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Agribusiness Value Chain Analysis of Guava from Producer Perspectives in Taluka and District Larkana Sindh Pakistan

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Abstract

Guava production in Larkana, Sindh, plays a crucial role in regional agriculture, yet several constraints limit its efficiency and market potential. This study examines the guava value chain from a producer's perspective, identifying challenges in input procurement, technology adoption, market infrastructure, transportation, storage, and export opportunities. A survey of 120 guava farmers using structured interviews provided primary data, analyzed through Microsoft Excel and KoboCollect. The findings indicate that essential inputs such as seeds, fertilizers, and machinery are widely accessible (Mean=4.89, Standard Deviation=0.31), with well-established maintenance services (M=4.72, SD=0.45). However, financial constraints persist due to limited access to subsidized inputs (M=1.88, SD=0.82) and moderate availability of credit facilities (M=3.21, SD=1.34). Compliance with input regulations is strong (M=4.47, SD=0.61), but adoption of modern technologies (M=2.12, SD=1.30) and awareness of export standards (M=1.51, SD=0.74) remain low. While transportation is efficient (M=4.92, SD=0.28), the lack of cold chain logistics (M=1.02, SD=0.13) and subsidized transport (M=1.49, SD=0.74) restrict export potential. Storage facilities exist (M=4.88, SD=0.33), but cold storage (M=1.32, SD=0.96) and food processing industries (M=1.00, SD=0.00) are nearly absent. Export market access is weak (M=2.22, SD=1.58), with limited knowledge of export policies (M=1.27, SD=0.78) and quality standards (M=1.18, SD=0.68). Government and NGO support is inadequate (M=1.45, SD=1.23), and financial transparency is low. The study recommends strengthening financial support, investing in cold storage and processing, promoting technology adoption, improving export policies, and expanding digital solutions to enhance productivity and market access.

Keywords: Guava Value Chain, Agribusiness Analysis, ProducerPerspectives, Larkana Guava Production, Post-Harvest Challenges, Sindh.

INTRODUCTION

The global population is growing at an accelerating rate and is projected to surpass 9 billion by 2050, necessitating a minimum 70% increase in food production to meet demand (Ammar et al., 2024). Agricultural value chains (VCs) are pivotal in advancing sustainable and equitable food systems. Yet, in developing nations, small-scale farmers frequently encounter obstacles that hinder their full participation in both local and international markets due to inefficiencies in the market. Climate change further aggravates these vulnerabilities, making it even more difficult to establish a resilient and inclusive food system (Gómez et al., 2020). A value chain represents the complete sequence of steps required to create a product or service, covering the entire process from its initial development to manufacturing, distribution, and eventual disposal. In contrast to conventional frameworks that prioritize production efficiency, this model underscores how each phase contributes to enhancing value (Thakur et

al., 2024). It provides a holistic framework that accounts for all goods and services involved in delivering an agricultural product from the farm to the final consumer (Pathak, 2019).The agricultural value chain comprises interconnected stages that guide the flow of farm-based commodities or services, including resource provision, cultivation, post-harvest processing, promotion, retail, and consumption. In order to maintain quality standards at every stage involves various stakeholders, such as suppliers, farmers, processors, marketers, customers, and service providers. In many developing and emerging nations, agricultural value chains have experienced considerable growth and structural changes in recent years. Studies recommend that these changes are largely driven by increasing consumer demand for processed and high-value foods, in addition to concerns about food safety, quality, and convenience factors influenced by urbanization and rising wealth (Ma et al., 2023).

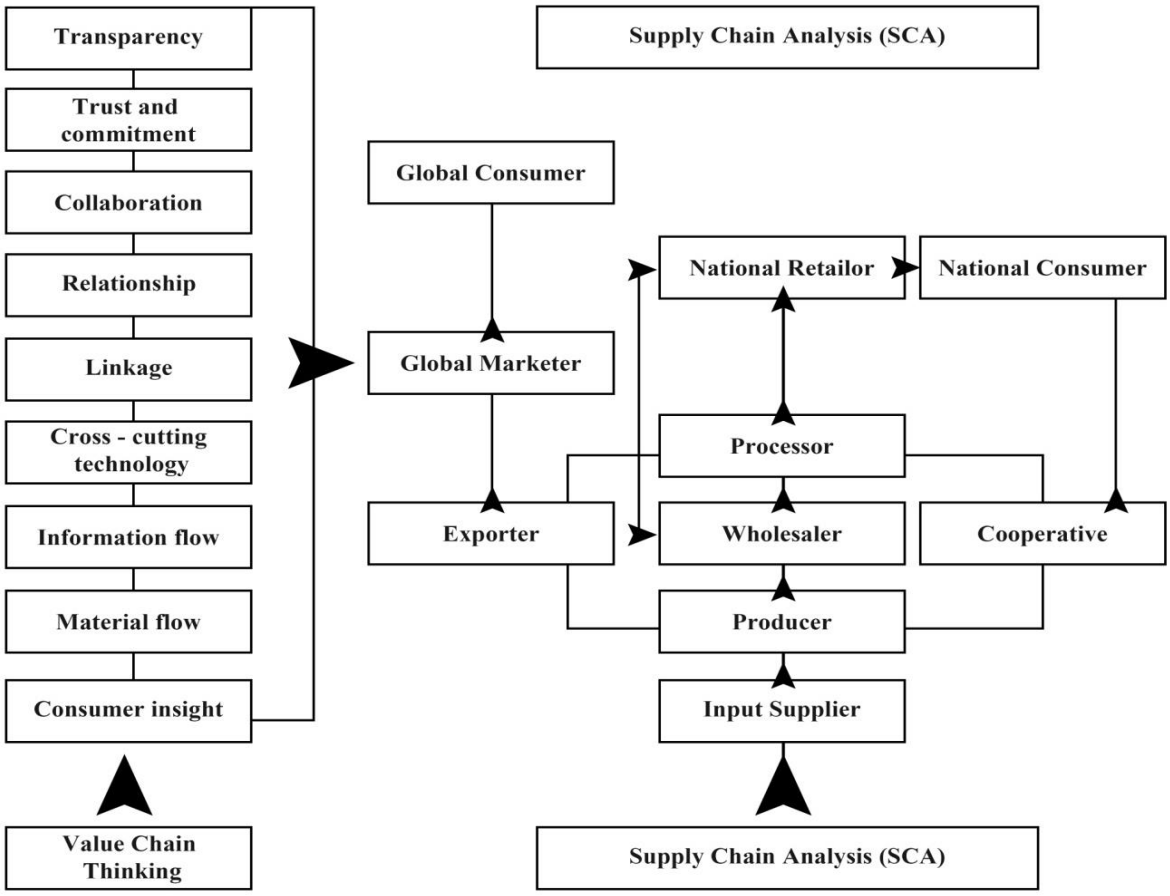

Figure 1.
Supply chain analysis to value chain thinking

The guava value chain framework includes consumer insights, material flow, technology, linkages, collaboration, trust, commitment, and transparency in (Fig. 1). This model, which aligns with the approach, used by Imtiyaz and Soni (2016) in their investigation of guava supply chains particularly those of growers, vendors, and buyers to identify systemic strengths and challenges.The study aimed to explore stakeholder views on multiple dimensions of the value chain. These encompassed the sourcing and application of farming resources, accessibility to technology, market infrastructure, logistical and warehousing capacities, the maturity of food processing sectors, potential for international trade, and cross-functional elements like transparency, trust-building and collaborative networks. To assess these factors,

multiple indicators were measured for each variable using a five-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree).

