MAXIMUM LIKELIHOOD ESTIMATION TECHNIQUE OF GRASSCUTTER (*Thryonomys swinderianus*) PRODUCTION IN OSUN STATE, NIGERIA

***OLATIDOYE, M.S., ALIMI, T., AKINOLA, A.A., AKINBODE, W.O. AND OWOMBO, P. T.**

Department of Agricultural Economics, Faculty of Agriculture, Obafemi Awolowo University, Ile-Ife, Osun State, Nigeria

** sharonsam2016@gmail.com; +2348035275825*

ABSTRACT

This study estimated quantitatively the technical efficiency and its determinants in grasscutter production in Osun State, Nigeria using a stochastic production frontier function approach. A total of seventy-two grasscutter farmers across the three agricultural zones were randomly selected. Using a well-structured questionnaire, data were collected on the socio-economic characteristics and other quantitative variables of interest. The Maximum Likelihood Cobb-Douglas estimation procedure was used. Careful analysis revealed that male respondents dominated grasscutter production in the study area with an average grasscutter farming experience of 11 years. The mean age of the respondents was 43 years while majority (97%) of the respondents had formal education. The result of the stochastic frontier production function showed that labour, capital, feed concentrates, and farm size were major factors determining total output of the enterprise in the study area. The study also showed that membership of cooperative, access to credit, level of education and extension contact; significantly determine efficiency level in the study area. The maximum technical efficiency attained by the farmers was 93% while the minimum technical efficiency was 45%. The mean technical efficiency (MTE) was 86%. The sum of output elasticities which denotes returns to scale was 1.04 signifying increasing returns to scale. In essence, the enterprise did not attain maximum production frontier. It is recommended that efficiency could be increased through better use of available resources, access to credit facilities and assisting and encouraging the farmers in joining cooperative societies so as to have access to loans. Also, educational programmes should be organized to sensitize farmers more on how to improve on their efficiency level.

Key words: Grasscutter enterprise, Stochastic Frontier, Technical Efficiency, Osun State, Nigeria

INTRODUCTION

Efficiency of various livestock sub-sectors can be improved through efficient use of the existing technologies, reallocation of resources and adoption of new technologies (Henry, 2010). The challenge to policy makers is how to improve efficiency especially of the small farmers so as to attain large gains in agricultural output and reduce food insecurity.

The shortage of animal protein in the third world countries can be ameliorated by improving the efficiency of production and existing conservation programme of wildlife particularly the domestication of rodents that are tractable, prolific and widely accepted to the public for consumption (Wogar*et. al.*, 2012). Captive breeding of species as a possible way to satisfy local demand without compromising the wild stock has also been recommended by several authors (Mensah and Okeyo, 2005). Grasscutter or canerat has been suggested as one of the mini-livestock

having potential for domestication. Grasscutter rearing has been stated to have health related advantages including better nutrition (Addo *et al.,* 2007). However, Onyeanusi and Famoyin (2005) opined that Nigeria as a developing country is faced with a worsening situation of inadequate protein consumption. The reason adduced for this is that out of the 54.5g recommended per capita protein consumption, the protein supply was 44g out of which animal products was less than 2.0%. This was further corroborated by Adedeji *et al.*(2013) who pointed out that the current per capita animal protein consumption in Osun State is less than 7.5g. The situation remains so because most of the farmers involved in grasscutter farming lack the technical knowledge, managerial ability and have failed to seek the counsels of experts.This has limited their ability to maximize output which in turn translates into huge capital loss. This study therefore aims to analyze the technical efficiency of grasscutter enterprise and identify the factors influencing its level and make policy recommendations towards improving the sector.

MATERIALS AND METHODS

The study area, sampling technique and data collection

The study was carried out in Osun State. The state is made up of thirty local government areas and comprises three Agricultural Development Zones, namely: Iwo, Osogbo and Ife-Ijesa, respectively. The State is located in the South-West geopolitical zone of Nigeria and occupies an area of land of about 14, 875km^2. The ecological conditions are conducive for an impressive diversity of livestock such as cattle, sheep, goat, pig, rabbit, grasscutter and poultry. The State has a population of about 3.5 million (NPC, 2006) and the vegetation is characteristically that of rain forest and derived savannah with a mean annual rainfall that varies between 980mm and 2800mm and a temperature range of 27 – 32^{o}C.

