



Review article

The Projection of Milk Production in Ecuador in Guayas and Other Scenarios

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Received: October 2023; Accepted: November 2023; Published: February 2024.

ABSTRACT

Background: Milk production in Ecuador varies by region. On the coast, and particularly in the low basin of Guayas, it tends to diminish due to socioeconomic and ecological factors. However, it is a priority for family and local consumption, with a high demand for milk and its derivatives producing daily income that guarantees payments to farmers and creates a diversified production system. **Aim.** To assess milk production in Ecuador and its projection, especially in Guayas. **Development:** The literature was reviewed to examine data available on cow's milk in Ecuador. The study found that there was an increase despite the variety of socioeconomic and ecological conditions, which determined the different production responses. In the low basin of Guayas, the lowest yields were observed, resulting from climatic factors and the characteristics of production systems that determine the search for alternatives that ensure their sustainability. **Conclusions:** Milk production was characterized by regions. The highest yields were found in the Sierra, followed by Amazonia, and then Costa, where natural pastures prevail, there are seasonal unbalances, and cropping is the main activity of agriculture. Accordingly, the set up of prospective scenarios is an alternative for decision-making in terms of milk production sustainability in the region.

Keywords: Low basin, scenarios, cattle (*Source MESH*)

INTRODUCTION

Cattle raising is the only source of sustenance for 20 million families and the main income source for millions of small farmers in tropical areas in Asia, Africa, and Latin America (Moreno *et al.*, 2023; Segovia, 2023). Parra *et al.* (2019), upon referring to Latin America and the imminent development of cattle raising frontier in agriculture, emphasized the need for decision-making to

Citatoins (APA) Medina Pinoargote, G., Pereda Mouso, J., & Curbelo Rodríguez, L. (2024). The Projection of Milk Production in Ecuador in Guayas and other Scenarios *Journal of Animal Prod.*, 36(1). <https://rpa.reduc.edu.cu/index.php/rpa/article/view/e4597>



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mitigate poverty, generate wealth, and encourage sustainable ways of production; that is, implementing a sustainable development approach in the best possible way.

In Ecuador, the Ninth Global Agenda for Sustainable Cattle Raising, stated the need for a new integrative and participatory vision that permits the transformation of planning and management of livestock systems, focusing on balancing productive diversification, searching for ecological stability, as well as new laws and policies, and strengthening farmer income (Proamazonía, 2019).

The dairy industry in Ecuador produces approximately 4% of the agro-food GDP, with an income of about 1.4 million dollars, one of the most relevant economic activities. The country produces approximately 6.15 million liters of raw milk daily, an activity that employs more than a million people. (Ionita, 2022).

Dairy farms have significant variability in the country. Viera *et al.* (2020) conducted a physical and productive characterization of the sector and detected four different types of dairy systems in the mountains of Ecuador, comprising 2.8-14.8 ha. The authors considered their physical dimensions, type of property, and technological development.

On the coast, particularly in the low basin of Guayas, Filian *et al.* (2019), characterized farm systems that included cattle raising and noted a broad variability in the physical dimensions and percentages of the cattle areas, which determined the different levels of diversification. The authors claimed that about 47% of them are located in up to 5 ha lots, and the other 53%, in areas between 6 and 50 ha, on average.

According to Ilbay *et al.* (2021), the low basin of Guayas is the main center of farming, thanks to the fertility of the soil and the availability of natural resources. The predominant activity is cattle raising (dual purpose), which alternates with cropping, the main economic activity (Chuquirima *et al.*, 2023).

In the low basin of Guayas, the main production system is family-type, a key element for rural development, according to Morales and Mideros (2021), who noted that 60% of foods produced in the country come from this sector. However, there has been a decrease in their relative engagement compared to other sectors of the economy which determines the low productivity and lack of generational renewal. Consequently, the authors stressed the need to generate strategies that foster sustainability.

In this context, there is no prospective planning that determines the efforts that must be made to cope with the issues affecting the low basin of Guayas, considering that cattle raising is an alternative offering stability and making the economy more dynamic. Accordingly, this paper aimed to assess milk production in Ecuador and its projection according to scenarios such as the low basin of Guayas.

