Assessing Handling Practices and Loss Factors in the Pineapple Value Chain in Camarines Norte, Philippines

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ABSTRACT

Pineapple (*Ananas comosus* L. cv. Queen) is a vital economic driver in Camarines Norte, Philippines, but losses in the value chain pose a significant challenge. This study employed a systems approach to investigate losses and management practices along the Queen pineapple value chain. Through surveys primarily involving 211 farmers and key informant interviews with other stakeholders, the study identified key players, their functions, and loss factors. The value chain comprises several systems, including activity and actor networks, with farmers and traders playing key roles. Preharvest losses are high at 14.9 percent, emphasizing the need for mitigation measures during production. Postharvest losses account for 47.8 percent, comprising 12.7 percent of nonmarketable and 35.1 percent of marketable rejects in the form of immaturity, mechanical damage, insect infestation, and decay due to poor harvesting practices, rough handling, and varied grading classification. In assessing loss factors, smallholder farms with less than one hectare significantly experience higher losses. Farm topography, distance from farm to collection centers, and harvesting practices also impact farm losses. To address these problems, improvements in production management practices and postharvest handling emphasizing the importance of collaboration among value chain participants and adherence to established grade standards and classification are recommended. The study likewise highlights the urgency

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of addressing postharvest losses in the Queen pineapple value chain with the government playing a pivotal role in providing an enabling environment such as infrastructure and logistics support, extension delivery, and market access. Policymakers, agricultural institutions, and industry stakeholders should prioritize handling and distribution improvements, sustainable practices, and technology adoption.

INTRODUCTION

In the Philippines, the pineapple industry is economically important as it significantly contributes to the country's gross domestic product, with 7.2 percent shares to the agriculture, fishery, and forestry sector in 2021 (Reinhardt and Rodriguez 2009; Balito 2011; Hossain 2016; Statista 2022). Pineapple (*Ananas comosus* L.) is extensively cultivated in the country and its yield and fruit quality are influenced by complex interactions of abiotic and biotic factors like the environment and soil condition, cultural management practices, postharvest handling system, and extra-technical factors like logistics support and infrastructure (Bartholomew, Paull, and Rohrbach 2003; Troger et al. 2020). In the case of Queen pineapple, a predominant cultivar grown in Camarines Norte province, the challenge of postharvest handling and management persists, as highlighted in the study of Serrano (1998), wherein losses along the handling chain can range from 20–30 percent. The industry is challenged by the high perishability of pineapples as they ripen within two days, limiting their suitability for long-distance transportation and resulting in a 24 percent price reduction after one day of delivery to major wholesale markets. Additionally, Queen pineapples are susceptible to mechanical damage usually incurred during harvesting and handling, and attack of insect pests and diseases, contributing to substantial losses.

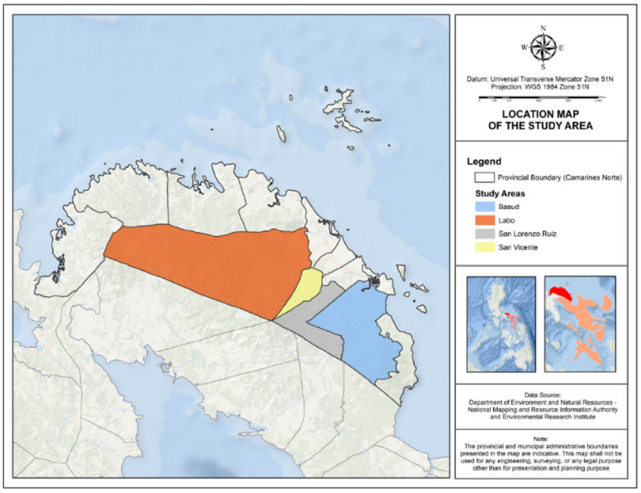
In the study of Begum et al. (2022), losses incurred especially at farm levels were strongly associated with sociodemographic and farm characteristics. Education level, farm size, farming experience, and yield were found to be associated with losses. Farmers with formal or more years of education had lower postharvest losses and longer farm experience meant lesser fruit loss. More experienced farmers are more likely to have developed good practices for handling and storing pineapples. Likewise, increasing the volume handled, such as operating larger farms and having higher yields, increased the likelihood of poor handling, management, and storage leading to higher levels of losses. This indicates that ensuring proper handling and storage is more difficult when dealing with large volumes of fruit. The same study ranked key postharvest handling activities based on their influence on postharvest losses, finding harvesting as the most critical factor, followed by sorting, grading, packaging, storage, transport, and marketing practices.