The list of grasscutter farmers was obtained from resident agricultural extension agents and the State Ministry of Agriculture.Twenty-four grasscutter farmers each were randomly selected from each of the three Agricultural Development Zones, making a total of seventy-two grasscutter farmers sampled for the study. Primary data were collected from the respondents using a well-structured questionnaire. Data collected include socioeconomic characteristics of farmers and production activities in terms of inputs, outputs and their respective prices.

Analytical Technique

The stochastic production frontier approach was used in estimating the technical efficiency scores of grasscutter production as well as the factors influencing efficiency levels since it gives better results, allows for the measurement of random errors such as inefficiencies of production, statistical noise measurement and the confidence of the results is much higher than from non-parametric models (Ajao *et al.*,2012). The frontier production function was specified by the Cobb-Douglas production function. Following Battese and Coelli (2008), a one stage procedure was employed, to avoid the biases of the two steps potential estimation procedure. It is worth stating that this functional form has been widely used in farm efficiency analysis for both developing and developed countries with great success (Ajao *et al.,* 2012). Furthermore, in one of the few studies examining the impact of functional form on efficiency, Kumbhakar (2001) concluded

that functional specification has a discernable but rather small impact on estimating efficiency. The model's basic structure is as specified below

$Y_i = f(X, \beta)\, e^{v-u}$

However, the empirical model for technical efficiency in grasscutter enterprises is stated thus:

$\ln Y_{ij} = \beta_0 + \beta_1 \ln X_{1ij} + \beta_2 \ln X_{2ij} + \beta_3 \ln X_{3ij} + \beta_4 \ln X_{4ij} + \beta_5 \ln X_{5ij} + \beta_6 \ln X_{6ij} + (v_i - u_i)$

Where:

Ln = Logarithm to base e

β_0, $\beta_1 - \beta_6$ are parameters to be estimated.

Y = Output or total value of grasscutter products (₦/Kg)

X_1 = Concentrates (₦)

X_2 = Green feeds (Kg/Colony)

X_3 = Drugs and Medication (₦)

X_4 = Capital inputs (₦)

X_5 = Labour (Man-days)

X_6 = Farm size (Number of grasscutter housed on the farm)

V_i = Normal random errors which are assumed to be independent and identically distributed having $N(0\delta v^2)$. They are not under the control of the farmer e.g. weather, diseases and measurement error.

U_i = Non negative random variables assumed to account for technical inefficiency in production function and are assumed to be $N(0\delta v^2)$.

RESULTS AND DISCUSSION

The results of the socio-economic characteristics and some management practices of the respondents are presented in Table 1. If old farmers are defined as those who are above 50 years of age, then, 27.8% of the grasscutter farmers in the study area can be said to be old. The mean age of the respondents was 42.7 and 72.2% of the farmers are within the age range 41–50 years. This implies that young people engage in grasscutter farming business than older people and hence represents a high percentage of grasscutter farmers in the studyarea. The Table further shows that (84.7%) of the respondents were male thus showing the dominance of male farmers in grasscutter production in the study area. This agrees with Anigboku et al. (2016) and Adedeji *et al.* (2013)that women in grasscutter production chain engage mostly in marketingwhile men do most of the production processes. In addition, 97.2% of the respondents had formaleducation ranging from primary to tertiary. Thus, the literacy level of the respondents is very high and this implies that grasscutter farming requires certain level of education in terms of management to ensure productivity. The mean years of experience in grasscutter farming was 11 years thus implying that majority of the farmers had a relatively few years of experience in grasscutter farming. Experienceaccording to Mensah and Okeyo (2005) and Kusi*et al.* (2012)provides the farmers with insights on how to militate against risk and possible losses since they have become acquainted with them. It was further revealed that the average farm size of grasscutter reared per respondent was 2.5 colonies while the average litter size per kindling was 4. Majority (58.3%) sourced their capital from cooperative societies. Table 1 also reveals that family labour (68%) was the predominant labour type in the study area. Furthermore, (86%) of the respondents had extension contacts. It is believed that extension contacts and training afford farmers the opportunity to learn and improve their knowledge of grasscutter production.

