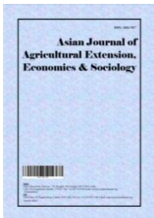

Asian Journal of Agricultural Extension, Economics & Sociology

38(3): 93-101, 2020; Article no.AJAEES.55747
ISSN: 2320-7027

Measurement of Technical Efficiency of Women Cassava Farmers in Ankpa Local Government Area, Kogi State, Nigeria

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/AJAEES/2020/v38i330328
Editor(s):
(1) Dr. Zhao Chen, University of Maryland, USA.
Reviewers:
(1) Srinivasa Rao Kasisomayajula, Madanapalle Institute of Technology and Science, India.
(2) Noufou Coulibaly, Institut National Polytechnique Félix Houphouët-Boigny, Côte d'Ivoire.
Complete Peer review History: http://www.sdiarticle4.com/review-history/55747

Original Research Article

Received 14 January 2020
Accepted 20 March 2020
Published 22 April 2020

ABSTRACT

The study was about technical efficiency of women cassava farmers in Ankpa Local Government Area of Kogi State, Nigeria. A simple random sample of 120 women cassava farmers were interviewed with a structured questionnaire and information concerning their socioeconomic attributes, revenue realized and cost incurred in cassava production were obtained. The data were analysed with the use of stochastic frontier Cobb-Douglas production function and the inefficiency model. Results indicated that farm size, family labour, hired labour, equipment depreciation, cassava stems, fertilizers and transportation had positive coefficients and thus influenced cassava output positively. Education, household size, farming experience and extension visits increased farmers' technical efficiency. Many farmers had high technical efficiency. The mean technical efficiency was 76 percent with a maximum of 98 percent technical efficiency. Recommendation made to improve cassava production were making farm inputs available at affordable prices, review of land tenure system, opening up of more credit agencies and increase extension visits among others.

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Keywords: Technical efficiency; women; cassava; farmers; measurement.

1. INTRODUCTION

Nigeria is ranked as the World's largest producer of cassava with an estimated output of about 54MT and this is considered to be about 19 percent of the total world production [1]. Other top producers are; Indonesia, Thailand, the Republic of Congo and Angola. FAOSTAT [1] reported that Nigeria has consistently been ranked as the largest producer of cassava since 2005 and the estimated production for year 2010 was about 37,5 million tonnes. It is noted that cassava production in Nigeria is done by continuous expansion in land rather than attempting to increase productivity per unit. It is further noted that while production volume and area harvested have increased significantly over the years, productivity slows with marginal increase from 100,000 kg in 1980 to 120,000 kg in 2011 [1]. As reported by [2] in their study revealed that cassava farmers in Nigeria are not technically efficient with a mean score of 72.14 percent. In a similarly study by [3] observed that the mean technical efficiency level of cassava farmers in Ogun State, Nigeria stood at about 79 percent. In a study by [4] observed that despite the fact that Nigeria is the largest producer of cassava in the world, production lags behind the increasing local demand for food and industrial usage, and cassava products are not price competitive in the global market. Also in a similar studies by [5] reported that despite the several efforts been made by the Nigerian government to improve the efficiency and productivity of cassava, yet, the farmers have not yet attained the desired technical efficiency in cassava production which may possibly be associated with poor access to agricultural farm inputs such as fertilizers, access to credit, herbicides, among others.

Cassava (*Manihot esculenta crantz*) is a perennial woody shrub with starch roots which are used for food, [6]. Cassava is a very popular food crop in Nigeria, where it is grown mostly in the south and middle belt religious with high rainfall. Small scale farmers grow most of it. It is mainly propagated from stem. It is usually planted on ridges and moulds for case of root penetration. Cassava is planted any time from the beginning of rainy season to about 6 weeks before the termination of rainy season [7]. Cassava can be harvested 12-15 months after planting. Even varieties that mature earlier than this duration have been developed by breeders.

Cassava is valued mainly for its roots. The roots are used for food and industrial raw materials. The roots are processed into flour, *Akpu,* garri *and lafun* [8]. The flour is mixed with flour of grains such as maize and sorghum and steamed to make a paste which is eaten with soup. The flour is also mixed with wheat flour to make bread. The leaves are used as livestock feed and as vegetable for human consumption [9].

These numerous uses have made cassava to gain more importance as a crop that can adequately secure nations with food and foreign exchange [10].

Efficiency of production is a measure of how much output have been obtained with a given level of inputs. In other words, it is the ratio of output and inputs. Farrel [11] decomposed this efficiency into technical, allocative and economic efficiency. The concept of technical efficiency entails comparison between observed and optimal values of output and inputs of a production unit. It is concerned with how closely the production unit operates to the frontier of production possibility set [12].

Technical efficiency is the ability of a farmer to produce a given level of output with a minimum quantity of resources under a given technology. The locus of points of outputs that can be produced with different mixtures of inputs is referred to as production frontier. Maximum efficiency is attained when it is impossible to reshuffle a given resource combination without decreasing the total output [13]. Technical efficiency of a production process is considered to be an amalgam of various factors which may be either within or outside the control of the producers. On the other hand, technical inefficiency may lead to unintended results which may not be the overall interest of the producer. As reported by [14], they observed that geographical locations of production sites may have varied climatic conditions and altitudes which may directly or indirectly have effects on the production of any given crop. The vulnerability of some localities to shocks and negative weather effects as well as proximity of the producers to information, all may likely affect the level of yield obtained in production [15].