In the Philippines, numerous studies have evaluated local pineapple value chains (Campita, Tokuda, and Sales 2022; Henry and Chato 2019; Galvez 2019; Lacaden 2019; Carbonell 2015). Key participants in the pineapple value chain in Camarines Norte include farmers, agents, wholesalers, retailers, and processors (Campita, Tokuda, and Sales 2022). Further, a considerable proportion of farmers in the area, approximately one-third, are still below the poverty threshold, indicating that income from pineapple cultivation falls short (DA-PRDP 2022). Within the network of value chain stakeholders, farmers receive comparatively smaller shares of the final value for their roles in pineapple production and marketing (Gessesse, Demrew, and Olana 2019; Vidanapathirana et al. 2020). These challenges persistently hinder local pineapple growers from accessing improved farming opportunities. Therefore, the overarching challenge revolves around increasing the profitability of Queen pineapple through improved handling operations and integrating technically feasible, economically viable, and socially acceptable loss reduction strategies. Despite the body of literature with similar framing and approaches, research has remained limited in thoroughly examining the influences and repercussions of numerous factors, including sociodemographics, postharvest handling, management practices, and other extra-

technical factors that can notably impact fruit losses.

Therefore, the study primarily focused on key features of the Queen pineapple value chain in Camarines Norte, Philippines, with a particular emphasis on the harvesting and postharvest handling practices of farmers in the region. It aimed to assess the cause, nature, and extent of losses and examine the factors affecting farm-level losses in the local pineapple value chain. The study also sought to shed light on the dynamics behind how and why losses occur and identify the critical loss points where potential interventions can be effectively integrated. Consequently, the study aimed to recommend appropriate solutions for an efficient and effective pineapple value chain to ensure sustainability and minimize losses.

Figure 1. Location map of Camarines Norte, Philippines



METHODOLOGY

Selection of Study Area

Region 5, also known as the Bicol Region, is an administrative region in the southern part of Luzon, Philippines. It comprises six provinces, namely, Albay, Camarines Norte, Camarines Sur, Catanduanes, Masbate, and Sorsogon. Recognizing the significance of the pineapple industry, the Philippine Rural Development Project has identified pineapple as one of the five priority commodities in the region. The region grows Queen pineapple primarily for domestic consumption and dedicated 4,609 hectares (ha) to pineapple cultivation in 2020, harvesting 164,162 MT. From 2016 to 2020, Camarines Norte province consistently played a critical role in the region's pineapple production, contributing 97 percent of the overall production. On average, approximately 4,166 ha were allocated for pineapple cultivation during this period, resulting in a total production volume of 143,852 MT (DA-PRDP 2022).

In 2019, the province had about 2,265 pineapple farmers. Among these, 70 percent were concentrated in the municipalities of Basud, San Lorenzo Ruiz, Labo, and San Vicente. The municipality of Basud contributes about 47 percent of total area planted to pineapple, 23.6 percent in the case of San Lorenzo Ruiz, 8.0 percent in Labo, and 5.4 percent in San Vicente. Most of these pineapple farms were relatively small, typically spanning one hectare or less in size, and were commonly situated in coconut-based agricultural areas. Figure 1 shows the location map of the study area.

