

# **Optimization of the Cocoa Production Chain: Key Strategies for a Stronger Industry in San Martin, Peru**

**Elizabeth Orrego Valverde**  
Bachelors of Industrial Engineering  
Facultad de Ingeniería  
Universidad de Lima  
Lima, Peru  
20152158@aloe.ulima.edu.pe

**Maria Teresa Noriega-Aranibar**  
Research Professor  
Facultad de Ingeniería  
Universidad de Lima  
Lima, Peru  
manorieg@ulima.edu.pe

## **Abstract**

This study analyzes the cocoa production chain in the San Martín region of Peru, aiming to propose improvements that increase the volume of product destined for export. The research follows a sectoral case study approach applied to the San Martín region, utilizing a non-experimental design with a descriptive and explanatory scope. The study consists of four phases, focusing on key research variables. Data collection involved interviews with a convenience sample and a bibliographic review. Using the MICMAC matrix, key factors within the production chain were identified, including farmer associations, road and storage infrastructure, limited agricultural technology, and government support. Based on the analysis of the IGO matrix and Pareto diagram, high-impact proposals are presented to strengthen the cocoa production chain. These include ensuring cocoa safety through an effective traceability system with technological integration, enhancing the Peruvian cocoa brand at both national and international levels, increasing producer association and retention, and promoting strategic alliances to optimize sector competitiveness.

## **Keywords**

Cocoa, Production Chain, San Martin Region-Peru, MICMAC, IGO Matrix

## **1. Introduction**

Cocoa is a bean with great economic and cultural relevance, which has had a significant growth in demand worldwide in recent decades. The cocoa bean market is projected to reach USD 17.24 billion in 2024, with a compound annual growth rate (CAGR) of 6.81% until 2029 (Mordor Intelligence 2024).

This increase is not only observed in the traditional markets of Europe, which remains the largest consumer, but also in emerging regions such as Asia and Latin America, where consumption of cocoa products is growing (MIDAGRI 2022). Furthermore, the 2024 price hike is attributed to a significant supply deficit in West Africa, caused by increased pests and diseases, extreme weather events, and underinvestment in plantations. These factors, compounded by financial speculation, have driven the price of cocoa to record levels, exceeding \$11,000 per ton, a 250% increase over the previous year (Morgan 2024; Kimball 2024; Criado 2024). However, this growth also means significant challenges

for producer countries and for long-term sustainability due to climatic fluctuations and logistical problems. Additionally, the growth of responsibly sourced cocoa is becoming more relevant than ever as consumers seek ethical and sustainable products (Foodcom Experts 2024).

In 2023, Peruvian exports reached approximately US\$300 million, showing sustained growth in international markets (MIDAGRI 2022). National exporting companies have begun to diversify and improve their agricultural practices to meet the demands of the global market; among them are Cacao del Perú Norte, Cacao Amazónico and Chocolepas; more than 250 cocoa exporting companies have been identified in the last 4 years, with Indonesia, the Netherlands, Malaysia, the United States, Belgium and Italy as their main destinations (Veritrade 2024).

According to INEI (2025), Peru produces around 160,000 metric tons per year, making it one of the world's leading producers. Among the most important regions are San Martín, Junín, Huánuco and Cusco. San Martín has become a benchmark for its organic production and focus on sustainable practices.

Despite the growth in demand and Peruvian exports, local producers must face problems such as climate change and pests affecting crops. In San Martín, for example, farmers have reported losses due to adverse weather events (MIDAGRI 2022).

In the international market, Peru competes with major producers such as Côte d'Ivoire and Ghana, which generate approximately 70% of world cocoa production (Omeni 2024). In Latin America, Ecuador is positioned as the main exporter, with 590,579 hectares planted and a production of 327,393 tons, while Peru has 177,000 cultivated hectares and 158,944 tons per year, which shows a smaller scale, but higher productivity per hectare, representing a technical gap and a strategic opportunity to optimize its agricultural performance (Charry et al. 2023). Furthermore, in Ecuador 48% of farms exceed 5 hectares, while in Peru the average size is 1.96 hectares (PRODUCE 2024), reflecting a more fragmented productive structure, with challenges in financing and technology, but also with potential for specialized and sustainable agricultural models (Hütz-Adams et al. 2022).