Importance of guava

Guava *(Psidium guajava Linn.)* is one of the most nutritious and high value fruit crop for the nutritional security of country. It is originated in tropical America. Being a very hard crop, it can be successfully grown with very little care (Singh et al., 2020a).Guava is an arborescent shrub or a small tree and is one of the popular fruits of the Sindh, Pakistan. It belongs to the family *Myrtaceae* and is one of the most gregarious of fruit trees. The place of origin of the guava is believed to be an area extending from the Southren part of Mexico up to the Central part of America. It has been disseminated by man, birds and other animals to all warm areas of tropical America and the West Indies. The guava fruit is a berry with a large seedy core. The fruit may be smooth or ridgy and waxy. Guava is ashallow rooted shrub with spreading branches. The height is generally 4-5 meters but older trees may reach a height of 9 meters (Bokhari, 2009). This tree can be able to give great profit and valuable quality fruit by diverse climate (Abbasi et al., 2015).

Guava is a highly nutritious and flavorful fruit, often referred to as the "poor man's apple" due to its health benefits and affordability (Sahu et al., 2025). It is available throughout the year since the tree produces fruit twice annually and requires minimal marketing expenses. Its vibrant color, uniform size, symmetrical shape, aromatic scent, and distinctive taste contribute to its widespread consumer appeal. In addition to its rich nutritional content and delightful flavor, guava also has medicinal benefits and holds great promise in the food processing industry for creating high-quality products. Despite these advantages, its commercial growth is hindered by a short post-harvest lifespan. Recent surges in global and local demand underscore the urgency to develop preservation techniques that improve its market longevity and economic potential (Noonari et al., 2016; Basheer et al.,2024).

Economic scenario of guava

Pakistan is the world's sixth-largest guava producer, yielding about 796,906 tons annually across 53,853 hectares. Over the past two years, guava production has remained consistent at 807 tons in both 2022 and 2023 (GoP, 2024). The country primarily exports guavas to the United Arab Emirates, the United Kingdom, KSA, Qatar, and Canada, with Canada alone receiving 56% of total exports. Globally, Pakistan holds the position of the second-largest guava-producing nation, trailing only India (GoP, 2023). Sindh ranks as Pakistan's second-leading region for guava cultivation, yielding approximately 52,918 tons annually across 5,578 hectares. The Guava thrives throughout the province due to its ability to adapt to diverse soil types and climatic conditions. Fruit is harvested in two primary seasons: winter, spanning from November to March, and summer, which lasts from April to mid-August.

Among these, the winter crop is considered more valuable and profitable for farmers. Larkana is the leading guava-producing district in Sindh, with cultivation spanning 3,232 hectares and an annual yield of 31,084 tons (GoP, 2024). Other key production areas include Hyderabad, Naushahro Feroze, Shaheed Benazirabad, and Mirpurkhas. The region from Madeji to Mohenjo-Daro is particularly known for its premium-quality guava. Popular guava varieties grown in Sindh include Riyali, Sindhi, Seedless, Ramzani, Allahabad, and Benazir (GoS, 2020). Despite its significant contribution to guava production, Sindh remains the second-largest agricultural province in Pakistan

(Hassan, S. G, 2021).Though the guava production plays a crucial role in Larkana's agricultural economy as it significantly contributes to the region's economic prosperity and nutritional well-being, but majority of the farmers have lack of knowledge regarding the recommended guava production practices such as irrigation, major diseases, insect pest and pruning of plant, low knowledge about treatment, disease control, insecticides, mulching, training of plant and post-harvest which intern impact the socioeconomic conditions of the farmers (Abbasi et al., 2015). The study was conducted at district Larkana in the year 2024-25 with the objective of gaining insight into agribusiness value chain analysis of guava from producer perspectives. Based on the forthcoming analysis, it can be anticipated that the cultivation of guava in taluka Larkana was prove to be economically viable, not only for farmers but also for entrepreneurs interested in commercial guava cultivation. However, it is essential to note that potential benefits such as higher employment generation and additional returns from introducing vegetables as intercrops have not been considered in this estimation of economic viability. Addressing these aspects in future studies could further strengthen the agribusiness and economic potential of guava cultivation in the region.

MATERIALS AND METHODS

Taluka Larkana is purposively selected for present study because guava being major fruit for the area.

Study area and sampling size

District Larkana is well-known for guava and rich in guava cultivated land in all other guava productive areas of Sindh. There are five main villages in Larkana here guava is produced i.e Choharpur, Akil, Kehar, Mahotta and Aghani (Abbasi et al. 2015).Due to the time and financial constraint present study was limited to taluka Larkana a sample of total 120 guava growers was selected from the taluka. A purposive sample of 120 guava farmers was participated in structured interviews using a tailored questionnaire, Imtiyaz and Soni (2016) employed the same questionnaire to predict the value chain analysis of guava: producer, retailer and consumer perspectives.

The primary data was collected with the help of personal interviews in the light of objectives of the study. The most significant aspect of survey process is development of questions; questionnaire for guava growers was designed for the current research. The questionnaire was developed with the help of supervisor including questions on procuring inputs, adopting technology for guava production, export markets, market infrastructure, transportation, storage, processing facilities, stakeholders' information, material flow and consumer perspectives.

Data Analysis

The data were organized and structured using Microsoft Excel and analyzed in SPSS (Statistical Package of Social Sciences), supplemented by data collected through KoboCollect. Descriptive statistics, such as frequencies and percentages, were used to identify barriers and opportunities within the value chain and suggest improvements for farmer participation.In addition to descriptive statistics, a Likert scale methodology was applied to gather participants' perceptions and attitudes on various aspects of the value chain. The Likert scale responses, ranging from strong agreement to strong disagreement, allowed for the quantification of subjective data, highlighting key issues from the farmers' perspectives. In SPSS, numerical responses were numerically

coded to facilitate aggregation and analysis, allowing for the computation of standard deviations, medians and means and to evaluate patterns and variability.

Mean and Median in the Analysis

The average response of the participants was determined by calculating the mean, which provided insight into broad tendencies. The following formula was used to determine the mean:

Mean = $\frac{X_i}{N}$

Where:

X_iRepresented all of the response,

NIndicated the number of responses there were throughout.

Conversely, the median was employed to determine the responses' center tendency, lessening the impact of extreme numbers. The following is how the median was calculated:

For an odd quantity of answers:

The middle value of the ordered data is the median for an even quantity of answers

For an even quantity of answers:

Median=$\frac{\text{The middle value of the data that is ordered}}{2}$

In situations where the data were skewed, the median was especially helpful because it guaranteed a more accurate depiction of the participants' opinions.

Standard Deviation in the Analysis

The standard deviation (σ), which measures the variation of responses around the mean, was computed using the following formula:

$\Sigma = \sqrt{\frac{(X_i - \bar{X})^2}{N}}$

Where:

- $X_i$represents each individual response,
- $\bar{X}$is the mean of the responses,
- N is the total number of responses.

By showing how much responses varied from the mean, the standard deviation shed light on the participants' perception variability. Although a lower number implied that answers were more concentrated around the mean, a higher standard deviation suggested greater variability.

Function of KoboCollect in calculating mean and standard deviation

KoboCollect, which recorded responses in real time straight from the field, was essential to the data collection process. The mean and median were then automatically calculated from the collected data. Applying statistical functions was made simpler by KoboCollect's ability to organize numerical responses. A thorough and trustworthy comprehension of the farmers' viewpoints was ensured by the effective computation of central tendency measures made possible by the integration of KoboCollect (Mahmood et al.,2016). The study's use of KoboCollect guaranteed a thorough analytical methodology, successfully highlighting the value chain's advantages and disadvantages and assisting with focused actions to improve farmer efficiency and involvement.

