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Strategies and Techniques Employed by Saba Banana Growers in Addressing the Problem of Unsold Bananas in the City of Puerto Princesa

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Abstract

This study examined the production conditions, drivers of unsold produce, and coping strategies of saba banana growers in selected barangays of Puerto Princesa City, Philippines. Anchored in the Sustainable Livelihood Framework (SLF), the research aimed to profile growers, identify the primary causes of unsold bananas, assess strategies and techniques employed to mitigate losses, and propose a context-specific program intervention to enhance profitability and sustainability. A descriptive-developmental research design was employed, utilizing a researcher-made survey questionnaire and Key Informant Interviews (KIIs). The study involved 91 saba banana growers selected through convenience sampling and agricultural officers as key informants. Quantitative data were analyzed using frequency, percentage, weighted mean, and ranking, while qualitative responses were examined through thematic analysis following Braun and Clarke (2006). Findings revealed that saba banana production is predominantly small-scale and labor-intensive, with low yield per hectare and substantial proportions of unsold produce and post-harvest losses. Key drivers of unsold bananas included low farmgate prices, poor fruit quality due to pests and diseases, price instability, oversupply, weak market linkages, limited storage and processing capacity, and transportation and infrastructure constraints. Although growers adopted adaptive strategies such as direct selling, mixed cropping, staggered planting, and basic sorting and grading, limited capital, technical training, cooperative participation, financial access, and institutional coordination constrained sustainable improvement. The study concludes that interconnected production, market, post-harvest, and institutional weaknesses collectively undermine profitability and industry resilience, and recommends strengthened extension services, improved post-harvest management, value-adding initiatives, cooperative development, and enhanced infrastructure support. The study supports SDG 2 (Zero Hunger), SDG 8 (Decent Work and Economic Growth), SDG 9 (Industry, Innovation and Infrastructure), and SDG 12 (Responsible Consumption and Production) by addressing agricultural productivity, livelihood stability, value-chain improvement, and food loss reduction. Its sustainability impact lies in advancing socio-economic resilience, environmental responsibility through reduced food loss and waste, and strengthened local institutional and policy support for small-scale agricultural systems.

Keywords: Agricultural marketing; Food loss and waste; Post-harvest losses; Saba banana growers; Sustainable Livelihood Framework; Sustainable agriculture; Value-adding strategies

1. Introduction

Bananas (Musa spp.) are among the world's most significant crops, serving as staple food and major export commodities in more than 130 countries. In the Philippines, saba banana (Musa acuminata × balbisiana) plays a crucial role in food security, rural livelihoods, and value-added processing. Despite strong domestic demand, saba banana growers—particularly small-scale producers—face persistent challenges, including post-harvest losses, pest and disease pressures, limited infrastructure, market inefficiencies, and unsold produce that contributes to food loss and waste (FLW). In Puerto Princesa City, a highly urbanized yet agriculturally active area, the saba banana industry remains an important livelihood source. However, recurring problems such as low-quality produce, inadequate storage, limited processing facilities, and weak market linkages threaten its sustainability. While national policies and global literature identify systemic constraints and propose broad interventions, limited localized empirical evidence exists regarding the specific drivers of unsold bananas, the farm-level strategies employed, and their effectiveness within urbanized agricultural settings. Anchored in the Sustainable Livelihood Framework (SLF), this study investigates the production profile of saba banana growers in Puerto Princesa, identifies the primary causes of unsold bananas, examines strategies and techniques used to address these issues, and proposes a program intervention to enhance profitability and sustainability.

