THE PROFIT EFFICIENCY OF MORINGA OLEIFERA PRODUCTION IN OSUN STATE, NIGERIA

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Abstract

The Moringa plant has nutritional value and numerous medicinal benefits. However, the profit efficiency of moringa production is yet to be investigated. This study, therefore, investigated the profit efficiency of Moringa oleifera production. A multistage sampling procedure was used for selecting 150 respondents for the study. The data were analyzed using descriptive statistics, budgetary analysis, and stochastic frontier production function. The descriptive statistics revealed that many of the respondents were male (53%), married (85%), and had formal education (87%). The results further revealed average values of 45 years for age, 7 people for household size, and 0.3 ha for farm size. Moringa production had a cost-benefit ratio of ₦5.857, profit margin of ₦0.182, expense structure ratio of ₦0.107, a net return on investment of ₦4.857, rate of return of ₦5.482, and profitability ratio of ₦0.981. Results obtained from the stochastic frontier model showed that moringa farmers had an average profit efficiency of 19% in their production. The empirical results from the frontier model showed that the price of family labour, seed, pesticide, hired labour, and transport significantly influence the profit efficiency of moringa farmers. However, years of education and farm size were the major sources of profit inefficiencies among moringa farmers. This study concludes that Moringa Oleifera production is highly profitable, but producers have been unable to maximize its profit efficiency. Therefore, this study recommended that producers should improve on adding value to moringa products and extend their distribution channels considering the cost incurred on transportation.

Keywords: Profit, Efficiency, Moringa Oleifera, Production, Osun State.

Introduction

Researchers have put in a lot of effort over the years to comprehend and pinpoint the plant's many advantages. Studies discovered that a specific tree had the solutions. One of the most beneficial trees in the world is called the "miracle tree," Moringa oleifera (Mann et al., 2003; Ojo et al., 2016). Almost every component has some sort of beneficial quality or can be used as food. The moringa tree has been used by humans for a variety of purposes, including food, domestic use, animal feed, plant manure, biopesticides, and ornamental plants. Omotesho et al. (2013) claim that because of the moringa tree's edible qualities and evidence of its value for human nutrition and health, people have long ingested it. The drumsticks are mature pods that have had the flesh removed; the fruits are boiled and eaten whole; the young, tender pods, which resemble string beans, are cooked and eaten whole or sliced; and the soft seeds from the immature drumsticks are boiled and eaten like fresh peas (Livestrong, 2012). In some states in northwest Nigeria, moringa producers use both manual and automated methods to extract the oils from the plant and turn it into salad dressings, sauces, soups, teabags, edible powders, juice, and soaps. Moreover, moringa seeds can be used as a flocculant to clear water and as a source of Ben oil, a non-drying and extremely stable oil. This oil, which was once used for lubricating watches and other delicate machinery, is clear, sweet, and odorless, almost never going rancid. It is edible and is becoming increasingly popular in the cosmetics industry. Leaves and young branches are used as fodder. Moringa may also be used in fish and poultry feeds.

Researchers and pharmaceutical corporations are interested in it because of its potential and variety of uses. As a result, the demand for moringa and related products is rising. There is a global demand for moringa, particularly in industrialized nations like the United States and Japan. Just 3.8% and 7.3%, respectively, of the demand for moringa oil in the United States and the European Union, could be satisfied (Bernavides et al., 2008). In order to increase the supply of moringa and satisfy the demand, additional workers must be put on the line. Both local communities and the world market would gain from it. Also, because moringa seed oil is used in the cosmetics industry and is seen as a more affordable alternative source of biodiesel, demand is expected to increase (Animashaun and Toye, 2014). Thankfully, Nigeria has a competitive advantage over other African nations because moringa is only grown in a few countries that are located in tropical and subtropical zones. Tapping into this opportunity, the federal government may produce over $500 billion in annual revenue from moringa and thousands of new jobs (FAO, 2011). Despite this, it is quite unfortunate that the level of moringa production among farmers in Nigeria is generally low (Omotosho et al., 2013). This is a major concern and the factors influencing the low production, have been traced to some socio-economic factors such as age, level of farmer's income, level of education, and so on. However, the rate of moringa production within the country could gradually increase with the idea of profit accruing to its production (Ojo et al., 2016).

