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Technical Efficiency of Wild Mango Extractors: A Study of Farmers in Rainforest Zone of ONDO State, NIGERIA

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ABSTRACT
Wild Mango (Irvingia wombulu) trees are a valuable source of income and extensively utilised tropical tree for Nigerian farmers. This study examined technical efficiency of wild mango extractors in rain forest zone of Ondo State of Nigeria.
A multistage sampling was employed for the study. Three Local Government Areas (LGAs) were randomly selected from the state. .In each LGA, two villages were randomly selected and this was followed by random selection of twenty-two households from each village. This was followed by random selection of twenty-two (22) households from each village. Lastly, data were randomly collected from one hundred and twenty two NTFPs extractors using structured questionnaire. The data were analyzed using descriptive statistics, budgetary and stochastic frontier models. Result shows that extractors NTFPs incurred an average cost of ₦38,625.78 per season; and within the same period they had an average estimated returns of ₦74,729.30. The result of analysis revealed that land size, knife, labour, rain boot and distance from NTFPs source to market significantly impacted on farmers efficiently. However, age, years of education and household sizes were found to increase the farmers' technical efficiency. This study showed that NTFPs extractors were not fully technically efficient and therefore there is allowance improvement by addressing some important policy variables that could negatively and positively influence extractors' levels of technical efficiency in the area
Keyword*: Technical efficiency, Wild mango extractors, Rain forest zone, Ondo state Nigeria*

INTRODUCTION

Wild mango *(Irvingia wombulu)* is a tropical forest fruit tree in Nigeria and can attain a height of 25m and 2m in girth when fully matured. The fruit has sweet edible fibrous pulp which is rich in vitamin c. The seeds are primarily used for soup making in many parts of Nigeria. Generally, it has a large market value and fast becoming an export forest produce in Nigeria to Europe. It is sold in 4 forms: fruit, kernels without skin (or belt), kernels with skin (or belt), in paste (processed). The fruits are not very demanded on the market, consumers prefer the kernels. It can be used as an ingredient or a soup..

As people become more interested in personal health and family activities, demand for wild forest products has increased. This increased demand coupled with an increased concern for sustainable management practices has focused attention on the variety of issues and products involved in the non-timber forest products industry. The bark of the wild mango fruit tree is used in traditional pharmacopoeia for the treatment of hernia, diarrhea and yellow fever. It is also used as to cure wounds, toothache and as antidote. On the local market, wild mango is more commercialized in the in large cities in Nigeria and major food markets in the sub-region (Gabon, Cameroon and Equatorial Guinea) and internationally in Europe and America. Non-timber forest products (NTFPs) are used by rural communities as energy sources, food items, medicinal products, materials for household equipment, construction materials, as well as equipment and materials for agricultural activities**.** In view of the growing competition in the agricultural sector and high production costs, technical efficiency will become an important determinant in the future of rural farming. In other words, total farm output can be increased without increasing total cost by making better use of available inputs and technology. Hence, technical efficiency in agriculture decreases cost and increases ouput. Technical efficiency in agriculture in forest peripheries is one aspect in which agricultural capacity and rural incomes can be enhanced.

Large numbers of rural households in Africa continue to generate some of their income from forest product activities. However, much of this involvement is in labour intensive low return activities that help to provide the poor with an income safety net, but which declines once better alternatives become

available. Expansion of forest product activities is likely to be concentrated on a limited number of products and services for which demand grows with rural and urban development [1]. In 2002, United Nations Food and Agriculture Organisation approximates that 80 per cent of the developing world relies on Non-Timber Forest Products for nutritional and health needs. The rise in food prices, un-employment and inflation brought by the structural adjustment [2] and the decline in the average real income of both rural and urban households have compelled them into extraction and marketing in NTFPs. A number of studies in developing countries in Asia that have been carried out on extraction and marketing of NTFPs have shown that NTFP based small scale enterprises provide up to 50 per cent of income for 20 to 30 per cent of the rural labour force in India; where as 55 per cent of employment in the forestry sector is attributed to the NTFP sector alone [3]. Also, in South India, 50 per cent of a tribe in Western Ghats derived their means of livelihood from NTFP as it has become a major source of income and employment [4-6]. However, the resource use efficiency of the extractors of NTFPs in a society is case-specific [7]. Due to the relatively limited stock and increased seasonal variability in supply, the rural households depending on NTFP extraction are highly prone to the vagaries of income poverty in the dry tracts. This study therefore deals with technical efficiency of wild mango extractors in rainforest zone of Ondo state, Nigeria

