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# Market participation and profitability of small scale *garri* processing in Edo, Ogun and Oyo States, Nigeria

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**Abstract**

Nigeria is the largest producer of cassava which is a staple food crop consumed in different forms. *garri* is one of the products commonly consumed by households. Improving the production process for greater gains has been at the fore front of discourse on potential for growth of the *garri* industry. Studies have not adequately explored variations in processing techniques across major producing and consuming communities for evaluation of the associated commercial potentials. This study examines market participation, cost structure and profitability of *garri* processing in major producing communities of Nigeria. Data were collected through survey of 300 processors selected by multi-stage sampling technique in Edo, Ogun and Oyo states of Nigeria. The results show that *garri* processing varies in length of processing period, quantity of cassava processed, *garri* yield and cost efficiency across the states. Processing was characterised by high market participation across the states while the cost structure shows that the bulk of the cost of *garri* processing was incurred on procurement of fresh tubers. A greater proportion of the labour cost was incurred on peeling (20.4 %), washing (11.9 %) and frying (31.1 %). garrification rates were higher in Ogun (26.54 %, 20.25 %) and Oyo (24.09 %, 15.57 %) than in Edo state (23.44 %, 14.15 %) in the dry and wet seasons respectively, with the latter having a shorter processing period. Cost per kilogram of *garri* produced was lowest in Edo state during the dry season but highest during the rainy season. However, *garri* processing was generally profitable, with significant differences in gross margin percentage (GM %) across states only in the rainy season. The highest GM % was recorded by processors in Ogun state (47.14 %) followed by Edo (18.92 %) and Oyo (17.37 %) states. Market participation and profitability indicated potential for increased investment in cost- and labour-saving technologies to improve productivity in the *garri* processing industry.

*Keywords:* cassava, garrification rate, commercialiseration, gross margin

## 1 Introduction

Cassava (*Manihot esculenta*) is one of the most important sources of household calories in sub-Sahara Africa. It is widely consumed in different forms and readily available across seasons. As a tuber crop, cassava is drought tolerant and less sensitive to competition for soil nutrients from weeds and other crops thereby making it attractive to cultivation by resource constrained smallholder farmers. However, the rapid deterioration of the tubers after harvest makes processing a very vital factor in the sustainable production of the crop (Ume *et al*., 2016, Anagah *et al*., 2020; Akpan and John, 2020, Adesope *et al*., 2020). Nigeria has largely been described as not making the most of its position as the world's largest producer of cassava, with processing efforts focused on meeting the dietary energy needs of households, rather than making the commodity a strategic food security crop.

Cassava processing at the household level is an important income generator in poor rural areas, particularly for women, and has good potential to contribute to economic diversity and creates opportunities for consumption and processing industries (Rahman & Awerije, 2015). *garri* is a

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traditional food product and accounts for 70 % of cassava produced in Nigeria (Sanni & Olubamiwa, 2004; Ezeocha *et al.*, 2019; Onuche *et al.*, 2024). The production system is characterised by a wide range of indigenous practices with some parts of the process being mechanised. Traditional cassava processing into *garri* is however, very labour intensive and productivity is often low to justify investment of labour, time and money (Amoah *et al.*, 2010). However, the mechanisation of some stages helps to reduce drudgery and labour requirement, cost-saving with possible potential for greater *garri* yield. Mechanisation also allows for involvement of men thereby entrenching a multi-stakeholder diversity in the enterprise. While tuber supply and preliminary processing are dominated by men as farmers/aggregators and operators respectively, the *garri* processing itself is dominated by women. The involvement of multiple stakeholders at different levels contributes to the diversity in terms of the level of investment in technologies, cost structure, profitability and the potential for expansion of the enterprise. Understanding of the cost structure goes a long way in determining the point at which intervention aimed at mechanisation is likely to have a significant impact on greater profitability and growth of the industry.

Profitability is considered to be the major incentive for investment in any agricultural enterprise while value addition is primarily targeted at making products of higher economic value available to the market. Consequently, market access is a necessary condition for profit maximisation and the growth of the *garri* processing industry. The significance of market participation in agricultural growth, development, structural transformation of the production process, poverty alleviation and food security has been pointed out by Wickramasinghe (2015). Consequently, this study examines the market participation and economic potential of smallholder *garri* processing in the context of profit maximisation objective of an agricultural enterprise. The study presents the characteristics of *garri* processing in Edo, Ogun and Oyo states with a profile of the inherent variation across states and seasons in terms of length of processing period, *garri* yield, market participation, costs and returns of smallholder *garri* processing in the states.

## 2 Materials and methods

### *2.1 Study area and data collection*

The survey was carried out in the Edo, Ogun and Oyo states of Southern Nigeria known for their cassava production and processing. The climate in the region is classified as typically equatorial with distinct dry and rainy seasons. Rainy season is between April and October while the dry season is from November to March. Average rainfall is 1480 mm with a mean monthly temperature range of 18 °C–24 °C during the raining season and 30 °C–35 °C during the dry season. The farming system is dominated by arable crops such as cassava, maize, yam, cowpea, sorghum, millet and soybean while notable tree crops are cocoa, kolanut, oil palm, citrus, cashew and mango among others (FMANR, 1997, Ogazie *et al*, 2022).