DEVELOPMENT

Farming in Ecuador

In Ecuador, this sector is in charge of 95% of the national demands of the economy, especially food. It employs 25% of the economically active population, and it is the greatest hard currency generator, only after oil production (Chávez *et al.*, 2020). A significant aspect is that 36.1% of the population resides in rural areas, and 20% is engaged in food production (Chuncho *et al.*, 2021).

Lara *et al.* (2022) said that the contribution of this sector to the GDP in 2019 was 9.6%, with a relevant role played not only in rural development but also in economic and social advancement. In that direction, Cedeño and Sotomayor (2020) noted that growth has been uneven, though stable, with an annual rate of 4.0%.

An analysis of its distribution reveals that there are three major production systems. One is mixed, on a coastal plantation area with warm temperatures, accounting for about 25% of the total area and half of the Ecuadoran population, whose main activities are food exports and cattle raising. Another is a mixed system on the Andes mountains, with a diversity of production items and farms, such as maize, barley, potato, and beans in what is known as subsistence farming. Another type is made of mid-sized farms, engaged in the same crops and large farms for dairy cattle. The other is in the Amazon region, east of Los Andes, accounting for 45% of the country. It is associated with forestry productions with a progressive addition of extensive cattle-raising areas for meat and dairy productions (Lascano *et al.*, 2022; Puga *et al.*, 2022).

One of the characteristics of the country is the large biological diversity and different ecosystems, according to Tapia *et al.* (2008). Its geographical location and the presence of the Los Andes mountain range determine the existence of a broad variability of forests and micro-climates, including the wet areas in the Amazon and the northwest, as well as the dry ecosystems in the south, from the warm beaches in the Pacific to the perennial snow on the volcanoes.

The condition described creates a potential to develop various types of productions with various agro-food items. Peralta *et al.* (2018) said that Ecuador produces almost every food needed for the domestic market. The authors claim that farming is the only sector of the economy with a favorable trade balance whose sales are 9-1 over the purchases. Besides, the public budget of this sector is proportionally lower than the contribution of Agriculture to the Gross Domestic Product (GDP).

Despite these facts, Valarezo *et al.* (2019) and Lara *et al.* (2022) noted that agriculture production has undergone economic, political, social, and industrial changes that slowed down economic growth.

Natural resources have been affected by the national farming policies, namely the soil and water. Viteri and Toledo (2020) have mentioned that from 2000-2010, more than three million hectares of tropical forests were lost, following an annual deforestation rate of almost 0.65. Moreover, Vera *et al.* (2020) referred to issues with water supply and quality associated with population management and growth, which compete against the sector's needs.

In turn, FAO (2021) claimed that under the existing conditions, cattle raising produces high CO₂ emissions per milk or meat unit, which are inversely proportional to the productivity level, unsustainable practices of some provinces, and the generation of three major threats to the environment: soil loss and risk of desertification, higher emissions of polluting substances and greenhouse gases, and spreading of the farming borderline.

In that sense, Bernal *et al.* (2020) analyzed the relationship of cattle raising to sustainable development in Ecuador and stressed that climate change is harming productivity, particularly due to variations of temperature and precipitations, and the competition of nature against other agents of the economy. This assertion poses a red flag due to the variety of ecosystems, their management, and the productive characteristics of cattle raising in Ecuador.

However, Mogrovejo (2023), in a study of the environmental policy, said that Ecuador ratified its commitment to the Sustainable Development Goals (SDG) in the 2030 Agenda, as a policy of the national government, which considers them a compelling work referent. According to the author, there have been changes in the future planning by observing and fulfilling SDGs in their agenda and projects.

Toledo *et al.* (2023) identified key factors in implementing agro-food policies in Ecuador, which according to the authors, targeted production increases and better productivity. Nevertheless, among other aspects, they have caused an unfavorable effect on the environment. The goals associated with food safety have not been met, especially due to a lack of perseverance and follow-up of state program implementation, the lack of proper decision-making regarding actions that favor the sector, and consequently, rural poverty continues.

Dairy cattle raising in Ecuador Overview

Ecuador has favorable soil and weather conditions to perform a competent and efficient dairy business as a major economic sector in Ecuador. An analysis of economically critical productions for Ecuador as a farming power, cropping stands out. Dairy farming, particularly does not behave the same way, though milk exports have continued in recent years, and there is a will to position milk as part of the export goods (MAG, 2020).

