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Cost Structure and Information Asymmetry Analysis in the Sugarcane Cultivation Supply Chain in Jember Regency, East Java

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ABSTRACT

Keywords:
Supply chain, information asymmetry, cost structure, sugarcane cultivation

Abstract

Sugarcane farmers face the persistent issue of information asymmetry, an imbalance of knowledge between farmers and sugar mills that disrupts transparency and undermines trust within the supply chain. In addition, a high dependency on intermediaries and limited access to financing further exacerbates the economic disparity experienced by farmers. Investigating cost structures, information asymmetry, and partnership models within the sugarcane supply chain is therefore essential. This study was conducted in 2024 in Jember Regency, East Java. The methods employed include cost structure analysis, identification of information asymmetry, and estimation of sugar mill production potential. The findings reveal that sugarcane cultivation in Jember is predominantly organized under two partnership schemes: the Revenue-Sharing System (Sistem Bagi Hasil/SBH) and the Sugarcane Purchase System (Sistem Pembelian Tebu/SPT). Information asymmetry remains a major challenge, as farmers heavily rely on sugar mills as their primary source of information (78.4%), thereby diminishing their bargaining power. Despite being financially profitable (with an average income of IDR 24.4

million per hectare), the cost structure is largely concentrated in labor (59.24%) and fertilizers (20.56%). Market transaction costs account for 87.1% of total expenditures, indicating significant inefficiencies within the supply chain. An analysis of sugar mill capacity shows considerable variation in production scale; however, sugarcane supply remains unstable as farmers tend to sell to mills offering higher prices. Strengthening farmer groups, improving market information transparency, implementing integrated planting coordination, and fostering more equitable partnership models are all critical measures to ensure supply chain stability and enhance farmer welfare.

INTRODUCTION

Sugarcane cultivation constitutes a vital component of agricultural production, serving as a raw material for sugar, ethanol, and bioenergy (Huang et al., 2020). In developing countries, including Indonesia, sugarcane farming plays a significant role in economic growth and rural livelihoods. Beyond its economic relevance, sugarcane farming contributes to the socio-economic fabric of rural communities by supporting smallholder farmers (Oyugi, 2006). However, the sustainability of this sector requires effective collaboration between farmers and the sugar processing industry, particularly through equitable partnership models (Aguilar-Rivera, 2019).

East Java stands out as one of the major sugarcane-producing regions, contributing substantially to national sugar output (Bosma, 2013; Solomon et al., 2024). Current sugarcane cultivation practices involve partnership schemes, including revenue-sharing and contract-based purchase systems, aimed at ensuring a stable supply of raw materials while encouraging farmer participation. Theoretically, such systems are designed to improve farmers' welfare by providing access to markets, technical assistance, and financial resources. Nevertheless, the full potential of these schemes remains unrealized due to several persistent challenges. Many farmers encounter information asymmetry, an imbalance of knowledge between farmers and sugar mills, that undermines transparency and trust (Dal Belo Leite et al., 2020). Additionally, dependency on intermediaries and limited access to credit further deepen the economic disparity faced by smallholder farmers (Abebe et al., 2016). These challenges not only hinder the effectiveness of partnership systems but also raise concerns about their long-term viability in addressing farmers' economic and social well-being.

Previous studies have examined various aspects of the sugarcane supply chain (Asrol et al., 2024; Chouhan et al., 2022), contract farming systems in developing countries (Bahati et al., 2022; Machimu, 2024), and optimal models for sugarcane production and cost structures (Lozano et al., 2024). Moreover, studies on sugarcane farm cost calculations have highlighted the high variable costs, particularly labor (Fathikin dan Sudjoni, 2020; Saputro dan Rianti, 2024). These calculations have been extended to assess farming efficiency (Zaky et al., 2019), income risk (Kumalasari et al., 2019), and sugarcane production potential (Zainuddin, 2018), both within and outside partnership frameworks. However, there remains limited discussion on partnership models and the resulting information asymmetry, particularly in the Indonesian context. This study aims to analyze the cost structure and identify information asymmetry within the sugarcane supply chain in Jember Regency. Transaction cost approaches and cost structure analysis are employed to provide insights into farmers' income.

Additionally, this study maps active sugar mills in East Java based on their Total Cane per Day (TCD) capacity to assess the growth potential of the sugar industry. The findings are expected to contribute to the growing body of knowledge on sugarcane farming partnerships while offering practical recommendations for policymakers, sugar mills, and farmers.

Methodology

This study employs a quantitative descriptive approach combined with a case study method. The primary objective is to analyze transaction costs, cost structures in sugarcane farming, and the development potential of the sugar industry.

The primary subjects of the study are sugarcane farmers in Jember Regency, including both those engaged in partnerships with sugar mills and independent farmers. Additional insights were gathered from key stakeholders in the sugarcane commodity chain across three regencies: Jember, Lumajang, and Malang. These locations were selected based on their substantial contributions to East Java's sugar industry, as reported by the Central Bureau of Statistics in the 2023 plantation crop production data.

Multiple data collection techniques were employed to ensure robust and comprehensive findings:

1. In-depth Interviews: Farmers and stakeholders were interviewed using structured questionnaires and interview guides. This approach captured detailed insights regarding their experiences with partnership systems, as well as perceived challenges and benefits.
2. Focus Group Discussions (FGDs): FGDs were organized to facilitate interactive dialogue among farmers, sugar mill representatives, and other stakeholders. This method enabled the exploration of collective perspectives on sugarcane farming practices.

The collected data were analyzed using cost structure analysis to evaluate farmers' income and production costs. Profit was calculated as net income derived by subtracting total operational production costs (TC) from total revenue (TR) (Mankiw et al., 2014):

$$\pi = TR - TC \quad \ldots (1)$$

TCD, or Total Cane per Day, measures a sugar mill's processing capacity. From TCD, the following can be estimated: total cane processed during a harvest season, daily land requirement, and the total land needed to optimize seasonal capacity, as follows:

$$\text{Land Area Needed } (ha/day) = \frac{TCD}{Yields\ (ton/ha)} \quad \ldots (2)$$

$$Total\ Land\ Area\ (ha) = Land\ Area\ Needed\ (ha/day) \times Milling\ Days\ (180\ days) \quad \ldots (3)$$

$$Total\ Cane\ (tons) = TCD \times Milling\ Days\ (180\ days) \quad \ldots (4)$$

Equation (2) estimates the daily harvest area required to meet mill capacity. The average sugarcane yield is 67.39 tons per hectare, with the harvesting season typically lasting six months, from May to November (Statistics Indonesia, 2022). Equation (3) calculates the total

land area needed for the entire milling season, while equation (4) computes the total volume of sugarcane processed during that period.

