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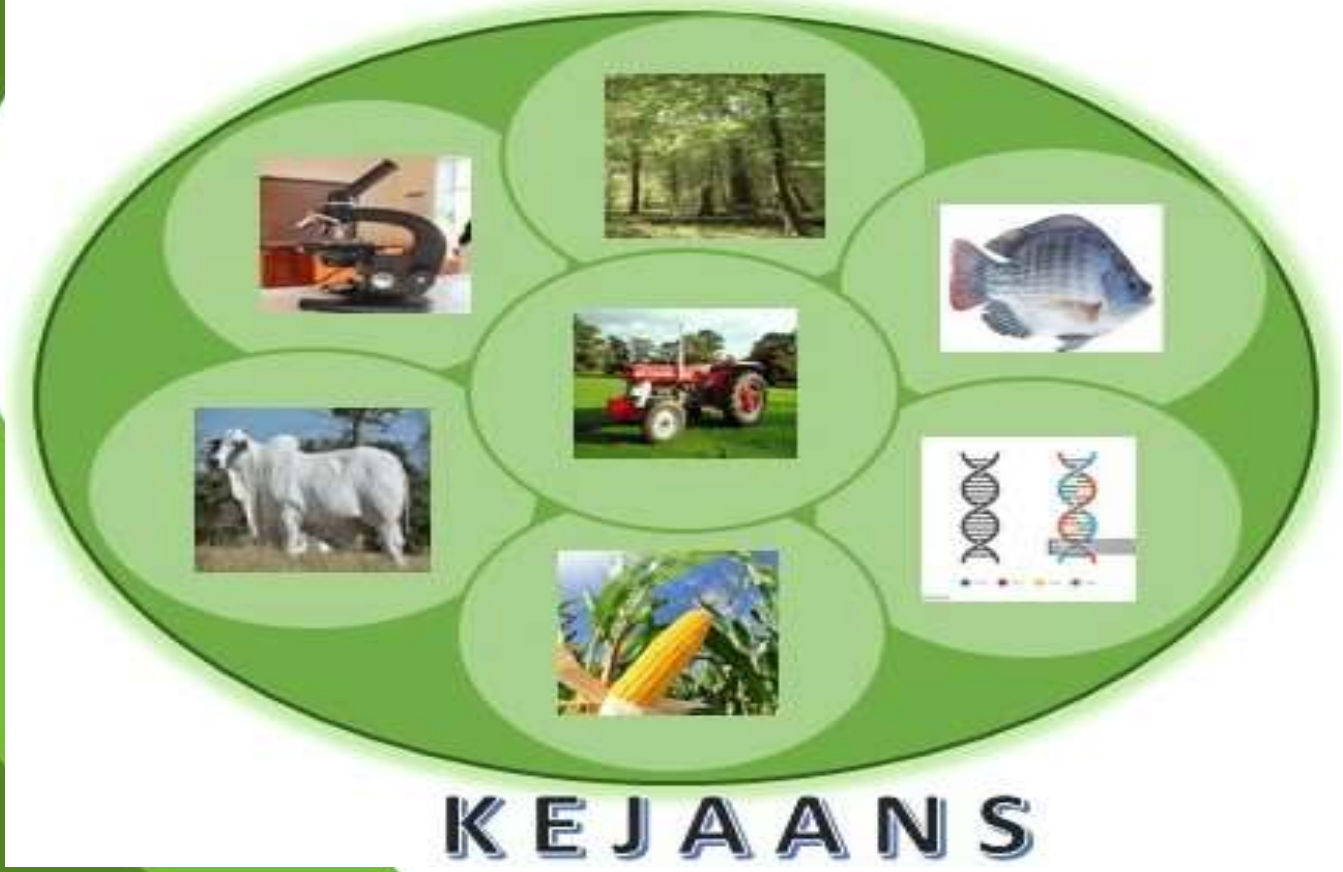

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About the Journal

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The Kebbi Journal of Agriculture and Natural Sciences has the sole aim of providing an intellectual platform and ideas for scholars, by promoting interdisciplinary studies related to agriculture and natural science through publishing the latest scientific research findings that are of direct policy implications and beneficial to the research community. Consequently, the journal covers all aspects of Crop Science, Animal Science, Agricultural Economics, Agricultural Extension and Rural Development, Food Science, Fisheries and Aquaculture, Biotechnology, Soil Science and Agricultural Engineering, Forestry and Environment, Wildlife, Agricultural Education, Agro-allied Industries as well as all Natural Science researches related to Agriculture.