1.1 Background of Saba Banana Production and the Problem of Unsold Bananas among Growers in Puerto Princesa City

Bananas (Musa spp.) are globally valued at approximately USD 25 billion and support thousands of growers in major producing countries such as Colombia, Ecuador, and the Philippines (Voora et al., 2023). Beyond export revenues, bananas

contribute significantly to food security and employment in tropical and subtropical regions. In the Philippines, saba banana (Musa acuminata × balbisiana) is widely cultivated and processed into flour, chips, vinegar, and other products. However, production remains largely traditional and unstandardized, with limited grading, packaging, and post-harvest facilities. These deficiencies contribute to unsold bananas, market rejection, and food loss and waste. Pest and disease infestations, poor post-harvest practices, and infrastructure constraints further reduce profitability. Government intervention through the Philippine Banana Industry Roadmap (2021–2025) recognizes production constraints, market segmentation, logistics challenges, short shelf life, and inefficiencies in post-harvest systems (Department of Agriculture, 2022). Recommended strategies include value-adding, composting, animal feed conversion, and improved handling practices, aligned with the High-Value Crops Development (HVCD) Act (RA7900, 1995), which promotes diversification, productivity, and rural employment. In Puerto Princesa City, saba banana production is predominantly small-scale, with farms typically ranging from 0.25 to 3 hectares and reliant on traditional methods (Palawan Commodity Investment Plan (Enhanced), 2023, March; City of Puerto Princesa, n.d.). Limited mechanization, inconsistent pest management, and weak infrastructure contribute to irregular yields and post-harvest losses. Although growers adopt strategies such as improved sorting, scheduling harvests, simple storage technologies, processing, direct selling, and cooperative marketing, the extent and effectiveness of these approaches remain insufficiently documented.

1.2 Themes and Insights from Related Literature on Saba Banana Production, Post-Harvest Losses, and Marketing Strategies

Global literature emphasizes the vulnerability of smallholder banana growers to market concentration, climate shocks, and limited bargaining power (Voora et al., 2023; Bebber, 2022). Smallholders typically cultivate 1–5 hectares, rely on family labor, and face challenges including market instability, pest pressures, post-harvest losses, and limited access to capital and infrastructure (Coral & Mithofer, 2023). Post-harvest losses are a recurring concern. Bananas' perishability makes them highly susceptible to damage during harvesting, handling, and transportation (Rolle, 2018; Acevedo et al., 2021). Losses in developing countries may reach 30–40% due to poor handling and limited preservation facilities (Bexell and Jonsson, 2017). In the Philippines, post-harvest losses for bananas range from 3% to 30%, depending on infrastructure and market access (Barrion et al., 2023). Marketing inefficiencies further contribute to unsold produce. Studies identify poor logistics, inadequate storage, price volatility, stringent quality standards, and reliance on intermediaries as major constraints (Permadi et al., 2022; Akmad et al., 2024; Aguilar and Gibertan, 2018). Market gluts during peak harvest seasons exacerbate rejection and wastage. Biotic threats also significantly affect productivity. Bacterial diseases such as Moko and Bugtok, Fusarium wilt (FOC TR4), and other pests pose serious risks to banana systems (Blomme et al., 2017; Montiflor et al., 2019; Drenth & Kema, 2021; Brown et al., 2017). Limited access to disease-resistant varieties, certified planting materials, and extension services further constrains growers (Echiverri, 2024). Adoption of innovations and coordinated stakeholder responses are critical to improving resilience and competitiveness (Montiflor et al., 2019; Richey & Klein, 2005). The Sustainable Livelihood Framework highlights how farmers mobilize human, natural, financial, physical, and social capital to cope with vulnerabilities and diversify income sources (Wang et al., 2023).

1.3 Local, National, and Global Context of Saba Banana Industry Constraints and Market Challenges

Globally, banana production supports food security and export economies, yet smallholders remain vulnerable to structural market imbalances and environmental risks (Voora et al., 2023; Bebber, 2022). Nationally, banana production is integral to Philippine agriculture, particularly in regions such as Davao, where challenges include inconsistent yields, pest infestations, poor post-harvest handling, and unsold harvests (Teoxon, 2020). The Department of Agriculture (2022) identified post-harvest losses, stringent standards, oversupply, logistics issues, weak market linkages, and rapid ripening as primary causes of unsold bananas. At the provincial and city levels, Palawan's and Puerto Princesa's commodity investment plans document small-scale, rainfed, traditional farming systems, limited mechanization, irregular fertilization, weak infrastructure, and marketing constraints (Palawan Commodity Investment Plan (Enhanced), 2023, March; City of Puerto Princesa, n.d.). These contextual realities highlight the need for localized assessment and intervention.

