

Original Article

Profit efficiency of marketing Shea butter (*Vitellaria paradoxa*) in Kaduna state: Applications of stochastic profit frontier model

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ABSTRACT

This study evaluated profit efficiency of marketing Shea butter (*Vitellaria paradoxa*) in Kaduna State, Nigeria: Applications of stochastic profit frontier model. Specifically, the research study was designed to answer the following objectives: Determine the socio-economic characteristics profiles of Shea butter (*V. paradoxa*) marketers, analyze the costs and returns of marketing Shea butter (*V. paradoxa*), evaluate factors influencing profits of Shea butter (*V. paradoxa*) marketers, and determine the constraints facing marketers of Shea butter (*V. paradoxa*) in the study area. Data from primary sources were used for this study. Data were collected with the aid of well-designed, well-structured questionnaire. The questionnaire was subjected to validity and reliability test. Personal interview and focus group discussions were also conducted. Statistical and econometrics tools used in analyzing data were descriptive statistics, gross margin (GM) model, marketing margin, marketing efficiency, stochastic frontier model, and principal component analysis (PCA). The results show that marketers of Shea butter were young, active, energetic, and resourceful. The mean age was 39 years. Marketers of Shea butter were mostly female (85%) and about 73% of them were married. Furthermore, 75% of Shea butter marketers had formal education and were literate. The household sizes were large with an average of nine people per households. The respondents had considerable experiences in Shea butter marketing with an average of 12 years marketing experiences in Shea butter. Marketing of Shea butter was profitable with GM and net returns of 351,500 Naira and 345,700 Naira, respectively. GM ratio of 0.937 implies that for every one Naira invested 0.937 Kobo covered profits, taxes, depreciation, and interest. Purchase price and marketing cost had negative coefficients and were statistically significant in influencing profit efficiency of Shea butter marketers. Marketing experience and education of marketers had positive coefficients and were statistically significant in influencing profit efficiency of Shea butter marketers at 5% probability levels, respectively. The mean profit efficiency score was $0.48 \bar{x} = 0.48$. This means that marketers of Shea butter have 52% chances of increasing profit efficiency. The statistically and significant predictor variables included in the stochastic profit inefficiency model were age ($P < 0.10$), access to credit ($P < 0.05$), gender ($P < 0.05$), membership of cooperatives ($P < 0.05$), and household sizes ($P < 0.05$). The constraints facing marketers of Shea butter were lack of credit facilities, bad road infrastructures, inadequate extension officers, lack of storage facilities, and poor transport facilities. PCA shows that the retained components explained 71.61% of all constraints included in the model. The study recommends provision of credit facilities at low interest rate, appropriate government policies to further promote export potentials of Shea butter, and adequate transport facilities for easy evacuation of Shea butter from producing areas to urban centers.

Keywords: Kaduna State, marketing, Nigeria, Shea butter (*Vitellaria paradoxa*), stochastic profit frontier model

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INTRODUCTION

Shea butter tree (*Vitellaria paradoxa*) is a non-timber forest products which is far gaining much attention among researchers and breeders as a tree which enormous potentials worth investigation for the purpose domestication and also as an agricultural tree crop.^[1] The tree grows within Nigeria in large quantity in the guinea savannah and sudano-sahelian regions. The Shea tree has played an important role in the livelihoods of rural people in Nigeria. The local Shea business apart from farming activities is a vibrant business among rural people particularly women in Nigeria. According to Schreckenber,^[2] Shea butter is a staple component among diets of rural people and together with the kernel serves as source of income for rural women. The tree has great potentials to earn foreign exchange for Nigeria. The Shea fruit pulp is very nutritious which contains protein and minerals and is highly medicinal.^[3] The fruit pulp has laxative properties and it is edible. Shea nuts are a good source of affordable cooking fats.^[4] Shea butter is locally produced by rural women as loaves in the market.^[4] Shea butter is used as a base in medical, cosmetic ointments, as an illuminants, and hair cream.^[4] Shea butter obtained from Shea nut trees is used in food, pharmaceutical, and cosmetic industries. The Shea butter refined can be used as substitutes for cocoa butter and margarine in food industries. Shea butter contains high concentrations of triglyceride and is used for shampoo, skin creams and cosmetics.^[2] The Shea butter from Shea nut may have up to 50% oil content.

