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Coffee industrialization model in Misantla, Veracruz: A comprehensive approach to sustainable development and value creation

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ABSTRACT: *This article explores the feasibility and components of a coffee industrialization model in the Misantla region of Veracruz, with the aim of fostering sustainable development and value generation throughout the production chain. Despite being a historic coffee-growing region, Misantla faces challenges related to low profitability, vulnerability to international markets, and limited product diversification. This study proposes a comprehensive approach that ranges from improving agricultural practices and adopting innovative processing technologies to creating fair trade schemes and promoting value-added products. The methodology employed included a comprehensive review of specialized literature, analysis of socioeconomic and production data from the region, and a qualitative case study with key actors in the local coffee sector. The findings suggest that a successful industrialization model in Misantla requires coordination among producers, entrepreneurs, the government, and civil society organizations. It is concluded that the implementation of this model can not only improve producers' income and generate employment, but also contribute to the conservation of natural resources and strengthen the cultural identity associated with coffee in the region.*

KEY WORD*: coffee industrialization, sustainable development, added value, Misantla, Veracruz, value chain, fair trade*

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I. INTRODUCTION AND LITERATURE REVIEW

Coffee is an agricultural product of great economic and social importance worldwide, constituting a source of income for millions of families, particularly in developing countries (International Coffee Organization [ICO], 2024). Mexico, and particularly the state of Veracruz, has historically been a key player in coffee production, contributing significantly to the country's rural economy and cultural heritage (Servicio de Información Agroalimentaria y Pesquera [SIAP], 2023). However, the Mexican coffee industry faces various challenges, ranging from price volatility in the international market, the effects of climate change, a lack of investment in technology, and the limited capacity of producers to add value to their products (García & López, 2021).

Misantla, an emblematic coffee-growing region in the state of Veracruz, is no stranger to these problems. Despite having favorable agroecological conditions for high-altitude coffee cultivation, most local producers focus on selling cherries or parchment coffee, which substantially reduces their profit margins and exposes them to market fluctuations (Hernández et al., 2022). This situation has led to constant rural migration and economic stagnation in many coffee-growing communities.

The concept of industrialization in the agricultural sector implies going beyond primary production, encompassing the processing, transformation, and marketing of products with higher added value (Porter, 2015). In the context of coffee, this translates into the production of roasted and ground coffee, instant coffee, extracts, ready-to-drink beverages, and even derived products such as cosmetics or energy by-products from coffee waste (Smith & Jones, 2020). Industrialization not only seeks to increase profitability, but also to generate employment, diversify the local economy, and strengthen the region's competitiveness.

Coffee industrialization has generated employment and boosted local economies. However, it has also exacerbated inequalities, as small producers face barriers to accessing technologies, financing, and international markets. Public policies have attempted to mitigate these gaps through support programs and certifications such as organic or fair trade coffee.

In recent decades, demand for specialty coffee, characterized by its origin, variety, altitude, and processing methods, has grown. Mexico has responded to this trend with traceability initiatives, certifications, and agroecological practices. This has driven a new phase of industrialization based on quality and sustainability (Escobar, 2017).

Sustainability, for its part, has become a fundamental pillar for modern economic development. A sustainable development model in coffee farming involves considering the environmental, social, and economic dimensions (Elkington, 1997). This includes agricultural practices that conserve soil and water, the protection of biodiversity, fair working conditions for workers, and the generation of stable and equitable incomes for producers (United Nations, 1987). Integrating these principles into a coffee industrialization model is crucial to ensuring its long-term viability.

A review of the specialized literature on agricultural industrialization models (e.g., Aksoy & Isik, 2018; Reardon et al., 2007) and specifically in the coffee sector (e.g., Daviron & Ponte, 2005; Lee et al., 2017) highlights the importance of several factors: the availability of infrastructure, access to financing and technology, producer training, the articulation of value chains, product differentiation, and brand building. In the context of Misantla, it is essential to adapt these principles to the particularities of the region, including its cultural heritage and socioeconomic conditions.

