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Profitability, efficiency, and productivity of Marang (*Artocarpus odoratissimus*) in Southern Mindanao, Philippines

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Abstract This study is evaluated the profitability, efficiency, and productivity of marang (Artocarpus odoratissimus) farmers and traders in Southern Mindanao, Philippines. Findings showed that profitability significantly varied across seasons, with peak seasons yielding higher net returns. Soccsksargen is outperformed Davao in marang production and trade, with farmers and commission agents in Soccsksargen achieving the highest net profit margins. In contrast, wholesaler-retailers in Davao is generated the highest profitability among traders. The efficiency analysis indicated that assembler-wholesalers in Davao and commission agents in Soccsksargen are the most efficient players. Total factor productivity is found to be highest among wholesaler-retailers in Davao and farmers in Soccsksargen, suggesting better resource use. Policy interventions such as post-harvest infrastructure investments and farmer training programs are recommended to reduce inefficiencies and improve profitability across the supply chain.

Keywords: Efficiency, Marang, Productivity, Profitability, Southern Mindanao

Introduction

Agriculture remains a cornerstone of the Philippine economy and plays an important role in employment, food security, and rural development. Marang (*Artocarpus odoratissimus*) is one of those tropical fruits throughout the country and known for its distinct scent, soft flesh, and high nutritional value. It is extensively cultivated in Southern Mindanao, particularly in the Davao and Soccsksargen regions, with smallholder farmers and traders as the main actors of the marang value chain. The marang industry is underdeveloped despite its economic value because of seasonal production, substantial losses during post-harvest phase because of poor handling and storage and limited infrastructure (cold chains) and reliable transportation (Anand and Barua, 2022). These factors hindered its profitability, efficiency, and productivity by creating supply volatility and making it hard to get the fruit to consume before it spoils (Ziv and Fallik, 2021).

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A major challenge facing the marang industry is seasonal production and market fluctuations, which greatly impacts profitability. Farmers often experience high yields during peak season months, causing oversupply and lower prices. In contrast, lean season months lead to limited supply and higher market prices (Alvarado, 2023). Even with higher prices during lean season months, farmers and traders find it hard to keep a stable income due to lower sales volume. Furthermore, post-harvest losses remain a constant problem since marang is a highly perishable fruit that needs immediate consumption or proper storage to keep its quality (Ismail *et al.,* 2023). The lack of post-harvest facilities, like cold storage and processing centers, worsens market inefficiencies and causes significant losses along the supply chain (Mopera, 2016).

Another important issue is the economic viability of marang production and trade. While previous studies have investigated its nutritional value, processing potential, and consumer acceptance, limited research on financial performance and efficiency in the supply chain has been assessed (Pustadan, 2024). Without detailed data on costs, profit margins, and resource use, stakeholders shared limited insights to create strategies that improve the economic sustainability of marang farming and trading. In particular, the cost-return dynamics and efficiency ratings of various market players are not well documented, making it hard to identify bottlenecks and opportunities for improvement.

This research is identified the problem through initial field assessments, consultations with stakeholders, and analysis of secondary data. These approaches revealed major inefficiencies and differences in profitability among various industry players. Farmers often deal with high production costs, unpredictable yields, and limited bargaining power. Traders experience fluctuating profit margins, logistic issues, and unpredictable demand. Additionally, poor post-harvest handling leads to significant losses, which further decreasing the income potential for both farmers and traders. Without appropriate interventions, these challenges might persist to hinder the growth and sustainability of the marang industry.

This study aimed to evaluate the profitability of both marang farmers and traders by analyzing their cost structures, revenue sources, and net profit margins during peak and lean seasons, to assess efficiency levels in the marang supply chain by identifying reasons for operational inefficiencies and post-harvest losses, to measure productivity among key players by examining how resources are used and looking at total factor productivity (TFP) indicators, and to provide policy recommendations and strategic interventions for improving the economic performance of marang production and trade in Southern Mindanao.