Shea butter business has a lot of advantages both for local and international communities, processors are mostly rural women and they obtained low revenue which hardly cover the costs of production making profits to be low. The low profits of Shea butter business could be disincentives to invest in Shea butter business in the rural economy.^[5] Shea butter trading and processing activities offers rural women employments as an income generating activities.^[6] The by-products of processed nuts which is the low quality butter are smeared on earthen walls to serve as waterproof and protect the walls during the rainy season.

Africa produces about 1,760,000 metric tonnes of raw Shea nuts annually.^[7] Large quantities of Shea nuts are produced in West Africa. Seven African countries that produced Shea nuts include: Nigeria, Ghana, Burkina Faso, Benin, Cote d'Ivoire, Mali, and Togo. The seven West African countries produce about 500,000 tonnes of Shea nuts. These countries export about 270,000 tonnes as raw nuts. Europe is the regular importer of Shea nuts with annual import values between 6000 tonnes and 60,000 tonnes.^[8] Four major players that control refining of Shea in the world markets are: Denmark, Japan, Sweden, and Holland.^[9] Unites States of America (USA) and United Kingdom (UK) also import Shea butter. Most of the exports of Shea from West Africa consist of crude butter that

has no significant refining.^[9] The West African variety of Shea (*V. paradoxa*) has been traditionally processed and locally used.^[9] Shea butter trade is a good source of income and has potentials to raise the standard of living of rural people in subsistence economy. The different methods of Shea processing introduce many different combinations of technology, cost, scale, and efficiency.^[9] Efficiency defines the possibilities of producing a certain optimal level of output at lowest cost from given resources. According to Rahman and Awerije^[10] defines marketers as allocative inefficient if it is not using marketing inputs in optimal proportions, marketing inputs such as storage, transportations, loading and off-loading cost, marketing space, and utilities. Furthermore, marketers can be scale inefficient if the marketer does not offer quantity of products at a selling price that will be equal to the marginal cost of marketing. These two inefficiencies can be combined in analyzing profit function framework. Specifically, the research study was designed to answer the following objectives: Determine the socio-economic profiles of Shea butter (*V. paradoxa*) marketers, analyze the costs and returns of marketing Shea butter (*V. paradoxa*), evaluate factors influencing profits of Shea butter (*V. paradoxa*) marketers, and determine the constraints facing marketers of Shea butter (*V. paradoxa*) in the study area.

METHODOLOGY

This research study was conducted in Kaduna State. The State lies within Lies within Latitudes 10° 20'N and Longitudes 70 45'E. The population of Kaduna is about 6,113, 503 people.^[11] The State has total land area of 46, 053 Km². Agriculture is the main occupation of the people. They are involved in marketing of agricultural and forest products. The crops grown include maize, ginger, sorghum, rice, millets, onion, and tomatoes. Forest products marketed include: Avocado, Shea butter, date palm, locust bean, bitter kola, and bitter leaf. The state has an annual rainfall of 120 mm which starts from May to October each year. Purposive sampling technique was used to select Kaduna State because of the predominant of Shea butter marketers. Multi-stage sampling technique was used to select the sampled marketers. First stage involves simple random selection of two local government areas through raffle-draw ballot-box method. The local government areas are Kaduna North and Kaduna South. Second stage involves simple random selection through raffle draw ballot-box method four markets. Third stage involves simple random selection of 100 Shea butter marketers following^[12] formula of estimating sample size:

$$n = \frac{N}{1 + N(e^2)} = 100 \quad (1)$$

Where, n = Sample Size (Units)
N = Population (Units)
e = Level of Precision (10%).

Primary data were used. Data were obtained through the use of well-designed and well-structured questionnaire. Personal interview schedules and focus group discussions were also used to obtain data. Questionnaire was subjected to validity and reliability test. Data obtained were analyzed using the following statistical and econometric tools:

Descriptive Statistics

This was used to summarize the socio-economic profiles of Shea butter marketers. This involves the use of frequency distributions, percentages, and mean. This was used to achieve specific objective one (i)

Gross Margin (GM) Model: According to Molua,^[13] GM is defined as:

$$GM = \sum_{j=1}^m P_j Y_j - \sum_{i=1}^m P_i X_i \tag{2}$$

$$\pi_j = \left[\sum_{j=1}^m P_j Y_j - \sum_{i=1}^m P_i X_i \right] - K \tag{3}$$

Where,

- P_j = Unit Price of Shea Butter (Naira/Kg)
- Y_j = Quantity of Output (Kg)
- P_i = Unit Price of Variable Inputs (Naira per Units)
- X_i = Quantity of Variable Inputs (Units)
- K = Fixed Cost (Naira)
- π_j = Profits (Naira).

