# Revitalizing the countryside: The transformative potential of genetic improvement in livestock for municipalities in Minas Gerais

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**ABSTRACT**

The article highlights the importance of the livestock sector in Minas Gerais and the need for public policies that support genetic improvement in this sector. Raising awareness and training rural producers in the use of genetic reports, such as Expected Progeny Differences (EPD), for selecting breeders is essential for modernizing livestock farming. Thus, the study proposes the creation of robust educational programs and continuous technical support to integrate genetic improvement practices into daily operations, aiming to increase productive efficiency and sector competitiveness. The adoption of advanced genetic improvement practices can significantly enhance the productivity and quality of livestock production, better meeting internal demand. This stimulates job creation in various related sectors and drives local economic development. The need for training in genetics also promotes educational advancement and attracts investment in research, contributing to robust and sustainable economic growth in the municipality and region.

**Keywords:** Genetic improvement, Livestock, Minas Gerais, Public policies, Productive efficiency.

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## INTRODUCTION

Agriculture and livestock are fundamental pillars of the economy in Minas Gerais, generating both income and employment. In 2020, the Gross Added Value (GAV) of these sectors amounted to BRL 39.99 billion, representing 6.65% of the state's total GAV. In the labor market, approximately 1.34 million people were employed in activities related to these sectors in the third quarter of 2022, corresponding to 12.58% of workers in Minas Gerais. In terms of trade, the revenue from agricultural and livestock product exports reached USD 15.3 billion in 2022, accounting for 38.2% of the state's exports.

This article evaluates the importance of agriculture and livestock in the municipalities of Minas Gerais, using the GAV of these sectors in relation to the total GAV of each municipality. In 2020, 100 municipalities in Minas Gerais had these sectors as their main economic segment, indicating a comparative advantage. Economic development in these sectors can be enhanced through investments in research, technical assistance, rural credit, sectoral policies, and support for small producers.

For small towns where livestock predominates, various strategies can increase productivity and economic advantages, such as adopting modern technologies, improving local infrastructure, and forming cooperatives. Product diversification and investment in genetic improvement are crucial, allowing the development of more productive and disease-resistant breeds. Training and education on best practices in management and animal welfare are also essential for improving productivity.

This study focuses on the proposal of genetic improvement and the effectiveness of public policies in raising awareness among rural producers about the importance of this practice, mainly through the use of artificial insemination technology and genetic reports (Expected Progeny Differences - EPD) for selecting ideal breeders. Artificial insemination provides access to high-quality genetics, ensuring greater consistency and predictability in productive outcomes. Thus, public policies that promote awareness and training of producers can transform the productive efficiency of livestock activities in small and medium-sized properties.

## MATERIALS AND METHODS

This study adopted a methodology based on a comprehensive literature review to identify effective genetic improvement practices in livestock and propose solutions through public policies. The critical analysis of these studies allowed for the identification of the main barriers faced by rural producers in adopting these technologies, such as the technical complexity of genetic reports and the associated costs.

Based on this information, public policies were proposed focusing on the education and technical training of producers, as well as financial incentives for the adoption of genetic improvement technologies. These proposals aim to increase the productive efficiency and competitiveness of the livestock sector, promoting sustainable economic development in rural areas of Minas Gerais.

## GENETIC MERIT

Expected Progeny Difference (EPD) is an essential tool in the field of cattle genetic improvement, serving as a crucial indicator of an animal's genetic value as a breeder. This tool allows breeders to compare the genetic merit of different animals concerning various hereditary traits, which are fundamental for herd selection and improvement.

EPD provides an estimate of how well an animal can transmit its genetic characteristics to its offspring. This is extremely valuable for producers aiming to enhance specific aspects of their herds, such as feed efficiency, weight gain, fertility, and more. The utility of EPDs lies in their ability to offer a relatively fair comparison base, allowing animals from different herds to be evaluated uniformly. This capability is highlighted by EUCLIDES FILHO (2009) in his analysis of the impact and application of these tools in genetic improvement.

One of the major advantages of EPDs is that they are calculated considering various factors that help isolate the genetic value from environmental and management effects. This means EPDs can reflect an animal's true genetic potential, minimizing distortions caused by external conditions. Consequently, producers can make more informed and strategic decisions regarding breeding and herd management.

Moreover, EPDs play a significant role in defining groups of animals with similar characteristics, facilitating the analysis of relationships between genetic values and economically important traits, as noted by LOPES et al. (2013). This usage allows producers to fully exploit the available genetic potential, contributing to a better understanding and optimization of EPD use in the production system.

In summary, EPDs are fundamental not only for genetic selection within a herd but also for the overall evolution of the beef cattle industry. They enable producers to plan breeding better, promote the use of superior genetics, and achieve significant improvements in efficiency and profitability. Therefore, the continuous adoption and enhancement of genetic evaluation techniques based on EPDs are crucial for the economic and genetic advancement of the livestock sector. Below are detailed descriptions of the main genetic variables, as provided in the Geneplus Technical Manual.

