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Profit efficiency in maize-peanut ball (Dakuwa) processing among women in Torankawa District, Yabo Local Government Area, Sokoto State, Nigeria

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ABSTRACT

The study examined profit efficiency in Maize-Peanut Ball (*Dakuwa)* processing among women in Torankawa District, Yabo Local Government Area, Sokoto State, Nigeria. *Dakuwa* is a cereal and groundnut-based snack, mainly consumed in the northern parts of Nigeria and is prepared from mixtures of cereals, groundnut, grounded pepper, ginger, sugar and salt. Multi-stage sampling techniques was adopted in eliciting 112 *Dakuwa* women processors used for the study. Primary data were collected with the aid of a semi-structured questionnaire. Respondents' socioeconomic characteristics, such as age, educational attainment, household size, marital status, experience, and cooperative participation, are among the data elicited. Also elicited were prices for the input and output of the maize-peanut ball processing. Descriptive statistics, Net farm income and the Normalized Stochastic Profit Frontier Model were used to analyze the data. The findings revealed that Torankawa's maize-peanut ball processors are young, educated in primary schooling, with large household sizes and ample processing experience. The average NFI was estimated at ₦3,802.5 per week. The result from the stochastic frontier shows that the coefficient of millet grain, labour, firewood and ingredients were significant at $p<0.01$ and $p<0.05$ levels with the mean technical efficiency score of 97.3%. Based on the findings, for economic and relative sustainability of the enterprise, the study recommends that, proper arrangement should be made to improve and manage educational system, adequate supply of millet grain at affordable price to the processors. It was also recommended that Government and relevant stakeholders to provide credit to the processors to enable them to acquire necessary input.

Keywords: Normalized profit; efficiency; maize-peanut ball; processing

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INTRODUCTION

Agricultural processing activities are small scale and require low investment capital which makes it easily undertaken by women especially in the core northern Nigeria. The processing of agricultural products is an efficient method of maintaining the shelf-life of agricultural produce which serves as local foods for consumption among the population. The agricultural processing industry in Nigeria is dominated by small and medium scale rural enterprises owned and operated by men and women who depend solely on indigenous or traditional technology for processing (Adebayo *et al.,* 2020). Therefore, the importance of processing industries cannot be over emphasized.

Snacks are sweet or savoury foods eaten to provide life sustenance in a quick and convenient form. They are eaten as an alternative to main meals (Hess *et al.,* 2016). Snack foods are essential vehicles for the delivery of essential nutrients because of the growing change in eating habits (Popkin & Reardon, 2018). Maize-Peanut ball is one of such snacks that is readily available in the northern part of Nigeria (Ocheme *et al.,* 2014). It originated from Nigeria where it is known as *Dakuwa* and has been adopted by the voltarians in Ghana. *Dakuwa* is a traditional food basically made from maize, groundnuts, and some spices (Kanwa, 2022; Otunola *et al.,* 2014; Ocheme *et al.,* 2014).

Dakuwa is a street food, simply because it is a ready to eat food sold in the street or any public place such as the market by a hawker or vendor, normally in a portable food booth, food cart or food truck (Onyeaka *et al.,* 2021). *Dakuwa* is prepared from mixtures of cereals (Maize, millet and sorghum), tigernuts, groundnut, grounded pepper, ginger, sugar and salt (Osae *et al.,* 2017). The ingredients are thoroughly mixed, pounded and moulded into balls that can be eaten without further processing (Ocheme *et al.,* 2014). You have most likely been eating something different if *Dakuwa* is not nourishing and nutritious. *Dakuwa* is highly nutritious due to its maize and groundnut content (Osae *et al.,* 2017) with a protein content of 26.28%; fats 9.87%; fibre 1.06% and energy content of 80-120 calories (Greenbaskit, 2023).

Agricultural development policies and programmes have tended to lay emphasis on improving farm productivity, but with less attention on the processing and storage of the resultant output. For instance, 95% of funding of Consultative Group on International Agricultural Research (CGIAR) in about 20 to 30 years was devoted to production related research activities (FAO, 2017). Agricultural credit disbursement in Nigeria has also been in favour of crop production with grain alone taking 67% (CBN, 2016). Consequently, the gains of increased agricultural productivity will not be fully realized if not sustained through the developments of a viable processing and marketing sector to support the technical progress attained in production (Ishaya, 2018).