RESULTS

The study was carried out in 2025, to examine the guava agricultural value chain from the viewpoint of producers in the districts and taluka of Larkana, Sindh, Pakistan. A total of 120 respondents participated in the study, and data were collected using the KoboCollect tool.

Table 1.
Agricultural inputs

Variables	Respondent Likert Score	
	Mean	Standard deviation
• Availability of agricultural inputs like fertilizers, chemicals, electricity, fuel, labor, and machinery	4.89	0.31
• Accessibility of maintenance services for farm machinery and equipment	4.72	0.45
• Subsidy on agricultural inputs	1.88	0.82
• Credit facilities for purchasing agricultural inputs	3.21	1.34
• Chemicals and fertilizers follows national and international standards	4.47	0.61
• Availability of information on the right timing and quantity of agricultural inputs	4.63	0.66

This table 4.1 indicates that agricultural inputs such as seeds, fertilizers, chemicals, fuel, manpower, and farm machinery are highly accessible, with a mean score of 4.89 and a low standard deviation of 0.31, suggesting strong agreement among respondents. Similarly, maintenance services for farm equipment and machines are readily available (M=4.72, SD=0.45). However, the table reveals that agricultural inputs are not widely available at subsidized rates, as indicated by a low mean score of 1.88 with a standard deviation of 0.82. Access to credit facilities for purchasing agricultural inputs is moderate (M=3.21, SD=1.34), suggesting variability in responses. Furthermore, the application of chemicals and fertilizers is largely in compliance with national and international regulations (M=4.47, SD=0.61). The availability of information regarding the appropriate timing and amount of agricultural inputs is also well established (M=4.63, SD=0.66) (Rasheed et al.,2024).

The table 4.2 shows that the availability of appropriate and modern technology for guava production is quite limited, with a low mean score of 2.12 and a standard deviation of 1.30, indicating that respondents generally lack access to advanced agricultural technology. Similarly, awareness of modern technology is low (M=2.26, SD=1.36), and training in the use of such technology is even scarcer (M=1.63, SD=0.94). The availability of technology specifically designed for export-quality guava production is also significantly low (M=1.51, SD=0.74).

Table2.
Availability and adoption of technology

Variables	Respondent Likert Score	
	Mean	Standard deviation
• Appropriate and modern technology for guava production	2.12	1.30
• Knowledge of suitable and advanced technology	2.26	1.36
• Training to use modern technology for guava production	1.63	0.94
• Advanced technology for producing export quality guavas	1.51	0.74

• Information for national and international standard, regulations, and laws related to agricultural technology	2.26	1.32

Moreover, awareness of international and national standards and regulations regarding agricultural technology remains limited (M=2.26, SD=1.32). These findings highlight a significant gap in technological adoption and awareness in guava farming.

Table 3.
Market infrastructure

Variables	Respondent Likert Score	
	Mean	Standard deviation
• Proper road connectivity between the farm and the market	4.99	0.09
• Storage, display, grading, packaging, and banking facilities in the market	4.45	0.59
• Reasonability of commission charged by the commission agent	1.95	1.25
• Export facilities within the market	2.51	1.49
• Transparency and satisfaction in business activities in the marketing process	2.26	1.20
• Accessibility to cooperative marketing and supermarket facilities	2.44	1.67

The data in table 4.3 suggests that proper road connectivity between farms and markets is almost universally available, with a mean score of 4.99 and a very low standard deviation of 0.09, indicating near-unanimous agreement among respondents. Storage, display, grading, packaging, and banking facilities within the market premises are also well established (M=4.45, SD=0.59). However, the commission charged by agents is generally considered unreasonable, as reflected in a low mean score of 1.95 with a high standard deviation of 1.25, suggesting varied perceptions among respondents (Ayuningsih et al.,2024).

Additionally, the table shows that export facilities within the market are moderately available (M=2.51, SD=1.49), and transparency in business activities related to the marketing process is relatively low (M=2.26, SD=1.20). Furthermore, cooperative marketing and supermarket facilities are not widely available (M=2.44, SD=1.67), indicating a lack of structured marketing support for guava producers. The findings in table 4.4 indicate that roads for efficient transportation of fresh guava are widely available, with a high mean score of 4.92 and a low standard deviation of 0.28. Similarly, cooperative transportation systems are well-established, as reflected by a mean of 4.86 SD=0.42.

Table 4.
Transportation facilities

Variables	Respondent Likert Score	
	Mean	Standard Deviation
• Transport agencies at reasonable rates	2.75	1.32
• Maintenance of roads for the efficient transportation of fresh guavas	4.92	0.28
• Accessibility to cold chain transportation facilities	1.02	0.13
• Subsidized transportation services	1.49	0.74
• A cooperative transportation system is in place.	4.86	0.42

However, the table also shows that transport agencies are only moderately available at reasonable rates (M=2.75, SD=1.32), suggesting that some farmers may face

challenges in accessing affordable transportation services. Moreover, cold chain transportation facilities are virtually non-existent (M=1.02, SD=0.13), and subsidized transportation options are also very limited (M=1.49, SD=0.74). These results suggest that while basic road infrastructure is available, specialized transportation services, such as cold chain logistics, remain underdeveloped.

Table 5.
Storage facilities

Variables	Respondent Likert Score	
	Mean	Standard Deviation
• Normal storage facilities on the farm or in nearby areas	4.88	0.33
• Accessibility to cold storage facilities on the farm or in nearby areas	1.32	0.96
• Adequate storage facilities in the marketplace	4.15	0.99
• Cold storage facilities at the marketplace	3.60	1.23
• Storage facilities comply with government regulations	1.99	1.27
• Subsidized storage facilities	1.25	0.54

According to table 4.5 normal storage facilities are widely available in farming areas, as indicated by a mean score of 4.88 and a low standard deviation of 0.33. However, cold storage facilities at farms are largely unavailable (M=1.32, SD=0.96), highlighting a significant challenge for post-harvest management. The table further shows that storage facilities at marketplaces are relatively adequate (M=4.15, SD=0.99), although cold storage facilities at these locations are less accessible (M=3.60, SD=1.23). Compliance with government storage regulations appears to be moderate (M=1.99, SD=1.27), while subsidized storage facilities are nearly non-existent (M=1.25, SD=0.54). These findings suggest that while general storage facilities are accessible, cold storage infrastructure remains a major limitation (Huo et al.,2024).

The table 4.6 demonstrates that the presence of food processing industries in the district, city, or farm is almost non-existent, with a mean score of 1.00 and no variation (0.00). Similarly, contract farming agreements with food processing units are not present (M=1.00, SD=0.00). However, selling guava to food processing industries is considered moderately profitable (M=3.52, SD=1.12), indicating that while opportunities exist, access to processing facilities remains a challenge. The table also indicates that financial support from the food processing industry is minimal (M=1.23, SD=0.64), and information regarding international laws and regulations for guava production, storage, and quality is rarely provided (M=1.50, SD=1.11).