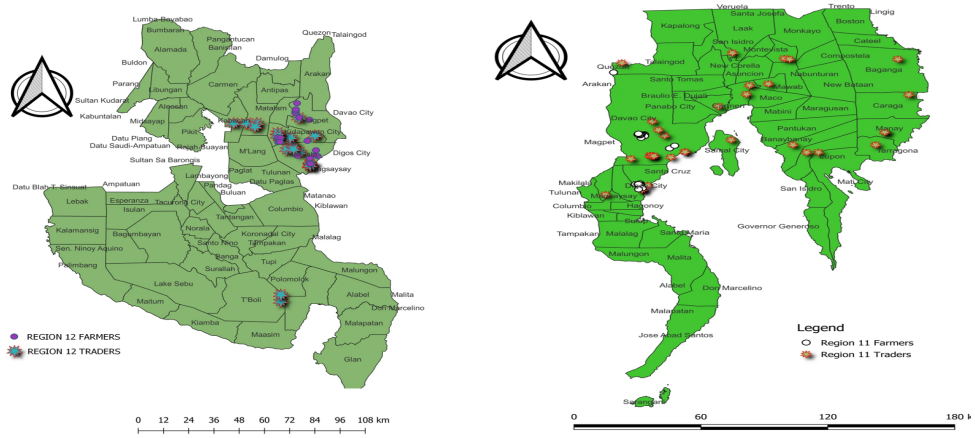
Materials and methods

Study area and timeframe

This study was conducted from January to December 2023 in Davao and Soccsksargen regions of Southern Mindanao, Philippines, where marang (*Artocarpus odoratissimus*) is widely cultivated. The study covered major marang-producing provinces, including Davao del Norte, Davao del Sur, South Cotabato, and Cotabato, where key industry players (farmers and traders) actively participate in production and marketing.

Research design and sampling method

A descriptive research design was used to address the objectives of the study. Data were systematically described the marang fruit industry in terms of profitability, efficiency, and productivity with the involvement of farmers and traders. A snowball sampling technique was applied to select the respondents to come up with the samples of farmers and traders. This technique was used due to the absence of a list of marang farmers and traders from municipal and provincial agriculture offices. A total of 236 farmers (53 respondents from Davao region and 183 from Soccsksargen region) were surveyed. On the other hand, a total of 110 traders (55 from Davao region and 55 from Soccsksargen region) were selected, and they were categorized into different trading roles: assembler-wholesalers, wholesaler-retailers, wholesalers, retailers, and commission agents.



a) Soccsksargen Region b) Davao Region

Figure 1. Location Map of Marang Farmers and Traders in Davao and Soccsksargen Regions

Data collection and research instrument

Primary data were collected through structured survey questionnaires, which were pre-tested among a small sample of respondents to ensure consistency, applicability, and suitability of different sets of questions. These questions consist of socio-economic profile, and cost and return in producing and selling marang by the respondents. Questions for profitability, efficiency, and productivity were collected from the cost and return data. These data were collected through self-administered survey conducted by trained enumerators. They visited these respondents in both regions to ensure that the responses were verified, and the questionnaires were retrieved by the team.

Data analysis procedure

The data were presented and analyzed using descriptive statistics such as percentages and means to summarize the results of socioeconomic characteristics of the farmers and traders.

On the other hand, the cost and return analysis was used to analyze the profitability of marang players (farmers and traders) involved in the marang industry. The Net Income (NI) was computed by getting the difference between total revenue and total production or trading costs. Net profit margin (NPM) was also computed to determine the proportion of profit (net income) to total revenue (sales) of every marang player. This was computed as:

$$\text{NPM} = \frac{\text{NI}}{\text{Revenue}} \tag{1}$$

Moreover, a Return on Expenses (ROE) was computed to determine whether it continued operating or whether profits substantially exceed the production or trading costs of each marang player. This was computed as:

$$\text{ROE} = \frac{\text{NI}}{\text{Cost}} \text{ x } 100 \tag{2}$$

Furthermore, efficiency was analyzed by using the Efficiency Performance Rating (EPR) to assess how well each marang players minimizes losses and transaction costs. The formula for determining efficiency is (Bayacag, 2012 as cited by Bugarin, 2013):

$$\text{EPR}_\text{i} = \frac{\text{Cp}}{\text{Ca}} \text{ x } 100 \tag{3}$$

where: EPR_i = efficiency performance rating of individual player *i*
Cp = potential cost
Ca = actual cost

Potential cost was computed by deducting the cost of inefficiencies which included losses and transaction costs from the actual cost of producing marang.