RESULTS AND DISCUSSION

The spatial distribution of sugarcane farmers in Jember is illustrated in Figure 1, revealing distinct clusters of sugarcane farming activity. These clusters indicate that certain areas are more suitable for sugarcane cultivation due to favorable agro-climatic conditions or proximity to sugar mills. The grouping of farmers suggests the potential for targeted infrastructure development, such as improved transportation networks, irrigation systems, or local milling facilities. Conversely, the presence of more dispersed farming locations underscores the importance of outreach initiatives to ensure inclusivity and equitable access to resources and support programs for all sugarcane farmers in the region (Joffre et al., 2019).

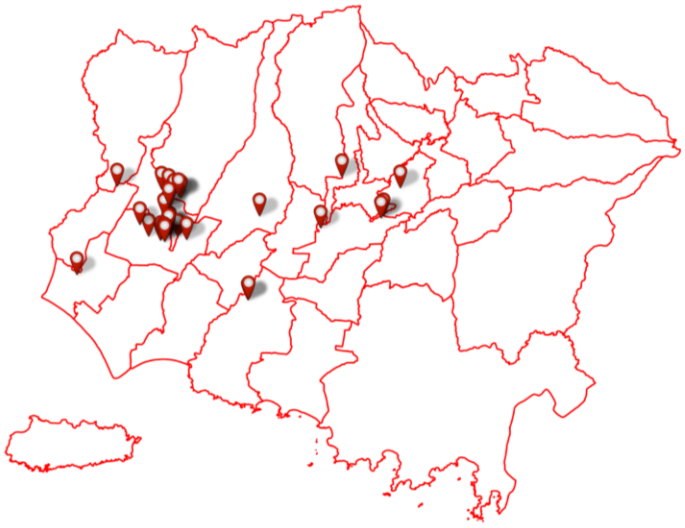

Figure 1. Spatial Distribution of Sugarcane Farmers in Jember Regency, 2024
Source: Primary Data

Densely clustered farming areas should be prioritized for infrastructure development, while more scattered locations require targeted support to enhance capacity building and farmer group participation (Nakano et al., 2018). Moreover, environmental considerations, such as soil conservation and water management, should be emphasized to ensure the long-term sustainability of sugarcane farming in the region (Tadele, 2021).

The characteristics of sugarcane farming in Jember are presented in Table 1, offering an overview of the demographic, economic, and social profiles of the farmers. The average age of farmers is 51.21 years, indicating that most are still within their productive years. This reflects a wealth of farming experience, as evidenced by an average of 16 years of sugarcane farming. However, the age profile also raises concerns regarding farmer regeneration and the future sustainability of sugarcane cultivation. On average, farmers have completed 12.2 years of education, suggesting a basic level of literacy and the capacity to comprehend agricultural technologies. Nevertheless, additional training is required to further optimize cultivation practices in light of evolving technological developments.

Table 1. Characteristics of Sugarcane Farmers in Jember Regency, 2024

Component	Unit	Average	Frequency	
			0	1
Age	Years	51.21		
Farming Experience	Years	16		
Education	Years	12.2		
Household Size	Persons	3.51		
Total Production	Tons	39,655.13		
Cultivated Area	Ha	40.75		
Land Ownership Status	1 (Owned); 0 (Rented)		28	9
Farmer Group Membership	1 (Member); 0 (Non-Member)		25	12

Source: Primary data. 2024

The average household size of 3.51 persons reflects a relatively small family structure. The total average production of 39,655.13 tons per season highlights the significant scale of sugarcane farming in Jember. Meanwhile, the average cultivated land area of 40.75 hectares indicates a mix of small- to medium-scale farming operations. Notably, 28 of the 37 surveyed farmers own their land, while 9 rent it. Land tenure plays a crucial role in determining farmers' ability to make long-term investments or adopt sustainable practices (Teshome et al., 2016). Furthermore, 25 respondents are members of farmer groups, underscoring the role of collective action in knowledge sharing, resource access, and collective bargaining, although barriers may still exist for those not affiliated with such groups (Taylor & Bhasme, 2018).

Partnerships and Information Asymmetry in Sugarcane Farming

The partnership or contract farming system in sugarcane cultivation in Jember is characterized by two primary selling mechanisms: the Revenue-Sharing System (Sistem Bagi Hasil or SBH) and the Sugarcane Purchase System (Sistem Pembelian Tebu or SPT). Under SBH, farmers share revenue with the sugar mill based on a predetermined percentage, making the system highly dependent on the mill's performance and prevailing market conditions. In contrast, the SPT model involves direct purchase, where farmers receive compensation based on the weight of sugarcane delivered, typically paid in cash.

The implementation of the SPT system has become increasingly prominent, reflecting the sugar mills' adaptation to Circular Letter No. 593/TI.050/E/7/2019 dated July 19, 2019, which regulates sugarcane purchasing. This regulatory push seeks to move away from the traditional SBH model, which, despite its longstanding use, has limitations regarding transparency and fair benefit distribution. The SPT system offers a more measurable and standardized approach by aligning compensation directly with harvested output. However, it also introduces complexities, such as yield potential estimation and price negotiation, which may present challenges for smallholder farmers lacking bargaining power or adequate access to resources.