1.4 Sustainable Livelihood Framework as Basis for Analyzing Growers' Strategies and Program Intervention

This study is anchored in the Sustainable Livelihood Framework (SLF), which explains how individuals utilize human, natural, financial, physical, and social capital to sustain livelihoods amid vulnerabilities and institutional constraints (Wang et al., 2023). Within Puerto Princesa's saba banana industry, livelihood assets include land area planted, number of trees, production volume, storage capacity, product development initiatives, and marketing linkages. The vulnerability context comprises post-harvest losses, unsold bananas, low prices, and transportation barriers. Growers respond through marketing strategies, value-adding, direct selling, cooperative efforts, and adaptive coping mechanisms. Guided by developmental research principles (Richey & Klein, 2005), the study seeks to generate practical knowledge and propose an evidence-based program intervention tailored to the local context.

1.5 Research Gaps on Farm-Level Drivers of Unsold Saba Bananas and Need for Localized Intervention in Puerto Princesa

Although national and international studies document production constraints, post-harvest losses, and market inefficiencies, limited empirical evidence exists on the actual incidence and drivers of unsold saba bananas at the farm and barangay levels in urbanized settings such as Puerto Princesa. Existing literature prescribes infrastructure improvements, coordination mechanisms, and value-chain strengthening (Aguilar and Gibertan, 2018; Department of Agriculture, 2022), yet lacks localized documentation of growers' profiles, coping strategies, and the effectiveness of decentralized, low-cost processing and aggregation models. Addressing these gaps requires systematic documentation of farm characteristics, reasons for unsold bananas, and current strategies employed. Such localized evidence is necessary to design context-specific interventions that enhance profitability, reduce FLW, and strengthen industry resilience.

1.6 Alignment of the Study on Saba Banana Growers with Relevant Sustainable Development Goals (SDGs)

This study aligns with: SDG 2 – Zero Hunger, by supporting improved agricultural productivity, reducing post-harvest losses, and enhancing food availability. SDG 12 – Responsible Consumption and Production, particularly Target 12.3, which aims to reduce food loss and waste across supply chains (Bexell and Jonsson, 2017). SDG 8 – Decent Work and Economic Growth, by strengthening livelihood opportunities and market competitiveness for small-scale growers. SDG 9 – Industry, Innovation and Infrastructure, through promotion of value-adding, processing, and improved post-harvest systems.

1.7 Importance of the Study to Socio-Economic, Environmental, and Institutional Sustainability of the Saba Banana Industry

This research contributes to socio-economic sustainability by improving income stability and market participation of small-scale growers. It supports environmental sustainability by reducing food loss and waste and promoting circular economy practices such as composting and by-product utilization (Acevedo et al., 2021). The study enhances policy and governance sustainability by informing local government programs and agricultural extension services in Puerto Princesa. It also contributes to community sustainability by strengthening organized associations and market linkages. Through an evidence-based program intervention grounded in the Sustainable Livelihood Framework, the study advances the long-term resilience and sustainability of the saba banana industry in a highly urbanized agricultural context

2. Materials and methods

2.1 Research Design

The study utilized a Descriptive-Developmental Research Design to systematically examine the existing conditions of the saba banana industry and formulate a practical intervention addressing the problem of unsold bananas. The descriptive component focused on profiling saba banana growers, identifying reasons for unsold bananas, and documenting strategies and techniques employed to mitigate post-harvest losses and marketing challenges. Quantitative data were gathered using a researcher-made survey questionnaire containing both closed-ended and open-ended items, while qualitative insights were obtained through Key Informant Interviews (KIIs) to provide deeper understanding of institutional perspectives and grower experiences. The developmental component involved crafting a program intervention based on analyzed findings and identified needs. Quantitative data were analyzed using descriptive statistics, including frequency distributions, percentages, weighted means, and rankings. Qualitative data from open-ended responses and KIIs were coded and analyzed thematically to identify recurring patterns and coping mechanisms related to unsold saba bananas.