Peru has found its niche by focusing on premium and organic products that appeal to a specific segment of the global market. Figure 1 shows an estimate, updated to August 2024, of cocoa bean production for the 2022–2023 agricultural season, according to the countries with the highest production worldwide, according to MIDAGRI (2025).:

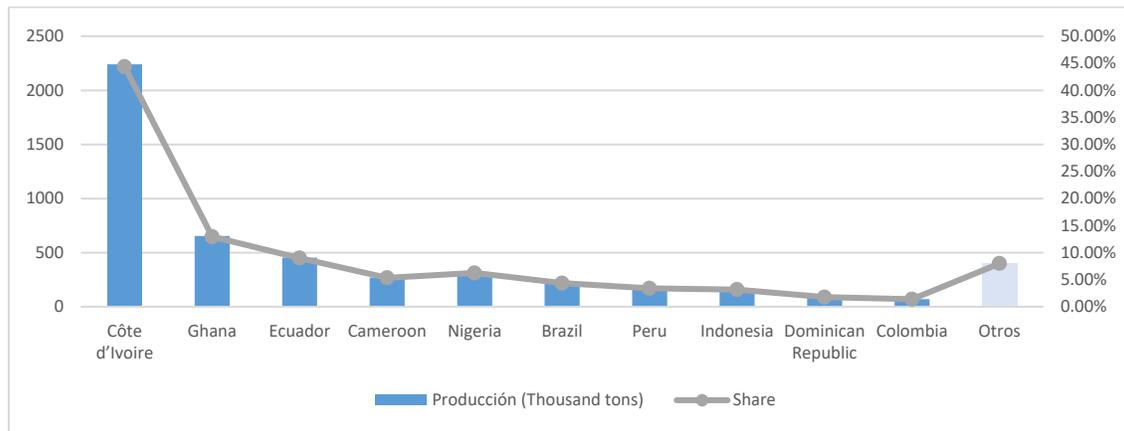


Figure 1. Cocoa Bean Exports by Leading Countries, 2022/2023

The producing areas are located mainly in the Peruvian Amazon and their efforts have made the country the second largest producer of organic cocoa in the world and the first producer of cocoa with double certification (organic and Fairtrade) (MIDAGRI, 2024). A comparative study on the economics aspects of different cocoa production systems in Colombia, Ecuador and Peru concluded that, in Peru, the systems evaluated were financially feasible, with IRR between 10% and 15%, profits between 337 and 929 USD/ha/year, and positive Net Present Values, indicating a superior return on investment and a significant contribution to value creation for investors (Charry et al 2025).

## **1.1 Objectives**

The objective of this research is to analyze the cocoa production chain in Peru, from production to export, identifying challenges and opportunities for local producers in a competitive global environment. The next question is raised: What are the main characteristics of the cocoa production chain and how can it be optimized through strategies and proposals to increase its production to have a greater presence in exports?

## **2. Literature Review**

Veliz Miranda (2024) evaluated the collaborative planning, forecasting and replenishment (CPFR) model as a strategy to improve collaboration among supply chain partners in a cocoa company, reducing sales losses from 78.5% to 1.8% and improving procurement, inventories and production. In addition, Lopez and Serna (2022) suggest optimizing supply chain management through accurate indicators, coding systems and technological tools.

Turin Limo and Quiroz Flores (2024) also proposes reducing logistics costs in grain collection by reducing dependence on external services, optimizing personnel and automating processes, improving quality and efficiency. Cusco and Mancheno (2024) highlights how farmers with access to social insurance adopt more modern technologies, boosting agricultural innovation.

Morales et al. (2018) suggest that farmer associations, technology transfer and improved distribution channels increase producer income, strengthening local development. Quintanilla and Rodas (2023) applied Lean methodology to optimize cocoa drying, reducing times by 48% and increasing production by 14%.

