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Research Article

Determinants of Profit Inefficiency of Soybean Producers in Niger State, Nigeria

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Abstract
This research work examined the determinants of profit inefficiency of soybean producers in Niger State of Nigeria. Multi-stage sampling method was used to sample 216 respondents for this research work. Primary data were taken on cost and return and determinants of profit inefficiency of soybean producers with the use of a questionnaire. The data collected were analyzed with cost and return analysis, stochastic profit frontier and profit inefficiency (SFPF) model. The gross margin was found to be ₦859,376.55 and profit efficiencies of soybean producers in the study area varied from 11.0% to 100.0% with a mean value of 80.4%. Farmland and seed affected soybean profit positively while herbicide and labour affected soybean profit negatively. Producers' age and access to credit facilities were the major determinants of profit inefficiency. This study concluded that soybean farmers in the area of study were profit-inefficient in soybean production. The study recommended that adult and extension education, workshops and seminars should be encouraged and made free among soybean farmers and those Young and experienced farmers should be encouraged to engage in soybean production by providing basic incentives such as credit facilities at a low interest rate to increase the profit efficiency of producers.

Keywords: *Cost, Return, Gross Margin, Profit Efficiency, Profit Inefficiency, Stochastic profit frontier.*

Introduction
Soybean (*Glycine max*) is an important cash crop which has the potential to lower and completely eradicate rural poverty level due to its importance, benefits and versatile nature, (Osman et al 2018). Soybean seed is highly rich in oil and protein composition (Patil et al 2017), and that is why it is a major food security crop to farmers (Amesimeku et al 2021). It is a multipurpose crop from which many products can be processed like soybean "dadawa", soybean oil, soy sauce, livestock feed, soybean milk, soybean "fufu'', and baby foods, such as, Nutrend, Babeena ,Golden morn, and Cerelac are derived (Biam et al 2016). Soybean is the third major food crop in Nigeria because of its importance as a source of protein for vegetarian, raw materials for livestock feed industries (Farikin et al., 2016). As population grows, the need for soybean crop keeps rising yearly as animal feed, foodstuff, and as raw material of food industry (Kuntariningsih and Mariyono, 2013). Soybean is a major crop that falls into the category of important commodities (Muslim and Darwis, 2012). Global production of soybean was over 250MMT in 2010, which rises at a Compound Annual Growth Rate (CAGR) of about 4.35% between 1991 and 2010 (FAOSTAT, 2018). Adekunle et al, (2003) in their study observed that soybean world production acclaimed Nigeria as the second biggest producer of soybean in Africa while Zimbabwe is the first and also, amazingly, rated Nigeria as a protein insufficient nation (Okuneye, 2002).

Profit efficiency is the ability of a farm to attain highest profit possible given the prices of variable inputs and fixed factors of the farm while on the other hand, profit inefficiency is the loss of profit

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for not operating on the frontier (Ali and Finn, 1989). It is when a farm fails to attain highest possible profit given the prices of variable inputs and levels of fixed factors of the farm.

Phuc and Orachos (2015) in their study of profit inefficiency among hybrid rice farmers in Central Vietnam using stochastic frontier analysis method with a stochastic trans-log normalized profit frontier function observed that the average profit efficiency was 0.63, implying 0.37 profit inefficiency. The research found that age, education, irrigation, share of rice income, share of hybrid rice area, frequency of training attendance, experience, and topography are robust factors contributing to profit inefficiency. They further suggested that to enhance farmers' profit efficiency, policies to improve educational level, increase training about production, improve irrigation system, and promote hybrid rice intensive production should be reinforced.

Yahaya *et al*., (2016) analyzed profit efficiency among paddy households in Malaysia, they found profit efficiencies of producers to vary between 30.5% and 94.8%, with a mean of 73.2%, suggesting that an estimated 26.8% of the profit is lost due to a combination of technical and allocative inefficiencies in paddy production. The variation in the actual profit from the maximum profit (frontier profit) among the farms was mainly due to the differences in farmers` production practices and socio-economic characteristics rather than random variability. These include: credit, education, farming experience, extension service, MR219 seed variety, broadcast planting method, machine broadcasting method and herbicides.

