Characterization of the Supply Chain in the Horticultural Production Process Under the Scor Model in the Province of Tundama, Boyacá

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ABSTRACT
This study characterizes the supply chain of the horticultural sector in the province of Tundama, Boyacá (Colombia), using the SCOR (Supply Chain Operations Reference) model as a guiding framework. Through a mixed-method approach—combining bibliometric analysis, surveys, interviews, and statistical processing—the research identifies critical gaps and improvement opportunities in the areas of production, sourcing, distribution, marketing, and sustainability. The findings reveal a predominantly traditional agricultural structure with limited adoption of advanced technologies, infrastructure deficiencies, high logistical costs, and weaknesses in marketing channels and customer loyalty. Despite these challenges, there is a high willingness among producers to adopt technological innovations and improve sustainability practices. The application of the SCOR model facilitated a comprehensive diagnosis of the chain's strengths and weaknesses, laying the foundation for strategic improvements and more resilient, competitive horticultural supply chains in the region.
KEYWORDS: Horticultural supply chain; SCOR model; logistics; sustainable agriculture; Colombia; producers; marketing; supply chain characterization; Boyacá.

INTRODUCTION

The horticultural sector plays a crucial role in Duitama's economy, contributing significantly to the supply of fresh and healthy products to the community. Nevertheless, the efficiency of the supply chain in this sector is susceptible to challenges that have ramifications for both producers and consumers. Among the extant problems, we can identify the lack of effective coordination between producers, distributors, and retailers in the horticultural supply chain. This coordination problem leads to redundancies, delays, and product loss. The inadequate implementation of information technologies and tracking systems impedes visibility and real-time monitoring of the supply chain, contributing to inefficiency and product loss (González, 2020).
The primary objective of this research project is to analyze and improve the supply chain in the horticultural sector of Duitama, identifying areas of opportunity and proposing strategies to optimize the flow of products from production to the final consumer. The present study will be developed using a mixed-method approach, implementing an exploratory descriptive

research design in focus groups, in which a Participatory Rural Innovation (PRI) model will be applied. Information collection strategies will be deployed through focus groups, interviews, and surveys. The expected outcomes of this initiative include enhanced chain visibility, identification of inefficiencies, optimization of processes and resources, improvement in collaboration and coordination, and enhanced decision-making. This initiative signifies a pivotal stride in fortifying the horticultural supply chain within the province of Tundama, Boyacá, holding the promise of engendering enduring economic, social, and environmental advantages.

THEORETICAL FOUNDATIONS

For the research, we looked at variables related to the supply chain, the SCOR model, and horticultural producers, starting with:

To prepare this review, a search was conducted in the Scopus database, considering the level of indexing, amount of scientific production, languages, and visibility of the information recorded. In January 2025, the search was conducted using the following equation:

(("Supply chain") AND ("horticultural" OR "horticultural"))

This search, without additional limitations, yielded 362 documents, which were subjected to bibliometric analysis according to the graphs presented in both the database and the VOSviewer software version 1.6.20 from 2023. These results provided the following information.

Analysis of keyword co-occurrence on supply chain in the horticultural production process

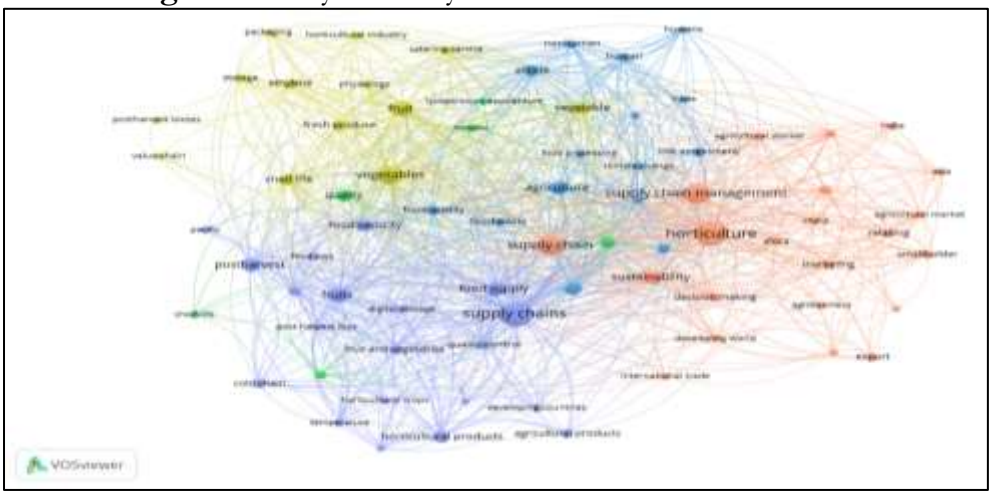
This is an analysis that allows the visualization of networks formed between nodes, which are segmented by color, making it possible to differentiate the clusters that are the set of elements. The purpose of this figure is to contribute to the identification of trends, in this case the use of keywords..

Network analysis: Of the 2,128 keywords identified, with a minimum of five (5) repetitions of each word, a total of 76 keywords were selected for display. The analysis, depicted in Figure 1, identifies five distinct clusters. The first (orange) category is the most visible and comprises concepts such as agribusiness, agricultural marketing, agricultural production, global development, entrepreneurship, exports, horticulture, international trade, retail, small farmers, supermarkets, supply chains, and sustainability, among others.

The second (purple) cluster encompasses concepts related to agricultural products, cold chain, developed countries, digital storage, food loss, food security, food storage, food supply, fruits and vegetables, horticultural crops, horticultural products, trade, post-harvest, post-harvest loss, product design, quality control, supply chain, and temperature. The third category, which is represented by the dark blue theme, encompasses a wide range of concepts including agriculture, articles, carbon footprint, climate change, trade, processed foods, food quality, food waste, humans, life cycle assessment, non-humans, risk assessment, sustainable development, and trade.

The fourth (yellow) and fifth (green) concepts are associated with the following subjects: food service, ethylene, fresh production, fruit, horticultural industry, packaging, physiology, post-harvest loss, shelf life, storage, supply chain, vegetables, food safety, horticultural products, Lycopersicon esculentum, quality, and tomato.

Figure 1 Analysis of keyword co-occurrence networks

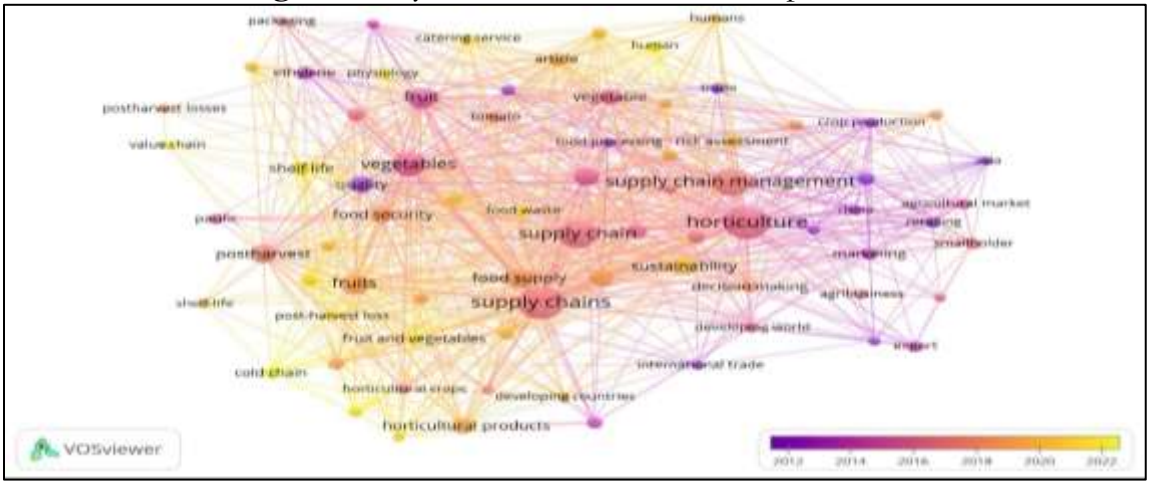


Note: Adapted from VOSviewer software version 1.6.20. (2023).