In Ecuador, vulnerabilities were identified in cocoa production related to climate change and cadmium contamination. One study proposes promoting associativity, increasing productivity and national consumption, consolidating international markets and promoting research to improve the rural environment (García-Briones et al. 2021).

## **3. Methods**

The current research is a sectorial case study applied in the San Martin region with a non-experimental design, descriptive and explanatory scope. The study includes 4 stages, which are shown below:

In the first stage, the parties and key factors that are important for addressing the problems in the cocoa production chain were identified based on literature and interviews with experts. The sample was non-probabilistic and by convenience, made up of 20 key parties in the chain: farmers, traders, producers, distributors and exporters. Two cocoa farms, three cooperatives and a multinational storage facility were visited. The selected stakeholders validated the list of factors. In the second stage, the MICMAC matrix was used to classify the factors according to their direct and indirect relationships and to analyze their dependence and influence.

In the third stage, with the objective of finding proposed solutions to the problems presented, experts in the area were consulted to obtain updated and accurate perspectives. The experts were interviewed individually with an in-depth questionnaire and including feedback on what was expressed by the group. From an open exploration and after successive attempts, an opinion that represent the group is, which includes farmers, producers and marketers (Reguant-Álvarez and Torrado-Fonseca 2016). It is worth mentioning that the structure of the interviews was validated by three experts.

In the fourth stage, with the information gathered by the experts in the interview and the results of the MICMAC matrix, the IGO matrix was prepared to prioritize the proposals. Simultaneously, it was complemented with the application of a final survey presenting the proposed solutions to all the experts, which they prioritized to finally elaborate a Pareto.

## **4. Results**

The cocoa production chain presented in Figure 2 begins with input suppliers (organic and inorganic fertilizers, agrochemicals, equipment and tools for field work and machinery for cultivation, fertilization and irrigation). The next party are the cocoa farmers responsible for activities from land preparation to harvest and post-harvest handling, requiring technical knowledge and good practices demanded by the market.

In San Martin, 32% of farmers are associated, who have access to better marketing options, differentiated prices and government support, although approximately 20% of their production is sold to intermediaries due to factors such as quality, prices and distance to collection centers (Perez 2023). The remaining 68% are farmers who are not associated with any cooperative or marketing company, they manage post-harvest individually, often without adequate control, and sell it to the intermediary that offers the best price, without considering quality.

Collection is mainly carried out by producer organizations and includes controlled processes of selection, fermentation, drying, storage, packaging and certification, which allows for a standardized process and less waste. Subsequently, distribution and marketing are carried out by wholesale traders or consolidated organizations, which have greater financial capacity, organic and fair-trade certifications, as well as traceability systems that guarantee grain traceability.

Finally, most of the cocoa beans are exported to the international industry, while a minority is processed locally into products such as liquor, butter and chocolate powder, which are traded in both international and local markets. Figure 2 below provides a summary overview of the entire cocoa production chain.