Project planning contacts were made to the staff of Agricultural Development Programmes (ADPs) and other stakeholders for discussion on modalities for the implementation of the baseline survey. The ADPs are the extension agencies of the Ministries of Agriculture in each of the states. The study adopted multi-stage sampling procedure to select *garri* processing communities and processors for the survey. In each of the states, five *garri* processing communities were randomly selected from the list of communities renowned for *garri* processing and as such acquainted with activities related to *garri* processing as part of their daily life and livelihood. Twenty *garri* processors were then randomly selected from the list of *garri* processors already compiled by the ADP staff in each of the communities. Data were collected from 300 *garri* processors using a structured interview in the month of April, 2022. The structured interview guide was face-validated by experts in agricultural extension, agricultural economics and the processing industry. The suggestions made by the validators were used to develop the final version of the interview guide. The interviews were administered by trained enumerators and data entered in the Open Data Kit (OKD). Data were collected on sources of cassava tubers, common cassava varieties processed and their attributes. Data were also collected on processing methods, stages and procedures of *garri* processing, material and labour costs, *garri* production, prices and marketing channels among others.

### *2.2 Data analysis*

The data were analysed with the use of the STATA (Version 8) software, to obtain descriptive and inferential statistics such as: means, standard deviation, frequencies and percentages. Productivity from processing methods by location were compared based on *garri* yield from processed quantity of fresh cassava tubers conceptualised as garrification rate which measures the level of dry *garri* yield as a percentage of the quantity of fresh cassava tubers processed. garrification rate gives a reflection of the level of material loss occurring at all stages of the processing in the form of peals, water content, and fibre loss among others In previous empirical studies (Amoa *et al.*, 2010; Nwaneri & Nwaneri, 2015; Ndaeyo *et al.*, 2022) material loss occurring at all stages of the processing in the form of peels, water content and fibre loss to grating, fermenting, sieving, pulverizing and frying were estimated as percentage of the initial weight of materials deployed into each stage of the processing. However, this study being an on-farm survey, relied largely on estimates of the quantity of fresh cassava processed and the *garri* produced as reported by the processors. The study considered the initial weight of the fresh cassava tuber processed and the weight of the final product (*garri*). Consequently, the garrification rate measured in percentage is given as:

$$GR_i = \frac{Q_i}{T_{ci}} \times 100 \; (i = 1, 2, 3, ......, n) \qquad (1)$$

Where: $GR_i$ = garrification rate (%) for processor $i$;
$Q_i$ = Quantity of *garri* produced by processor $i$;
$T_{ci}$ = Quantity of fresh cassava tuber processed by processor $i$.

Production objective is a significant determinant of the level of investment, scale of production and profitability as both goal and incentive for growth in a production system. In agribusiness, broad demarcation exists between subsistence and commercialisation when exploring agricultural production systems. According to Musa (2013), conceptual model on market participation suggests that smallholder farmers produce crops (output) for two main purposes; consumption and marketing. They could entirely consume, entirely market or consume and market at the same time depending on the commodity. Similarly, Otekunrin *et al.* (2019) viewed market orientation, commercialisation or participation as referring to the percentage of marketed output from total farm production. This study therefore adopted this exposition in measuring market participation as:

$$MP_i = \frac{Q_{Mi}}{Q_i} \qquad (2)$$

Where: $MP_i$ = Market participation for processor $i$;
$Q_{Mi}$ = Quantity of *garri* marketed by processor $i$;
$Q_i$ = Quantity of *garri* produced by processor $i$.

Moreover, farm budget analysis was employed to profile the cost structure, revenue and profitability of *garri* production. The economic potential of smallholder *garri* processing was assessed through the cost efficiency of the processing methods and gross margin analysis as shown below, with comparisons made across states and production seasons.

The initial focus was to determine the cost efficiency of processing techniques, as processing methods vary particularly in the use of technology and equipment by the processors. The benefits of such innovation lie in the potential for reduced drudgery, enhanced product quality and increased competitiveness through cost efficiency. The cost efficiency of the *garri* processors was determined as the estimates of the average variable cost (AVC) obtained from the farm budget analysis by comparing the estimated cost with the output of the production process as:

$$AVC = \frac{\sum_{L=1}^{m} X_{iL}C_{iL} + \sum_{j=1}^{k} W_{ij}}{Q_i} \qquad (3)$$

Gross margin (GM) was used as an estimate of the profitability of the *garri* processing given as:

$$GM_i = \sum_{i=1}^{n} GR_i - \sum_{i=1}^{n} VC_i, \; (i = 1, 2, 3, ......, n) \qquad (4)$$

Where:

$$\sum_{i=1}^{n} GR_i = \sum_{i=1}^{n} Q_iP_i \text{ for } i = 1, 2, 3, ......, n \qquad (5)$$

$$\sum_{i=1}^{n} VC_i = \sum_{L=1}^{m} X_{iL}C_{iL} + \sum_{j=1}^{k} W_{ij} \text{ for } i = 1, 2, 3, ......, n; \quad L = 1, 2, 3, ....., m; \; j = 1, 2, 3, ....., k \qquad (6)$$