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TECHNICAL EFFICIENCY OF SHEA BUTTER (BUTYROSPERMUM PARKII) PROCESSING IN KEBBI SOUTH SENATORIAL ZONE OF KEBBI STATE, NIGERIA

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ABSTRACT

This study analyzed the profitability and technical efficiency of shea butter (*Butyrospermum parkii*) processing in Kebbi South Senatorial Zone, Nigeria. A multistage sampling technique was used to select 120 processors, and data were analyzed using descriptive statistics, Net Farm Income (NFI) analysis, and the Stochastic Frontier Production Function (SFPF). The average processor was 42 years old, with eight years of processing experience and a household size of 11. The mean monthly revenue was ₦158,505.56, while total cost averaged ₦80,698.90, yielding a net income of ₦75,206.16 and a Benefit–Cost Ratio (BCR) of 1.90, indicating profitability. Labour and raw shea nuts accounted for the largest shares of total costs, underscoring the labour-intensive nature of the enterprise. The stochastic frontier results revealed that labour, shea nuts, and firewood significantly influenced output, while the mean technical efficiency was 0.68—indicating that processors operated 32% below the optimal frontier. Educational attainment and access to credit significantly reduced inefficiency, while age and limited experience increased it. Major constraints included non-standard measurements (85.8%), inadequate capital (83.3%), and market price fluctuations (75.8%). The study concludes that shea butter processing is profitable but constrained by inefficiency and financial limitations. It recommends interventions such as improved access to credit, standardization of processing practices, and the adoption of cleaner technologies to enhance productivity, income, and sustainability among rural women processors.

Keywords**:** Technical efficiency, profitability, shea butter, processors, stochastic frontier,

Introduction

The shea butter industry, derived from the nuts of *Vitellaria paradoxa*, plays a critical socio-economic and ecological role across sub-Saharan Africa, particularly in empowering rural women who dominate its production and processing (Abubakar et al., 2022; FAO, 2023). Rich in essential fatty acids, vitamins, and bioactive compounds, shea butter holds immense nutritional, cosmetic, and medicinal value, with studies confirming its antioxidant, anti-inflammatory, and healing properties (Emmanuel et al., 2023; Muoghalu et al., 2021).

However, despite its potential and growing global demand, Nigeria's shea butter industry remains largely traditional and inefficient. Women processors rely on labor-intensive methods that yield low output and inconsistent quality, largely due to limited access to mechanization, finance, and training (Ibrahim et al., 2016; Zaka et al., 2023). This study,

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therefore, focuses on Kebbi South Senatorial Zone to evaluate the technical efficiency of shea butter processors using Stochastic Frontier Analysis (SFA), aiming to identify key socio-economic determinants and constraints that can inform strategies for improving productivity, women's empowerment, and sustainable value addition in Nigeria's shea sector.

Methodology

The study was conducted in Kebbi South Senatorial Zone of Kebbi State, Northwestern Nigeria, encompassing seven Local Government Areas—Zuru, Fakai, Sakaba, Danko-Wasagu, Yauri, Shanga, and Ngaski—located between latitudes 10°36′N–11°36′N and longitudes 4°31′E–5°32′E. The zone, with an estimated population of over 1.3 million people (NPC, 2006), is ethnically diverse, comprising groups such as the Dakarkari (Lalna), Kambari, and Hausa, known for strong communal traditions and agricultural livelihoods (Nigerian Finder, 2020; Kebbi State Government, 2018).