CONCEPTUAL FRAMEWORK AND LITERATURE REVIEW

Non-timber forest products (NTFPs) have emerged as a complex set of issues reflecting changes in society and how natural resources are regarded. These issues range from the sustainability of forest management practices to the relationship of diverse cultures and communities to public lands and their resources. Understanding of the role and potential of NTFPs in livelihood strategies has been hindered by a lack of a clear theoretical framework and a functional typology of cases and the conditions that characterize each of the groups. Belcher et al., [8] found a strong relationship between the NTFP contribution to household income and the integration of households into the cash economy. It may be more fruitful to help people engaged in activities with declining prospects to move into other more rewarding fields of endeavour, rather than seeking to raise their productivity in their current line of work. Support to sustainable types of activity needs to be geared to meet the different needs of those at different points in the enterprise development process (start-up, expansion from a small beginning, further upgrading, etc.). Management of the resource needs to take account of the declining prospects for some of the presently more important products, the likely concentration of demand on a limited number of products of growing commercial value, and the need often to maintain forest resources for their 'buffer' role in times of hardship. The extractors of NTFPs will typically mine the forest products to satisfy household needs or make profit or both. If the interest were in producing for home consumption, the forest extractor would want to obtain the optimum from his/her effort. If on the other hand, the farmer produces for the market, then the cost of production and the returns accruable to his effort become important measure of performance. It is widely held that efficiency is at the heart of agricultural production and the scope of agricultural production can be expanded and sustained by farmers through efficient use of resources. Non-timber forest product (NTFP) literature frequently laments the absence of an information base for policy and management decisions. While formal scientific data on the biological and social ecologies of most NTFPs are limited to nonexistent, long-time gatherers often have extensive experiential knowledge bases. Researchers and managers may overlook this expertise because of assumptions about the nature of knowledge and the identity of individuals who possess valuable information. These assumptions are explored and contrasted to the concept of local knowledge. A case study of gatherers in Michigan's Upper Peninsula found that many possess extensive knowledge of the products they harvest and observe stewardship practices to assure their sustained availability. These rational objectives of production require efficient use of production inputs.

MATERIALS AND METHODS

The study area: The study was conducted in Ondo state, Nigeria. The state has a population of 3,440,000 people (NPC 2006). The number of Local Government Area in the state is eighteen. The state has Akure as its administrative capital. It lies between 4^{o} 30' and 6^{o} 01 East of the Greenwich Meridian and Latitude 5^{o} 45^{1} and 8^{o} 15^{1} North of the equator. The state land mass is about 12,000km^{2} The state, as in all part of Nigeria is with two district seasons, the wet season is between April – October, and the

dry season is November – March. There is 3,075 km2 of land gazette as state forest reserves, made up mainly of high forest and limited savanna and mangrove. Agriculture is the dominant economic activity and main source of employment in the states providing employment and income for more than 75.0 per cent of the population. The people are predominantly farmers, while women engage in food processing and trading in addition to farming.

Sources of Data and sampling procedure: Primary data was collected for the purpose of this study using structured questionnaire. Some of the data collected include: socio economic and demographic characteristics, Non Timber Forest Product (NTFPs) production activities, inputs and outputs and household market shares.

Multistage sampling technique was employed for this study. Three Local Government Areas (LGAs) were randomly selected from eighteen in Ondo state, Nigeria. The LGAs include: Akure North, Odigbo Local Government and Okitipupa Local Government Area. In each LGA, two villages were randomly selected. This was followed by random selection of twenty-two (22) households from each village. In all, a total of one hundred and thirty two (132) NTFP households were interviewed. However, only one hundred and twenty two have meaningful information for analysis.