As the cost of inefficiencies increases potential cost decreases bringing down the efficiency performance rating of the player, however at zero cost of inefficiencies players achieve a full efficiency performance rating of 100%.

In addition, the total factor productivity (TFP) was used to determine how efficiently and intensely the inputs are utilized by each player in marang production and trading. The formula to determine the productivity is (Sickles and Zelenyuk, 2019):

$$TFP_i = \frac{O_i}{I_i} \quad (4)$$

where: TFP_i = productivity rating of player *i*
O_i = total output (value of output produced) of player *i*
I_i = total input (value of input used) of player *i*

The interpretation of TFP means that every peso is paid by the players for the factor inputs reflected the market value of the output. The higher value signified the better value productivity of the factor inputs used.

Results

Socioeconomic profile of marang farmers and traders

The socioeconomic characteristics of marang farmers and traders in Davao and Soccsksargen regions are summarized in Tables 1 and 2. The mean age of farmers in Davao was 48.55 years, while in Soccsksargen, it was 49.72 years. In terms of gender distribution, 49% of the farmers in Davao were male, compared to 43% in Soccsksargen. Most farmers in Soccsksargen (86%) were married, compared to 49% in Davao. The mean years of formal education was slightly higher in Davao (9 years) compared to Soccsksargen (8 years). Farming served as the primary source of income for 91% of farmers in Davao and 81% in Soccsksargen.

Table 1. Socio-economic profile of marang farmers in Davao and Soccsksargen Regions

Item	Davao	Soccsksargen
Age (Mean)	48.55	49.72
Sex (% Male)	49	43
Civil Status (% Married)	49	86
Education (Mean number of years)	9	8
Main Source of Income (% with farming as source)	91	81

For traders, the mean age was 42 years in Davao and 41 years in Soccsksargen. A larger proportion of traders in Soccsksargen were male (33%) compared to Davao (25%). Majority of traders in both regions were married (84%). The mean years of formal education was 8.85 in Davao and 8.35 in Soccsksargen. Most traders in Davao (70%) relied on trading as their main source of income, compared to Soccsksargen (53%).

Table 2. Socio-economic profile of marang traders in Davao and Soccsksargen regions

Item	Davao	Soccsksargen
Age (Mean)	42	41
Sex (% Male)	25	33
Civil Status (% Married)	84	84
Education (Mean Years)	8.85	8.35
Main Source of Income (% w/trade as source)	70	53

Cost and return analysis of marang farmers

The cost and return analysis of marang farmers revealed differences in profits between regions and across different seasons (Tables 3 and 4). In Davao, the average net income per tree was ₱3,124.15 during the peak season, ₱1,677.95 in the lean season, and ₱4,802.10 for the whole season.

Table 3. Average cost and return per tree of marang production by farmers for peak, lean, and whole seasons in Davao region

Item	Peak Season	Lean Season	Whole Season
Volume sold (in pieces/tree)	447	228	675
Selling price (PhP/piece)	10.75	11.19	
Gross Income/Revenue (PhP)	**4,805.25**	**2,551.32**	**7,356.57**
Variable costs (PhP)	1,681.10	873.37	2,554.47
Hired Labor			
Pre-harvest activity	135.10	98.36	233.46
Harvest activity	749.81	292.23	1,042.04
Fertilizer	331.35	220.90	552.25
Packaging materials	325.80	217.20	543.00
Materials used in hastening	27.00	18.00	45.00
Transportation cost	97.50	17.14	114.64
Losses/wasted/rejected	14.54	9.54	24.08
Net Income (PhP)	**3,124.15**	**1,677.95**	**4,802.10**
Return on Expenses (%)	**185.84**	**192.12**	**187.99**

In Soccsksargen, farmers earned a significantly higher net income per tree, amounting to ₱9,786.68 during the peak season, ₱4,943.01 in the lean season, and ₱14,729.69 for the whole season. Farmers in Davao had an ROE of 185.84%

during the peak season and 192.12% in the lean season. In contrast, Soccsksargen farmers achieved a higher ROE of 663.12% during the peak season and 447.34% in the lean season. The results indicated that marang production in Soccsksargen was more profitable, likely due to higher production volumes and better revenue generation.