Table 6.
Food processing industry

Variables	Respondent Likert Score	
	Mean	Standard Deviation
• Availability of food processing industries in the district, city, or farm areas	1.00	0.00
• Producers contract farming agreements with food processing industries or units	1.00	0.00
• Selling guavas to food processing industries can be profitable	3.52	1.12
• The food processing industry provides loans for guava production	1.23	0.64
• The food processing industry offers information and guidance on international laws and regulations for production, storage, quality, and safety requirements for guavas.	1.50	1.11

These findings suggest a weak link between guava producers and the food processing sector. The results in table 4.7 indicate that the availability of an export

market for fresh guava in the district or city is relatively low (M=2.22, SD=1.58). However, the table also reveals that selling guava for export is perceived as highly profitable (M=4.56, SD=0.83), suggesting that farmers recognize its economic potential despite accessibility challenges (Basheer et al.,2024). Information regarding export policies and technical knowledge for export-quality guava production is largely unavailable (M=1.27, SD=0.78), and awareness of importing countries' quality and safety requirements is also minimal (M=1.18, SD=0.68).

Table 7.
Export Market

Variables	Respondent Likert Score	
	Mean	Standard Deviation
• An export market for fresh guavas in the district or city.	2.22	1.58
• Selling fresh guavas for export can be more profitable	4.56	0.83
• The government, NGOs, or chain partners provide information on export policies and technical knowledge for producing export-quality guavas.	1.27	0.78
• Information on quality and safety standards for fresh guavas in importing countries is provided by the government, NGOs, chain partners, or exporters.	1.18	0.68
• The government, NGOs, or chain partners offer logistic support for transporting fresh guavas to the export market.	1.45	1.23
• Small and marginal guava producers have access to the export market.	1.03	0.37

Furthermore, the table shows that government, NGOs, and chain partners provide little logistical support for export (M=1.45, SD=1.23), and small-scale producers have almost no access to export markets (M=1.03, SD=0.37). These findings highlight a significant gap in the availability of export infrastructure and market access for guava producers.The results in table 4.8 indicate that the reception of information regarding new technology for guava production from government agencies and chain partners is relatively low (M=1.68, SD=1.32). However, the table also reveals that farmers receive adequate information on market demand and market prices of fresh guava from chain partners (M=4.03, SD=1.36), suggesting that market-related insights are more readily available compared to production innovations.Furthermore, the table shows that information on quality and safety requirements for the local market is well-communicated (M=4.06, SD=1.10), while overall information sharing among chain partners is perceived as good (M=4.16, SD=0.73).

Table 8.
Information flow

Variables	Respondent Likert Score	
	Mean	Standard deviation
• Obtained information about new technologies for guava production from the government or supply chain partners.	1.68	1.32
• Supply chain partners provide updates on market demand and fresh guava prices.	4.03	1.36
• Received details on quality and safety standards for fresh guavas in the local market from supply chain partners.	4.06	1.10
• The exchange of information among supply chain partners is effective.	4.16	0.73
• Informed about profit-sharing arrangements among supply chain partners.	2.97	1.21

• Received guidance from supply chain partners on the transportation, storage, and packaging of fresh guavas.	4.35	0.76

In contrast, information regarding profit-sharing among chain partners is relatively lower (M=2.97, SD=1.21), indicating that financial transparency remains a challenge.Moreover, the table also shows that data about packaging, storage, and transportation is evenly distributed (M=4.35, SD=0.76), indicating a systematic flow of logistical data. These results indicate that although logistical and market-related information is effectively exchanged, there are notable deficiencies in financial transparency and technology adoption.

Table 9.
Material flow

Variables	Respondent Likert Score	
	Mean	**Standard deviation**
• Availability of agricultural inputs like farm machinery, irrigation, fertilizers, and chemicals on time for land preparation and guava production.	4.82	0.39
• Adequate storage facilities for storing harvested guavas	4.04	1.60
• Harvested guavas delivered to the market on time	4.72	0.45
• Harvested guavas are promptly supplied to chain partners and consumers.	4.96	0.20
• Efficient material flow enhanced consumer satisfaction, improves chain efficiency, and strengthens relationships among chain partners.	4.96	0.27

The data presented in table 4.9 highlights that agricultural inputs, such as farm machinery, irrigation systems, seeds, fertilizers, and chemicals, are widely accessible for land preparation and guava cultivation (M=4.82, SD=0.39), indicating a well-established input supply system. Yet, the data also resulted that suitable storage facilities for harvested guava are less available (M=4.04, SD=1.60), pointing to inconsistencies in post-harvest infrastructure. Additionally, study reveals that transportation of harvested guava to markets is highly efficient (M=4.72, SD=0.45), with an even more dependable supply to chain partners and consumers (M=4.96, SD=0.20). Moreover, the results emphasize that a smooth material flow plays a crucial role in enhancing consumer satisfaction, improving chain efficiency, and strengthening relationships among supply chain partners (M=4.96, SD=0.27). These outcomes imply that while input accessibility and distribution mechanisms operate effectively, inadequate storage infrastructure may hinder post-harvest processes, posing a critical challenge within the supply chain.

Table 10.
Transparency

Variables	Respondent Likert Score	
	Mean	**Standard deviation**
• The information provided by input suppliers is accurate, genuine, and reliable.	3.47	1.45
• Information on production, marketing, and profit is shared among chain partners.	3.25	1.34
• Tracing and verifying regarding input application, cultivation methods, and production processes.	3.18	1.23
• Transparency of supply chain activities, profit sharing, and risk distribution among chain partners.	2.23	0.97

• Quality and safety standards for fresh guava production are clearly defined and transparent.	4.08	0.96

The findings in table 4.10 suggest that input sources offer information that is somewhat accurate, authentic, and trustworthy (M=3.47, SD=1.45). In contrast, cooperative sharing of financial, operational, and promotional information amongst supply chain actors is rather limited (Mean=3.25, SD=1.34), suggesting a lack of transparency in financial concerns. The table also shows that while there is still some accountability for agricultural practices, resource use, and manufacturing procedures (Mean=3.18, SD=1.23), there is still very little insight into revenue distribution, logistical coordination, and cooperative risk management (Mean=2.23, SD=0.97). Notably, compliance with agricultural quality and safety regulations shows comparatively clear implementation (Mean=4.08, SD=0.96), demonstrating stricter oversight in this domain.

The data reveals a notable disparity between fiscal/operational openness and quality control enforcement. Regarding distribution networks, the table suggests moderately developed direct supply channels to retail outlets, collective marketplaces, processing facilities, and resource providers (Mean=3.32, SD=1.82). Crucially, the analysis demonstrates that streamlined market integration substantially lowers operational expenses while boosting earnings (Mean=4.35, SD=0.92), underscoring market connectivity's critical impact on economic outcomes. Additionally, the data illustrates that shortened supply chains enable growers to maintain consumer-friendly pricing (Mean=4.94, SD=0.27) and guarantee product freshness (Mean=4.92, SD=0.26). The analysis emphasizes that although direct market channels improve pricing advantages and freshness, producer access to these networks remains inconsistent.

Table 4.11 shows that fresh guava is relatively established in terms of direct supply to supermarkets, cooperative markets, food processing enterprises, and input suppliers (M=3.32, SD=1.82). The chart does, however, also show that direct connections with prospective markets greatly lower transaction costs and boost profitability (M=4.35, SD=0.92), indicating that market access is a critical component of financial performance. Furthermore, the table shows that direct linkages allow producers to offer competitive prices to consumers (M=4.94, SD=0.27) and ensure that consumers receive fresh guavas (M=4.92, SD=0.26).