However, intending farmers are concerned about the returns of moringa. Asking the question, how efficient is Moringa oleifera in yielding profit? This is because profit is the driving force of any farmer into business (Maudos et al., 2002). Profit is the difference between income and costs. There are essentially two types of profit concepts. These are the earnings in accounting and business. Only explicit costs are taken into account when calculating accounting profit, however, both implicit and explicit costs are taken into account when calculating economic profit (Kolawole, 2006). No matter how practical a business may be, Thompson (2005) and Overton (2007) contend that the question of economic profit should be thoroughly investigated before beginning. But, effective use of the resources at hand is required to achieve maximum profit. The price of inputs is one of the key elements affecting how profitable moringa production is. Efficiency is the comparison of what is actually produced with what can be achieved with the same consumption of resources such as money, time, labor, etc. Since the objective of every moringa producer is to minimize cost production and maximize profit, which conforms to the rule of production economics. Profit efficiency refers to a farmer's capacity to produce with the highest possible profit while spending the least amount possible on fixed production costs and variable inputs (Azeez et al., 2013). Be that as it may, not much effort has been put into investigating the profit efficiency of moringa production. In several kinds of literature, studies have been carried out on the technical efficiency of moringa (Azeez et al., 2013; Tafesse et al., 2020), production performance (Danso-Abbeam et al., 2021), production and marketing (Islam et al., 2021), Profitability of moringa (Ojo et al., 2016). Several studies on moringa have also been conducted in Nigeria, but little focus has been placed on measuring profit efficiency. Based on the above information, this study is motivated by a number of pertinent questions: what are the socio-economic characteristics of moringa producers? What are the costs and returns to moringa production? And what are the factors determining the profit efficiency of Moringa oleifera production?

We proposed a hypothesis that several socio-economic characteristics of moringa producers affect how profitable they are. These qualities are examined in relation to moringa in order to offer a rational perspective based on empirical evidence on the potential costs and benefits of growing Moringa oleifera. Knowledge of these can help shed light on how to lessen poverty and food insecurity in Nigeria. This study is required to add to the body of knowledge on crop profit efficiency studies, particularly those that focus on the production of moringa, with the secondary goal of enhancing the welfare of moringa farmers in Nigeria. Last but not least, it will give government organizations and developmental organizations additional knowledge to improve regulations and assess the profitability of moringa. As a result, the findings would be helpful in formulating appropriate strategies for the increase of moringa production in the region and the economy as a whole. The results would also offer pertinent information for more research on moringa production.

Materials and methods

Area of study

This study was carried out in Osun State, an inland State in the Southwestern geopolitical zone of Nigeria. It lies between longitude 4^{0}N and 5^{o} E and latitude 7^{0}N and 8 ^{o} N. Osun State is located in the Tropical western region of Nigeria. It is bounded in the north by Kwara State, in the east partly by Ekiti State and partly by Ondo State, in the south by Ogun State, and in the west by Oyo State. According to the 2006 census reports by National Population Commission in Nigeria, the population of Osun State stood at about 4.14 million consisting of the Yoruba ethnic group. The State has two distinct climatic seasons. The State experience raining season, with about three months of the dry season. The wet season commences from April to October, and the dry season operates between November and March (Oluwasola et al., 2016). Osun state has natural vegetation comprised of moist evergreen and semi-evergreen forests and secondary forests, with mean annual rainfall ranging between 1400 to 2000mm. Mean annual temperature ranges between 26^{o}c to 27°c. The state's soil and climatic condition are suitable for cultivating a wide range of crops. The State was selected because farming is predominant in this area, and they major in the production of permanent crops.

Sampling procedure

Primary data were used for this study. Following Ojo et al. (2016), the multi-stage sampling procedure was used to select respondents for the study. In the first stage, five Local Government Areas (LGAs) were purposively selected based on the predominance of moringa farmers in the LGAs. In the second stage, two villages were randomly selected from each LGA. In the third stage, 15 moringa producers were randomly selected in each village. A total of 150 respondents were interviewed.

