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Research Paper

Income of Owners and Workers of Traditional Sugarcane Brown Sugar Mills: A Descriptive Study in Buter Village, Ketol District, Central Aceh Regency

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Abstract

Traditional sugarcane brown sugar mills are a source of rural income in the Gayo highlands of Aceh, yet published studies report the returns of mill owners and rarely the wages of the workers they employ. This study describes the income of owners and workers of the three active mills in Buter Village, Ketol District, Central Aceh Regency, and the constraints on their operation. A descriptive design was used. Data were collected from three mill owners and six workers through observation, interviews and documentation between 6 November and 6 December 2025, and were analysed by data condensation, data display and conclusion drawing combined with a simple income analysis. Monthly gross income ranged from Rp28,600,000 to Rp39,000,000 per mill and totalled Rp101,400,000, against total costs of Rp52,600,000. Net income totalled Rp48,800,000, or Rp16,266,667 per owner per month, with a revenue–cost ratio of 1.93. Each worker earned Rp120,000 per day, or Rp3,120,000 per month, which is 84.7% of the 2025 Aceh provincial minimum wage. Rain, machine breakdown, labour scarcity and low-quality cane were the reported constraints. The mills are profitable for their owners, whereas workers' wages are below the provincial minimum-wage benchmark.

Keywords: Brown sugar; Non-centrifugal sugar; Income analysis; Rural agroindustry; Wage income; Central Aceh.

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1. Introduction

Processing sugarcane into brown sugar is one of the rural agroindustries through which farm households in Indonesia add value to a plantation crop. Agriculture supplies food, income and employment in rural areas [1], and household-scale agroindustries extend that role by creating jobs and raising household income [2], [3]. Brown sugar made from sugarcane belongs to the non-centrifugal sugars, which are produced by evaporating cane juice in open pans without separating the molasses and are made mostly by small, traditional units [4]–[6].

Studies of such units consistently report positive returns, although the amounts differ widely. In Kerinci, five brown sugar agroindustries earned an average income of Rp5,067,013 per month with revenue–cost (R/C) ratios above 1 [7], whereas farmer-processors in another village of the same regency earned Rp1,482,578 per month, which was 46.77% of household income [8]. In Ketol District, a mill that processes cane as a service earned Rp1,061,749 per month with an R/C ratio of 1.39 [9]. A value-added analysis in Kediri found a value-added ratio of 41.67% and a net profit margin of 8% [10], and cane processed into granulated brown sugar gave an R/C ratio of 2.12, compared with 1.56–1.98 for cane delivered to white sugar factories [11]. Outside Indonesia, benefit–cost ratios of 1.48 in Punjab [12] and 1.12 in Andhra Pradesh [13] have been reported for jaggery units.

The same literature identifies technical constraints. Traditional furnaces use 13–15% of the heat from burning bagasse and crushers extract 55–60% of the juice [4]; bagasse has to be dried in the open before it is used as fuel [5]; sucrose is lost when harvested cane waits before crushing [14]; and producers report labour shortages and inconsistent product quality [12].

Three gaps remain. First, the studies above take the owner or the enterprise as the unit of analysis, so the wage income of mill workers is not reported next to the owners' income. Second, the published study from Ketol District examined a single mill [9], which hides variation between mills in the same village. Third, no study has documented the mills of Buter Village, where families have produced brown sugar for generations from local cane varieties with traditional equipment, and where a preliminary observation found three active mills, each producing about 600 kg of brown sugar per day. This study addresses these gaps by covering all three active mills, reporting owners' net income and workers' wage income together, comparing the wage with the provincial minimum wage, and recording the constraints stated by the owners. Its aim is to describe the income level of owners and workers of sugarcane brown sugar mills in Buter Village, Ketol District, Central Aceh Regency, and the constraints on their operation.

2. Method

This study used a descriptive design with qualitative data collection, which suits the description of a little-documented phenomenon in its own setting [15]. The site, Buter Village in Ketol District, Central Aceh Regency, was chosen purposively because its mills still operate with traditional equipment. Fieldwork was carried out in November–December 2025, and the interviews were held between 6 November and 6 December 2025.