Fadil and Mitsuyasu (2012), studied "profit efficiency of rice producers in Brunei Darussalam" made use of stochastic profit frontier and inefficiency effect approach to analyze profit efficiency. The mean efficiency score was found to be 80.7 percent and the remaining 19.3 percent of profit is lost due to a combination of technical, allocative and scale efficiencies. The factors responsible for inefficiency were non-membership of cooperative, lack of training, low yield variety and no irrigation.

Also, Ogunniyi (2011) in a study on "profit efficiency among maize producers in Oyo State, Nigeria," used stochastic profit frontier function to measure profit efficiency among producers and found the mean profit efficiency of farmers to be 41.4% suggesting that 58.6% profit is lost. The study suggested improvement in level of education to attain profit efficiency which indicates that farmers with more years of schooling incur significantly higher profit efficiency than farmers with less years of schooling. These results are consistent with Abdulai and Huffman (2000). It found that respondents with farming experience are better performers than those without.

Dedi (2017) in his study on the determinant factors of technical inefficiency of Soybean Farming in Pangandaran Regency showed that seed and labor have positive and significant effect on soybean production, while chemical fertilizer and organic fertilizer have negative and significant effect on soybean production. The study further submits that land and insecticide have no significant effect on soybean production.
Hyuha *et al*., (2007) found that rice farmers in Eastern and northern Uganda do not operate on the profit frontier. Major causes of inefficiency are low levels of education and limited access to extension services.

Ogundari (2006) investigated factors that determine the profit efficiency among small-scale rice farmers in Nigeria. The results showed that their profit efficiency were positively influenced by age, educational level, farming experience and household size. Dedi (2017) study revealed that age, experience and family size are the major factors affecting the level of technical inefficiency, Job and Salihu (2013) found out that profit inefficiency is caused by factors such as education, farming experience, extension contact and sex of the respondents.

For Nigeria to attain profit efficiency in soybean production, it is important to carry out research on factors causing profit inefficiency. If soybean production resources are well managed, the yield of soybean should be between 2.0 - 2.5 tons/ha in Niger State (NAMDA, 2018). However, Low yield of less than 1ton/ha in Nigeria and

inadequate fertilizer supply constrain the capability of some countries to increase their soybean production. (IITA, 2015). Yield in soybean production fluctuates as a result of inefficient use of resources while soybean demand in the market tends to increase (Setiawan and Bowo, 2017). This study seeks to conduct analysis on the determinants of profit inefficiency of soybean producers in Niger State, Nigeria and specifically it will determine the profit level of soybean producers, determine the profit efficiency of soybean producers and analyze the determinants of profit inefficiency of soybean producers in Niger State.

To achieve productivity improvement in soybean production, good knowledge of the current efficiency or inefficiency as well as factors responsible for the level of inefficiency must be critically examined. An understanding of soybean production enterprise would provide policy makers with information to design appropriate intervention measures for efficient soybean production. Also, the result of this study would serve as a reference for researchers to embark upon similar or related work in the nearest future.
This research work attempts to contribute to profit efficiency in soybean production by helping farmers, traders, investors and others who need the information for their purpose of decision making and also provide useful information that could be used to formulate production development programs. It would also afford producers, marketers and consumers the opportunity to optimize utilities offered by the crop and as well ensure sustainability which will promote farmers profit by identifying and eliminating existing inefficiency to ensure optimum resource allocation.

Materials and Methods

Sampling Technique and Sample Size: Multi stage sampling method was used to select 216 soybean producers for this study. NAMDA zone 1 was selected due to the dominance in soybean production in the area and simple random sampling technique was used to select three (3) extension blocks from which 3 extension cells were selected to give 9 cells, 3 villages were selected from each extension cell to give in total 27 villages and in the final stage, 8 soybean farmers were sampled randomly from each of the selected villages to give a total of 216 soybean producers for the study.

Methods of Data Analysis: The analytical methods used in this study includes: Gross margin analysis, Stochastic Frontier Profit Function and Inefficiency function.