Analytical techniques

The study employed descriptive statistics, farm budgetary technique, and the Stochastic frontier model to analyze the data collected.

Descriptive statistics

Descriptive statistics such as frequency, percentage, and mean were used to describe the socio-economic characteristics of moringa producers in the study area.

Budgetary analysis

Budgetary analysis was used to estimate the cost and return on the moringa enterprise. Basically, it involves the estimation of total revenue and total cost from the same production period. The difference between the two parameters is the measure of net profit or net return for that period.

The technique is expressed as:

$$TC = TFC + TVC \qquad (1)$$

$$TR = P \times Q \qquad (2)$$

$$GM = TR - TVC \qquad (3)$$

$$\pi = GM - TFC \qquad (4)$$

$$\pi = TR - TC \qquad (5)$$

Where π = profit on moringa production; TR = Total Revenue; TFC = Total fixed cost; TVC = Total Variable Cost; TC = Total Cost; GM = Gross Margin

Gross margin analysis

Gross margin analysis is the difference between gross farm income and total variable cost (Mohammed et al., 2011). Normally, it is used to determine the potential profitability (Samm, 2009; Kehinde, 2021).

The gross margin analysis was estimated from costs and returns in moringa production.

Following Mohammed *et al*. (2011), Adeyemo et al. (2020), Kehinde (2021), and Oluponna et al. (2022), the gross margin model is expressed as follows:

$$GM = TR - TVC \qquad (6)$$

Where; GM = Gross margin (₦/ha); TR = Total revenue or the total value of output from the moringa enterprise (₦/ha). It is the product of the average output per hectare multiplied by the market price. The price used was the market price of the year 2017; TVC = Total variable cost or the cost used up in producing moringa (N/ha). This includes the cost of inputs such as seed cost, agrochemicals (herbicides and insecticides), labour cost (family labour and hired labour), and other miscellaneous expenses.

The formula is given as: $$GM_i = \sum_{i=1}^{n} P_i Y_i - C_i \qquad (7)$$

Where;

GM_i = Gross margin of producer per hectare I; P_i = price per kg of moringa leaf and seed of producer I; Y_i = Total quantity in kg of moringa leaf and seed of producer I; C_i = Total variable costs incurred on producer I; i…n = Total number of moringa producers

Subsequently, a net return was obtained from the gross margin.

$$\text{Net returns} = GM - TFC \qquad (8)$$

where,

TFC = Total fixed cost

Profitability and efficiency ratio

The following ratios were calculated to understand how profitable moringa production is.

Operating expense ratio = TVC/GR (9)

Net return on investment/Return Per Naira outlay = NI/TC (10)

Benefit Cost Ratio (BCR) = TR/TC (11)

Expense Structure Ratio = TFC/TVC (12)

Profitability Index or profit margin = NI/GR (13)

Where,

GR is Gross Revenue; NI is Net Income; TC is Total Cost

Stochastic frontier production function

Theoretical model

The Stochastic frontier approach (SFA) was used to determine the profit efficiency of Moringa oleifera production and the factors affecting profit efficiency in moringa production. The frontier production function shows the maximum amount of output obtained from the given inputs, thus representing maximum efficiency (Tijani, 2006; Kehinde and Olatidoye, 2019). This method is still the most widely used for estimating efficiency, and more especially, profit efficiency (Akite et al., 2022). It has been extensively utilized in determining how profitable a crop grower is (Saysay et al., 2016; Wongnaa et al., 2019; Jonah et al., 2020). SFA is helpful since it has two error components that are cumulative in nature and enables hypothesis testing. One element of the error takes into consideration the statistical noise connected to data measurements, while the other element measures departures from the frontier connected to production inefficiency. So, a producer's incentive for operating at the frontier is profit efficiency (Akite et al., 2022). On the other hand, a profit frontier is the highest possible profit function (le et al., 2020). The stochastic profit technique also takes into account the fact that any mistakes made when making production decisions result in lower sales or profits for the company. The profit lost from failing to operate on the frontier would be referred to in this context as profit inefficiency, which can then be expressed as a linear function of the explanatory variables describing farm characteristics (Battese and Coelli, 1995). This approach was chosen for estimating profit efficiency because of its ability to estimate farm-specific efficiency levels and sources of inefficiency in a single-step procedure using the Maximum Likelihood Estimation (MLE) method. The stochastic profit frontier model is therefore specified as:

$$\pi_i = f\left(p_{ij}, Z_{kj}\right) Exp. e_i \qquad (14)$$

Where,

π_i= normalized profit of the j^{th} farm calculation as gross revenue minus the variable inputs divided by farm-specific output price, p

p_{ij}= price of j^{th} variable input encountered by the i^{th} farm divided by the out price

Z_{kj}= level of the k^{th} fixed factor in the i^{th} farm

e_i=error term

$i \dots \dots . n$=number of farmers in the sample

Furthermore, Rahman (2003) postulated that the error term behaves consistently with the frontier concept and is composed of two random parts as specified in equation (15).

$$e_i = V_i - U_i \quad (15)$$

V_i= symmetric error term presumed to be independently and identically distributed, it is two-sided in nature representing random effects, measurement errors, and statistical noise.

U_i=one-sided error term representing the inefficiency of the farm.

The inefficiency *Ui* is thus expressed as in equation (16).

$$U_i = \delta_0 + \sum \delta_1 z_{di} \quad (16)$$

z_{di}= (1 x m) vector of farm-specific variables varying across respondents and not over time.

δ_0= (m x 1) vector of unknown coefficients of farm-specific variables.

The inefficiency *Ui* is non-negative demonstrating a profit deficit from its maximum possible value that will be provided by the stochastic frontier. Since the MLE method was employed in estimating stochastic profit frontier and inefficiencies simultaneously, it is thus expressed in variance parameters as in equations (17) and (18)

$$\sigma^2 = \sigma_v^2 + \sigma_\mu^2 \quad (17)$$

$$\gamma = \frac{\sigma_\mu^2}{\sigma_\mu^2} + \sigma_v^2 \quad (18)$$

Empirical model

The explicit Cobb-Douglas functional form for the moringa farmers in the study area is therefore specified as follows:

$$\ln\pi i = \ln\beta_0 + \ln\beta_1 X_{1i} + \ln\beta_2 X_{2i} + \ln\beta_3 X_{3i} + \ln\beta_4 X_{4i} + \ln\beta_5 X_{5i} + (Vi\text{-}Ui) \quad (19)$$

Where

πi = normalized profit computed as total revenue less variable cost divided by firm-specific moringa price; X_1 = cost of family labour; X_2 = cost of hired labour; X_3 = transport cost; X_4 = seed cost; X_5 = pesticide cost

Inefficiency model

The inefficiency model (**Ui)** is defined as

$$Ui = \delta_0 + \delta_1 W_1 i + \delta_2 W_2 i + \delta_3 W_3 i + \delta_4 W_4 i + \delta_5 W_5 i + \delta_6 W_6 i + \delta_7 W_7 i + \zeta i \quad (20)$$

Where W_i is the socioeconomic variables included in the model to indicate their possible influence on the profit efficiencies of the moringa farmers (determinant of profit efficiency).

Where,

W_1 = Gender; W_2 = Age; W_3 = Level of education; W_4 = Household size; W_5 = Moringa farming experience; W_6 = Moringa farm size; W_7 = Record keeping (dummy variable)