Analytical Tools: This study employed a number of analytical tools based on the objectives of the study. The tools include: Descriptive statistics, budgetary analysis and stochastic frontier function. (i) Descriptive statistics such as tables, frequencies, mean and percentages

(ii) Budgetary analysis (Gross margin): This was used to estimate the cost and return in Non Timber Forest Products (NTFPs) extraction in the study area. It is given as:

GM = TR-TVC,

Where GM = Gross Margin, TR = Total Revenue and TVC = Total Variable Cost (cost incurred in the use of variable inputs)

$$\text{Gross Ratio} = \frac{\text{Gross Margin}}{\text{Total Revenue}} \quad \text{.....(1)}$$

(iii) Stochastic frontier function: This was used to estimate the resource use efficiency in Non Timber Forest Products (NTFPs) extraction. It is given by:

$\ln Y_i = \ln ß_o + \Sigma\, ß_j \ln X_{ij} + v_i - \mu_i$; ....(2)

Where Yi = Farm output (ton/ha) from farm i; X_i = Vector of farm inputs used. X_1 = Forest area (in hectares); X_2 = Basket/Naira; X_3 = Cutlass/Naira; X_4= Knife/naira; X_5= Bag/Naira; X_6=Rainboot/Naira and X_7= Distance of farm to market cost (km/Naira); v = random variability in the production that cannot be influenced by the NTFPs extractor; μ = deviation from maximum potential output attributable to technical inefficiency. $ß_o$ = intercept; ß = vector of production function parameters to be estimated; i = 1, 2, 3, n farms; j = 1, 2, 3, m inputs. The inefficiency model is:

$\mu_i = \delta_0 + \delta_1 Z_1 + \delta_2 Z_2 + \ldots + \delta_4 Z_4$ ..... (3)

Where, μ_i = technical inefficiency effect of the ith farm; Z_1 = sex of NTFPs extractor (dummy; 1= male, 0 female); Z_2 = age of NTFPs extractor (years); Z_3 = year of formal education of NTFPs extractor (years); Z_4 = marital status of NTFPs extractor (dummy; 1= married, 0= otherwise); Z_5 = household size; Z_6 = experience of NTFPs extractor in years;

δ = parameters to be estimated.

The ß and δ coefficients are un-known parameters to be estimated along with the variance parameters δ_2 and γ. The δ_2, and γ, coefficients are the diagnostic statistics that indicate the relevance of the use of the stochastic production frontier function and the correctness of the assumptions made on the distribution form of the error term. The δ_2 indicates the goodness of fit and the correctness of the distributional form assumed for the composite error term.

The γ, indicates that the systematic influences that are unexplained by the production function are the dominant sources of random errors. The statistical significance of the shows the presence of a one-sided error component, vi, in the model specified. This means that a traditional response function estimated by the ordinary least square cannot adequately represent the data; and the use of a stochastic frontier function estimated by the maximum likelihood estimation procedures is therefore appropriate. The parameters of the models were obtained by the maximum likelihood estimation method using the computer programme, FRONTIER version 4.1.

RESULTS AND DISCUSSION

Table 1 shows the socioeconomic characteristics of NTFPs extractors in the area of study. Majority (59.0 %) of NTFPs extractors in the area are above 40years.The mean age was 45.5±11.2years. This implies that NTFPs extractors in the area are dominated by young and active people. Most of the respondents were married. The implication is that the present economic challenges in Nigeria have made married and poor rural households to engage in all kind of businesses in order to augment their income. In other hand, 51.6% of the farmers had at least six years of compulsory education whereas fewer (2.5%) had over twelve years of formal education. This has implication in there are ability to adopt technology that can improve their efficiency and resource use. Household size was high in the area with an average of about 6.0±1.3 persons per household. Farmers have the tendency to bear as many children as possible in the belief the greater the opportunity to use them as source of family labour.

