



**Technical Efficiency of Giant African Land Snail (*Archachatina marginata*) Production in Plateau State, Nigeria**

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**Abstract**

*The Low productivity in Non-timber Forest Product (NTFP) is mainly due to the inability of the farmers to exploit the available technologies fully, resulting in lower efficiencies of production. This study employed a Cobb-Douglas stochastic frontier production function to measure the level of technical efficiency and its determinants in Giant African land snail production in Plateau State, Nigeria. Primary data was generated through the use of closed and open ended structured questionnaire in line with the objectives of the study. Respondents were selected through a systematic random sampling procedure. Eighty-seven Giant African land snail farmers were selected, from whom socioeconomic and input-output data were obtained using the cost-route approach. The parameters of the stochastic frontier production function were estimated using the maximum likelihood method. The study revealed stock size (0.44), labour (0.55) and feed (0.15) were positively and significantly related to output at 5% level of significance. Socioeconomic factors influencing technical efficiency directly were farming experience and credit access at 5% level of significance. Age was negatively and significantly related to technical efficiency at 5% level of significance. Result of returns to scale analysis showed that snail production is at the stage of increasing returns to scale. The study recommend that Snail farmers should have greater access to formal credit facilities from lending institutions in order to expand and improve their production. They should be encouraged to form stronger co-operative societies so as to expand their scope of production and marketing. Farmers are advised to grow most of the green feed stuffs the snails eat to save costs.*

**Key words:** Technical efficiency, Snail, stochastic frontier production function, Plateau

**Introduction**

Forestry enterprises utilize various inputs for production, the outcome of input processing is not directly related to the amount and cost of inputs. It is the technical process that affects the final output. Hence, two identical firms having identical input structures may end up with different quantities of outputs or different cost-revenue structures. However, the evaluation of success of the enterprises in terms of effective use of inputs and maintenance of a sound cost structure lies in the technical efficiency analysis of the process (Zira and Ghide, 2013). Thus snail farming an aspect of Non Timber Forestry Product (NTFP), being a relatively new business enterprise in Nigeria requires a scrutiny of their technical efficiency of

production. The most common commercial types in Nigeria are the *Archachatina marginata* and *Achatina achatina*. Snail farming can be a lucrative enterprise because these days' snails are seen as rich people's stuff because of their costs that are usually out of reach of the average Nigerian. Most of the snails come from the wild and it is only recently that snails have been raised domestically. Nigeria is naturally endowed with a high population of edible snails. They have huge export potentials to earn foreign exchange either as primary or finished goods. Local demands are high and usually command premium prices in restaurants and drinking bars (Ojo and Zira, 2017).

Snails are treasured as traditional sources of nutrition and delicacy in the study area even in other parts of the country where snail consumption is not regarded as a taboo. This endowment can best be harnessed by establishing commercial farms for snails; else they will become less available or even extinct as a result of the present uncontrolled destruction of their natural habitat through bush burning and other forms of deforestation (Arifalo *et al.*, 2008). According to Banta (2012), snail meat is rich in protein and irons. In addition, it is low in total fat content 1.64%; saturated fatty acid 28.71%; and cholesterol content 20.28mg/100g fresh sample when compared to other samples (Beef, Broiler meat, Goat meat, Mutton, Pork, *Clarias lazera*, and *Tilapia macrocephala*) while its amino acid profile was generally similar to those of other samples. He also showed that snail meat is a rich source of minerals particularly calcium and phosphorous, with values of 185.70mg/100g and 61.24mg/100g dry sample respectively. Again the amounts of these minerals in the others for example beef sample 53.00mg/100g calcium and 24.05mg/100g phosphorous is much lower than is present in snail meat (Zira, *et. al.*, 2016). Hosea (2014) posited the merits of snails as food along the West African coast was not only because of the nutritive value of the meat; he asserted that scientific reports proved that snail is used for the treatment of hypertension, vitality in men, heart diseases, stomach ulcer, anaemia, pile, asthma and many others. He also asserted that it is also good for pregnant women.

