Economic Efficiency and its Determinants: A Case Study of Cowpea Production in the Western Agricultural Zone of Nasarawa State, Nigeria

Abstract

This study estimated the economic efficiency level and assessed the influencing factors among cowpea farmers in the western agricultural zone of Nasarawa state, Nigeria. A sample size of 160 cowpea farmers was selected using multi-stage sampling technique. The data used was collected for the 2017 farming season using structured questionnaire and was analysed using data envelopment analysis (DEA) and tobit regression model. The study revealed that cowpea farmers in the study area operated on a small scale and at an average of 1.0 ha/farmer. Findings also indicated that, the mean technical (TE), allocative (AE) and economic efficiencies (EE) were: 0.31, 0.18 and 0.06 respectively. The implication of these results is that an average farmer in the study area has the scope for increasing TE by 69% in the short run under the existing technology. An average farmer in the study area also has the scope of increasing their allocative and economic efficiencies by 82% and 94% respectively in the short run under the existing technology. The economic efficiency was only influenced significantly by the farm size. Education, farming experience, and extension visits were not significant determinants of the economic efficiency. The study recommends for policies of government at all levels and those of all the stakeholders to discourage land fragmentation and promote efforts that encourage farmers to form strong cooperatives so that they can pool their resources together to increase their scale of operations and by so doing improve their cowpea production efficiency.

Key words: Cowpea, production, economic efficiency, determinants, farmers

Introduction

Cowpea (simply known as 'beans' in Nigeria) is one of the most economically important indigenous African legume and most versatile African crop which feeds the people, their livestock, the soil and other crops (Okereke *et al*., 2006). Botanically, it is called *Vigna unguiculata* L. Walp and is mostly grown in the semi-arid tropics which cover Asia, East and West Africa, Central and South America. Cowpea has its root in Africa most especially South, West and East Africa but the name Cowpea probably emerged when it got to the United States of America and was used as an important feed for the Cows (Ernest, 2009). Most cowpeas are grown on the African continent, particularly in Nigeria and Niger which account for over 55% of world cowpea production (FAO, 2018). It can be intercropped with large taller plants such as maize, millet, or sorghum particularly in high rainfall areas because of its exceptional shade tolerance as reported by the Savana Agricultural Research Institute (SARI), Kenya in 2012. There is a high level of morphological diversity found within the cowpea species with large variations in the size, shape and the structure of the plant. Cowpeas can be erect, trailing or climbing. The seeds also vary in size, shape, colour and the number of seeds per pod.

Niger is the main exporter of cowpea and Nigeria is the main importer and the leading cowpea producer (FAO, 2018). Outside Africa, the major production areas are Asia, Central America and South America. United States of America is the most substantial producer and exporter of cowpea in the developed world (Carlos, 2004). In terms of the land area for cowpea production, Niger has the largest area (5.2 million hectares) which is over 36% of the world total land area for cowpea production but due to their lower yield per hectare (383Kg), they are the second world producers after Nigeria that has3.6 million hectares, about 25% of the world total land area and 852Kg/ha productivity (FAO, 2018).

In some traditional cropping methods in Nigeria, the yield could be as low as 100 kg/ha (Abdullahi *et al.,* 2015). The low productivity of cowpea in Nigeria is mostly attributed to high level of illiteracy, high cost of inputs, physical and biotic constraints, lack of high yielding seeds coupled with the use of primitive and crude tools, such as hoes, cutlasses, axes etc. However, Savana soils are also said to be inherently low in nutrients particularly nitrogen and phosphorus. Phosphorus (P) is among the most needed elements for crop production in many tropical soils. Phosphorus is critical to cowpea yield because it is reported to stimulate growth, initiate nodule formation as well as influence the efficiency of the rhizobium-legume symbiosis (Haruna and Aliyu, 2011).

Cowpea's high protein content, its adaptability to different types of soil and inter-cropping systems, its resistance to drought, and its ability to improve soil fertility and prevent erosion, make it an important economic crop in Nigeria. The sale of the dry stalks and leaves (haulms) and also the husks (the dry outer covering of the seeds) as animal feed during the dry season provides a vital income for the farmers. Cowpea plays several key roles in the nutrition and economic life of many people in Nigeria and the world over. According to Usman *et al.,* (2014), cowpea has a protein content of about 23% making it a good source of plant protein. It was further reported that it has an implication in its ability to cover a gap created by inadequacy of animal protein in the diet of common people in poor countries including Nigeria. Cowpea is gradually attaining its economic importance all over Nigeria even though the bulk of the production is done in the semi-arid zone of the northern part of the country (Petu-Ibikunle and Smith, 2008). The increasing socio-economic importance of cowpea may be due to its food value to both humans and livestock and ability to improve the fertility and cover for the soil against erosion. Its high protein content comparable only to that of the animals makes it a good supplementary source of protein (Ya'aishe *et al*., 2010). Apart from having much protein content than the cereals, cowpea is also a good source of dietary fibre and starch, minerals and vitamins.