Table 11.
Linkage

Variables	Respondent Likert Score	
	Mean	**Standard deviation**
• Fresh guavas supply directly to supermarkets, cooperative markets, food processing industries, and input suppliers.	3.32	1.82
• Having a direct linkage with potential markets reduces transaction costs and significantly improves profitability.	4.35	0.92
• A direct connection with potential markets allows producers to offer competitive prices to consumers.	4.94	0.27
• Consumers receive fresher guavas due to producers' direct linkage with potential markets.	4.92	0.26

These findings highlight that while direct market connections enhance price competitiveness and product freshness, accessibility to such linkages varies among producers.

The results in table 4.12 indicate that the commitment to maintaining long-term relationships with financial institutions is relatively moderate (M=2.63, SD=1.83),

suggesting that while some engagement exists; trust and dependency on financial organizations remain limited. Furthermore, the table reveals that commitment to long-term relationships with government agencies is notably low (M=1.01, SD=0.09), indicating minimal interaction or reliance on public sector support.Additionally, the table shows that producers exhibit a moderate level of commitment to maintaining long-term relationships with input suppliers (M=3.25, SD=1.89) and an even stronger commitment towards wholesalers and retailers (M=3.74, SD=1.58).

Table 12.
Relationship

Variables	Respondent Likert Score	
	Mean	Standard deviation
• Producers' commitment to maintaining a long-term relationship with financial institutions	2.63	1.83
• Producers' dedication to building a long-term partnership with government agencies.	1.01	0.09
• Producers prioritize a long-term relationship with input suppliers.	3.25	1.89
• Producers committed to sustaining a long-term partnership with wholesalers and retailers.	3.74	1.58
• Producers strive for a long-term association with the food processing industry, exporters, and supermarkets.	1.00	0.00
• Producers devoted to fostering long-term collaboration with chain partners.	2.77	1.82
• Producers' joint investments with input suppliers, the food processing industry, or chain partners.	1.00	0.00

However, the table highlights that commitment to long-term relationships with food processing industries, exporters, and supermarkets is almost nonexistent (M=1.00, SD=0.00), suggesting a lack of integration with higher-value market segments. Moreover, the results indicate that commitment to long-term relationships with chain partners is relatively low (M=2.77, SD=1.82), and joint investments with input suppliers, food processing industries, or other chain partners are virtually absent (M=1.00, SD=0.00). These findings suggest that while there is a moderate level of relationship-building with local market actors, there is a significant gap in forming long-term collaborations with larger industry players, financial institutions, and government agencies.

Table 13.
Collaboration

Variables	Respondent Likert Score	
	Mean	Standard deviation
• Agreement with the bank for loans to purchase agricultural inputs and machinery.	2.33	1.82
• Input supplier has an agreement with producers to ensure the timely supply of adequate agricultural inputs for guava production.	1.29	0.81
• Chain partners exchange relevant and accurate information on guava production and marketing in a timely manner.	3.18	1.70
• Chain partners share both the risks and benefits associated with guava production and marketing.	1.52	0.87
• Chain partners collaborate to share knowledge and information on the forecast of fresh guava supply and demand.	4.77	0.42
• Chain partners work together to identify new and potential markets for fresh guava.	4.72	0.45

The results in table 4.13 indicate that agreements with banks to provide loans for purchasing agricultural inputs and machinery are relatively weak (M=2.33, SD=1.82), suggesting financial constraints in accessing credit. Additionally, the table reveals that agreements with input suppliers for the timely provision of agricultural inputs are even lower (M=1.29, SD=0.81), highlighting potential inefficiencies in securing essential production resources. Furthermore, the table shows that the exchange of relevant and accurate information regarding guava production and marketing among chain partners is moderate (M=3.18, SD=1.70), indicating that while information flow exists, there is still room for improvement. In contrast, the table highlights that risk and benefit sharing among chain partners is considerably low (M=1.52, SD=0.87), reflecting a lack of collaborative financial security within the supply chain. However, the results indicate that chain partners actively share knowledge and information regarding the forecast of supply and demand for fresh guava (M=4.77, SD=0.42), and they also coordinate efforts to identify new and potential markets for fresh guava (M=4.72, SD=0.45). These findings suggest that while financial collaboration and risk-sharing remain weak, there is strong cooperation in market intelligence and expansion efforts, which could enhance the supply chain's overall competitiveness.

The results in table 4.14 indicate that financial institutions provide financial assistance for purchasing agricultural inputs in an untimely manner (M=2.10, SD=1.32). Similarly, the table reveals that government agencies provide minimal support in updating farmers with national and international laws, regulations, and subsidies (M=1.32, SD=0.93), suggesting that policy implementation and financial accessibility remain weak. Furthermore, the table shows that chain partners provide moderately effective logistical support for the timely delivery of fresh guava (M=3.33, SD=1.71). However, joint ventures and contract farming among chain partners are significantly lacking (M=1.12, SD=0.60), indicating a low level of collaborative investment.

Table 14.
Commitment and trust

Variables	Respondent Likert Score	
	Mean	Standard deviation
• Financial institutions provide timely financial assistance for purchasing agricultural inputs.	2.10	1.32
• Government agencies keep producers informed about national and international laws and regulations while also providing subsidies for guava production and marketing.	1.32	0.93
• Chain partners offer appropriate and cost-effective logistics for the timely delivery of fresh guavas.	3.33	1.71
• Chain partners engage in joint ventures or contract farming for guava production.	1.12	0.60
• Chain partners have agreements ensuring open communication in guava production and marketing.	2.17	1.27

The table also shows that there is still a lack of trust and coordination among supply chain participants, as seen by the weak open communication agreements in marketing and production (M=2.17, SD=1.27). These results imply that although there is some logistical assistance, long-term collaboration is limited by the general lack of commitment and confidence among stakeholders.

The findings in table 4.15, guava production uses very little sophisticated technology (M=1.87, SD=1.26), indicating that conventional cultivation techniques continue to be widely used. The chart also shows that there is limited use of improved packaging techniques to reduce losses during storage and transit (M=2.50, SD=1.54). Nonetheless, the table demonstrates that farmers are aware of the effectiveness of digital platforms

for sales and promotion, as evidenced by the much higher usage of information and communication technology (ICT) for guava marketing (M=4.41, SD=0.70).

Table15.
Cutting edge technology

Variables	Respondent Likert Score	
	Mean	Standard deviation
• Use of advanced technology for guava production to reduce cultivation costs.	1.87	1.26
• Utilization of advanced packaging technology to minimize losses during transportation and storage of fresh guavas.	2.50	1.54
• Leverage information and communication technology (ICT) for guava marketing to save time and reduce costs.	4.41	0.70
• Producers apply ICT to understand consumer needs and preferences for fresh guavas.	4.47	0.59

Additionally, ICT is utilized to better understand customer preferences and enhance product quality (M=4.47, SD=0.59). These results show that although production and packaging innovations are still underutilized, technology is increasingly being used in market operations.

