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DATA ANALYSIS, SOCIOECONOMIC INDICATORS, AND ROADS: FACTORS FOR REGIONAL DEVELOPMENT IN THE PORTO VELHO AREA

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ABSTRACT

This study analyzes the evolution of agricultural and livestock production in the municipality of Porto Velho, Rondônia, Brazil, based on a ten-year historical series (2014–2024). The analysis focuses on soybean production, corn production, cattle herd expansion, and milk production, selected due to their economic relevance and production volume within the regional agricultural sector. Data were obtained from the Brazilian Institute of Geography and Statistics (IBGE) and analyzed using descriptive statistics, correlation analysis, and linear regression models.The results indicate substantial growth in soybean production, corn production, and cattle herd size during the analyzed period. Soybean production increased significantly, reflecting the expansion of grain cultivation in the municipality, while cattle production exhibited stable and sustained growth. Corn production also demonstrated a positive trend despite temporary fluctuations. In contrast, milk production remained relatively stable, although productivity per animal increased over time.The findings suggest that the expansion of agricultural and livestock activities may increase demand for transportation and logistics services, particularly in regions where road transport is the primary mechanism for production flow. Although the study does not directly evaluate road conditions or transportation costs, the observed

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production growth highlights the importance of future investigations integrating agricultural performance, logistics indicators, and infrastructure capacity.

Keywords: Agricultural production; Livestock production; Soybean; Corn; Transport logistics; Porto Velho..

1. INTRODUCTION

The State of Rondônia, throughout its historical development from its formation to the present day, has undergone successive cycles of significant economic expansion. These cycles include mineral and forest extractivism, growth in the construction sector, the implementation of Hydroelectric Power Plants, the establishment of large-scale enterprises, and, more recently, the expansion of agribusiness. This trajectory has resulted in a high level of productive diversification, with emphasis on soybean and corn cultivation, cattle ranching, and dairy production, positioning the state as a prominent productive hub both within the Northern Region and at the national level.

Individually, these economic cycles have acted as strong drivers of migration, attracting populations from various regions of the country. Such cycles have stimulated economic growth not only at the state level but also within individual municipalities, leading to periods of population increase followed by subsequent stabilization or decline, in accordance with prevailing economic demands.

The municipality of Porto Velho was established on October 2, 1914, by Law No. 757, initially settled by the existing local population. Decree-Law No. 5,839, dated September 21, 1943, elevated the municipality of Porto Velho to the status of capital of the Federal Territory of Guaporé. In honor of Marshal Cândido Mariano da Silva Rondon, Law No. 21,731, enacted in February 1956, renamed the territory as the Federal Territory of Rondônia, comprising the municipalities of Porto Velho and Guajará-Mirim. Subsequently, Complementary Law No. 41, dated December 22, 1981, elevated the Federal Territory of Rondônia to the status of a State, maintaining Porto Velho as its capital (IBGE, 2025a).

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Porto Velho currently marks 111 years of existence and, according to its territorial division established in 2009, comprises 13 districts: Porto Velho, Abunã, Calama, Demarcação, Extrema, Fortaleza do Abunã, Jaci-Paraná, Nazaré, Nova Califórnia, São Carlos, Nova Mutum Paraná, União Bandeirantes, and Vista Alegre do Abunã (IBGE, 2025a).

Throughout these 111 years, Porto Velho has experienced significant economic peaks, notably the rubber cycle, which began around 1877. This period represents the first major economic cycle, promoting the migration of workers from Brazil's Northeast region for the exploitation of rubber trees and latex production, reaching its decline after 1912 (Teixeira, 2001).

Concurrently, in 1907, the construction of a major infrastructure project began—one that contributed not only to regional development but also to the identity of the area: the Madeira-Mamoré Railway. This undertaking fostered a new migratory cycle, attracting not only individuals from various Brazilian states but also immigrants from other countries, including people from the Caribbean, Spain, Portugal, and the United States.

In 1942, during the context of World War II, a second rubber production cycle emerged, attracting global demand for latex in the Amazon region. It was during this period that the so-called "rubber soldiers" reoccupied the Amazonian valleys (Teixeira, 2001).

From 1952 onward, a new economic scenario developed in the municipality, driven by mineral extractivism following the discovery of tin deposits and the subsequent cassiterite extraction cycle. In 1971, manual cassiterite mining was officially prohibited, transitioning from artisanal mining practices to mechanized systems, which led to significant socioeconomic impacts. Meanwhile, the agricultural sector began to consolidate.

Around 1970, another economic cycle began in the state with the arrival of migrants from the South and Southeast regions of Brazil. This period marked the expansion of agricultural activities, pasture formation, and the establishment of timber industries, which continue to play a relevant role in the state's economy to this day.

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In parallel with these primary economic cycles, other complementary activities also emerged during the same periods, jointly contributing to regional economic development notably, gold mining activities along the Madeira River deserve special mention. However, in the early 1990s, many of these operations were deactivated. While they generated significant economic wealth, they also caused severe environmental impacts, particularly due to heavy metal contamination, resulting in an unprecedented environmental disaster. Despite this, such mining activities persist to the present day.

Subsequent to the 2000s, a new economic phase emerged, driven by the construction sector. More specifically, in 2008, the construction of Porto Velho Shopping began, generating income and creating jobs, marking the onset of this new economic cycle in the capital. Simultaneously, construction works commenced on the Santo Antônio Hydroelectric Power Plant and the Jirau Hydroelectric Power Plant, both developed under the Growth Acceleration Program – PAC. This set of large-scale infrastructure projects significantly boosted the local economy, generating employment and income, while also triggering a new wave of labor migration that contributed to substantial population growth. However, upon completion of these projects, this economic cycle gradually declined, as many workers left the region or returned to their states of origin (Gonçalves Filho, 2014).

Considering these economic cycles—rubber extractivism, mineral extraction (gold and cassiterite), the Madeira-Mamoré Railway, the shopping center development, and the hydroelectric power plants—their contributions to the economic landscape of Porto Velho are undeniable. Nevertheless, they did not consolidate as sustained development drivers, whether due to environmental degradation, their limited construction timeframe, or the lack of continuity in productive activities. In essence, these cycles emerged, reached their peak, and eventually declined.

Shifting the focus to the current scenario, a new economic cycle is underway, driven by investments in technology, genetic improvement, and productivity gains, demonstrating strong and sustained growth. In this context, agribusiness stands out, particularly not only in beef and dairy cattle production

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but especially in grain cultivation—namely soybeans and corn—which has exhibited significant and exponential growth since 2013 (IBGE, 2025).

Porto Velho currently stands out within the state as the largest producer of soybeans, cassava, bananas, and watermelons. It also holds the largest cattle herd and demonstrates notable production levels of oranges and robusta coffee.

Despite the remarkable expansion of agricultural and livestock production, an important question remains unanswered: does the current agribusiness expansion represent a structural regional development process capable of overcoming the temporary economic cycles historically observed in Porto Velho?

In this context, this study seeks to investigate whether the recent growth of soybean production, corn cultivation, and cattle ranching constitutes a sustainable development trajectory or merely another cyclical economic phenomenon.

The central hypothesis is that agribusiness differs from previous economic cycles because it is supported by technological innovation, productivity gains, and stronger integration with national and international markets, thus presenting greater potential to generate long-term regional development.

2. THEORETICAL FRAMEWORK

2.1 Regional Development, Agribusiness and Transport Infrastructure

Regional development is a multidimensional process involving economic growth, productive diversification, income generation, employment expansion, and improvements in the quality of life of the population. In this context, infrastructure plays a strategic role, particularly transportation systems, which enable the integration of production areas with consumer markets and contribute to reducing logistical costs.

According to François Perroux's Growth Pole Theory, economic development does not occur uniformly across space but is concentrated around dynamic sectors capable of generating productive linkages and inducing growth

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in related activities. These sectors function as growth poles, stimulating investments, employment creation, technological innovation, and regional economic expansion. In agricultural regions, agribusiness can assume this role by creating forward and backward linkages involving transportation, storage, processing industries, financial services, and commercialization networks.

Hirschman (1958) argues that economic development is driven by unbalanced growth processes in which strategic sectors generate investment opportunities and stimulate complementary economic activities. In this perspective, agricultural expansion may promote the development of supporting sectors such as transportation infrastructure, logistics services, equipment supply chains, and agro-industrial processing activities. Consequently, the effects of agricultural growth extend beyond the farm gate and influence broader regional economic dynamics.