Most farmers in Nigeria practice subsistence farming with low productivity and consequent inefficiencies. This is mostly attributed to both technical and allocative inefficiencies resulting from the farmers' lack of access to appropriate inputs and relevant information that could guide them to higher and efficient productions. Since cowpea production is mainly dominated by small scale farmers who have limited resources and produce the crop under unfavourable conditions like; little use of inputs, marginal farmlands and intercropping with competitive crops in some cases which mostly leads to inefficient production and consequently low economic efficiency, there is great need for all the stakeholders of cowpea production not only in the study area, but all over the country and beyond to inculcate the awareness for the need of increased and economically efficient cowpea production and its determinants that will lead to its profitability. For an economic efficiency of cowpea production to be achieved, efficiency at both allocative and technical must be achieved since economic efficiency is the totality of both technical and allocative efficiencies (Farrell, 1957). That is; economic efficiency is the result of the product of both technical and allocative efficiencies. Since the economic efficiency is the totality of both technical and allocative efficiencies, there is need to consider both for effective analysis and informed decision as to the appropriate steps to be taken to improve the economic efficiency and profitability of the cowpea production. Hence, the need for the current study; to empirically investigate the technical efficiency, allocative efficiency and the economic efficiency and its determinants of the cowpea production in the Western Agricultural Zone of Nasarawa State, Nigeria.

Materials and Methods

The study was conducted in the Western Agricultural Zone of Nasarawa State, Nigeria, where cowpea production is prevalent. Nasarawa state is made up of 13 local government areas (LGAs) divided into three agricultural zones by the Nasarawa Agricultural Development Programme (NADP). The Western zone consists of four LGAs namely; Karu, Nasarawa, Keffi and Toto, with its zonal headquarters in Keffi. The agricultural zone lies within the guinea savannah climatic zone of the state with annual rainfall ranging between 1000mm and 1500mm.The zone has tropical climate marked by distinct dry and wet seasons with annual mean temperature ranging from 23^0C–37^0C. The natural vegetation in the area is of the savannah type, featuring dense tropical woodland with shrubs and grasses.

The population of interest was all the Cowpea Farmers of the Western Agricultural Zone of Nasarawa State while the sampling unit was the cowpea farming household. A multi-stage sampling technique was used. In the first stage of sampling, Karu and Keffi local government areas were purposively selected from the four Local Government Areas of the State due to the prevalence of cowpea production in the two areas. In the second stage, eight wards were randomly selected, four from each of the Local Government Areas. The third stage of sampling was the random selection of two villages each from the eight wards. Finally, a simple random sampling technique was used to select 10 cowpea farmers in each of the 16 villages selected. This resulted in a sample size of 160 cowpea farmers. From the reconnaissance conducted in the study area, a total of 600 cowpea farmers were identified in the zone (NADP, 2017). This number serves as the sampling frame for the study. The Data collection was through the administration of a structured questionnaire in the study area for the 2017 cowpea cropping season. Information collected includes; Family and Hired labour input (Man-days), capital input- rent on land(₦), output (Kg), input prices (₦), seeds (Kg), agro-chemicals (L).

This study estimated the economic efficiency level and assessed it determinants among cowpea farmers in the study area by applying the Data Envelopment Analysis (DEA) at constant return to scale (CRS) and the application of a two-limit tobit regression; the economic efficiencies were regressed against the potential determinants (the socio-economic attributes of the cowpea farmers). Tobit model, which is also known as censored regression model is designed to estimate linear relationships between variables when there is left and/or right censoring in the dependent variables. A two limit (left and right censored) tobit model was applied in this study because efficiency scores are bounded between zero and one (0 and 1). The regression was used to determine the impact of certain desirable attributes of the farmers and some institutional-support factors on the economic efficiency scores generated through the DEA analysis.