Keyword co-occurrence overlap analysis: This analysis enables the identification of keywords within publications over time. As illustrated in Figure 2, the search encompasses the period from 2012 to 2022. With respect to the division of this era, it is evident that a primary phase extends from 2012 to approximately 2016. This phase encompasses concepts such as quality, ethylene, supermarkets, trade, retail, processed foods, international trade, exports, and employment, among others.

In the intermediate period (2016-2020), the concept of supply chain is reiterated most frequently, along with horticulture; however, concepts such as post-harvest, food security, food loss, digital storage, developed countries, decision-making, agribusiness, vegetables, fruits, agriculture, horticultural production, and others are also found. The final period under consideration extends from 2020 to 2022, showcasing the most recently utilized keywords. Of particular note are the terms "sustainability," "cold chain," "food service," "physiology," "human," "food waste," "risk assessment," "fruits and vegetables," "value chain," and "post-harvest loss."

Figure 2 Keyword co-occurrence overlap análisis



Note: Adapted from VOSviewer software version 1.6.20. (2023).

Therefore, based on the visual analysis obtained from the software, it has been established that the keywords in the publications not only include conceptual aspects, but also methodological criteria and references to countries or continents where the different research projects were carried out. Figure 3 presents an analysis of the figures presented by the software.

Table 1. Conceptual, methodological, and geographical relationship of keyword co-occurrence analysis

Conceptual trends			**Methodological criteria**		**Countries/ continents**
Concept	Occurrences (repetitions)	Fuerza de enlace	Document type	Article	África
Supply chains	62	254			Asia
Horticulture	61	204			China
Supply chain management	41	97	**Other conceptual trends**		India
Supply chain	41	79	Environment		
Vegetables	32	159	Production-products		
Fruits	23	101	Distribution-marketing		
Food supply	21	104	Process evaluation (from		
Post-harvest	20	69	production to final disposal)		

Note: Data taken from VOSviewer software version 1.6.20 (2023).

THEORETICAL REVIEW

SUPPLY CHAIN

In order to comprehend the operational particularities of the supply chain, it is necessary to take into account the most significant events in the context of its evolution (see Table 1). Although the transition from physical distribution management through logistics to current supply chain models has been occurring for some time, it has only recently gained momentum, and supply chain models have become more complex.

In the context of the intensely competitive environment that organizations currently face, it is imperative to explore alternative approaches that are tailored to market requirements. These alternatives can serve to foster exchange relationships at every link in the production and product marketing process. In essence, it is imperative to comprehend the nature of a supply chain and the requisite resources, in the appropriate amounts, to achieve business objectives.

In this sense, the supply chain is defined as "the network of services, materials, and information flows that links a company's customer relations, order fulfillment, and supplier relations processes with the processes of its suppliers and customers" (Krawjesky et al., 2008, p. 372).

In their seminal work, Manrique et al. (2019) delineate the supply chain as "the set of interrelated links that carry out various activities through which the necessary inputs, the product, and the information flow until delivery to the final consumer" (p. 1138). The supply chain exerts a significant influence on an organization in its entirety.

Additionally, Santander et al. (2014) posit that supply chains are influenced by environmental factors, including contracting, resource allocation, and investment plans. While these factors

can be controlled to a certain extent, unanticipated events may emerge, deviating from the initial plan. Conversely, there exist elements that are inherently uncontrollable, including natural disasters, the infrastructure of the country, and government policies. Consequently, it is incumbent upon companies to devise action plans aimed at averting disruption to their supply chains.

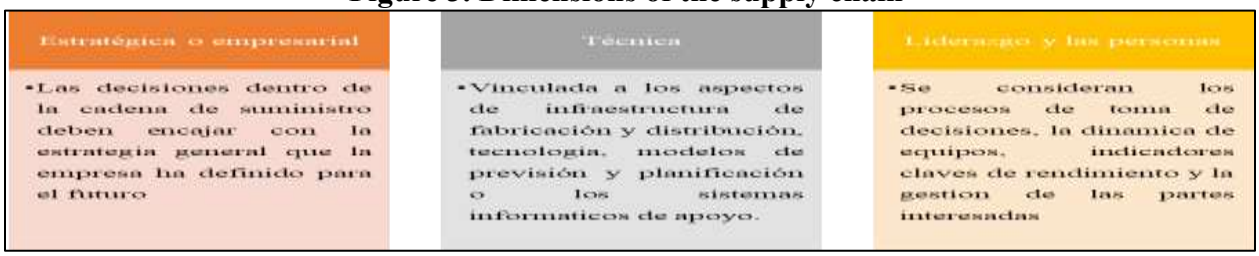
In light of the aforementioned considerations, the term "resilient supply chains" is employed to denote those supply chains that, subsequent to being impacted by internal or external events, demonstrate the capacity to revert to their original state or transition to a new, desired state (Santander et al., 2014).

In general terms, from the point of view of the key links, the supply chain consists of three phases: As posited by Pires and Carretero (2007), the procurement process encompasses the collection points for raw materials. The production process is the transformation of raw materials into a finished good. Distribution is the transportation of the finished product to points of sale for storage and subsequent sale.

However, contemporary supply chains must be conceptualized beyond the links that comprise them. The key operating attributes presented in Table 2 must also be taken into account.

However, numerous factors (see Figure 1) contribute to the management of supply chains. These are well differentiated and very heterogeneous in nature.

Figure 3. Dimensions of the supply chain



Source: Own elaboration, information taken from Weenk (2022)

Supply chain management (SCM)

The term supply chain management was used by Oliver & Webber (1982) to refer to a new marketing perspective that replaced the unsatisfactory methods of integrated marketing channel management. The primary objective of SCM was to maximize the profitability and competitiveness of the supply chain, including the end consumer (Lambert et al., 1998). With the aim of achieving better results for the system as a whole, Cooper & Ellram (1993) define SCM as the management and analysis of the entire network, from the supplier to the end user. Conversely, Vargas (2014) asserts that supply chain management encompasses "the transfer of knowledge, the promotion of innovation, the improvement of quality standards, and the implementation of efficient communication mechanisms throughout the chain" (p. 47).

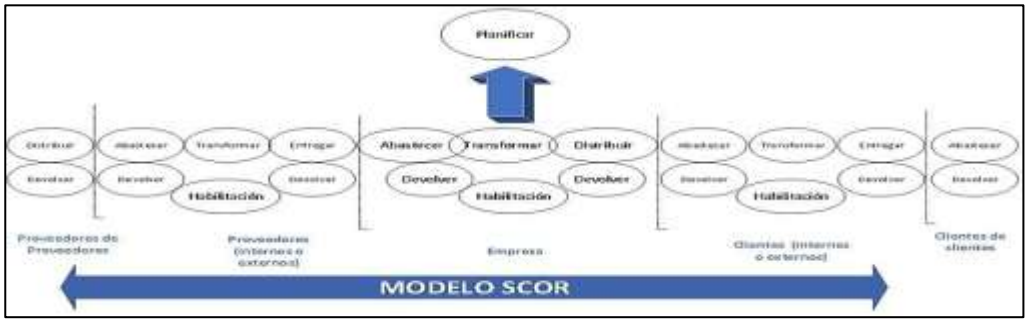
The term "SCM" is broadly defined by Mentzer et al. (2001) as the strategic coordination of traditional business functions and tactics across these business functions within a particular company, and across companies in the supply chain, for the purpose of improving the long-term performance of individual companies and the supply chain as a whole.

Conversely, the supply chain is not merely a linear sequence of entities; rather, it is a network of interconnected companies that are centrally involved in the business process, from the procurement of raw materials to the end customer (Lambert & Cooper, 2000).

Furthermore, the intricacies of the supply chain are determined by "generic components (such as actors, activities, and resources) and generic interfaces (such as interaction, coordination, cooperation, and competition)" (p. 247), as asserted by Svensson (2007). The interfaces and components collectively constitute the framework for supply chain management.
It is imperative to acknowledge that supply chain management models exist which enable the anticipation of certain events in order to respond to environmental changes. The most influential models are described in Table 3.