Gross margin analysis: Gross margin analysis was used to determine the relationship between cost and revenue in other to assess profit level of soybean producers in the study area. In line with (Olugbenga et al, 2020) the equation to analyze the costs, returns, and profitability is given by:

GM = TR – TVC…… (1)

Where:
GM = Gross Margin
TR = Total Revenue (quantity of soybean produced multiplied by prevailing price)
TVC = Total Variable Cost (cost of: seed, fertilizer, herbicide and labour)

Stochastic frontier profit function: Stochastic frontier profit function of Cobb-Douglas functional form was used to analyze the profit efficiency of soybean producers in the study area. The frontier model in line with (Sunday et al., 2013) is given as:

$$ln\Pi_i^* = \beta o + \sum_{j=1}^{5} \beta_j ln X_j^* + v_i - u_i \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Where:
Π^*_i= Normalized Profit for ith farm, computed as gross revenue minus variable cost divided by soybean price (dependent variable),
ln = natural log,
X_j = 1, 2, 3,……5.
X^*_1= cost of soybean seed (₦/kg)
X^*_2= cost of fertilizer (₦/kg)
X^*_3= cost of hired labour (₦/manday)
X^*_4= cost of herbicides (₦/lt)
X^*_5 = area of land cultivated for soybean (₦/ha),
β_o, $\beta_{1\text{-}5}$ are parameters to be estimated,
v_i represents statistical disturbance term and
u_i represents profit inefficiency effects of ith farmer. It is a non-negative random variable assumed to be independently, identically and normally distributed $\{ui\ [N|(0, \sigma u2)]\}$, it is independent of vi. Also, the technical inefficiency effects in the stochastic frontier are expressed in

terms of all explanatory variables related to farm and farmers related socio-economic factors.

Stochastic frontier profit function and inefficiency model: The determinants of profit inefficiency of soybean producers in line with (Ogunniyi, 2011) were modeled following the specific factors of farmers in the study area.

When $U_i = 0$, it means that the soybean producer is technically efficient. However, when $U_i > 0$ soybean producer is inefficient since the profit level will lie below the profit frontier.

The component is specified as follows:

$$\mu i = \lambda o + \sum_{r=1}^{13} \lambda r Wr + k \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

Where:

μ_i= Profit inefficiency of ith farmer, (dependent variable)

λ_o and λ_r are parameters to be estimated,

W_r are variables explaining inefficiency effects, r =1,2,3....,13,

k is truncated random variable,

W_1= Soybean producer`s age (years),

W_2 = Level of education of soybean producer (years),

W_3= Marital status of soybean producer (married= 1, otherwise =0),

W_4= Household size of soybean producer (number),

W_5= Farming experience of soybean producer (years),

W_6= Access to extension contact (yes= 1, no =0),

W_7= Quality of soybean seed (viable= 1, not viable =0)

W_8= Soybean planting method (broadcasting = 1, drilling = 0),

W_9= Agrochemical usage (used = 1, not used = 0)

W_{10}=Tractor usage (yes = 1, no = 0)

W_{11}= Off-farm employment of soybean producer (yes= 1, no =0)

W_{12}= Membership of cooperative of soybean producer (yes=1, no=0)

W_{13}= Credit access by soybean producer (yes=1, no=0)

Results and Discussions

Profit level of respondents: The cost and return of soybean production in the study area is summarized in table 1. Result showed the mean total variable cost (TVC) of ₦157,774.45. The average cost used on seed, fertilizer, herbicide and labour are ₦33,822.74, ₦20,006.05, ₦3,485.26 and 100,460.40 respectively. The mean total revenue (TR) is ₦1,017,151.00. The gross margin was found to be ₦859,376.55 which shows a high profit level in the study area. This is similar to the findings of (Olugbenga et al, 2020) that had a gross margin of 68,509.40.