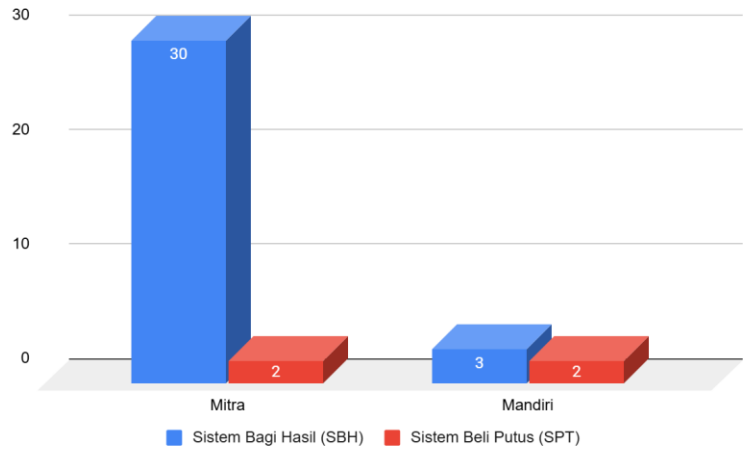

Figure 2. Sugarcane Sales Mechanism in Jember Regency in 2024
Source: Primary Data, 2024

Based on respondent data, 32 sugarcane farmers collaborated with traders or sugar mills, while five operated independently. Among the partnered farmers, two worked with traders under the Sugarcane Purchase System (Sistem Pembelian Tebu, or SPT), while the remaining collaborated with sugar mills under the Revenue-Sharing System (Sistem Bagi Hasil, or SBH) (Figure 2). This distribution indicates that SBH remains the dominant model despite regulatory efforts to promote SPT. The preference for SBH stems from familiarity, perceived stability, and reduced financial risk, as the revenue-sharing mechanism protects farmers from price volatility. However, the adoption of SPT reflects a gradual shift toward more transparent transactional systems. This transition may foster greater efficiency in the sugarcane supply chain, although it necessitates enhanced farmer capacity to comprehend and operate within the system. This study reveals that both SBH and SPT partnerships provide farmers with access to structured markets, technical assistance, and financial support (Eaton & Shepherd, 2001; Gramzow et al., 2018).

Furthermore, the presence of information asymmetry was assessed among both partnered and independent farmers. An analysis of access to and utilization of information among sugarcane farmers in Jember revealed significant indicators of information asymmetry—a condition in which one party in an economic transaction possesses more or better information than the other (Ullah et al., 2020). Data presented in Figure 3 highlights key findings underscoring the disparities in information dissemination and utilization in sugarcane farming, where a majority of farmers (78.4%) rely heavily on sugar mills and traders as their primary sources of information. Only a small percentage access information through farmer groups (10.8%) or the internet (10.8%). This heavy dependence on mills and traders suggests a concentration of informational control in the hands of a few actors, potentially placing farmers at a disadvantage in market negotiations or decision-making processes (Adams et al., 2019). The limited use of farmer groups and digital platforms indicates a lack of adoption of collective and modern information-sharing methods, which could otherwise empower farmers with broader and more transparent market insights.

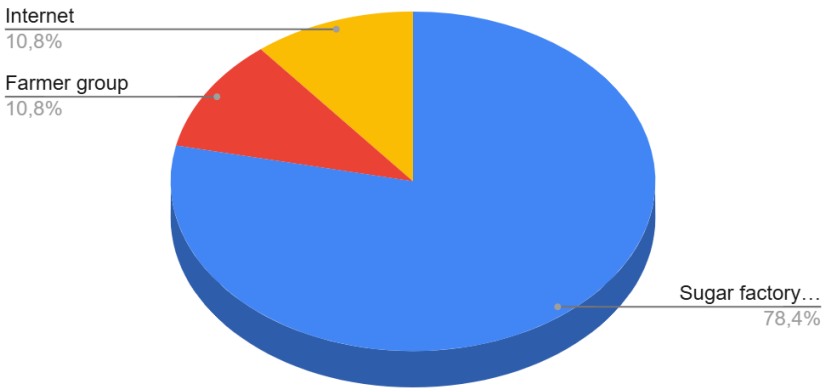

Figure 3. Various Sources of Sugarcane Price Information in Jember Regency, 2024
Source: Primary data, 2024

The frequency with which farmers receive information related to sugarcane farming is presented in Figure 4. The majority (73%) report receiving information only occasionally, while 13.5% receive it once a month. This infrequency reflects deficiencies in the agricultural extension system and the limited integration of farmers into information services. Farmers lacking timely and regular access to operational and market information are less likely to adopt innovations or respond effectively to market demands (Babu & Glendenning, 2019).

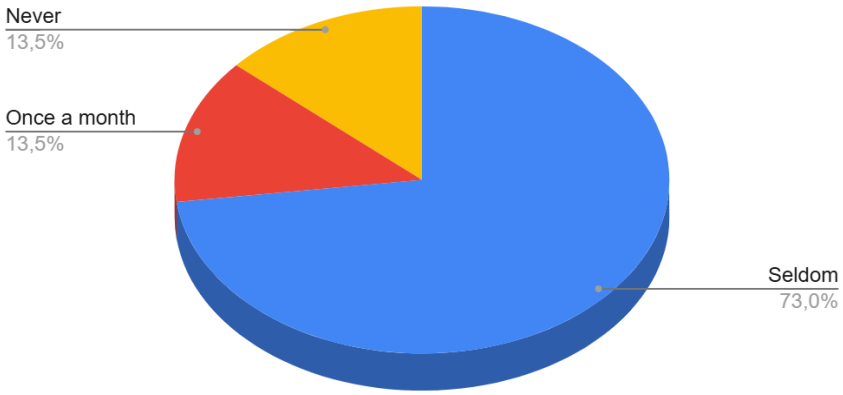

Figure 4. Frequency of Farmers Receiving Sugarcane-Related Information in Jember Regency, 2024
Source: Primary data, 2024

These findings indicate the presence of information asymmetry in sugarcane farming in Jember. Such asymmetry results in inefficiencies, such as farmers receiving lower prices for their harvests due to limited bargaining power (Pingali et al., 2019), inability to optimize production techniques (Ullah et al., 2020), and increased reliance on intermediaries (Xhoxhi et al., 2018). Dependence on limited information sources also creates opportunities for

information manipulation, potentially exacerbating the gap between better-informed market actors (e.g., traders) and farmers.