Consequently, gross margin percentage was estimated as the proportion of the recorded gross margin over the gross revenue as:

$$\sum_{i=1}^{n} GM(\%) = \frac{\sum_{i=1}^{n} GM_i}{\sum_{i=1}^{n} GR_i} \times 100 \qquad (7)$$

Where: $AVC_i$ = Average variable cost for processor $i$;
$GR_i$ = Gross revenue for processor $i$;
$VC_i$ = Variable cost for processor $i$;
$GM_i$ = Gross margin for processor $i$;
$Q_i$ = Quantity of *garri* produced by processor $i$;
$P_i$ = Price per unit of *garri* produced by processor $i$;
$X_{IL}$ = Quantity of input $L$ used by processor i (e.g. cassava, labour for different operations for different operations) by processor $i$;
$C_{Ll}$ = Cost per unit of input $L$ used in *garri* processing by processor $i$;
$W_{ij}$ = Service charge paid by processor $i$ for operation $j$ conducted such as bagging, transportation, stall tax and carriage ($j$ = 1, 2, . . . k).

## 3 Results

### 3.1 *garri processing periods, output and commercialisation*

The results in Table 1 show the frequency of cassava processing among processors during dry and rainy season. The results show that averages of six batches of cassava were processed by *garri* processors monthly. There are significant differences in the number of batches processed between the three states in both seasons, however, the number of batches processed per processor per month in Edo State (8 batches) was much higher than those processed in Oyo (5 batches) and Ogun (4 batches) states respectively. The number of batches processed were however similar across the two seasons in each of the states. This is a pointer to similarity in access and availability of cassava tubers across seasons in each of the states. The results in Table 2 show that length of processing period per batch also differed significantly across the states with Edo state recording the shortest period followed by Ogun and Oyo states in increasing order of processing periods.

**Table 1:** *Average number of cassava batches processed per processor into* garri *per month by season.*

| | *Dry season* | | | | *Rainy season* | | | |
|---|---|---|---|---|---|---|---|---|
| *State* | *mean* | *SD* | *min* | *max* | *mean* | *SD* | *min* | *max* |
| Edo | 8.29 | 2.35 | 2 | 15 | 8.10 | 11.98 | 1 | 10 |
| Ogun | 4.44 | 3.40 | 1 | 13 | 4.70 | 5.51 | 1 | 5 |
| Oyo | 5.51 | 6.36 | 1 | 4 | 5.10 | 6.12 | 1 | 4 |
| Pooled | 6.16 | 4.58 | 1 | 15 | 6.02 | 8.63 | 1 | 10 |
| F-Stat | 20.06** | | | | 4.28** | | | |

Source: survey data, 2022; *** Sig $P < 0.01$; ** Sig $P < 0.05$.

**Table 2:** *Average length of* garri *processing period by state and season.*

| *State* | *Dry season (days)* | *Rainy season (days)* |
|---|---|---|
| Edo | 5.24 (3.71) | 4.12 (3.70) |
| Ogun | 6.45 (3.21) | 5.88 (2.26) |
| Oyo | 6.54 (2.97) | 7.07 (3.00) |
| Pooled | 6.05 (3.38) | 5.85 (3.19) |
| F-Stat | 4.38** | 13.76*** |

Source: survey data, 2022; *** Sig $P < 0.01$; ** Sig $P < 0.05$.; Values in parentheses are standard deviations.

In addition to the availability of cassava tubers, the frequency of processing can also be influenced by the length of the processing period for each batch within a given period. In this regard, processors with shorter processing periods are usually given the opportunity to process more batches, as is evident in the case of processors in Edo state compared to others.

The results in Table 3 show significant difference in the quantity of cassava processed per batch, quantity of *garri* produced and the garrification rate across the states in both seasons. The quantity of cassava processed was higher in Oyo state than recorded in Ogun and Edo states in the dry season. However, the garrification rate (*garri* yield) for dry season processing in Ogun state (26.54 %) was higher than for Oyo (25.09 %) and Edo (23.44 %) states respectively. A similar pattern was observed in all states during the rainy season. The results also showed that the dry season garrification rate was significantly higher than the rainy season garrification rate for each of the states. Cassava tubers are highly perishable due to their high-water content, which varies depending on the variety and season of harvest. The water content and processing methods affect the yield of *garri*. These two attributes were notable factors considered by processors in the choice of cassava varieties, the maturity at which cassava is harvested for processing, and the prices offered for such tubers.

Technology use in *garri* processing was predominantly for grating, fermentation, pressing and pulverisation with results indicating significant relationship between location and use of technologies among the processors (Appendix 1). Grating was done mainly with the use of rasper grater and harmer mill. However, hammer mill was more popular among Ogun state processors (86.8 %). The choice of this machine could have been responsible for the fine texture of the popular brand (*garri* egba) known with the state. Fermentation was done on the floor in the open while a few of the farmers from Ogun (22 %) and Oyo (24 %) states stacked sacs of grated *garri* paste on standing racks for fermentation. The processors adopted the use of vertical hydraulic press and screw press for dewatering wet paste after fermentation. However, processors in Ogun state used more of screw press than any other type of press in *garri* processing. Pulverisation was mainly done with rasper grater by the processors across states while frying was done manually in the open with locally fabricated metal oven fuelled with firewood (Appendix 1). The deployed machines in most instances belonged to operators who charge processors for operations for which the machines were deployed. However, only two of the processing centres visited were fully automated with the use of more sophisticated graters, automated press fryers and sieves powered by diesel electricity generating sets. The two processing centres had however suspended

