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Postproduction System and Losses of Mango in Davao del Sur, Philippines

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Abstract *— The study was conducted to determine the major postharvest system of mango and assess the postproduction losses in the different stages of the existing mango supply chain in Davao del Sur, Philippines. The needed information were collected through key informant interviews (KII) and focus group discussions (FGD) with major stakeholders of the Philippine mango industry. The gathered data were analyzed using descriptive statistics such as percentages and measures of central tendency. The postharvest system of mango from Davao del Sur encompasses harvesting, sorting, weighing, packaging, hauling, transporting (both by sea and land), and delivery to the different market outlets in Metro Manila, Cavite, and Cebu. Postharvest losses were estimated at 11.82% at the farm level, 9.86 percent at the trader level, 2.44 percent at the shipper level, and 2.35 percent at the wholesale/retail level, with total losses at 26.47%. Since the farmer level incurred the highest percentage of recorded losses, intervention should focused on the management of mango pests and diseases, such as modified fruit bagging materials, bio-control, or organic pesticides and insecticides. In addition, studies on suitable packaging material and conditions, as well as further research on prolonging the shelf-life of mango while maintaining the good quality attributes are highly recommended.*

Keywords— *Mango, postharvest loss, postproduction system.*

I. INTRODUCTION

Mango is the third most essential fruit crop in the Philippines. It can be classified as green, mature, or ripe for processing. It can be eaten as a dessert or relish. The Philippines has been a vital player in the Mango Global Market since 1980 and exports took off in the 1990s. In 2015, the nation was positioned 7th in the exportation of fresh and dried mango, with exports amounting to US 91 million and a 4% stake in the worldwide market (https://www.da.gov.ph/). In the year 2021, the production of mango in the country reached 603,100.95 metric tons with a total land area of 145,418.23 hectares planted to mango (psa.gov.ph).

In the Philippines, estimated production and post-harvest losses on fruits and vegetables was about 27 to 42 percent (psa.gov.ph, 2012). Postharvest loss assessment conducted by Calica et al (2014) revealed that during peak and lean months, system loss was 30.40 and 28.10 percent respectively from Davao del Sur to Manila. Food loss can be attributed to small farmers' limited capability to implement proper postharvest handling, including access to storage facilities, infrastructure, cold chains, packaging, and marketing systems. These challenges, combined with the country's climate conditions that promote spoilage and disease, often result in significant food losses (Mopera, 2016).

Reducing food loss and waste is acknowledge strategies to lower production costs, enhance the efficiency of the food system, and promote better food security and nutrition (FAO,2019). This study seeks to update the postharvest losses of mango in every stage of the major postharvest system.

II. METHODOLOGY

A. Description of study area and time of study

The province of Davao del Sur is located in the Davao Region (Region XI) in Mindanao, the south-eastern part of the Philippines. Davao del Sur ranked 5th in the top 10 mango-producing provinces in the Philippines with a total of 11,356 hectares of land planted to mango with an annual production volume of 27, 831.20 MT, contributing 4.61 percent of the total volume produced in the country for year 2021 (PSA Database Portal, 2022). Year-round production in Davao del Sur makes it a primary supplier of mango during the off-season.

Figure 1. Map of Davao del Sur
(Source: https://www.philatlas.com/mindanao/r11/davao-del-sur.html)

B. Framework of the study

Figure 2 presents the research framework, illustrating the study's inputs, processes, and anticipated outputs. Information sources included both primary and secondary data. Primary data were collected through focus group discussions, key informant interviews, and personal interviews with farmers, traders, and processors, involved in postharvest activities and knowledgeable about the commodity's postharvest aspects.

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Secondary data was obtained through desk research and a literature review of related publications.

The study used two-stage purposive stratified random sampling in generating data. Using a structured questionnaire, data were gathered through personal interviews with the farmers, traders, wholesalers, and retailers. The questionnaire covered information on the socio-economic characteristics of farmers, postharvest practices, the market flow of mangoes, perceived postharvest losses, and the role of different stakeholders in the industry. This approach of gathering data using perceptions on losses was also undertaken by: Memon, A. (Estimation of Mango Postharvest Losses in Sindh, 2013), Sab, M. (Estimation of Post-harvest Losses of Mangoes at Different Stages from Harvesting to Consumption, 2017), and Kofi Kyei1 and Kenichi Matsui (Assessing Fruit Farmers' Perceptions of Post-Harvest Losses in the Ashanti Region of Ghana, 2019).

