

Selection Of Tropical Dairy Cattle – The Experience From The Brazilian Gyr And Guzerat

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Introduction

In 2008, the Brazilian milk production was estimated in 27 million liters, produced by 21,484,000 cows, which provides a national average production of 1,261 kg per cow per year (EMBRAPA, 2008). Most of the Brazilian territory lies in the tropical zone and for this reason dairy farming is characterized mainly by pasture based production systems, varying from exclusive grazing systems (zero supplementation) of up to 50% of dry matter supplementation with roughage and concentrate (Assis, 1997). Most of the genetic resources used for the improvement of the Brazilian dairy cattle originates from temperate countries (North America and Europe), where the production and market circumstances are overall different from those prevailing in Brazil. Holstein is the main specialized dairy breed imported in Brazil. However, after the implementation of the Breeding Programs for dairy Zebu breeds in Brazil (Gyr and Guzerat), the interest in the national market for proven semen of Zebu breeds has increased significantly. According to the Brazilian Association of Artificial Insemination (ASBIA, 2010), in 2008, the Gyr dairy cattle was responsible for more than 50% of the national semen commercialized in Brazil for dairy purposes. This breed is responsible for 80% of the bovine genetic material exported from Brazil. At present, Gyr is the third zebu breed in embryo production, and the total birth registrations increased to almost 70% in the last five years (ABCZ, 2010).

Zebu breeds are characterized by rusticity, thermo-tolerance, resistance to parasites and great capacity of gross roughage utilization, characteristics of great importance in tropical dairy production systems. The Zebu was first introduced in Brazil in the beginning of the twentieth century. The last importation occurred in 1962, and it is estimated that a total of 6,262 zebu animals entered the Country in all importations (Santiago, 1986). Different breeds were imported from India and Pakistan, such as Ongole (which has originated the Nelore, the most used beef breed in Brazil), Guzerat, Gyr and Sindi. The Herd Books for zebu breeds were created in 1936. The good adaptation of the Zebu skills to the Brazilian environmental conditions and the existence of large pasture areas resulted in its fast dissemination mainly in the Southeast and Central regions of the country. Initially, the empiric selection of these breeds was directed towards beef production. A small group of farmers however, decided to steer the selection of the Guzerat (Rio de Janeiro state) and Gyr (São Paulo state) breeds to milk production since the beginning of their activities in the twenties and thirties, respectively. In the fifties, some very traditional herds of Gyr and Guzerat cattle were formed

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in Minas Gerais state. In 1980, a group of Gyr breeders established the Brazilian Breeders Association of the Dairy Gyr. In 1985, a Progeny Testing Program was initiated along with Embrapa-Dairy Cattle. Despite being initially used as beef cattle, nowadays, the Guzerat is considered to be a double purpose breed. A milk recording program was started in 1992 by a group of double purpose breeders of Guzerat cattle, and in 1994, a joint program of progeny testing and a MOET nucleus scheme involving meat and milk traits as breeding goals was commenced.

The development of breeding programs involving Zebu breeds in Brazil is quite relevant to ensure the adequate maintenance of crossbreeding schemes, largely practised nationwide. Crossbred animals (Zebu x European) are widely used in pasture based milk production systems in Brazil, due to their adaptation skills, and are responsible for roughly 80% of the total milk produced in the country. According to Gomes (2001), these systems also have the advantage of being flexible and easily adjusted to the market.

This article summarizes the evolution of the Dairy Gir and Dairy Guzerá Breeding Programs in Brazil.

The Brazilian Dairy Gir Breeding Program (PNMGL)

The Brazilian Dairy Gir Breeding Program is a project managed by EMBRAPA Dairy Cattle, in partnership with the Brazilian Dairy Gir Breeders Association (ABCGIL) and the Brazilian Zebu Breeders Association (ABCZ), with the technical and financial support of governmental (CNPq, FAPEMIG, MAPA, local state research centers) and private companies, such as AI Centers. The idea for the implantation of a technical program for the selection of Dairy Gir began in the late seventies by a small group of breeders, researchers of Embrapa Dairy Cattle, and Dr. Fernando Enrique Madalena, a FAO representative in Brazil at that time.

