeos. In recent years there has been a sharp increase in registers for this breed reaching over 700 in 2007, reflecting the success of the conservation program and increased interest in this horse. Two municipalities are responsible for almost 70% of all registers: Poconé where the breeders' association is based and Corumbá where Embrapa Pantanal carries out its research on the animal. This shows the importance of these institutions in the continued success of the program. Of the animals registered, 50.66% had known sires and 48.86% known dams. The quantity of information increased with generation number. For all generations, relatively more information was available for the male pedigree than the female, but in recent generations more information on females was available.

3.4. Hair sheep breeds

Hair sheep breeds are thought to have originated on the African continent and brought to Brazil in the 17th and 18th centuries along with slaves (Primo, 1999). Recent studies have shown lack of characterization in these breeds and much crossbreeding (Paiva et al., 2006). These breeds such as Santa Inês, Morada Nova and Brazilian Somalis, have extremely high quality skins which are in high demand for manufacturing shoes and clothes. The Santa Inês is at present the most numerous breed in the country.

McManus et al. (2009a) showed that sheep breeds with European blood (pure or crossbred) had higher infection levels than the Brazilian hair breeds (Santa Inês and Morada Nova). These breeds may be naturally more resistant to parasite infections. This is in agreement with Amarante et al. (2004), who showed that while 100% of Santa Inês lambs were resistant to infection, 80% Suffolk lambs were susceptible, under the same management conditions. Bueno et al. (2002) observed that Santa Inês animals were less susceptible to nematode infection and better adapted to intensive management compared to Suffolk, Ile de France and Poll breeds. All these positive traits led to an increase in population numbers, and this breed that was restricted to the Northeast region has now widespread to the Central region of the country. Nevertheless indiscriminate crossbreeding of this breed has led to reduction in heat tolerance (McManus et al., 2009 a,b) and susceptibility to some diseases such as scrapie (Ianella et al., 2009).

3.5. Other breeds

The Monteiro pig (*Sus scrofa*) is a domestic swine which became feral in the Pantanal region of Brazil, developing some phenotypic traits that resemble those of a wild hog. At present, about 9,800 groups have been identified. The Monteiro pig is used as a tourist attraction as

well as an economic diversification through hunting and extensive production. This breed is highly adapted to these extensive systems, characterized by its survival during rainy and dry seasons and has recently been introduced in extensive systems in the Federal District. Several other studies are being carried out and herd numbers rising in cattle breeds such as Crioulo Lageano and Curraleiro, pig such as Moura and goats such as Canindé and Moxotó.

4. Conclusion

The success of Brazil's conservation program is evident when looking at the Global Plan of Action (GPA) for Animal Genetic Resources. Brazil had already been working for over 25 years on the main Strategic Priority Actions defined in the GPA. While other countries are starting to build their National Plans, Brazil has reformatted its conservation program into a National Network for AnGR as part of the Brazilian Platform of Genetic Resources. Continued success depends on all parts of the network continuing to work together towards its main objectives. As Brazil is a huge country, some isolated actions in characterization and conservation of AnGR exist, which could have more success with interaction within the National Platform.

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