Myrdal (1957) emphasizes that economic growth can produce cumulative causation effects, whereby initial productive advantages attract additional investments, labor, and capital, reinforcing regional competitiveness over time. In regions where agricultural production expands continuously, positive cumulative effects may emerge through increased income generation, public revenue growth, and infrastructure investments. However, the sustainability of these benefits depends on institutional capacity and adequate public policies capable of supporting long-term development.

The institutional perspective proposed by North (1990) highlights the importance of formal and informal institutions in shaping economic performance. Efficient transportation systems, regulatory stability, property rights protection, and public investment in infrastructure constitute essential conditions for reducing transaction costs and increasing economic competitiveness. In agricultural regions, the quality of road networks directly affects transportation efficiency, market access, and producers' profitability.

In the Brazilian context, Furtado (2007) argues that regional development requires the productive integration of economic activities with infrastructure and institutional support mechanisms. Economic growth alone is insufficient to guarantee development if it is not accompanied by structural

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transformations capable of generating income distribution, productive diversification, and social improvements. Therefore, the expansion of agribusiness should be analyzed not only through production indicators but also through its capacity to stimulate broader regional development processes.

Within this framework, transportation infrastructure assumes a central role in the competitiveness of agricultural production systems. Grain production and livestock activities depend heavily on efficient logistics networks due to the large volume of goods transported and the distance between production areas and consumer markets. Improvements in highways, rural roads, storage facilities, and intermodal transportation systems contribute directly to reducing operational costs and increasing market competitiveness.

In Porto Velho, the recent expansion of soybean production, corn cultivation, and cattle ranching has increased the importance of transportation infrastructure as a strategic component of regional development. The growth of agricultural production generates greater demand for freight transportation, storage capacity, equipment, fuel supply, and logistical services. Consequently, agribusiness may be interpreted not only as an economic activity but also as a potential driver of regional development capable of inducing investments, generating employment opportunities, increasing public revenues, and strengthening local productive systems.

Therefore, the relationship between agribusiness, logistics, and regional development constitutes the theoretical basis of this study. The central assumption is that sustained growth in agricultural and livestock production may contribute to regional development when supported by adequate infrastructure, institutional capacity, and productive integration mechanisms capable of transforming economic expansion into long-term socioeconomic benefits.

.2.2 Agricultural Expansion and Freight Transportation Systems

Investments in large-scale production chains are directed toward genetic improvement of seeds, soil conditioning and correction, and the use of advanced planting, spraying, and harvesting equipment, resulting in increased productivity per cultivated area. In the livestock sector, emphasis is placed on genetic improvement of herds, optimized feeding systems, and feedlot-based

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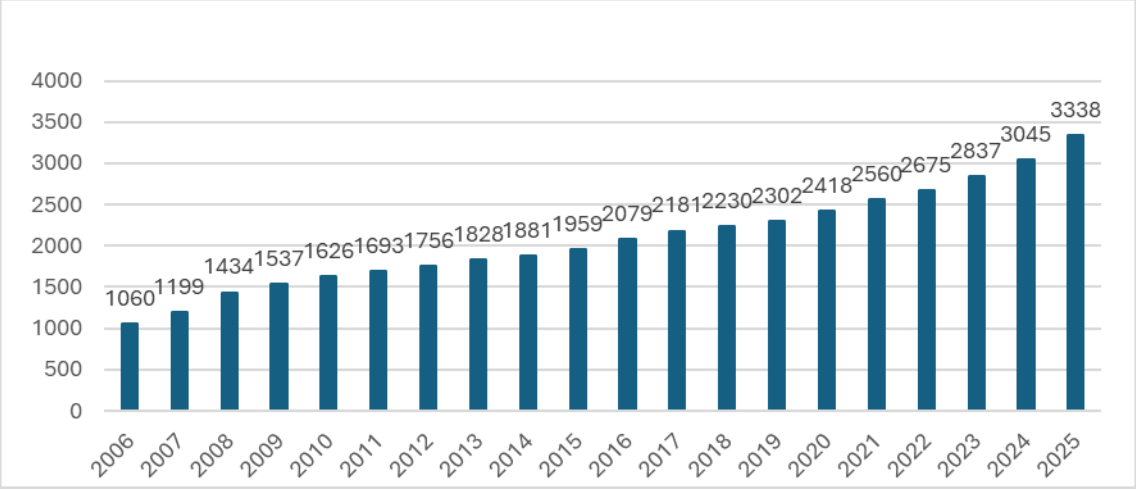
production models, enabling higher stocking densities and more efficient use of physical space.

These constitute the primary factors, to which an integrated freight transportation system is closely linked. This system has evolved in parallel with increasing productivity levels, requiring higher-powered equipment and, consequently, greater load capacity across both road and waterway transport modes—the predominant modes used for high-volume cargo transportation in the state. The integration of these factors directly contributes to enhanced competitiveness in the final cost of the product.

According to the National Traffic Council (CONTRAN, 2021), through Resolution No. 882/2021, which establishes weight limits for vehicles operating on terrestrial roadways, trucks traditionally ranged from 2 to 5 axles, with load capacities between 16.00 and 46.00 tons. Currently, however, the market offers equipment with greater power, a higher number of axles, and larger dimensions, resulting in significantly increased load capacities. Modern vehicle combinations can transport up to 74 tons using a 9-axle configuration, clearly demonstrating a redesign of freight transport equipment in response to evolving logistical demands. The quantitative results are presented in Chart 01 for better visualization and interpretation.

Chart 01. Trailer Truck Fleet in the Municipality of Porto Velho (2014–2024).



Source: Brazilian Institute of Geography and Statistics (IBGE, 2025).

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Economic expansion factors are also reflected in the paved road network, which, in response to increasing freight demands, has undergone significant adaptation. This includes improvements in design and construction planning, particularly through the incorporation of economic scenario forecasting, as well as the adoption of materials and construction methodologies capable of meeting new operational requirements. In this context, the use of rigid pavements has emerged as a viable engineering alternative, offering enhanced ride quality, structural strength, and durability, and has been increasingly implemented across several Brazilian states due to its proven benefits.

On the other hand, when considering primary roads and unpaved rural roads, it is evident that, in terms of construction systems and rehabilitation practices, little to no significant progress has been achieved. These roads are often treated with palliative or inefficient interventions that fail to meet existing demands. In many cases, they are not properly designed to accommodate productive activities or differentiated traffic conditions, whether in terms of load or volume. Furthermore, the frequent use of inadequate or low-quality materials directly contributes to a scenario characterized by safety risks, low service durability, and inefficient allocation of maintenance resources (Bernucci et al., 2007).

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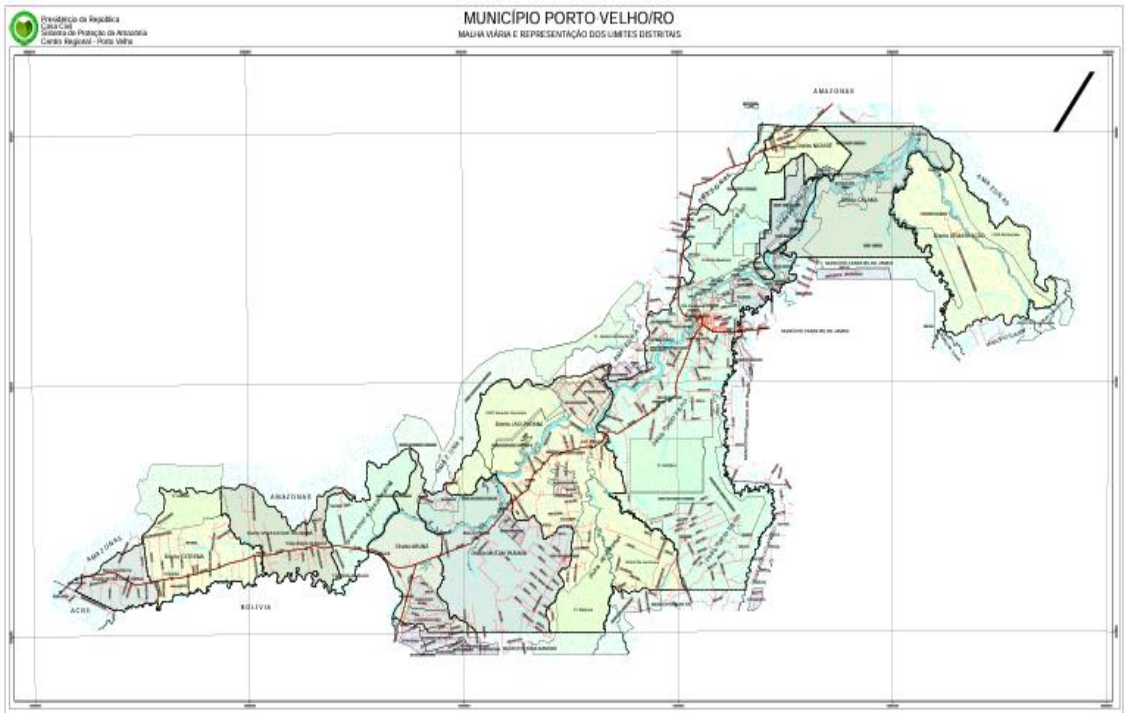
Figure 01: Road map of Porto Velho, RO