Economically, the area is predominantly agrarian, with residents engaged in crop farming, livestock rearing, and fishing, particularly along the Niger River and Kainji Lake. Major crops include rice, millet, sorghum, and groundnut, while fishing and livestock production remain vital income sources (ACReSAL, 2024). Additionally, small-scale gold mining in Fakai and local trading activities contribute to the regional economy. However, the zone faces persistent environmental challenges such as desertification, flooding, and dry spells, which threaten its agricultural productivity and livelihoods (ACReSAL, 2024).

Sampling Procedure

A **multistage sampling technique** was employed to ensure systematic, representative, and cost-effective data collection among shea butter processors in **Kebbi South Senatorial Zone**. In the **first stage**, four Local Government Areas (LGAs) were **purposively selected** based on the high concentration of shea butter processing activities, ensuring that the study targeted areas most relevant to its objectives. In the **second stage**, **two villages** were **randomly selected** from each chosen LGA, resulting in **eight villages** that adequately captured the spatial and socio-economic diversity of the zone. In the **final stage**, **fifteen processors** were **randomly chosen** from each village, giving a **total sample size of 120 respondents**. The combination of **purposive and random sampling** enhanced the study's **validity and representativeness**, balancing focused inquiry with unbiased respondent selection. This approach aligns with established sampling procedures used in agricultural and rural livelihood research (Yamane, 1967; Etim et al., 2020; Adesope et al., 2022), where multistage designs enable efficient data collection while ensuring coverage of key population segments. Consequently, the procedure effectively captured the diversity, scale, and socio-economic dynamics of shea butter processing across the study area.

Analytical Techniques

The study utilized both descriptive and econometric methods to achieve its objectives. Descriptive statistics such as means, frequencies, and percentages were applied to summarize the socio-economic characteristics of respondents and identify constraints in shea butter processing.

Profitability was assessed using the **Net Farm Income (NFI)** model, which measures net returns as:

NFI = TR-TC…… (1)

Where,

NFI = Net Farm Income (₦)

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TR = Total Revenue from Shea butter processing (₦)
TC = Total Cost of production (₦)
TC = TVC + TFC
Thus, the model can be rewritten as:
NFI = TR – TVC – TFC……………. (2)
To further evaluate economic performance, the Rate of Return (ROR) was calculated using the ratio of total revenue to total cost:
Rate of return = Total Revenue/ Total C…….(3)
This approach has been widely applied in agricultural and agro-processing profitability studies, particularly in resource-limited settings, due to its simplicity and clarity in capturing net economic gains (Kay et al., 2012; Ojo, 2003).
To estimate technical efficiency and its determinants, the **Stochastic Frontier Production Function (SFPF)**, based on the **Cobb–Douglas** form, was employed:

Stochastic Frontier Production Function Model:
$\ln Y = \beta_0+\beta_1\ln X_1+\beta_2\ln X_2+\beta_3\ln X_3+\beta_4\ln X_4 +\beta_5\ln X_5+\beta_6\ln X_6+ V_i - U_i$ ……(3)
Where:
Y = Shea butter output (kg)
X_1 = Labour (man-hours)
X_2 = Capital (₦)
X_3 = Shea nut (kg)
X_4 = Volume of water (liters)
X_5 = Transportation cost (₦)
X_6 = Firewood (₦)
V_i = random (symmetric) error term accounting for Output (Shea Butter in Kg) from the frontier caused by noise.
U_i = Non negative (asymmetric) random error accounting for Technical Inefficiency in processing.
ln = natural logarithm
$\beta_0,\beta_1,\beta_2,\beta_3,\beta_4,\beta_5,\beta_6,\ldots\beta_n$ = Unknown parameters estimated.
Technical Inefficiency Model is as follows;
$U_i = d_0 + d_1 z_1 + d_2 z_2 + d_3 z_3 + d_4 z_4 + d_5 z_5 + d_6 z_6 V_i - U_i$……………………………………………(4)
U_i = Technical Inefficiency
Z_1 = Age of processor (Years)
Z_2 = Educational level (number of years spent in school)
Z_4 = Farming experience (years)
Z_5 = Household size (number)
Z_6 = Amount of credit accessed (₦)
$d_0, d_1, \ldots d_n$ = parameters to be estimated.