TABLE 1. SELECTED SOCIO-ECONOMIC CHARACTERISTICS OF THE RESPONDENTS IN THE STUDY AREA

Parameters	Frequency N = 72	Percentage (%)	Parameters	Frequency N = 72	Percentage (%)
Age (Years)			**Types of Labour**		
41 - 50	52	72.2	Family	49	68
51 – 60	11	15.3	Hired	10	13.9
61 – 70	9	12.5	Both	13	18.1
Gender			**Extension contact**		
Male	61	84.7	Yes	62	86.1
Female	11	15.3	No	10	13.9
Educational Level			**Sources of funds**		
No Formal Education	2	2.8	Personal savings	11	15.3
Primary Education	7	9.7	Friends and Relatives	5	7.0
Secondary Education	22	30.6	Cooperatives	42	58.3
Tertiary Education	41	56.9	Commercial Banks	14	19.4
Grasscutter Rearing Experience (Years)			**Farm size (colony)**		
1 – 5	23	31.9	1	11	15.3
6 – 10	39	54.2	2	33	45.8
11 – 15	10	13.9	3	19	26.4
Extension contact			4	9	12.5
Yes	62	86.1	**Types of Labour**		
No	10	13.9	Family	49	68
			Hired	10	13.9
			Both	13	18.1

Source: Data analysis, 2018

The maximum likelihood estimates (MLE) of the stochastic frontier production function are represented in Table 2. The estimate of sigma-squared (σ^2), which is 0.231 is significantly different from zero, indicating a good fit and correctness of distributional assumption specified. The variance of ratio (γ) which measures the effect of technical inefficiency in the variations of observed output has a value of 0.19. This implies that about 19 percent of the difference between the observed and maximum production frontier outputs were due to differences in farmer's level of technical efficiency and not related to random variability. Hence, those factors are under the control of the farm and the influence of which can be reduced to enhance technical efficiency of the grasscutter production.

The constant term for grasscutter enterprise (Table 2) is positive and statistically significant. It shows the level of output or revenue accruable to the farmer at zero level of use for each of the inputs. The estimated coefficient being 3.101. In

essence, the farmer could rent out some fixed cost items owned by the enterprise which could as well account for the positive constant terms. Estimate of Cobb-Douglass production function for grasscutter production in the study area presented in Table 2 also shows that all the explanatory variables (except labour) included in the model for grasscutter farms had expected signs. However, concentrates, capital inputs, labour and farm size, among other variables, were found to be statistically significant. The quantity of grasscutter concentrates/pelletized feeds available does influence grasscutteroutput positively and significantly at 1% probability level such that a 1% increase in the quantity of the concentrates increases grasscutter output by 0.19%. This suggests that the more the concentrates a farmer gives, the higher the output. This finding concurs with Addo*et al.*(2007) which indicated that productivity of intensive small holder livestock production systems directly correlates with the amount of pelletized feeds and feeding available to the enterprise.The capital inputs for the enterprise showed a positive coefficient as hypothesized which was significant at 1% level. Thus, a 1% increase in the amount of capital available to grasscutter enterprise significantly improved productivity by 0.329%. The results revealed that capital inputs and availability was the factor with the highest impact on the productivity of the grasscutter enterprise. The findings are consistent with Anigboku*et al.*(2016) and Wogar (2012) where capital was found to be a key factor in the grasscutter production. Capital as a factor of production enhances farm infrastructure and small holder grasscutter rearing farm structures construction, purchase of modern grasscutter rearing equipment, and technology transfer, and hence its great effect on productivity.