1.2 Research Objectives

The overall objective of this research is to propose a comprehensive coffee industrialization model for the Misantla region of Veracruz, which fosters sustainable development and value generation throughout the production chain.

The specific objectives are:

- Identify the barriers and opportunities for coffee industrialization in Misantla.
- Analyze current agricultural and processing practices in the region.
- Propose strategies to improve the quality and differentiation of Misantla coffee.
- Design key components of an industrialization model that includes technological, organizational, financial, and market aspects.
- Evaluate the potential socioeconomic and environmental impact of implementing the proposed model.

II. METHODOLOGY

2.1 Research Methodology and Data Analysis

To address the objectives of this research, a mixed-method approach was adopted, combining quantitative and qualitative elements. The methodological design was structured in the following phases:

2.1.1 Document and Bibliographic Review: A comprehensive review of the scientific and technical literature related to agricultural industrialization, sustainable development, the coffee value chain, and relevant case studies from other coffee-growing regions was conducted. Academic databases (Scopus, Web of Science, Google Scholar), reports from international organizations (ICO, FAO), and government publications (SIAP, SAGARPA - Secretariat of Agriculture, Livestock, Rural Development, Fisheries and Food) were consulted.

2.1.2 Secondary Data Collection and Analysis: Socioeconomic and agricultural data were obtained from the municipality of Misantla and the state of Veracruz, from the National Institute of Statistics and Geography (INEGI), SIAP, and other official sources. These data included information on coffee production, yield, prices, population, employment, and geographic characteristics.

2.1.3 Qualitative Case Study: A case study was conducted in the Misantla region, using semi-structured interviews with various key actors in the coffee value chain. Participants included:

- Coffee producers (small, medium and large).
- Local marketers and collectors.
- Owners of coffee mills (wet and dry).
- Representatives of cooperatives and producer organizations.
- Municipal and state authorities related to the agricultural sector.
- Local coffee consumers.

The interviews were designed to explore perceptions about current challenges, opportunities for improvement, interest in industrialization, existing capabilities, and support needs. Fifteen in-depth interviews, each lasting an average of 60 minutes, were conducted between March and April 2024. The interviews were recorded (with prior consent) and transcribed for subsequent qualitative analysis.

2.1.4 Data Analysis:

Quantitative Analysis: Secondary data were analyzed using descriptive statistical tools (means, percentages, standard deviations) to characterize the productive and socioeconomic situation of Misantla. Statistical software was used to process these data.

Qualitative Analysis: Interview transcripts were analyzed using thematic analysis (Braun & Clarke, 2006). Recurring themes, patterns, and relationships between the perceptions of the different actors were identified. Codes and categories were generated to organize the information and construct a coherent narrative about the proposed model.

III. FINDINGS AND INTERPRETATION

The findings of this research reveal a series of key opportunities and challenges for coffee industrialization in Misantla, as well as the need for a comprehensive approach to its success.

3.1 Diagnosis of the Current Value Chain

The coffee value chain in Misantla is primarily characterized by the sale of cherry or parchment coffee (see Figure 1). There is limited infrastructure for roasting and grinding at the local level, forcing producers to sell their product with little added value, as can be seen in Table 1.

The coffee industrialization value chain comprises several phases: agricultural production, processing (wet and dry), industrial processing (roasting, grinding, instant coffee), and marketing. In Mexico, this process has evolved from artisanal methods to semi-industrialized systems, especially in traditional coffee-growing regions such as Misantla, Veracruz (Aguirre, 1999).

Wet processing involves separating the pulp from the bean through friction and water, while dry processing involves drying and sorting the bean. These stages are crucial for determining the quality of the green coffee, which is the raw material for industrialization (Aguirre, 1999).

Green coffee is transformed into consumer products such as roasted, ground, and instant coffee. This stage requires technological infrastructure and quality standards.