Results and Discussion
Socio-Economic Characteristics

Table 1: Summary statistics of variables for Shea butter processing in Kebbi South Senatorial Zone of Kebbi State.

Variable	Mean	Minimum	Maximum	Standard dev.
Age (years)	42	21	68	9.760
Shea nuts (kg)	33	18	102	11.402
Labour (man-hour)	26	33	103	103.201
Capital (₦)	49,000	24,000	145,000	2113.450
Years of experience	8	2	25	31.093
Family size	11	2	22	20.568
Output (Kg)	19	11	43	104.330
Fire wood cost (₦)	3600.50	1,330	7,340	38.001
Transportation (₦)	2,200	1,255	4,500	8.772
Water cost (₦)	1600.50	480	2450	61.060

Source: Field survey: 2022

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The findings in **Table 1** reveal that shea butter processors in Kebbi South Senatorial Zone are predominantly within their **economically active age** (average 42 years) and possess moderate experience (about 8 years). Their **large household sizes** (average 11 members) suggest dependence on **family labour**, while the **average capital investment of ₦49,000** indicates limited financial resources. Processors work an average of **33 man-hours monthly**, with significant variation reflecting differences in production scale. Expenditures on **firewood, transport, and water** show reliance on **traditional processing methods**. The **average monthly output of 19 kg** is low compared to regions like Niger State, where production ranges from **2,000–3,000 kg**, signifying that shea butter processing in Kebbi South Senatorial Zone remains **subsistence-oriented and labour-intensive**.

These results mirror earlier studies that identified similar **constraints in Nigeria's shea industry**, including low access to capital, outdated techniques, and limited technology adoption (Adesope et al., 2022; Akinsokeji et al., 2017; Tijani & Sanusi, 2020). To improve productivity and income, enhanced access to **credit, training, and modern processing equipment** is imperative.

Cost and Returns

Table 2 sows te average costs and returns in Shea butter Processing per Month in Kebbi South Senatorial Zone

Table 2: Average costs and returns in Shea butter Processing per Month in Kebbi South Senatorial Zone.

Variable	Average amount(₦)	Total amount (₦)	Percentage
(A) Revenue	158,505.56	19,020,667.20	
(B) Variable			
Labour	33,470.20	4,016,424	41.47
Shea nuts	20,103.40	2,412,408	24.91
Water Cost	5,600.50	672,060	6.94
Transportation	5,200.00	624,000	6.44
Firewood	3,120.50	374,400	3.75
Grinding (Milling)	6,450.30	654,036	6.54
(C) Total Variable Cost	69,824.40	8,393,328	90.05
(D) Fixed Cost			
Pots	2,600.00	312,000	3.22
Basin	1,930.00	231,600	2.34
Spoon	1,220.00	146,400	1.51
Bucket	2,083.50	250,020	2.58
Plates	940.40	112,848	1.16
Calabash	2,100.60	252,072	2.60
(E) Total Fixed Cost	10,874.50	1,304,945	13.41
(F) Total Cost (C+E)	80,698.90	9,683,868	100.00
Net Income (A-F)	75,206.16		
Benefit Cost Ratio	1.90		

Source: Field survey: 2022

Monthly revenue averaged ₦158,505.56, with total cost of ₦80,698.90, yielding ₦75,206.16 in profit and a BCR of 1.90. Variable costs constituted 90% of total costs—labour (41.5%) and raw nuts (24.9%) being dominant. This confirms the labour-intensive nature of processing (Adinya et al., 2007; Osei-Agyemang et al., 2021). The enterprise is highly profitable, consistent with similar studies in Oyo, Kwara, and Niger states (Afolabi & Adebayo, 2023; Bello et al., 2022).

Technical Efficiency Estimates

Results in Table 3 indicates the maximum likelihood estimates of variables in Shea Butter processing.

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Table 3: Maximum likelihood estimates of variables in Shea Butter processing.