Supply chain analysis was employed to characterize the various actors involved in the identified chains. Each actor's roles, operations, and practices were documented and analyzed. The study's main outputs include: an overview of the major postharvest system, postharvest losses by activity in the chain, key players and functions in the marketing system, and identified constraints and opportunities.

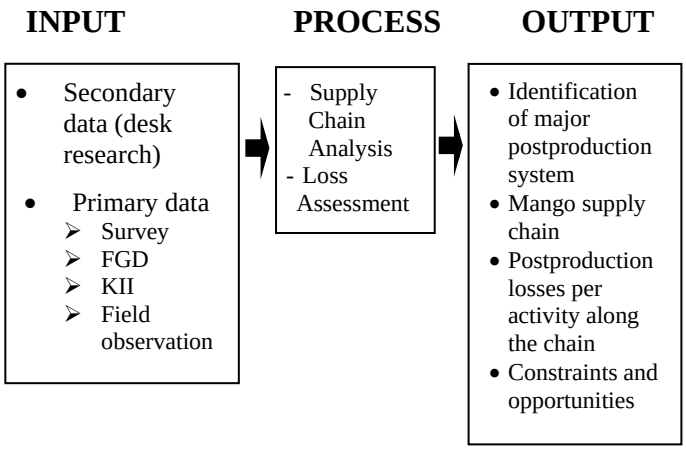

Figure 2. Research framework of the study

C. Methods of Analysis

All data gathered were organized, encoded, and tabulated using SPSS. Descriptive analysis such as percentages and measures of central tendency was used to process the data.

III. Results and Discussion

A. Farmer and Farm Profile

A total of 106 farmers were interviewed, with majority of the respondents composed of male (70.75 %) and female (29.25 %). More than half (58.65%) of the respondents were middle-aged adults (40–59 years old), followed by older adults (60–99 years old) at 26.92 percent and young adults (20–39 years old) comprising 14.42 percent. Most (48.96%) of the respondents were high school graduates (44.22%) and 37.31% obtained college level education. The mango growers have around 17 years of experience in mango farming, accumulated knowledge and practical experience in producing the crop.

On the average, the farmer respondents have 5.14 hectares planted to mango. The average number of trees per hectare in the study area was 97.95 mango trees, with an average yield of 195.41 kg per tree.

B. Postharvest Practices

The primary postharvest system for mangoes encompasses several key stages: harvesting, sorting, packaging, and transporting the fruit to market. Each stage is crucial in ensuring the mangoes maintain their quality and freshness, ultimately influencing their market value and consumer satisfaction.

Harvesting

Harvesting is done about 105 days after flower induction. Majority of farmers harvest mangoes from around 8:00 AM to 9:00 AM. Mangoes are harvested manually using bamboo pole with a net (Figure 3) and carried to the sorting area utilizing big baskets known as a *"bukag"*, lined with plastic bags (Figure 4).

Figure 3. Harvesting of mango

Figure 4. Hauling of harvested mangoes to the sorting area

Sorting and packaging

Mangoes are typically harvested and sorted simultaneously at the farm, with size being used as primary criteria. The current sorting practice categorizes mangoes into four size groups: small, medium, large, and extra-large. For domestic markets, mangoes are usually packed in 17 to 18-kg boxes (Figure 5), while fruits intended for processing are packed in 20-kg plastic crates.

Marketing

Marketing is essential for connecting producers with consumers, helping to raise awareness and drive demand for products in competitive markets. There are three identified market outlets of mangoes; processors, exporters, and

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wholesalers/retailers. Mangoes harvested in Davao del Sur are mainly transported to Metro Manila markets via wing vans with a 20-metric-ton capacity (equivalent to 700-900 boxes, each weighing 23 kg). Travel takes around 3-4 days by land and sea. Meanwhile, some mangoes destined for export are airlifted to Metro Manila, reducing travel time to just two (2) hours.