Participants were selected by purposive sampling, in which participants are chosen for their fit with the aim of the study [16]. They comprised the owners of all three active mills (aged 40, 45 and 60 years) and six workers involved in production (four women and two men, aged 22–50 years). Participants are identified by codes, O1–O3 for owners and W1–W6 for workers.

Data were collected by observation of the production process, interviews on income, costs and constraints, and documentation. The data were analysed with the interactive model of data condensation, data display and conclusion drawing [17]. Credibility was examined through triangulation of sources (owners and workers) and of techniques (observation, interviews and documentation) [18].

Income was calculated in three steps. Monthly gross income is the daily gross income stated by each owner multiplied by 26 working days. Net income is gross income minus total cost (Equation 1), the mean is the sum of the individual values divided by the number of informants (Equation 2), and the R/C ratio is gross income divided by total cost (Equation 3):

$$\pi = TR - TC \qquad (1)$$

$$\bar{X} = \Sigma X / n \qquad (2)$$

$$R/C = TR / TC \quad (3)$$

where π is net income, TR is total revenue (gross income), TC is total cost, $\bar{X}$ is the mean, ΣX is the sum of the values and n is the number of informants.

Income levels were classified with the four-tier monthly income grouping attributed to Statistics Indonesia (BPS): low (below Rp1,500,000), medium (Rp1,500,000–2,500,000), high (above Rp2,500,000 to Rp3,500,000) and very high (above Rp3,500,000). Workers' wages were also compared with the 2025 Aceh provincial minimum wage of Rp3,685,616 per month [19], which is used here as a benchmark and not as a test of legal compliance.

3. Results and Discussion

Results

Gross Income of Mill Owners

The three owners reported daily gross incomes of Rp1,100,000 to Rp1,500,000 (Table 1). With 26 working days per month, monthly gross income was Rp39,000,000 for O1, Rp33,800,000 for O2 and Rp28,600,000 for O3. The three mills together earned Rp101,400,000 per month, a mean of Rp33,800,000 per mill.

Table 1. Daily and monthly gross income of mill owners

No.	Informant	Daily gross income (Rp)	Working days	Monthly gross income (Rp)
1	O1 (owner, 60 years)	1,500,000	26	39,000,000
2	O2 (owner, 45 years)	1,300,000	26	33,800,000
3	O3 (owner, 40 years)	1,100,000	26	28,600,000
	Total	3,900,000	–	101,400,000
	Mean	1,300,000	26	33,800,000

Source: Primary data (processed, 2025).

Wage Income of Workers

All six workers reported the same daily wage of Rp120,000 (Table 2). Over 26 working days, each worker earned Rp3,120,000 per month, and the six workers together earned Rp18,720,000. This wage falls in the high category of the classification used (above Rp2,500,000 to Rp3,500,000). It is Rp565,616 lower than the 2025 Aceh provincial minimum wage, or 84.7% of it [19].

Table 2. Daily and monthly wage income of mill workers

No.	Informant	Daily wage (Rp)	Working days	Monthly wage (Rp)
1	W1 (woman, 50 years)	120,000	26	3,120,000
2	W2 (man, 38 years)	120,000	26	3,120,000
3	W3 (woman, 34 years)	120,000	26	3,120,000
4	W4 (woman, 22 years)	120,000	26	3,120,000
5	W5 (man, 36 years)	120,000	26	3,120,000
6	W6 (woman, 36 years)	120,000	26	3,120,000
	Total	720,000	–	18,720,000
	Mean	120,000	26	3,120,000

Source: Primary data (processed, 2025).