Table 1: Stages of the Coffee Value Chain in Misantla, Veracruz (Current Situation)

Stage	Main Activities	Agents Involved	Added Value
Primary Production	Cherry cultivation and harvesting	Producers	Low
Wet Processing	Pulping, fermentation, washing, drying	Producers, wet mills	Low to Medium
Dry Beneficiation	Final drying, threshing	Dry benefits, intermediaries	Half
Primary Marketing	Sale of parchment coffee	Collectors, intermediaries	Low
Industrialization and Final Marketing	Roasting, grinding, packaging, distribution	Companies outside the region	High

Source: Own elaboration

3.2 Barriers Identified to Industrialization

The main barriers perceived by key stakeholders include:

Lack of Capital and Access to Financing: Producers lack the necessary resources to invest in processing machinery and infrastructure improvements.

Poor Local Infrastructure: The absence of modern dry mills, roasters and industrial-scale mills limits processing capacity.

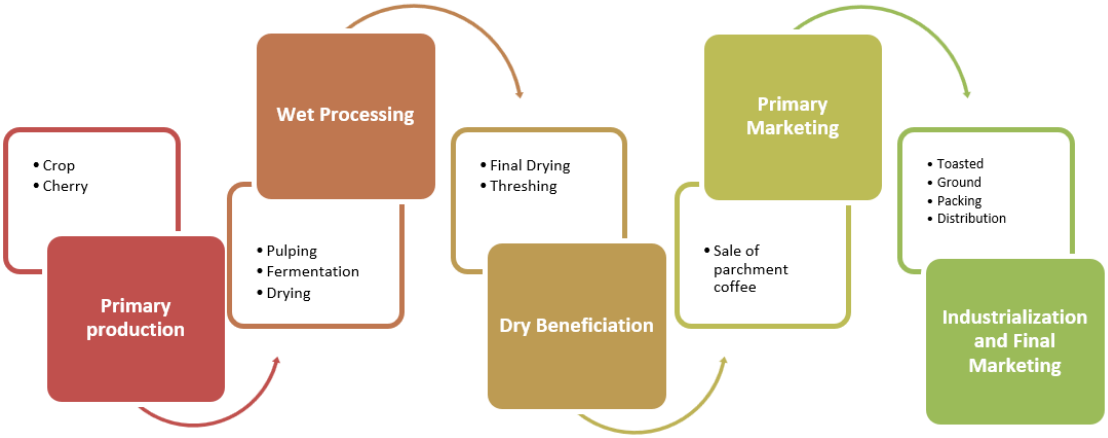
Lack of Knowledge and Training: There is a need for training in roasting techniques, quality control, packaging, marketing, and business management.

Limited Access to Differentiated Markets: Producers do not have direct contacts with specialty markets or high-value niches.

Producer Fragmentation: The lack of organization and cooperation among producers makes it difficult to adopt joint strategies.

Vulnerability to Pests and Diseases: Climate change and the presence of pests such as rust affect grain production and quality.

Figure 1: Flowchart of the Coffee Value Chain in Misantla (Current Situation)



Source: Own elaboration

3.3 Opportunities for Value Generation and Sustainable Development

Despite the barriers, significant opportunities were identified:

Coffee Quality Potential: The Misantla region produces high-altitude coffee with distinctive sensory characteristics, which can be positioned in specialty markets.

Growing Demand for Specialty and Sustainable Coffee: There is a global trend towards the consumption of coffee with traceability, produced in an ethical and environmentally responsible manner (Fairtrade International, 2024).

Cultural Identity and Tourism: Coffee is an integral part of Misanteca culture. This offers opportunities for agrotourism and the promotion of products with a narrative of origin.

Availability of Local Labor: There is an experienced workforce in coffee cultivation.

Support from Government Programs and NGOs: Possibility of accessing funds and support programs for the coffee sector.