Figure 5. Sorting and packing mango

C. Role of the different stakeholders of the mango Industry

Farmer/Grower

The primary stakeholder in the mango supply chain is the farmer or grower, who typically holds ownership of the farm. In managing production operations, the farmer often engages services from financers or spray contractors to provide inputs to optimize yield and quality.

Spray - Contractor

Contractor/financer and farmers have special arrangements. Contractors or traders cover all inputs and labor costs from flower induction through to bagging, pest management, farm maintenance, and transport to market destinations.

Middleman/Agent

Middlemen or agents serve as intermediaries between growers and contractors, earning commissions from contractors/traders for their services. Their primary responsibility is to identify farms with fruit-bearing mango trees that are ready for contract spraying. Acting as a bridge, they help contractors connect with farmers whose trees are at the ideal stage for spraying, ensuring a smooth collaboration in the production process.

Trader/Wholesaler

Traders or wholesalers buy fresh green mangoes in large quantities from multiple farms and then distribute them in bulk to various markets. By aggregating produce from different sources, they play a crucial role in the supply chain, ensuring a steady supply of mangoes to meet market demand.

Shipper

The shipper plays a vital role in the mango supply chain by ensuring that the harvested fruit is transported efficiently and safely from farms or packing facilities to various market destinations. Shippers are responsible for managing the logistics, which includes coordinating transportation methods (such as trucks, boats, or planes).

Export Trader

The exporter plays a crucial role in extending the market reach of mangoes beyond domestic borders. Exporters manage all aspects of compliance and logistics necessary for international trade, which includes obtaining certifications, meeting phyto-sanitary and quality standards, and handling customs documentation required by the importing country.

Retailer

Retailers are responsible for selling mangoes to consumers through various marketing strategies. Retailers may operate from their stores or engage in mobile selling, where they walk around to sell mangoes directly to customers.

C. Market flow of mangoes

Figure 6 illustrates the current mango supply chain in Davao del Sur. Farmers usually engage with contract sprayers to manage the mango orchard by providing inputs, bagging fruits, and ensuring the care and maintenance of the plants. A 70:30 profit-sharing scheme is typically agreed, but in areas not easily accessible by transportation, an 80:20 scheme in favor of the contractor is implemented.