SCOR Model
According to Arana-Solares et al. (2012), effective supply chain management is imperative for companies to enhance their competitiveness, optimize resource utilization, and assist end users in achieving their service objectives. This management approach also fosters positive relationships among supply chain participants, contributes to inventory reduction, and accelerates delivery times.
Consequently, in order to respond to changes in the environment, there are supply chain management models that allow for the prediction of certain events, among which is the SCOR model.
The SCOR model is a reference framework developed by the Supply Chain Council that provides a set of processes, metrics, and best practices for managing and measuring supply chain performance. Standardization of processes and terminology in supply chain management is facilitated by this approach (Supply Chain Council, 2008).
It comprises indicators that seek to measure performance at the internal level (costs and assets) and external level (reliability, responsiveness, and flexibility) in general, facilitating decision-making (Zuluaga-Mazo et al., 2014).
It is important to acknowledge that this model facilitates the delineation of the business activities essential for addressing consumer needs. The model is structured around six primary management processes, as illustrated in Figure 4: planning, sourcing, production, distribution, returns, and enabling.

Figure 4. SCOR Model structure



Source: Taken from APICS (2017)

White (2021) also mentions that there are three levels used to measure supply chain performance, which allow for the standardization of supply chain performance metrics so that companies can be evaluated against other companies, even if they operate differently. The three levels are presented in Figure 2..

Figure 5. Levels of the SCOR model

Source: own elaboration based on information taken from White (2021)

Agricultural supply chain

Supply chain management in the agricultural sector is imperative to ensure efficiency and quality in the production, distribution, and sale of agricultural and livestock products. The selection of a management model is contingent on numerous factors, including the nature of the products, market trends, the capabilities of the actors involved, and geography. Furthermore, shifts in industry trends and technological advancements can also influence the selection of the most suitable model.

Fundamental elements are also in place to facilitate the chain's functioning and progression. Supply chain institutions, through regulations or laws governing business practices, product quality, and food safety, guide the actions of chain participants. Infrastructure encompasses telecommunications systems, logistics service providers, and packaging and preservation technologies (King & Venturini, 2005).

In this context, the global agri-food supply chain encompasses a network of companies involved in primary production, sales, and the delivery of goods to end consumers. The composition of this sector encompasses primary producers, processors, distributors, traders, and service providers. Each actor carries out specific activities related to the purchase, processing, and sale of products and/or services, adding value to the product until it reaches its destination (Gutiérrez & Infante, 2017).

Horticultural Producers

According to DANE (2015), an agricultural producer is defined as "a natural or legal person who manages an agricultural production unit and makes the main decisions regarding plant cultivation, animal husbandry, agricultural practices, the use of means of production, and the sale of agricultural products" (p. 3).

Accordingly, the term "horticultural producer" refers to an individual, entity, or organization involved in the cultivation and production of vegetables, fruits, and other horticultural crops. These crops may include vegetables, legumes, fruits, and ornamental plants. Horticultural producers engage in a multifaceted role encompassing land management, planting, plant care, harvesting, and, in numerous instances, marketing their products.

According to Rozano et al. (2005), "vegetables are a group of plants generally grown in gardens or irrigated fields, which are consumed as food, either raw or cooked." The term "vegetable" encompasses vegetables and green legumes (p. 3).

In the context of Colombia's agri-food sector, the chain encompasses primary producers, wholesale marketers, chain stores and supermarkets, processing industries, seed producers and importers, planters, exporters of inputs, representatives of academia and research centers (Minagricultura, 2016).

A salient attribute of primary producers is that 75% of farms exhibit an area of less than 3.0 hectares, with 40% falling below the threshold of 1.0 hectare. The economy is characterized by its rural nature and the satisfaction of domestic market demands. The constrained generation of value through processing limits the availability of fresh produce for marketing (Minagricultura, 2020).

METHODOLOGY FOR CHARACTERIZATION

The research is part of a mixed exploratory-descriptive approach, combining qualitative and quantitative social techniques (Barrena, 2014; Hernández, et al., 2010; Creswell, 2008) in order to analyze the production, logistics, and commercial processes involved in the supply chain. To characterize the horticultural supply chain in the province of Tundama-Boyacá, the **Supply Chain Operations Reference (SCOR)** model was used.
Table 2 shows the criteria used in the methodological process for preparing this document.

Table 2. Methodological procedure

Criterion	**Quantitative**	**Qualitative**
Research focus	Deductive	Inductive
Type of study	Descriptive	Interpretive
Unit of analysis	Key players in the horticultural supply chain	Experts
Sample	Probabilistic	By content
Instruments	Surveys	Interviews
Analysis tools	Excel - SPSS	AtlasTi – Nvivo

Source: Own elaboration

The research was conducted in three stages:
In the initial phase, a documentary study was conducted using the Scopus database to contextualize the development of knowledge on the subject under investigation. This phase enabled the definition of the guiding constructs. The results were analyzed using VOSviewer software, which provided explanations regarding the conceptualization, types, and determining variables in supply chain management.
In the subsequent phase of information collection, a measurement instrument incorporating Likert scales was developed and implemented, with consideration given to variables including production, suppliers and storage, logistics and distribution, marketing and commercialization, sustainability and social responsibility, and prospects for improvement. The sample was randomly selected from horticultural producers in the province of Tundama.
In the final phase of analysis and interpretation of the quantitative data, descriptive and analytical statistical techniques were applied, using software such as SPSS, Excel, and VOSviewer. A qualitative approach was utilized to interpret the identified problems and opportunities for improvement. This approach was consistent with the classification of supply chain activities according to their organization into five levels of the SCOR Model (Herrera & Herrera, 2016). The SCOR Model was employed as a tool for configuring, studying, and building the horticultural supply chain in the province of Tundama in the department of Boyacá.

Levels of the SCOR Model:

- **Planning:** production planning and supply process.
- **Source:** Identification of suppliers, procurement, and quality of inputs.
- **Do:** Cultivation, harvesting, post-harvest, and processing
- **Delivery:** Distribution and marketing logistics.
- **Return:** Handling defective products and complaints.

RESULTS

Characterization of the horticultural sector

Colombia is the third largest horticultural producer in Latin America, with more than 966,000 hectares dedicated to fruit and vegetable crops. The estimated annual production of these crops is 10.7 tons, which is part of the national supply available to consumers (Asohofrucol, 2018). Horticultural production has been identified as a catalyst for the economic development of select endemic regions of Colombia (Muñoz et al., 2020). The strategic exploitation of this production has been shown to generate employment opportunities and to fortify the foundational elements of the supply chain. Rincón & Guerrero (2024) have noted that Minagricultura (2020) has indicated that horticultural production in Colombia is carried out under small-scale farming schemes and is primarily intended to meet domestic demand. Horticultural producers are defined as small-scale farmers, with 75% of farms being less than 3 hectares in size and 40% being less than 1 hectare. Vegetable production in Colombia encompasses a wide array of more than 30 different crops. The most extensive harvest areas are dedicated to the cultivation of peas, tomatoes, onions, carrots, squash, and green onions. Tomatoes have the highest production volume. The highest yields for tomato production are achieved under cover (greenhouses).

The vegetable chain in Colombia is estimated to generate a total of approximately 220,000 jobs per year, of which around 70,000 are direct jobs and approximately 150,000 are indirect jobs. (Minagricultura, 2019)

According to Agronet (2024), in 2021, the production of various vegetables in Colombia was 75,676.97 tons, with a yield of 11.55 tons per hectare, representing a decrease compared to the previous year. According to the Organization for Economic Development and Cooperation (ODEB, 2024), based on the report from the Agricultural Sector Price and Supply Information System (SIPSA), the supply of vegetables was 73,726 tons in January 2024, an increase of 8.1% compared to the same period in 2023. The primary departments responsible for the production of fruit and vegetables at the national level are Boyacá, Cundinamarca, and Antioquia, which collectively account for slightly more than a third of national production. This is attributable to the productive culture and extensive cultivated area of these departments. In the Cundinamarca region, potatoes are the most prominent crop, accounting for more than 60% of the total production. This is followed by mangoes and carrots. In Boyacá, potatoes account for 57% of the total production, followed by tomatoes and onions, which include both green onions and regular onions. In Antioquia, plantains account for approximately 35% of the total fruit production, followed by potatoes, table tomatoes, and tree tomatoes" (Asohofrucol, 2018).