- **Birth Weight (BW) – kg**: The calf's birth weight is an important evaluation characteristic. This trait should be monitored carefully to avoid significant increases that could result in higher chances of dystocia or calving difficulties.

- **Weaning Ratio (WR) - %**: This is the ratio between the calf's weight and the cow's weight at weaning. According to SCHWENGBER et al. (2001), the calf's weight at weaning is the best predictor for evaluating cow productivity in beef cattle. However, JONHSON et al. (2007) found that weaning ratios above 0.50% indicate more economically efficient and viable cows.
- **Post-Weaning Weight Gain (PWG) – kg**: This variable provides a good indication of the calf's weight accumulation and fattening capacity.
- **120-Day Weight (W120) - kg**: Evaluated at 120 days of age, this characteristic indicates the genetic potential of an animal to produce daughters with superior (or inferior) maternal ability, expressed by the weight of the calves.
- **Yearling Scrotal Circumference (YSC) – cm**: Scrotal circumference measures the bulls' scrotal circumference. YSC indicates the animal's potential to produce sons with larger (or smaller) scrotal circumference at 450 days of age. Studies by MCGOWAN et al. (2002) and GARMYN et al. (2001) confirm that scrotal circumference is strongly related to fertility and semen quality, with high genetic transmission rates.
- **Age at First Calving (AFC)**: A reproductive characteristic measured in days, indicating the animal's potential to produce daughters that calve earlier (or later) than the average daughters of other animals.
- **Stayability (STAY) %**: An indicator representing the probability of an animal producing daughters capable of delivering at least three viable calves by 76 months. This is crucial for evaluating reproductive precocity in cattle.
- **Weaning Weight (WW) - kg**: WW indicates the animal's potential to produce offspring with superior (or inferior) performance compared to the average offspring of other animals at weaning (210 days old).
- **Yearling Weight (YW) – kg**: Evaluated at 450 days, this characteristic indicates the animal's potential to produce offspring with superior (or inferior) performance compared to the average offspring of other animals at yearling age. It reflects the growth and fattening potential of the offspring.
- **Ribeye Area (REA) - cm²**: This measure indicates the animal's potential to produce offspring with larger (or smaller) ribeye area. It is an indicator of bovine muscling, reflecting the amount of muscle covering the animal's body and is a crucial quality indicator for beef cattle, affecting carcass yield and meat production.
- **Backfat Thickness (BFT) - mm**: An important indicator of carcass finishing, BFT relates to the precocity of finishing and reproduction. According to BONIN et al. (2015),

it also affects the gustatory experience of beef consumers, relating to flavor and juiciness characteristics.

- **Marbling (MARB) - %**: A finishing measure indicating the percentage of intramuscular fat in beef.
- **Genetic Qualification Index (GQI)**: The Genetic Qualification Index (GQI) aims to aggregate an animal's genetic contribution into a single classification value for selected traits, assigning an importance weight to each trait. It is an empirical value where the Expected Progeny Differences (EPDs) are standardized, multiplied by relative weights, and summed to form the index. The suggested GQI formula is: GQI=(10%*MPW+15%*WW+20%*TMW+15%*YW+15%*PWG+15%*AFC+5%*I2C +5%*YSC); where: MPW = maternal phase weight, WW = weaning weight, TMW = total maternal weaning weight, YW = yearling weight, PWG = post-weaning weight gain, AFC = age at first calving, I2C = interval between the first and second calving, YSC = yearling scrotal circumference.

## INTERPRETATION OF EPD - AN EXAMPLE

Table 1 reports the estimated EPDs for the Nellore bull "REM USP," renowned as a prominent breed sire. The price of this animal's semen is the highest in our sample, at R$ 200.00 (BRL - all economic values are given in Brazilian Real) per dose, which is more than 500% higher than the sample's average price (R$ 38.05).

The interpretation of the EPD results, such as those in Table 1, indicates the expected difference in the offspring of this bull compared to the offspring of other evaluated bulls of the same breed. Taking the variable Weaning Weight (WW) as an example, according to its EPD, it is expected that the offspring of this bull (REM USP) will weigh 9.16 kg more than the offspring of other Nellore bulls when they reach the weaning age. As for the variable Yearling Scrotal Circumference (SCY), the EPD indicates that the offspring of this bull will have, on average, 1.71 cm more scrotal circumference than the offspring of other Nellore bulls. Additionally, the table indicates that the progeny of the evaluated Nellore bull ranks in the top 1% for the WW characteristic and in the top 10% for SCY among the best-evaluated bulls.