Concepts of Efficiency

Based on Koopmans's (1951) and Debreu's (1951) work on the measure of efficiency, Farrell, (1957) proposed that the efficiency of a firm consisted of three components: technical, allocative and economic efficiencies. Technical efficiency is defined as the ability to produce a given level of output with a minimum quantity of inputs under certain technology. Allocative efficiency on the other hand refers to the ability to choose optimum input levels for a given factor prices to produce maximum output. While economic efficiency is the product of both technical and the allocative efficiencies. Thus, economic efficiency refers to the choice of the best combination of inputs for a particular level of output which is determined by both input and output prices (Wautabouna, 2012).The concept of economic efficiency in the production of cowpea is therefore associated to the criterion of value. Thus, any change that is inclined to the increase of productivity, performance of the inputs, quality and quantity of the output and higher profitability and return on investment on the one hand, and of the reduction of the total production costs on the other hand is considered to be economically efficient cowpea production and economically inefficient when it is in the contrary.

Efficiency Estimation Methods

Parametric or stochastic frontier production approach and the non-parametric or data envelopment analysis approach are the two basic approaches to efficiency estimations (Kenneth, 2013). The stochastic frontier approach assumes a functional relationship between outputs and inputs and uses statistical techniques to estimate parameters for the function. It incorporates an error term composed of two additive components: a symmetric component that accounts for statistical noise associated with data measurement errors and a non-negative component that measures inefficiency in production (Kenneth, 2013). The disadvantage of stochastic frontier approach is that it imposes specific assumptions on both the functional form of the frontier and the distribution of the error term. In contrast, the non- parametric or data envelopment analysis (DEA) that is used in this study uses linear programming methods to construct a piecewise frontier of the data. Because it is non-parametric, data envelopment analysis does not require any assumptions to be made about functional form or distribution type. It is thus less sensitive to mis-specification relative to stochastic frontier approach. However, the deterministic nature of data envelopment analysis means that all deviations from the frontier are attributed to inefficiency

Data Envelopment Analysis (DEA) Model Specifications

Data envelopment analysis (DEA) is one of the several techniques that can be used to calculate the best practiced production frontier (Osman et al. 2009). The Farrell input-oriented measure of efficiencies will be used in this study as a measure of efficiency since farms tend to have a greater control over their inputs than over their outputs. Farrell (1957) proposed that the efficiency of a firm consists of two components: (1) technical efficiency, which reflects the ability of a firm to obtain maximum output from a given set of inputs; and (2) allocative efficiency, which reflects the ability of a firm to use the inputs in optimal proportions, given their respective prices and the production technology. These two measures are then combined to provide a measure of economic efficiency (also referred to as cost efficiency). The Farrell measure equals 1 for farms on the efficiency frontier, and then decreases with inefficiency as low as 0. The DEA model constructed will be based on the assumption that each cowpea farm produces a quantity of (yi,) using multiple inputs (xi,) and that each farm (i) is allowed to set its own set of weights for both inputs and output. The data for all farms are denoted by the *K* x N input matrix (X) and *M* x N output matrix (Y).): Using the DEA model specification, the TE score can be calculated for the i^{th} farm as the solution to linear programming (LP) problem below:

$$TE_n = Min_{i\theta\lambda}\theta_n \qquad (1)$$

Subject to; $Y\lambda - yi \geq 0$

$\theta Xi - X\lambda \geq 0$

$\lambda \geq 0$

Where, TE is the technical efficiency, θ is the technical efficiency score having a value of $0 \leq \theta \leq 1$. If the value is = 1, the farm is on the frontier. The vector λ is an N x 1 vector of weights that define the linear combination of the peers of the i^{th} farm. The input based minimum cost for the i^{th} farm can be obtained by solving the following linear programme problem;

$$MC_i = Min_{\lambda x*i} W^T_i X*_I \qquad (2)$$

Subject to; $Y\lambda - y_i \geq 0$

$X^*_i - X\lambda \geq 0$

$\lambda \geq 0$

Where; MC_i is the minimum total cost for the i^{th} farm, W_i is a vector of an input prices for the i^{th} cowpea farm; subscript T is the transpose function; X^*_i is the cost minimising vector of input quantities for the i^{th} cowpea farm calculated by the linear programming, given the input prices W_i and output level yi; and λ is an Nx1constatnt vector. Equations 1 and 2 represent the cost minimisation under the constant return to scale (CRS) technology. Here, constant to scale means that, the output changes in proportion to changes in all inputs. The cost efficiency $(CE_i)_{(CRS)}$ of the i^{th} farmer can then be calculated thus;

$CE_{i(CRS)} = W^T i X^*_i / W^T X_i$ which is also = the EE in terms of price of the input or = to the revenue efficiency in terms of the revenue of the output

That is; $CE_{i(CRS)}$ = the ratio of the minimum cost to the observed cost given input prices and Constant Rate of Scale(CRS) technology(Coelli et al. 1998). Despite having the cost efficiency or revenue efficiency being equal to the economic efficiency of a firm, the overall efficiency of a firm is still the product of the TE and the AE (Onur, 2014).