Boyacá

As for the Department of Boyacá, domestic production accounts for 84.8% with 601,419 tons through 84 producer organizations (Secretariat of Agricultural Development of Boyacá, 2018), generating significant income of 25% (Asohofrucol, 2018). The municipality of Duitama accounts for a large part of vegetable production, which is why a group of producers has formed an association for horticultural production and marketing. However, the association has been plagued by organizational problems, as it only has 22 producers, who show weaknesses within the association, generating mistrust, lack of credibility, and commitment among the members.

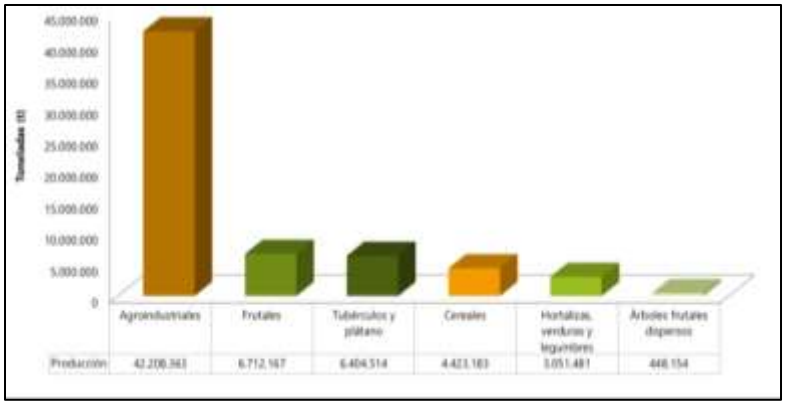


Figure 6. Statistics. Source: (DANE, 2019)

Figure 6 shows that, according to the 2019 National Agricultural Survey (ENA), total production was 63,247,863 tons, of which 42,208,363 tons correspond to the agro-industrial group (66.7%), 6,712 167 tons to fruit trees (10.6%), 6,404,514 tons to tubers and bananas (10.1%), 4,423,183 tons to cereals (7.0%), 3,051, 481 tons to vegetables and legumes (4.8%), and 448,154 tons (0.7%) to scattered fruit trees. (DANE, 2019).

The municipality of Duitama The region's economic foundation remains predominantly agricultural and livestock-based, capitalizing on its abundant natural resources. Historically, the region's agricultural practices have been characterized by the cultivation of traditional crops, including potatoes, vegetables, and fruit trees. Historically, the region's agricultural output has been dominated by traditional crops, including potatoes, vegetables, and fruit trees. However, according to data provided by the municipal development secretariat, these crops have been adversely affected by various factors. These include climate change, diseases, pests, and the absence of research organizations and advanced technology. These challenges have had a direct impact on agricultural productivity and yield. The municipality cultivates a variety of vegetables, including onions, broccoli, potatoes, cilantro, lettuce, cabbage, carrots, and peas, among others, as well as cereals such as corn and beans. Additionally, traditional fruit orchards persist in their production of a variety of fruits, including apples, peaches, feijoa, strawberries, plums, tree tomatoes, and cape gooseberries. However, these orchards have experienced a decline in productivity due to the high costs associated with operating and maintaining orchards, compounded by a paucity of advanced technology. Given the municipality's status as a producer of vegetables and fruits, large-scale producers do not engage in sales to rural or local collectors or regional intermediaries. Instead, they utilize direct marketing strategies, such as selling their products in trucks, to reach the wholesale market in Duitama. The situation is

different for small producers, who sell to intermediaries on the farm and sometimes take their produce to the wholesale market, handling small volumes at prices that do not compensate for their labor. Due to the comparatively limited volume of production, these entities do not engage in the practice of traveling to other cities, as this would not be a financially viable option given the lower demand in comparison to the capacity of wholesale markets (Cely, 2018).

Municipalities in the province of Tundama

Tundama Province, comprising the municipalities of Belén, Cerinza, Duitama, Floresta, Paipa, Santa Rosa de Viterbo, and Tutazá.

Growth and changes in demand According to the United Nations Food and Agriculture Organization, global production of fruits and vegetables has experienced sustained growth in recent years (Flórez, 2013). In recent years, global food consumption trends have undergone significant changes, and fruits and vegetables have been crucial in the eating habits of consumers, who have **oriented their preferences towards healthier products** (Chaparro, 2017). Recently, the agricultural industry has become more dependent on information, requiring a broad spectrum of scientific and technological data for the agricultural community to make efficient decisions (Manrique et al., 2019).

To develop the characterization, the instrument was designed and presented to the surveyed population, where x is placed according to opinion, with five measurement levels on the Likert scale.

1. Strongly disagree
2. Disagree
3. Neutral
4. Agree
5. Strongly agree

Table 3.

Variable	Question
Production	We use advanced cultivation techniques to improve vegetable production.
	Our production capacity is sufficient to meet market demand.
	The climatic conditions in the Cundiboyacense highlands are favorable for vegetable production.
	We practice crop rotation to establish healthy soils.
	We have quality facilities and equipment for vegetable production.
	We have a wide range of products.
Suppliers and Procurement	We have reliable suppliers for all necessary inputs
	The inputs we receive are of high quality and meet our expectations
	We do not face recurring problems in the supply of inputs
	Suppliers consistently meet agreed delivery deadlines
	Input prices are excessively high in relation to their quality
	We have shortcomings in coordination and communication with suppliers
Logistics and distribution	Vegetables are harvested and stored efficiently
	We have adequate transportation methods for distributing our vegetables
	Vegetables arrive at their destination undamaged and in good condition
	Our logistics system has the capacity to respond adequately to unforeseen events and emergencies
	Transportation costs for vegetables are fair
	We have infrastructure for adequate storage of vegetables
Market and marketing	The prices of our vegetables are competitive in the market
	We use various marketing channels to reach our customers
	The demand for our vegetables is high and constant
	We monitor and build loyalty among our customers
	We develop effective promotion and marketing activities to increase visibility and sales
	Technological platforms are essential for marketing our products
Sustainability and social responsibility	We apply sustainable practices in vegetable production and distribution
	We are certified in quality or sustainability
	We carry out social responsibility actions with local communities
	We apply waste management in vegetable production to minimize environmental impact
	We adequately communicate our social responsibility efforts
Outlook and continuous improvement	There are clear opportunities for improvement in our supply chain
	We are interested in implementing technological innovations in the near future
	Collaboration with other actors in the supply chain is good and effective
	We receive and act on suggestions and input from our customers to improve vegetable production
	We use participatory workshops, events, and talks as training tools

PRODUCTION VARIABLE

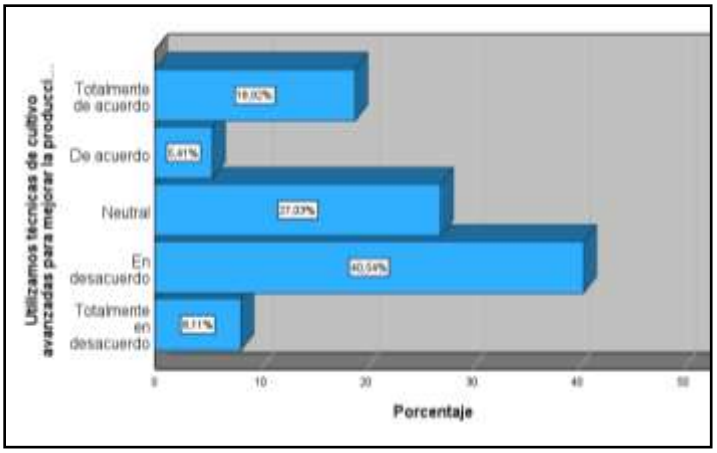


Figure 7. Cultivation techniques

Figure 7 shows respondents' opinions on whether they use advanced farming techniques to improve vegetable production: **18.92%** strongly agree that they use them, **5.41%** agree, **27.03%** are neutral, neither for nor against, **40.54%** disagree, believing that these techniques are not used, and **8.11%** strongly disagree. Overall, the majority (almost **49%**) believe that advanced cultivation techniques are not being used, while only **24%** think that they are.