Table 1. Estimated Expected Progeny Differences (EPD) for the Nellore bull "REM USP".

| | **EPD** | **Percentile (%)** |
|---|---|---|
| Weight at 120 days | 4.46 | 0.50% |
| Weaning Weight | 9.16 | 1.00% |
| Yearling Weight | 23.28 | 0.10% |
| Yearling Scrotal Circ. | 1.71 | 0.10% |
| Age at First Calving | -23.76 | 2.00% |
| Stayability | 41.48 | 0.10% |
| Ribeye Area | 0.11 | 51.00% |
| Subcutaneous Fat T. | -1.37 | 95.00% |
| Marbling | 0.08 | 44.00% |
| Genetic Qualification Index | 33.77 | 0.10% |

Source: Alta Genetics agency and GENEPLUS.
Note: EPD represents the values of Expected Progeny Differences for the bull "REM USP".

The interpretation of EPD results, as shown in Table 1, indicates the expected difference in the offspring of this bull compared to the offspring of other evaluated bulls of the same breed. Taking the variable Weaning Weight (WW) as an example – according to its EPD, it is expected that the offspring of this bull, REM USP, will weigh, on average, 9.16 kg more than the offspring of other Nellore bulls at weaning age. For the variable Yearling Scrotal Circumference (YSC), the EPD indicates that the offspring of this bull will have, on average, 1.71 cm more scrotal circumference than the offspring of other Nellore bulls. Additionally, the table indicates that for the WW characteristic, the evaluated Nellore bull's progeny ranks among the top 1%, and for YSC, among the top 10% of the best-evaluated bulls.

## RESULTS AND DISCUSSION

### IDENTIFYING THE PROBLEM

The principal issue in the utilization of Expected Progeny Differences (EPD) by rural producers is their lack of familiarity with these reports. Despite the significant utility of EPDs for genetic improvement, many producers are hesitant to adopt them primarily due to the technical complexity of the reports, which can be challenging to understand without specialized training in genetics.

Beyond the complexity, other factors such as the costs associated with obtaining and interpreting EPDs, the preference for traditional selection and herd management methods, and a lack of clear perception of the economic benefits can discourage producers from using these tools. Many producers remain attached to practices passed down through generations, viewing them as sufficiently effective, which creates resistance to transitioning to genetically based approaches.

In fact, findings by DETONI (2024) suggest that genetic reports have little influence on the variation in semen prices in the Nelore beef cattle market in Brazil. These results align with the findings of IRSIK et al. (2008), which similarly indicated that EPD data do not exert a strong influence on bull prices. Furthermore, as highlighted by VESTAL et al. (2013), producers still need time to familiarize themselves and build confidence in the available genetic reports. BRAGA (2021) and ABREU (2017) investigated the factors influencing the pricing of Nelore bulls at beef cattle auctions in Brazil. Their evidence indicates that the Genetic Quality Index (GQI) provides little explanation for these price determinations.

Possibly, other aspects not considered, such as exhibition awards and the breeder's reputation, generate strong appeal for producers when selecting their breeding bull. To support this conjecture, Table 2 presents the EPD results for the Nelore bull Alarme, whose semen price is R$80.00, approximately 110% above the average.

Table 2. EPDs of Bull "Alarme".

| | **EPD** | **Percentile (%)** |
|---|---|---|
| Weight at 120 days | -7.68 | 0,99 |
| Weaning Weight | 5.88 | 0,06 |
| Yearling Weight | 8.83 | 0,11 |
| Yearling Scrotal Circumference | -0.33 | 0,79 |
| Age at First Calving | 7.08 | 0,8 |
| Stayability | 23.5 | 0,98 |
| Weaning Ratio | -2.7 | 0,99 |
| Ribeye Area | -0.11 | 0,59 |
| Subcutaneous Fat Thickness | -0.65 | 0,8 |
| Marbling | -0.76 | 0,83 |
| GQI | -1.39 | 0,64 |
| Semen price - R$80.00 | | |

Source: Alta Genetics agency and GENEPLUS.
Note: EPD's represents the Expected Progeny Differences.

As presented in Table 2, the EPD results for the bull Alarme are not among the best in almost any category. However, according to discretionary comments from Alta Genetics Agency, this bull was a champion at Expozebu in 2012 and reproduces racial beauty in its offspring.

The principal challenge faced by rural producers in adopting Expected Progeny Differences (EPD) lies in the technical complexity of these reports. Despite their value, this information is based on advanced genetic concepts that can be intimidating for those without specific training in the field. This technical barrier is exacerbated by the fact that many producers still rely on traditional methods of selection and herd management, which have been passed down through generations. Therefore, the resistance to changing to practices based on detailed genetic information is not only a matter of training but also of culture and habit.