2.2 Locale of the Study

The study was conducted in selected barangays of Puerto Princesa City, a Highly Urbanized City serving as the administrative, commercial, and agricultural center of the province. Five major saba-producing barangays—Langogan, Tagabinet, Concepcion, Napsan, and Maoyon—were selected due to their active banana-growing activities, large production areas, concentration of growers, and high production volumes. These areas were considered most affected by post-harvest and marketing challenges associated with unsold bananas.

2.3 Respondents of the Study

The respondents comprised two groups: saba banana growers and agricultural officers or high-value crop technicians, including barangay agricultural technicians. The primary participants were active saba banana growers from the five identified barangays who were directly involved in cultivation, harvesting, and marketing. For the qualitative phase, two to three agricultural officers or technicians were selected as key informants based on their technical expertise, professional engagement with growers, and knowledge of agricultural support programs and post-harvest management practices.

2.4 Sample and Sampling Procedure

Convenience sampling was employed to select respondents based on availability, accessibility, and willingness to participate. From a reported population of 233 saba banana growers identified by the City Agriculture Office, the five top-

producing barangays were selected, representing a population of 113 growers. The sample size was computed using Slovin's formula with a 5% margin of error and 95% confidence level, resulting in 91 respondents for the quantitative phase. Proportional allocation was applied across the five barangays, yielding 26 respondents from Langogan, 14 from Napsan, 19 from Concepcion, 12 from Maoyon, and 20 from Tagabinet. The sampling process involved coordination with the City Agriculture Office and barangay officials to identify active growers. For the qualitative component, key informants were purposively selected based on expertise and involvement in banana production programs.

2.5 Research Instrument

The researcher developed a structured survey questionnaire and a set of guide questions for the KIIs to collect both quantitative and qualitative data. The questionnaire covered four major areas: farm profile and production characteristics; reasons for unsold bananas; strategies and techniques employed to address unsold bananas; and suggestions for improving profitability and sustainability. The instrument included Likert-scale items to measure frequency of occurrences and practices, ranking questions, and open-ended items to capture personal insights. Prior to implementation, the instrument underwent content validation by subject matter experts, pilot testing with fifteen growers not included in the final sample, and reliability testing using Cronbach's alpha to assess internal consistency. Revisions were made to ensure clarity, contextual relevance, and methodological soundness.

2.6 Data Gathering Procedure

After validation and reliability testing, the researcher secured approval from the Graduate School Dean and research adviser, followed by coordination with the Puerto Princesa City Agriculture Office and barangay officials. Assistance was obtained to identify and locate active growers for house-to-house data collection. Respondents received orientation regarding the study's objectives, procedures, and ethical safeguards prior to participation. Informed consent was obtained in compliance with the Data Privacy Act of 2012 (RA 10173). Participation was voluntary, and respondents were assured of confidentiality and the right to withdraw at any time. Surveys were administered in private settings to minimize undue influence. For respondents with limited literacy, consent information was read aloud and verbal consent was documented. KIIs were conducted with selected agricultural officers and technicians to obtain institutional perspectives on support programs, marketing initiatives, and post-harvest challenges. After analysis of quantitative and qualitative data, the developmental phase commenced, leading to the formulation of a proposed program intervention designed to improve profitability and sustainability of the saba banana industry in Puerto Princesa.

2.7 Data Analysis Techniques

Quantitative data were coded, tabulated, and analyzed using descriptive statistics, including frequency distributions, percentages, weighted means, and ranking to summarize growers' profiles, production characteristics, reasons for unsold bananas, and adopted strategies. Qualitative data from KIIs and open-ended responses were analyzed using thematic analysis following the steps of familiarization, initial coding, theme generation, theme review, and interpretation (Braun & Clarke, 2006). The integration of quantitative and qualitative findings strengthened the validity and comprehensiveness of the results. Ethical approval was granted by the DMMMSU Research Ethics Committee. Confidentiality, voluntary participation, anonymization of data, and secure storage procedures were strictly implemented. Physical documents were secured in locked storage, electronic data were password-protected and encrypted, and all data will be retained for five years before secure disposal. Potential conflicts of interest were declared absent to ensure transparency and research integrity.