That is; $EE = TE \times AE$ (3)

The allocative efficiency (AE) is calculated residually from equation 3 as follows:

$AE_{CRS} = EE/TE$

Tobit Regression Model Specifications

The economic efficiency estimates that are obtained through the DEA method described above were regressed on some farm and household specific attributes using the Tobit model. This approach has been used widely in efficiency literature (Kenneth, 2013). The farm and household specific factors to be regressed here include; age, school years, farming experience of the farmer, farm size and the number of extension contact a farmer had during the period.

The tobit model is specified as follows:

$U^*_i = \beta o + \Sigma^k_{j=1} \beta_j Z_{ij} + Ui$

U_i^* = latent variable representing the economic efficiency score for the i^{th} farm;

β_0 and β_j = parameters to be estimated;

$Ui = 1$, if $U^*i \geq 1$

$Ui = U^*i$, if $0 < U^*i < 1$

$Ui = 0$, if $U^*i \leq 0$

Zij = hypothesized determinants of efficiency scores or latent variable, namely: age (years/No), household size (No), level of education (years/No) and cowpea farming experience (years/No) etc. The latent variable (U_i^*) is generated from the observed variable U_i through DEA estimation, which ranges from zero to one (0-1).

Z_1= age (years)

Z_2 = extension contacts (No)

Z_3 = school years (yrs/No)

Z_4 = farming experience (yrs/No)

Z_5 = farm size (ha)

Results and Discussion

Efficiency of Cowpea Production

As shown in Table 1, the mean technical, allocative and economic efficiencies were at; 0.31, 0.18 and 0.06 in the study area, respectively. This shows that the cowpea farmers in the study area are more technically efficient than they are allocative and generally lower in terms of the economic efficiency. Meanwhile With the standard deviation (SD) of the TE, AE and EE at 0.23, 0.21 and 0.09 respectively, it shows that the variability of the results around the mean is more in TE than in AE and lower in EE. However, the coefficient of variation (CV) is higher in the EE followed by that of the TE and lowest with the AE. The smaller the CV, the more consistent the data is and the better for predictability due to lower dispersion of the results.

Table 1.0: Descriptive statistics of the Efficiencies

Statistics	Technical Efficiency (TE)	Allocative Efficiency (AE)	Economic Efficiency (EE)
Maximum	1.0	0.84	0.42
Minimum	0.03	0	0
Mean	0.31	0.18	0.06
Standard Deviation	0.23	0.21	0.09
Coefficient of Variation	74.2	11.7	150

Source: Field survey, 2018

Estimated Technical Efficiency of the Respondents

The frequency distribution of the technical efficiency levels of the respondents in the study area as presented in Figure 1 indicates that respondents whose technical efficiency ranged from; 0 – 0.13 constituted about 19% of the respondents, 0.14 – 0.27 (35%), 0.28 – 0.41(26%), 0.42 – 0.55(10%), 0.56 – 0.69(1.3%), 0.70 – 0.83(2%) and 0.84 – 1(6%) with the minimum and maximum efficiencies at 0.03 and 1 respectively. Meanwhile, the mean technical efficiency is at 0.31. This implies that majority (about 70%) of the respondents in the study area produced below the technical efficiency frontier(1) and that an average farmer in the study area has the scope for increasing TE by 0.69 in the short run under the existing technology. The results also showed that on the average, over 61% of the farmers in the study area were not able to obtain up to 50% technical efficiency level from a given mix of production inputs. These results are consistent with those of Sabiko et al., (2010) who reported mean technical efficiency of about 0.4 but inconsistent with those of Sofoluwe and Kareem, (2011), Omonona et al., (2010), Taru et al., (2011) and Oseni et al., (2015) who reported mean technical efficiency; 0.66, 0.87, 0.89, 0.76 respectively as against the 0.31 mean TE in the current study.