Source: SIPAM,2010

2.3 Road Infrastructure and Regional Logistics in Porto Velho

According to data from the Amazon Protection System (SIPAM), the municipality of Porto Velho presented the following road network characteristics in 2010:

- Federal paved roads: 520.60 km
- State paved roads: 5.30 km
- State unpaved roads: 73.20 km
- Municipal paved roads: 154.30 km
- Municipal unpaved roads: 4,490.30 km

These figures provide an overview of the municipality's transportation infrastructure. State and municipal paved roads totaled only 159.60 km, whereas unpaved state and municipal roads reached 4,563.50 km. This scenario highlights the importance of continuous maintenance and infrastructure investments to ensure adequate traffic conditions and accessibility throughout the municipality.

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Regarding unpaved roads, several types of pavement-surface deterioration are commonly observed on rural roads, including potholes, corrugations (washboarding), mud spots, erosion processes, and the loss or displacement of soil particles. Such conditions may compromise road safety and functionality, in addition to contributing to dust generation and the sedimentation of nearby water bodies. According to Pinheiro et al. (2020), these problems are generally associated with deficiencies in construction planning, inadequate drainage systems, or the poor quality of materials used in road surfacing.

These factors lead to increased operational risks, longer travel times, higher fuel consumption, and an elevated likelihood of accidents, as well as greater vehicle wear and potential loss or damage to transported goods. Consequently, within the freight transport system, these conditions result in higher transportation costs due to the risks often involved, ultimately reducing profit margins. In extreme cases, they may also lead to total cargo loss, particularly in the event of vehicle overturning.

According to the National Department of Transport Infrastructure (DNIT, 2023), based on its Road Maintenance Condition Map, the federal highway network in the state of Rondônia is classified as follows: 59% in good condition, 27% in fair condition, 9% in poor condition, and 7% in very poor condition.

Returning to the context of Rondônia, the state has 1,629.44 km of paved highways and 3,867.08 km of unpaved roads, with the latter accounting for 70.36% of the total road network (Government of Rondônia, 2023).

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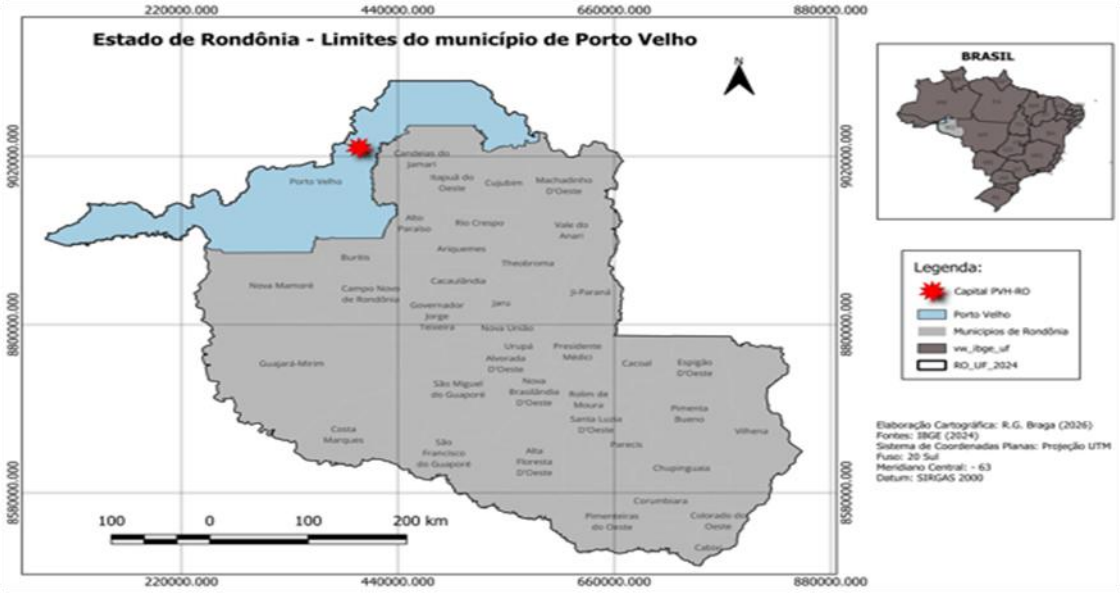
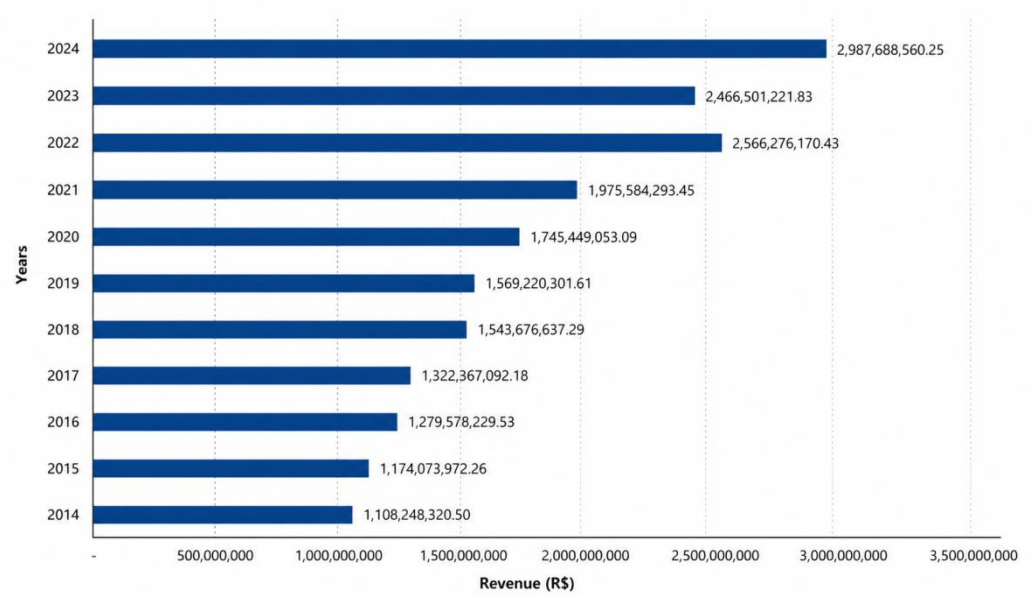
Figura 02: Mapa de Rondônia com destaque para a área de Porto Velho



Source: Prepared by the authors (2026)

Porto Velho, the capital of the State of Rondônia, has a territorial area of 34,091.146 km² (2004), with a population of 460,434 inhabitants (2022). By 2025, the population is estimated to reach 517,709 inhabitants, and its gross revenues amount to R$ 2,987,688,560.25 (2024) (IBGE, 2025b).

Chart 01: Gross Revenue of Porto Velho Municipality (2014–2024).



Source: Brazilian Institute of Geography and Statistics (IBGE, 2025b).

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Based on Chart 01, it can be observed that Porto Velho experienced a consistent increase in revenue over the last decade (2014–2024), despite some fluctuations. The growth rates show an overall upward trend, with the lowest increase recorded at 1.65% between 2018 and 2019. Conversely, the highest growth was observed in 2022, with a 29.90% increase compared to 2021.

In 2023, a decline in revenue occurred, with a reduction of -3.89%. However, in 2024, a strong recovery is evident, representing the second-highest growth rate in the analyzed period, at 21.13%. Furthermore, when comparing 2014 to 2024, there is an approximate increase of 170% in total revenue.

This scenario indicates that, despite short-term fluctuations, the municipality has more than doubled its total revenue over the ten-year period, reflecting a sustained long-term growth trend.

By applying a correlation analysis between the years considered and their respective revenue values, a coefficient of 0.954714876 was obtained, indicating a strong positive correlation. Additionally, when regression analysis is applied to the dataset, an upward trend is observed, as illustrated in Chart 02.