3. Results and Discussion

3.1 Farm Profile and Production Characteristics

3.1.1 Farm Size, Tree Population, and Production Volume

Most respondents operated small farms, with 58% cultivating one hectare or below, followed by 25% with 1.01 to 3 hectares. Only a small proportion managed larger areas. Similarly, 51% had 100 banana trees or fewer, while fewer respondents reported more than 300 trees. Annual production commonly ranged from 1,000 pieces and below (34%) and 1,001 to 3,000 pieces (32%), with only 9% producing 5,001 pieces or more. Yield per hectare was generally low, as 38% reported 1,000 pieces or fewer and 36% reported 1,001 to 3,000 pieces per hectare. These findings indicate that saba banana production in Puerto Princesa is predominantly small-scale and labor-intensive. Limited land area and low tree density restrict economies of scale and mechanization. This aligns with Aguilar and Gabertan (2017), who observed that smallholder farming dominates the Philippine banana sector, often resulting in lower efficiency. Brown et al. (2017) further noted that traditional layouts and low planting density among smallholders contribute to reduced productivity. Variability in annual production also reflects differences in crop management, pest and disease incidence, and input use, consistent with Drenth and Kema (2021), who emphasized the influence of farm management and disease pressure on banana yield variability.

3.1.2 Unsold Produce and Post-Harvest Losses

More than half of the respondents (54%) reported that 26% to 50% of their production remained unsold, while 30% experienced 1% to 25% unsold produce. A smaller proportion reported unsold rates exceeding 50%. In terms of post-harvest losses per cycle, 60% experienced losses of 1% to 25%, and 31% reported 26% to 50%. The high proportion of unsold bananas significantly undermines growers' income and reflects inefficiencies across production, post-harvest handling, and marketing. These outcomes are consistent with Permadi et al. (2022) and Voora et al. (2022), who identified market access constraints and weak value-chain linkages as drivers of unsold produce among smallholders. Post-harvest losses linked to improper handling and transportation further corroborate the findings of Buhion et al. (2024), which emphasized poor harvest handling and transport systems as major contributors to banana production losses.

3.2 Factors Contributing to Unsold Bananas

3.2.1 Market-Driven and Price-Related Constraints

The most frequently cited factors were low price offered by buyers, poor fruit quality or inconsistent sizing, and price volatility or market uncertainty. In ranking the top three reasons, low price offered by buyers accounted for 28% of responses, followed by poor fruit quality (22%) and lack of market access or transportation problems (13%). Likert-scale results showed that low farmgate price was rated "often" ($\bar{x} = 3.80$), ranking first. These findings reveal a buyer-driven market structure where intermediaries largely determine prices. Growers reported that prices as low as PHP 0.60 to PHP 0.80 per piece discouraged selling, especially when transport costs were not covered. This supports Akmad et al. (2024) and Permadi et al. (2022), who identified weak bargaining power and price volatility as major barriers for small producers. Voora et al. (2022) similarly highlighted power asymmetries within banana value chains that expose smallholders to unstable pricing and income losses.

3.2.2 Quality Issues, Diseases, and Post-Harvest Deterioration

Poor fruit quality and grading issues were consistently reported, both quantitatively and in thematic responses. Growers cited stunted fruits, discoloration, blackening, and disease symptoms resembling "Sigatoka" and "bugtok." Many reported buyer rejection due to visible defects. Thematic analysis further highlighted disease-related defects and quality deterioration as dominant concerns. These results confirm that plant health directly affects marketability. Blomme et al. (2017) and Drenth & Kema (2021) documented the impact of banana diseases on fruit quality and acceptability. Aguilar and Gabertan (2017) associated limited adoption of Good Agricultural Practices (GAP) with higher rejection and post-harvest losses. Lucas and Jomanga (2021) also described fungal and bacterial diseases that reduce yield and fruit quality, reinforcing the link between disease pressure and unsold produce.