**Table 3:** *Quantity of cassava processed and* garri *produced per batch by state and season.*

| *Item* | *State* | | | *Pooled* | *F-Stat* |
|---|---|---|---|---|---|
| | *Edo* | *Ogun* | *Oyo* | | |
| *Dry season* | | | | | |
| cassava processed (kg) | 1,610 (1,791.0) | 2,410 (2,869.0) | 4,735 (8,151.1) | 2,846 (5,105.0) | 9.48*** |
| *garri* produced (kg) | 334 (347.4) | 615 (698.3) | 1,073 (1,841.5) | 656 (1158.1) | 9.85*** |
| *garri* sold (kg) | 331 (36.3) | 608 (368.3) | 1,035 (313.3) | 637 (355.9) | 10.45** |
| garrification rate (%) | 23.4 (6.38) | 26.5 (6.17) | 24.1 (7.61) | 24.7 (6.83) | 5.37** |
| market participation (%) | 95.0 (10.4) | 98.2 (3.6) | 95.3 (5.8) | 96.2 (7.5) | 5.29*** |
| *Rainy season* | | | | | |
| cassava processed (kg) | 1,709 (2,216.1) | 2,522 (5,712.2) | 6,098 (8,594.3) | 3,343 (6,226.8) | 13.48*** |
| *garri* produced (kg) | 269 (366.1) | 505 (1,105.9) | 666 (693.6) | 470 (789.6) | 60.03*** |
| *garri* sold (kg) | 260 (356.9) | 498 (1,104.1) | 641 (680.4) | 459 (782.5) | 5.79*** |
| garrification rate (%) | 14.2 (5.6) | 20.3 (2.0) | 15.6 (7.5) | 16.6 (6.0) | 31.07*** |
| market participation (%) | 95.3 (7.6) | 97.7 (4.9) | 94.4 (8.1) | 95.8 (7.1) | 5.40*** |
| comparison of garrification rate by season within state (t-stat) | 7.49*** | 9.27*** | 7.06*** | 11.90*** | |

Source: survey data, 2022; *** Sig $P < 0.01$; ** Sig $P < 0.05$.; Values in parentheses are standard deviations.

**Table 4:** *Marketing channels for* garri *across states.*

| *Channel* | *State* | | | *Total* |
|---|---|---|---|---|
| | *Edo* | *Ogun* | *Oyo* | |
| Retails | 28 (28.9) | 51 (57.3) | 17 (20.2) | 96 (35.6) |
| Wholesales | 69 (71.1) | 38 (42.7) | 67 (79.6) | 174 (64.4) |
| Processing centre | 33 (34.0) | 11 (12.4) | 09 (10.7) | 53 (19.6) |
| Local market | 76 (78.4) | 72 (80.9) | 50 (59.5) | 198 (73.3) |
| City market | 36 (37.1) | 37 (41.6) | 49 (58.3) | 122. (45.2) |
| Food vendors | 04 (4.1) | 03 (3.2) | 03 (3.4) | 10 (3.6) |
| Aggregator | 01 (1.0) | 05 (5.6) | 01 (1.2) | 07 (2.6) |
| Supermarkets | | 01 (1.1) | 02 (2.4) | 03 (1.1) |
| Export | 02 (2.1) | 01 (1.1) | 01 (1.2) | 04 (1.5) |

Source: survey data, 2022; *** Sig $P < 0.01$; ** Sig $P < 0.05$.; Values in parentheses are percentages.

operation due to high cost of diesel required for powering the plant at the time of the survey. Peeling and frying which accounted for the larger percentage of the labour cost were done manually at the processing centres. This reflects critical points of intervention in easing drudgery and possibly enhancing cost efficiency.

The market participation index shows that more than 90 % of *garri* produced was marketed by the processors thereby pointing to high level of commercialisation, which was highest for Ogun state. However, the results in Table 4 show variation in the marketing channels and mode of sales across the states. *Garri* was mainly sold through local markets (78 %) as wholesales (71 %) in Edo state while processors in Ogun state also sold their product mainly through local market (81 %) but relatively in retail quantities (57 %). Oyo state patronized both local (60 %) and city (58 %) markets for sales of their *garri* commonly and sell in bags as wholesales (80 %). The prominence of selling in wholesales despite use of community markets by processors in Edo and Ogun state was found to have been facilitated by their practice of targeting weekly community market days during which large convergence of aggregators from cities are common. Other marketing channels include local markets, city markets and gate of processing centres (Table 4). *Garri* was also sold through