The estimated coefficient of labour was negative and statistically significant at 5% probability level. This implies that when labour increases from the present levels, grasscutter production declines. The plausible explanation for this observation is that, increase in the size of labour enables the farmer to shift away from grasscutter farming to other alternative activities which could be more profitable. This agrees with Addo *et al.,* (2007) and Owen and Dike (2013).The estimated coefficient of farm size is positive and statistically significant at 1% level. This conforms to *apriori* expectations. The scale of production in a given farm enterprise affect the output and hence profitability of the farms (Aiyeloja and Ogunjimi, 2013). Fakoya*et al.* (2008) stressed that the more farm animals that are housed together, the more economical the operation becomes. Benjamin *et al.* (2006) and Fakoya*et al.* (2008) also stressed that the net income increases in direct proportion to the size of the flock. The elasticity of farm size is 0.294, which implies that 1% increase in grasscutter colonies (farm size) would lead to a 0.294% increase in the output or revenue accruing to the enterprise.

The farm specific efficiency distribution is shown in Table 3. For policy purposes, it is useful to identify the sources of these inefficiencies which can be done by investigating the relationship between the computed TE and δ_1– δ_6. All the variables have negative relationship with TE except δ_1, δ_7 and δ_8. The variables with positive coefficients were age, gender and household size and incidentally not significant at either 1 or 5 percent probability levels. It should be noted that a negative coefficient means that the variable

is improving technical efficiency; that is the farmer becomes less technically inefficient as the level of the variable increases. A positive coefficient on the other hand implies technical inefficiency. However, the results showed that access to credit, membership of cooperative society and extension contact were negatively signed and significant at 5% probability levels, while farming experience and level of education coefficients were also negativeand significant at 1% level.

In essence, the estimated coefficient for access to credit and membership of cooperative society were both negative and statistically significant at 5% level, which conforms to *apriori* expectations. The number of associations a farmer belongs to is expected to influence his interactions positively with his fellow farmers and enhances the possibility of accessing agricultural credit. Hence, farmers in these categories tend to be less technically inefficient. These findings agree withAiyeloja and Ogunjimi(2013) and Owen and Dike(2013). Hence, access to credit, farming experience, level of education, membership of cooperative society and extension contact were the factors that influenced the level of efficiency of grasscutter farmers in the study area.

TABLE 2: MAXIMUM LIKELIHOOD ESTIMATES OF THE PARAMETERS OF THE STOCHASTIC PRODUCTION FUNCTION (TECHNICAL EFFICIENCY MODEL).

Production factors	**Parameters**	**Estimated coefficients**	**Standard errors**	**t-values**
Constant term	β_o	3.101	0.319	9.721
Concentrates(X_1)	β_1	0.229	0.054	4.241***
Green feeds (X_2)	β_2	0.127	0.115	1.095
Drugs and medication(X_3)	β_3	0.135	0.109	1.238
Capital inputs(X_4)	β_4	0.329	0.131	2.511**
Labour (X_5)	β_5	-0.079	0.038	-2.099**
Farm size (X_6)	β_6	0.294	0.112	2.625***
Inefficiency factors				
Constant (Z_0)	δ_o	0.092	0.017	5.142
Age (Z_1)	δ_1	0.127	0.095	1.337
Access to credit(Z_2)	δ_2	-0.092	0.042	-2.215**
Farming experience (Z_3)	δ_3	-0.319	0.057	-6.380***
Level of education (Z_4)	δ_4	-0.118	0.034	-3.471***
Membership of cooperative (Z_5)	δ_5	-0.113	0.057	-1.983**
Extension contact (Z_6)	δ_6	-0.037	0.014	-2.643**
Gender (Z_7)	δ_7	0.055	0.037	1.486
Household size (Z_8)	δ_8	0.597	0.681	0.877
Diagnostic statistics				
Sigma-squared	σ^2	0.231	0.073	
Gamma (γ)		0.193	0.101	
LR test		17.13		
Log-likelihood function		21.15		

Source: Data Analysis, 2017***= 1% and ** = 5% alpha level.