Data Collection and Sampling Procedure

A rapid appraisal gathered essential data on handling practices, challenges, and losses. This involved key informant interviews (KIIs), focus group discussions (FGDs), and on-site observations at various points of the handling chain, including farms and packinghouses or collection centers. In addition, a comprehensive survey targeted various operations within the value chain. The survey involved face-to-face interviews and utilized pretested structured questionnaires and guide questions.

A sample of pineapple farmers was selected through stratified random sampling from the population. The study focused on the four municipalities with the highest number of farmers, namely, Basud, San Lorenzo Ruiz, Labo, and San Vicente, which collectively had 1,916 pineapple

Table 1. Number of farmer-respondents per municipality, Camarines Norte, Philippines, 2023

Municipality	Villages	Respondents	Percentage
Basud	San Jose, Binatagan, Oliva, Guinatungan	65	30.81
San Lorenzo Ruiz	Daculang Bolo, Laniton, Dagotdotan, Maisog, Mampurog, Matacong	36	17.06
Labo	Lugui, San Antonio, Matanlang	32	15.17
San Vicente	Fabrica, Iraya Sur, San Jose, Asdum, Man-ogob, Cabanbanan, Calabagas	78	36.97
Total		211	100.00

farmers. From this population, 211 farmers participated in the study (Table 1).

Data Analysis

Descriptive analysis

Descriptive analysis characterized the key features of the Queen pineapple value chain focused on the handling system and losses in the region, with data gathered through KIIs, FGDs, surveys, and documentation of actual field practices. Relevant information was examined, including farmer profiles and characteristics, various methods and practices, the nature, causes, and extent of losses, and other relevant information.

Assessment of loss factors among farmers

In terms of farm-level operations, losses were categorized into preharvest and losses after harvesting, commonly referred to as postharvest losses. T-test comparison of means was used to assess observed differences in the average farm losses by selected farmer characteristics and varied field practices. Based on existing practices and conditions, we sought to determine whether losses obtained from the diverse practices and handling operations in the area differed significantly. The variables tested included farm size and topography, distance from farm to collection area, harvest containers used, and time of harvesting. Also tested were important farmer demographics such as age and active membership in organizations in the area.

Value chain mapping and critical loss point identification

Mapping of the value chain served to identify the chain actors and to trace information flows pertaining to Queen pineapple. It highlighted practices, commencing at the farm level and encompassing postharvest handling and marketing operations. This process identified various issues and limitations along the chain and established estimates of losses and their underlying causes at each step of the chain.

Using the data gathered from interviews, the study pinpointed the specific stages in the Queen pineapple value chain where respondents reported losses. Quantitative losses were estimated based on the information provided by the respondents, while qualitative losses were determined by the practices described during the interviews. Critical loss points are specific stages in the food supply chain where food losses have the most significant magnitude, the greatest impact on food security, and the most substantial effect on the economic performance of the food supply chain (FAO 2016). The study determined critical loss points in

the handling chain by identifying the stages with high loss estimates from the survey.

RESULTS AND DISCUSSION

Farmers' Profile and Farm Characteristics

The sociodemographic profile of 211 Queen pineapple farmer respondents from the four leading municipalities in Camarines Norte appears in Table 2. Their predominant ages ranged from 41 to 60 years old, constituting a majority at 57.82 percent. On average, these farmers were approximately 50 years old. This data underscores the aging demographic of the farming population and highlights the need to integrate a younger workforce to ensure continued vitality of agricultural activities, particularly within the pineapple industry in the region.

About 95 percent of the respondents were engaged in farming while a meager 4.7 percent of the farmers engaged also in trading. Examining their household and livelihood characteristics shows that family farming holds a prominent position in the area. Both husbands and wives actively engaged in farming, resulting in a balanced gender-based representation among farmer-respondents. Agriculture is the primary source of livelihood for an average household of four to five members.