To address these challenges, several strategies are recommended. First, strengthening the role of farmer groups and local sugarcane associations as platforms for information exchange can enhance collective bargaining power and provide farmers with unbiased market data (Li et al., 2024). Second, promoting digital literacy and expanding internet access among sugarcane farmers can help bridge the digital divide and ensure more farmers benefit from real-time market information (Fabregas et al., 2019). Third, the government or private sector should focus on establishing transparent and easily accessible information-sharing systems, such as mobile-based agricultural advisory services, to disseminate market and technical information more effectively. Lastly, integrating more farmers into regular extension services can facilitate knowledge transfer and improve their capacity for sound decision-making (Koutsouris, 2018).

Cost Structure, Financing, and Income in Sugarcane Farming

The cost structure in agricultural production significantly influences managerial decision-making. Figure 5 illustrates the three main components constituting total costs. Labor accounts for the largest portion of variable costs, reflecting the manual intensity involved in activities such as planting, fertilizing, weeding, and harvesting. This reliance on manual labor highlights the need for interventions aimed at improving labor productivity through training or mechanization (Tong et al., 2024), which could reduce costs and enhance efficiency. Fertilizer represents the second-largest variable cost component, comprising 20.56% of total variable costs. This dependency indicates the need for sustainable practices, such as integrated soil fertility management or organic alternatives, to manage input costs while minimizing environmental impact.

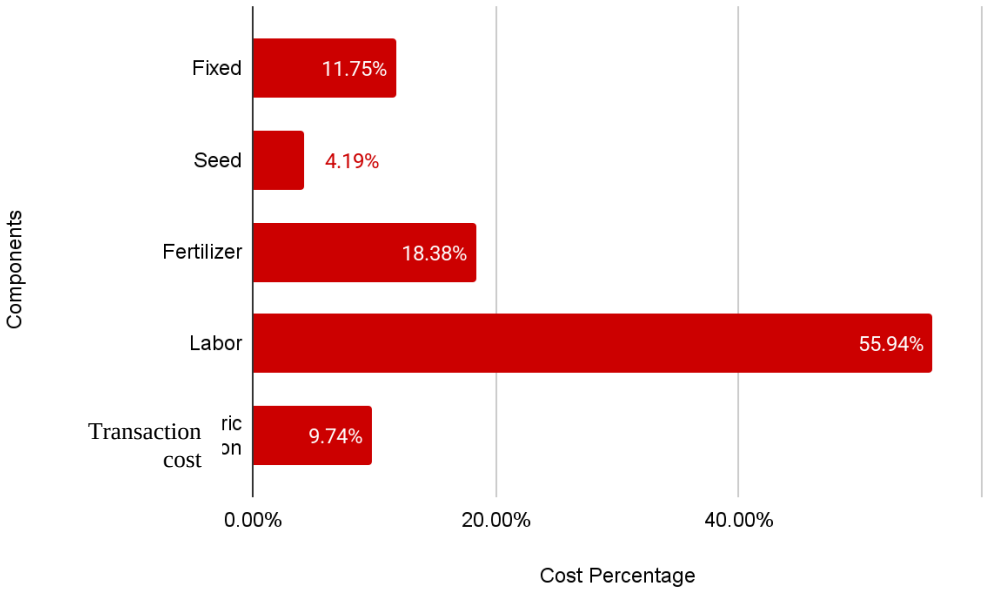

Figure 5. Cost Structure of Sugarcane Farming in Jember
Source: Primary data, 2024

Transaction costs account for 9.74% of the total production cost. Furthermore, data presented in **Figure 6** illustrates the breakdown of transaction costs. This data reveals that 87.1% of transaction costs are related to market activities, while labor and capital contribute 12.6% and 0.3%, respectively. This indicates that the majority of transaction costs are concentrated in activities such as price negotiations, transportation, and buyer search (Otekunrin et al., 2019), highlighting inefficiencies in market structures or limited access to transparent market mechanisms.

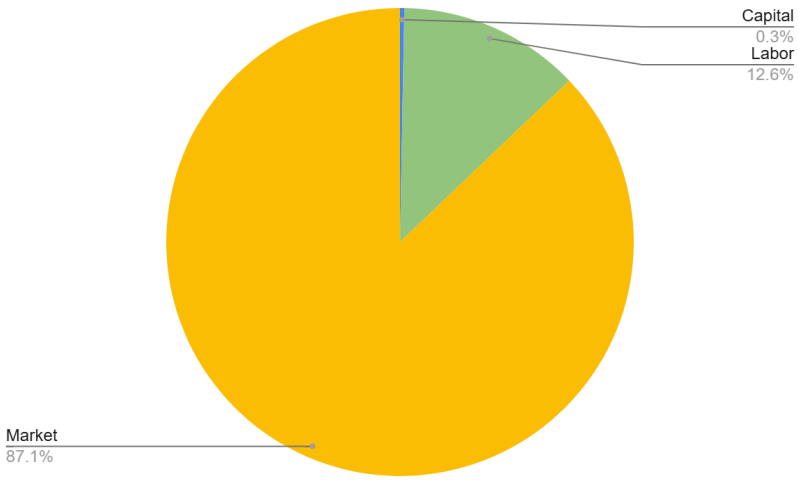

Figure 6. Structure of Transaction Costs in Sugarcane Farming in Jember Regency, 2024
Source: Primary data, 2024

The dominance of market-related expenditures within transaction costs may reflect systemic issues, such as asymmetric power dynamics in the marketplace or limited access to competitive markets (Vroegindewey et al., 2018), These conditions often lead farmers to depend on a narrow set of market actors, such as traders or sugar mills, who control pricing and market entry conditions (Negi et al., 2018). Such dependency frequently stems from unequal access to market information, leading to power imbalances. Farmers with limited knowledge of prevailing prices, demand levels, or alternative buyers may struggle to negotiate fair prices or gain access to more favorable market opportunities (Negi et al., 2018). Information asymmetry thus plays a crucial role in shaping the structure of transaction costs in sugarcane farming (Bijman et al., 2020).