León *et al.* (2022), have said that Ecuadoran cattle raising is mainly supported by households, with small farmers with low technological development. Interestingly, it is one of the highest farming contributors to local food safety, creating jobs directly or indirectly. In that sense, Taipei

et al. (2022), said that cattle raising is responsible for the creation of 432 454 permanent jobs. This condition represents an economic and social priority, considering the economic crisis and the need for employment of Ecuadorians, particularly in rural areas with low job offers and access.

In terms of cattle raising in Ecuador, FAO (2021) noted that the production systems are mostly extensive (5 million hectares comprising 4.1 million cattle heads), with low productivity and poor grass use. There are around 300,000 cattle farms, of which 57% covers less than 10 ha, and almost 34% of the national milk production is made by families that own less than 20 ha.

Milk production in Guayas

Dairy production is significant. According to CFN (2023), there has been some progression in recent years; in 2021 the production accounted for over five million liters. However, there was a 7% drop compared to 2020, which may be explained, among other factors, by the priority given to other more profitable production alternatives, undesired climate effects in some areas leading to production reduction, informal trading, distortions caused by trading intermediaries, accounting errors, and the lack of control. Another aspect that may have led to this drop was competition and cheaper imported milk and by-product availability.

Despite the previous factors, Brassel and Hidalgo (2007) claimed that milk is the only traditional item that has provided increasing relative safe income in recent years, to dairy farmers in Ecuador. This development was possible thanks to strict domestic market protection by the government. However, the authors expressed their concerns about milk imports and the possibility of a free trade agreement, which could threaten the protection of national production.

Distribution was also dealt with in a study by Franco *et al.* (2019), who noted that the Andes Mountain Range is the region with the largest dairy production levels nationally, accounting for 64%, whereas the Costa region takes 30% and the East has 6%. An analysis of sales revealed that 73% goes to the market, with sales mounting 23 million dollars, regardless of exports. The location is another major factor, 54% of the milk was produced in the provinces of Pichincha, Azuay, Manabi, and Cotopaxi (CFN, 2023).

Regarding average yields, the differences among regions show that La Sierra (7.4 liter/cow) with outstanding values, thanks to the amounts of dairy cattle and the quality of the grasslands, with a high percentage of cultivated pasture. The Amazon region ranks second with 4.9 liters/cow, whereas Costa ranks third, with 3.6 liters/cow (INEC, 2020).

Concerning the low yields reported in Costa, Ramírez *et al.* (2019) said that low-quality natural grass prevails in tropical areas, whose availability is conditioned by climatic factors and dry periods in which the management strategies and supplementation raise costs. Accordingly, Chuquirima *et al.* (2023), in a study of productive systems on the Ecuadoran coast, claimed the

prevalence of dual-purpose cattle, particularly the breed Brahman, with restricted access to forages, depending on the season, as well as poor trading coordination, and low productivity.

The Costa region, particularly, the low basin of Guayas, is the major alluvial coastline plain on the Pacific coast of South America, located on the foot of the west Lost Andes Mountain Range, heading toward the Gulf of Guayaquil through a wide estuary delta. The area is made of 300 km long by 150 km wide, near the base level, with heights below 20 meters above sea level (Moreno *et al.*, 2018).

The region is characterized by a large potential for crop farming, especially rice (*Oryza sativa* L.), banana (*Musa acuminata* Colla), cocoa (*Theobroma cacao* L.), soybean (*Glycine max* L.), sugarcane (*Saccharum officinarum* L.), and grass, such as Guinea grass (*Megathyrsus maximun* Jacq.), African star grass (*Cynodon nlemfuensis* Vanderhyst, Bull.), molasses grass (*Melinis minutiflora* P. Beauv.), leguminous trees like algarrobas (*Prosopis glandulosa* Torr.), leucaena (*Leucaena leucocephala* Lam. de Wit), and guaracabuya (*Caesalpinia coriaria* Jacq. Willd.). Besides, there are other areas where Para grass (*Urochloa mutica* Forssk T. Q. Nguyen), signalgrass (*Urochloa decumbens* Stapf R. D. Webster), Janeiro (*Eriochloa polystachya* Kunth), and *Cenchrus purpureus* Schumach have been established. Morrone, known as Taiwán (León *et al.*, 2018).