This was used to achieve specific objective two (ii)

GM Ratio:^[14] Define GM ratio as:

$$\text{Gross Margin Ratio} = \frac{\text{Gross Margin}}{\text{Total Revenue}} \tag{4}$$

This was used to achieve specific objective two (ii)

Marketing Margin:^[15] Defines marketing margin as:

$$\text{Marketing Margin} = \frac{\text{Selling Price} - \text{Supply Price}}{\text{Selling Price}} \tag{5}$$

This was used to achieve specific objective two (ii)

Marketing Efficiency:^[15] Define marketing efficiency as:

$$\text{Marketing Efficiency} = \frac{\text{Value of Output}}{\text{Value of Input}} \tag{6}$$

This was used to achieve specific objective three (iii).

Stochastic Profit Frontier Model: The stochastic profit function according to Rahman and Awerije^[10] is defined as:

$$\pi_i = f(P_i, Z_i) e^{v_i - \mu_i} \tag{7}$$

Where,

- π_i = Profits from Shea Butter (Naira)
- P_i = Vector of Variable Input Prices (Naira)
- Z_i = Vector of Fixed Factor (Naira)
- V_i = Two Sided Random Error
- μ_i = One Sided Half Normal Error
- P_1 = Purchase Price of Shea Butter (Naira)
- P_2 = Marketing Cost per Unit of Product (Naira)
- Z_1 = Education of Marketers (years)
- Z_2 = Marketing Experience (years).

$$\mu_i = \delta_0 + \sum_{d=1}^5 \delta_d W_d + w \tag{8}$$

Where,

- W_d = Socio-Economic Characteristics of Marketers to Explain Inefficiency
- w = Truncated Random Variable
- d_1 = Age of marketers (years)
- d_2 = Access to Credit (1, Access; 0, Otherwise)
- d_3 = Gender (1, Female; 0, Otherwise)
- d_4 = Membership of Cooperatives (1, Membership; 0, Otherwise)
- d_5 = Household Size (Units)

This was used to achieve specific objective three (iii).

Principal Component Analysis (PCA)

According to Alabi *et al.*,^[16] PCA was used to reduce many interrelated constraints facing Shea butter marketers into few unrelated constraints.

RESULTS AND DISCUSSION

Socio-economic Profiles of Shea Butter (*V. paradoxa*) Marketers

Table 1 shows the socio-economic profiles of Shea butter marketers. The mean age of marketers was 39 years. This implies that the marketers were young, active, energetic, and resourceful. About 51% of Shea butter marketers were less than 40 years of age. This is an indication that the marketers are in their active age and will be able to easily adopt new technologies and research findings. Furthermore, 85% of Shea butter marketers were female, and 73% of them were married. Shea butter enterprises are dominated by women as an income generating activities. Shea butter marketers can read and write as 75% of them had formal education. This implies that they had primary (54%), secondary (19%), and tertiary (2.00%) educations, respectively. The household sizes were averagely large with about nine people per household. Furthermore, 56% of Shea butter marketers had less than 10 people per households. Averagely, respondents had 12 years experiences in marketing Shea butter. Experiences in

Table 1: Socio-economic profiles of Shea butter (*Vitellaria paradoxa*) marketers

Socio-economic profiles	Frequency	Percentage	Mean
Age (years)			
21–30	23	23.00	39.60
31–40	29	29.00	
41–50	32	32.00	
51–60	16	16.00	
Gender			
Male	15	15.00	
Female	85	85.00	
Marital Status			
Single	23	23.00	
Married	73	73.00	
Divorced	04	04.00	
Level of education (years)			
Primary	54	54.00	
Secondary	19	19.00	
Tertiary	02	02.00	
Non-Formal	25	25.00	
Household size (units)			
1–5	17	17.00	9.95
6–10	39	39.00	
11–15	32	32.00	
16–20	12	12.00	
Marketing experience (years)			
1–5	09	09.00	12.30
6–10	41	41.00	
11–15	15	15.00	
16–20	25	25.00	
21–25	10	10.00	
Total	100	100.00	

Source: Field Survey (2019)

marketing and as marketers advanced in age coupled with formal education will enable marketers adopt easily new technologies and research findings. This result is in line with earlier findings of Adesope *et al.*^[17] who reported that Shea butter business are mostly dominated by females.