IV. PROPOSAL FOR A COMPREHENSIVE INDUSTRIALIZATION MODEL

Based on the findings, a model is proposed, presented in Figure 2, for coffee industrialization for Misantla that integrates four fundamental pillars.

The proposed model for coffee industrialization in Misantla is presented as a holistic and multifaceted strategy designed to transform the region's coffee value chain. It is based on four interconnected pillars, each addressing a critical aspect, from production to marketing, with a focus on sustainability, innovation, and community development. This model seeks to overcome traditional challenges in coffee production, such as low productivity, lack of added value, and limited market access, to generate more equitable and robust economic and social development in Misantla.

4.1 Productive Improvement and Environmental Sustainability

This pillar is the foundation of the model, focusing on optimizing primary production and mitigating environmental impact.

• **Adoption of Sustainable Agricultural Practices:** The transition to agroecology and integrated pest management (IPM) is crucial. This implies a paradigm shift, leaving behind intensive practices that degrade the soil and pollute water. Agroecology, in particular, promotes agroecosystem resilience, biodiversity, and resource efficiency, reducing dependence on external inputs. IPM, for its part, seeks more balanced pest control that is less dependent on chemicals, utilizing biological, cultural, and genetic methods. Soil and water conservation through techniques such as terracing, contour lines, and efficient irrigation systems is essential to ensuring long-term productivity and resilience to climate change.

• **Coffee Plantation Renovation:** The introduction of pest-resistant, high-yielding varieties is a strategic investment. This not only reduces losses from diseases such as rust but also increases production per hectare, improving profitability for producers. Variety selection must consider local factors such as soil type, climate, and altitude to ensure their adaptation and optimal development.

• **Farm Training and Certification:** Knowledge transfer through training in good agricultural practices (GAP) is vital for the effective implementation of the above strategies. Farm certification (e.g., Rainforest

Alliance, Fair Trade, Organic) is a step forward, not only validating sustainable practices but also opening doors to specialty markets that value these attributes, which often translates into better prices.

• **Coffee Waste Management:** The integrated management of coffee waste (pulp, mucilage) is an opportunity for the circular economy. Biogas production from these wastes offers a renewable energy source for communities and farms, reducing dependence on fossil fuels. Composting improves soil fertility and reduces the need for chemical fertilizers. Furthermore, the exploration of byproducts (flours, pectins, colorants) from these wastes can generate new sources of income and diversify the supply.

4.2 Innovation in Processing and Added Value

This pillar focuses on transforming coffee cherries into higher-value final products, capturing a greater share of the profit in the value chain.

• **Infrastructure Investment:** The establishment of collection and dry processing centers equipped with modern technology is essential. This includes state-of-the-art roasters, grinders, and packaging plants that allow for efficient and high-quality coffee processing. Infrastructure modernization reduces post-harvest losses, improves product uniformity, and facilitates large-scale production.

• **Product Diversification:** Going beyond simply selling green coffee is key. Producing roasted and ground coffee for local and national consumption not only adds value but also strengthens the regional brand. Entering the specialty coffee industry (with unique flavor profiles and traceability) allows for access to highly profitable niche markets. The creation of coffee-based beverages (ready-to-drink, concentrates) and other derived products (confectionery, cosmetics) opens new avenues of income and positions Misantla as a center of coffee innovation.

• **Rigorous Quality Control:** The implementation of rigorous quality control protocols from cherry to cup is imperative to ensure product consistency and excellence. This includes careful selection of ripe cherries, a flawless wet and dry processing process, and finally, professional cupping to evaluate the coffee's organoleptic characteristics. Quality certifications (such as SCA - Specialty Coffee Association) are crucial for recognition in specialized markets

4.3 Capacity Building and Community Organization

This pillar addresses strengthening human and social capital, empowering producers and fostering collaboration.

• **Ongoing Training and Capacity Building:** Training and capacity building programs should be comprehensive and encompass everything from coffee processing (wet milling, drying, roasting) to business management, marketing, professional cupping, and new product development. This equips producers with the skills needed to operate their businesses more efficiently and make informed decisions.