Table 2. Average Cost and Profit Values of Sugarcane Farming in Jember (per hectare)

Component	Fixed Costs	Variable Costs	Total Costs	Revenue	Profit
Value (IDR)	3,166,709.942	21,980,844.71	25,147,554.66	49,597,218.64	24,449,663.99

Source: Primary data, 2024

Table 2 presents the average annual income and profit from sugarcane farming in Jember. The data provides a detailed breakdown of fixed costs, variable costs, total costs,

revenues, and resulting profits. The average total cost of sugarcane farming is IDR25,147,554.66 per hectare, consisting of fixed costs amounting to IDR3,166,709.94 and variable costs of IDR21,980,844.71. This shows that variable costs dominate the total production cost, comprising approximately 81.6%. The main components of variable costs include labor, fertilizers, seeds, and transaction costs. Fixed costs encompass expenses such as land rent, equipment depreciation, and maintenance, contributing around 12.59% of total costs. From a revenue perspective, farmers generate an average annual income of IDR49,597,218.64 with a net profit of IDR24,449,663.99 per hectare. This indicates strong financial performance, with farmers achieving a return of approximately 197.22% on their total investment. Such high profitability can be attributed to favorable market prices and economies of scale (de Roest et al., 2018), as sugarcane cultivation generally requires extensive land areas with high yield potential (Cardozo et al., 2018).

The substantial profit margins in sugarcane farming reflect the economic viability of this commodity in Jember. However, the heavy reliance on labor and fertilizers may pose long-term challenges, particularly if input prices rise or labor shortages occur. Additionally, despite the current profitability, market volatility and external factors, such as changes in government policy or global sugar prices, could significantly impact farmers' income.

Sugar Mill Potential in the Sugarcane Industry

Ton Cane per Day (TCD) is a unit of measurement used to determine the capacity of a sugar mill to process sugarcane (Ingaramo et al., 2009). The map and data provided illustrate the distribution and processing capacities of sugar mills across East Java, represented through TCD metrics that indicate each mill's daily processing capability. The map highlights the spatial distribution of these mills in relation to river basins across Java, emphasizing their concentration in certain areas, likely aligned with high sugarcane productivity zones and resource availability.

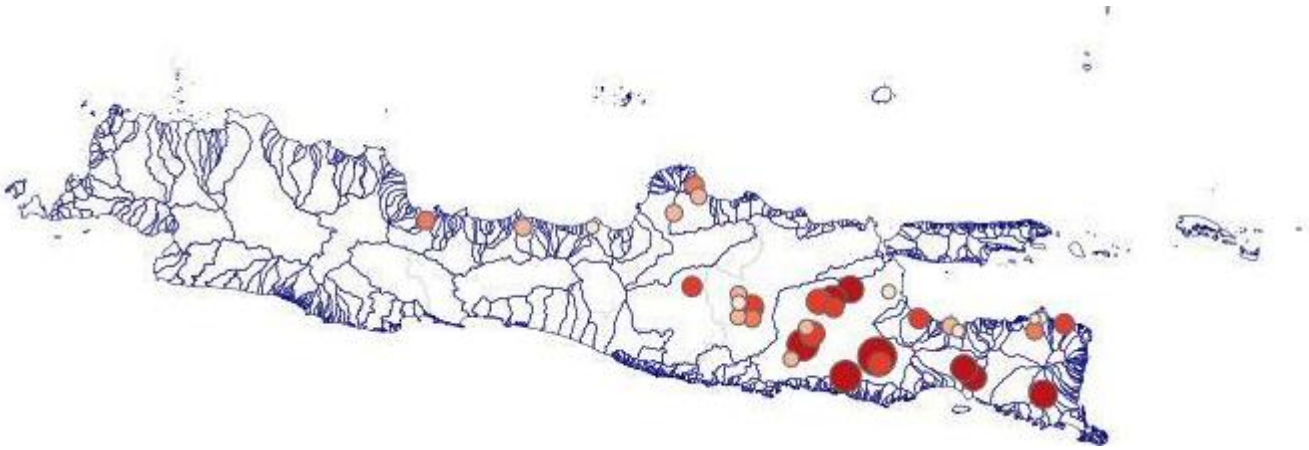

Figure 7. The Location of the Sugar Factory Based on Ton Cane per Day (TCD)
Source: Primary data, 2024

The spatial distribution illustrated in Figure 7 underscores the alignment of sugar mill locations with major river basins. This strategic placement is likely intended to ensure access to irrigation, transportation networks, and other essential resources for efficient sugarcane cultivation and processing. The clustering of mills in regions such as East Java also reflects the historical and economic significance of sugarcane as a key agricultural commodity in the area. Data presented in Table 3 provides an overview of the operational performance of sugar mills in East Java, focusing on processing capacity, land requirements, and the total volume of cane processed during the milling season. Among these mills, Kebonagung stands out with the highest processing capacity of 15,000 tons of cane per day (TCD), requiring 222.58 hectares (Ha) of land daily and processing a total of 2,700,000 tons throughout the season. This figure is significantly higher than smaller mills such as Panji, which processes 1,500 TCD with a daily land requirement of 22.26 Ha and a seasonal output of 270,000 tons. Similarly, Cepiring, with a capacity of 1,800 TCD, operates on a smaller scale, requiring 26.71 Ha of land per day and processing 324,000 tons per season.

The data further reveals a direct correlation between a mill's TCD and its land requirements, both daily and seasonally. Mills with higher TCD values, such as Kebonagung and Rejoso Manis Indo, require extensive land allocations, each demanding more than 26,000 hectares during the milling season. In contrast, smaller mills like Panji and Cepiring require significantly less land, making them more adaptable to local areas with limited resources.