There are approximately 25,000 registered cows, including Gyr dairy and beef cows, although, the majority of beef farmers in Brazil worked with dual - purpose cows in the last decade.

The general structure of the progeny testing program (PTP) is as follows: there are nearly 40 purebred herds providing young sires to be tested per year; the semen of testing bulls (550 doses of semen per animal) are distributed over approximately 420 farms (200 cows per animal); out of this total 70% are crossbred herds (Zebu x European) and 30% are purebred Gyr.

During the early beginning, the only selection criterion was the milk and fat production. Since 1999, protein and total solids were also recorded and included in the genetic evaluations, as were the conformation and management traits.

The main objective of this program is to provide breeders and commercial farmers with sire information on the PTAs of traits of economic importance such as milk production and composition, conformation and management traits. Molecular information on alleles A and B of κ -casein and β -lactoglobulin are also available.

Despite the initial difficulties, at present, the program has an organized and solid data base with productive and reproductive performance information about Dairy Gyr and its crosses, with more than 50.000 complete lactations.

The results of 25 years of the Dairy Gyr breed progeny testing program implantation are discussed below.

1- Milk, fat, protein production and lactation length

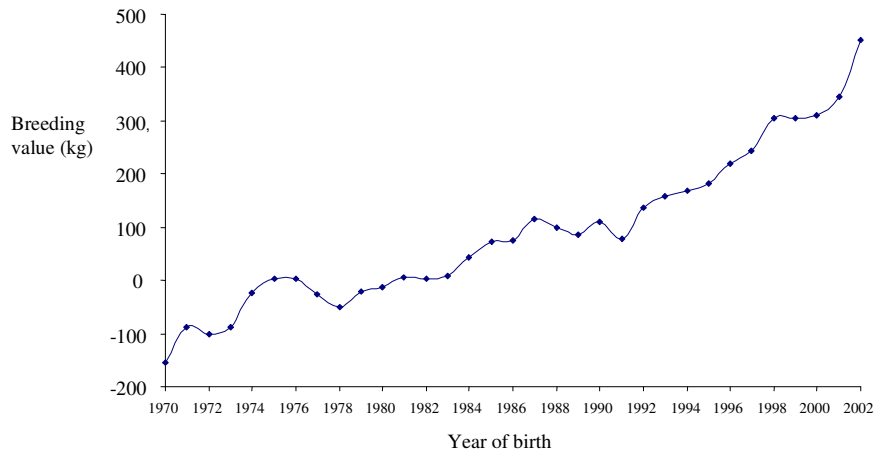
Up to 2009, 325 sires, divided into 23 groups, were included in the PTP, representing the different genetic lineages currently existent in Brazil. Genetic evaluations have been performed based on progeny and herdmatr information, taking the pedigree information into account, as well. The proofs of a total of 186 sires divided into 17 groups have been completed. Their genetic evaluations were based on the performance of 7,197 daughters and 8,851 herdmatrs, with a total of 16,048 lactations. The progeny of these sires are distributed nationwide, with a higher concentration in the Southeast region. In 2009, the twenty-fourth group was formed, consisting of 32 young bulls.

The variation in milk production in 305 days of lactation and the total milk production according to the birth year of cows, shows an expressive increase throughout the years, starting with cows born in 1970 presenting about 1,500 kg, and cows born in 2002 presenting averages of 3,289 kg and 3,583 kg of milk, respectively in 305 days of lactation and in total lactation

Figure 1 shows the average breeding values of the cows born in 1970, 1991, and 2002 were respectively, -154 kg, 77kg and 452 kg. The genetic trend estimated in the milk production taking into account the period from 1970 to 2002 was 14.3 kg/year. Considering the 1985 to 2002 period, the average genetic trend was 19.69 kg of milk per year, representing a genetic gain close to 1% of the average production of the cows born in 2002, indicating that there was a genetic progress in the dairy Gyr population after the start of the PTP.