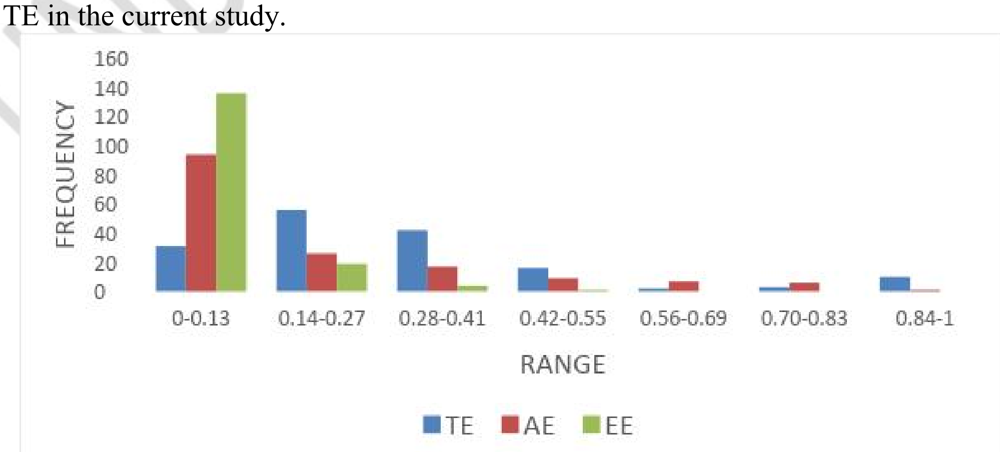

Figure 1.0: Frequency distribution of the TE, AE and the EE

Estimated Allocative Efficiency of the Respondents

The frequency distribution of the allocative efficiency of the respondents in the study area is shown in Figure 1. It shows that those within the range of 0 – 0.13 were in the majority (58.7%) while, the remaining ranges and percentages were as follows: 0.14 – 0.27(16.3%), 0.28 – 0.41(10.6%), 0.42 – 0.55(5.6%), 0.56 – 0.69(4.4%), 0.70 – 0.83(3.8%) and 0.84 – 1(0.63%). From the allocative efficiency ranges, no cowpea farmer reached the frontier (1) in the study area and over 85% of them could not even reach the 50% allocative efficiency level of 0.5. The mean AE was at 0.18. This indicates that an average farmer in the study area has the scope for increasing allocative efficiency by up to 82% in the short run under the existing management, prices of inputs and output to be able to reach the frontier(1). However, the result tend to agree with those reported by Kenneth et al., (2013), who reported mean allocative efficiency in Eastern Uganda to be around 0.2, but at variance with those of Jimjel et al., (2012) who reported the mean allocative efficiency to be at 0.66. These results generally imply that majority of the cowpea farmers were not able to apply the right combinations of available inputs given the current input prices in such a manner that could minimize their overall production costs and improve their allocative efficiencies (0.18).The implications of the low allocative efficiency result of the cowpea operations in the study area means that, the farmers were not able to equate the ratio of marginal product of inputs with the ratio of their prices (Yotopolous, 1971). That is to say that, the prices of output were low while those of inputs were high and the allocations and distribution of both inputs and output were improper to the extent of making the whole process costly and therefore unprofitable. The low allocative efficiency had a direct effect on the economic efficiency of the farm since economic efficiency is the product of TE and AE.