Maximum likelihood Estimates of Profit Function of Soybean Producers: Using Cobb-Douglas Stochastic Frontier Production Function (SFPF), the result of the Maximum Likelihood Estimates (MLE) of the variables of the of Soybean producers is shown on table 2. The statistics showed that the estimated sigma-squared (δ^2) and gamma (γ) were 57.195 ($\rho < 0.01$) and 0.996 ($\rho < 0.01$), respectively. The sigma-squared confirms the goodness of fit and accuracy of the specified distributional form assumed for the composite error term. The observed significance of δ^2 conforms to earlier findings of (Ojo et al., 2009). The estimated gamma parameter (γ) of 0.996 implies that 99.6 percent of deviation in actual profit from maximum profit (profit frontier) between farms is mainly due to the differences in farmers' practices in place random variability.

Seed had a positive coefficient and it is significant at 1%, implying that a percentage increase in cost of incurring seed will increase soybean farm profit by 0.553%. The positive coefficient and level of significance is in line with the findings of (Biam et al 2016). The coefficient of farm land revealed that 1% increase in the size of farm cultivated with soybean would increase farm profit of soybean by 1.083. This result conforms with the findings of Arifalo and Ayilaran (2011), that land is a significant variable in the production of crops. Fertilizer has a positive influence on soybean farm profit. This is in line with *apriori* expectation. This means that for a 1% increase in the cost incurred through fertilizer procurement, the profit gotten from soybean production will increase by 0.819%. This is in line with the findings of Oladeebo and Oluwaranti (2012), that a positive relationship between fertilizer application and soybean production at 1% level of significance. Herbicide and Labour has a negative coefficient which is significant at 5% with a coefficient of 0.752 and0.167 percent respectively. The result

revealed that continuous increase in the cost used for herbicide and labour will lead to the reduction in farm level profit of soybean farmers in the study area.

Determinants of Profit Inefficiency of Soybean Producers: The factors affecting inefficiency of the soybean producers are presented on table 3. The negative signs of the variables indicate that as the variables raises, the profit inefficiency of soybean farmers reduces while the coefficients with positive signs implies that as these variables rises, the profit inefficiency of soybean producer rises as well. Farmers' age and access to credit inversely affected the profit inefficiency of soybean farmers at 5% level of significance while level of education is at 10% level of significance. This means that as these variables increase, profit inefficiency reduces. Soybean farmers' age has a negative coefficient and is significant at 5%. This implies that as farmers age rises, profit inefficiency reduces, which is in line with *apriori* expectation. This shows that older farmers were more profit efficient than the younger ones. This result is in line with the findings by Sudrajat and Yusuf (2017). Age plays a major role in making quality decisions and contributes towards learning and sense of correct judgment. If farmers' age increases, then profit inefficiency will decrease, this may be due to management practices of farmers (Ali and Jan, 2017), leading to increased profit efficiency. Level of educational attainment has a negative coefficient and is significant at 1% indicating reduction in profit inefficiency due to increased years of education. This implies that education and literacydecreases profit inefficiency (increase in efficiency) in soybean production. These results are similar to Yahaya et al. (2016) who reported a negative relationship also.

Having access to credit help farmers to purchase tools and inputs such as seed, farm implements, and also used to hire more labors for different activities. Access to credit is expected to help with the acquisition of inputs, reduce financial constraints, and improve revenue and profits. Result of the study shows that access to credit facilities had a negative coefficient significant at 5%. This implies that when soybean farmers have access to credit facilities, the profit inefficiency of the farmers will reduce. Farmers who have access to credit had more profit than those who do not. Marital status, Extension contact and Cooperative society have positive effect on profit inefficiency of soybean farmers and is significant at 5%. However, other variables include: farming experience, non-farm employment, planting methods, improved seed, tractor usage and agrochemical usage. All these are not significant at any level.

Profit Efficiency indices of respondents: As shown on table 4, the profit efficiency ranges between 0.12 and 1.00 for the soybean farmers in the area, and with an average profit efficiency of 0.804 (80.4%). This implies that average soybean farmer in the area could improve profit by 19.6%. This is similar to the findings of Yahaya et al., (2016) which analyzed profit efficiency among paddy households in Malaysia. They found profit efficiencies of producers to vary between 30.5% and 94.8%, with a mean of 73.2%, suggesting that an estimated 26.8% of the profit is lost due to a combination of technical and allocative inefficiencies in paddy production.