A substantial 78.2 percent of respondents had received education only up to the primary and secondary levels, with only a small minority having had pursued tertiary education. This underscores the limited availability of complete formal education opportunities for farmers in the area.

In the region, farming experience spanned a wide range among respondents. A significant majority of farmers had been actively engaged in farming for 11 to 20 years, with an average of 20.3 years. Specifically, most farmers had been producing pineapple for a decade, with 15.8 years of experience on average. Both the years spent in farming and access to formal education played fundamental roles in shaping the overall

Table 2. Sociodemographic profile of farmer respondents in Camarines Norte, Philippines, 2023 (n=211)

Farmer Characteristics		Frequency	Percentage
Age	20 years old and below	1	0.47
	Between 21 to 40 years old	49	23.22
	Between 41 to 60 years old	122	57.82
	61 years old and above	39	18.48
Gender	Male	103	48.42
	Female	108	51.18
Town or village	San Lorenzo Ruiz	36	17.06
	Labo	32	15.17
	Basud	65	30.81
	San Vicente	78	36.97
Farmer type	Farmer only	200	94.79
	Farmer/trader	10	4.74
	Farmer/agent	1	0.47
Education	Primary	71	33.65
	Secondary	94	44.55
	Tertiary	37	17.54
	Others	9	4.27
Household size	4 members and below	110	52.13
	5 to 7 members	83	39.34
	8 members and above	18	8.53
Farming Experience			
General	10 years and below	62	29.38
	11 to 20 Years	66	31.28
	21 to 30 Years	47	22.27
	31 Years and above	36	17.06
Pineapple	10 years and below	93	44.08
	11 to 20	65	30.81
	21 to 30	37	17.54
	31 and above	16	7.58
Farming organization	With membership	112	53.08
	Without membership	99	46.92
Off-farm income	With off-farm income	79	37.44
	Without off-farm income	132	62.56

farming expertise and skills of individuals within this farming community. Further, a portion of these households belonged to agriculture-based organizations operating within the local community (53.1%). Additionally, it was common for households to supplement their incomes through various off-farm activities (37.4%). This diversification in income sources underlines the adaptability and resilience of the farming households in managing their livelihoods.

On average, each farmer owned about 3.6 ha of land for agricultural activities, allocating 1.1 ha for pineapple cultivation. This allocation characterizes pineapple farmers in the province as falling under the smallholder farm category.

When it comes to land tenure and ownership, most farmers (54.5%) in the area were classified as farm tenants (Table 3). This means they did not own the land they cultivated. However, it is a customary practice in Camarines Norte for farmers to operate on a certain plot without the need for leasing or renting agreements. Approximately 40 percent of the farmers in the area owned the land they cultivated. In the area, the predominant practice was multiple cropping (77.73%), followed by monocropping. Queen pineapple plantations in Camarines Norte were frequently intercropped with coconut and banana. These pineapple plantations were situated either in flat terrain (37.44%) or sloping areas (45.02%).

Table 3. Farm profile of farmer-respondents, Camarines Norte, Philippines, 2023

Farmer Characteristics		Frequency	Percentage
Land ownership	Owned	82	38.9
	Leased or rented	21	10.0
	Tenant	115	54.5
Farm topography	Flat	79	37.4
	Sloping	95	45.0
	Both	37	17.5
Cropping system	Monocropping	46	21.8
	Multiple cropping	164	77.7
	Crop rotation	1	0.50

Factors Affecting Losses Among Farmers

The analysis of average losses at the farm level involves an understanding of various farming characteristics, socioeconomic factors, and practices employed by Queen pineapple farmers. Table 4 shows a significant difference in farm losses between small and large farms. Notably, smaller farms, characterized by plantations covering less than one hectare, significantly incurred higher losses compared to their larger counterparts.

According to majority of the farmer-respondents, high losses in smallholder farms can be attributed to their limited access to resources including inadequate availability of farm equipment, harvesting tools and containers, and financial capital for some operations such as hiring farm laborers. Limited resources directly influence the efficiency of farm operations, consequently contributing to high losses at the farm level.