Table 4. Average cost and return per tree of marang production by farmers for peak, lean, and whole seasons in Soccsksargen

Item	Peak Season	Lean Season	Whole Season
Volume sold (in pieces)	1,114	504	1,618
Selling price (PhP/ piece)	10.11	12.00	
Gross Income/Revenue (PhP)	**11,262.54**	**6,048.00**	**17,310.54**
Variable costs (PhP)	1,475.86	1,104.99	2,580.85
Hired Labor			
Pre-harvest activity	199.16	354.32	553.48
Harvest activity	580.38	326.33	906.71
Fertilizer	101.78	67.86	169.64
Herbicide	62.37	41.58	103.95
Packaging materials	259.44	172.96	432.40
Materials used in hastening	82.80	55.20	138.00
Transportation cost	145.56	63.46	209.02
Losses/wasted/rejected	44.37	23.28	67.65
Net Income (PhP)	**9,786.68**	**4,943.01**	**14,729.69**
Return on Expenses (%)	**663.12**	**447.34**	**570.73**

Table 5. Average cost and return in trading marang per week during peak season by type of trader in Davao region

Item	Assembler-Wholesaler	Wholesaler-Retailer	Wholesaler	Retailer
Volume sold (in kgs.)	537.47	1,503	410	384
Selling price (PhP/kg.)	28	30	20	34
Gross Income/ Revenue (PhP)	**15,049.02**	**45,097.50**	**8,190.00**	**13,039.00**
Variable Costs (PhP)	9,725.67	6,298.62	6,364.00	6,132.99
Hauling costs in purchasing	800.00	2,900.00	-	1,791.00
Labor costs in pre-selling and selling	6,507.00	920.00	4,312.00	2,145.96
Materials and supplies costs in pre-selling and selling	2,027.00	1,829.40	1,140.00	1,860.86
Losses/wasted/rejected	391.67	649.22	912.00	335.17
Net Income (PhP)	**5,323.35**	**38,798.88**	**1,826.00**	**6,906.01**
Return on Expenses (%)	**54.74**	**615.99**	**28.69**	**112.60**

Cost and return analysis of marang traders

The cost and return analysis of traders across different trading roles is summarized in Tables 5 and 6. During the peak season in Davao, assembler-wholesalers earned an average net income of ₱5,323.35 per week, wholesaler-retailers earned ₱38,798.88, wholesalers earned ₱1,826.00, and retailers earned ₱6,906.01. In Soccsksargen, commission agents had the highest weekly net income at ₱82,235.60, followed by assembler-wholesalers at ₱69,171.01, wholesaler-retailers at ₱30,514.31, wholesalers at ₱36,306.13, and retailers at ₱18,386.52.

Table 6. Average cost and return in trading marang per week during peak season by type of trader in Soccsksargen region

Item	Commission-Agent	Assembler-Wholesaler	Wholesaler-Retailer	Wholesaler	Retailer
Volume sold (in kgs.)	5,430.00	537.47	1,503	410	384
Selling price (PhP/kg.)	18.67	28	30	20	34
Gross Income/ Revenue (PhP)	**101,378.10**	**15,049.02**	**45,097.50**	**8,190.00**	**13,039.00**
Variable Costs (PhP)	**19,142.50**	9,725.67	6,298.62	6,364.00	6,132.99
Hauling costs in purchasing	5,600.00	800.00	2,900.00	-	1,791.00
Labor costs in pre-selling and selling	5,100.00	6,507.00	920.00	4,312.00	2,145.96
Materials and supplies costs in pre-selling and selling	7,860.00	2,027.00	1,829.40	1,140.00	1,860.86
Losses/wasted/ rejected	582.50	391.67	649.22	912.00	335.17
Net Income (PhP)	**82,235.60**	**5,323.35**	**38,798.88**	**1,826.00**	**6,906.01**
Return on Expenses (%)	**429.60**	**54.74**	**615.99**	**28.69**	**112.60**