Table 01 – Regression Statistics for Porto Velho Municipal Revenue (2014–2024)

Regression Statistics	
Multiple R:	0.954714876
R-squared:	0.911480495
Adjusted R-squared:	0.901644994
Standard Error:	1.040146654
Observations:	11

The study of economic growth theory is regarded as one of the main challenges for scholars in the field of economics, as it seeks to understand the mechanisms and factors that determine growth, aiming to explain the conditions under which growth occurs or fails to occur. Among the key factors of production, those associated with land, capital, and labor are particularly emphasized.

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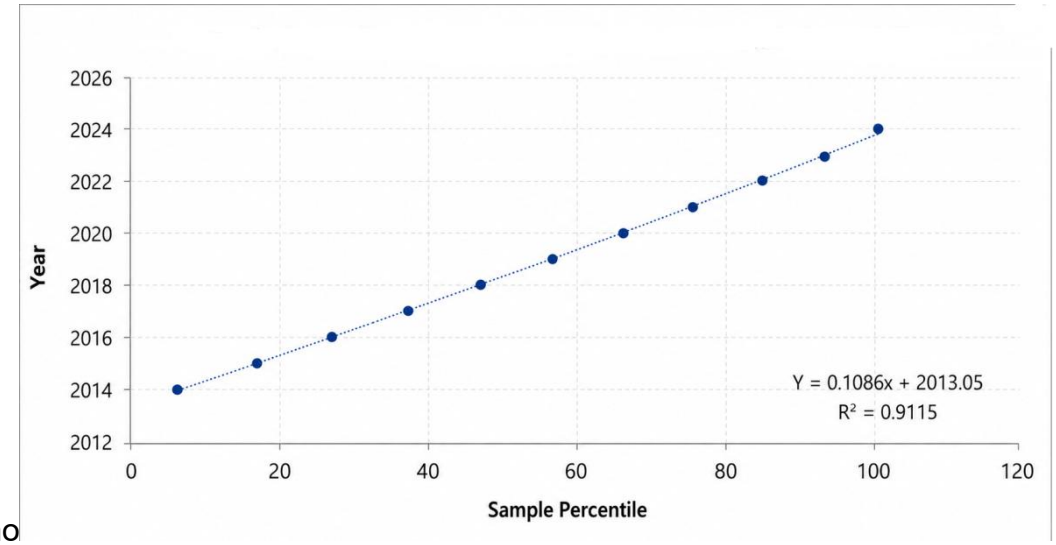
Chart 02: Normal Probability Plot of Gross Revenue Data in Porto



Velho

Source: Prepared by the authors (2025).

Within this framework, the focus is placed on economic factors derived from agriculture, especially those related to arable land and natural resources. In this context, the three factors—land, capital, and labor—are deeply interconnected and function as fundamental determinants of economic growth.

Natural Capital, composed of existing natural resources and land suitable for cultivation; Physical Capital, represented by available infrastructure, goods, and financial assets; and Human Capital, characterized by health, education, and labor capacity—together form a tripartite framework in which investments are distributed, constituting the fundamental basis for economic success.

It is argued that investments in natural and physical capital tend to generate financial returns in the short term. In contrast, investments in human capital formation require initial financial inputs for their implementation, with the potential to yield gains in the long term (Viana and Lima, 2010).

To some extent, financial capital can be associated with its presence in agricultural fairs held throughout the State of Rondônia, particularly evidenced by the significant volume of business transactions generated at the Rondônia Rural Show Internacional, recognized as the largest agribusiness fair in Brazil's Northern Region, illustrates this dynamic. In its first edition in 2012, it recorded a business volume of R$ 185 million. By its 10th edition in 2023, this figure had

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increased to R$ 3.5 billion, followed by R$ 4.4 billion in the 11th edition in 2024, and reaching R$ 5.1 billion in the 12th edition in 2025 (SEAGRI, 2025).

2.4 Conceptual Model of Regional Development

The theoretical discussion developed throughout this study suggests that regional development in Porto Velho may be understood as the result of interactions among agricultural production, transportation logistics, road infrastructure, and local economic performance. Based on the contributions of Perroux (1955), Hirschman (1958), North (1990), and Furtado (2007), a conceptual model is proposed to explain the relationship between agribusiness expansion and regional development.

The model assumes that the expansion of soybean production, corn cultivation, and cattle ranching increases the demand for transportation services and freight movement. As production volumes increase, greater pressure is exerted on transportation systems, particularly road infrastructure, which remains the dominant mode for agricultural freight transportation in Rondônia.

The increase in productive activity contributes to the generation of income, employment opportunities, commercial transactions, and tax revenues. Consequently, municipal revenue tends to increase alongside the expansion of agricultural production. This process may generate cumulative economic effects capable of stimulating regional development through productive integration, investment attraction, and infrastructure improvements.

Therefore, the proposed conceptual framework assumes that agribusiness expansion influences regional development through both direct and indirect channels, involving logistics systems, transportation infrastructure, and public revenue generation. This framework serves as the analytical basis for interpreting the empirical results presented in this study.

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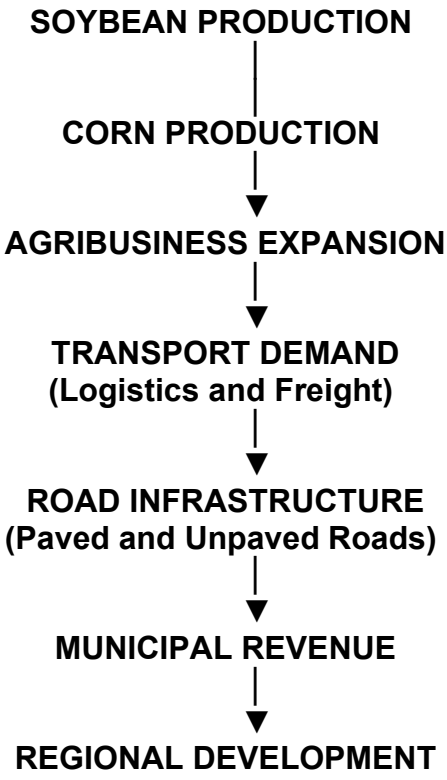

3. METHODOLOGY

The methodology adopted in this study is characterized as a mixed approach, combining both quantitative and qualitative methods. Initially, it is classified as quantitative research due to the collection and analysis of data.

The data presented in this study represent a historical series of production factors covering the period from 2014 to 2024. The selection of the analyzed products was based on their productive potential, as well as criteria such as aggregated weight and production volume. Within this context, the following products were selected: soybeans, corn, cattle, and dairy production (cows versus milk production), as they stand out both in terms of quantitative production and economic relevance.

The data were obtained from the Brazilian Institute of Geography and Statistics (IBGE), reference year 2025, and are publicly available.

For the statistical analysis, the correlation method was initially applied to evaluate the relationship between years and the productivity of each product. Subsequently, linear regression analysis was conducted, with data tabulation performed using Microsoft Excel.

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The research also incorporates a qualitative approach through bibliographic review, including sources such as books, scientific articles, dissertations, and regulatory documents that support the study.

The objective of this study is to analyze the historical evolution of soybean production, corn production, cattle herd expansion, and milk production in Porto Velho between 2014 and 2024. In addition, the study discusses how the observed growth in agricultural and livestock activities may increase demand for transportation and logistics services, emphasizing the relevance of future investigations on the maintenance of paved roads and the planning of rural road infrastructure within the municipality.

4 RESULTS AND DISCUSSION

The results reveal significant transformations in the productive structure of Porto Velho during the period analyzed. The expansion of soybean cultivation, growth in corn production, and continuous increase in cattle herd size demonstrate the strengthening of agribusiness as one of the municipality's most dynamic economic activities.

The statistical analyses indicate positive correlations between time and production levels for most variables examined. These findings suggest a process of productive consolidation, particularly in grain production and livestock activities. However, the observed growth patterns should be interpreted as indicators of agricultural expansion rather than direct measures of regional development.

From a logistical perspective, increasing production volumes may generate additional demand for transportation services, storage facilities, and distribution networks. Nevertheless, the present study does not establish causal relationships between production growth and road infrastructure performance. Instead, the results highlight the importance of future studies incorporating direct indicators of transportation efficiency, freight costs, road quality, and infrastructure investment.