Results and Discussion

Socio-economic characteristics of moringa farmers

The socioeconomic characteristics of the respondents were presented in Table 1. About 55.3% of moringa producers were male. This shows that in the study area, moringa production is predominantly a male-dominated enterprise. The average age of the respondent was 44.92 (±13.68) years. This is an indication that moringa production is mainly done by young people who are active and within their productive age group. This corresponds to the findings of Nenna, (2016). The majority (85.3%) of respondents were married. This shows that most of the respondents are responsible for their families. This conforms with Azeez et al. (2013). Most (86.7%) of the respondent were educated. This implies that the farmers tend to embrace a new innovation or technology that will improve their efficiency and the use of resources (Adewuyi et al., 2013). All the sampled producers had an average farm size of 0.30 (±0.08) hectares. It implies that the study area is dominated by small-scale farmers. The majority (80.7%) of respondents operate moringa on a part-time basis. This suggests that most respondents do not fully concentrate on moringa production. The majority (86.7%) of respondents' financial capital source is from personal savings. It also suggests that producers may face financial constraints by not having easy access to other sources of funds, such as a bank. The average farming experience was 19.93 (±13.15) years. This suggests that the farmers have many years of farming experience. The majority (67.3%) of respondents had access to extension services This implies information about new technologies in cocoa production will be properly disseminated among the farmers. This could be ascribed to the fact that extension services keep farmers abreast of new farm technologies (Alao et al., 2020; Adeyemo et al., 2020). The mean household size of about 7.00 (±3.09). This implies that households are excessively large, which could serve as a cheap source of farm labour for the farmers (Anigbogu et al., 2015).

Table 1: Socio-economic Characteristics of Moringa Farmers

Variables	Moringa Farmers
Age (years)	44.92(±13.68)
Male (%)	55.3
Married (%)	85.3
Formal education (%)	86.7
Household size (#)	7.00 (±3.08)
Personal saving	86.7
Farm size (ha)	0.30(±0.08)
Formal education (%)	86.7
Years of farming experience	19.93(±13.15)
Extension visit (%)	67.3
Part-time (%)	80.7

Source: Field survey, 2017

Profitability of moringa enterprise

Table 2 presents the profitability of the moringa enterprise. However, the total cost (TC) was determined by the addition of both the variable cost and the fixed cost, and it summed up to ₦55,709.0471. The variable cost took the larger percentage of about 90.4% of the total cost incurred in moringa production, while the fixed cost calculated using the depreciated value was 9.63% of the total cost. In addition, of all the various costs incurred in production, hired labour took the largest percentage which accounted for about 48.35% of the total cost. This confirms that

Moringa oleifera production is an employer of labour as stated by Ojo et al. (2016). The mean depreciated value of ₦807.87 spent on processing equipment was 1.48% of the total cost. This is an indication that most producers of moringa spend less on processing. This could imply that most farmers are reluctant to add value to Moringa oleifera production. About 3.67% of the total cost was spent on the seed. This low percentage was attributed to the fact that most moringa producers in Osun State received free improved seeds from non-governmental agricultural agencies such as Youth Initiative for Sustainable Agriculture, Women Farmers Advancement Network, and OFFER centre in Iwo, Osun State, among others. Pesticide application was 4.11% of the total cost, which signifies that producers do not commonly apply pesticides or do not apply them in large quantities. The cost incurred on using capital signifies the cost spent in running capital equipment on the farm. This includes fueling, leasing, repair of damages, etc. This cost takes about 19.49% of the total cost This is an indication that moringa oleifera production is labour intensive, not capital-intensive. The average gross margin realized was ₦275,958.819. An average Net farm income (NFI) value of ₦270,591.2529 was realized in the study area. A positive NFI shows that an enterprise is profitable and worth continuous execution. Since the net profit of moringa production was positive, therefore producers generate profit and should continuously involve themselves in its production.

Table 2: Budgetary Analysis of Moringa oleifera production in Osun State, Nigeria.

S/N	ITEM	MEAN AMOUNT (₦)	PERCENTAGE
A	**Total Revenue**	**326,300.3**	
	Variable cost		
	Family labour	5,110.667	9.17
	Hired labour	26,938	48.35
	Transport cost	3,095.667	5.56
	Seed cost	2045.147	3.67
	Pesticide	2,292	4.11
	Cost incurred on the use of capital	10,860	19.49
B	**Total Variable Cost/ha (TVC)**	**50,341.481**	**90.37**
C	**Gross margin (TR-TVC)**	**275,958.819**	
	Fixed cost		
	Rent on land	3,941.747	7.08
	Depreciated value on implement	617.9524	1.11
	Depreciated value of processing equipment	807.8667	1.45
D	**Total fixed cost**	**5,367.5661**	**9.63**
E	Total Cost/ha (TC) = (TFC+TVC)	55,709.0471	
F	**Net Income (NI) = (GM-TFC)**	**270,591.2529**	

Source: Field survey, 2017; Notes: ₦ = Naira (Nigerian currency)

As shown in Table 3, the return to moringa production in Osun State was approximately ₦5.48 which is greater than 1, and the benefit-cost ratio was ₦5.857. This shows that the moringa enterprise in the study area is well managed. The study further suggests that the business of moringa production is viable and profitable. This is in line with the study carried out by Ojo et al.