During the lean season, wholesaler-retailers in Davao earned ₱4,379.38 per week, while retailers earned ₱874.42. In Soccsksargen, commission agents earned ₱59,118.00, assembler-wholesalers ₱17,147.25, wholesaler-retailers ₱2,731.88, wholesalers ₱4,295.92, and retailers ₱6,713.66 as shown in Tables 7 and 8. The return on expenses (ROE) analysis showed that commission agents in Soccsksargen had the highest ROE at 927.20%, while wholesaler-retailers in Davao followed with 615.99%.

Table 7. Average cost and return in trading marang per week during the lean season by type of trader in Davao region

Item	Wholesaler-Retailer	Retailer
Volume sold (in kgs.)	249.38	92.39
Selling price (PhP/kg.)	33.00	25.00
Gross Income/ Revenue (PhP)	**8,229.38**	**2,309.75**
Variable Costs (PhP)	**3,850.00**	**1,435.33**
Hauling costs in purchasing	400.00	550.00
Labor costs in pre-selling and selling	1,500.00	250.00
Materials and supplies costs in pre-selling and selling	950.00	385.33
Losses/wasted/rejected	1,000.00	250.00
Net Income (PhP)	**4,379.38**	**874.42**
Return on Expenses (%)	**1.14**	**0.61**

Table 8. Average cost and return in trading marang per week during the lean season by type of trader in Soccsksargen region

Item	Commission-Agent	Assembler-Wholesaler	Wholesaler-Retailer	Wholesaler	Retailer
Volume sold (in kgs.)	5,038.00	1,102.25	386.93	352.62	419.99
Selling price (PhP/kg.)	13.00	21.00	25.00	16.00	31.00
Gross Income/ Revenue (PhP)	**65,494.00**	**23,147.25**	**9,673.13**	**5,641.92**	**13,019.69**
Variable Costs (PhP)	**6,376.00**	**6,000.00**	**6,941.25**	**1,346.00**	**6,306.03**
Hauling costs in purchasing and selling	4,404.00	3,000.00	2,060.00	336.00	1,916.67
Labor costs in pre-selling and selling	-	500.00	768.50	1,010.00	2,062.50
Materials and supplies expenses in pre-selling and selling	1,807.00	1,100.00	2,806.75	-	2,148.29
Losses/wasted/rejected	165.00	1,400	1,306	-	178.57
Net Income (PhP)	**59,118.00**	**17,147.25**	**2,731.88**	**4,295.92**	**6,713.66**
Return on Expenses (%)	**927.20**	**285.79**	**39.36**	**319.16**	**106.46**

The profitability of marang players was further analyzed using the net profit margin (NPM) to determine the percentage of profit relative to total revenue. The highest NPM values were observed among wholesaler-retailers in Davao, who earned 0.81 pesos for every peso in revenue, and among farmers and commission agents in Soccsksargen, who had an NPM of 0.85 (Figure 2). The lowest NPM values were recorded for wholesalers in Davao at 0.22 and for retailers in Soccsksargen at 0.47.