**Table 5:** *Production cost and cost efficiency of garri processing in dry and rainy season.*

| | | *Cassava cost* | | *Labour cost* | | *Transaction cost* | | *TVC* | *AVC* |
|---|---|---|---|---|---|---|---|---|---|
| *Season* | *State* | *₦ per batch* | *TVC %* | *₦ per batch* | *TVC %* | *₦ per batch* | *TVC %* | *₦ per batch* | *₦ per kg* |
| Dry | Edo | 35,598 | 80.0 | 8,731 | 19.64 | 514 | 1.2 | 44,467 | 137 |
| | Ogun | 89,204 | 92.4 | 7,200 | 7.5 | 1,828 | 1.89 | 96,589 | 179 |
| | Oyo | 165,045 | 88.9 | 20,357 | 11.0 | 7,675 | 4.14 | 185,584 | 188 |
| | Pooled | 93,540 | 88.6 | 11,844 | 11.2 | 1,220 | 1.16 | 105,551 | 166 |
| | F-Stat | 16.0*** | | 19.5*** | | 13.3*** | | 18.2*** | 254.6*** |
| Rainy | Edo | 24,595 | 72.42 | 8,761 | 25.79 | 607 | 1.79 | 33,963 | 234 |
| | Ogun | 49,981 | 83.12 | 7,202 | 11.98 | 2,948 | 4.9 | 60,131 | 142 |
| | Oyo | 89,692 | 77.81 | 20,410 | 17.71 | 5,170 | 4.49 | 115,272 | 175 |
| | Pooled | 53,216 | 78.97 | 11,864 | 18.41 | 1,768 | 2.62 | 67,387 | 185 |
| | F-Stat | 8.7*** | | 19.5*** | | 14.1*** | | 11.6*** | 11.4*** |

Source: survey data, 2022; *** Sig $P < 0.01$; ** Sig $P < 0.05$.; \$1 = ₦448; TVC = total variable costs; AVC = average variable costs.

**Table 6:** *Labour cost components per batch for dry season* garri *processing.*

| | *Edo state* | | *Ogun state* | | *Oyo state* | | *Pooled* | |
|---|---|---|---|---|---|---|---|---|
| *Item* | *₦* | *%* | *₦* | *%* | *₦* | *%* | *₦* | *%* |
| Peeling | 881.9 | 9.99 | 2,294.4 | 31.9 | 4,676.1 | 19.7 | 2,567.6 | 19.4 |
| Washing | 785.8 | 8.90 | 314.9 | 4.4 | 1,281.8 | 5.4 | 992.6 | 7.5 |
| Grating | 1292.3 | 14.64 | 768.0 | 10.7 | 2,919.6 | 12.3 | 1,429.4 | 10.8 |
| Fermentation | 98.2 | 1.11 | 46.1 | 0.6 | 2,065.1 | 8.7 | 780.9 | 5.9 |
| Pressing | 986.6 | 11.17 | 203.9 | 2.8 | 1,614.1 | 6.8 | 966.2 | 7.3 |
| Pulverisation | 663.6 | 7.52 | 136.0 | 1.9 | 593.4 | 2.5 | 476.5 | 3.6 |
| Frying | 2628.2 | 29.8 | 2,744.9 | 38.1 | 7,738.1 | 32.6 | 3,851.4 | 29.1 |
| Sieving | 392.9 | 4.45 | 109.1 | 1.5 | 735.8 | 3.1 | 476.5 | 3.6 |
| Milling | 26.2 | 0.30 | 529.2 | 7.3 | 973.2 | 4.1 | 767.6 | 5.8 |
| Packaging | 768.4 | 8.70 | 30.3 | 0.4 | 569.7 | 2.4 | 741.2 | 5.6 |
| Others | 305.6 | 3.46 | 24.7 | 0.3 | 569.7 | 2.4 | 185.3 | 1.4 |
| Total | 8,829.6 | 100 | 8,100.6 | 99.9 | 23,736.3 | 100 | 13,235.2 | 100.00 |

Source: survey data, 2022; \$1 = ₦448.

other channels including direct sales to food vendors, aggregators and supermarkets.

### 3.2 *Costs and returns to* garri *processing*

Profit is the primary motivation for investment in any business. The value addition sector of the Nigerian agricultural industry has attracted attention in recent times owing to the need to minimise the huge postharvest losses, strengthen the commodity value chain, create markets for produce, and increase the economic value of products using the agribusiness approach. Sustainable investment in this process is based on the profitability of the processes, which in turn is influenced by the efficiency and productivity of the processes. Profit maximisation as the goal of a commodity business can be approached through improvement in processes to either minimise costs or maximise output through appropriate technologies. Consequently, an understanding of the cost structure offers a powerful platform for critical analysis of the stage at which a proposed intervention will have sufficient impact to increase the productivity and growth of the business.

Total variable cost (TVC) is the cost incurred in the procurement of fresh cassava tubers, payment to labour for different operations, bags, transport and other transaction costs. The variable cost structure in *garri* processing shows that not less than 89 % and 79 % of the TVC was expended on procurement of fresh cassava tubers in the dry and rainy seasons respectively (Table 5). Labour cost accounted for 11 % and 18 % while transaction cost expended on bags, transport and stall tax accounted for 1.2 % and 2.6 % in dry and rainy season *garri* processing respectively.