In Nigeria, women occupy a dominant place in the socioeconomic life of the nation. There is increasing realization of the essential role of women in agriculture and food production and in fact that the empowerment of women is necessary for achieving sustainable development (Shuaibu, 2015). In order to mitigate the adverse effect of poverty and contribute to the care and upkeep of members of their families, Nigerian women are engaged in a variety of income earning as a way of improving their livelihoods, and such activities include groundnut processing (Shuaibu, 2015; Nwachukwu & Jibowo, 2000).

Studies have shown that rural women are usually disadvantaged in their access to factors of production and processing in spite of their involvement in the enterprise generally (Johnson & Steven, 2024). Palacios-Lopez and Lopez (2015) documented that over 80% of

all rural women in Sub-Saharan Africa including Nigeria are economically active in one agricultural activity or the other. Despite the dominance and important role women play in agricultural activities in the country, they are hardly given attention they so desire.

Despite the constraints to produce high quality products due to inefficiency of technology inputs, resources, and information among women processors and marketers, the demand for traditionally processed raw materials continues to predominate in most developing countries. This tends to limit women's ability to engage in agricultural trade to complement economics gains (Ishaya, 2018).

METHODOLOGY

Study Area

The study was conducted in Torankawa, which is a district in Yabo Local Government Area, Sokoto State, Nigeria. The district comprises of two (2) wards namely, Torankawa and Binjin Muza. The Torankawa ward having twelve (12) villages and Binji ward having seventeen (17) villages making the total villages in the district to be twenty-nine (29). It has its headquarters in Torankawa town with the coordinates of 12°45'20''N 4°50'36.1''E (GIS Lab, 2023). The projected population as of 2024 is 23,096 persons at 3.5% growth rate per annum (Muhammad & Sunday, 2020). It is located near to Gela and Kakosso.

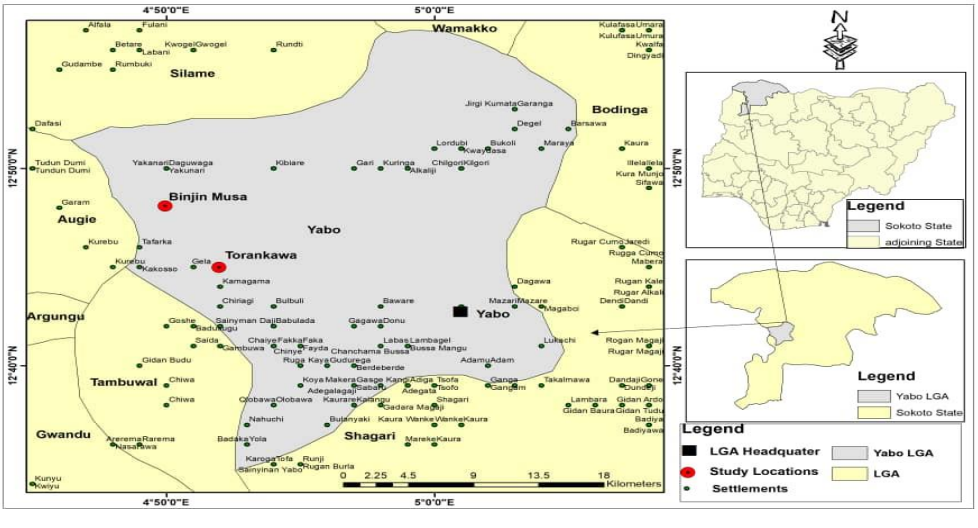

Figure 1: Map of the study area
Source: GIS Lab, Department of Geography, Usmanu Danfodiyo University Sokoto (2023)

Sampling Techniques and Sample Size

A multi-stage sampling procedure was employed in the study. In the first stage, Yabo Local Government Area was purposively selected. The selection was premised on the intensity of *Dakuwa* processing in the Local Government Area. In the second stage, a

purposive selection of Torankawa district was made based on its intensity in *Dakuwa* processing. Subsequently, the two wards in Torankawa district namely: Torankawa and Binjin Muza were selected. In the fourth stage, there was a random selection of seven (7) villages from each ward, and finally in the fifth stage, eight (8) *Dakuwa* processors were selected randomly from each village, and this gave a sample size of 112 *Dakuwa* processors for the study. However, after data cleanup, 100 copies of the questionnaire were fit for analysis.