In terms of topography, Queen pineapples in flat terrains faced lower losses than those in sloping plantations. However, their losses did not significantly differ. In addition, pineapple plantations with longer distance from farm to collection center, particularly beyond 1 km, faced slightly higher losses than those with shorter distances. However, losses did not differ significantly, and this can be attributed to the same poor road conditions regardless of farm distance.

When evaluating specific harvesting practices, using jute sacks as field containers resulted in higher losses compared with using *sagad* or *kareta* (animal-drawn carts). Additionally, harvesting in the afternoon and evening led to increased farm losses compared with early harvest hours. This can be attributed to prolonged sunlight exposure of pineapples and the challenges faced by farmers during unfavorable low-light conditions. Despite varied practices, losses did not differ significantly by harvest container and timing of harvesting.

Table 4. Average farm losses based on select farm and farmer characteristics, Camarines Norte, Philippines, 2023

Characteristics		Farm Losses (%)	t-test	p-value
Farm size	Big (1.0 ha and above)	12.5		
	Small (less than 1.0 ha)	18.2		
	Difference	*-5.732****	*-2.6961*	*0.0076*
Farm topography	Sloping areas	15.8		
	Flat terrain	13.6		
	Difference	*2.175*	*0.9858*	*0.3254*
Distance from farm to collection area	Short (less than 1 km)	15.4		
	Long (1 km and beyond)	15.4		
	Difference	*0.004*	*-0.0017*	*0.9987*
Harvesting container	Jute sacks	16.4		
	Sagad or kareta	15.7		
	Difference	*0.740*	*0.1629*	*0.8709*
Harvest time	Afternoon to evening	16.4		
	Midnight to early morning	14.4		
	Difference	*2.023*	*0.8527*	*0.3948*
Age	Young (40 years and below)	13.2		
	Old (41 years old and above)	15.5		
	Difference	*-2.344*	*-0.9373*	*0.3497*
Membership in Organization	No active membership	15.5		
	With active membership	14.4		
	Difference	*1.059*	*0.4948*	*0.6212*

Note: *** p<0.01, ** p<0.05, * p<0.1

As to demographic factors, older farmers in the area tended to experience higher farm losses than younger farmers. In addition, farmer-members of farm-related organizations exhibited lower rates of losses. Although demographic attributes exhibited various levels of farm losses, they did not differ significantly.

Loss Estimates and Critical Loss Points in the Queen Pineapple Value Chain

A thorough analysis of the Queen pineapple value chain allowed us to assess the practices and activities at each stage, shedding light on the types and causes of losses incurred. Within the value chain activities, farmers were able to estimate losses incurred in various stages. These losses, encompassed both preharvest (Figure 2a) and postharvest (Figure 2b), including marketable and nonmarketable rejects. The analysis also identified the critical loss points within the chain. These loss points are the stages in the chain where interventions can be introduced to minimize losses and enhance the overall efficiency of the Queen pineapple value chain.

Several critical loss points have been pinpointed in the value chain (Table 5). During production stage or at the farm level, poor cultural management practices led to undersized fruit, and the challenges related to insect pest infestations and disease contributed to preharvest losses of up to 14.93 percent from total production (Table 5). Technical improvements in production practices like fertilization, planting density, and pest management will reduce preharvest losses.