Soybean production, initially originating in Brazil's Southern Region, expanded into the Central-West Region, with a strong productive focus in the states of Mato Grosso do Sul and Mato Grosso. Subsequently, its cultivation

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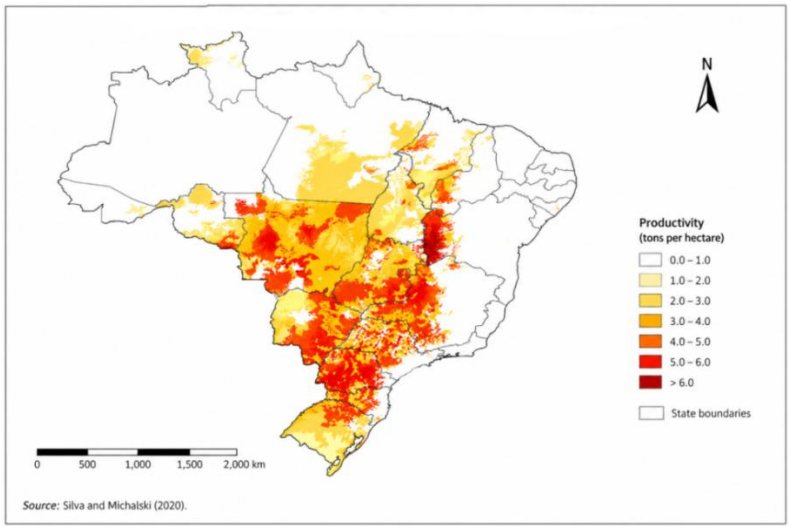
advanced into the southern region of Rondônia. This expansion was driven by factors such as proximity to the state of Mato Grosso, land tenure structure, land prices, and favorable geographic conditions. From 1997 onward, soybean cultivation began to expand throughout the entire state of Rondônia (Silva, 2000).

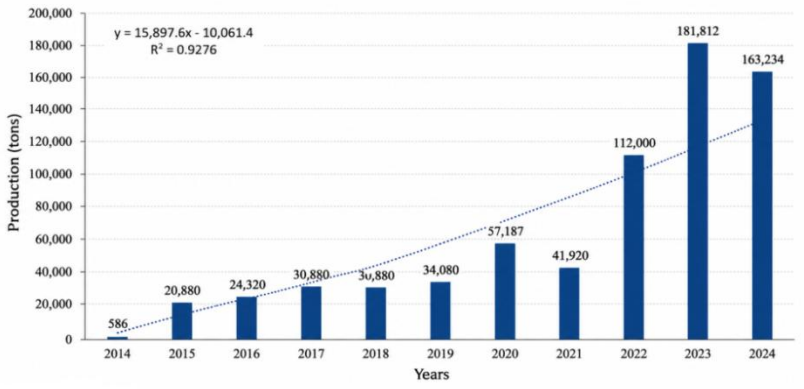
Figure 02: Soybean Production in Brazil (tons per hectare), 2018.



Source: Silva and Michalski (2020).

Thus, initiating the analysis of productive dynamics in the municipality of Porto Velho, soybean production (in grain form) will be examined over a 10-year historical series, covering the period from 2014 to 2024. The corresponding data are presented in Chart 03.

Chart 03: Soybean Production (Grain) in Porto Velho (2014–2024).



Source: Brazilian Institute of Geography and Statistics (IBGE, 2025b).

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Soybean production in the municipality of Porto Velho shows modest figures at the beginning of the historical series, with 586 tons produced in 2014, which may indicate the initial introduction of the crop in the region. A significant increase is observed in 2015, followed by continuous growth until 2017, reaching 30,880 tons, and remaining stable in 2018.

In 2020, production again demonstrates a substantial increase, reaching 57,187 tons. However, in 2021, there is a decline to 41,920 tons. From 2022 to 2023, peak production levels are observed, reaching 112,000 and 181,812 tons, respectively. Despite maintaining an overall upward trend, 2024 shows a notable reduction to 163,234 tons.

When analyzing the historical series (from beginning to end), covering the period from 2014 to 2024, a steep growth trend is evident, reflecting a complete transformation in the production level. Despite occasional declines in 2021 and 2024, the overall trend indicates expansion and consolidation, with a total growth of approximately 27,887%.

By applying the correlation method between the years and production values, a coefficient of 0.87531116 was obtained, indicating a positive variation and a strong growth trend in soybean production in the municipality. Furthermore, when linear regression analysis is applied, an upward projection is observed, as illustrated in Chart 04.

Table 02 – Regression Statistics for Porto Velho Municipal Revenue (2014–2024)

Regression Statistics	
Multiple R:	0.87531116
R-squared:	0. 766169626
Adjusted R-squared:	0. 740188474
Standard Error:	1. 690540384
Observations:	11

The regression analysis revealed a strong positive relationship between time and soybean production in Porto Velho ($R = 0.875$; $R^2 = 0.766$). This result indicates that approximately 76.6% of the variation observed in soybean

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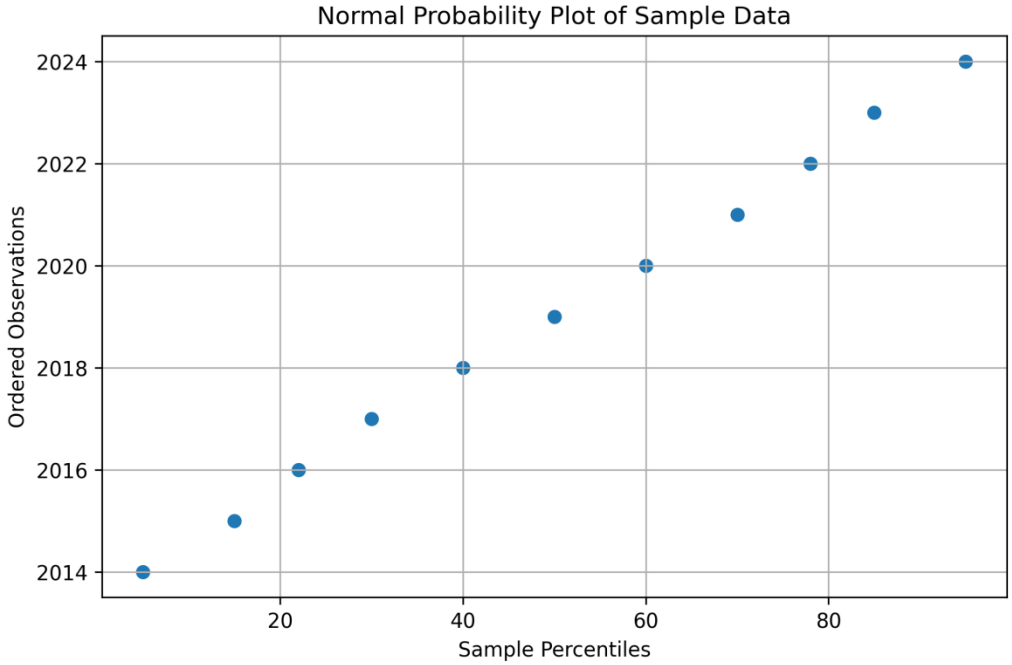
production can be explained by the temporal trend of the analyzed period. Therefore, soybean production exhibited a consistent expansion pattern between 2014 and 2024, despite temporary fluctuations observed in specific years.

Chart 04: Regression Analysis of Soybean Production in Porto Velho



Source: Prepared by the authors (2025).

The analysis of corn production in the municipality of Porto Velho also reveals an increasing trend, largely driven by the practice of crop rotation, in which soybean cultivation is alternated with corn during the off-season. These patterns are more clearly illustrated in chart 5.