Method of Data Collection

Primary data were collected for the study, using a semi-structured questionnaire, containing relevant information on the socioeconomic characteristic of women maize-peanut ball processors; cost and of course returns accruing to the enterprise. Efforts were made to elicit information on the prices of both input and output to maize-peanut ball processing.

Data Analysis

Descriptive and inferential statistics were employed for the study.

Net Farm Income Analysis (NFI)

This technique was used in achieving objective 2. Mathematically this expressed as:

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

Where:

NFI = Net farm income (₦)
TR = Total revenue (₦)
TC = Total cost (₦).

However, Total revenue (TR) is expressed as:

$$TR = Py * Q \quad \ldots\ldots (2)$$

Where:

Py = Price of output
Q = Quantity of output.

TC is expressed:

$$TC = TVC + TFC \quad \ldots\ldots (3)$$

Where:

TVC= Total variable cost (₦)
TFC= Total fixed cost (₦)

Stochastic Profit Frontier Function

Profit efficiency is a broad concept since it takes into account the effect of the choice of vector of production on both cost and revenue. Two profit functions can be distinguished depending on either or not markets force for output and inputs are perfectly competitive given the input (W) and output price vector as (P), the firm maximizes profit by adjusting the amount of inputs and output (Abu *et al.,* 2012).

Thus, the profit function can be expressed explicitly as: $\pi = f\ (P, W, V, U)$ and in logarithm terms:

$\ln\ (\pi + \emptyset) = \ln(P, W) + (V - U)$ ……. (4)

Where, $\emptyset$ is a constant added to profit of each firm in order to attain positive values, enabling them to be treated logarithmically. The exogenous nature of prices in the concept of profit efficiency, assumes that there is no market power on the firms/farmers side (Ogundari & Ojo, 2006). If instead of taking price as given, the firms/farmers assume the possibility of imperfect competition, given only the output vector and not that of price, thus, alternative profit function is defined as:

IIA = IIA (Y, W, V, U) …….. (5)

A profit function is an extension and formalization of the production decision taken by a farmer. According to production theory, a farmer is assumed to choose a combination of variable inputs and output that maximize profit subject to technology constraints (Sadoulet & De Janrry, 1991). However, Yotopoulos and Lau (1973) popularized the use of profit function approach in which farm specific prices and level of fixed factors are incorporated in the analysis of efficiency. The advantage of using this approach is that input and output prices are treated as exogenous to farm household decision making and they can be used to explain input use.

The Cobb-Douglas stochastic profit frontier function was used to examine the profit efficiency among women maize-peanut processors. The stochastic frontier function is specified explicitly as:

$$ln\pi^{*} = \beta_0 + \beta_1 \ln P_1 + \beta_2 \ln P_2 + \beta_3 \ln P_3 + \beta_4 \ln P_4 + \beta_5 \ln P_5 + \beta_6 \ln P_6 + \beta_7 \ln P_7 + \beta_8 \ln P_8 + V_i + U_i \quad \ldots\ldots (6)$$

Where:

$\ln\pi^{*}$= Normalized profit in Naira (₦)/processed *Dakuwa*; defined as gross revenue minus total cost divided by output price

$\ln P_1^{*}$= Normalized price of Millet grain (₦); defined as price of millet grain / output price

$\ln P_2^{*}$ = Normalized price of groundnut seed (₦); defined as price of groundnut seed / output price

$\ln P_3^{*}$ = Normalized price of tiger nut (₦); defined as price of tiger nut / output price

$\ln P_4^{*}$ = Normalized price for wage of labor (₦); defined as price for wage of labor / output price