A similar situation is observed in the lactation length. Cows born until 1991 showed a rather constant average lactation length of around 275 days. From 1991 to this date, there was a progressive increase, and cows born in 2002 showed an average lactation length of 293 days.

In addition to milk production, fat production and its percentages were also evaluated since the implantation of the program. The 305-day production of fat had a constant increase for cows born between 1980 to 2002, (from 76.26 kg to 133.2 kg). The fat percentage demonstrated insignificant variation over time, with a slight decrease from 4.23% to 4.03% for cows born between 1980 and 2002. The other constituents (protein, lactose and total solids in milk) were only included in the program since 1999. The average percentages of fat, protein, lactose and total solids, of cows born from 1994 to 2002 were 4.04%, 3.03%, 4.58% and 12.81%, respectively.



Source: Verneque et al. (2008)

Figure 1. Mean milk breeding values (kg) by the year of cow births.

1. Calving intervals and Age at first calving

The calving intervals and the age at first calving are variables of great relevance to any milk production system. The average interval of calving decreased from 517 to 466 days for cows born between 1970 and 2002 with a reduction of 51 days in 32 years.

The mean age at first calving also decreased over time. There was a phenotypic reduction of 37 days per year, in the last five years and 8.6 days per year in the average genetic value of this trait in the same period. These reductions suggest that there has been an effort among breeders to improve reproductive traits in order to obtain more profitable animals. In addition, there is an indication that the improvement in milk traits was not incompatible with the improvement in reproductive traits.

2. Conformation traits

Conformation traits have been measured since 1992 in dairy Gyr purebred daughters of bulls under PTP. Since 1999, the results of genetic evaluations for some of these traits have been released, and it has been used as an aid to the selection of more productive animals. The measured conformation traits are: body traits (rump height, heart girth, body length, rump length, pin width, hip width, rump angle and navel length), legs and feet (foot angle, rear legs – side view and rear view), mammary system (fore udder attachment, rear udder width, udder depth, teat length and diameter). Scores on milking ease and temperament are also obtained for genetic evaluation purposes.

3. Molecular Information

Genotyping bulls in PTP provide molecular information on A and B alleles of κ -casein and β -lactoglobulin. These proteins are related to the ability to coagulate the milk, which results in a higher cheese yield. The Dairy Zebu Genome Project started in 2009 coordinated by Embrapa-Dairy Cattle, where a dairy Gyr bull would have its genome completely sequenced and a SNP genome scan would allow the use of this information for selection.

4 – New developments

Due to the continuous loss of genetic variability resulting from the increase of inbreeding, and reduction of the effective population size (Veneque, et al., 2006; Faria et al., 2009), from 2009 on, it was established that preferably 10% of the young sires to be tested should be those of alternative lineages. Based on the evaluation of the average relatedness of the candidates with the population of active cows, those with the lowest rate coefficients are preferably chosen.

Studies on the derivation of economic values of traits and selection indexes to be implemented in the selection of young sires have been carried out.

The National Program for improvements on Dairy Guzerat - NPIDG

In India and Brazil, The Guzerat is traditionally known to have dual aptitude. Initially, it was exploited in the country for meat production. Due to its dairy potential, in 1992 the Guzerat Breeders Association of Brazil (ACGB) began to encourage the utilization of the official dairy control. This step was crucial for the implantation of The National Program for Improvements in Dairy Guzerat - NPIDG, coordinated by EMBRAPA Dairy Cattle, in partnership with CBMG (Brazilian Center of Guzerat Improvement) and ABCZ.

The development of this program is based on the integration of two important and advanced tools of genetic improvement: progeny testing and the MOET nucleus selection techniques. The NPIDG aims to improve milk and beef traits for the environmental conditions and production systems considered economic for the Brazilian circumstances. Since the main market for sires of this breed is for milk and grass-fed beef production with medium-input levels, the selection process is conducted under these conditions (Penna et al, 2002).