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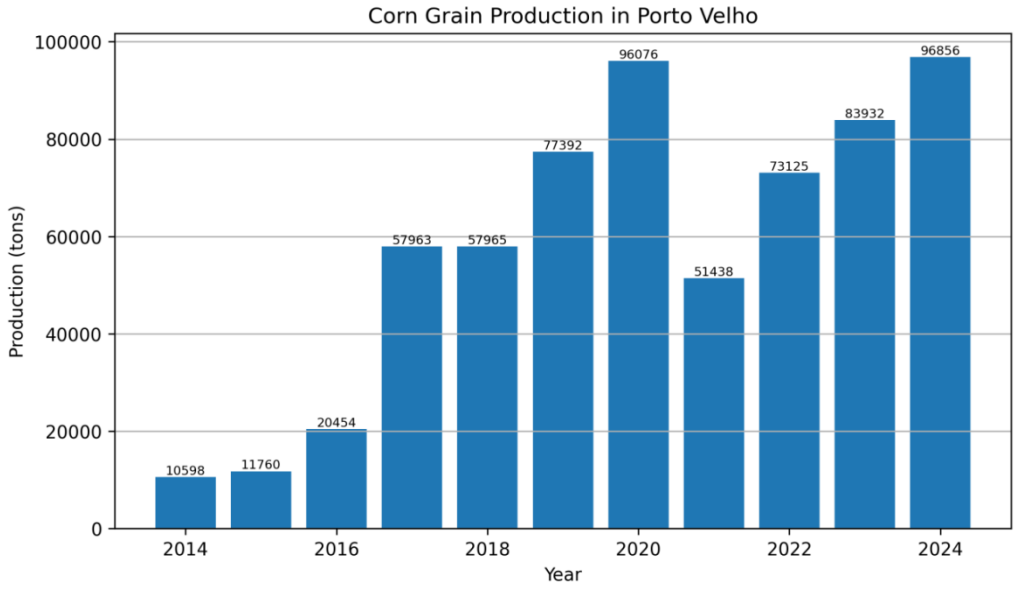
Chart 05: Corn Production in Porto Velho



Source: Brazilian Institute of Geography and Statistics (IBGE, 2025e).

The trajectory of corn production also shows an overall upward trend throughout the analyzed time series, despite periods of stagnation and significant declines. In 2016, production nearly doubled compared to 2014, reaching 20,454 tons. This growth continued sharply in 2017, when production almost tripled, totaling 57,963 tons, a level that remained relatively stable in 2018.

In the 2019–2020 period, production reached a historical peak of 96,076 tons. However, in 2021, it experienced a sharp decline of nearly 47%, dropping to 51,438 tons. Subsequently, production showed a steady recovery, reaching a new series peak of 96,856 tons in 2024.

A comparative analysis of both crops indicates that soybean production has followed a pattern of aggressive expansion, whereas corn, likely due to its greater vulnerability to climatic risks, experienced a production decline in 2021. Nevertheless, the overall trend for both crops remains upward, reflecting sustained growth in the municipality's agricultural sector.

The application of correlation analysis between time and production values yielded a coefficient of 0.85782876, indicating a strong positive trend in

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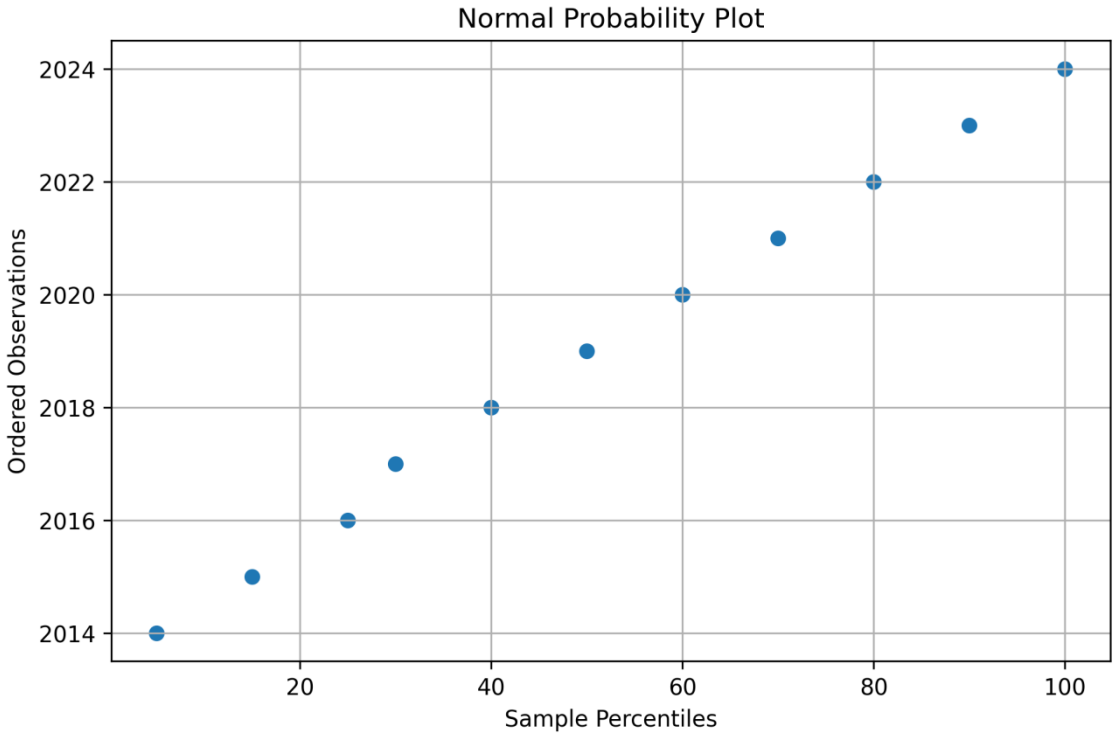
soybean production. Likewise, linear regression results consistently demonstrate an increasing trend in corn production, as shown in Chart 06.

Table 03 – Regression Statistics for Porto Velho Municipal Revenue (2014–2024)

Regression Statistics	
Multiple R:	0. 85782876
R-squared:	0. 735870182
Adjusted R-squared:	0. 706522424
Standard Error:	1. 796734074
Observations:	11

Corn production also presented a strong positive relationship with time ($R = 0.858$; $R^2 = 0.736$). The results indicate that 73.6% of the observed variation in production is associated with the temporal trend, demonstrating a consistent long-term growth pattern despite short-term production fluctuations.

Chart 06: Linear Regression Model for Corn Production in Porto Velho.



Source: Prepared by the authors (2025).

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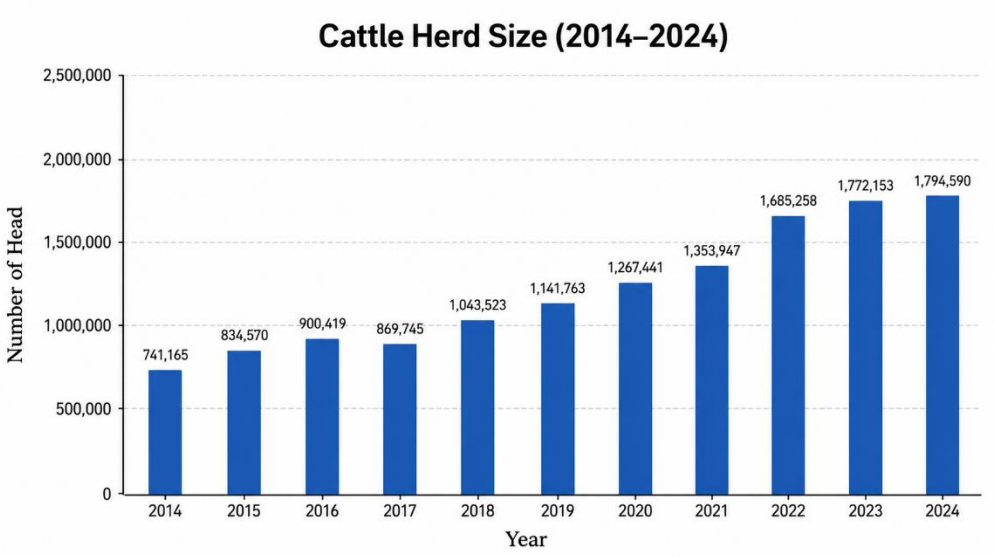
Following the analysis of agricultural grain production, particularly soybean and corn, the study now examines the livestock sector, with emphasis on total cattle herd size, the number of dairy cows, and milk production levels.

Chart 07: Cattle Herd in Porto Velho



Source: Brazilian Institute of Geography and Statistics (IBGE, 2025f).

When analyzing the graph of cattle population (herd size), a more linear, consistent, and sustained growth trend can be observed over the years, without sharp declines—this being a typical characteristic of extensive livestock systems. A slight contraction of approximately 3.4% is noted in 2017, with a total of 869,745 head. However, in 2018, the herd surpassed one million head, reaching 1,043,523, and maintained strong growth thereafter until 2024.

Unlike soybean and corn production, which experienced significant declines in 2021—particularly corn—the cattle sector showed continued expansion, reaching a peak of 1,794,590 head in 2024. This trend indicates the consolidation of the region as a livestock production hub.

Overall, the historical series from 2014 to 2024 reveals an approximate growth of 142% over the decade.