$\ln P_5^{*}$ = Normalized price of firewood (₦); defined as price of firewood / output price

$\ln P_6^{*}$ = Normalized price grinding (₦); defined as price of grinding / output price

$\ln P_7^{*}$ = Normalized price of transportation (₦); defined as price of transportation / output price

$\ln P_8^{*}$= Normalized price of ingredients (₦); defined as price of ingredients / output price

$V_i + U_i$ = Error term

Where,

V_i = are random variables which are assumed to be independent of U_i, identical and normally distributed with zero mean and constant V variance N (0, $\sigma^2 v$)

U_i=are non-negative random variables which are assumed to account for profit inefficiency in processing and are often assumed to be independent of V_i such that U_i is the non-negative truncated (at zero).

$$U_i = \delta_0 + \delta_1 z_1 + \delta_2 z_2 + \delta_3 z_3 + \delta_4 z_4 + \delta_5 z_5 + \delta_6 z_6 + w_i \quad \ldots\ldots (7)$$

Where:
U_i = Profit Inefficiency
Z_1 = Age (years)
Z_2 = Sex (1 if male; 0, otherwise)
Z_3 = Marital status (1 if married; 0, otherwise)
Z_4 =Education (years spent in school)
Z_5 = Household size (number)
Z_6 = Experience in maize-peanut ball processing (years)
δ_0 - δ_6 = Parameters to be estimate

Table 1: A-priori expectation and definition of the inefficiency variables in the model

Variables	Unit of measurement	Definition	A-priori	Reference
Age	Years	This is the age of the respondents	_	Ishaya, 2018
Membership of Cooperative	1 if yes; 0, otherwise	This indicates if the women belong to any association	+	Zakaria *et al*., 2019
Marital Status	1 if married; 0, otherwise.	This is the marital status of the respondents	+/_	Patrick *et al*., 2017
Education	Years	This is the number of years spent in school	_	Ishaya, 2018
Household size	Number	This refers to the total number of persons who eat from the same pot in the household	+	Sadiq *et al*., 2019
Experience	Years	This is the year spent on maize-peanut ball processing	+	Sadiq *et al*., 2019

RESULTS AND DISCUSSION

Socioeconomic Characteristics of the Respondents in the Study area

This section presents the summary statistics of the socioeconomic characteristics of the maize-peanut ball in the study area.

Dakuwa processors had a mean age of 39.4 years. This is a clear indication that women maize-peanut ball processors in Torankawa district are young and energetic within the productive age which avails them the propensity to increase their maize-peanut ball processing activities. On average, these women have completed 5.20 years of schooling, with primary education being the highest qualification in the study area. This might have an effect on the processors not likely to adopt improved maize-peanut ball processing. The mean household size of the processors was 13.78. This may be considered significant as family labour is recognized which tends to lower the production expenses that processors with smaller households are likely to experience. The polygamous nature of the regions as well as their family structure would likely explain the enormous family sizes observed. Though, the number of people in a certain family cannot be used to justify the potential for processing as

it could be affected by some important factors such as age, sex, and health status (Abdulrahman *et al*., 2015). A typical women maize-peanut ball processors had 10.71 years of processing experiences. This could be seen as considerable years of experience, which could help set a reasonable goal.

Table 2: Summary statistics of the socioeconomic characteristics of the *Dakuwa* processors

Variable	Mean	Minimum	Maximum	Standard Deviation
Age	39.40	23	60	10.26
Education	5.20	3	10	2.25
Household size	13.78	3	30	6.51
Experience	10.71	2	40	9.17

Profitability Analysis

The viability of an enterprise is indicated by the amount of profit realized per period of time. This is the difference between the monetary value of goods produced and the cost of the resources used in its production.

