Providing genetics for the dairy industry in the tropics - the Brazilian Dairy Gir Breeding Program

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Abstract

Milk production is usually challenging under tropical environments. Heat stress and/or recurrent parasite infestations frequently cause cattle's reduced fitness and productivity. As a way to overcome this challenge, the Gir indicine cattle breed has increasingly been used in crossbred schemes to constitute milk production herds in Brazil and other countries in tropical regions. The Brazilian Dairy Gir Breeding Program was established in 1985, based on a partnership between the Brazilian Agricultural Research Corporation and the Brazilian Association of Dairy Gir Breeders. It was the first breeding program outlined with a progeny test for the improvement of an indicine breed for milk production in the world. Several technical innovations were employed along the time. Now, producers can access genomic predictions for thousands of Gir males and females. Those predictions are used mainly by Brazilian breeders, but also increasingly in other tropical countries from South America, Central America and Asia.

Introduction

India is the world's largest milk producer, responsible for more than 20% of the global production, followed by the United States of America, China, Pakistan and Brazil. A significant part of the global milk production occurs under tropical conditions. European cattle breeds are very successful under temperate or subtropical climates, but struggle to keep good production and reproduction performances in tropical regions, especially because of heat stress and/or recurrent parasite infestations. Thus, better adapted cattle genetics is needed to constitute tropical dairy herds, especially in some parts of Asia, Africa, Central and South Americas.

The Gir indicine breed has been increasingly used in successful crossbreeding schemes to compose dairy herds in the tropics. The initial idea of such crossbreeding schemes was to combine the productivity from one European breed, mainly Holstein, to the rusticity from one indicine breed, mainly Gir. Some breeders in Brazil, though, started selecting purebred Gir for

milk production during the last century, with the idea of improving the performance of crossbred production herds. Those breeders later created the Brazilian Association of Dairy Gir Breeders (ABCGIL, from the initials in Portuguese), and stablished a partnership with the Brazilian Agricultural Research Corporation (EMBRAPA), to initiate the Brazilian Dairy Gir Breeding Program (PNMGL, from the initials in Portuguese), back in the 1980s. It was the first breeding program in the world outlined with a progeny test for the improvement of an indicine breed aiming milk production. The objective of this paper was to describe a very successful public-private partnership in Brazil, in which EMBRAPA provides the technology and detachment needed for reliable genetic evaluations, serving the breeders with information to improve their herds, while breeders provide the data allowing EMBRAPA and partners to continue developing relevant research projects.

Materials & Methods

The PNMGL started in 1985 by selecting a group of purebred Gir sires, based on the data available at that time. Semen from those sires were distributed to small holder dairy producers, being used in purebred Gir, Holstein/Gir crossbreds of various genetic compositions or even purebred Holstein cows. EMBRAPA's and ABCGIL's personnel started making systematic visits to those herds in order to keep reproductive and productive records of the resulting female progeny. This progeny test scheme continues until the present day, with a new group of sires being included every year. Together with the purebred Gir genealogical and productive data, recorded by the Brazilian Association of Zebu Breeders (ABCZ, from its Portuguese initials), and the composite Girolando breed genealogical and productive data, recorded by the Brazilian Girolando Association, the progeny test composes the basis for the Brazilian Dairy Gir genetic evaluations. The Dairy Gir Sire Summary published in 2021 included a list of more than 500 bulls, evaluated for up to 26 different traits.

Traits recorded. In the beginning of the program, only milk yield, milk fat and age at first calving were recorded. In 1994, the program started recording 18 linear conformation and handling traits (*body traits*: rump height, heart girth, body length, rump length, pin width, hip width and rump angle; *legs and feet traits*: foot angle, rear legs side view and rear legs rear view; *mammary system traits*: fore udder attachment, rear udder height, rear udder width, udder depth, teat length and teat diameter; *handling traits*: milking ease and temperament). In 1999, milk protein, lactose, total solids and somatic cell count started being recorded. From 2001 biological samples from sires and production cows started being collected for DNA extraction and storage. Some markers of interest, related to milk properties started being analysed and published from 2006 and analyses for genetic diseases were included in 2013. The beta-casein genotype started being published in 2016, allowing some breeders to select their herds for the production of the A2A2 milk. Even though a number of traits are already included and many others still need to be properly recorded, the main selection objective of Dairy Gir breeders in Brazil still is 305 days milk yield.