Additionally, high losses are attributed to rough handling during postharvest operations, including harvesting, hauling, field sorting, and transport. Rough handling has a substantial impact on fruit quality, leading to nonmarketable rejections, particularly due to mechanically damaged fruits. To mitigate these losses, it is imperative to introduce

Figure 2a. Preharvest losses in Queen pineapple, Camarines Norte, Philippines, 2023

Undersized and immature fruits

Insect- and pest-damaged fruits

Figure 2b. Postharvest losses in Queen pineapple, Camarines Norte, Philippines, 2023

Insect and pest damage (rats, birds)

Immature

Overripe

Mechanical damage (crack, severe bruise, and compression)

Deformed, small crown

Mechanical damage (crown removal)

Table 5. Identified critical loss points along the Queen pineapple value chain, Camarines Norte, Philippines, 2023

Chain Level and Activities	Type and Nature of Losses	Cause of Losses	Extent of Losses	Critical Loss Point
Farmer: Cultural practices (pest, disease, weed management)	*Preharvest:* Undersized, infested, and decayed fruits	Poor management practices like fertilization and pest management to include insects, diseases, rats, birds, and weeds	14.93%	Yes
Trader: Preharvest ethylene treatment	*Marketable rejects:* Fruits are either sour or lack sweetness (manifesting at retail)	Preharvest injection of ethephon (Ethrel) on fruits to induce peel coloration	Not identified	Yes (on inferior eating quality)
Farmer/trader: Harvesting	*Nonmarketable rejects:* Mechanical damage (fruit cracking, severe compression, crown removal)	Rough handling at harvest (twist-and-bend harvesting method)	5.04%	Yes
Farmer/trader: Hauling	*Nonmarketable rejects:* Mechanical damage (severe compression, fruit cracking, severe bruising, fruits falling from container and left in the field)	• Rough handling (tossing of pineapples) • Long distance hauling • Inappropriate hauling containers • Poor road conditions	0.95%	No
Trader: Field sorting	*Nonmarketable rejects:* Overripe, severe insect and pest damage, immature, mechanical damage (fruit cracking, severe compression), severe deformation, crown removal	• Rough handling such as throwing of fruits and fruit dropping • Non-adherence to recommended maturity index	3.41%	Yes
	Marketable rejects: Butterball or undersized fruits (extra small)	Non-uniformity in sorting (size classification) and grading	32.85%	Yes (on income and profits)
Trader: Loading onto transport vehicles	*Nonmarketable rejects*: Not identified	Non-usage of protective barriers, dividers, pallets	Not identified at the farmer-level	No
	Marketable rejects: Irregular ripening pattern	• Alternate piling and stacking • Spraying of ethephon (Ethrel)	Not identified at the farmer-level	Yes (on inferior eating quality)
Trader: Transport	*Nonmarketable rejects:* Overripe, decay	• Temperature buildup in vehicle • Poor transport conditions • Manner of loading	3.31%	Yes
	Marketable rejects: ripe, deformed, compression damage	• Temperature buildup in vehicle • Poor transport conditions • Manner of loading	2.25%	Yes

improvements in postharvest handling practices, emphasizing careful handling and appropriate handling aids to maintain fruit quality.