Costs and Net Income

Total monthly costs ranged from Rp15,924,000 to Rp19,160,000 per mill and summed to Rp52,600,000 (Table 3). Net income (Equation 1) was Rp19,840,000 for O1, Rp16,284,000 for O2 and Rp12,676,000 for O3, a total of Rp101,400,000 − Rp52,600,000 = Rp48,800,000. Mean net

income (Equation 2) was Rp48,800,000 / 3 = Rp16,266,667 per owner per month, which is in the very high category (above Rp3,500,000).

The R/C ratio (Equation 3) was 2.04 for O1, 1.93 for O2 and 1.80 for O3, and 1.93 for the three mills combined, so each rupiah of cost returned Rp1.80–2.04 of gross income. Net income equalled 44.3–50.9% of gross income. The mill with the highest gross income also had the highest R/C ratio.

Table 3. Monthly gross income, total cost and net income of mill owners

No.	Informant	Gross income, TR (Rp)	Total cost, TC (Rp)	Net income, π (Rp)	R/C
1	O1	39,000,000	19,160,000	19,840,000	2.04
2	O2	33,800,000	17,516,000	16,284,000	1.93
3	O3	28,600,000	15,924,000	12,676,000	1.80
	Total	101,400,000	52,600,000	48,800,000	1.93
	Mean	33,800,000	17,533,333	16,266,667	–

Source: Primary data (processed, 2025). R/C calculated by the authors from TR and TC.

Constraints Reported by Owners

The three owners named four constraints. The first is rain. Under dry conditions the mills burn bagasse, the residue of crushing, after drying it in the sun, which keeps fuel costs low. In the rainy season the bagasse cannot be dried, wet bagasse gives insufficient heat, and the owners buy firewood or used tyres, which is an unplanned cost. Rain also makes the work area wet and slippery, slows the work and at times stops production. The second constraint is breakdown of the cane crusher, the main machine of the mill. The owners attributed breakdowns to the age of the machines and to intensive use; production stops until the repair is completed, and the repair of main components is costly.

The third constraint is labour. The owners find it difficult to recruit workers because the work is physically heavy (carrying cane, operating the crusher and boiling the juice for long periods) and exposes workers to heat from the furnace and to accidents. The fourth is low-quality cane. Cane received from farmers is sometimes poorly maintained, cut at the wrong time or delivered late after cutting. According to the owners, such cane yields brown sugar with a less attractive colour, an unsuitable texture and a less sweet taste, which leads to consumer complaints and lower selling prices.

Discussion

The net income of Rp12,676,000–19,840,000 per mill per month is higher than the incomes reported for other small brown sugar units in Indonesia (Table 4). The mean of Rp16,266,667 is about three times the average in Kerinci [7] and more than ten times that of farmer-processors [8] and of the service mill in the same district [9]. The R/C ratio of 1.80–2.04 is above the 1.39 of the service mill [9] and the benefit–cost ratios of 1.48 and 1.12 reported for jaggery units in India [12], [13], and close to the 2.12 reported for granulated brown sugar [11]. Two explanations are possible. One is scale: the Buter mills operate 26 days per month, whereas farmer-processors in Kerinci produced about three times per month [8], and scale economies have been reported in jaggery units [12]. The other is cost coverage: each owner reported total cost as a single figure, and if depreciation, family labour or cane from the owners' own fields were not counted, net income and the R/C ratio are overstated.

Table 4. Net income and R/C ratio in this study and in previous studies

Study	Location	Unit of analysis	Net income per month (Rp)	R/C or B/C
This study	Buter, Central Aceh	3 mills	12,676,000–19,840,000 (mean 16,266,667)	1.80–2.04
Hikmah [9]	Blang Mancung Barat, Central Aceh	1 service mill	1,061,749	1.39
Effran [7]	Lindung Jaya, Kerinci	5 agroindustries	5,067,013 (mean)	> 1
Putra et al. [8]	Sungai Asam, Kerinci	58 farmer-processors	1,482,578 (mean)	–
Singh et al. [12]	Punjab, India	30 jaggery units	–	1.48
Rao [13]	Andhra Pradesh, India	Jaggery units	–	1.12

Source: Table 3 and the studies cited. –: not reported.