Table 3: Average cost and return analysis of *Dakuwa* processing/week

Variable	Average (₦)	Percentage
Variable Costs		
Cost of millet seed	1896.00	9.03
Cost of groundnut seed	2045.50	9.74
Cost of tigernut seed	1815.99	8.65
Cost of labour	450.50	2.15
Cost of firewood	323.50	1.54
Cost of grinding	419.30	2.00
Cost of transportation	473.00	2.25
Cost of ingredients	2778.50	13.23
Total variable cost ₦ (TVC)	10202.29	
Fixed cost (Depreciated cost)		
Basin	1863.95	8.88
Pot	2666.98	12.70
Mortar	4453.98	21.21
Pistil	1046.89	4.99
Sieve	277.89	1.32
Spoon	485.80	2.31
Total fixed cost ₦ (TFC)	10795.53	
Total cost ₦ (TC) = TVC+TFC	20997.82	100.00
REVENUE		
Total revenue ₦ (TR) = Py*Q	24800.50	
Net farm income ₦ (NFI) = TR – TC	3802.68	

Having known that, the revenue realized, and the operating cost of an enterprise determines how much gain or loss the enterprise would achieve within a certain period. The cost and return to maize-peanut ball processing was measured by estimating the difference between the total revenue from the sale of *Dakuwa* and the cost component involved in the processing. Table 3 presents the result for cost and return analysis in maize-peanut ball processing.

The result in Table 3 reveals an average total cost of processing of ₦ 20, 997.82. This comprised of total variables cost of ₦10, 202.29 which account for 48.59% of the average total cost and total fixed cost of ₦10, 795.53 which accounts for 51.41% of the average total cost of processing. In terms of returns, the average gross revenue per processor was ₦24, 800.5 from maize-peanut ball processing. The average net farm income per processors was ₦3802.682. This implies that maize-peanut ball processing is a profitable venture in Torankawa district.

Maximum likelihood estimates of Cobb-Douglas Stochastic Profit Frontier Function

The profit efficiency of the processors was obtained using stochastic frontier profit function model. The maximum likelihood estimates (MLE) of the parameters of the stochastic profit function are presented in Table 4.

Table 4: Maximum likelihood estimates of Cobb-Douglas stochastic frontier profit function

Variables		Coefficient	Standard error	t-ratio
Constant	β_0	9.433***	0.159	59.327
Millet grain	β_1	0.123*	0.065	1.892
Groundnut seed	β_2	0.004	0.057	0.070
Tigernut	β_3	0.003	0.011	0.273
Labour	β_4	0.075**	0.034	2.201
Firewood	β_5	-0.239***	0.083	-2.879
Grinding	β_6	0.006	0.045	0.133
Transportation	β_7	-0.015	0.012	-1.500
Ingredients	β_8	0.287***	0.093	3.086
Diagnostic statistics				
Sigma square	σ^2	-2.749***	0.137	-20.065
Gamma	γ	-5.218*	2.696	-1.935
Log likelihood		-114.029		

***; **; and * denote level of significance at 1%; 5% and 10% levels respectively

The result in Table 4 shows that sigma square (-2.749) and gamma (-5.218) was statistically significant ($p<0.01$). The sigma square indicates the goodness of fit of the model and correctness of the specified distributional form assumed about the composite error term (Ishaya, 2018). The gamma indicated the systematic influences that are un-explained by the function. This means that the inefficiency effects made significant contribution to the inefficiencies of the processors. The estimated coefficients of the parameters of the explanatory variables modelled in the normalized profit function based on the assumption of competitive market were positive except for normalized cost of firewood. This includes the coefficients of millet grain ($\beta_1 = 0.123$; $p<0.1$); labour ($\beta_4 = 0.075$; $p<0.05$); firewood ($\beta_5 = -0.239$; $p<0.01$); and ingredient ($\beta_8 = 0.287$; $p<0.01$). The estimated value of the maximum likelihood estimate for millet grain, labour and ingredients were positive and significant. This implies a direct relationship with the profit frontier of the processors, holding other variables constant. This is consistent with the findings of Onuche *et al.* (2020); Muhammad-Lawal *et al.* (2012); and Ogundari and Ojo (2006). The inverse relationship of the coefficient of firewood suggests that as the expenditure increases, the profit efficiency of the processors decreases. This implies that a unit increase in the quantity of firewood utilized decreases the

return on the maize-peanut ball by 23.9%. This corroborates with the work of Muhammad-Lawal *et al.* (2012) who reported that an increase in fuel consumption will bring about a corresponding decrease in revenue made from the processing activities.