Table 1: Socio-economic characteristic of NTFPs extractors

Variable	Frequency	%
Sex		
Female	76	62.3
Male	46	37.7
Total	122	100
Age		
< 30	5	4.1
31-40	45	36.9
41-50	40	32.8
51-60	17	13.9
>60	15	12.3
Total	122	100
Mean	45.5	
SD	11.2	
Min	15	
Max	73	
Years of Education (years)		
Less than 5	25	20.5
6	63	51.6
12	31	24.4
Greater than 12	3	2.5
Total	122	100
Mean	6.1	
SD	1.3	
Min	0	
Max	15	
Marital status		
Married	111	90.9
Single	11	9.1
Total	122	100
Household size		
1-3	3	2.4
4-8	90	73.8
Greater than 8	29	23.8
Total	122	100
Mean	6.0	
SD	1.3	
Min	0	
Max	10	

Years of experience (years)		
Less than 5	66	54.1
6-10	31	25.4
Greater than 10	25	20.5
Total	122	100
Mean	4.1	
SD	1.1	
Min	0	
Max	15	

The result of cost and return to wild mango by farmers is shown in Table 2. Olukosi and Erhabor [9] stated that gross margin analysis enables the estimation of the total expenses (costs) as well as various receipts (revenue or returns) within the production period. Table 2 shows that extractors NTFPs incurred an average cost of ₦38,625.78 per hectare; and within the same period they had an average estimated returns of ₦74,729.30. This implies that the farmers made a profit of ₦36,103.52. The Gross Ratio (GR) of the farm was 0.48 which showed that 48% of the gross income went for total cost. A ratio less than 1 is always desirable for any farm business. The lower the ratio, the higher the returns on naira invested [9]. The returns on naira invested in production by the farmers were ₦0.93 that is 93.0%. The NTFPs farmers are therefore encouraged to continue in the business because it is profitable.

Table 2: Cost and Return in NTFPs extraction

Cost item	Average cost (Naira)	Percentage
Labour	18322.04	47.4
Transport	14910.60	38.6
Basket	3106.90	8.0
Cutlass	1429.70	3.7
Knife	600.40	1.6
Bag	256.14	0.6
Rain boot	1200.15	3.1
Total cost	38625.78	100.0
Total variable cost	38625.78	
Total revenue	74729.30	
Gross margin	36103.52	
Return on naira invested	0.93	
Gross Ratio	0.48	

The results of the estimates of the parameters of the stochastic frontier and the inefficiency model are presented in Table 3. The result shows that gamma has a coefficient that is significant. This implies that there is the presence of technical inefficiency in agricultural production among the NTFPs extractors. With an estimated gamma value of 0.99, this study shows that about 99.9% of the variation in the output of the respondents from the frontier is due to their technical inefficiency. The coefficient of forest size was found to be positive and significant at 1% level. This result is in line with the findings from Okike's [10] study of farmers in the savanna zone of Nigeria reported farm size to be significant and positive for the low-population-high-market domain. The result could mean that it is possible to expand farming activity in the study area. It may be possible that competition between infrastructure development and crops for land is not yet keen enough to jeopardize the expansion of agricultural activities. Statistically, the magnitude of the coefficient of farm size shows that output is inelastic to land or farm size. If the farm size is increased by 10%, output level will improve by less than proportionate (by a margin of 0.2%). The coefficient of labor was significant and had a positive sign at 10% level. This shows the importance of labour in NTFPs farming in the study area. Extraction of NTFPs involves the use of traditional farming implements such as hoe and machete. Human power

plays crucial role in virtually all farming activities. This situation has variously been attributed to small and scattered land holding, poverty of the farmers and lack of affordable equipment [11]. It appears that labour will continue to play important role in NTFPs agriculture, affecting its efficiency, until those factors constraining mechanization are addressed.

In the other hand, the coefficients of purchase of knife and rain boot were negative and significantly affected the quantity of wild mango the extractor harvested from forest. The estimates show that the purchases of knife and rain boot are important inputs determining the output of NTFPs extractors. The coefficient of knife is 0.27 indicating that increasing the purchase of knife by 10.0% will lead to increased output of NTFPs by 2.7%. In case of rain boot, increase in purchase led to decrease of in efficiency by 0.4%. However, coefficient of distance from the source of NTFPs to market was negative and significantly related to productive output of extractor. A unit increase in distance from the source to market led to increased productivity of the extractor by 0.4%.

The inefficiency model shows that the coefficients of year of education was positive while age of NTFPs extractor and household size were negative and significantly affected output of NTFPs extracted by farmers in the study area. Level of education is also positively related to technical inefficiency. This implies that there is increased level of technical inefficiency as level of education increases. This is in contrast with the findings of Ferenji and Heidhues [12] and Raphael [13] that education of the household has negative and significant influence on the technical inefficiency of farmers. The reason for this is probably because of the orientation of most people in the country linking education with white collar job. As such, the more educated ones among the extractors may develop inferiority complex which might be responsible for their efficiency in agricultural production.