3.2.3 Transportation, Infrastructure, and Environmental Barriers

Transportation and market access problems ranked among the top contributors to unsold bananas. Respondents described poor road conditions, flooded rivers, steep terrain, and high hauling costs. Weather-related disruptions such as typhoons and heavy rains further aggravated spoilage and delayed transport. These logistical constraints increase the risk of overripening and spoilage before reaching buyers. Rolle (2018) and Scott (2021) emphasized that inadequate infrastructure significantly contributes to post-harvest losses and inefficiencies in banana value chains. Lucas and Jomanga (2021) likewise identified geographic isolation and poor infrastructure as major constraints to agricultural marketing.

3.2.4 Oversupply, Market Saturation, and Lack of Buyers

Oversupply and synchronized harvesting were recurring themes. Growers reported that simultaneous harvesting led to market saturation, price collapse, and lack of buyers. The absence or sudden cancellation of buyers was also reported in recent experiences, resulting in disposal, sharing, or repurposing of bananas. These findings are consistent with Permadi et al. (2022) and Coral & Mithofer (2023), who identified poor production planning and weak coordination as drivers of price drops and unsold harvests. Voora et al. (2022) further emphasized the instability of informal market arrangements and their impact on smallholder income security.

3.3 Strategies and Techniques to Address Unsold Bananas

3.3.1 Marketing Strategies

Direct selling to consumers ($\bar{x} = 3.31$) and selling to wholesalers or traders ($\bar{x} = 3.07$) were practiced "sometimes," while participation in cooperatives and use of social media were generally rated "never." Contract or forward selling agreements were also used occasionally. These findings show reliance on informal and intermediary-based channels. While direct selling may improve margins, inconsistent practice reflects limited integration into structured markets. This aligns with Permadi et al. (2022) and Akmad et al. (2024), who noted that smallholders depend on localized channels. Voora et al. (2022) highlighted that dependence on intermediaries reinforces price-taking behavior and weak bargaining power. Montiflor et al. (2019) explained that absence of functional cooperatives limits access to standardized pricing and formal markets.

3.3.2 Post-Harvest Management Practices

Sorting and grading were practiced "often" ($\bar{x}$ = 3.50), while timely transport was practiced "sometimes." Improved packaging was used "rarely," and ripening control techniques and formal handling training were rated "never." The dominance of basic sorting indicates awareness of buyer requirements, but limited adoption of improved packaging, ripening control, and SOPs reflects gaps in technical capacity. Aguilar & Gabertan (2017) emphasized grading as fundamental to competitiveness, while Rolle (2018) and Buhion et al. (2024) associated limited post-harvest infrastructure with increased losses. Echiverri (2024) underscored the role of training in improving quality control and reducing rejection.

3.3.3 Value-Adding and Diversification

Value-adding activities were rarely practiced ($\bar{x}$ = 1.60), with minimal engagement in processing or semi-processed selling. Some by-product utilization occurred informally. This indicates limited capital, equipment, and training for processing. Acevedo et al. (2021), Buhion et al. (2024), Echiverri et al. (2024), and Kirimi et al. (2023) emphasized that limited institutional support and processing facilities hinder value addition among smallholders.

3.3.4 Production Adjustment and Risk Management

Mixed cropping ($\bar{x}$ = 4.00) and staggered planting ($\bar{x}$ = 3.53) were practiced "often," while reducing planting area in response to market signals was rated "never."

These results show adaptive risk management through diversification and timing, consistent with Brown et al. (2017), who noted that diversified systems buffer smallholders against price and climate shocks. Permadi et al. (2022) and Akmad (2024) recognized staggered planting as a strategy to reduce oversupply. However, continued production despite unfavorable prices aligns with Voora et al. (2022), who described livelihood dependence and weak market feedback mechanisms.

3.3.5 Financial, Cooperative, and Innovation Strategies

Financial and cooperative strategies were largely rated "never," including crop insurance, credit access, joint marketing, and cooperative membership. Engagement in training, institutional collaboration, and ICT use was also minimal. These findings reflect institutional gaps and low integration into formal support systems. Wang et al. (2023) noted barriers to agricultural insurance among smallholders. Kirimi et al. (2023) linked limited credit access to fear of indebtedness and low financial literacy. Liang & Haiping (n.d.) highlighted technological exclusion and limited ICT adoption among small farmers.