(2016). Moringa producers operate at a profit margin of 82.9% in Osun State. This indicates that for every ₦1 income received, ₦0.829 of profit is generated. The net return on investment of the enterprise was ₦4.86. This indicates that for every ₦1 spent on total cost, ₦4.86 is generated as profit. This shows that moringa production has a huge return on investment. The operating expenses ratio was 0.182. This indicates that for every ₦1 received from the gross margin, ₦0.182 was spent on total variable cost. The enterprise expense ratio was 0.1066. This ratio indicates that there is less fixed cost than variable cost. The profitability index for this enterprise was ₦0.98. This confirms that moringa production is a profitable venture in Osun state.

Table 3: Profitability ratios estimated in Moringa oleifera production in Osun State.

S/N	Profitability ratios	Calculated value
1	Benefit-cost ratio	5.857
2	Profit margin	0.829 (82.9%)
3	Operating expense ratio	0.182
4	Expense structure ratio	0.107
5	Net return on investment	4.857
6	Rate of return	5.482
7	Profitability index	0.981

Source: Field survey, 2017; Notes: ₦ = Naira (Nigerian currency)

Stochastic frontier production function

The results of the estimates of the parameters of the stochastic frontier and the inefficiency model are presented in Table 4. The coefficient of the gamma parameter (γ) of 0.99 was significant at a 1 percent level of significance. The sigma squared *δ2* indicates the goodness of fit and correctness of the distributional form assumed for the composite error term, while the gamma *γ* indicates that the systematic influences are unexplained by the production. The mean profit efficiency was 18.73%. It implies that, on average, the respondents were able to obtain just 18.73% of the optimal profit from a given set of inputs. This indicates that most farmers are relatively too low in maximizing profit efficiency. In other words, about 81 % of the profit is lost to the inefficiency of management. This suggests that a sizeable portion of the earnings from moringa production in Osun State is wasted due to profit inefficiencies at the current input prices and technological levels. Hence, there is potential to increase profit from moringa production by 81% in the short run. The mean profit efficiency level obtained in this study was much lower than the levels reported by Okorie et al. (2021) for Nigerian cassava farmers (73%), Wongnaa et al. (2019) for Ghanaian maize farmers (48%), and Akite et al. (2022) for Ugandan smallholder rice farmers (65%).

The efficiency model revealed that the coefficient of hired labour (0.174) has a positive sign and is statistically significant at 1% profit efficiency. An increase in the cost of hired labour by ₦1 would increase the farm's profit efficiency by 17.4%. The coefficient of family labour (0.062) also has a positive sign and is statistically significant at 1% profit efficiency. An increase in the cost of family labour by ₦1 would increase the farm's profit efficiency by 6.2%. This conforms with the findings of Ojo et al., (2016). This could be because increasing labour rate would encourage more labour to work in moringa production and marketing activities thus reducing losses from postharvest and weeds. Availability of family and hired labour, therefore, plays a censorious role in achieving profit efficiency. The price of Seeds and pesticides have a negative sign and are statistically significant at 1% and 5% respectively. The coefficient of seed cost was -0.159. This negative sign conforms with the expected negative sign and was significant at 1% level. This could be related to the upsurge in costs brought about by increased prices because seed costs account for a significant part of moringa production. However, transportation cost showed a positive effect on profit efficiency at a 1% level of significance. It was found that an increase in transportation cost by ₦1 would increase the farm's profit efficiency by 7.9%.