Table 3. Ton Cane per Day (TCD) of Sugar Mills in East Java

Sugar Mill	TCD (Ton/Hari)	Daily Land Requirement (Ha)	Total Land Required for Milling Season (Ha)	Total Cane Processed (Tons)
Asembagus	4,000	59.36	10,684.08	720,000
Panji	1,500	22.26	4,006.53	270,000
Wringinanom	1,200	17.81	3,205.22	216,000
Prajekan	3,200	47.48	8,547.26	576,000
Industri Gula Glenmore	8,000	118.71	21,368.16	1,440,000
Semboro	7,000	103.87	18,697.14	1,260,000
Wonolangan	3,000	44.52	8,013.06	540,000
Gending	1,700	25.23	4,540.73	306,000
Djatiroto	7,000	103.87	18,697.14	1,260,000
Kedawoeng	4,000	59.36	10,684.08	720,000
Kebonagung	15,000	222.58	40,065.29	2,700,000
Krebet	5,500	81.61	14,690.61	990,000
Candi	2,000	29.68	5,342.04	360,000

Gempolkerep	7,200	106.84	19,231.34	1,296,000
Cukir	4,000	59.36	10,684.08	720,000
Jombang	7,200	106.84	19,231.34	1,296,000
Rejoso Manis Indo	10,000	148.39	26,710.19	1,800,000
Merican	2,500	37.10	6,677.55	450,000
Pesantren baru	6,200	92.00	16,560.32	1,116,000
Ngadirejo	10,000	148.39	26,710.19	1,800,000
Mojopanggung	2,500	37.10	6,677.55	450,000
Lestari	6,250	92.74	16,693.87	1,125,000
Rejoagung	5,800	86.07	15,491.91	1,044,000
Pagotan	3,200	47.48	8,547.26	576,000
Rejosari	2,650	39.32	7,078.20	477,000
Purwodadi	2,250	33.39	6,009.79	405,000
Sudono	2,700	40.07	7,211.75	486,000
Mojo	4,000	59.36	10,684.08	720,000
Pakis Baru	3,700	54.90	9,882.77	666,000
Trangkil	2,800	41.55	7,478.85	504,000
Rendeng	3,000	44.52	8,013.06	540,000
Cepiring	1,800	26.71	4,807.83	324,000
Sragi	3,050	45.26	8,146.61	549,000
Tersana Baru	3,300	48.97	8,814.36	594,000

Source: Primary data, 2024

The diversity in operational scale across mills highlights their varying roles within East Java's sugar industry. Larger mills benefit from economies of scale to maximize efficiency and production, contributing significantly to the regional economy. Conversely, smaller mills cater to local demands and are essential in areas with limited land availability. This variation underscores the need for strategic land-use planning and effective stakeholder collaboration to balance production demands with sustainable resource management (Sulaiman et al., 2019). Larger-capacity mills place increased pressure on land and water use, requiring the adoption of sustainable practices to mitigate environmental impacts. Additionally, the heavy reliance on extensive land areas for high-TCD mills raises questions about equitable resource distribution and the inclusion of smallholder farmers in the supply chain. The data illustrate the dominance of large-scale sugar production in East Java, driven by high-capacity mills with significant land and resource requirements. Nevertheless, sustainable sugarcane production requires effective management of land use, water resources, and equitable participation throughout the supply chain (Kiezebrink et al., 2015).

The discussion of TCD in this study is critical as it serves as a benchmark for understanding the scale and capacity of sugar mills, which directly influences the dynamics of the sugarcane supply chain (Le Gal et al., 2008). TCD acts as a nexus between agricultural production and industrial processing, highlighting the interaction between land use, labor demand, and production efficiency. High-TCD mills necessitate a broader and more reliable network of sugarcane suppliers, which can drive strategic decisions in land management, such as clustering sugarcane plantations near mills to reduce transportation costs and optimize resource distribution (Laasasenaho et al., 2019).

However, one of the major challenges in the sugarcane industry lies in ensuring farmers remain committed to supplying their partnered mills. Despite formal partnerships with mills, farmers often choose to sell their produce to mills offering higher prices. This disrupts the consistency of supply required to optimize mill operations and meet production capacity.

To address this issue, several strategic solutions are proposed, including enhancing planting schedules and adopting coordinated planting patterns (Le Gal et al, 2008). By organizing planting calendars, mills can ensure a steady supply of sugarcane throughout the milling season, avoiding supply shortages or surpluses that hinder operational efficiency. The establishment of clear planting guidelines and incentives for compliance can foster stronger collaboration between farmers and mills. Moreover, improved cropping patterns can maximize land productivity, reduce costs, and enhance cane quality, yielding long-term benefits for both parties.

Such interventions require the active engagement of all stakeholders, including farmers, sugar mills, and local government authorities. Sugar mills must provide technical assistance, transparent pricing mechanisms, and additional incentives to encourage farmers to remain committed to their harvest deliveries. Farmers, in turn, need assurances that such partnerships will yield stable and competitive returns. Through effective planning and communication, the sugarcane industry can achieve a sustainable balance that meets production objectives while economically empowering farmers.

CONCLUSION

This study reveals that sugarcane cultivation in Jember, East Java, is predominantly governed by partnership models, namely the Revenue-Sharing System (Sistem Bagi Hasil or SBH) and the Sugarcane Purchase System (Sistem Pembelian Tebu or SPT), with information asymmetry emerging as a major challenge due to farmers' heavy reliance (78.4%) on sugar mills as their primary information source, reducing their bargaining power. Although sugarcane farming is financially profitable (with an average profit of IDR 24.4 million per hectare), the cost structure is dominated by labor (59.24%) and fertilizers (20.56%). The analysis of sugar mills' processing capacity, measured in Ton Cane per Day (TCD), indicates significant variations in production scale. However, supply inconsistencies persist, as farmers often prefer to sell to mills offering higher prices. To enhance sustainability, it is essential to strengthen farmer groups, promote transparency in market information, implement integrated planting coordination, and establish more equitable partnerships to ensure stable supply chains and improve farmer welfare. These findings offer critical insights for policymakers and industry actors aiming to optimize a more efficient and inclusive sugarcane supply chain.

RECOMMENDATION

Future studies are recommended to evaluate the long-term economic and environmental impacts of partnership models on sugarcane productivity and farmer well-being across a broader geographical scope.

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REFERENCES

Abebe, G. K., Bijman, J., & Royer, A. (2016). Are middlemen facilitators or barriers to improve smallholders' welfare in rural economies? Empirical evidence from Ethiopia. *Journal of Rural Studies*, *43*, 203–213. https://doi.org/https://doi.org/10.1016/j.jrurstud.2015.12.004

Adams, T., Gerber, J.-D., Amacker, M., & Haller, T. (2019). Who gains from contract farming? Dependencies, power relations, and institutional change. *The Journal of Peasant Studies*, *46*(7), 1435–1457.