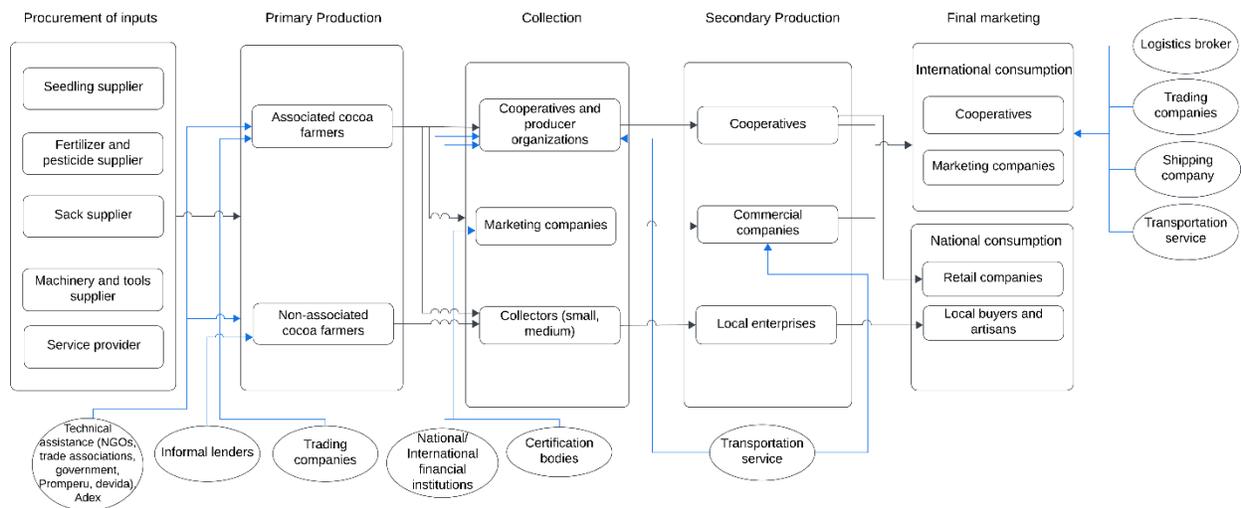


Figure 2. Cocoa production chain today

The cocoa export process is mainly carried out by sea, representing 99% according to Veritrade (2024); each destination country requires certifications and verifications by the exporter.

To identify the key variables that influence the cocoa production chain in San Martin, interviews were conducted with experts in the sector and relevant internal and external problems that could affect its configuration were evaluated. The resulting Table 1 is fundamental for the effective application of the MICMAC tool, which allows the identification of the most determining variables that impact the functioning of the production chain (Table 1).

Table 1. Variables clave para el sector

<b>Key Variables</b>	<b>Description</b>	<b>Label</b>
Selection of Cocoa Varieties	It involves choosing cocoa varieties that are resistant, high performing and well adapted to local conditions to improve production and quality.	V1
Good Agricultural Practices	These are agricultural techniques that optimize production, ensure sustainability and improve cocoa quality, such as proper fertilization and pest control.	V2
Low Productivity per Hectare	Reflects low crop performance, generally due to the use of non-optimized varieties or lack of good agricultural practices.	V3
Climatic Conditions	San Martin has a tropical climate that can be unpredictable, which affects cocoa production. Factors such as drought or excessive rainfall can reduce yields.	V4
Market Adaptation	The ability of producers to respond to market demands and trends, such as the preference for high quality cocoa, is key to improving exports.	V5
Low National Per Capita Consumption	Low domestic consumption of cocoa and cocoa derivatives limits the local market and makes producers mainly dependent on exports.	V6
Commercial and Logistics Costs	High transportation and distribution costs affect the competitiveness of San Martin cocoa in international markets.	V7
Poor Financing and Access to Credit	Lack of access to financing prevents farmers from investing in crop improvements, infrastructure or technology.	V8
Limited Research and Technological Development	The lack of innovation in agricultural techniques and cocoa processing limits the growth and quality improvement of the product.	V9
High maintenance costs	Cocoa plantation maintenance, such as pruning and disease control, can be costly and reduces profitability.	V10
Farmer associativity	The lack of farmer-to-farmer associations or the absence of links with companies facilitates the exploitation of producers by intermediaries and limits access to resources.	V11
Absence of New Agricultural Technologies	The lack of adoption of advanced technologies such as efficient irrigation and modern machinery reduces the competitiveness of the sector.	V12
Government Support	Government support for the implementation of policies to promote cocoa competitiveness is developing working groups.	V13
Traceability	A poor-quality control system can result in low quality cocoa, which affects reputation in international markets. NTP 107.306:2018 + MT 1:2021 sets standards for quality assurance.	V14
Infrastructure and Services	The lack of adequate infrastructure, such as roads and storage, makes access to markets difficult and increases production and distribution costs. In addition, collection centers with poor infrastructure have been identified.	V15

In the second stage, the MICMAC tool was applied to relate the variables collected, classifying them according to their degree of incidence and dependence. This analysis facilitates understanding and addressing the most relevant aspects of the production chain, with the aim of improving its competitiveness and formulating effective optimization strategies. The matrix of incidence and indirect dependence (Figure 3) reveals the more subtle and complex relationships of influence between variables, showing how one can affect others through chained interactions. In this study, variables V13, V11, V15 and V12 were identified as priorities, followed by the conflicting variables V2, V5, V8, V9 and V14.