Despite the importance of snail farming we are still faced with the precarious situation where the cost of conventional protein sources which cannot be kept by the poor, such as cattle, goat, sheep and fish has become so prohibitive in recent times. The animal protein intake/capita/day of Nigerians has been estimated at 15g and this is only

about 43% of the recommended daily requirement (Udo, 2009). Hence, in view of this protein deficiency, the role of increased efficiency and productivity of snail farms is no longer debatable but a great necessity in order to reverse the seemingly low technical efficiency of snail farms in Nigeria, since it has the potential for bridging the protein gap. This study is aimed at opening a new dimension to farmers and policy makers on how to increase snail production by determining the extent to which it is possible to raise efficiency of snail farms with the existing resource base and available technology in order to address fully the snail production problems in Nigeria.

## Materials and Methods

### *The Study Area*

The study was conducted in the central zone, which covers Bokkos, Mangu and Barkin-Ladi Local Government Areas (LGAs) of Plateau State., Nigeria. These areas lies between Longitudes 8° 40' and 9° 50' E and Latitudes 9° and 10° 45' N. The Jos Plateau is bordered in the North-East by Bauchi State, in the North by Kano State, and in the North West by Kaduna State and in the South –West by Nasarawa State. Jos Plateau elevation ranges between 1100m and 1400m above sea level (Banta, 2012). The area has a wet season (April to late October) with a mean annual rainfall of about 1,500 mm and a dry season that lasts from November to March.

### *Sources of Data and Sampling Techniques*

Data for this study were derived mainly from primary sources which were collected with the use of a questionnaire. Information was obtained on the socio-economic characteristics of the respondents. A multi-stage sampling technique was employed in selecting the sampled population. This involved a purposive selection of three (3) LGAs Bokkos, Mangu and Barkin-Ladi out of six Snail producing LGAs. The second –

stage involved a random selection of 4 villages from each of the 3 selected LGAs. Finally, a random sampling was conducted to select 10 Snail farmers from the 12 villages selected in the study areas. Out of the one hundred and twenty questionnaires distributed, 84 were properly filled and were used for the analysis. Where household head was not present at the time of the interview, they were sampled by proxy; the wife or any other older person present in the house was administered the questionnaire.

**Analytical Techniques**

Inferential statistics was used for the study.

**Estimation of Technical efficiency:**

The Cobb-Douglas functional form using the stochastic frontier production function was used to estimate the technical efficiency of the farmers. The stochastic frontier production model is specified as follows following Aigner *et al.*(2012), Meeusen and van den Broeck (1977)

$$Y_i = F(X_i; \beta) \exp(V_i - U_i); \quad ; = 1, 2, \dots, n \quad \text{-----} \quad (1)$$

Where,

$Y_i$  = denotes number of matured snails from the  $i^{\text{th}}$  farm

$X_i$  = is a vector of functions of actual input quantities used by the  $i^{\text{th}}$  snail farm

$\beta$  = is a vector of parameters to be estimated

$V_i - U_i$  = is the composite error term

Where,

$V_i$  and  $U_i$  = are assumed to be independently and identically distributed

$U_i$  = is a non-negative random variable, associated with technical inefficiency in production.

$V_i$  = is a random error, which is associated with random factors not under the control of the snail farmers.

The functional form of this model used in estimating the level of technical efficiency is the Cobb-Douglas type (Bravo-Ureta and Evenson, 1994) is

$$\ln Y_i = \beta_0 + \beta_1 \ln X_1 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + \beta_4 \ln X_4 + \beta_5 \ln X_5 + V_i - U_i \quad \text{.....} \quad (2)$$

Where,

$\ln$  = represents the natural logarithm

The subscript  $i$  represents  $i^{\text{th}}$  sample farmer

$Y_i$  = Snail output in numbers for the  $i^{\text{th}}$  farm

$X_1$  = stock size measured as total number of snails per farm

$X_2$  = Labour used, in mandays used in production

$X_3$  = Quantity of green and supplementary feeds used in kg

$X_4$  = Number of breeding stock

$X_5$  = Depreciation on capital inputs such as wooden boxes and concrete trenches (physical structures in naira)

$\beta_0$  = intercept.