Until recently, the progeny testing program (PTP) comprised of 10 annual groups of bulls (74) were set up. The semen is randomly distributed among purebred and crossbred herds. For the genetic evaluation, the information on progeny performance resulting from controlled mating in purebred herds in conjunction with the milk recording program, carried out by the Zebu Herd Book (ABCZ) are also included, provided the requirements concerning number, distribution among herds, and genetic connection among contemporaneous groups are met.

The MOET nucleus is an open MOET scheme; the young bulls are evaluated according to the milk production of their full sisters, related to the father's and mother's side and other relatives. The program is designed to obtain 24 full-sib families per year, with at least 4 females and one male, by hierarchical insemination with 4 bulls. Initially, as no genetic

evaluations were yet available, the donor cows were chosen from the associated herds by genetic screening grounded in milk yield (more than 3,000kg/305-d) and mature weight over 450kg. Presently, the selection of donor dams and sires are based on their estimated breeding values.

In some cases, donor cows are taken to private company premises (CENATTE-Embryos) for embryo transference or in vitro fertilization while in other cases, these techniques are performed at the donors herd. When the embryos are born, a common protocol for raising the females is adopted, and after weaning they are transferred to a central evaluation nucleus which is a private farm belonging to the major MOET partner, in which there is the required technical and operational infra-structure to conduct the evaluations of the animals. The management provided for these animals are similar to those of commercial farms, i.e., pasture based supplemented with silage or sugar cane-urea, plus limited amount of concentrates, according to yield. MOET male progeny are kept on the farm they are born, and are submitted to the measurements of beef traits according to beef breeding programs. So far, 100 full-sib families have already been produced by mating individuals of different lineages or genetically distant lineages. The results of the breeding value of 77 families have already been published. The animals produced in MOET nucleus can also be conducted on the PTP, and when their daughters' performance is measured, additional accuracy is incorporated to their genetic evaluation. The great advantage of the program is that the integration of these systems allows reduced time and increased accuracy.

Figure 2 shows the evolution of the average 305-day milk production and the breeding value of the young testing bulls' daughters. As it can be observed, in 2004 when the first daughters of tested bulls had their lactation completed, the milk production and the breeding values were positive and rising. In that period, the averages of milk production and the breeding values of the cows increased, respectively, 97 kg and 63 kg per year. Mean milk, fat, protein and total solids production of the Guzerat cows that completed their first lactation until March 2009 was 2.190kg, 93kg, 60kg, and 229kg respectively.

Regarding the age at first calving, there is a gradual reduction of 20 days per year in the same period. The average age at first calving of the Guzerat cows that ended their first lactation until March 2009 was 36, 4 months. These are aspects of extreme importance for the productive and economic efficiency of dairy farming.

MOET and PTP schemes of Guzerat, were designed in a manner which allows different lineages to be represented, aiming to diminish the risk of inbreeding, which is increased by genetic bottlenecks attributed to the use of few famous sires and their offspring. The tendency to decrease the average inbreeding coefficient in the last ten years coincides with the beginning of the programs. This decrease can be attributed to the strategies adopted in the design of the programs and the use of bulls from different lineages, inconsistent with those that have been used so far on several herds. This attitude stems from the breeders' concern about the eventual losses in the production system, resulting from the increase of the inbreeding coefficient, and from the reliability offered by the genetic evaluations, i.e., the breeders have started using bulls belonging to other herds and even of some other lineages, until then untested, based on the reliability in their published PTAs.