The results further showed that 29% of the sampled farmers have technical efficiencies ranging between 0.81 and 0.90. The technical efficiency estimates are widely distributed across the grasscutter farmers (Table 3). The firm-specific technical efficiency also varied between 0.45 and 1 (Table 3) with mean technical efficiency (TE) of 0.86. This implies that in the short-run, it is possible to increase output in the study area on the average by 14% by using the technology of best performers. The minimum technical efficiency value was 45% indicating that some farmers are located far from the frontier region while the maximum technical efficiency was 93% indicating that some farmers are very close to the frontier region. The mean technical efficiency value of 86% however, portrays that there is a wide opportunity for the grasscutter farmers to increase their current level of technical efficiency. The analysis however implies that it will take an average grasscutter farmer (1 – 0.86/0.93) which equals 7.5% cost saving to become the most efficient grasscutter farmer while the worst performing grasscutter farmers (1 – 0.45/0.93) would need 52% cost saving to become the most efficient grasscutter farmer.

TABLE 3: FREQUENCY DISTRIBUTION OF TECHNICAL EFFICIENCY OF GRASSCUTTER FARMERS

Efficiency levels	Frequency	Percentage (%)
$0.41 \leq TE < 0.50$	9	12.5
$0.51 \leq TE < 0.60$	13	18.1
$0.61 \leq TE < 0.70$	8	11.1
$0.70 \leq TE < 0.80$	17	23.6
$0.80 \leq TE < 0.90$	21	29.2
$Te \geq 0.9$	4	5.56
Total	72	100
Maximum TE	0.93	
Minimum TE	0.45	
Mean TE	0.86	

Source: Data Analysis, 2017; TE: Technical Efficiency

TABLE 4: DISTRIBUTION OF PRODUCTION ELASTICITY AMONG VARIABLES FORGRASSCUTTER ENTERPRISE

Variables	Estimated values
Concentrates	0.229
Green feeds	0.127
Drugs and medication	0.135
Capital inputs	0.329
Labour	-0.079
Farm size	0.294
Sum of elasticities	**1.035**

Source: Data analysis, 2017

CONCLUSION AND RECOMMENDATION

This study empirically estimated technical efficiency of grasscutter farmers and also identified the socio-economic factors that determine the level of estimated technical efficiency of the sampled respondents. The study found the average technical efficiency estimate to be 86% and returns to scale of 1.04 and thus concludes that 14% of the farmers' output or income is lost to technical inefficiency and this was influenced by access to credit, farming experience, level of education, membership of cooperative society and extension contact. The direct variable (inputs), which will increase grasscutter output are concentrates, capital inputs, labour and farm size. This implies that the combined effects of the above stated direct variables will bring about a substantial increase in grasscutter output. This also means the consistent availability of these inputs will ensure commensurate grasscutter products. This also generates ready income for the grasscutter farmers. Therefore, the study recommends that efforts should be made by financial institutions and NGOs targeted at grasscutter farmers to improve farmers' access to credit. In addition, educational programmes such as workshop, seminars should be organized for grasscutter farmers and new entries into grasscutter production enterprise since education helps to improve technical efficiency.Policies aimed at strengthening the agricultural extension delivery system should be encouraged and farmers should be encouraged to form cooperative societies so as to improve their access to funds.

REFERENCES

Addo, P. G., Dodoo, A., Adjei, S.,Awumbila, B., Awotwi, E. and Ankrah, N. A. (2007). Comparative Characterization of the Grasscutter (*Thryonomys swinderianus*) and the Guinea Pig (*Caviaporcellus*) by the Hystricomorph Vaginal Membrane Perforation Phenomenon. *Livestock Research and Rural Development*, 19(14): 32 – 48.

Adedeji, I. A., Adelalu, K.O., Ogunjimi, S.I. and Otekunrin, A.O. (2013). Application of Stochastic Production Frontier in Estimation of Technical Efficiency of Poultry Egg Productionin Ogbomoso Metropolis of Oyo State, Nigeria. *World Journal of Agricultural Research*, 1(6): 119 – 123.