Methods applied. First sire groups were formed by breeder's choices, based on the information they had from the genetic evaluations of parents, or the milk yield of the dam of the young bull. Along the time, the technical coordination followed the results of each group of sires, while implementing various innovations and rules to the program and the choice of sires to enter the progeny test. The animal model was implemented in 1995, replacing the formerly used sire model. One important rule was included to the group of sires selected in 2008, in which only young bulls from the top 10% dams of each herd, in terms of milk yield Expected Breeding Values ($EBV_{milk\ yield}$), should participate on the progeny test. The last breaking point of the program was the implementation of the genomic selection to the young bulls, that began in the group of sires selected in 2016, after structuring of the Gir genotyped reference population (Boison et al., 2017). From this point, breeders had more accurate information to choose the best young animals within their herds and the program was able to select the most promising animals, amongst all breeders, to compose the groups of sires.

Results

Average milk yield of participating herds has considerably grown since the beginning of the breeding program. The phenotypic trend for this trait in the population can be observed through illustration in Figure 1.

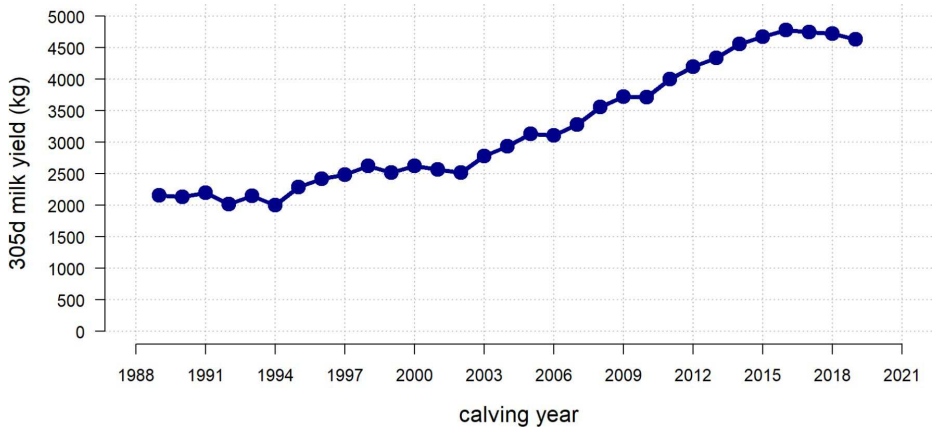

Figure 1. Phenotypic trend for 305 days milk yield since the beginning of the Brazilian Dairy Gir breeding program.

The impact of two actions taken by que program coordination on the genetic evolution for milk yield can be observed by the change in the slope of the genetic trend indicated by the average genomic values estimated for the groups of sires according to the year they have been included in progeny test (Figure 2).