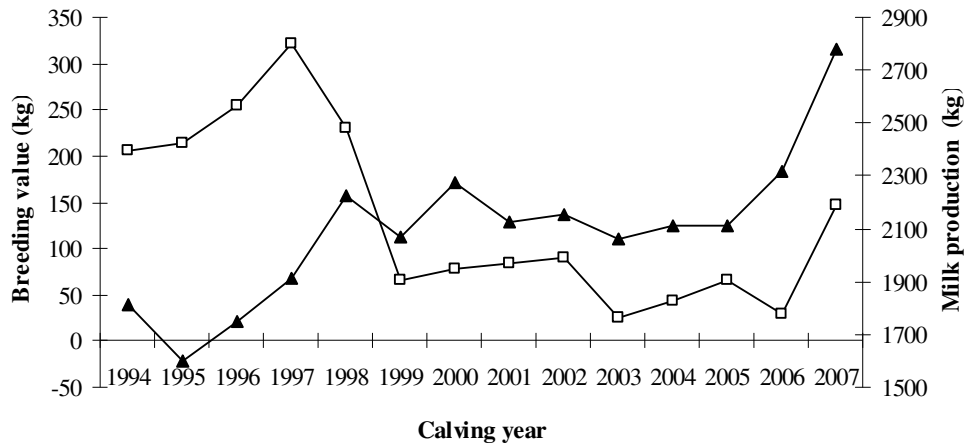


Figure 2 – Genetic (▲) and phenotypic (□) trends for milk production in 305 days related to the year of calving of the Guzerat cows (2004 = birth year of the first daughters of tested bulls).

In 2009, the year in which the tenth summary of bulls was released, performance data from 67 herds (74% purebred and 26% crossbred), with a total of 7,636 lactations (4,458 lactations of heifers) was available for the genetic evaluation. For the genetic evaluation, a repeatability model is adopted. Records of subsequent lactations of cows are used in the genetic evaluation only when the first lactation records are available. The reason for including crossbred cows in this program is to increase the number of breeding females, and as a result, to increase the accuracy of the test. Additionally, crossbred herds represent a large market share of buyers for tested zebu semen. The minimum accuracy for the release of the results is 50%. So far, the results of 299 bulls were published.

Since it is a dual-purpose breed, the dairy Guzerat breeding program has a few peculiarities. One of them is the fact that it is integrated into a beef Guzerat genetic evaluation program for beef and reproduction traits. Both the nucleus and the greatest part of the partner herds, seek the simultaneous improvement of beef, dairy and reproduction traits, maintaining the rusticity of the breed. Therefore, the whole selective work is performed under a “realistic environment”, i.e., in commercial conditions (pasture based, roughage supply during the dry season and lowly concentrated during lactation). In both the nucleus MOET and most of the partner herds, growth and reproduction traits are also taken into account in the selection of sires and cows, in addition to the PTAs of dairy traits. In order to meet the current and future demands of society, behavior and welfare traits have been measured recently by the Program.

At this time, the breeders have supported studies based on DNA to get additional information on the genetic evaluation. The testing bulls have been genotyped for genes of economic interest. It was verified that, for example, the favorable allele of the gene for κ -casein has a

frequency of 18%, the highest found in zebu breeds and similar to those observed in European breeds. In 2009, the Zebu dairy Genome project was initiated and coordinated by Embrapa-Dairy Cattle. The genome of the Guzará bull will be completely sequenced and a SNP genome scan will allow the use of this information for the selection.

Although quite recent, the NPIDG annually publishes the results of genetic evaluations of sires for the following traits: milk production, fat, protein, lactose, total solids in milk, genotype for κ -casein. Beginning this year, results of conformation traits and management with impact on the functional animals will also be published. Somatic cell score and milking ease have been measured. The results of age at first calving, gestation length, scrotal circumference, weight and growth before and after weaning, adult weight, loin area, fat thickness and cumulative yield of cows have been published in beef summaries.

Conclusion

The Zebu dairy breeds represent a valuable and strategic genetic resource for Brazilian circumstances. The development of breeding programs involving the dairy Zebu, although recent and still in need of some implementations and adjustments, is quite relevant given that there is no semen of tested bulls from other countries available in the international market. It could provide for the demand of other tropical countries with tested genetic material in similar production conditions. In addition, the dairy Zebu, which is characterized by rusticity and docility, aside from the milk potential, is indispensable for the production of suitable crossbred animals, which constitute the prevailing population of commercial dairy herds in Brazil and other tropical countries

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