One important aspect is the fragility of the basin's ecosystem, which is vulnerable to ecological, economic, and social changes. In that sense, Ilbay *et al.* (2019), in a study of the effect of precipitations on the basin, pointed out that the seasonal distribution and the annual totals are extremely uneven, with the occurrence of floods and droughts that cause severe economic losses.

The local cattle systems face low grass productivity, according to seasonal changes mainly conditioned by seasonal unbalances, floods, and the poor use of residues, even though this region generates large volumes of crop wastes. Consequently, farm management is difficult, and there is a need to relocate animals in high areas with improved draining and feed availability for long periods (Filian *et al.*, 2019).

In reference to milk production in the low basin of Guayas, Filian *et al.* (2019) remarked on the need to ensure sustainability. The authors stressed that milk is an alternative for family and local consumption, including guaranteed sales of this item and by-products. It is also a way of creating additional daily income in times when crop farming does not provide enough sustenance. Moreover, in an extreme case, farmers use the cattle trade as a form of property sales to make cash. Furthermore, cattle raising plays a major role in nutrient diversification, integration, and recycling by supplying ecological and economic stability.

Filian *et al.* (2022) evaluated rice husks as a forage alternative in the low basin of Guayas, and their study revealed it has become a feed source for animals in times of floods, with higher milk

yields, milk quality, and income. The authors recommended this alternative to maintain animals during floods.

An element that has encouraged dairy production in Ecuador is price stability, at \$0.41 a liter by late 2022, 5% higher than in 2021 (CFN, 2023). However, it requires analysis in different areas of Ecuador due to the country's geographical and ecological characteristics that demand higher feed inputs or the implementation of production alternatives several times a year, which increase costs and may create economic unbalances and losses. In that sense, Filian *et al.* (2022) referred to the costs of production of a liter of milk in the low basin of Guayas and found that at certain moments, the price for the liter discouraged production.

In that sense, Polanco *et al.* (2021) noted that prices vary depending on the region and the production system. In reference to the cost, the \$0.70 price for the milk corroborated the previous.

Andrade *et al.* (2023) also evaluated the price of milk according to the farmer categories in Ecuador. They said that stable prices threaten production and therefore, these prices are set depending on the costs of production. Furthermore, mid-sized and large farmers set their prices depending on the intermediaries, and in a low percentage, prices are determined by the mobilization, delivery volume, and delivery times.

Cadena *et al.* (2019) claimed for a true transformation of the national dairy sector and the policy of prices, every actor in the chain must be committed to the process. They stress the need for deregulating prices coordinately and coherently, based on voluntary contracts that provide stability and safety to both buyers and salesmen and lead to a type of relationship that fosters technical support and production improvements in the mid-term.

An analysis of the factors affecting cattle raising (Chacón, 2023) revealed that though the dairy sector must overcome several challenges, it is a critical area for the Ecuadorian economy, not only because it supplies highly demanded foods and nutrients, but it does contribute to farming-related GDP and creates quite an important number of jobs.

The relevance of cattle raising, particularly dairy productions, in Ecuador, is undeniable, so there is a need to study the national production systems that include cattle raising and provide foods that pave the way for decision-making in terms of policies that encourage the sector's development.

Construction of prospective scenarios and their relationship to milk production in the low basin of Guayas

Planning is the human capacity based on anticipation and the possibility to generate action alternatives to change undesired outcomes (Pinto, 2021). Planning is the first step in

management, which is translated into adaptable working lines used to arrange resources and actions (Montoya *et al.*, 2023). According to the authors, anticipatory thinking leads to the creation of possible future scenarios based on present actions.

About scenario-based strategic planning, Godet *et al.* (2000) stressed that since statistics about the future are nonexistent the only element to foresee outcomes is the information available from personal judgment. Hence, there is a need to collect other opinions to contrast ours and plan outcomes as subjective probabilities.

Fernández *et al.* (2021) stated that scenarios are built thanks to the clarity in presenting outcomes and their articulation with the intentionality of human actions. Tapinos (2017), in Introspective Analysis: studying how individuals can predict outcomes and make sensible forecasting, said that the strategic process is based on well-documented analysis and wide practical use, research is limited, particularly in the form uncertainty is captured, analyzed, and interpreted by individuals.