Table 16.
Consumer insight

Variables	Respondent Likert Score	
	Mean	Standard deviation
• Usage of recommended rates of fertilizers, insecticides, herbicides, and growth promoters in guava production to minimize health risks for consumers.	4.67	0.52
• Complying of national laws and regulations for guava production to ensure consumer safety.	4.67	0.58
• Awareness about consumer preferences regarding the quality and safety of fresh guavas.	4.84	0.43
• Follow of proper storage, packaging, and transportation methods for fresh guavas.	4.84	0.37
• Implementation of appropriate production, storage, and packaging techniques to maintain the taste, appearance, and competitive pricing of fresh guavas.	4.94	0.24
• Collaboration with various stakeholders in the fresh guava supply chain to enhance overall consumer satisfaction.	4.93	0.25

The results in table 4.16 indicate that producers actively follow recommended guidelines for fertilizers, insecticides, and growth promoters to minimize health risks for consumers (M=4.67, SD=0.52). A high degree of attention to safety standards is suggested by the table's strong compliance with national laws and regulations for guava production (M=4.67, SD=0.58). Additionally, the table demonstrates that manufacturers rigorously adhere to proper storage, packaging, and shipping procedures (M=4.84, SD=0.37) and are well aware of consumer preferences regarding guava quality and safety (M=4.84, SD=0.43). Furthermore, the findings show that producers use appropriate methods to preserve the flavor, appearance, and competitive price of guava (M=4.94, SD=0.24) and collaborate with different supply chain participants to improve customer satisfaction (M=4.93, SD=0.25). These results point to a robust consumer-focused strategy that guarantees both quality and legal compliance.

DISCUSSION

Agricultural inputs

The study supports the accessibility of essential agricultural inputs such seeds, fertilizer, chemicals, gasoline, labor, and farm equipment, and it is consistent with previous research on the guava value chain. Maintenance services for farm equipment are also readily available, supporting prior research by Imtiyaz and Soni (2016). However, bot the literature and current findings highlight a critical gap in financial support, as subsidies for agricultural inputs remain largely unavailable, and access to credit facilities is inconsistent, limiting farmers' purchasing power. Encouragingly, this study indicates that farmers are largely compliant with national and international regulations regarding fertilizer and chemical application, contradicting earlier findings that suggested a lack of awareness. Additionally, the widespread availability of information on the appropriate timing and quantity of agricultural inputs suggests improved coordination between farmers, chain partners, and government agencies. While these findings indicate progress in certain areas, persistent financial constraints continue to challenge guava farmers, underscoring the need for policy interventions to enhance access to credit and subsidies for sustainable production and market competitiveness.

Availability and adoption of technology

The most relevant study in this area of researched by Noonari et al. (2016) highlighted the need to develop and promote appropriate technologies for the production, processing, and utilization of guava and its by-products. The findings suggest a significant gap in the adoption of modern agricultural technology for guava production. The availability of appropriate technology remains limited (Mean=2.12, Standard Deviation=1.30), with low levels of awareness (M=2.26, SD=1.36) and inadequate training (M=1.63, SD=0.94). Furthermore, export-quality guava production technology is almost non-existent (M=1.51, SD=0.74), restricting farmers' ability to compete in international markets. Awareness of national and international standards regarding agricultural technology is also low (M=2.26, SD=1.32). These findings highlight the need for increased efforts in technology dissemination, farmer training, and policy interventions to promote the adoption of modern farming techniques.

Market infrastructure

Gopal (2024) conducted a study highlighting that large-scale guava producers typically sell their orchards to pre-harvest contractors during the flowering stage through direct negotiations. Generally, 25% of the agreed amount is paid upfront by the contractors at the time of contract signing, while the remaining 75% is settled during the harvesting period. The study also emphasizes the strong road connectivity between farms and markets (Mean=4.99, Standard Deviation=0.09), facilitating efficient transportation of produce. Additionally, market infrastructure is well-developed, offering storage, grading, packaging, and banking facilities (M=4.45, SD=0.59). However, certain challenges persist, particularly regarding commission charges imposed by agents, which are often viewed as excessive (M=1.95, SD=1.25). Export facilities are moderately available (M=2.51, SD=1.49), and transparency in market transactions remains relatively low (M=2.26, SD=1.20). Furthermore, cooperative marketing and supermarket linkages are insufficient (M=2.44, SD=1.67), restricting farmers' access to structured and competitive markets. These findings highlight the need for greater transparency, market reforms, and enhanced support for export-driven guava production.

Transportation facilities

Liu et al. (2025) emphasized that the agricultural sector, particularly the agri-product supply chain, is a critical area of concern as it significantly impacts farmers' livelihoods, both directly and indirectly. While roads for fresh guava transportation are widely available (Mean=4.92, Standard Deviation=0.28) and cooperative transportation systems are well-developed (M=4.86, SD=0.42), challenges persist in affordable transport services (M=2.75, SD=1.32). Notably, cold chain transportation is virtually absent (M=1.02, SD=0.13), which poses a significant constraint for maintaining fruit quality, particularly for export purposes. Similarly, subsidized transportation is largely unavailable (M=1.49, SD=0.74), making logistics expensive for small and marginal farmers. These findings suggest that while general transportation infrastructure is adequate, the absence of cold chain facilities limits the potential for high-value guava marketing and exports.

Storage facilities

Normal storage facilities are widely available at farms and nearby areas (Mean=4.88, Standard Deviation=0.33), but cold storage facilities are significantly lacking (M=1.32, SD=0.96). At marketplaces, storage infrastructure is relatively adequate (M=4.15, SD=0.99), though access to cold storage remains moderate (M=3.60, SD=1.23). Compliance with government storage regulations appears to be inconsistent (M=1.99, SD=1.27), and subsidized storage facilities are nearly non-existent (M=1.25, SD=0.54). Similarly Gopal (2024) revealed that, a well-structured and scientific storage system is a crucial aspect of guava marketing, considering its highly perishable nature and the limited time it remains available in the market. These findings emphasize a critical need for investment in cold storage infrastructure to improve post-harvest management and reduce losses.

Food processing industry

Vikram et al. (2024) highlighted that the global guava puree market was valued at 313.8 million rupees in 2017, with a projected growth rate of 5.6:1 from 2017 to 2025. The segment is expected to maintain its significance in the food industry, particularly in the Asia-Pacific region, which is anticipated to witness the fastest growth from 2020 to 2025. However, despite the growing global demand for guava puree, the study area lacks food processing industries (Mean=1.00, Standard Deviation=0.00) and contract farming agreements with processing units (M=1.00, SD=0.00). While selling guava to processing industries is perceived as moderately profitable (M=3.52, SD=1.12), financial support (M=1.23, SD=0.64) and guidance on international quality and safety standards (M=1.50, SD=1.11) remain inadequate. These findings underscore the weak integration between guava producers and the processing industry, emphasizing the urgent need for industrial development, structured contract farming, and stronger linkages between farmers and value-added processing units.

Export market

Keerthika et al. (2024) highlighted the strong growth of processed fruit exports, emphasizing the need for advanced value-addition and packaging for guava. However, this study reveals that fresh guava exports remain limited (Mean=2.22, Standard Deviation=1.58) despite their high profitability (M=4.56, SD=0.83). Key challenges include inadequate access to export policies (M=1.27, SD=0.78),quality standards (M=1.18, SD=0.68), and insufficient logistical support from government and NGOs (M=1.45, SD=1.23). Small-scale farmers face significant barriers to market entry (M=1.03, SD=0.37). These findings emphasize the need for policy interventions to

improve market access, enhance information dissemination, and strengthen export logistics. Addressing these issues can better integrate fresh guava into global markets, aligning with the growth seen in processed fruit exports.