Cost and Returns Analysis of Shea Butter (*V. paradoxa*) Marketing in the Study Area

The various costs involved and associated returns of Shea butter marketing are presented in Table 2. The revenue evaluated was based on prices prevailing as at the time of this field survey.

Table 2: Costs and returns of marketing Shea butter (*Vitellaria paradoxa*) per month in the study area

Variable	Value (Units)	Value (Dollar)	Percentage
a. Variable Costs (Naira)			
Storage cost	3500	08.75	11.91
Transportation cost	5750	14.37	19.57
Loading and offloading cost	2300	05.75	07.28
Processing cost	6700	16.75	22.80
Handling cost	3200	08.00	10.89
Market fees	2130	05.33	07.24
b. Total Variable Cost	23,500	58.75	79.98
c. Fixed Cost (Naira) (depreciation, taxes, interest)	5,880	14.50	20.02
d. Total Cost (Naira)	29,380	73.47	100.00
e. Total Revenue (Naira)	375,000	93.75	
f. Total Revenue (Naira)	35,000	87.50	
g. Purchasing Price (N/ton)	49,000	122.50	
h. Selling Price (N/ton)	0.285		
i. Marketing Efficiency (%)	14,000		
j. Marketing Margin (Naira)	351,500		
k. Gross Margin	0.937		
l. Gross Margin Ratio	345,700		
m. Net Returns (Naira)			

Source: Field Survey (2019). 1 US Dollar=400 Naira

Table 3: Result of stochastic profit frontier model

Variable	Parameter	Coefficient	t-ratio
Profit efficiency			
Constant	β_0	1.291*	1.91
Purchase price	β_1	-0.189**	-2.61
Marketing cost	β_2	-0.126**	-2.81
Education of marketers	β_3	0.206**	2.91
Marketing experience	β_4	0.1306**	3.05
Inefficiency model			
Constant	δ_0	1.206*	1.92
Age	δ_1	-0.102**	-2.56
Access to credit	δ_2	-0.067**	-2.61
Gender	δ_3	-0.231**	-2.17
Membership of cooperatives	δ_4	-0.321**	-2.41
Household size	δ_5	-0.102*	-1.95
Diagnostic statistics			
Log-likelihood		-115.09	
Sigma squared	σ^2	0.619***	
Gamma	γ	0.771***	

Source: Field Survey (2019). *Significant at 10% probability level. **Significant at 5% probability level. ***Significant at 1% probability level

The total variable cost accounted for about 58.75% of total cost involved in marketing Shea butter in the study area. The total

variable costs consists of storage cost (08.75%), transportation cost (14.37%), loading and off-loading cost (07.28%), processing cost (22.80%), handling cost (10.89%), and market fees (7.24%). The fixed cost accounted for about 20.02% of total cost of marketing Shea butter in the study area. The total revenue amounted to 375,000 Naira equivalents to 93.75 US Dollar. The GM and net returns were 351,500 Naira and 345,700 Naira, respectively. This implies that marketing of Shea butter is profitable in the study area. The GM ratio of 0.937 implies that for every one Naira invested in marketing Shea butter 0.937 Kobo covered depreciation, profits, taxes, and interest. The marketing margin was 14,000 Naira and marketing efficiency was fairly efficient at 28.50%. This result is in line with findings of Adeyemo *et al.*^[18] who obtained GM and net returns of 159,233 Naira and 15,636 Naira in Shea butter production, respectively.

Maximum Likelihood Estimates of Stochastic Profit Frontier Model

Table 3 presented the results of maximum likelihood estimates of stochastic profit frontier model for marketers of Shea butter (*V. paradoxa*) in the study area. The predictor variables included in the profit efficiency model were: Purchase price, marketing cost, education of marketers, and marketing experience. All the

Table 4: Distribution of profit efficiency scores of marketers of shea butter (*Vitellaria paradoxa*)

Efficiency scores	Frequency	Percentages
Less than 0.20	5	5.00
0.20–0.30	11	11.00
0.31–0.40	17	17.00
0.41–0.50	22	22.00
0.51–0.60	12	12.00
0.61–0.70	21	21.00
0.71–0.80	12	12.00
Mean	0.48	
Maximum	0.78	
Minimum	0.08	

Source: Field Survey (2019) Computed using STATA version 14

Table 5: Principal component analysis of constraints facing marketers of shea butter (*Vitellaria paradoxa*)