Thus, it can be concluded that livestock production, together with agriculture (soybean and corn), has exhibited both exponential and absolute growth. Livestock, in particular, has demonstrated a stable foundation and

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significant productive potential. In this context, soybean and corn act as the primary drivers of economic expansion—albeit with higher associated risks—whereas livestock functions as an economic buffer, providing stability and steady growth.

Applying the correlation method between time (years) and herd size, a coefficient of 0.974376095 was obtained, indicating a strong positive growth trend in cattle production within the municipality. This upward trend is further confirmed through linear regression analysis, as illustrated in chart 08.

Table 04 – Regression Statistics for Porto Velho Municipal Revenue (2014–2024)

Regression Statistics	
Multiple R:	0. 974376095
R-squared:	0. 949408775
Adjusted R-squared:	0. 943787528
Standard Error:	0. 786344195
Observations:	11

Among all variables analyzed, cattle production presented the strongest statistical relationship with time ($R = 0.974$; $R^2 = 0.949$). Approximately 94.9% of the variation in herd size is explained by the temporal trend, indicating a highly stable and sustained expansion of cattle production throughout the study period.

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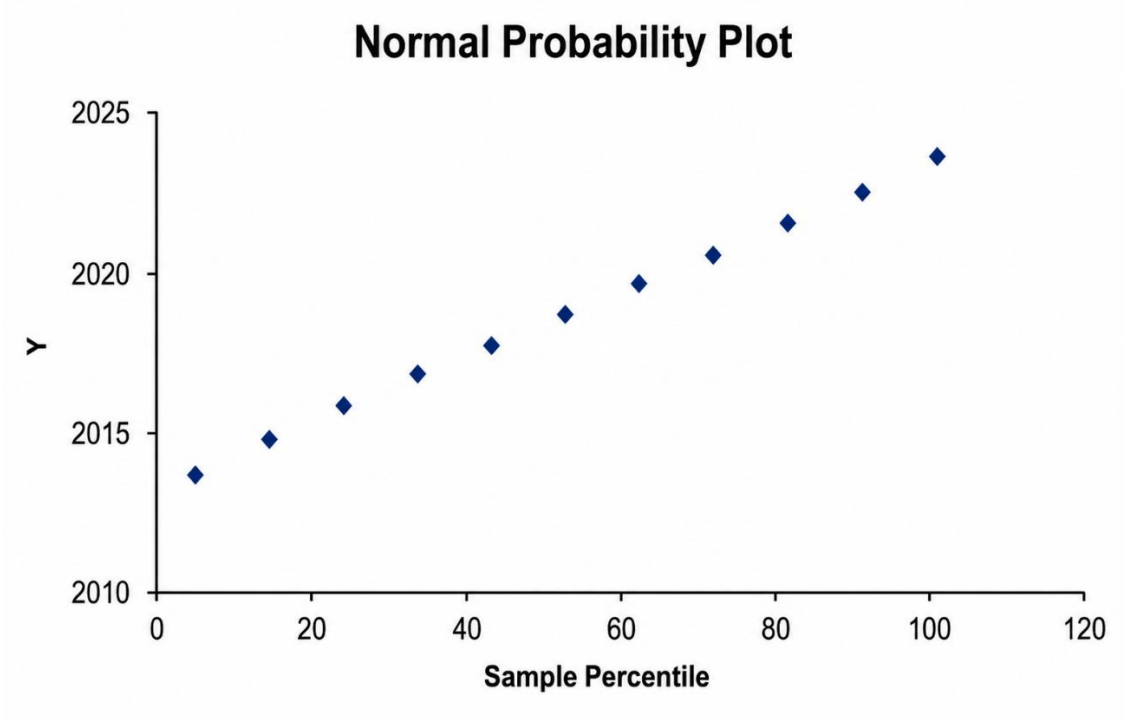
Chart 08 – Regression Method for Cattle Production in Porto Velho



Source: Prepared by the authors (2025).

Chart 09 presents the relationship between total milk production and the number of dairy-producing females. An upward trend is observed from 2014 to 2018, followed by a decline in herd size from 2019 to 2024. This reduction in the number of animals led to a decrease in total milk production over the same period.

However, when analyzing individual productivity per animal, a different pattern emerges. In 2018, productivity was approximately 1.38 liters per cow, increasing to 1.72 liters in 2020 and reaching 1.74 liters per cow in 2024. This indicates that, despite the reduction in herd size, productivity gains per animal partially offset the decline in total production.

These results suggest an improvement in herd efficiency, with a transition toward a more productive system. Economic factors are closely associated with this dynamic, particularly production costs and the price paid to

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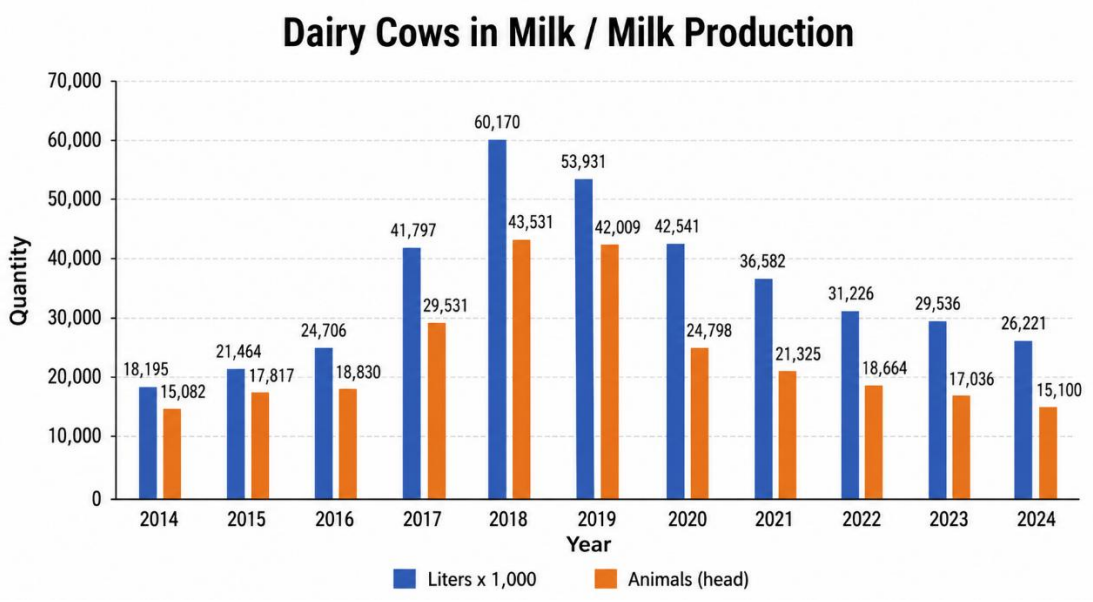
producers per liter of milk, which directly influence herd management decisions and productivity levels.

Chart 09: Number of Dairy Cows in Milk and Milk Production



Source: Brazilian Institute of Geography and Statistics (IBGE,2025g-h).

Applying the correlation method between time (years) and the number of dairy-producing females, a coefficient of 0.144 was obtained, indicating a weak relationship and a negative growth dynamic between milk production and the number of productive animals in the municipality.

This result suggests that increases in milk production are not directly associated with herd expansion, reinforcing the hypothesis of productivity gains per animal rather than growth in herd size. This pattern is also reflected in the linear regression analysis, as illustrated in chart 10.

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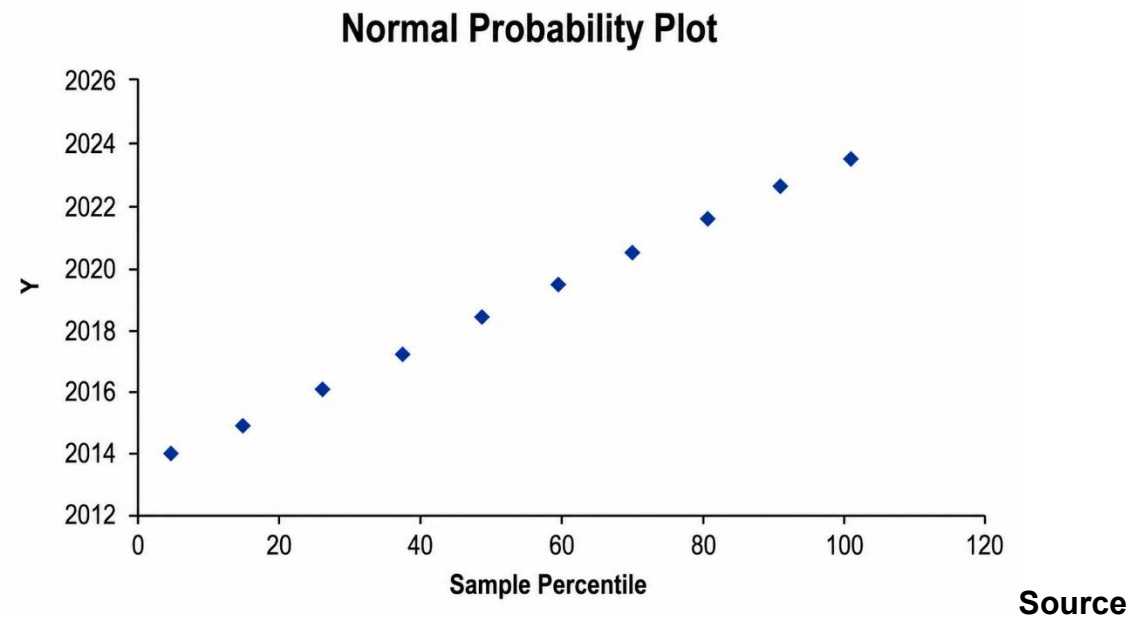
Regression Statistics	
R múltiplo	0,144044868
R-Quadrado	0,020748924
R-quadrado ajustado	-0,088056751
Erro padrão	3,459569953
Observações	11