Information flow

Morepje et al. (2024) and Stoeva et al. (2024) highlighted the significant role of e-commerce platforms in promoting sustainable agriculture by equipping smallholder farmers with essential knowledge on eco-friendly practices such as integrated pest management, organic farming, and precision agriculture. Additionally, efficient information-sharing within supply chains improves farmers' understanding of product availability, quality standards, business operations, and consumer demand while enhancing transparency in profit distribution. The findings of this study support these insights, revealing that farmers receive sufficient market-related information from supply chain networks, particularly regarding market demand (Mean=4.03, Standard Deviation=1.36), local quality and safety standards (M=4.06, SD=1.10), and logistics, including transportation, storage, and packaging (M=4.35, SD=0.76). Moreover, strong collaboration exists among chain partners in information exchange (M=4.16, SD=0.73), demonstrating well-functioning communication channels. However, there are notable gaps in the dissemination of new agricultural technology (M=1.68, SD=1.32), which hinders the adoption of innovative and sustainable practices. Additionally, financial transparency remains limited, with restricted access to profit-sharing details (M=2.97, SD=1.21), potentially affecting fair participation in value chains. Addressing these challenges through improved technology transfer and financial transparency mechanisms can strengthen market efficiency and support sustainable agricultural development.

Material flow

The data highlight a well-functioning supply chain for guava production, with timely availability of agricultural inputs (Mean=4.82, Standard Deviation=0.39) and efficient delivery of harvested guava to markets (M=4.72, SD=0.45) and chain partners (M=4.96, SD=0.20). Additionally, efficient material flow enhances consumer satisfaction and strengthens chain relationships (M=4.96, SD=0.27). However, storage facilities for harvested guava remain a challenge (M=4.04, SD=1.60), reflecting inconsistencies in post-harvest handling. These findings suggest a need for enhanced storage solutions to further improve supply chain efficiency. By conducting a systematic literature review Toruan et al. (2025) provided insights that coordination also aids in optimizing material flow and delivery while enhancing product traceability.

Transparency

Jyothi and Kumar (2022) highlighted that transparency in agricultural marketing promotes crop diversification, ensures high-quality produce for consumers, stabilizes prices, and supports the growth of agro-based industries, especially in food processing, contributing to overall economic development. The findings of this study align with these insights, revealing that while input suppliers provide moderately reliable information (Mean=3.47, Standard Deviation=1.45), transparency in production, marketing, and profit-sharing among chain partners remains limited (M=3.25, SD=1.34). Supply chain visibility, including traceability of input use and cultivation methods, is also moderate (M=3.18, SD=1.23). Notably, financial collaboration is weak, with low transparency in profit- and risk-sharing (M=2.23, SD=0.97). However, quality and safety standards for fresh guava production are

relatively well enforced (M=4.08, SD=0.96). These findings underscore the need for improved financial and operational transparency to strengthen supply chain efficiency while maintaining high product standards.

Linkage

Kamal (2025) highlighted that the rapid growth of e-commerce in Indonesia has created new opportunities for expanding distribution channels and fostering direct engagement with consumers. Similarly, advancements in agricultural practices, such as improved farming and processing techniques, have enhanced product quality and shelf life, making them more appealing to premium markets. These insights align with the findings of this study, which indicate that the direct supply of fresh guava to supermarkets, cooperative markets, food processing industries, and input suppliers is only moderately established (Mean=3.32, Standard Deviation=1.82).

However, direct market linkages significantly reduce transaction costs and enhance profitability (M=4.35, SD=0.92), reinforcing the financial advantages of bypassing intermediaries. Additionally, such connections allow producers to offer competitive prices to consumers (M=4.94, SD=0.27) and ensure efficient delivery of fresh guavas (M=4.92, SD=0.26). While these direct supply channels provide substantial benefits, accessibility varies among producers, potentially limiting opportunities for smaller farmers to participate in these profitable arrangements.

Relationship

Commitment to long-term relationships with financial institutions is relatively moderate (Mean=2.63, Standard Deviation=1.83), suggesting some engagement but limited trust or dependency on financial entities. Additionally, commitment to long-term relationships with government agencies is strikingly low (M=1.01, SD=0.09), indicating minimal public sector involvement. While producers demonstrate a moderate commitment to input suppliers (M=3.25, SD=1.89) and even stronger ties with wholesalers and retailers (M=3.74, SD=1.58), long-term relationships with food processing industries, exporters, and supermarkets are nearly absent (M=1.00, SD=0.00). Moreover, producers exhibit a low commitment to chain partners (M=2.77, SD=1.82), and joint investments with suppliers, processors, or chain actors are virtually nonexistent (M=1.00, SD=0.00). Domeher and Abdulai (2011) highlighted that credit is a crucial driver of economic growth worldwide. Its significance is even greater in developing nations, where poverty is widespread and deeply entrenched. These findings suggests that while local market relationships exist, deeper collaborations with larger industry stakeholders remain weak, limiting opportunities for scaling up guava production and value addition.

Collaboration

The findings suggest weak collaboration with banks for loan agreements to purchase agricultural inputs and machinery (Mean=2.33, Standard Deviation=1.82), reflecting financial constraints in credit access. Agreements with input suppliers for the timely provision of agricultural resources are even lower (M=1.29, SD=0.81), highlighting inefficiencies in securing production materials. Furthermore Jonas et al. (2025) revealed that most smallholder farmers operate on communal lands without title deeds. Consequently, the absence of collateral makes it challenging for these farmers to obtain credit from financial institutions. Although chain partners moderately exchange information on production and marketing (M=3.18, SD=1.70), risk and benefit sharing remains considerably low (M=1.52, SD=0.87), indicating weak financial

coordination. However, chain partners actively share knowledge about supply and demand forecasts (M=4.77, SD=0.42) and collaborate to identify new market opportunities (M=4.72, SD=0.45). These findings suggest that while financial and risk-sharing mechanisms remain weak, strong cooperation in market intelligence and expansion could enhance the supply chain's overall competitiveness.

Commitment and trust

Teyea and Quarshie (2021) observed that financial institutions' mistrust of smallholder farmers creates significant obstacles to their access to loans and credit. This distrust is reflected in practices such as demanding excessive collateral, requiring guarantors, imposing high savings capital requirements, charging steep interest rates on agricultural loans, and causing delays through bureaucratic procedures. The study reveals that financial institutions provide financial assistance for purchasing agricultural inputs in an untimely manner (Mean=2.10, Standard Deviation=1.32), and government agencies provide minimal support in updating farmers with regulations and subsidies (M=1.32, SD=0.93). While logistical support from chain partners for guava transportation is moderate (M=3.33, SD=1.71), joint ventures and contract farming arrangements among chain actors are significantly lacking (M=1.12, SD=0.60). Additionally, agreements for open communication in production and marketing remain weak (M=2.17, SD=1.27), suggesting limited trust and coordination among supply chain actors. These findings indicate that while logistical support exists, low trust and weak institutional support hinder long-term collaboration in guava production.

Cutting-Edge technology

Ammar et al. (2025) highlighted the role of emerging technologies, such as nanotechnology and 3D food printing, as well as established preservation techniques like dipping and spraying, to improve post-harvest quality and align with global sustainability goals. These advancements align with global sustainability efforts and present promising opportunities for agricultural development. However, the study's findings indicate that guava production has yet to widely adopt these advanced technologies, with a reported low usage rate (Mean = 1.87, Standard Deviation = 1.26), as farmers primarily depend on traditional cultivation practices. Parallel findings by Vikram et al. (2024) identify inefficiencies in conventional guava processing systems, which depend heavily on manual labor, leading to operational delays, high labor costs, and substantial product waste. While, modern packaging technologies designed to reduce post-harvest losses remain underutilized (M = 2.50, SD = 1.54). On the other hand, the integration of information and communication technology (ICT) in guava marketing is relatively high (M = 4.41, SD = 0.70), illustrating the growing significance of digital platforms in sales and promotion. Additionally, ICT is a useful tool for analyzing consumer preferences and improving product quality (M = 4.47, SD = 0.59). These results point to a growing dependence on digital tools for market operations, whereas production and packaging technology developments are still not fully understood. Strategic technology advancements could close these gaps, increase productivity, cut waste, and boost guava production's competitiveness.