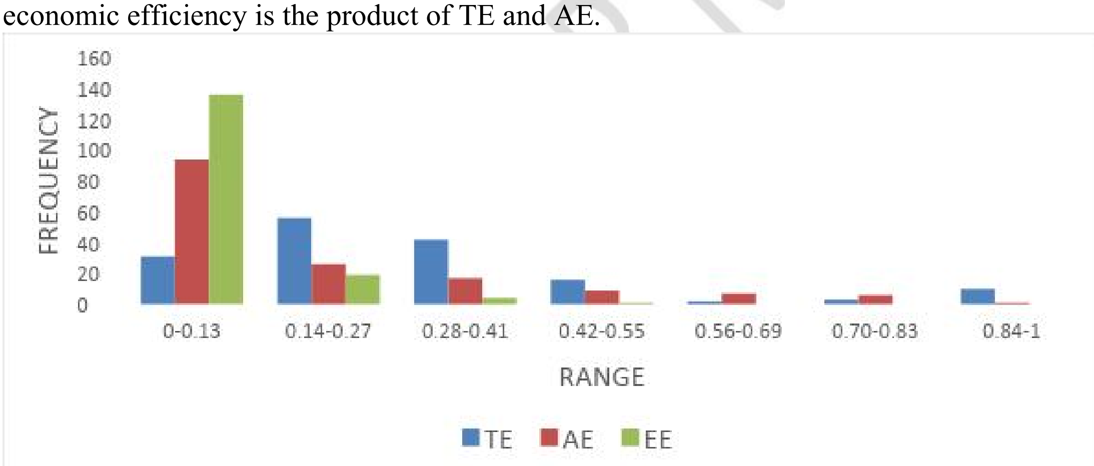

Figure 1.0: Frequency distribution of the TE, AE and the EE

Estimated Economic Efficiency of the Respondents

Figure 1 also shows the frequency distribution and the ranges of the economic efficiency results obtained. The efficiency ranges and their equivalent percentages were as follows: 0 – 0.13 (85%), 0.14 – 0.27(11.9%), 0.28 – 0.41(2.5%), 0.42 – 0.55(0.63%), 0.56 – 0.69(0%), 0.7 – 0.83(0%) and 0.84 – 1(0%). None of the respondents reached the frontier production level of 1 and the best performing famers produced at 0.42 while the least was zero (0). The mean, highest and the least economic efficiency levels were at, 0.06, 0.42 and 0.0 respectively. This indicates that the economic efficiency performance in the study area is poor. These results are at variance with that of Kenneth et al., (2013) who reported higher economic efficiency of 0.60 in their studies. At 0.06 mean economic efficiency, it means that majority of the respondents in the study area are yet to achieve their best in terms of reaching the frontier (1). This indicates that an average farmer in the study area has the scope for increasing economic efficiency by up to 0.94 in the short run under the existing management, prices of inputs and output to be able to reach the frontier since the mean EE was at 0.06. This also indicates that the overall profitability of cowpea production in the study area is negatively affected. This has been confirmed by the presence of both low technical and allocative efficiency results for their operations as shown in Figure 1. With the low EE therefore, it means that both the allocative and the technical efficiencies were both not high enough to support higher economic efficiency since economic efficiency is the product of the TE and AE. It is also evident from this study that economic efficiency (EE) of the cowpea farmers could be improved substantially and that low allocative efficiency constitutes a more serious problem than technical efficiency judging from the average technical and allocative efficiency obtained in the study area; 0.31 and 0.18 respectively. Generally however, both the technical efficiency (0.31) and allocative efficiency (0.18) are serious problems to the cowpea production in the study area, vis-à-vis economic efficiency.