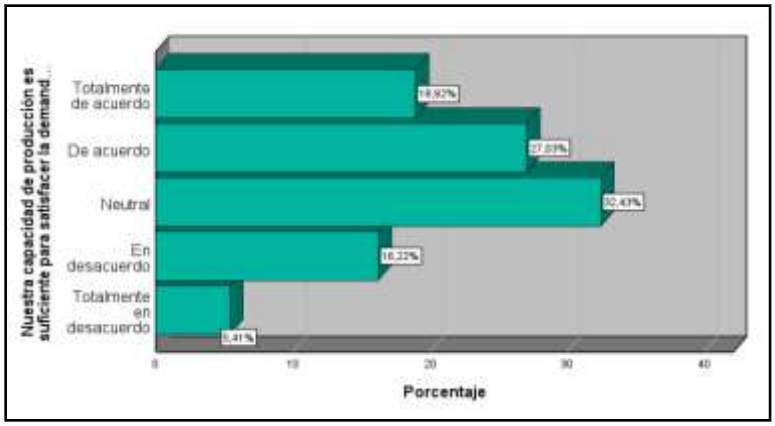


Figure 8. Production capacity

Figure 8 illustrates that nearly half (45.95%) of the respondents believe that their production capacity is adequate to meet market demand, while only 21.63% believe that it is insufficient. Conversely, 32.42% of respondents expressed uncertainty regarding their production capacity, suggesting an ambivalent perception of their performance in relation to the demands of the business environment. This finding indicates that, while a substantial proportion of the participants expressed confidence in their abilities, a significant number of individuals may benefit from a more comprehensive evaluation of their skills and resources. The variability in responses could also be indicative of differences in individual experiences and the specific sectors in which they operate, thereby presenting an opportunity to strengthen training and development strategies. Consequently, it is imperative for companies to implement measures that will identify areas for improvement and foster continuous growth, thereby increasing productive capacity in the market.

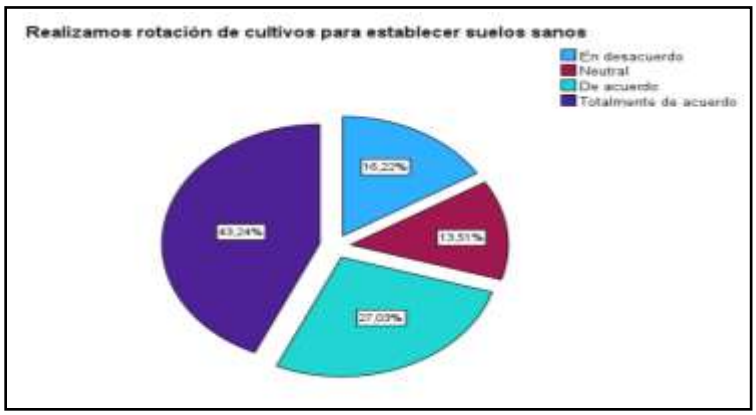


Figure 9.

The pie chart illustrates the responses concerning the implementation of crop rotation for the purpose of establishing healthy soils. The distribution of opinions is as follows: The data reveals a division among respondents, with 16.22% expressing disagreement, 13.51% maintaining a neutral stance, 27.03% expressing agreement, and 43.24% strongly aligning with the perspective put forth. The majority of respondents, 70.27% of the sample (assuming "Agree" and "Strongly agree" responses are considered positive), support the practice of crop rotation to improve soil health. This finding suggests a notable trend toward the adoption of agricultural practices that prioritize sustainability. The implementation of crop rotation practices has been demonstrated to play a pivotal role in the preservation of soil nutrients. Additionally, this agricultural technique has been shown to contribute to the mitigation of pests and diseases, thereby fostering a more balanced ecosystem. Furthermore, 43.24% of respondents who expressed "complete agreement" underscored a noteworthy dedication to implementing responsible agricultural practices, a crucial consideration in the face of escalating soil degradation. It is noteworthy that a mere 16.22% of respondents expressed disagreement, suggesting that negative perceptions of this practice are relatively uncommon. This presents a valuable opportunity to educate those who remain skeptical about the long-term environmental and agricultural benefits of crop rotation. The promotion of discourse and the dissemination of exhaustive information may prove instrumental in the augmentation of support for practices that are mutually beneficial to farmers and the environment in which they operate.

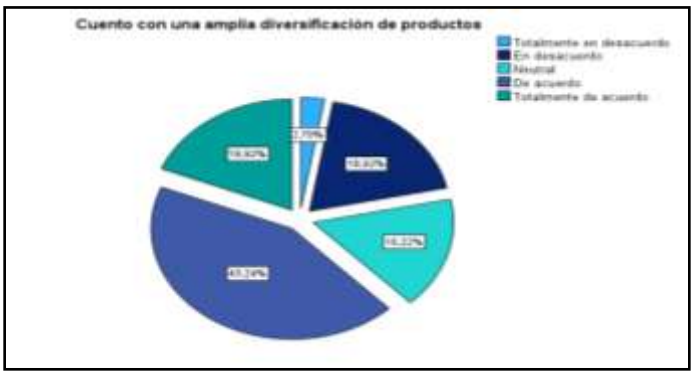


Figure 10. Diversification

A significant proportion of respondents, 43.24%, attest to having access to a diverse array of products, with lettuce, spinach, and chard being prominent examples. It is noteworthy that a minority of respondents do not concur with this perception. This development signifies a favorable trend in the availability and diversity of fresh products within the market. Furthermore, 36.15% of respondents attest to the generally high quality of these products, citing freshness and the absence of pesticides as pivotal factors in their selection. However, 20.61% of respondents expressed indifference, indicating the presence of a segment that does not prioritize quality or variety in their shopping behavior. This image underscores the necessity to educate consumers about the advantages of a diet abundant in vegetables, thereby fostering the acceptance of healthy and sustainable dietary choices.

VARIABLE SUPPLIERS AND SUPPLY

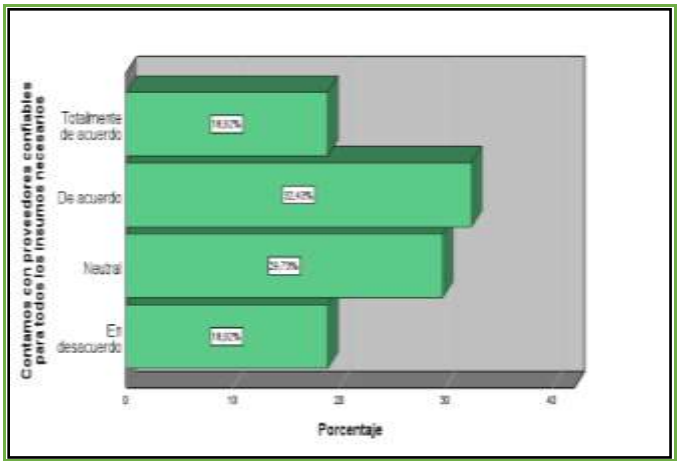


Figure 11. Trusted suppliers

While the perception is generally favorable, the high percentage of unfavorable responses and disagreement suggest that there is room for improvement in communication with suppliers or in providing greater clarity about their reliability. Furthermore, the implementation of a more effective feedback system that allows suppliers to express their concerns and suggestions is imperative. The establishment of this communication channel would serve two primary functions: first, it would serve to reinforce the existing foundation of mutual trust between the parties involved; and second, it would facilitate the identification of specific areas where improvements can be made. Transparency in collaboration processes has been demonstrated to foster a more cohesive and efficient environment.

The implementation of periodic training sessions, encompassing both parties, is also recommended. These sessions should focus on the articulation of quality standards and expectations. This approach would facilitate a harmonization of vision and objectives, thereby enabling a more seamless and cooperative relationship. Trust, which is known to be developed over time, is the cornerstone of any business partnership. The first step in establishing a solid foundation for such a partnership is clear and open communication.