In dry season *garri* processing, cost incurred on cassava tuber, labour and consequently total variable costs (TVC)

**Table 7:** *Labour cost components per batch for rainy season* garri *processing.*

| | *Edo state* | | *Ogun state* | | *Oyo state* | | *Pooled* | |
|---|---|---|---|---|---|---|---|---|
| *Item* | ₦ | % | ₦ | % | ₦ | % | ₦ | % |
| Peeling | 969.6 | 11.1 | 2,294.4 | 31.9 | 4,223.3 | 20.7 | 2,418.5 | 20.4 |
| Washing | 805.7 | 9.2 | 314.9 | 4.4 | 1,223.8 | 6.0 | 774.0 | 6.5 |
| Grating | 1,217.7 | 13.9 | 768.0 | 10.7 | 2,310.8 | 11.3 | 1,409.5 | 11.9 |
| Fermentation | | 0.0 | 46.1 | 0.6 | 1,779.8 | 8.7 | 568.9 | 4.8 |
| Pressing | 1,024.0 | 11.7 | 203.9 | 2.8 | 1,773.8 | 8.7 | 987.0 | 8.3 |
| Pulverisation | 501.0 | 5.7 | 136.0 | 1.9 | 654.2 | 3.2 | 428.3 | 3.6 |
| Frying | 2734.9 | 31.2 | 2,744.9 | 38.1 | 5797.6 | 28.4 | 3,691.1 | 31.1 |
| Sieving | 405.6 | 4.6 | 109.1 | 1.5 | 639.0 | 3.1 | 373.7 | 3.2 |
| Milling | 15.5 | 0.2 | 529.2 | 7.3 | 1,241.8 | 6.1 | 566.3 | 4.8 |
| Packaging | 872.3 | 10.0 | 30.3 | 0.4 | 498.9 | 2.4 | 4786 | 4.0 |
| Others | 214.4 | 2.4 | 24.7 | 0.3 | 266.7 | 1.3 | 168.2 | 1.4 |
| Total | 8,760.7 | 100.00 | 7,201.6 | 100.00 | 20,409.7 | 100.00 | 11,864.2 | 100.00 |

Source: survey data, 2022; $1 = ₦448.

differed significantly across the states and this is reflective of the difference in the average quantity of cassava tubers processed across the states with Edo state recording the lowest. The results also showed significant difference in the average variable costs (AVC) across the states in both seasons. However, processors in Edo state recorded better cost efficiency with the lowest AVC during the dry season, while Ogun state recorded the lowest costs during the rainy season. It was observed that labour costs for operations did not vary much by season except for transaction costs such as the price of bags and transport. While the cost of bags could be attributed to the market dynamics, the cost of transport seems to be higher in the rainy season when roads to villages and processing centres usually become more deplorable, thereby attracting an increase in transport fares. Variations in labour costs occur on cassava farms and are often passed on to processing centres through higher tuber prices.

The labour cost structure of *garri* processing practices in the dry season (Table 6) shows that operations such as cassava peeling (19.4 %), grating (10.8 %) and *garri* frying (29.1 %) accounted for larger proportions of cost of *garri* processing in all the states, while pulverisation, sieving, milling and packaging accounted for smaller proportions of the cost of processing. The cost structure for labour in the rainy season (Table 7) shows similar trend with peeling, grating and frying accounting for 10.4 %, 11.9 % and 31.1 % of the labour costs respectively.

Income from *garri* processing was estimated for the processors based on the quantity of *garri* produced and the prevailing price at which *garri* was sold. The study show a significant difference in the average price at which *garri* was sold by the processors with the price in Ogun state (N220.45, N223.36) being higher than those in Oyo (N198.26, N190.87) and Edo (N155.35, N165.15) states in the dry and rainy seasons respectively. In the results presented earlier in Table 4, there is significant difference in the quantity of *garri* sold across the states with processors in Oyo state recording the highest quantity sold in both seasons. The quantity of *garri* sold reflects the quantity of *garri* produced in the states. In addition, the results in Table 8 show significant difference in the average gross margin percentage across the states in the rainy season with Ogun state processor recording the highest at 47.1 % ($P<0.01$). The highest cost efficiency recorded by Ogun state in the rainy season seems to have had a significant impact on the GM. However, there was no significant difference in the GM between the states in the dry season. These results have shown that the economic potential of *garri* processing varies by season and location.

## 4 Discussion

Value addition process is highly dependent on the availability of raw materials for the production processes. Cassava is a crop that is grown throughout the year with the potential to assure a regular supply of fresh tubers for processing into *garri* throughout the year. However, access to cassava is affected by distance to market or sources of supply and the prevailing market price for the tubers. These vary by season and may influence the frequency of *garri* processing among processors. The processing technique in terms of length of processing also determines the potential number of batches that can be produced per period. The results showed variation in the length of processing per batch and the number of