The inefficiency model revealed that the level of education and farm size are the inefficiency variables that have significant effects on the level of profit inefficiency. The level of education has a coefficient of -1.404, it has a negative sign and is statistically significant at 1%. This suggests that the level of education of the producers is a major constraint in moringa production. More education brings about a decrease in inefficiency and as such increases profit efficiency. This however conforms with Ezeh et al., (2012). The consequence is that having completed many years of education facilitates learning about new technology and developments that may increase the profitability of moringa farmers (Okon et al., 2010; Okorie et al., 2021). Thus, extension programmes should be used to fill the gaps in education among the farmers. Moringa farm size has a coefficient of -1.404 which is also negative but statistically significant at 10%. This implies that as the farm size increases, profit efficiency increases. Increased farm size may have encouraged the employment of contemporary technology, resulting in greater efficiency benefits. This conforms with Oyebanjo et al., (2021).

Table 4: Maximum Likelihood estimates of the stochastic frontier function and profit efficiency.

Variable	Parameters	Coefficient	Standard Error	T-ratio
Constant	Beta 0	5.812	0.465	12.492***
Family labour	Beta 1	0.062	0.026	2.385**
Hired labour	Beta 2	0.174	0.030	5.882***
Transport cost	Beta 3	0.079	0.025	3.189***
Seed cost	Beta 4	-0.159	0.052	-3.052***
Pesticide	Beta 5	-0.094	0.038	-2.466**
Constant	Delta 0	7.251	2.088	3.474***
Gender	Delta 1	0.767	0.846	0.906
Age	Delta 2	-0.047	0.032	-1.469
Level of education	Delta 3	-1.404	0.453	-3.098***
Household size	Delta 4	0.193	0.144	1.338
Moringa farming experience	Delta 5	-0.202	0.192	-1.048

Moringa farm size	Delta 6	-1.814	1.015	-1.788*
Record keeping	Delta 7	-1.351	0.951	-1.421
Sigma-squared		5.649	1.553	3.638***
Gamma		**0.99999999**	**0.00000755**	**132458.900*** **
Mean technical efficiency	**18.73**			
Log likelihood function	**-286.76843**			
LR test	**70.840005**			

Source: Field survey, 2017 ***, ** and * shows statistical significance at 1%, 5% and 10%

Notes: ₦ = Naira (Nigerian currency)

Conclusion and recommendations

This study investigated the profit efficiency of Moringa oleifera production. A multistage sampling procedure was used for selecting 150 respondents for the study. The data were analyzed using descriptive statistics, budgetary analysis, and stochastic frontier production function. The descriptive statistics revealed that many of the respondents were male (53%), married (85%), and had formal education (87%). The results further revealed average values of 45 years for age, 7 people for household size, and 0.3 ha for farm size. Moringa production had a cost-benefit ratio of ₦5.857, profit margin of ₦0.182, expense structure ratio of ₦0.107, a net return on investment of ₦4.857, rate of return of ₦5.482, and profitability ratio of ₦0.981. Results obtained from the stochastic frontier model showed that moringa farmers had an average profit efficiency of 19% in their production. The empirical results from the frontier model showed that the price of family labour, seed, pesticides, hired labour, and transport costs significantly influence the profit efficiency of moringa farmers. However, years of education, and farm size were the major sources of profit inefficiencies among moringa farmers. This study concluded that moringa producers in Osun State were profit inefficient, despite the high returns to moringa production. The findings further revealed that the level of education and farm size influenced the profit efficiency of moringa production. Based on the finding of the result, the study concluded by inferring from the results obtained that there is scope for increasing the profitability of moringa production in the study area by directing policy focus on the significant inefficiency factors. It was recommended that attempts at improving farm incomes need to look at enhancing the value of family and hired labour to achieve significant positive effects on moringa profits. Also, Channels of distribution need to be enhanced beyond local communities and extend to other States as well as other countries through exportation. This should be done in an attempt to improve transportation costs because of its positive and significant effect on moringa production. Finally, training should be provided to less educated farmers to enable them to adopt the best moringa farming practices and adopt innovative ideas in processing in order to add value to moringa. Moringa farmers in the study area should register in adult education centers to improve their efficiency. The same study should be encouraged in other zones of the country. A study should be conducted on the impact of profit efficiency on the welfare of moringa farmers in the area.

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