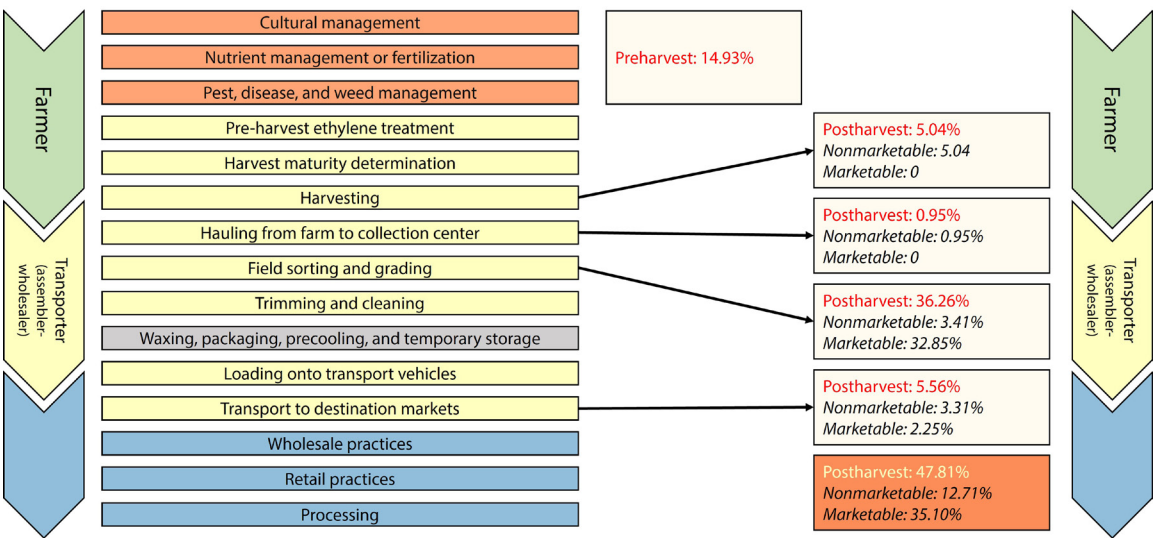
Field sorting also emerged as a critical point in the value chain, wherein the variations in sorting (sizing and grading classification), as influenced by the volume of harvest and trader's discretion, significantly contributed to losses in the form of marketable rejects amounting to 32.9 percent (Table 5). The fruits, although marketable, were priced lower than the other size categories thus reducing the farmer's income. Further, the practice of preharvest ethylene treatment on fruits several days before actual harvest and spray applications before transport also contributed to losses. Immature pineapples treated with ethephon would only induce yellow peel coloration but will not enhance its eating quality. Moreover, if the recommended concentration of ethephon is not followed, harvested fruits will prematurely ripen during long distance transport. Implementing strategies of the Philippine National Standards for Pineapple (PNS BAFPS 09:2004)[1] in collaboration with local government units is imperative.

1 http://spsissuances.da.gov.ph/attachments/article/793/PNS-BAFPS%2009-2004.pdf

Figure 3 provides a summary of losses within the Queen pineapple value chain. Notably, a substantial preharvest loss of 14.93 percent is already incurred, emphasizing the need for loss mitigation measures starting from production. Queen pineapples are renowned for their good eating quality, and preserving this quality until they reach consumers is highly important. However, postharvest losses occur along the value chain, with both marketable and nonmarketable rejects contributing to these losses. These losses accumulate from harvest to transportation to destination markets, with nonmarketable rejections accounting for 12.71 percent and marketable rejections at 35.10 percent. The total postharvest losses comprise 47.82 percent. These losses are considerably higher than the estimates of Mopera (2016) (30% to 40% loss) and Serrano (1998) (20% to 30% loss) on pineapples.

It is worth noting that the estimated loss values represent not only physical losses but, more significantly, economic losses in terms of potential profits for all stakeholders in the value chain. While these estimates clearly show the losses occurring throughout the handling stages in the chain, it is essential to conduct actual loss assessments to validate these estimates. Such assessments are

Figure 3. Queen pineapple value chain map with loss estimates, Camarines Norte, Philippines, 2023



crucial for accurately quantifying losses and implementing tailored solutions to minimize these losses effectively.

Interventions and Best-Fit Solutions to Reduce Losses

To address significant losses among smallholder farmers, interventions should focus on enhancing resource accessibility. Implementing a clustering program and encouraging production programming among clustered farmers can pool resources, improve farm practices, and reduce losses. Studies in the Philippines show positive impacts of such initiatives, including increased production, income, and access to resources (Montiflor, Batt, and Murray-Prior 2008; Rola-Rubzen et al. 2013; Oakeshott 2018). Promoting farm-related organizations and investigating relevant demographic factors can further empower smallholder farmers, improving operational efficiency, and reducing losses in Queen pineapple.