$\beta_1 - \beta_5$  = coefficients estimated

**Determinants of Technical Efficiency**

In order to determine factors contributing to the observed technical efficiency in snail production, the following model was formulated and estimated jointly with the stochastic frontier model in a single stage maximum likelihood estimation procedure.

$$U_i = \delta_0 + \delta_1 Z_1 + \delta_2 Z_2 + \delta_3 Z_3 + \delta_4 Z_4 + \delta_5 Z_5 + \delta_6 Z_6 + \delta_7 Z_7 + \delta_8 Z_8 \quad \text{.....} \quad (3)$$

Where ;

$U_i$  = is the technical efficiency of the  $i^{\text{th}}$  farmer,

$Z_1$  = farmers age in years,

$Z_2$  = farmers level of education in years,

$Z_3$  = the number of extension contacts made by the farmer in the year,

$Z_4$  = household size,

$Z_5$  = stock size,

$Z_6$  = farmer's farming experience in years,

$Z_7$  = supplementary feed, a dummy variable which takes the value of unity for supplementary feed use and zero otherwise,

$Z_8$  = credit access, a dummy variable which takes the value of unity if the farmer has access to credit and zero otherwise,

while  $\delta_0$  and  $\delta_1, \delta_2, \dots, \delta_8$  are regression parameters to be estimated. It is expected  $\delta_1,$

$\delta_2, \delta_3, \delta_5, \delta_6, \delta_7$  and  $\delta_8$  to be positive (i.e.  $>0$ ) and  $a_4$  negative (i.e.  $<0$ ).

### Returns to Scale

The coefficients of the model in Equation (2) are the measures of elasticity of production. Coefficient  $\beta_1$  is the percent change in output resulting from a one percent change in the input  $X_1$ . Similarly, the coefficient on each input is the percent change in output resulting from a one percent change in the input. In a Cobb-Douglas production function, the sum of these coefficients,  $\beta_1 + \beta_2 + \beta_3$ , is the degree of homogeneity, which measures whether the production function is constant, increasing, or decreasing returns to scale. Three possibilities exist:

- (1) If  $(\beta_1 + \beta_2 + \beta_3 \dots n) = 1$ , there are constant returns to scale.
- (2) If  $(\beta_1 + \beta_2 + \beta_3 \dots n) < 1$ , there are decreasing returns to scale.
- (3) If  $(\beta_1 + \beta_2 + \beta_3 \dots n) > 1$ , there are increasing returns to scale.

### Result and Discussion

The result as revealed in Table 1 showed that the estimate of the variance parameter (0.0724) was significantly different from zero at 5% level of significance, indicating a good fit and the correctness of the distributional assumption specified. The variance ratio ( $\gamma$ ) which was significantly different from zero at 5% level of significance showed that the farm specific variability contributed about 25% variation in yield among the respondents, which implies that about 25% of the differences between the observed and maximum production frontier outputs were due to differences in farmer's levels of technical inefficiency and not related to random variability. Hence, labour, stock size and feed are under the control of the farmer and the influence of which can be minimized to enhance technical efficiency. As expected, the signs of the slope coefficients of the stochastic frontier were all

positive. This implies that any increase in the variables whose coefficient was positive would lead to increase in output which agrees with a *priori expectations*. Labour has the highest coefficient of 0.55 followed by stock size at 0.44 and supplementary feed at 0.15, being significant at 5%.

### Determinants of Technical Efficiency

The result of the determinants of technical efficiency in Table 1 show that the coefficient for age was negative and significantly related to technical efficiency, which agrees with a *priori expectation* at 5.0% level of probability. This implies that increasing age would lead to decreased technical efficiency. Ageing farmers would be less energetic to do strenuous work thus, leading to low productivity as well as low technical efficiency, this is in line with the findings of Okoye *et al.*, (2007), Ajibefun and Daramola (2003) and Ajibefun and Aderionla (2004).

Stock size had a positive coefficient and highly significant at 5% level of probability. This corroborates the findings of Baba and Adeleke (2006) who posited that stock size was the most important factor determining profitability and hence technical efficiency of snail enterprises. Ojo and Zira (2017) reported that the coefficient for level of experience was also positive and significant at 5% level of probability. This also confirmed a *priori expectations* more experienced farmers are expected to have higher level of technical efficiency than farmers with lower farming experience. This result agrees with the findings of Onyenweaku and Effiong, (2005), Onyenweaku and Nwaru (2005), Onyenweaku, Igwe and Mbanasor (2005), Okoye *et al.*, (2007) and Zira *et al.*, (2019). Access to credit also had a positive coefficient at 5.0% level of significance which confirms a *priori expectation*.