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Distribution of the Profit Efficiency Score of *Dakuwa* Processors in the Study Area

Result in Table 5 shows the distribution of the maize-peanut processors according to their profit efficiency scores. The result shows a mean profit efficiency score of 0.973. This indicate that majority of the respondents operated close to their profit frontier with the minimum efficiency of 0.600 and maximum of 0.999. This indicates that an average maize-peanut ball processors were able to obtain 97.3% potential output from a given mix of processing respectively. Theres is an allowance of 2.7% to be met by the processors. This could be achieved by adopting improved technology to maize-peanut processing.

Table 5: Distribution of profit efficiency score of maize-peanut ball processors

Efficiency Score	Frequency	Percentage
0.600 - 0.699	2	2
0.700 - 0.799	3	3
0.800 - 0.899	1	1
0.900 - 0.999	94	94
Total	100	100
Mean	0.973	
Minimum	0.600	
Maximum	0.999	

Source: Computed from MLE Results

Inefficiency Effect of *Dakuwa* Processing in the Study Area

Table 6 presents the parameter estimates of profit inefficiency from the stochastic frontier profit function. The coefficient of membership of association ($Z_2 = 0.626$; $p<0.1$) and educational ($Z_4 = 0.091$; $p<0.01$) was found to be positive and statistically significant at 1% and 10 % level of significance. According to this relationship, women processors' profit efficiency will increase as a result of joining the association. In other words, the processing inefficiency will decrease with the unit increase in membership of association. Therefore, the involvement of female processors in associations has a beneficial impact on profit. This is because membership in organizations like cooperative societies gives women access to information and facilitates the diffusion of innovations and improvements in their output. This is in tandem with the findings of Shuaibu *et al.* (2018) but contrary to that of Muhammad-Lawal *et al.* (2012). The coefficient of education level occurred as expected, therefore, suggests that processing inefficiency will decrease with the unit increase in years of schooling. The implication is that for every additional year spent schooling by the women, their profit efficiency is increased by 9.1%. This contrasts with the findings of Shuaibu *et al.* (2018), who found that women's years of formal education had a significant impact on their earnings and go against expectations. This indicates that as women's years of formal education grow, their efficiency declines, which would undoubtedly result in a fall in profit. However, the result supports the position of Abdulrahman *et al.* (2015) who reported that

processors with considerable years of education respond greatly to effective decision-making in processing.

Table 62: Inefficiency effects in *Dakuwa* processing

Variable		Coefficient	Standard error	t-ratio
Age	Z_1	0.009	0.008	1.125
Membership of association	Z_2	0.626*	0.352	1.778
Marital status	Z_3	0.146	0.211	0.691
Education level	Z_4	0.091***	0.034	2.676
Household size	Z_5	-0.019	0.016	1.187
Years of experience	Z_6	0.006	0.007	0.857

***; * denote level of significance at 1% and 10% levels respectively

CONCLUSION

The study reveals that *Dakuwa* processors in Torankawa district are young, with large families and significant experience, but limited education, impacting their potential to adopt improved maize-peanut ball processing techniques. The study also indicated a profitable market for the production of maize-peanut balls. Most processors were operating near maximum capacity based on the profit efficiency findings. It is essential to address the identified inefficiencies to obtain the optimum profit frontier level. Furthermore, increasing both the quantity of millet grain utilized and the literacy levels among women processors could contribute to this optimum profit frontier level.

Based on these findings, it is recommended to enhance educational opportunities for *Dakuwa* processors to increase their adoption of improved processing techniques. Additionally, leveraging the large household sizes for labour can be optimized through targeted training programs for family members involved in the processing activities. Lastly, efforts should be made to support these processors with access to better resources and tools to maximize their significant experience in the industry, potentially increasing productivity and efficiency in maize-peanut ball processing. Therefore, to maximize processing profits, it is advised that women who process maize-peanut balls be provided with a sufficient supply of millet grain at an affordable price.

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