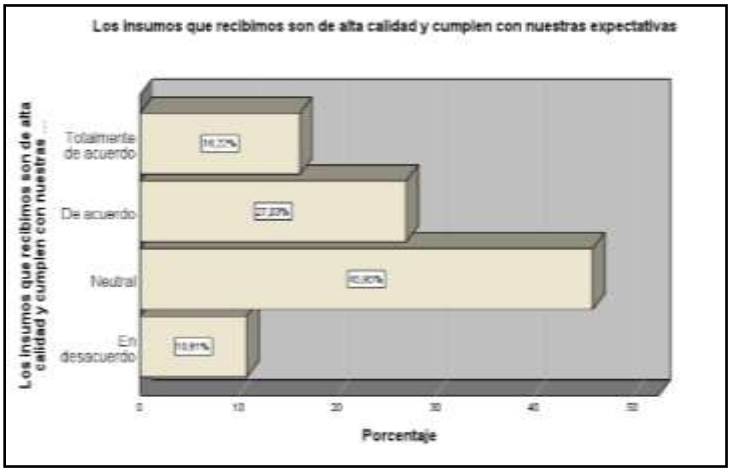


Figure 12. Quality of inputs

A significant proportion of respondents expressed a neutral stance, indicating that the inputs merely met the minimum requirements and did not surpass expectations. Alternatively, there is a possibility that the quality is subject to variation. A total of 43.25% of respondents expressed a favorable opinion, as indicated by their responses to the question, "Agree" and "Strongly agree." This data suggests that a considerable proportion of the respondents are experiencing a high degree of satisfaction. A mere 10.81% of respondents expressed disagreement, suggesting that the quality of inputs is generally satisfactory. It is imperative to acknowledge that this distribution of opinions is indicative of the diversity of experiences among respondents. Those who express a favorable opinion appear to value specific aspects of the inputs, such as availability and functionality, which have enabled them to adequately meet their needs. However, the substantial proportion of neutral responses indicates a considerable margin for enhancement in the collective perception of quality.

The variability in satisfaction could also be influenced by external factors, such as the context in which the inputs are used or comparison with competing products. Consequently, a more comprehensive evaluation identifying specific domains where inputs could be enhanced would be advisable. This could entail the implementation of more comprehensive surveys that delve into aspects such as durability, performance, and the quality of customer support.

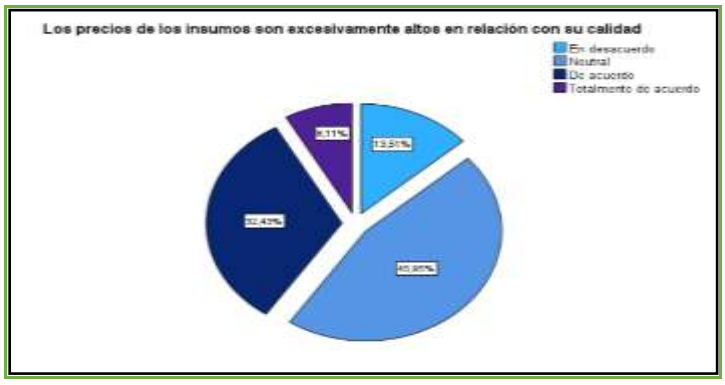


Figure 13. Input prices

45.95% of respondents are neutral, suggesting that many people do not have a clear opinion on the price-quality ratio of inputs. Adding those who "Agree" and "Strongly agree," 40.54%

consider prices to be high compared to quality. Only 13.51% believe that prices are not excessive. Although a significant proportion of respondents believe that prices are high, almost half do not have a definite opinion, suggesting uncertainty or a lack of information about the relationship between prices and the quality of inputs.

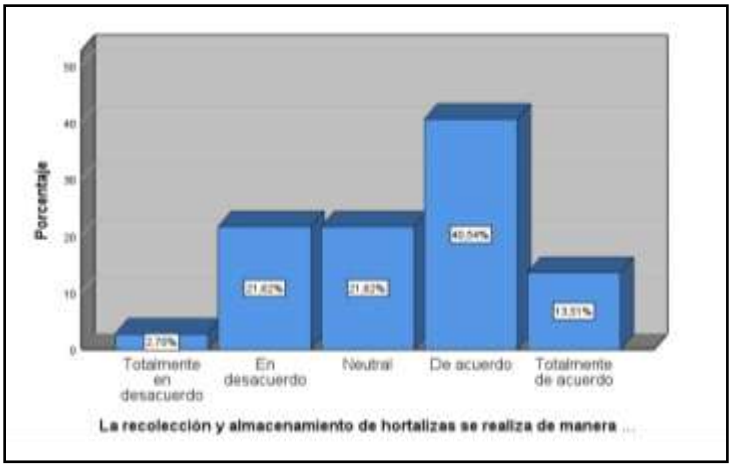


Figure 14. Collection and storage

The majority of respondents (54.05%) expressed satisfaction with the efficiency of vegetable harvesting and storage, either in general terms or in their overall assessment. However, a substantial proportion (21.62%) of the respondents expressed ambivalence or a lack of consensus, suggesting potential areas for enhancement. Additionally, it is noteworthy that 2.27% of respondents expressed a strong disagreement, indicating that a small but significant portion of the population has concerns about the efficiency of the process. This diversity of opinion underscores the necessity for periodic audits and more in-depth studies to identify specific areas where improvements can be made, both in harvesting techniques and vegetable storage.

Figure 15. Transportation costs

The results of the survey indicate that a significant proportion of respondents (51.36%) hold the view that the cost of transporting vegetables is not equitable, while only 24.33% (18.92% agree and 5.41% strongly agree) perceive the cost to be fair. This finding suggests a pervasive perception that these costs are either exorbitant or insufficient.

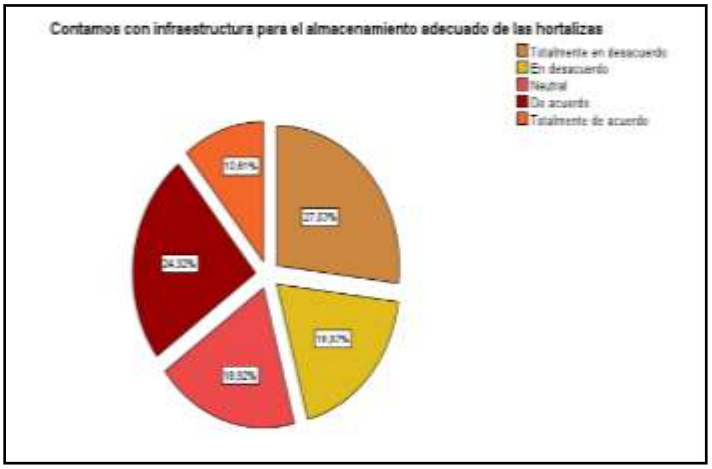


Figure 16. Infrastructure

There is a notable division of opinion: 45.95% consider that the infrastructure for vegetable storage is inadequate, while 35.13% believe that it is adequate. 18.92% are neutral, indicating that some may be undecided or lack sufficient information.

MARKETING AND SALES VARIABLE

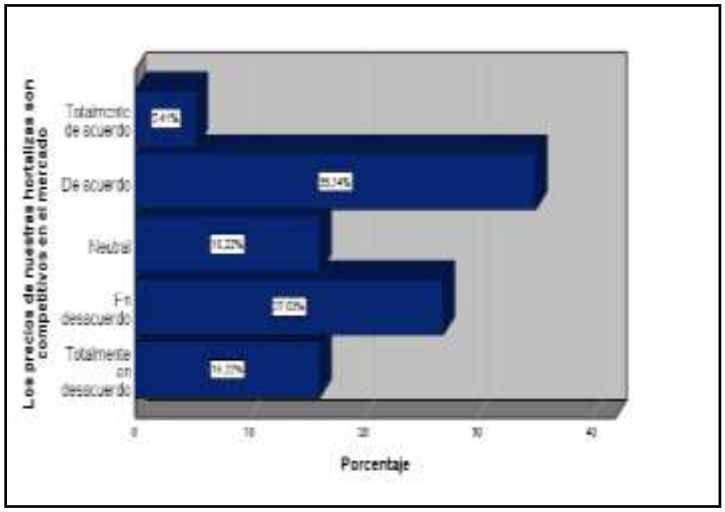


Figure 17. Competitive prices

Despite the pervasive perception that prices are competitive, a considerable proportion of respondents expressed disagreement, while others maintained a neutral stance. This discrepancy in opinions suggests that the market is segmented, with different consumers valuing products and services differently. While certain observers emphasize the affordability of the options and the variety of options available, others argue that the costs are excessive in relation to the quality offered. This phenomenon prompts inquiries into the efficacy of marketing strategies and the capacity of companies to tailor their offerings to the distinct requirements of their customers.