**Table 8:** *Revenue and gross margin per batch from dry and rainy season* garri *processing.*

| *Item* | *States (in ₦)* | | | *Pooled* | *F Stat.* |
|---|---|---|---|---|---|
| | *Edo* | *Ogun* | *Oyo* | | |
| *Dry season* | | | | | |
| TVC | 44,467 (29,795.5) | 96,589 (99,725.3) | 185,584 (258,597.9) | 105,551 (167,810.5) | 18.15*** |
| Revenue | 53,236 (50,081.0) | 107,369 (119,298.3) | 219,321 (313,887.8) | 122,751 (199,564.8) | 14.39*** |
| Gross margin | 8,770 (26,797.2) | 10,780 (38,743.3) | 33,920 (105,484.0) | 17,200 (64,793.0) | 0.56 |
| GM (%) | 14.1 (5.02) | 12.8 (4.8) | 11.7 (4.7) | 12.0 (5.0) | 2.23 |
| *Rainy season* | | | | | |
| TVC | 33,963 (39,022.3) | 60,131 (125,794.78 | 115,271 (139,454.0) | 67,387 (112,855.3) | 11.57*** |
| Revenue | 40,213 (53,922.0) | 100,481 (223,452.3) | 134,122 (166,071.6) | 89,295 (166,568.3) | 9.61*** |
| Gross margin | 6,886 (30,928.4) | 43,298.6 (104,487.6) | 22,723 (158,389.2) | 23,816 (109,115.2) | 3.17** |
| GM % | 18.9 (8.6) | 47.1(22.2) | 17.4 (10.2) | 28.1 (17.2) | 5.49*** |

Source: survey data, 2022; *** Sig $P < 0.01$; ** Sig $P < 0.05$.; $1 = ₦448; TVC = total variable costs; GM = gross margin.

batches produced. The variation in the length of processing period is due to the fact that majority of the processors in Edo state do not ferment *garri* or their processing methods allow for a shorter fermentation period of cassava before dewatering and frying.

One of the challenges associated with *garri* processing is the threat of cyanide poisoning due to shortened period of fermentation among some processors. Fermentation before frying reduces the cyanide content in *garri* and the length of fermentation period is a significant determinant of the safety of the processing methods. In addition to reducing cyanide level, fermentation also improves nutritional value through increase in protein content, utilisation and reduction in pathogen concentration (Aletor, 1993; Uyoh *et al*., 2007; Airaodion *et al*., 2019). In an instance of non-fermentation or reduction in fermentation period as commonly practiced by processors in Edo, palm oil is added to the paste by the processors before frying. This gives the final product its yellowish colour as a brand tagged '*garri* ibo' in the local markets. Airaodion *et al*. (2019) noted that *garri* with palm oil has its cyanogenic glucoside content significantly reduced when compared with *garri* without palm oil. Similarly, mechanisation of the process was found to affect the processing time, cyanide content and nutritional value of the *garri*.

Processors in rural communities were observed to use improvised presses with stones and heavy logs as presses, while those in urban and peri-urban communities used either screw or hydraulic presses. The study by Kamalu & Oghone (2012) showed that mechanical pressing resulted in a significant reduction in hydrocyanide (HCN) than manual pressing. However, the pronounced dependence on manual labour for peeling, washing and frying across the three states points to drudgery. The use of stone for pressing among Edo state processors, low attention accorded washing of peeled tubers before grating in Oyo state, the fermentation and frying in the open across the states point to potential sources of impurities and threats to quality assurance, health and food safety. These results portray a lack of standardisation in the *garri* processing techniques. The diversity in the processing techniques is considered a major contributing factor to the diverse brands of *garri* available in the market. It is also a pointer to challenges regarding instituting food safety and quality control measures against food poisoning in the *garri* industry. Although cases of cyanide poisoning from *garri* consumption are rare, possibly due to the complementary effect of frying on cyanide reduction, studies (Ogbona *et al*, 2017; Adesemoye *et al*, 2021; Okinedo *et al*, 2024) have however discovered microbial contaminants associated with diseases and food poisoning problems in *garri* sold in local and community markets. There are therefore food safety concerns in method of *garri* processing. Minimizing such risk requires enhanced used of modern technologies to minimize contact with soil and human during processing.

Post-harvest deterioration in cassava tuber has made it the least stored root tuber due to physiological and microbial activities resulting in primary and secondary deterioration respectively. Primary deterioration sets in within the first day of harvest and accounts for 40-60 % of losses within the first seven days while the secondary occurs much later between 3 to 5 days with both factors influencing the distribution, processing and commercial utilisation potential of the crop (Karim *et al*, 2009; Uchechukwu *et al*, 2015; Ano & Eru, 2022). The processing methods, and period between harvesting and processing therefore influence the yield and quality of *garri*, . garrification rate measures the *garri* yield from all the processes and it is considered critical to the profitability of processing methods. It also offers a pointer to the level of material loss along the processing operations and the suitability of processing techniques, age of cassava tubers and cassava varieties for *garri* processing (Amoah *et al*., 2010; Ndaeyo *et al*., 2022). The garrification rate (*garri* yield) was much higher for processors in Ogun state and Oyo States, which had longer processing periods than Edo state in all seasons. However, the garrification rate was significantly higher in the dry season than in the rainy season in each of the states, indicating lower water content of the fresh cassava tubers and consequently higher dry matter content in the dry season. The estimates of garrification rate for each of the states are comparable with the estimates of 16.3 % to 28.5 % reported by Amoa *et al*. (2010) and 22.6 % by Nwaneri & Nwaneri (2015).

Investment in production is driven by the level of commercialisation and return to such investment on the production process. Profitability of an enterprise imparts substantial motivation for greater investment on improved technologies. Commercialisation of the *garri* processing enterprise measured by level of market participation showed high level of commercialisation among the processors in Edo (98.1 %), Ogun (95.2 %) and Oyo (96.4 %) states respectively. This is an indication of the potential for growth of the industry through market-led investment in productivity enhancing technologies.