Variables	Coefficient	Standard Error	t-Values
Constant	1.167	1.008	1.157ns
Labour (man-days)	1.388	0.411	3.377***
Capital (₦)	0.879	1.304	0.674
Shea nuts (kg)	1.347	0.513	2.625**
Volume of water (liters)	0.695	1.221	0.569^{ns}
Transportation cost (₦)	0.213	0.119	1.789*
Firewood (₦)	2.118	1.017	2.082 ***
Diagnostic statistics			
Sigma squared (s^2)	0.718	0.216	3.324***
Gamma ($_\gamma$)	0.697	0.130	5.361***
Log likelihood ratio test	18.825		

Source: Field survey: 2022

The sigma-squared (0.718) and gamma (0.697) were highly significant, indicating that 70% of output variation stems from inefficiency. Labour, shea nuts, and firewood were significant ($p<0.05$), while capital and water were not. Similar patterns were observed by Ojo & Adebayo (2022) and Shehu et al. (2020), emphasizing the influence of labour and raw materials in agro-processing productivity.

Efficiency Indices

Table 4 shows the frequency distribution of technical efficiency estimates in Shea Butter processors.

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Table 4: Frequency distribution of technical efficiency estimates in Shea Butter processors.

Efficiency Estimates	Frequency	Percentage
0.21- 0.30	06	5.00
0.31- 0.40	15	12.50
0.41- 0.50	18	15.00
0.51 – 0.60	12	10.00
0.61 – 0.70	27	22.50
0.71 – 0.80	19	15.83
0.81 – 0.90	15	12.50
Above 0.90	08	6.67
Total	120	100.00
Minimum efficiency	0.21	
Mean efficiency	0.60	
Maximum efficiency	0.90	

Source: Field survey: 2022

Mean technical efficiency was 0.68, implying 32% inefficiency. None of the processors achieved full efficiency, suggesting substantial room for improvement through better training, equipment, and credit access. This corroborates Ibrahim et al. (2014), who observed similar inefficiencies among processors in Niger State.

Determinants of Inefficiency

Table 1.5: Determinants of Technical Inefficiencies in Shea butter processing

Variables	Coefficients	Standard error	T-Values
Constant	3.212	1.009	3.183***
Age	1.048	0.326	3.215***
Educational level	-1.576	0.556	-2.835**
Amount of credit accessed	-1.035	0.397	-2.607**
Membership of association	1.083	1.005	1.077^{ns}
Family size	0.347	1.0889	0.318^{ns}
Years of experience	1.422	0.781	1.821*

Source: Field survey: 2022

Education and access to credit significantly reduced inefficiency ($p<0.05$), while age and experience increased it. Membership in associations was insignificant. These findings align with Iliyasu et al. (2021) and Ojo & Adebayo (2022), who linked education and finance to improved processing performance.

Processing Constraints

Table 6 shows tha distribution of Shea butter processors according to the problems encountered.

Table 1.6: Distribution of Shea butter processors according to the problems encountered.

S/No	Problems	*Frequency	Percentage	Ranking
1.	Non-standard measurements	106	85.83	1st
2.	Insufficient capital	103	83.33	2nd
3.	Fluctuating market prices	91	75.83	3rd
4.	Difficulty in accessing credit	82	68.33	4th
5.	High cost of Shea nuts	73	60.83	5th
6.	High cost of labour	66	55.00	6th
7.	Firewood is expensive	57	47.50	7th

Source: Field survey: 2022 (*Multiple responses were recorded)

The main constraints were non-standard measurements (85.8%), limited capital (83.3%), and price fluctuations (75.8%), followed by credit access (68.3%) and high input costs (firewood, nuts, labour). Similar challenges were identified by Nana & Owusu (2022), Agboola et al. (2021), and UNDP (2023)

Conclusion and Recommendations

Shea butter processing in Kebbi South is profitable but inefficient. Processors operate below the production frontier due to inadequate finance, traditional technology, and lack of standardization. To enhance efficiency:

1. Government should establish a standardized measurement systems for quality assurance.
2. Government and Financial Institutions should facilitate access to affordable credit and processing equipment.
3. Government and NGOs should provide targeted training on modern techniques and financial literacy.
4. Government and NGOs should promote clean energy alternatives to reduce firewood dependency.

Such interventions would improve productivity, profitability, and women's empowerment in rural shea value chains.

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