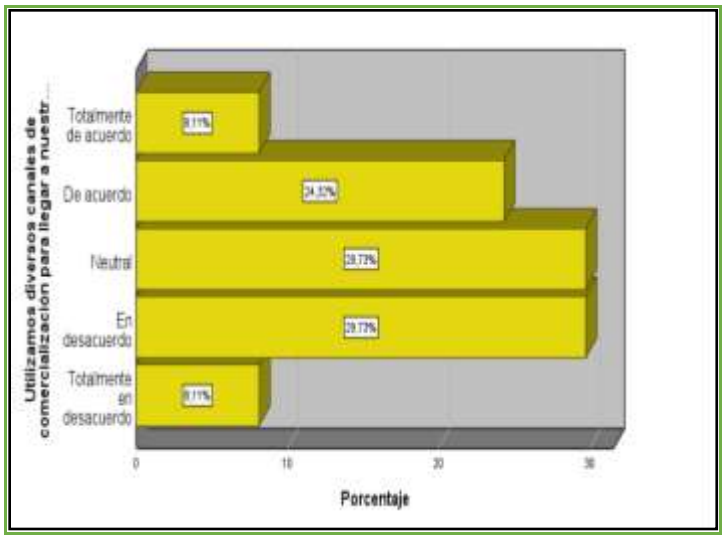


Figure 18. Marketing channels

The prevailing sentiment is one of discord, with divergent viewpoints that complicate the matter further. A survey of the subject's relevant literature reveals that 37.84% of respondents believe that not enough marketing channels are being used, while 32.43% believe that several are being used. A total of 29.73% of respondents expressed a neutral stance, indicating a sense of uncertainty or a lack of clarity regarding the issue at hand. This diversity of perceptions suggests that the problem may be more complex than it appears at first glance. A significant proportion of individuals who subscribe to the notion that an inadequate number of marketing channels are being utilized contend that a paucity of innovation and a failure to adapt to novel technologies constrain the extent and efficacy of prevailing strategies. Conversely, proponents of the utilization of multiple channels cite instances of effective campaigns that have successfully garnered public attention through the mediums of digital platforms and social media.

However, the 29.73% of the population that identifies as neutral provides a foundation for further analysis. This group may comprise individuals who, despite being exposed to brand communication, have not yet formed a definitive opinion regarding its efficacy. This underscores the necessity for qualitative and quantitative research to enhance our comprehension of market dynamics and consumer expectations.

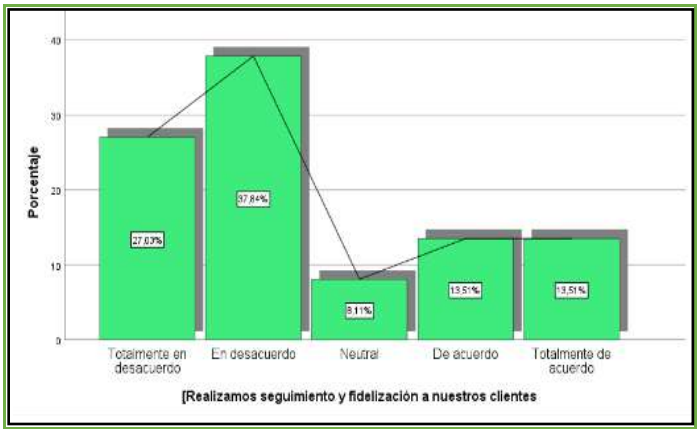


Figure 19. Follow-up and loyalty

Figure 19 suggests a general perception that customer follow-up and loyalty are deficient, indicating a necessity for enhancement in this domain. This can have significant repercussions on business sustainability, as a lack of connection with customers can lead to the loss of valuable opportunities. It is imperative to implement more effective strategies that enable continuous contact with customers, as well as personalizing interactions to make them more meaningful. Furthermore, the integration of suitable technological instruments could enable the aggregation and examination of data concerning customer preferences and behaviors, thereby facilitating more precise segmentation and more targeted communication.

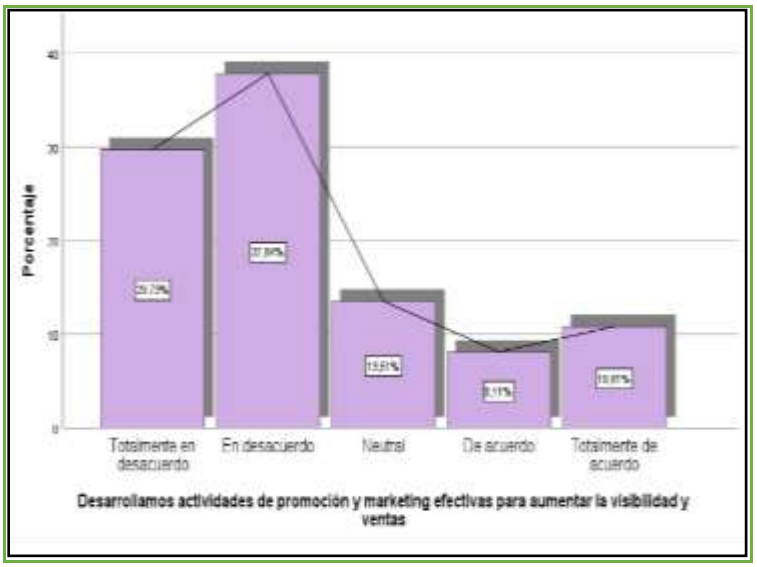


Figure 20. Promotion and marketing

67.57% consider promotional and marketing activities to be ineffective, while only 18.92% believe the opposite. This indicates a negative view of marketing's ability to increase visibility and sales.

VARIABLE SUSTAINABILITY AND SOCIAL RESPONSIBILITY

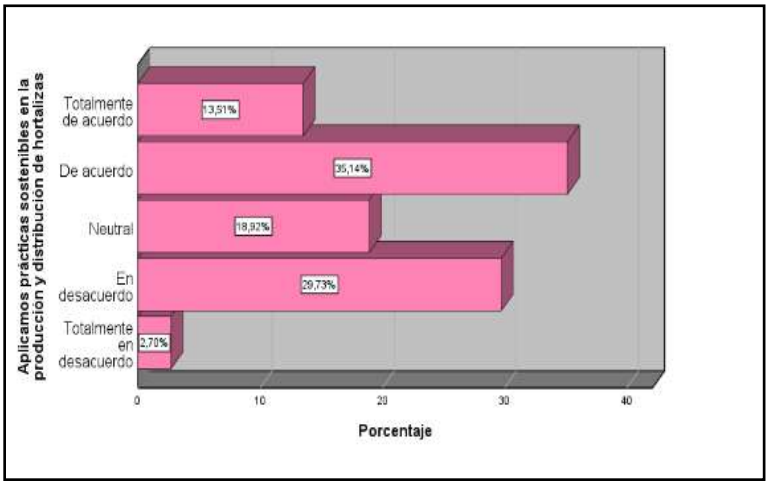


Figure 21. Sustainable practices

Figure 21indicates that 48.65% of individuals engage in sustainable practices when it comes to vegetable production and distribution. However, 29.73% of respondents expressed disagreement, and 18.92% maintained a neutral stance. These findings suggest that, despite a prevailing positive perception, concerns regarding sustainability persist. This discrepancy in perspectives prompts inquiries into the factors that influence the adoption of sustainable practices. It is imperative to comprehend the obstacles confronting vegetable producers and distributors in implementing these practices. These include a paucity of information, the initial investment required, and resistance to change.