Aguilar-Rivera, N. (2019). A framework for the analysis of socioeconomic and geographic sugarcane agro industry sustainability. *Socio-Economic Planning Sciences*, *66*, 149–160. https://doi.org/https://doi.org/10.1016/j.seps.2018.07.006

Asrol, M., Marimin, Machfud, Yani, M., & Rohayati. (2024). A multi-criteria model of supply chain sustainability assessment and improvement for sugarcane agroindustry. *Heliyon*, *10*(7), e28259. https://doi.org/https://doi.org/10.1016/j.heliyon.2024.e28259

Babu, S. C., & Glendenning, C. J. (2019). *Chapter 6 - Information needs of farmers: a systemic study based on farmer surveys* (S. C. Babu & P. K. B. T.-A. E. R. in S. A. Joshi (eds.); pp. 101–139). Academic Press. https://doi.org/https://doi.org/10.1016/B978-0-12-818752-4.00006-0

Badan Pusat Statistik, B. (2022). *Analisis Data Gula Provinsi Jawa Timur 2022*. https://web-api.bps.go.id/download.php?f=/fhdDc164jH1vGy+7IrUemdHQUNRcS8rdXNHSGVpb0daU1hFV0xDckF0K1ZHbmJVT3VIcWZ2MTlLcmZydnJqdmRWaXpvYnRsbVNkZFRRZHcvK0hiV09CMVp3YkYraGczT2hnYTdVV0dwQS9NdjBZZ1FhWXRNVmtTNEVoKzY4VWxFQ3BoKzZQUnE4TE5BY1dUQ3M5VlpNakJuWjNDWGw0N0

Bahati, I., Martiniello, G., & Abebe, G. K. (2022). The implications of sugarcane contract farming on land rights, labor, and food security in the Bunyoro sub-region, Uganda. *Land Use Policy*, *122*, 106326. https://doi.org/https://doi.org/10.1016/j.landusepol.2022.106326

Bijman, J., Mugwagwa, I., & Trienekens, J. (2020). Typology of contract farming arrangements: a transaction cost perspective. *Agrekon*, *59*(2), 169–187.

Bosma, U. (2013). *The sugar plantation in India and Indonesia: industrial production, 1770-2010*. Cambridge University Press.

Cardozo, N. P., de Oliveira Bordonal, R., & La Scala, N. (2018). Sustainable intensification of sugarcane production under irrigation systems, considering climate interactions and

agricultural efficiency. *Journal of Cleaner Production*, *204*, 861–871. https://doi.org/https://doi.org/10.1016/j.jclepro.2018.09.004

Chouhan, V. K., Khan, S. H., & Hajiaghaei-Keshteli, M. (2022). Hierarchical tri-level optimization model for effective use of by-products in a sugarcane supply chain network. *Applied Soft Computing*, *128*, 109468. https://doi.org/https://doi.org/10.1016/j.asoc.2022.109468

Dal Belo Leite, J. G., Langa, F. M., von Maltitz, G., Lima Verde Leal, M. R., & Barbosa Cortez, L. A. (2020). Sugarcane outgrower schemes model: Friend or foe? A question for smallholder farmers in Mozambique. *World Development Perspectives*, *19*, 100232. https://doi.org/https://doi.org/10.1016/j.wdp.2020.100232

de Roest, K., Ferrari, P., & Knickel, K. (2018). Specialisation and economies of scale or diversification and economies of scope? Assessing different agricultural development pathways. *Journal of Rural Studies*, *59*, 222–231. https://doi.org/https://doi.org/10.1016/j.jrurstud.2017.04.013

Eaton, C., & Shepherd, A. (2001). *Contract Farming: Partnerships for Growth*. Food and Agricultural Organization.

Fabregas, R., Kremer, M., & Schilbach, F. (2019). Realizing the potential of digital development: The case of agricultural advice. *Science*, *366*(6471), eaay3038.

Fatikhin, M., & Sudjoni, N. (2020). Analisis efisiensi usahatani serta faktor-faktor yang mempengaruhi produksi tebu di Desa Badang Kecamatan Ngoro Kabupaten Jombang. JU-ke (Jurnal Ketahanan Pangan), 4(1), 10-16.

Gramzow, A., Batt, P. J., Afari-Sefa, V., Petrick, M., & Roothaert, R. (2018). Linking smallholder vegetable producers to markets - A comparison of a vegetable producer group and a contract-farming arrangement in the Lushoto District of Tanzania. *Journal of Rural Studies*, *63*, 168–179. https://doi.org/https://doi.org/10.1016/j.jrurstud.2018.07.011

Huang, J., Khan, M. T., Perecin, D., Coelho, S. T., & Zhang, M. (2020). Sugarcane for bioethanol production: Potential of bagasse in Chinese perspective. *Renewable and Sustainable Energy Reviews*, *133*, 110296. https://doi.org/https://doi.org/10.1016/j.rser.2020.110296

Ingaramo, A., Heluane, H., Colombo, M., & Cesca, M. (2009). Water and wastewater eco-efficiency indicators for the sugar cane industry. *Journal of Cleaner Production*, *17*(4), 487–495. https://doi.org/https://doi.org/10.1016/j.jclepro.2008.08.018

Joffre, O. M., Poortvliet, P. M., & Klerkx, L. (2019). To cluster or not to cluster farmers? Influences on network interactions, risk perceptions, and adoption of aquaculture practices. *Agricultural Systems*, *173*, 151–160.

Kiezebrink, V., van der Wal, S., Theuws, M., & Kachusa, P. (2015). *Sustainability issues in the sugar cane supply chain*. Stichting Onderzoek Multinationale Ondernemingen (SOMO). Amsterdam (NL). www ….

Koutsouris, A. (2018). Role of extension in agricultural technology transfer: A critical review. *From Agriscience to Agribusiness: Theories, Policies and Practices in Technology Transfer and Commercialization*, 337–359.

Kumalasari, A. D., Budiraharjo, K., & Setiadi, A. (2019). Komparasi produksi dan pendapatan petani tebu mitra dan non mitra pabrik gula Rendeng di Kabupaten Kudus. Agrisocionomics: Jurnal Sosial Ekonomi Pertanian, 3(1), 28-38.