• **Strengthening Cooperatives and Associations:** Organizing producers into cooperatives and associations is critical to achieving economies of scale and improving their market bargaining power. These structures allow for joint purchasing of inputs, access to financing, collective marketing, and knowledge sharing, reducing individual costs and increasing profitability.

• **Strategic Partnerships:** Fostering collaboration among producers, local entrepreneurs, academic institutions, and government agencies creates a robust support ecosystem. Academic institutions can provide research and development, local entrepreneurs can provide capital and management expertise, and government agencies can provide public policy and funding. These partnerships are crucial to the long-term sustainability of the model.

4.4 Market and Marketing Strategies

This pillar focuses on how Misantla coffee will reach consumers, highlighting its value and unique attributes.

• **Brand Differentiation "Café TAMI":** The creation of a distinctive brand ("Café TAMI") is essential to position Misantla coffee in the market. This brand must effectively communicate the geographical origin, exceptional quality, and commitment to sustainability, differentiating it from other generic coffees. The narrative behind the brand can include the producers' story, sustainable agricultural practices, and the region's coffee culture.

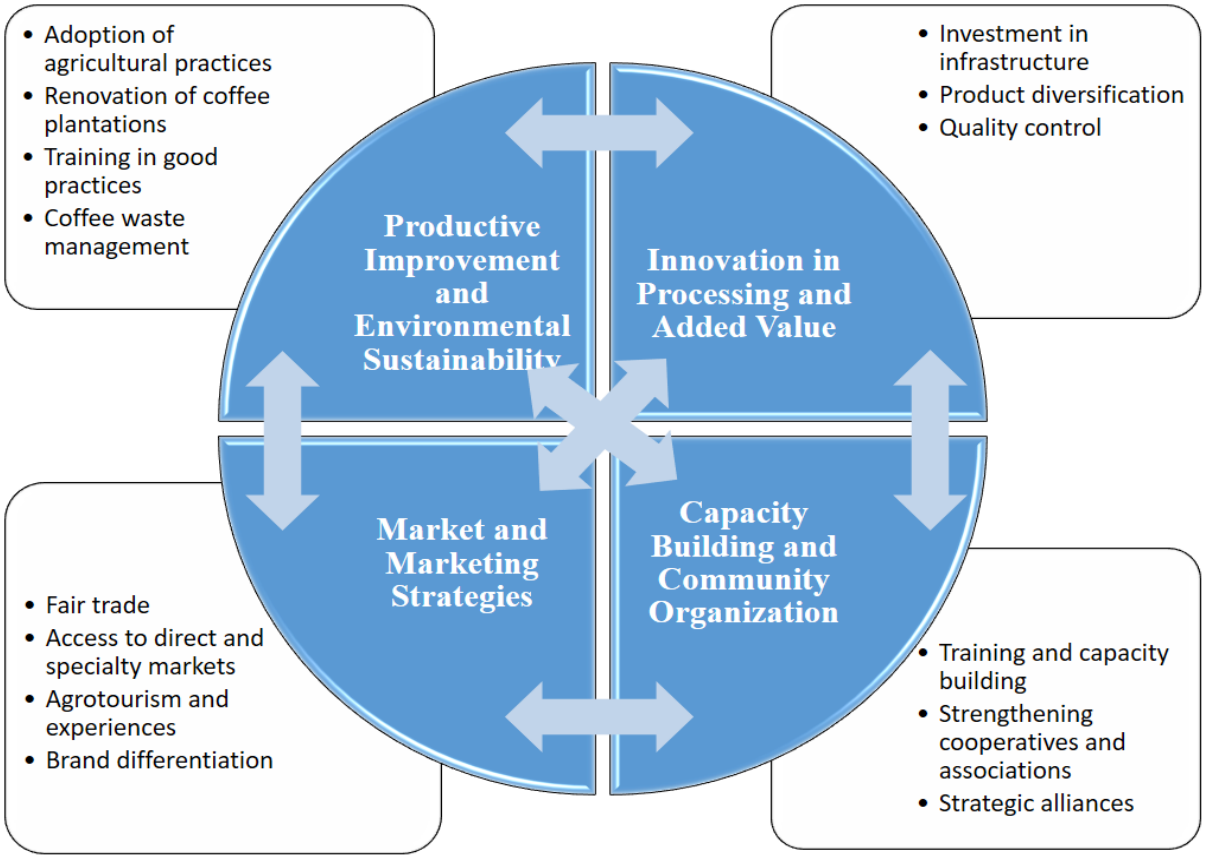
• **Access to Direct and Specialty Markets:** Promoting Misantla coffee at national and international fairs is a key strategy for establishing contacts and opening new distribution channels. The use of e-commerce platforms expands market reach, enabling direct sales to the end consumer. Direct relationships with roasters and specialty coffee shops eliminate intermediaries, resulting in higher profit margins for producers and better traceability for buyers.