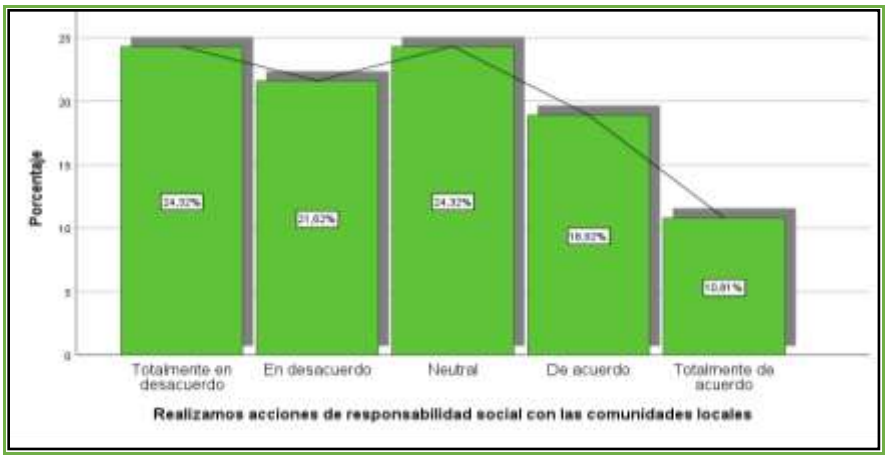


Figure 22. Communities

Figure 23 reveals a division in opinions: A significant proportion of respondents, 45.94%, expressed concerns regarding the perceived inadequacy of social responsibility actions undertaken by local communities. In contrast, 29.73% of respondents held the opposite view, perceiving that such actions were sufficiently implemented. Furthermore, 24.32% of respondents expressed neutrality, indicating a substantial proportion of the population lacks a definitive stance on the subject. This finding suggests a tangible concern among respondents regarding companies' commitment to the needs and aspirations of the communities they directly impact. The perception that social responsibility actions are inadequate may be indicative of an expanding societal expectation for enhanced ethical and participatory corporate conduct.

VARIABLE PERSPECTIVES AND CONTINUOUS IMPROVEMENT

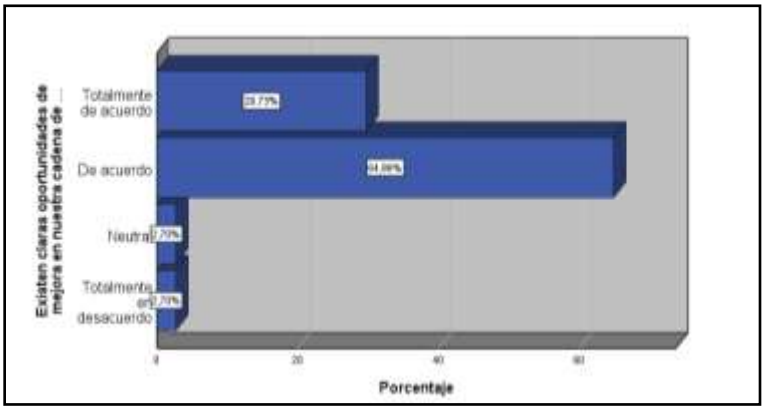


Figure 23. Opportunities for improvement

Most people (64.86% agree and 29.73% strongly agree) believe that there are clear opportunities for improvement in the supply chain. Only 2.70% strongly disagree and another 2.70% are neutral, showing that almost everyone sees room for optimization in this area.

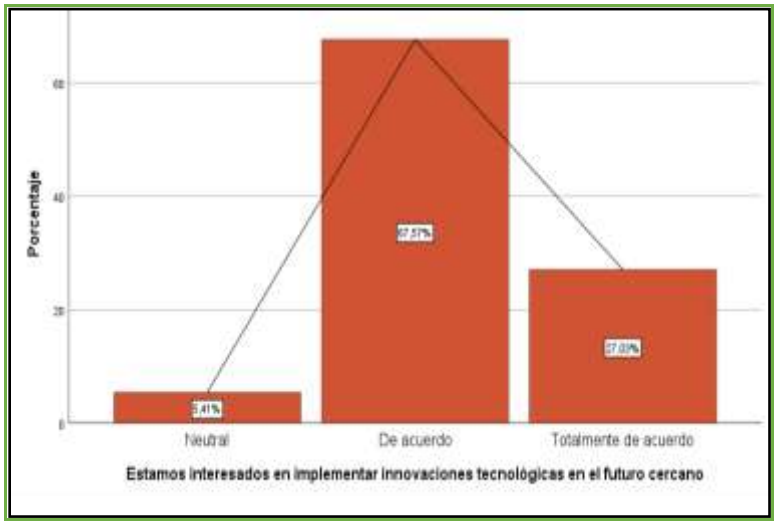


Figure 24. Technological innovation

The vast majority (67.57%) expressed strong interest in implementing technological innovations in the near future, with an additional 27.03% indicating strong agreement. A mere fraction of the respondents (5.41%) have expressed a neutral stance on the matter. This suggests a clear enthusiasm for adopting new technologies in the short term.

The predominant opinion among the general public (45.95% of respondents agree, and 27.03% strongly agree) is that effective waste management practices are employed in vegetable production with the objective of reducing the environmental impact. A mere 24.32% of respondents do not subscribe to this belief, while a negligible 2.70% maintain a neutral stance. This finding suggests a predominantly favorable perception of waste management practices.

DISCUSSION OF RESULTS ACCORDING TO THE SCOR MODEL

1. Planning (Production and supply planning)

The data obtained reflects agricultural planning that still depends largely on traditional schemes linked to the peasant economy, where smallholdings predominate: 75% of farms are less than 3 hectares in size. Although 45.95% of producers consider their production capacity to be adequate to meet demand, 32.42% remain undecided, revealing gaps in planning tools, demand forecasting, and capacity assessment.

The strong interest (over 94%) in adopting technological innovations indicates that there is awareness of the need to improve planning and decision-making systems. However, the low implementation of advanced farming techniques (almost 49% disagree) shows a gap between intention and reality, possibly caused by a lack of access to training or financing.

2. Source (Procurement of inputs and suppliers)

The results show an average level of satisfaction with suppliers, although 43.25% are satisfied with the quality of inputs, almost 50% are impartial, suggesting that inputs are barely adequate,

as confirmed by Asohofrucol (2018) in terms of gaps in standardization and quality assurance in agricultural inputs in Colombia.

3. Making (Production, harvesting, post-harvesting, and processing)

70.27% of respondents highlight the importance of crop rotation, as explained by Chaparro (2017), who states that producers have a growing ecological awareness. However, 24% consider that there is a low level of modern technology uptake, as corroborated by MinAgricultura (2020) in a diagnostic study on agricultural modernization. For 54.05% of producers, harvesting and storage is a good practice and generates relative strength.

4. **Deliver (Distribution and marketing**)

The results at this level reveal major weaknesses in Boyacá's horticultural system. 67.58% indicate that transport costs are unfair and storage infrastructure is inadequate, bottlenecks that affect product competitiveness and increase losses; a situation confirmed by the SIPSA Report (2024), which reveals logistical problems in medium-production areas such as Boyacá. In terms of marketing, 67.57% of respondents identified problems with channels and effective promotion, reinforced by Chaparro (2017), whose study found weak links with urban and institutional markets, as well as poor customer follow-up and loyalty.

5. Returns (Handling of complaints and defective products)

Although this item was not investigated, a low level of post-sale follow-up was identified, along with insufficient traceability and feedback to producers, which is consistent with the findings of Manrique et al. (2019) in Colombian agri-food chains.

Although the study does not provide direct data on returns or complaints management, it does reveal a poor perception of customer follow-up, which is an essential part of this component. Low post-sale engagement means that many producers lack crucial information about consumer acceptance, rejection, or dissatisfaction, which weakens learning and continuous improvement.

CONCLUSIONS

It can be inferred that the majority of horticultural producers in Boyacá operate under traditional schemes, with limited strategic planning and low adoption of advanced cultivation technologies. There is a moderate perception of the quality of inputs and the reliability of suppliers.

The relative use of crop rotation contrasts with the persistent limitation in the absorption of high-yield technologies, which restricts the productive potential of the territory. Furthermore, difficulties in the distribution and marketing phases, such as high transportation costs, deficiencies in storage infrastructure, limited variety of commercial channels, and ineffective marketing strategies, prevent the adoption and consolidation of solid commercial relationships.

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