Conclusion

Results of estimates of Cobb-Douglas stochastic frontier production function revealed that farmland ($p<0.01$), seed ($p<0.01$), and fertilizer ($p<0.1$) positively affected soybean profit efficiency, by implication, increasing cultivated soybean farmland, seed and fertilizer would increase soybean profit efficiency, while herbicide ($p<0.05$) and labour ($p<0.05$) negatively affected soybean profit efficiency, which means as herbicide and labour use increase, profit efficiency reduces. The inefficiency model revealed that soybean producers' age, level of education and access to credit reduced the profit inefficiency of soybean farmers in the study area by 5%, 1% and 5% respectively. This implies that increasing these factors will decrease profit inefficiency, that is, increase profit efficiency. The study further shows that soybean producers` profit efficiency has not reached the frontier level, soybean producers' profit efficiency varied widely among the sampled farmers. It ranged from 11% to 100% with a mean value of 80%. The mean level of profit efficiency indicates that there exists room to increase profit by up to 20% using the available technology to the farmers. The study

showed the major determinants of profit inefficiency to be soybean producers' age, level of education and access to credit facilities.

Based on the findings of this study, adult and extension education, workshops and seminars should be encouraged and made free among soybean farmers, Young and experienced farmers should be encouraged to engage in soybean production through the provision of basic incentives such as credit facilities at low interest rates to increase the profit efficiency of producers.

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Table 1: Input, Output and Profit level of respondents

Variables	Mean (₦)	Std. Dev	Minimum	Maximum
Seed	33,822.74	21,468.89	6,210.00	120,000.00
Fertilizer	20,006.05	11,124.40	4,800.00	70,000.00
Herbicide	3,485.26	2,310.02	0.00	12,000.00
Labour	100,460.40	75,652.06	0.00	398,125.00
Total Variable Cost	157,774.45	88,739.43	18,800.00	534,625.00
Total Revenue	1,017,151.00	1,088,026.00	8,000.00	7,500,000.00
Gross Margin	859, 376.55	1,050,709.00	-40,900.00	7,433,400.00

Table 2: Maximum likelihood Estimates of Stochastic Profit Frontier Function Soybean Producers

Variables	Parameters	Coefficient	Standard Error
Constant	β_o	5.791	3.180
Seed	β_1	0.553***	0.156
Fertilizer	β_2	0.819	0.428
Labour	β_3	-0.167**	0.068
Herbicide	β_4	-0.752**	0.370
Farmland	β_5	1.083***	0.068
$Sigma^2$	δ^2	57.195***	20.178
Gamma	γ	0.996***	0.014
Log-likelihood		-109.401	

Source: Computed from Field Survey Data, 2021.
***P< 0.01, **p< 0.05

Table 3: Parameter Estimates of Profit Inefficiency Model

Variables	Parameters	Coefficient	Standard Error
Constant	λ_o	-7.073*	4.023
Age	λ_1	-0.097**	0.040
Level of Education	λ_2	-1.005*	0.659
Marital status	λ_3	2.225**	0.983
Household size	λ_4	0.222***	0.080
Farm experience	λ_5	-0.040	0.038
Extension contact	λ_6	4.024**	1.942
Quality seed	λ_7	-1.832	1.878
Planting method	λ_8	1.937	2.181
Agrochemical use	λ_9	-1.226	1.119
Land Cultivation Technology	λ_{10}	-0.245	1.505
Off-farm employment	λ_{11}	0.940	1.377
Cooperative membership	λ_{12}	6.407**	2.683
Credit access	λ_{13}	-5.835**	2.708

Source: Computed from Field Survey Data, 2021.
***P< 0.01, **p< 0.05, *p< 0.1

Table 4: Distribution of Profit Efficiency Indices of Soybean Producers

Profit Efficiency	Frequency	Percentages
<=0.400	19	10.00
0.401-0.500	25	13.16
0.501-0.600	13	6.84
0.601-0.700	6	3.16
0.701-0.800	6	3.16
0.801-0.900	5	2.63
>0.901	116	61.05
Total	190	100.00
Mean	0.80	
Minimum Value	0.12	
Maximum Value	1.00	

Source: Computed from Field Survey Data, 2021.