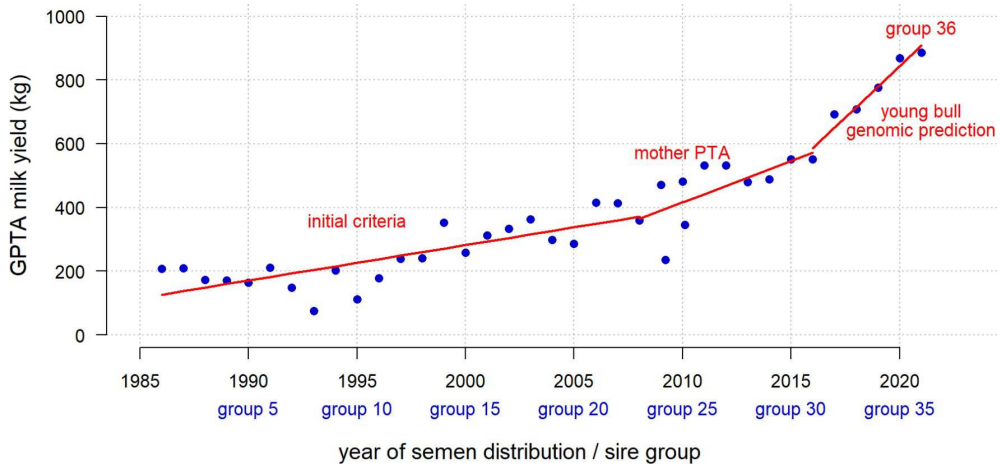

Figure 2. Genetic trend of the groups of sires since the beginning of the PNMGL: effect of change of criteria for the inclusion of young sires.

In Figure 2, the blue dots indicate average genomic predicted transmitting abilities for milk yield of each group of sires. From the year 1985 to 2008 a small rate of genetic evolution can be observed (initial criteria). For this period, the milk yield of the dam was the main criteria used by the breeders to choose young sires to be included in the progeny test. For the second period (2008 to 2016) the mother of the young bull should be among the top 10% dams within

the herd. This new rule, as expected, resulted in an increased genetic evolution in the population. For the most recent period observed (2016 to 2021) the increase in the rate of genetic evolution was even bigger. The use of genomic values for the selection of young bulls to be included in the progeny test allowed breeders to include more animals as candidates, by genotyping all born males at a young age. Thus, with better accuracy of genetic predictions and higher selection intensity, the rate of genetic evolution resulted in the program having its best Dairy Gir sires included in recent groups.

Discussion

Despite higher input costs and unfavourable weather conditions, Brazil's milk output is likely to rise by 1.0 percent year-on-year due to increasing dairy cattle numbers, increased herd sizes, improved genetics, and high yields in large-scale farms (FAO, 2021). Such conclusion from FAO's technical report is in accordance to the results observed in the Brazilian Dairy Gir breeding program, partially presented here. Genetic composition of dairy cattle herds in Brazil and other tropical countries include Gir and Holstein as the main breeds. Girolando is a composite breed formed by these two breeds, largely used for milk production and continually including improved sires and dams from both, Gir and Holstein breeds.

Genetic improvement of Holstein, Girolando and Gir populations have great impact on the milk production and dairy industry in the tropics. Considering the advances recently achieved by the Brazilian Dairy Gir Breeding Program, we can assume that newly obtained sires, and also genomic selected dams, have the potential to cause great improvements for the dairy herds in Brazil and other tropical countries, if the best animals are properly used for reproduction. Actually, exportation of Dairy Gir genetics from Brazil to tropical regions is clearly growing in recent years (unpublished data). Main countries importing Dairy Gir from Brazil are Colombia, Ecuador and Costa Rica. Even India, which is the country of origin of the Gir breed, can greatly benefit from improved Dairy Gir from Brazil.

Research groups should work as closely as possible the production environment, benefiting from the possibilities of obtaining field data and stimulating improved data annotation and collection. As an outcome of this approximation, innovation and technological solutions can be provided, resulting in quality and productivity advances to the sector.

Acknowledgments

The authors received financial support from EMBRAPA (Brazilian Agricultural Research Corporation); CNPq: INCT-CA (National Council for Scientific and Technological Development: Animal Science National Institute); FAPEMIG (Minas Gerais Research Foundation); and CAPES (Coordination for the Improvement of Higher Education Personnel). The authors would like to thank the ABCGIL (Brazilian Association of the Dairy Gir Breeders) for coordinating all the progeny test and pre-selection processes in the field and financial support to the program and ABCZ (Brazilian Association of Zebu Breeders) and Girolando breeders association for providing important additional data.

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