3.4 Suggested Interventions and Institutional Support

Respondents suggested strengthening value-adding and processing, improving plant health and disease management, establishing permanent buyers, increasing government support, improving infrastructure, and forming cooperatives. These suggestions reflect growers' recognition of systemic constraints and the need for institutional intervention. The emphasis on processing aligns with Acevedo et al. (2021) and Buhion et al. (2024). Calls for improved disease management are consistent with Blomme et al. (2017) and Drenth & Kema (2021). Strengthened market linkages and cooperative formation align with Permadi et al. (2022) and Coral and Mithofer (2023). The need for government support reflects the Philippine Banana Industry Roadmap 2021-2025 and Aguilar & Gabertan (2017), which stress extension services, capacity-building, and infrastructure investment. Overall, the findings demonstrate that unsold saba bananas in Puerto Princesa result from interconnected production, post-harvest, market, and institutional challenges. While growers employ adaptive strategies such as mixed cropping and informal marketing, limited access to stable buyers, infrastructure, technical training, and institutional support constrains sustainable improvement.

4. Conclusion & Recommendations

The study concludes that saba banana production in selected barangays of Puerto Princesa City is predominantly small-scale, labor-driven, and characterized by limited land area, low yield per hectare, minimal adoption of Good Agricultural Practices, and restricted access to institutional support, resulting in high proportions of unsold bananas and post-harvest losses. Unsold produce is driven by interconnected factors including low farmgate prices, poor fruit quality due to pests and diseases, price instability, oversupply, weak market linkages, limited storage and processing capacity, and transportation and infrastructure constraints, all of which reduce growers' income and bargaining power. Although growers demonstrate adaptability through direct selling, mixed cropping, staggered planting, and limited value-adding activities, these strategies remain insufficient due to lack of capital, technical skills, cooperative engagement, financial access, innovation, and institutional coordination. The findings emphasize that farm-level limitations and broader structural weaknesses within the local agricultural system collectively constrain productivity, marketing efficiency, and sustainability of the saba banana industry in Puerto Princesa City.

It is recommended that saba banana growers strengthen production and post-harvest management practices, including improved harvesting, grading, sorting, handling, and production planning, while gradually engaging in value-adding and

basic processing activities and actively participating in training and extension programs. Farmers' associations should enhance collective marketing, cooperative selling, shared post-harvest facilities, and organizational capacity-building to improve bargaining power and reduce losses. The City Government of Puerto Princesa should intensify extension services, provide disease-free seedlings, improve farm-to-market infrastructure, support storage and processing facilities, and strengthen market linkages aligned with the City Commodity Investment Plan. Food processors and product developers should establish partnerships with growers to absorb surplus production and expand value-added products. Researchers should disseminate findings and develop training and policy materials, while future studies should expand geographical scope, conduct cost-benefit analyses of processing interventions, and employ broader research designs to deepen evidence for sustainable industry development.

This study is limited to selected barangays in Puerto Princesa City and focuses primarily on small-scale saba banana growers, which may restrict the generalizability of the findings to other localities or larger production systems. The results are based on self-reported survey responses and Key Informant Interviews, which may reflect perception-based assessments of production levels, losses, and market conditions. In addition, the cross-sectional design captures conditions during the specific period of data collection, and therefore may not fully account for seasonal variations, long-term market changes, or evolving environmental and institutional factors affecting the saba banana industry.

Compliance with ethical standards

This study adhered to established ethical principles in the conduct of research involving human participants. Ethical approval was granted by the DMMMSU Research Ethics Committee. Participation was voluntary, and respondents were informed of the study's objectives, procedures, and ethical safeguards prior to data collection. In compliance with the Data Privacy Act of 2012 (RA 10173), confidentiality and anonymity were strictly maintained. Surveys were administered in private settings, and respondents were assured of their right to withdraw at any time without consequence. For participants with limited literacy, consent information was read aloud and verbal consent was documented. Data were anonymized and securely stored; physical documents were kept in locked storage, and electronic files were password-protected and encrypted. All data will be retained for five years before secure disposal.

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