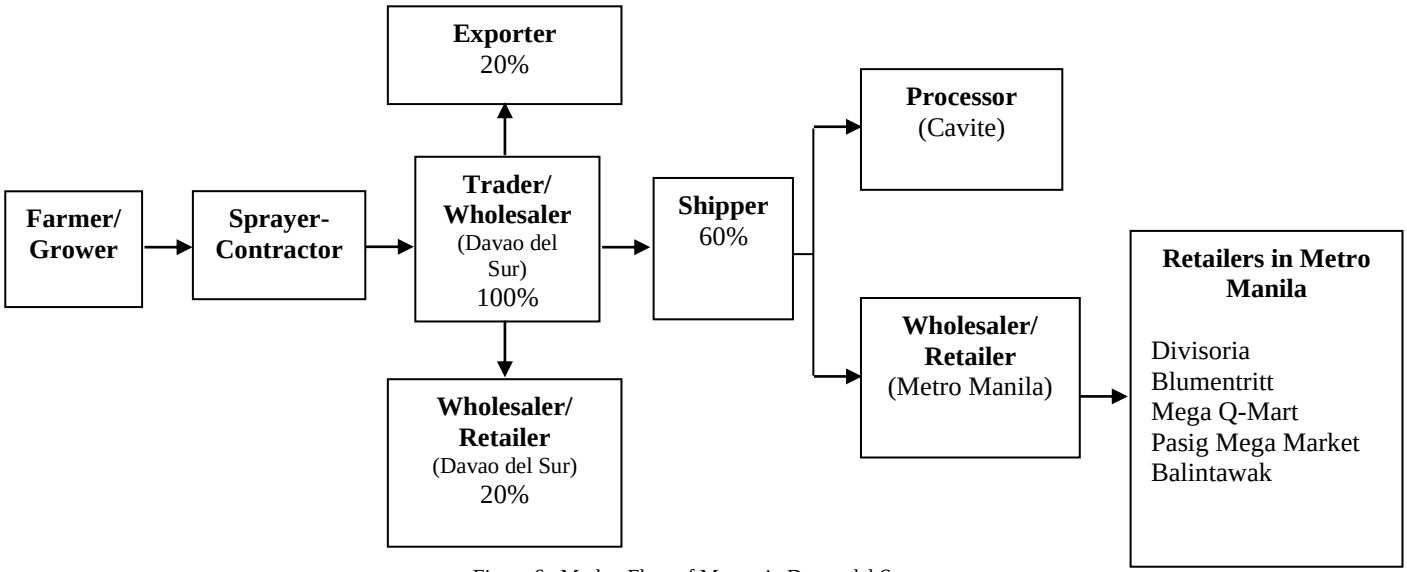

Figure 6. Market Flow of Mango in Davao del Sur
(Source: Survey/FGD among mango traders and contractors in Davao del Sur, 2022)

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Most mangoes harvested in Davao del Sur are transported to Metro Manila markets, particularly during the Luzon off-season.

Three (3) market channels were identified; processors, exporters and wholesaler/retailer. Around 60 percent of production is being shipped to Metro Manila to cater the demand requirements of processors and wholesaler/retailers around Metro Manila public markets. During off-season of mangoes in Luzon area, majority of the production from Davao del Sur is supplied to local markets in Manila for a highly favorable price, however, during regular season harvest of Luzon, majority of mangoes produced in Davao del Sur is supplied to processors located in Davao City, Cebu and Cagayan de Oro. Export-grade mangoes are delivered to exporters in Davao City and Metro Manila (20%). Export quality mangoes are delivered to Manila via air freight directly from traders in Davao del Sur. Wholesaler/retailers are estimated to capture 20 percent.

D. Perceived Postproduction Losses of Mango

The postproduction losses of mango as perceived by different stakeholders are shown in Table 1. On-farm losses caused by insect damage, cracks, misshapen and ripened were estimated at 11.82 percent. At the shipper level, 2.44 percent losses composed of partially burnt skin caused by high temperatures during transport were recorded. Since shipping takes 4 to 5 days, losses occur due to bumps from transport, and in rare instances, adverse weather conditions may lead to trucks or wing vans becoming stuck at the port, causing the mangoes to ripen prematurely before reaching the market. These defects in mangoes become evident at the trader level. The perceived postharvest losses at the trader level in Davao del Sur are estimated to be 9.86 percent of the total volume traded. At the wholesaler and retailer levels, perceived postproduction losses are 2.35 percent. These losses are primarily attributed to over-ripening, rotting, and the emergence of diseases such as anthracnose and stem-end rot.

TABLE 1. Postproduction losses of mango at different stages in the supply chain, Davao del Sur, 2022

Stages in the supply chain	Losses (%)	Sources of losses
Farm	11.82	insect damage, cracks, misshapen, overripe
Traders level	9.86	bumps, ripened
Shipper	2.44	burnt skin
Wholesaler/ retailer level	2.35	over ripe, rotten, stem-end rot, anthracnose
Total	**26.47**	

IV. Conclusion and Recommendation

Carabao" mango is one of the best varieties in the world when it comes to aroma and eating quality. Mango is the third most important fruit crop in the Philippines. High postharvest losses are one of the major causes of reduction in the quantity of mangoes in the market. The 2022 study on mango losses, based on perception, reported a total loss of 26.47 percent. The losses are mostly attributed to poor harvesting practices that cause cracking and droppings, poor handling and compression during transport. Postharvest diseases such as anthracnose and stem-end rot also contribute to losses. The highest perceived losses were recorded at the farm level (11.82%).

Due to inherent perishability of the crop, mangoes are susceptible to rapid spoilage if not properly handled after harvest. Inadequate post-harvest and processing facilities in many areas prevent effective storage and preservation of mangoes, leading to substantial losses.

To address the problems, interventions are recommended to effectively manage and reduce post-harvest losses. Research and development efforts could focus on pest and disease management protocols using biological control agents and the use of durable, weather-resistant bagging materials to mitigate pest infestations, a primary cause of farm-level losses. Moreover, research on optimal storage conditions and suitable packaging materials could be explored to help maintain fruit quality and minimize losses during transport. At the wholesaler and retailer levels, technologies such as protective coatings to preserve quality and the establishment of treatment facilities, such as Hot Water Treatment (HWT) could be implemented.

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