Laasasenaho, K., Lensu, A., Lauhanen, R., & Rintala, J. (2019). GIS-data related route optimization, hierarchical clustering, location optimization, and kernel density methods are useful for promoting distributed bioenergy plant planning in rural areas. *Sustainable Energy Technologies and Assessments*, *32*, 47–57.

Le Gal, P.-Y., Lyne, P. W. L., Meyer, E., & Soler, L.-G. (2008). Impact of sugarcane supply scheduling on mill sugar production: A South African case study. *Agricultural Systems*, *96*(1), 64–74. https://doi.org/https://doi.org/10.1016/j.agsy.2007.05.006

Li, Q., Hadj-Hamou, K., & Rekik, Y. (2024). The formation of cooperatives with the implications of information sharing and contract farming. *International Journal of Production Research*, 1–22.

Lozano, M. A., dos Santos, R., Santos, J. J. C. S., & Serra, L. M. (2024). Optimal modes of operation and product cost allocation in sugarcane steam cogeneration plants. *Thermal Science and Engineering Progress*, *52*, 102686. https://doi.org/https://doi.org/10.1016/j.tsep.2024.102686

Machimu, G. M. (2024). Next steps for smallholder sugarcane contract farmers in developing countries: A review. *Social Sciences & Humanities Open*, *9*, 100865. https://doi.org/https://doi.org/10.1016/j.ssaho.2024.100865

Martiniello, G., & Azambuja, R. (2019). Contracting sugarcane farming in global agricultural value chains in eastern Africa: Debates, dynamics, and struggles. *Agrarian South: Journal of Political Economy*, *8*(1–2), 208–231.

Nakano, Y., Tsusaka, T. W., Aida, T., & Pede, V. O. (2018). Is farmer-to-farmer extension effective? The impact of training on technology adoption and rice farming productivity in Tanzania. *World Development*, *105*, 336–351. https://doi.org/https://doi.org/10.1016/j.worlddev.2017.12.013

Negi, D. S., Birthal, P. S., Roy, D., & Khan, M. T. (2018). Farmers' choice of market channels and producer prices in India: Role of transportation and communication networks. *Food Policy*, *81*, 106–121. https://doi.org/https://doi.org/10.1016/j.foodpol.2018.10.008

Otekunrin, O. A., Momoh, S., & Ayinde, I. A. (2019). Smallholder farmers' market participation: concepts and methodological approach from Sub-Saharan Africa. *Current Agriculture Research Journal*, *7*(2), 139.

Oyugi, B. A. (2016). Socio-economic impacts of sugarcane farming on livelihoods and the biophysical environment in Trans Mara Sub-County, Kenya. Unpublished Master's, Kenyatta University.

Pingali, P., Aiyar, A., Abraham, M., Rahman, A., Pingali, P., Aiyar, A., Abraham, M., & Rahman, A. (2019). Linking farms to markets: reducing transaction costs and enhancing bargaining power. *Transforming Food Systems for a Rising India*, 193–214.

Saputro, A. J., & Rianti, T. S. M. (2024). Tingkat Risiko Pendapatan dan Faktor yang Mempengaruhi Pendapatan Usahatani Tebu Keprasan. Jurnal Sosial Ekonomi Pertanian, 20(1), 1-10.

Solomon, S., Vanichsriratana, W., Duong, C. A., Manimekalai, R., Singh, P., Misra, V., & Rao, G. P. (2024). Sustainability Issues and Opportunities for Sugar and Integrated Industries in ASEAN Region. *Sugar Tech*, *26*(4), 932–950.

Sulaiman, A. A., Sulaeman, Y., Mustikasari, N., Nursyamsi, D., & Syakir, A. M. (2019). Increasing sugar production in Indonesia through land suitability analysis and sugar

mill restructuring. *Land*, *8*(4), 61.

Tadele, E. (2021). Land and heterogenous constraints nexus income diversification strategies in Ethiopia: systematic review. *Agriculture & Food Security*, *10*, 1–14.

Taylor, M., & Bhasme, S. (2018). Model farmers, extension networks and the politics of agricultural knowledge transfer. *Journal of Rural Studies*, *64*, 1–10. https://doi.org/https://doi.org/10.1016/j.jrurstud.2018.09.015

Teshome, A., de Graaff, J., Ritsema, C., & Kassie, M. (2016). Farmers' perceptions about the influence of land quality, land fragmentation and tenure systems on sustainable land management in the north western Ethiopian highlands. *Land Degradation & Development*, *27*(4), 884–898.

Tong, T., Ye, F., Zhang, Q., Liao, W., Ding, Y., Liu, Y., & Li, G. (2024). The impact of labor force aging on agricultural total factor productivity of farmers in China: Implications for food sustainability. *Frontiers in Sustainable Food Systems*, *8*, 1434604.

Ullah, A., Arshad, M., Kächele, H., Khan, A., Mahmood, N., & Müller, K. (2020). Information asymmetry, input markets, adoption of innovations and agricultural land use in Khyber Pakhtunkhwa, Pakistan. *Land Use Policy*, *90*, 104261. https://doi.org/https://doi.org/10.1016/j.landusepol.2019.104261

Vroegindewey, R., Theriault, V., & Staatz, J. (2018). Coordinating cereal farmers and buyers: evidence from Mali. *Journal of Agribusiness in Developing and Emerging Economies*, *8*(2), 234–255.

Xhoxhi, O., Pedersen, S. M., & Lind, K. M. (2018). How does the intermediaries' power affect farmers-intermediaries' trading relationship performance? *World Development Perspectives*, *10–12*, 44–50. https://doi.org/https://doi.org/10.1016/j.wdp.2018.09.004.

Zainuddin, A. (2018). Analisis potensi produksi tebu dengan pendekatan fungsi produksi frontir (Studi kasus di PT. Perkebunan Nusantara x). Jurnal Pangan, 27(1), 33-42.

Zaky, Y., Pambudy, R., & Harianto, H. (2019, April). ANALISIS EFISIENSI USAHATANI TEBU PETANI MITRA DAN NON MITRA DI KABUPATEN BLORA JAWA TENGAH. In Forum Agribisnis: Agribusiness Forum (Vol. 9, No. 1, pp. 85-106).