• **Fair Trade:** The implementation of fair trade schemes ensures that producers receive fair and stable prices for their coffee, regardless of market fluctuations. This not only improves their income and quality of life but also reinforces the social and ethical commitment of the "Café TAMI" brand, attracting conscious consumers.

• **Agritourism and Experiences:** The development of coffee routes, farm and roastery visits, and tastings offers an immersive experience for tourists. This not only generates additional income through tourism but also educates visitors about coffee culture, production processes, and the hard work of producers. Agritourism can strengthen the bond between consumers and the coffee origin, creating ambassadors for the "Café TAMI" brand.

In summary, the "Comprehensive Industrialization Model" for Misantla coffee is an ambitious proposal that seeks to transcend the traditional primary production model. By integrating productive improvements with a focus on sustainability, innovation in processing and value addition, community capacity building, and a robust market strategy, the model aims to build a more equitable, profitable, and resilient coffee value chain for the Misantla region. Its success will depend on coordinated implementation and the commitment of all stakeholders involved.

Figure 2: Comprehensive Coffee Industrialization Model in Misantla



Source: Own elaboration

V. CONCLUSIONS

The research conducted has demonstrated that a comprehensive coffee industrialization model in Misantla, Veracruz, is not only feasible but necessary for the region's sustainable development and the improvement of producers' living conditions. The current dependence on the sale of under-processed coffee beans significantly limits the capacity to generate value and exposes producers to high market vulnerability.

The proposed model, based on sustainable production improvements, processing innovation, organizational capacity development, and differentiated market strategies, offers a clear path toward transforming the Misanteco coffee sector. Investment in local infrastructure for roasting and grinding, along with a strong commitment to product quality and differentiation, are crucial elements. Likewise, strengthening producer organizations and implementing fair trade schemes will be essential to ensure that the benefits of industrialization translate into higher incomes and a better quality of life for coffee-growing communities.

In summary, the "Comprehensive Industrialization Model" for Misantla coffee is an ambitious proposal that seeks to transcend the traditional primary production model. By integrating productive improvements with a focus on sustainability, innovation in processing and value addition, community capacity building, and a robust

market strategy, the model aims to build a more equitable, profitable, and resilient coffee value chain for the Misantla region. Its success will depend on coordinated implementation and the commitment of all stakeholders involved.

It is recognized that implementing this model will require a significant investment of capital, both public and private, as well as a coordinated effort from all stakeholders. However, the long-term benefits—in terms of economic growth, job creation, environmental conservation, and strengthening of cultural identity—fully justify such an effort.

Future lines of research could include detailed economic feasibility studies for the installation of processing plants, specific market analyses for coffee-derived products, and evaluation of the social impact of training and community organization programs. Misantla coffee has the potential to be an engine of development, and industrialization is the key to unleashing that potential.

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