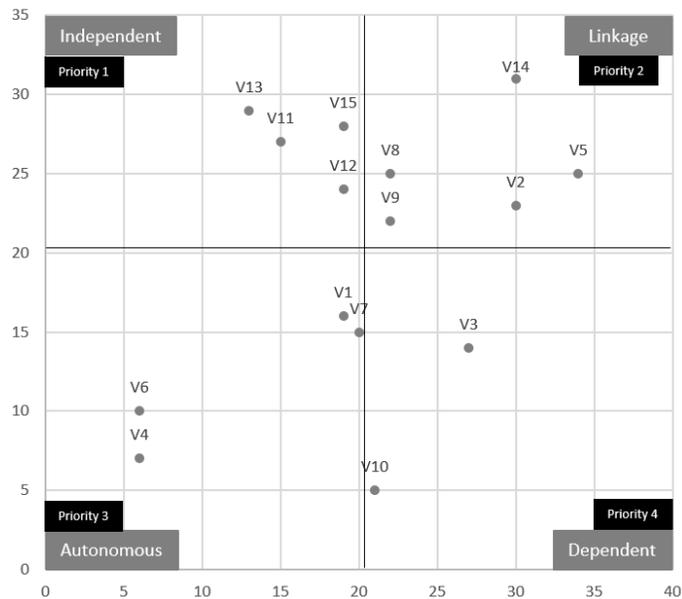


Figure 3. MICMAC Matrix: Analysis of Variables in the Cocoa Production Chain

Based on expert interviews, literature review and research results, solutions that can be adopted by stakeholders were proposed as shown in Table 2.

Table 2. Proposals by Link in the Production Chain

Chain link	Activity	Proposed solution	Label
Procurement of inputs	Self-management of biofertilizer by farmers	Produce biofertilizer based on seaweed, poultry, phosphate rock, and other small animals.	P1
Primary production	Cloning, soil and interinstitutional alliances	Strengthening research and technological development in cocoa through plant cloning, soil optimization with biological inputs and strategic alliances with universities and international centers.	P2
	Technified irrigation	Implement infrastructure to optimize irrigation according to specific crop needs.	P3
	Increased farmer association and loyalty	Formalization of small and medium-sized farmers to work on economies of scale, achieving cost reduction and greater crop profitability. Likewise, to build their loyalty through an integral offer of services, informing and communicating the objectives, knowing their expectations and sharing work plans.	P4
	Ensuring cocoa safety with effective traceability	Implement layouts to prevent cross-contamination, use stainless steel equipment, and tongue and nose AI measuring quality indicators.	P5
	Implementation of post-harvest cocoa technology	Use artificial drying by solar panels or others, controlling the temperature and optimizing the process time.	P6

	Financing and banking	Integrating farmers into the formal financial system with bank accounts, insurance and structured credit. Adoption of affordable and competitive products such as collaborative microcredit. As well as increasing Agrobanco usage.	P7
	Relationship with the government	Establish working groups between the government and producers to strengthen the guild. Establish policies or guidelines on the scope of each link in the chain.	P8
Collection and secondary production	Improve public and private infrastructure	Promote initiatives to improve public and private infrastructure. Emphasize the connectivity of the jungle with the port of Chancay or Callao, the main centers of import storage at the national level.	P9
	Establish strategic alliances	Greater business, corporate and association alliances, as well as the creation of direct channels between farmers and marketing companies to promote fair prices and the creation of processing plants.	P10
	Development of guarantee and insurance schemes	Prepare guarantees and insurance to mitigate commercial and credit risks, as well as investment funds considering fortuitous situations.	P11
Final marketing	Strengthening the Peruvian cocoa brand at the national and international level	Develop a differential brand for Peruvian cocoa, highlighting its quality and organoleptic characteristics. Apply conventional marketing or promote agrotourism.	P12