In that sense, Astigarraga (2016) said that strategic perspective should be continued over time since it trains individual people, organizations, and territories ahead of change; it leads to the integration of thinking in the long term, a vision of the future, and possible changes of all types (social, technological, cultural, demographic, and economic) that would come and must be considered for successful planning strategy and processing.

The construction of prospective scenarios not only entails the collection of external information, this process consists of several steps. According to Borges and Janissek (2021), it kicks off with information search, its use, and meaning, which can generate results associated with the innovation suggested, as well as considering the organizational performance and the competitive advantage.

One of the relevant aspects in the formulation of the proposal of new prospective scenarios is the veracity and objectivity of the research sample, information collection, the design of change variables, and scenario layout.

Prospective may be based on predictive methods generated by experts. According to Fasioli (2022), the results must not be read as probabilities but as trends (weak, strong, or very strong), and the forecast analysis must include all possible scenarios (probable, trendy, or referential through probability qualification).

An assessment of works published in this area and their relation to the agro-food sector revealed that Sánchez *et al.* (2022) in a study to design the most cost-effective and efficient public policies, noted that FAO in Paraguay worked on the detection of priority sectors for agro-food investment that ensure economic growth and reduce poverty. The study concluded in the simulation of 21 scenarios, a base scenario, and other 20, in which public investment in comprehensive agriculture increased. Then individually, in all its sectors, such as the dairy sector.

The authors said that making these investment decisions helped maximize the role of agriculture in sustainable development, and the entire nation.

Also, Lara *et al.* (2022), in a study of the impact of the COVID-19 crisis on Ecuadoran agro-food, anticipated two scenarios with no favorable outcomes due to sudden economic variations that halted steady recovery, increasing their problems.

In turn, Carvajal and Rubiano (2021), in a paper entitled Scenarios, 2025, for farming extension: challenges and possibilities through strategic prospective, emphasized the need for integrated approaches that include technology, economy, politics, society, and resources (humans, infrastructure, and technology). These aspects confer scenario-related studies with a comprehensive perspective.

In the study of integrated approaches in milk production chains, Arcila *et al.* (2018), implemented a strategy in the dairy sector in western Antioquia, targeting two specific objectives: to perform a retrospective evaluation and future scenarios in the dairy sector. The study concluded in a strategic matrix with a horizon applicable between 2018 and 2030. It comprised four major projects: global production chains, clean productions, research, development and innovation, and new markets.

Narváez (2023), constructed prospective scenarios for sustainable regional development at the Colombian-Ecuadoran border, and the results suggested the intervention of institutional actors in critical areas, such as infrastructure, education, trade, the business sector, transport, employment, and environment.

Other authors used the construction of prospective scenarios designed locally to promote the diversification of production. In that direction, Pelzer *et al.* (2020) included aspects like the introduction of Leguminosae in French territory and predicted their possibilities in the context of sustainable production systems.

The universe for the study where the construction of prospective scenarios as a tool for analysis. However, an examination of agricultural sciences, particularly dairy production, did not produce the same results. Fernández *et al.* (2021) in a literature review, emphasized that prospective scenarios used as planning tools are under constant evolution, changing and broadening into the different branches of science. They have been useful in several various areas of knowledge, with a special focus on the energy sector.

The condition presented in this study paves the way for the utilization of analysis tools in agriculture, considering the need for future strategies in dairy production systems influenced by economic, ecologic, and social factors. Consequently, the formulation of prospective scenarios in cow's milk production in the low basin of Guayas could become an essential tool that offers ways to ensure sustainability, considering the factors affecting it.

A relevant aspect associated with the implementation of the method is the introduction in a sector that has not received much attention from science, in a particular region that is common to some Latin American countries.

CONCLUSION

Milk production differed from region to region. The highest yields were found in the Sierra, followed by the Amazon, and then Costa, where natural pastures prevail, with are seasonal unbalances, and cropping as the main activity of agriculture. Accordingly, the set up of prospective scenarios is an alternative for decision-making in terms of milk production sustainability in the region.

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AUTHOR CONTRIBUTION STATEMENT

Research conception and design: JPM, LCR; data analysis and interpretation: GEMP, JJPM, LMCR; redaction of the manuscript: GEMP, JJPM, LMCR.

CONFLICT OF INTEREST STATEMENT

The authors state there are no conflicts of interest whatsoever.