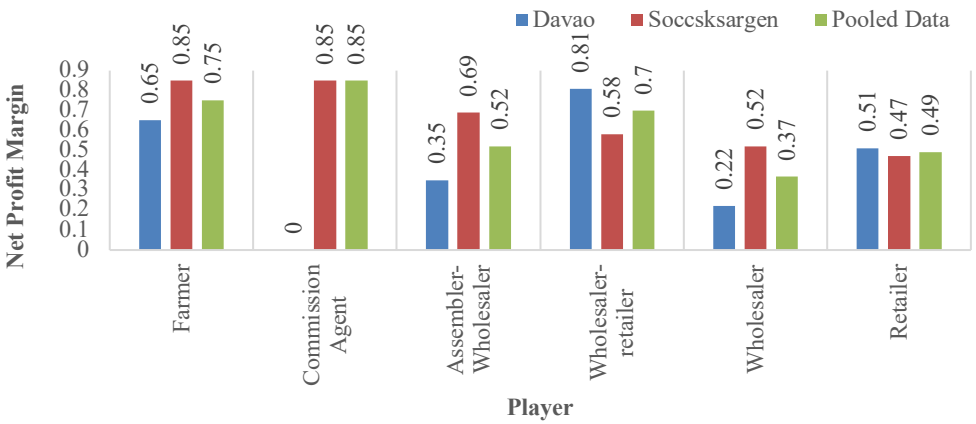


Figure 2. Average net profit margin of marang key players for the whole season in Davao and Soccsksargen regions

Productivity and efficiency of marang players

Productivity was assessed using total factor productivity (TFP), which measured the efficiency of input utilization. The results obtained the highest TFP which was recorded among wholesaler-retailers in Davao, with a TFP score of 5.25, followed by farmers in Soccsksargen at 6.71 and commission agents in Soccsksargen at 6.54. The lowest TFP values were observed among wholesalers in Davao (1.29) and retailers in Soccsksargen (1.90) as shown in Figure 3.

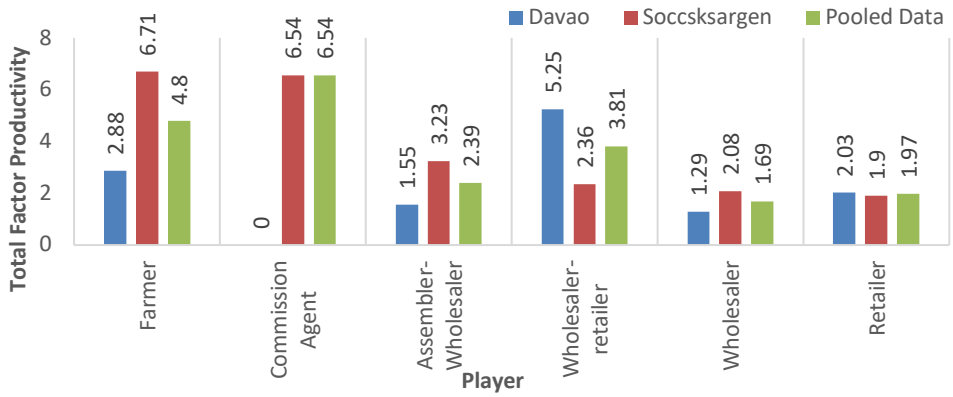


Figure 3. Average total factor productivity of marang key players for the whole season in Davao and Soccsksargen regions

Efficiency was evaluated using the Efficiency Performance Rating (EPR), which measured the cost-effectiveness of operations. The assembler-wholesalers in Davao achieved the highest efficiency rating at 77.48%, followed by

wholesaler-retailers (75.95%) and retailers (75.15%) as shown in Table 9. In Soccsksargen, commission agents had the highest efficiency rating at 95.44%, followed by wholesalers (77.67%) and wholesaler-retailers (76.97%) as shown in Table 10.

Table 9. Efficiency rating of key players of marang for the whole season in Davao region

Rating	Farmer f(n=53)	Assembler-Wholesaler f(n=3)	Wholesaler-Retailer f(n=24)	Wholesaler f(n=2)	Retailer f(n=81)
100.00–80.01	24	1	15	-	39
80.00–60.01	19	2	3	-	29
60.00–40.01	5	-	3	2	9
40.00–20.01	2	-	2	-	3
20.00–0.00	3	-	1	-	-
Mean	**73.70**	**77.48**	**75.95**	**47.80**	**75.15**

Table 10. Efficiency rating of key players of marang for the whole season in Soccsksargen region

Rating	Farmer f(n=183)	Commission Agent f(n=3)	Assembler-Wholesaler f(n=7)	Wholesaler-retailer f(n=23)	Wholesaler f(n=3)	Retailer f(n=19)
100.00–80.01	71	3	2	15	2	11
80.00–60.01	26	-	3	4	-	2
60.00–40.01	20	-	1	1	1	2
40.00–20.01	19	-	1	2	-	-
20.00–0.00	43	-	-	1	-	4
Mean	**57.11**	**95.44**	**67.88**	**76.97**	**77.67**	**68.99**