A second survey of experts was conducted to identify the proposals with the greatest impact on the production chain, and a ranking was carried out based on the potential impact of each initiative. The resulting Pareto analysis (Figure 4) reveals that a small group of proposals -P5, P9, P7, P12 and P4- concentrate more than 50% of the total impact, thus representing the key priorities for chain improvement. In the second category are proposals P10, P1, P3 and P6, which have a relevant but secondary impact. Finally, the proposals related to the relationship with the government, guarantees and cloning have a lower immediate impact and are positioned as less urgent priorities.

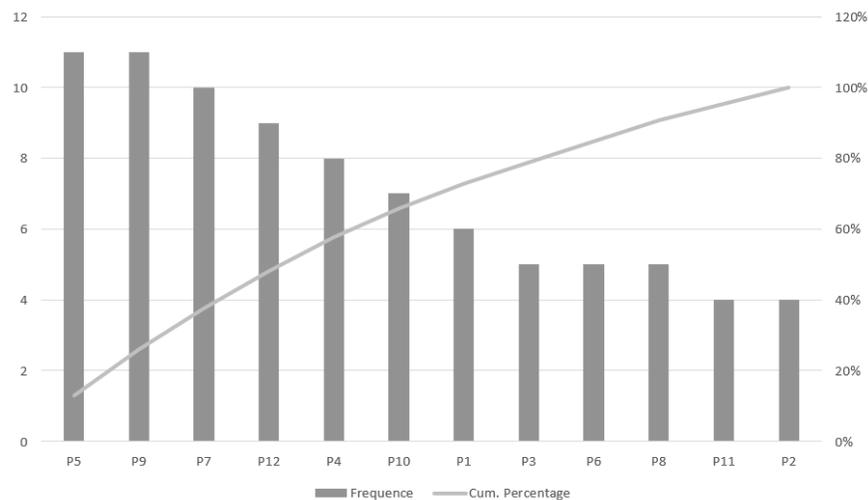


Figure 4. Pareto Diagram of Proposals

Finally, the IGO matrix (Figure 5) was implemented to evaluate the governance of each proposal in order to prioritize actions. According to this matrix, the immediate actions - P5, P12, P4, P10, P1, P3 and P6 - are prioritized due to their high feasibility and direct impact on quality, associativity and technology. In contrast, improving infrastructure and financing (P9 and P7) represent more complex challenges, given that they depend mostly on external factors. Lastly, actions considered less urgent (P11 and P2) or unnecessary (P8) have lower priority in the short term.

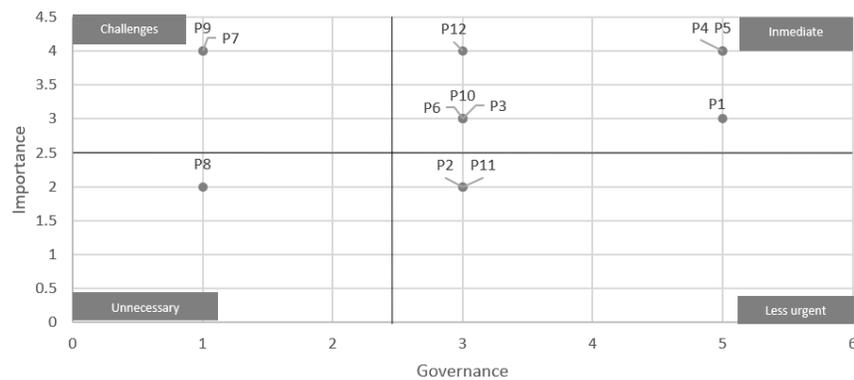


Figure 5. IGO Matrix with Proposals

The integration of the Pareto analysis and the IGO matrix reveals that the proposals with the greatest impact, feasibility and governance -P5, P12, P4 and P10- could represent a 41% improvement in the cocoa production chain, addressing 8 of the 15 problems identified in the supply chain. These results allow focusing resources and efforts on initiatives with high potential and feasibility, optimizing the competitiveness and sustainability of the cocoa supply chain.