In addition to the complexity, other factors such as the cost of obtaining and interpreting EPD reports and the unclear perception of their direct economic benefits further discourage the use of these advanced tools. Recent studies, such as those by DETONI (2024) and BRAGA (2021), indicate that even in the Nelore beef cattle market, where one would expect such data to have a significant impact, genetic reports have little influence on pricing decisions. This scenario suggests an urgent need to improve producers' familiarity and confidence in genetic reports, aiming for greater transparency and effectiveness in communicating the real benefits that genetics can offer to livestock farming.

## PUBLIC POLICY GUIDELINES

The principal barrier to the utilization of Expected Progeny Differences (EPD) by rural producers is the lack of familiarity with these reports. The technical complexity of EPDs and the need for specialized genetic training make the adoption of these essential genetic improvement tools challenging. Additionally, the costs associated with obtaining and interpreting EPDs, the preference for traditional selection and herd management methods, and the unclear perception of economic benefits also discourage producers from using these tools.

To overcome these obstacles, it is essential to develop robust training programs that demystify the complexity of genetic data and concretely demonstrate how this information can lead to economic gains. Educational programs that teach producers to interpret and apply EPDs through workshops, seminars, and informational materials are crucial. Demonstrating success stories of other producers who have adopted EPDs with significant benefits can encourage the adoption of these practices.

Continuous support is also essential, providing technical assistance to help producers integrate EPDs into their daily operations practically. Partnerships between universities, research institutions, breeder associations, and the government can strengthen this initiative, promoting and facilitating the use of EPDs. Furthermore, financial incentives or subsidies should be considered to reduce the economic barriers to accessing these technologies.

Implementing public policies focused on education and technical support can significantly transform the perception and utilization of EPDs by rural producers. Training programs should be practical, accessible, and frequent, allowing a large number of producers to participate and benefit. Collaboration between local and state governments, academic institutions, and research centers is fundamental for the development and delivery of these educational programs.

An effective communication campaign that highlights the economic and productive benefits of EPDs is also necessary. This campaign could include local case studies and testimonials from producers who have successfully adopted these practices, reinforcing the message with economic analyses that show the return on investment of adopting genetic improvement practices. Continuous technical support through genetic consultants and specialized veterinarians would help producers integrate EPDs into their daily operations, addressing doubts and providing constant support.

In addition to education and technical support, public policies must consider the cost associated with acquiring high-quality semen. The price of semen can be a significant factor influencing rural producers' decisions to adopt these practices. To overcome this barrier, public policies could include subsidies or financial incentives for the acquisition of high-quality semen, making it more accessible. Reducing costs for producers facilitates the adoption of genetic improvement practices and ensures that the benefits of these practices are widely distributed.

In summary, addressing the lack of familiarity with EPDs can improve herd productivity efficiency and promote greater sustainability and competitiveness in the agricultural sector. The key lies in education, technical support, and clearly demonstrating the benefits of these advanced genetic improvement practices. Implementing public policies that encourage the use of genetic improvement practices in livestock not only enhances herd productivity efficiency but also promotes greater sustainability and competitiveness in the agricultural sector. When well-executed, these initiatives can significantly transform local livestock farming, benefiting the entire community.

## CONCLUSION

The effective implementation of public policies for genetic improvement in livestock can have significant positive impacts beyond the agricultural sector, benefiting the local and regional economy in various ways. Firstly, the adoption of these practices can increase farm productivity and efficiency, resulting in higher quality and greater quantities of meat and other livestock products. This not only better meets internal demand but also enhances export potential, generating more revenue for producers.

Moreover, more productive and profitable farms create a growing demand for qualified workers, not only in the agricultural sector but also in related areas such as agro-industrial processing, logistics, sales, and specialized technical services. This increased demand for labor generates a virtuous cycle of employment and income, strengthening the agricultural sector and driving local economic development. The increase in employment and income stimulates consumption, generating greater demand for goods and services in various sectors, which in turn encourages economic growth on a broader scale.

The growing need for specialized knowledge in genetics and genetic improvement techniques catalyzes the development of advanced educational programs at both technical and university levels. The expansion of these programs elevates the educational level of the population and better prepares individuals for a variety of professional opportunities, fostering a more qualified and adaptable workforce.

The development and implementation of advanced genetic technologies can attract significant investments for research and development from both governmental and private sources. This influx of resources is fundamental for creating research centers and startups focused on biotechnology and advanced technological solutions for agriculture, enhancing the region's innovative and competitive potential. These initiatives can transform the agricultural sector into an innovation hub, attracting more investments and promoting a dynamic and prosperous economic environment.

In summary, public policies that encourage the use of genetic improvement practices in livestock not only increase the quality and quantity of agricultural production but also drive economic development, increase job opportunities, improve local education, and attract more investments. These policies benefit various sectors, contributing to more robust and sustainable economic growth for the municipality and region.

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