**Table 1; Estimation of the Cobb-Douglas Stochastic Production Function of factors affecting snail production.**

Production factors	Parameter	Coefficient	Standard error	t-value
Constant term	$\beta_0$	4.7423	0.4781	9.9190**
Stock size	$\beta_1$	0.4411	0.0944	4.2134**
Labour	$\beta_2$	0.5529	0.0863	7.3523**
Feed	$\beta_3$	0.1515	0.0563	2.6909**
Breeding stock	$\beta_4$	0.0861	0.0618	1.3932 <sup>NS</sup>
Depreciation of assets	$\beta_5$	0.0441	0.0508	0.8681 <sup>NS</sup>
<b>Factors of inefficiency</b>				
Constant term	$\delta_0$	0.4527	0.2512	1.8019
Age	$\delta_1$	-0.0148	0.0061	-2.4376**
Education	$\delta_2$	0.0133	0.0130	1.0276 <sup>NS</sup>
No of ext. visits	$\delta_3$	0.0092	0.0300	-0.3065 <sup>NS</sup>
Household size	$\delta_4$	0.0086	0.0153	0.5621 <sup>NS</sup>
Stock size	$\delta_5$	0.9595	0.3653	2.6267**
Farming experience	$\delta_6$	0.0174	0.0067	2.5970**
Feeds	$\delta_7$	0.0234	0.1354	1.7296 <sup>NS</sup>
Access to credit	$\delta_8$	0.2730	0.1258	2.1701**
<b>Diagnostic Tests</b>				
Total variance	$\sigma^2$	0.0724	0.0094	8.9140*
Variance ratio	$\gamma$	0.2506	0.1502	2.6718*
LR Test		16.6180		
Log-likelihood function		-5.7863		

Source: Author's computation from field data using Frontier version 4.1(2019)

\* = significant at 5%, \*\* = significant at 1%, NS= Not Significant

### Returns to scale (RTS)

The Cobb-Douglas production function was estimated to measure the degree of returns to scale for snail farms in the study area. The regression results were presented in Table 1 while the RTS is tabulated in Table 2. For testing that the production function was constant returns to scale, the null hypothesis that  $h=1$  was also tested. As the  $t$ -statistic in absolute terms was less than 2.00, the test rejected the null hypothesis, as the coefficient  $h$  was greater than 1 by this test. As described in methodology,  $h = \beta_1 + \beta_2 + \beta_3 + \beta_4 + \beta_5$ , which measures the degree of homogeneity. As  $\sum \beta's > 1$  ( $h=1.3206$ ) by the above test, these results showed that the production function for snails exhibited increasing returns to scale.  $T$ -statistics and p-value were significant. These results indicated that if all

inputs are increased proportionately, the output is increased by a larger proportion (Varian, 2012).

### Conclusion and Recommendations.

The parameters of the stochastic frontier production function were estimated using the maximum likelihood method. The study revealed that Stock size, labour and supplementary feed are positively and significantly related to output at 5% level of significance. Socio-economic factors influencing technical efficiency directly were farming experiences and credit access at 5% level of significance. Age was negatively and significantly related to technical efficiency at 5% level of significance. Result of returns to scale analysis showed that snail production is at the stage of increasing returns to scale and

as such all efforts should be geared towards increasing output. The study recommend that Snail farmers should have greater access to formal credit facilities from lending institutions in order to expand and improve their production. They should be encouraged

to form stronger co-operative societies so as to expand their scope of production and marketing. Farmers should learn to grow most of the green feed stuffs the snails eat to save costs.

**Table 2: Elasticity of snail production and returns to scale**

Variable	Elasticity
Stock size	0.1537
Labour	0.5741
Feed	0.4642
No of breeding stock	0.0799
Depreciation of assets	0.0487
RTS	1.3206

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