## 5. Discussion

The international cocoa industry is very competitive, which is why the most efficient alternative is the optimization of the supply chain, oriented to strategic planning and the level of competitiveness as recommended by Hinojosa et al. (2022), allowing the producer or organization to better position itself in relation to its competitors.

Zavala (2023) and Alonso and Chávez (2021) agree that is key to improving the competitiveness of smallholder cocoa producers. Zavala stresses the importance of developing leadership and skills in members, supported by adequate social and institutional environments, as well as resources for production and marketing. Alonso and Chávez conclude that help to reduce costs, obtain better prices and increase production per hectare. Those that prioritize the development of management skills and reinvest income in training and inputs achieve greater competitiveness and profitability, effectively addressing social, economic and ecological concerns.

A study in Ghana analyzed cocoa quality management practices among 200 farmers, highlighting the key role of associations in improving processes that contribute significantly to strengthening the quality through technical training and knowledge sharing (Adams et al. 2024). This practice should be replicated in Peru, specifically in San Martin, to reduce farmer efforts and also achieve cocoa quality.

Technological innovation also plays a key role in improving cocoa competitiveness. Flores-Rosales et al. (2024) discusses the implementation of technological innovations in the cocoa industry, such as artificial intelligence, deep learning and automation using 4K drones, to assess crop condition, optimize product quality and resource sustainability.

Atiencia Fuentes et al. (2024) propose a semi-automatic machine for bagging and weighing cocoa, which improves dosing accuracy, reduces cycle times and increases productivity, reduces operating costs and improves labor safety. The implementation of equipment with similar characteristics has been identified in some cooperatives in San Martin; however, the province has a limited electricity supply, resulting in instability in the post-harvest process, slower return on investment and process planning.

Agricultural areas present problems due to lack of connectivity or poor connection quality in the San Martin region; however, Yascaribay et al. (2022) mention that the development of the Internet of Things (IoT) has made it possible to implement technologies to improve agriculture by connecting devices that collect and send data.

The responsibility for implementing technology in the cocoa sector lies with both educational institutions and the government, so it is essential to actively involve agencies such as PRODUCE and CITES, which have tools to motivate

innovation, as well as universities to promote research. In addition, the creation of an entity dedicated to research on tropical crops, including cocoa, is suggested.

## **6. Conclusion**

The supply chain proposal for cocoa beans is based on improvements suggested by supply chain participants, experts and literature review in order to achieve higher volumes of finished products with standardized quality, increasing productivity, business profitability and meeting the demand of domestic and international customers thus improving the country's competitiveness against other producers that currently dominate the international market.

To achieve better performance in the chain, it is essential to work on process optimization, cocoa bean quality safety and greater government participation. We have seen from various cooperatives that, despite having an efficient process, there are important limitations due to extrinsic aspects such as transportation routes, electricity supply and financial support.

It is also essential that universities participate in the development of research related to technology, quality management, supply chain and agile methodologies, allowing chain actors to incorporate new knowledge.

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## **Biographies**

**Elizabeth Fiorella Orrego Valverde** holds a bachelor's degree in industrial engineering at the University of Lima, with experience in national and multinational companies. She applies engineering principles to Human Resources, leading initiatives in digitalization, process optimization, and operational efficiency. Currently, she works as an HR business partner at a global company, focusing on aligning people strategies with business objectives, optimizing workflows, and fostering a culture of operational excellence and organizational agility.

**Maria Teresa Noriega-Aranibar** is an Industrial Engineer from the University of Lima, has a Master's degree in Forest Industries from the National Agrarian University La Molina, and a Ph.D. in Accounting and Business Sciences from the National University of San Marcos. She is a professor at the Faculty of Industrial Engineering at the University of Lima and serves as the production area editor of the faculty. She is also an evaluator for the National Quality Award. She is co-author of *Cartera de proyectos*, *Técnicas para el estudio del trabajo* and *Disposición de planta*.