Discussion

The cost and return analysis showed that marang farmers in Soccsksargen earned much higher net incomes than those in Davao during peak and lean seasons. This finding suggested better yields and access to markets boost profitability in fruit-producing areas (Department of Primary Industries, 2020). However, the slightly higher return on expenses (ROE) seen among Davao farmers in the lean season in contrasts with other studies on tropical fruit farming. Those studies indicated that profitability usually decreases outside peak seasons due to storage issues (International Network for Natural Sciences, 2019). This

difference might be due to Davao farmers' utilization of various marketing channels, which help them maintain profitability even with lower yields.

Among traders, commission agents in Soccsksargen reported the highest net income and ROE, outperforming other market players. This supports earlier research showing that intermediaries handling bulk transactions often earn higher margins (Australian Centre for International Agricultural Research, 2020). On the other hand, the lower profits of wholesalers in Davao suggest inefficiencies in the local supply chain, likely because of insufficient post-harvest infrastructure. Studies on post-harvest technology indicate that poor facilities can lead to increased losses and lower profitability, emphasizing the need for better infrastructure in these areas (Castro, 2021).

Total factor productivity (TFP) analysis revealed that farmers in Soccsksargen and wholesaler-retailers in Davao had the highest productivity scores, indicating optimal resource use. This aligns with research linking higher productivity in fruit farming to effective management of inputs and marketing strategies (Department of Primary Industries, 2020). The high TFP of commission agents in Soccsksargen also matches studies showing that traders handling large fruit volumes experience economies of scale (Australian Centre for International Agricultural Research, 2020).

Efficiency assessments found that assembler-wholesalers in Davao and commission agents in Soccsksargen are the most efficient, achieving the highest Efficiency Performance Ratings (EPR). These findings support previous research emphasizing that intermediaries with direct access to farmers and established buyer networks have lower transaction costs and fewer post-harvest losses (Philippine Institute for Development Studies, 2015). However, the lower efficiency of wholesalers in Davao and retailers in Soccsksargen contrasts with other studies suggesting that small-scale fruit retailers often show high efficiency due to direct consumer engagement (International Network for Natural Sciences, 2019). This difference may result from regional variations in demand and infrastructure. For instance, retailers in Soccsksargen face higher transportation costs, which reducing their overall efficiency.

In conclusion, the findings confirm that Soccsksargen surpasses Davao in marang production and trading, with commission agents and wholesaler-retailers achieving the highest profit margins. Yet, inefficiencies remain among wholesalers in Davao and retailers in Soccsksargen, mainly due to post-harvest losses, market access problems, and high transportation costs.

To address these issues, investing in post-harvest infrastructure such as cold storage, processing facilities, and drying units is essential to reduce losses and enhance farmer profitability. Training programs on cost-efficient farming practices, value addition, and quality control should be introduced to boost the

competitiveness of marang farmers and traders. Strengthening direct market linkages by promoting farm-to-market systems, farmers' markets, and digital trading platforms could lessen reliance on intermediaries and increase producers' profit. Encouraging the formation of farmer cooperatives would give small-scale farmers better access to financial support, collective bargaining power, and shared resources, ultimately improving overall productivity. Additionally, research institutions should investigate post-harvest innovations like those in durian and jackfruit industries, which could prolong marang's shelf life and broaden its market reach.

Future research should focus on scaling up post-harvest innovations, improving direct market access, and exploring potential export opportunities for marang to boost its economic viability and sustainability. By implementing these recommendations, policymakers and industry stakeholders can help create a more efficient and profitable marang industry in the Philippines.

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Conflicts of interest

The authors declare no conflict of interest. There are no financial, personal, or institutional affiliations that could have influenced the research findings, data interpretation, or conclusions presented in this study. This declaration is made to ensure transparency and uphold the integrity of the review and decision-making process in accordance with the guidelines of the International Journal of Agricultural Technology (IJAT).

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