The findings for workers add a dimension that owner-centred studies omit. The wage of Rp3,120,000 per month is classified as high under the income grouping used, yet it is 15.3% below the provincial minimum wage, and the mean net income of an owner is 5.2 times the wage of a worker. The two yardsticks give different readings of the same figure because the grouping uses fixed nominal thresholds, whereas the minimum wage is set each year. The wage level is also relevant to the labour constraint reported by the owners. Labour shortage is among the main problems of jaggery producers in Punjab [12], and open-pan processing is labour-intensive and carried out under harsh working conditions [4]. Heavy work, heat exposure and a wage below the minimum-wage benchmark together make mill work less attractive than alternative jobs, although this study did not ask the workers about their reasons.

The technical constraints match those described for non-centrifugal sugar elsewhere. Dependence on sun-dried bagasse makes the fuel supply sensitive to rain, because bagasse has to be dried in the open before burning [5] and traditional furnaces use only 13–15% of the heat produced [4]; in Kerinci, the supply of firewood was likewise a cost problem [8]. The owners' account of cane quality agrees with evidence that sucrose declines after harvest as the interval between cutting and crushing lengthens [14] and that colour is among the main criteria of jaggery grade [6]. These links indicate three points at which costs and quality losses could be reduced: covered storage or assisted drying of bagasse, scheduled maintenance of the crusher, and delivery agreements with cane farmers.

Several limitations apply. First, the income figures are monthly estimates derived from daily amounts stated in interviews and a fixed 26 working days; they were not verified against sales or cost records and do not capture seasonal variation, although the owners reported production stoppages during rain. Second, production volume and selling price were not recorded for each mill, so gross income could not be decomposed into price and quantity or reconciled with the daily output of about 600 kg noted in the preliminary observation. Third, costs were reported as totals without a breakdown into fixed and variable components. Fourth, the study covers three mills in one village during one month, and the constraints were reported by the owners only. Fifth, the income grouping uses fixed nominal thresholds, so the minimum-wage comparison is the more informative yardstick for the workers' wage.

4. Conclusion

The three sugarcane brown sugar mills in Buter Village earned a combined gross income of Rp101,400,000 and a net income of Rp48,800,000 per month, or Rp16,266,667 per owner, with an R/C ratio of 1.93. The owners' income is in the very high category of the classification used. Each worker earned Rp3,120,000 per month, which is in the high category but equals 84.7% of the 2025

Aceh provincial minimum wage. Rain, crusher breakdown, labour scarcity and low-quality cane constrain production, product quality and income.

Mill owners are advised to keep daily records of output, prices and costs, to protect bagasse from rain, to schedule maintenance of the crusher and to agree delivery times with cane suppliers. Local agencies can support these steps with technical assistance on fuel and furnace efficiency. Future studies should record production volume, selling price and itemised costs over a full production year, include the workers' own views of mill employment, and compare mills across villages in Ketol District.

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Authors' contributions and responsibilities

Nova Eliza Fitri: conceptualization, investigation, data curation, formal analysis, writing – original draft. Sakdiyah: methodology, validation, writing – review & editing. Raihani: supervision, validation, writing – review & editing. All authors have read and approved the final manuscript.

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Availability of data and materials

The interview and observation data that support the findings are available from the corresponding author upon reasonable request, in a form that does not identify the participants.

Competing interests

The authors declare no competing interests.

Ethical approval

Formal institutional ethical approval was not required for this study, as it involved interviews with adult mill owners and workers about business income, costs and wages and did not collect sensitive personal data. All participants were informed of the purpose of the study and agreed to take part before the interviews. They are reported under codes, and no names are disclosed.

Declaration of generative AI use

In revising this manuscript, the authors used Claude (Anthropic) to help translate the Indonesian draft into English, restructure the text, re-check the calculations in the tables and identify relevant literature. All field observations, interview data and figures were produced by the authors. The authors reviewed every AI-assisted passage, verified each cited source and take full responsibility for the published content.

Additional information

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