Chart10: Regression Method for the Number of Dairy Cows in Porto Velho



Source

Source: Prepared by the authors (2025).

Applying the correlation method between time (years) and total milk production, a coefficient of 0.114 was obtained, indicating a very weak relationship and suggesting a stagnant or slightly negative growth trend in milk production within the municipality.

This result reinforces the absence of a consistent upward trajectory in total production over the analyzed period. The same pattern is observed in the linear regression analysis, as illustrated in chart 11.

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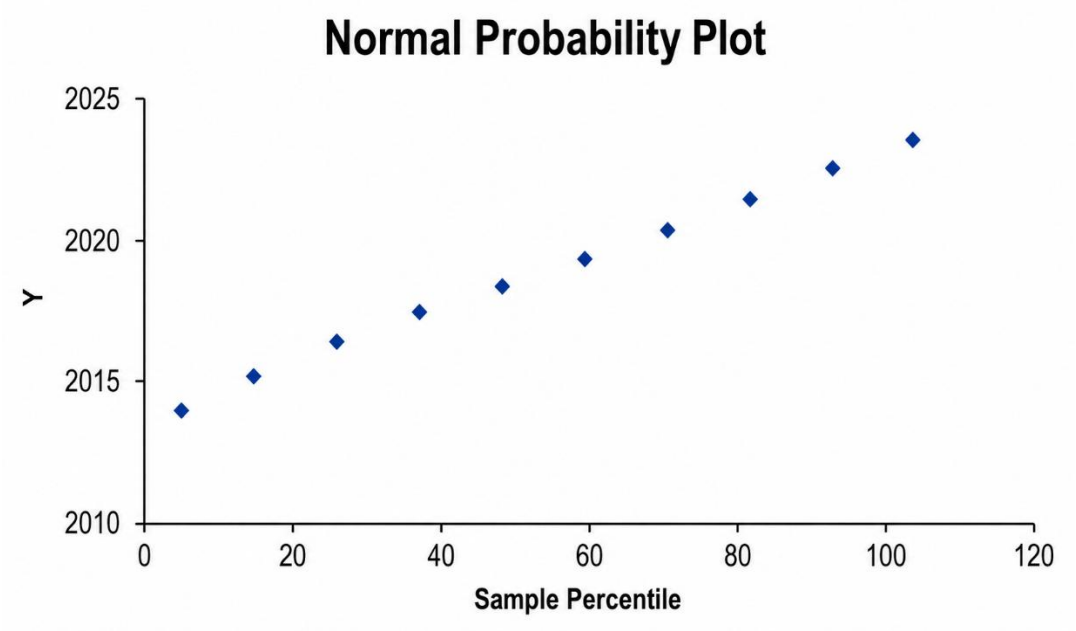
Regression Statistics	
R múltiplo	0,11408629 1
R-Quadrado	0,01301568 2
R-quadrado ajustado	-0,09664924 2
Erro padrão	3,47320337 2
Observações	11

Chart 11: Linear Regression Analysis of Milk Production in Porto Velho.



Source: Prepared by the authors (2025).

Unlike soybean, corn, and cattle production, dairy indicators did not demonstrate a statistically relevant growth trend. The number of dairy cows presented a very weak correlation with time ($R = 0.144$; $R^2 = 0.021$), while milk production also showed a weak relationship ($R = 0.114$; $R^2 = 0.013$). These results suggest relative stability in dairy activity throughout the analyzed period.

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However, productivity per animal increased over time, indicating improvements in production efficiency rather than herd expansion.

Grain production (soybean and corn), cattle herd size, and milk production are key components of the Gross Value of Agricultural Production (GVAP) indicators in Rondônia. In 2024, the GVAP reached R$ 25,768,728,977.00, with an estimated value of R$ 30,469,167,122.00 for 2025, according to data provided by EMBRAPA (2025).

These values can be better visualized in Figure 03.

Figure 03 – Gross Production Value (GPV) by Agricultural Products (2024–2025)

Products	2024 (a)	2025 (b)	Change % (b/a)
Cattle	12,100,639,549	14,651,531,246	21.1
Coffee	3,146,701,576	4,843,141,087	53.9
Soybean	4,579,664,958	4,488,906,000	-2.0
Corn	1,622,078,765	2,001,468,050	23.4
Milk	1,233,195,965	1,346,204,348	9.2
Cassava	782,728,082	713,861,980	-8.8
Fish	760,913,558	742,410,000	-2.4
Banana	331,884,062	371,977,310	12.1
Rice	298,096,082	271,166,550	-9.0
Cotton (lint)	126,110,213	114,225,200	-9.4
Others	786,716,167	924,275,351	17.5
Total GPV	**25,768,728,977**	**30,469,167,122**	**18.2**

Source: Prepared by the authors (2025).

The summary statistics indicate strong positive temporal trends for municipal revenue (Figure 04), soybean production, corn production, and cattle herd size. In contrast, dairy cow numbers and milk production presented weak correlations with time, suggesting relative stability during the analyzed period.

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These findings reinforce the expansion of grain production and livestock activities while indicating that gains in dairy productivity are more closely associated with efficiency improvements than with herd growth.

Figure 04. Summary of correlation and regression results for the variables analyzed between 2014 and 2024.

Variable	R	R^2	Interpretation
Municipal Revenue	0.955	0.911	Strong positive trend
Soybean Production	0.875	0.766	Strong positive trend
Corn Production	0.858	0.736	Strong positive trend
Cattle Herd	0.974	0.949	Very strong positive trend
Dairy Cows	0.144	0.021	No significant trend
Milk Production	0.114	0.013	No significant trend

5. CONCLUSIONS

The results of this study demonstrate substantial growth in agricultural and livestock production in the municipality of Porto Velho between 2014 and 2024. Soybean production exhibited the most pronounced expansion, while corn production and cattle herd size also showed consistent positive trends throughout the analyzed period. Milk production remained relatively stable, although productivity indicators suggest improvements in production efficiency.

The statistical analyses revealed strong positive correlations between time and production levels for soybean, corn, and cattle production, indicating a process of productive consolidation within the municipality. These findings reinforce the growing importance of agribusiness in the local economy and its contribution to the productive structure of Porto Velho.

The study further suggests that the continued expansion of agricultural and livestock activities may increase demand for transportation and logistical services. However, the available data do not allow direct conclusions regarding the performance, quality, or adequacy of the existing road infrastructure.

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Therefore, any relationship between production growth and transportation challenges should be interpreted as a potential area for future investigation rather than as a demonstrated causal effect.

The statistical results demonstrated strong positive temporal trends for soybean production, corn production, cattle herd expansion, and municipal revenue. Conversely, milk production and dairy herd size did not present statistically relevant growth trends, indicating relative stability in the dairy sector during the analyzed period. Improvements observed in milk productivity appear to be associated with production efficiency rather than expansion of the productive herd.

Future studies should integrate agricultural production data with transportation indicators, freight costs, road maintenance records, traffic volumes, and infrastructure investment data. Such an approach would provide a more comprehensive understanding of the interactions between productive growth, logistics systems, and regional development processes.

In conclusion, the evidence presented confirms the strong expansion of agribusiness activities in Porto Velho and highlights the relevance of further interdisciplinary research linking production dynamics, logistics, and infrastructure planning.

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