Constraints	Eigen-value	Difference	Proportion	Cumulative
Lack of credit facilities	2.8872	0.2675	0.1658	0.1658
Bad road infrastructures	2.6781	0.2607	0.1533	0.3191
Inadequate extension services	1.9786	0.2267	0.1408	0.4599
Lack of storage facilities	1.6720	0.2187	0.1336	0.5935
Poor transport facilities	1.5371	0.2006	0.1226	0.7161
Bartlett test of sphericity				
KMO=0.731				
Chi-square=2076.29***				
Rho=1.0000				

Source: Field Survey (2019), Computed using STATA Version 14

predictor variables included in the profit model were statistically significant. Purchase price had negative coefficient and was statistically significant at 5% probability level. This implies that 1% increase in purchasing price will lead to 18.9% decrease in profit earned by marketers of Shea butter in the study area. Furthermore, marketing experience had positive coefficient and was statistically significant at 5% probability level. This shows that as marketers acquired formal education, this will leads to about 0.1306 increases in profit earned by marketers of Shea butter in the study area. In the inefficiency model, the predictor variables included in the model were age, access to credit, gender, membership of cooperatives, and household sizes. All predictor variables included in the inefficiency model had negative coefficients. Access to credit had negative coefficient of -0.067 and was statistically significant at 5% probability level. This implies that as marketers acquired credit facilities will lead to 0.067 decreases in profit inefficiency from marketing Shea butter in the study area. Furthermore, membership of cooperatives had negative coefficient and was statistically significant at $P < 0.05$. As marketers join cooperatives associations this will leads to about 0.321 decrease in profit inefficiency from Shea butter marketing in the study area. The sigma square (σ^2) was 0.619 which was statistically significant at 1% probability level. This shows that correctness of fit of the stochastic profit frontier model. The estimated gamma value was 0.771 which was significant at 1% probability level. This implies that 77.1% of the variations in the total profit among sampled marketers were due to differences in their profit efficiencies. Table 4 presented the profit efficiency scores of sampled marketers. The mean profit efficiency score of Shea butter marketers was 0.48 ($\bar{x} = 0.48$). This implies that marketers of date palm have the scope of increasing profit efficiency by 52%. About 51% of Shea butter marketers fell between profit efficiency scores of 0.20 and 0.50. This result is in line with findings of Adeyemo *et al.*^[18] who obtained mean efficiency scores of 0.67 in their studies on Shea butter production.

Constraints Facing Marketers of Shea Butter (*V. paradoxa*) in the Study Area

Constraints facing marketers of Shea butter (*V. paradoxa*) were subjected to PCA, results are presented in Table 5. PCA is an econometric tool that can reduce many interrelated variables into

few variables that are unrelated. Lack of credit facilities had an Eigen value of 2.8872 and this explained 16.58% of all constraints included in the model. All retained constraints explained 71.61% of all constraints included in the model. The Chi-square of 2076.29 was significant at 1% probability level. Furthermore, bad road infrastructure had Eigen-value of 2.6781 and this explained 31.91% of total constraints retained in the model. This result is in line with findings of Garba *et al.*, Alabi *et al.*, Adeyemo *et al.*^[1,16,18] who obtained similar constraints facing Shea butter enterprises.

CONCLUSION

Marketing of Shea butter (*V. paradoxa*) is profitable enterprise in the study area. The GM and net returns were positive with values of 351,500 Naira and 345,700 Naira, respectively. Marketers were young, energetic, resourceful, and in their active age. Marketers can easily adopt new innovations and research findings. The mean profit efficiency score was 0.48. The statistically and significant predictor factors included in the model that influence profit efficiency were purchasing price, marketing cost, education of marketers, and marketing experience. The statistically and significant predictor variables that are included in the profit inefficiency model were age, access to credit, gender, membership of cooperatives, and household sizes. Lack of credit facilities, bad road infrastructures, inadequate extension officers, lack of storage facilities, and poor transport facilities were retained constraints with Eigen-values greater than one and they explained 71.61% of all constraints retained in the PCA.

RECOMMENDATIONS

Based on the results of these research findings, the following recommendations were made:

- i. Federal Government should put appropriate policies in place to promote export potentials of Shea butter
- ii. Credit facilities should be provided for Shea butter marketing at low interest rate
- iii. Feeder roads should be constructed for easy evacuation of agricultural and forestry product from producing areas to urban centers
- iv. Transport facilities should be provided to move agricultural and forest products from rural areas to urban centers
- v. Extension officers should be employed in the study areas to disseminate research findings to marketers of Shea butter in the study area.

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