Market access as an important component of market participation refers to the medium through which smallholder farmers interact with the output and input markets, its scope being bounded by the level of transaction costs. Transaction costs constitute constraints experienced by smallholder farmers and a critical factor in choice of channels and point of sales for farm produce. Marketing channels is the pathway through which products move from the producer to the final consumer and its strength in terms of structure and organisation determines the efficiency of the marketing system. (Alene *et al*., 2008; Musah, 2013; Otekunrin *et al*., 2019). In the same vein, producers' choice of sales point is influenced by producers characteristics, social capital, state of public infrastructures (e.g. road), distance, nature of produce/products regarding perishability and bulkiness, market prices, availability of buyers and transaction costs arising from haulage and stall tax among others (Musah 2013, Mango *et al*, 2018).

The magnitude of transaction cost due to haulage, stall tax and others influence the level of market margin. High transport cost arising from long distance to markets, poor state of road infrastructure, stall tax, and other transaction costs can be limiting on market margin thereby constituting disincentive to profitability of *garri* processing. Such constraints limits the capabilities of producers from exploring potentials for greater profit in distant urban markets, hence, selling of *garri* at gates of processing centres or sales points closer to processing centres become attractive to processors. This study has however shown some level of deviation from the traditional practice of selling produce at the gate. Contrary to the practice of selling in wholesale at the gate of processing centre reported by Atunramu *et al* (2021), the practice of wholesales by processors in local and city markets points to the growth of the marketing system in reducing the role of middlemen. Such deviation points to the possibility of gains from selling at distant markets outweighing likely impediments from transaction costs from packaging (bags), haulage, stall tax and others.

The processing cost structure shows that cost of procurement of fresh cassava tubers accounted for the bulk of 88.62 % and 78.97 % in the dry and rainy season production respectively. It was observed that labour cost for operations do not vary by season except transaction costs such as price of bags and haulage. While cost of bags could be attributed to the market dynamics, cost of transport are usually higher in the rainy season when roads to villages and processing centres usually becomes more deplorable thereby attracting increase in haulage prices. Variation in labour cost occurs at the cassava farms and this is often transmitted to processing centres through higher price of tubers. The high proportion of expenses incurred on labour for cassava pealing grating and *garri* frying suggests that any intervention targeted at reducing the cost profile with respect to peeling, grating and frying through appropriate technology has the potential of raising the economic potential of the *garri* processing assuming constant output, market prices and transaction costs. However, *garri* processing is a profitable venture with gross margin percentage of 23.6 % and 41.5 % in the dry and rainy season respectively. The dry season gross margin estimate compared favourably with estimates of 42 % reported by Ibekwe *et al* (2012). Similarly, Atunramu *et al*, (2021) and Moris *et al* (2022) reported gross margin estimates of

66.9 % and 55.6 % for *garri* processing in Ondo and River states respectively.

These results have shown that economic potential of *garri* processing vary by season and location. The spatial and season variations in *garri* yield and gross margin potential of *garri* processing points to influence of differences in processing methods of the processors. Processors in Ogun and Oyo state were observed to have processed larger quantity of cassava into *garri*, recorded greater garrification rate and greater rate of return arising from better cost efficiency, especially in the dry season. Although processors in Edo state had better cost efficiency in dry season *garri* processing, the potential for greater rate of return could have been undermined by lower *garri* yield and lower prices for the product in the state compared to the price of the commodity in Ogun and Oyo states respectively.

## 5 Conclusion

The study revealed some degree of disparity in the attributes of *garri* processing and its economic potential in the three states. The disparities were more pronounced in the length of processing time and the use of technology in *garri* processing. The use of technology was generally low for peeling, washing and frying, which were predominantly done manually by the processors. The processing methods indicate drudgery, quality, and food safety concerns, so innovations that address these core concerns will go a long way in improving processors' capacity for quality products, higher productivity and business growth. Providing access to such technologies can leverage on social capital through existing groups, formation of new ones or establishment of cluster processing zones. In addition, access to investible funds or other incentives can explore different credit support programmes and initiatives of government and non-governmental organisations (NGOs). Such programmes include the Federal Government sponsored multi-enterprise Small Scale Enterprise Investment Scheme (SMEIS) and the agriculture-specific Agricultural Small and Medium Enterprise Investment Scheme (AgSMEIS). These initiatives are essentially targeted at groups and access to the support system can be enhanced by formation of processors into cooperative societies or establishment of *garri* processing clusters. Such initiatives will ensure more cost-effective deployment of technologies, innovations and credit for enhanced growth of the *garri* processing industry.

In addition, the establishment of cluster processing zones has the potential to ensure standardisation of processing methods for a safe and nutritious product. Such efforts will also create a more conducive environment for tailor-made training and empowerment programmes aimed at promoting a safe processing environment and a quality product for domestic and export markets.

The garrification potential showed a huge loss of material during processing. The endogenous primary factor responsible for this can be addressed by breeding improved varieties. Therefore, it is imperative that research attention be sustained on developing improved varieties with higher starch content for higher garrification rate, increased income and profitability. Such efforts can also increase the number of varieties with improved nutritional potential, such as vitamin A-enriched cassava varieties, which are not yet popular with processors.

*Conflict of interest*

The authors declare that they have no conflict of interest.

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*Supplement*

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