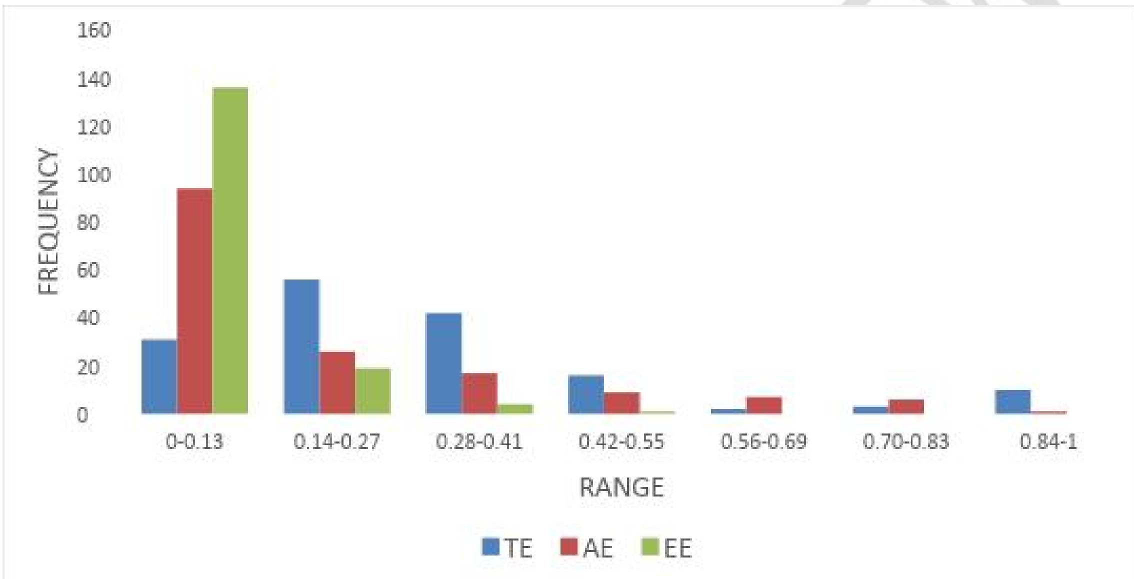

Figure 1.0: Frequency distribution of the TE, AE and the EE

Determinants of the Economic Efficiency

The results in Table 2 show estimates of the two-limit tobit regression of selected socio-economic and institutional-support factors against farmer-specific economic efficiency scores. The explanatory variables chosen for the regression were; age, years spent in school, farming experience, farm size and extension visit. Among the selected variables, the farm size positively and significantly influenced the economic efficiency. That is to say that increasing the farm size translates into increase in the economic efficiency. This result was similar to what Kenneth *et al.* (2012), Omonona *et al.* (2010), Ya'aishe *et al.,* (2010), Taru *et al.,* (2011), Dadson et al., (2013), Jimjel et al., (2012) and Egbetokun and Ajijola, (2008) observed in their studies. They observed that farm size was significant and positively affected the efficiency, but at variance with the observations of; Oseni *et al.,(*2015) and Sofoluwe and Kareem, (2011) where plot size was not one of the positive influencing factors of the economic efficiency. Meanwhile, the school years, farming experience and extension visit had no significant effect or influence on the economic efficiency except for the age that was negative but not significant.

Table 2.0: Tobit Regression Estimates of Factors Influencing Economic Efficiency.

Variable	Coefficient	Standard Error	T-Value
Constant	0.0038	0.0318	0.121
Age	- 0.002	0.0007	-0.121
School Years	0.001	0.0014	0.71
Farming Experience	0.0014	0.001	0.14
Farm Size	0.032	0.0095	3.33
Extension Visit	0.0025	0.0023	1.09

Source: Field survey, 2018

Conclusion

The main objective of this study was to estimate the economic efficiency level and to assess it determinants among cowpea farmers in the Western Agricultural Zone of Nasarawa State, Nigeria. The average farm size was 1.0 ha. Since economic efficiency is the product of both technical and the allocative efficiencies, the two efficiencies were also determined and the following results were obtained; mean technical and allocative efficiencies were: 0.31 and 0.18 respectively. Economic efficiency among the cowpea farmers in the study area was 0.06 with farmers having higher farm sizes showing a significantly higher efficiencies than those with smaller plots. However, there was a large discrepancy between the most efficient and the least efficient farmer. Finally, the two-limit tobit regression of some selected socio-economic and institutional support-factors against the farmers' economic efficiency scores shows that only the farm size positively and significantly influenced the economic efficiency at 5% level of significance with the age being a negative influence to the economic efficiency.

Recommendations

Since the economic efficiency is the product of both the technical and allocative efficiencies, efforts geared towards improving the economic efficiency of the cowpea farmers should be holistic and inclusive of both the technical and allocative efficiencies. The study also recommends the need for policies of government at all levels and all the stakeholders to discourage land fragmentation and promote efforts that encourage farmers to form strong cooperatives so that they can pool their resources together to increase their scale of operations and by so doing improve their cowpea production efficiency.

REFERENCES:

Abdullahi, Z., Makama, S. A. and K. I. Mika'il, (2015): Resource Use Efficiency in Small Scale Cowpea Production System in Dawakin Kudu Local Government Area, Kano State, Nigeria, *Journal of Agriculture and Sustainability,* 8(2): 69-82

A.O. Egbetokun and S. Ajijola (2008): Technical Efficiency of Cowpea Production in Osun State Nigeria; *Journal of Continental Agricultural Economics.* 2: 32 - 37.

Carlos*, G.,* (2004):"Cowpea Post-harvest Operations". *Food and Agriculture Organization of the United Nations. Retrieved 2017*

Coelli, T.J., P.D.S. Rao, C.J. O'Donnell and G.E. Battese, (2005). *An Introduction to Efficiency and productivity Analysis.* New York, USA: Springer Science Business+ Media Inc.

Dadson, A., Bakang, J. and Smith, C. (2013): Estimation of Farm Level Technical Efficiency of Small-Scale Cowpea Production in Kumasi, Ghana. *American-Eurasian Journal of Agriculture & Environmental Science.*13 (8): 1080-1087

Debreu, G. (1951): The coefficient of resource utilization, *Econometrica*, 19(3): 273 – 292

Farrell, M.J. (1957): The Measurement of Productivity Efficiency; *Journal of Royal Statistical Society Series A.*120 (3):253-290.