Table 3: Maximum Likelihood Estimates of the Stochastic Frontier Function and Technical Inefficiency

Variable	Description	Parameter	Coefficient	Standard error	T-statistic
		Stochastic Frontier			
Constant		β_0	1.3824*	0.69954	1.97
Log Land size	Hectare	β_1	0.01605***	0.00517	3.10
Log Basket	Number of Basket purchased	β_2	0.07016	0.09610	0.73
Log Cutlass	Number of cutlass purchased	β_3	-0.11754	0.48051	-0.65
Log Knife	Number of knife purchased	β_4	-0.27329***	0.05122	5.33
Log Bag	Number of bag purchased	β_5	-0.01619	0.03877	-0.41
Log Rainboot	Number of rain boot purchased	β_6	-0.042768**	0.01741	2.45
Log Labour	labour (man-day)	β_7	0.400747*	0.20478	1.95
Log Distance	Distance from forest to market (Km)	β_8	-0.04472***	0.01259	3.55
			Inefficiency parameter		
Constant		Z_0	0.353117	0.51005	0.69
Sex	(male=, 0=female)	Z_1	0.111995	0.74405	0.15
Age	years	Z_2	-0.349721**	0.11736	-2.97
Year of education	years	Z_3	0.02119***	0.00351	6.02
Marital status	(Married=1, 0= other)	Z_4	0.016297	0.01679	0.97
Household size	Continuous	Z_5	-0.330729**	0.11541	-2.86
Year of experience	years	Z_6	-0.13728	0.54947	-0.24
			Varianceparameter		
Sigma-squared (δ^2)			0.51456***	0.16921	3.04
Gamma			0.99999***	0.00017	5743.1

Log likelihood function			-80.0095		
LR test			0.22243		

Table 4 shows that there was a minimum estimated efficiency of 14.5%, maximum efficiency of 99.9% and mean technical efficiency of 51.9%. Even though about 52.0% of the respondents are operating at about 50% level of technical efficiency, the mean value indicates that if the efficiency of input usage is increased by 48.1%, the NTFPs extractors will be operating on the production frontier. Thus, greater opportunity still exists for increasing extractors' productivity and income through increased efficiency in the use of existing farm technology.

Table 4: Farm Specific Resource Efficiency Indices among Farm

Class interval	Frequency	Percentage
0.01-0.19	2	1.6
0.20-0.39	48	39.3
0.40-0.59	19	15.6
0.60-0.79	30	24.6
0.80-1.00	23	18.9
	122	100.0
Mean efficiency = 0.519788	Min = 0.145145	Max = 0.99895

CONCLUSION AND RECOMMENDATIONS

The results obtained in this study showed that NTFPs production is a profitable business in the study area with a net income of ₦36, 103.52. The market for NTFPs also is different from other food crops and is prone to price fluctuations. A Cobb-Douglas production frontier was estimated by maximum likelihood estimation method to obtain ML estimates and inefficiency determinants. The MLE results revealed that TE of extractors varied due to the presence of technical inefficiency effects in NTFPs production. Land size, knife, labour, labour, rain boot and distance from NTFPs source to market were found to be the significant production factors which accounted for changes in the output of extractors. The distribution of the technical efficiency indices revealed that most of the extractors were technically efficient with mean TE index of 0.519 (about 43.5.22% of the farmers had technically efficiency above 59%). The results of the inefficiency model showed that the age, years of education and household size significantly increased the farmers' technical efficiency. This study showed that NTFPs extractors were not fully technically efficient and therefore there is allowance of efficiency improvement by addressing some important policy variables that could negatively and positively influence extractors' levels of technical efficiency in the area

The policy implication of this study is that there is scope for raising the present level of technical efficiency of NTFPs production in the study area given the variation in the levels of technical efficiency i.e. the mean technical efficiency of 0.519 could be increased by 48.0% through better use of available resources. It was shown that education (years of schooling) had a positive relationship with technical efficiency and therefore extractors should be encouraged to improve their levels of education adult literacy programme in the area.

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