Consumer insight

Chang et al. (2025) highlighted organic foods have a positive impact on customer attitudes because of its practical advantages, which include boosting health and being free of dangerous chemicals. In order to lower health hazards, their research revealed that guava growers closely follow advised procedures for fertilizers,

insecticides, and growth enhancers (Mean = 4.67, Standard Deviation = 0.52). There is also a high level of adherence to national laws controlling the production of guavas (M = 4.67, SD = 0.58), demonstrating a strong commitment to food safety standards. Along with strict post-harvest handling procedures for transportation, packaging, and storage (M=4.84, SD=0.37), producers also show increased awareness of market expectations for guava safety and quality standards (M=4.84, SD=0.43). While strategic alliances among supply chain participants guarantee alignment with customer needs (M=4.93, SD=0.25), advanced farming techniques are used to maintain the fruit's flavor, aesthetic appeal, and market competitiveness (M=4.94, SD=0.24). In order to increase customer pleasure and trust, these results highlight a market-oriented approach focused on product excellence, regulatory compliance, and cooperative logistics.

CONCLUSION

The study explores the complexities of guava production, supply chain management, and market access, highlighting both advantages and challenges. Easy access to farming supplies including seeds, fertilizer, and equipment, as well as sophisticated market systems, dependable road networks, and efficient transportation, are among the main advantages. However, a number of barriers restrict the sector's expansion. Financial difficulties, such as limited access to affordable inputs and credit, make it hard for farmers to invest in modern techniques. The use of advanced agricultural technology, especially for exports, is low due to a lack of awareness, training, and suitable equipment. While market systems offer opportunities, issues like expensive fees, underdeveloped cooperatives, and poor export facilities hold back progress. Guava spoils and loses its attractiveness in high-end markets when it is not stored and transported at a temperature that is controlled. Opportunities to add value to products are blocked by a lack of funding and contract farming, as well as weak linkages between farmers and food processors. Export growth is further hampered by gaps in policy knowledge, technical expertise, and logistical support.

Although farmers receive timely updates on market prices and demand, they lack guidance on new technologies and financial options. Partnerships with supermarkets and food factories show promise, but poor coordination with banks and suppliers slows expansion. The sector also struggles to adopt modern farming and packaging methods, relying instead on outdated techniques. To enhance the sector, policies should focus on improving financial access, strengthening export infrastructure, and promoting cold storage and processing facilities. Strengthening partnerships between governments and businesses, along with promoting tech adoption through incentives, could drive progress. Addressing these gaps could make guava farming more competitive, sustainable, and profitable. Future efforts should explore affordable financing and new technologies to improve supply chain efficiency.

RECOMMENDATIONS

- Modern agricultural technology must be implemented in order to increase guava output. The Sindh Agriculture Extension Department ought to start educating people about modern farming practices, including as effective irrigation systems and pruning procedures. To create high-yielding and disease-resistant guava cultivars, the Sindh Board of Investment (SBI) and Pakistan Horticulture Development & Export Company (PHDEC) should also support research partnerships between farmers and agricultural universities.

- The Sindh Enterprise Development Fund (SEDF) and Sindh Agriculture Department should implement targeted subsidies for necessary farming supplies like machinery, fertilizers, and pesticides in order to alleviate financial difficulties. To promote investment in contemporary farming methods, Sindh Bank and the State Bank of Pakistan's Agricultural Credit Division must offer low-interest loans with adjustable payback schedules. Enhancing public-private partnerships will guarantee small-scale farmers have access to essential resources and support financial aid even more.
- One of the biggest problems is the absence of suitable cold storage facilities and transportation. To lower post-harvest losses, the Sindh Board of Investment (SBI) ought to promote investments in cold chain logistics, including as refrigerated transport and storage facilities. The Sindh Agriculture Department should also enforce adherence to appropriate storage standards and implement transportation subsidies to enhance small-scale farmers' access to markets.
- Farmers' profitability can be considerably increased by improvements to the market infrastructure. Digital platforms that offer real-time market prices, demand projections, and trade insights should be developed by the Sindh Information Science & Technology Department. Cooperative marketing strategies can allow farmers to sell directly to supermarkets and exporters, but regulations must be put in place to curb exorbitant commission fees.
- In order to enhance worldwide market access and facilitate guava exports, PHDEC and TDAP should set up specialized export zones, packaging facilities, and quality control facilities that adhere to international standards. Programs for capacity-building should also be implemented to teach farmers about quality compliance, export documentation, and food safety laws. Small-scale farmers' integration into global supply chains will be further aided by government assistance in trade facilitation and logistics.
- Opportunities for value addition may arise from the growth of the guava processing sector. Businesses setting up guava-based processing facilities should be eligible for tax breaks and financial incentives from the Sindh Board of Investment (SBI) and the Trade Development Authority of Pakistan (TDAP). In order to guarantee a steady supply of raw materials and secure fair rates for farmers, PHDEC should also support contract farming methods. Market prospects would be further enhanced by promoting guava-based value-added products such pulp, juice, and dried guava.
- There should be an improvement in stakeholder participation and financial transparency. To guarantee equitable revenue distribution among farmers, wholesalers, and exporters, the Sindh Agriculture Department ought to put profit-sharing procedures into place. To improve financial accountability and supply chain traceability, the Sindh Information Science & Technology Department should also implement digital tracking systems.
- Institutional cooperation is essential to maintaining the growth of the guava sector. To improve farmers' access to credit and streamline lending processes, Sindh Bank and the State Bank of Pakistan's Agricultural Credit Division ought to collaborate closely. The Sindh Agriculture Department ought to increase its support services, financial assistance, and training initiatives. Economic growth will also be fueled by collaborative private sector investments in guava cultivation, processing, and export logistics.
- The Sindh Information Science & Technology Department, in collaboration with the SBI and TDAP, should promote e-commerce platforms to enhance direct-to-consumer sales of guava and guava-based products. Establishing online marketplaces and integrating guava farmers into existing e-commerce networks will

enable them to reach a broader customer base nationally and internationally. Additionally, digital payment solutions and logistics partnerships should be developed to streamline order fulfillment and ensure timely deliveries, boosting profitability for small-scale farmers.

- The SBI and TDAP should help producers, supermarkets, and cooperatives establish direct relationships in order to strengthen market ties. Guava growers can immediately connect with domestic and foreign consumers by promoting online marketplaces and e-commerce platforms. In addition to securing higher prices, promoting group selling methods through farmer cooperatives will boost negotiating strength.
- To increase efficiency, advanced agriculture technologies must be adopted. The utilization of digital tools like mobile applications that give farmers access to weather forecasts, market data, and best practices should be increased by the Sindh Information Science & Technology Department. Productivity will be increased and post-harvest losses will be decreased by implementing contemporary packaging solutions and investing in agri-tech firms through funding and incubation programs.
- To uphold quality standards and establish brand recognition, a robust consumer-focused strategy is necessary. To increase consumer trust, the Sindh Agriculture Department and TDAP should endeavor to brand "Sindh Guava" as a certified product. The demand for both fresh and processed guava products should rise as a result of awareness initiatives highlighting the health advantages of guava and the rigorous adherence to national and international food safety regulations.

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