Losses occur due to rough handling during postharvest operations. To reduce such losses, it is critical to improve some postharvest handling practices, emphasizing careful and appropriate techniques to maintain pineapple fruit quality. Using proper harvesting tools, such as clippers and gloves, and adopting careful harvesting methods instead of manually snapping pineapples, can significantly decrease mechanical damage including fruit cracking and crown removal. Additionally, rough handling during hauling of harvested pineapples exacerbates mechanical damage. It is important to emphasize careful hauling, filling the vehicle to its capacity, using pallets and liners, and ensuring proper ventilation during transport. These measures, targeted at transporters or assembler-wholesalers, may reduce compression damage and minimize the risk of fruit rejections at destination markets.

The government's role is also critical in creating an enabling environment among Queen pineapple value chain players. Standardizing handling practices, enforcing quality standards, and addressing inappropriate preharvest treatments are vital steps. While national standards are not mandatory, local governments may implement ordinances regarding standards in sizing and grading classification. Infrastructure investments in common service facilities, road networks, and transportation are likewise necessary to improve efficiency. The government can initiate investments in modern facilities such as low-cost cold storage and packinghouses or collection areas. These facilities can extend the shelf life of pineapples particularly during periods of overproduction. Further, the development of road networks and transportation infrastructure are essential for the efficient movement of Queen pineapples from farms to markets. While these operations and investments may entail costs for farmers and traders, the government can facilitate financial access by providing low-interest or subsidized loans for the acquisition of modern postharvest equipment and facilities.

Extension services provided by government agencies should focus on educating stakeholders on best practices, modern technologies, and ensuring market access for local pineapple growers, fostering a sustainable and thriving industry. The government's proactive involvement can curtail postharvest losses and upgrade the overall standards of production, postharvest handling, and distribution. Further, a collaborative approach involving government agencies, agricultural extension services, farmer organizations, and stakeholders is essential in fostering a sustainable and thriving pineapple value chain, one that delivers significant benefits to all stakeholders in the region.

CONCLUSION

The study's findings reveal a complex landscape of losses within the Queen pineapple value chain in Camarines Norte, Philippines, encompassing both quantitative and qualitative aspects. Notably, preharvest loss is substantial at 14.9 percent and postharvest losses are much greater at 47.8 percent, with nonmarketable rejections accounting for 12.7 percent and marketable rejections at 35.1 percent. On top of the significant postharvest

losses, marketable fruits represent qualitative losses characterized by lower quality and reduced prices. These factors can substantially impact on the income and profit losses of stakeholders.

The analysis of farm-level losses considered several factors, revealing that smaller farms below one hectare experience significantly higher losses due to limited access to resources, including farm equipment and financial capital. Topography and distance from the collection center influence losses, with flat terrains and shorter distances associated with lower losses. Harvesting practices, like the use of jute sacks and harvest timing, impacted losses but registered no significant differences. Demographic factors, including age and membership in farm-related organizations, play a role in losses, with older farmers experiencing higher losses and organization members facing lower losses.

The value chain faces several critical loss points at various stages. Preharvest losses are primarily linked to poor cultural management practices and challenges related to insect and pest infestations. Postharvest operations, including harvesting, hauling, field sorting, and transport suffer from rough handling operations leading to significant fruit quality deterioration and nonmarketable rejections. To address these issues, it is crucial to implement improvements in postharvest handling practices, emphasizing careful and appropriate techniques to maintain fruit quality. The absence of standardization in field sorting practices also contributes to losses within the value chain. Moreover, preharvest ethylene treatment of fruits and spray applications before transport are identified as critical loss points, negatively impacting the fruit's taste and ripening at the consumer levels. It is imperative to establish regulatory and implementation strategies to solve these issues and to promote standardization.

Government intervention is necessary to boost the Queen pineapple value chain in Camarines Norte. This includes addressing the lack of standardized practices, particularly in sorting and grading and preharvest treatments, improving infrastructure, road networks, and transportation, and facilitating extension activities and market access. Such interventions will foster a sustainable and thriving pineapple value chain that benefits farmers, traders, and consumers, while reducing postharvest losses and boosting competitiveness.

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