Aiyeloja, A.A. and Ogunjimi, A. A. (2013). Economic Aspects of Grasscutter Farming in Southwest Nigeria: Implications for Sustainable Adoption and Conservation. *International Journal of Scientific and Engineering Research*, 4 (10): 17 – 23.

Ajao, A. O., Ogunniyi, L. T. and Adepoju, A. A. (2012). Economic Efficiency of Soybean Production in Ogo-Oluwa Local Government Area of Oyo State, Nigeria. *American Journal of Experimental Agriculture*, 2 (4): 667 – 679.

Anigboku T. U., Agbasi, O. E. and Okoh, I. M. (2016). Socioeconomic Factors Influencing Grasscutter Production among Cooperative Farmers in Anambra State, Nigeria. *International Journal of academic Research in Economics and Management Sciences*, 4(3): 43 – 58.

Battese, G. E.and Coelli, T. J. (2008). Prediction of Firm-level Technical Efficiencies with a Generalized Frontier

Production function and Panel data. Pp. 123 – 132.

Benjamin, U. U., Akinyemi, A. F. and Ijeomah H. M. (2006). Problems and Prospects of Grasscutter (*Thryonomys swinderianus)* farming in Ibadan, Nigeria. *Journal of Agriculture ,Forestry and Social Sciences*(JOAFSS). 4(2): 24-32.

Fakoya, E. O., Sodiya, C.I.,Alarima, C. I. and Omoare, A. M. (2008). Information Needs ofFarmers in Grasscutter Production for Improving Performance in Ona-Ara Local Government Area of Oyo State. *Proceedings of 33rd Annual Conference of Nigerian Society for Production, Ayetoro, Ogun State, Nigeria*, p300 – 301.

Henry, A. J. (2010). Reproductive Performanceof GrasscutterDoes at First Parity Reared in Humid Tropical Environment. *Proceedings of 35th Annual Conference of Nigeria. Society for Animal Production, University of Ibadan, Nigeria*, p155 –158.

Khumbhakar, S. C. (2001). A Generalized Production Frontier Approach for Estimating the Determinants of Inefficiency in US Dairy Farms, *Journal of Business and Economic Statistics,* 9: 279 – 286.

Kusi, C., Tuah, A. K.,Annor, S. Y., Djang-Fordjour K.T. (2012). Determination of Dietary Crude Protein Level Required for Optimum Growth of the Grasscutter in Captivity. *Livestock Research for Rural Development*, 24 (10).

Mensah, G. A. and Okeyo, A. M. (2005). Continued Harvest of the Diverse African Animal Genetic Resources from the Wild through Domestication as a Strategy for Sustainable use: A case study of the larger grasscutter *(Thryonomys swinderianus). International Livestock Research Institute*, 5 (4): 25 – 37.

NPC (2006). National Population and Housing Census Report, 2006.

Olukole, S. G., Oyeyemi M.O. and Oke, B. O. (2010). Gross Anatomy of Male Reproductive Organs of the Domesticated Grasscutter (*Thryonomys swinderianus* Temmink). *Proceedings of 25thAnnual Conference of Nigerian Society for Animal Production. University of Ibadan*, Nigeria. 268-271.

Onyeanusi, A. E. and Famoyin, J. B. (2005). Health Care Management of Grasscutter in Captivity: Assessment of Causes of Mortalities among Rearing Stock in Ibadan Metropolis. *Journal of Forestry Research and Management*, 2(5): 58 – 66.

Owen, O. J. and Dike, U. A. (2013). Japanese Quail (*Coturnixcoturnix japonica*) Husbandry: A Means of Increasing Animal Protein Base in Developing Countries. *Journal of Environmental Issues and Agriculture in Developing Countries.* 5 (1): 1 – 4.

Wogar G.S.I., Effiong, O.O. and Nsa, E.E. (2012). Performance of Growing Grasscutter on Different Fibre Sources. *Pakistan Journal of Nutrition,*11 (1): 51-53.