Food and Agriculture Organisation of the United Nations (FAO): FAOSTAT; 2018. Available at www.fao.org/faostat/en///data/QC

Haruna, I.M. and Usman, A. (2013): Agronomic Efficiency of Cowpea Varieties under Varying Phosphorus Rates in Lafia..*Asian Journal of Crop Science.* 5(2):209-215

Jimjel, Z., Maurice, D.C. and Comfort, Y. (2014): Determinant of Cost Efficiency in Cowpea Production: A Case Study of Adamawa State, Nigeria. *International Journal of Science and Research (IJSR) 3(9)*

Kenneth,W. S., Owuor, G., and Birachi, E.O. (2013): Analysis of Determinants of Productivity and Technical Efficiency among Smallholder Common Bean Farmers in Eastern Uganda, *Current Research Journal of Economic Theory.*5(3): 44-55

Koopmans, T. (1951) Activity analysis of production and allocation. John Wiley & Sons, New York. pp 33-97,

Nasarawa State Agricultural Development Programme (NSADP), Zonal Office Keffi, November, (2017)

Okereke, G.U., Egwu, S.E., and Nnabude, P. (2006): Effect of Cowpea Organic Residues and Fertilizer on Soil Fertility, Growth and Yield of Upland Rice. Proceedings of the Eighteenth World Congress Soil Science. Philadelphia, Pennsylvania, USA, July 9-15

Omonona, B.T., Egbetokun I., O.A. and Akanbi A.T. (2010): Farmers Resource – Use and Technical Efficiency in Cowpea Production in Nigeria. Economic Analysis & Policy, 40:1

Onur, T., (2014): The Relationship of Technical Efficiency with Economical or Allocative Efficiency: An Evaluation. *Quest Journals: Journal of Research in Business and Management 2(9):01-12*

Oseni, Y., Nwachukwu W. and Usman Z. A. (2015): Measurement of technical efficiency and its determinants in sampea-11 variety of cowpea production in Niger State, Nigeria. *International Research Journal of Agricultural Science and Soil Science:*5 (4): 112-119

Osman, K., Vedat C. & Isil A. (2009): Determinants of economic efficiency: A case study of Hazelnut (Corylusavellana) Farms in Samsun Province, Turkey, *New Zealand Journal of Crop and Horticultural Science,* 37(3): 263-270

Petu-Ibikunle, A.M., Abba-Mani. F, Odo. P.E., (2008). Determination of Rate and time of Nitrogen Application on Cowpea variety in the Sudan Savannah zone. *International Journal of Academic focus series* 1(1): 13-21.

Savana Agricultural Research Institute (SARI) Kenya, (2012): Production Guide on Cowpea (Vigna Unguiculata L. Walp)

Sibiko, K.W., Mwangi, J.K., Gido, E.O., Ingasia, O.A. and Mutai, B.K. (2010): Allocative efficiency of smallholder common bean producers in Uganda: A stochastic frontier and Tobit model approach; *International Journal of Development and Sustainability,* 2 (2): 640-652.

Small, E., (2009):Top 100 Food Plants, *NRC Research Press. P.104, Taxonomy and Etymology of cowpea: https//en.wikipedia.org/wiki/cowpea*

Sofoluwe Nurudeen and Kareem Rasaki, (2011): Technical Efficiency of Cowpea Production in Osun State, Nigeria. *Journal of Natural Sciences Research,* 1 (2): 29-34

Taru, V. B., Lawal, H. and Tizhe, I. (2014): Technical Efficiency of Sole Cowpea Production in Adamawa State, Nigeria A Cobb-Douglas Stochastic Frontier Function, *Journal of Economics and International Finance,* 3(8):504-507

Usman, S. M. and Fatima, K. M. (2014): Profitability Analysis of Cowpea Production in Rural Areas of Zaria Local Government Area of Kaduna State, Nigeria. *International Journal of Development and Sustainability,* 3(9): 1919-1926

Wautabouna, O. (2012): Economic Efficiency Analysis in Côte d'Ivoire. *American Journal of Economics,* 2(1): 37-46

Ya'aishe, A. P. and Petu-Ibikunle D.W. (2010): Economic Analysis of cowpea Production among women farmers in Askira-Uba L.G.A., Borno state. *African journal of general agriculture,* 6(1):7-9.

Yotopolous A. Pan and Lawrence J. Lau, (1971): A Test for Relative Efficiency and Application to Indian Agriculture; *the American Economic Association Review, 61(1); 94-109*