Farmers with their production resources and technology are trying to reach the production frontier. A measure of a farmer's technical efficiency is his closeness to the production frontier. Allocative efficiency measures the degree of success in achieving the best combination of different inputs in producing specified level of output having regard to the relative prices of these inputs [13]. The point of allocative efficiency on the production frontier is the point of tangency of the production frontier and the price line of the inputs. At that point, the least cost combination of inputs is achieved. Economic efficiency is the product of technical and allocative efficiency [16]. Women cassava farmers are said to be technically efficient when they combines the optimum combination of inputs to produce a given quantity of cassava. On the other hand, the women farmers may be technically inefficient if they fail to produce maximum output of cassava from a given set of inputs. This scenario reflects a situation in which the women farmers operating beneath the stochastic production functions frontier. Using stochastic frontier production function, it is possible to find out whether the deviation in technical efficiencies from the frontier output is due to the women farmers' specific factors or due to some external factors. Technical Efficiency (TE) is therefore defined as the amount by which all inputs applied could proportionally reduce without any decline in the level output. It is normally expressed in percentage with values ranging from zero and one. Technically, if the value of TE is equal to 1, it implies that the women cassava farmers' produces at full technical efficiency and vice versa.

In Nigeria, cassava is produced mostly by small scale farmers of which women form a significant part. Even though women have been part of the workforce on the farms, they are never consulted on farm house hold decisions. This study is therefore aimed at showcasing the contribution of women in the production of a major arable crop. The specific objectives of the study are to describe the effects of inputs used on the output of cassava and measure the technical efficiency of women cassava farmers and their distribution based on the technical efficiency.

2. MATERIALS AND METHODS

The study was carried out in Ankpa Local Government Area (LGA) of Kogi State, Nigeria. The study area shares boundaries with Oturkpo LGA of Benue State in the North, Olamaboro LGA in the East, Omala LGA in the West and Dekina Local Government Area in the South. Most of the inhabitants are farmers. Major crops grown by these people are yam, cassava, maize, sorghum, cowpea, melon, groundnut and soybean. Major tree crops grown in the area are oil palm trees, cashew, orchard and mango. Animals that are raised in the area are cattle, sheep, goat and poultry.

Purposive and simple random samplings were used to select the respondents for the study. Purposive sampling was used to select two villages from each of the three districts that make up the Local Government Area. Purposive sampling was used to select the villages based on the records of the State Agricultural Development Project which showed that the villages were leading cassava producers. A simple random sample of 20 women cassava farmers was drawn from each village making a total of 120 women cassava farmers and these were used for the study.

Structured questionnaire was used to collect information from the respondents Information obtained from the respondents were their socio-economic characteristics such as age, education level, marital status, farm size, extension visit and farmers association. Information was also collected on types, quantities and prices of inputs such as fertilizers, herbicides, cassava stems, implements, transportation and cassava output and its value.

Cob-Douglas production function was modeled as a stochastic frontier production function and used to analyse the data. The function was chosen because it has been widely used in developed and developing countries. It meets the requirement of being self-dual and it allows examination of economic efficiency [17].

The stochastic frontier Cobb-Douglas production function used was specified as follows:

$$\text{Log } Y = \log b_0 + b_1 \log X_1 + b_2 \log X_2 + b_3 \log X_3 + b_4 \log X_4 + b_5 \log X_5 + b_6 \log X_6 + b_7 \log X_7 + b_8 \log X_8 + V_i - U_i \quad (1)$$

Where Y = Output of cassava (Kg)

X_1 = Farm size (Ha)
X_2 = Family labour (Man- days)
X_3 = Hired labour (Man- days)
X_4= Depreciation of farm tools (Naira)
X_5 = Herbicides (litres)
X_6 = Cassava stems (Kg)
X_7 = Fertilizers (Kg)
X_8 = Transportation cost (Naira)

b_0 = Constant
$b_1 – b_8$ = estimated coefficients
Log = Natural logarithm
V_i = Random error due to statistical noise, whether, diseases etc which are not under farmers' control. V_i is assumed to be independently and normally distributed while Ui has half normal or exponential distribution [18].

The technical inefficiency model was also specified as follows:

$$\mu_i = \sigma_0 + \sigma_1 z_1 + \sigma_2 z_2 + \sigma_3 z_3 + \sigma_4 z_4 + \sigma_5 z_5 + \sigma_6 z_6 + \sigma_7 z_7 \quad (2)$$

Where:

μ_i = Randomness, that is, technical inefficiency
z_1 = Age of the farmers in years
z_2 = Years spent in schools
z_3 = Household size, that is number of persons in the household
z_4 = Years of cassava farming experience
z_5 = Number of extension visits in the previous years
z_6 = Access to credit
z_7 = Membership of farmers' association
σ_0 = Constant
σ_1 - σ_7 = estimated parameters

Maximum likelihood estimation procedure was used to jointly estimate the stochastic frontier Cobb-Douglas production function and technical inefficiency model.

3. RESULTS AND DISCUSSION

3.1 Effects of Inputs on the Output of Cassava

The coefficient of constant is positive with value of 8.7694 and t-ratio of 46.19. It is significant at one percent probability level. The estimated sigma squared (σ^2) is 0.0567 with t-ratio of 3.4817. It is also significant at 1 percent level of risk. This is an indication of a good fit for the model. The estimated gamma coefficient (Y) is 0.999. It is very high and significantly different from zero at one percent probability level. This means that 99 percent of the variation in cassava output among the farmers was due to their technical efficiency. All the estimated coefficients were positive except the coefficient of herbicide which had negative sign. Farm size, Family Labour, depreciation of farm tools, herbicides, Cassava stems and transport cost had influence on Cassava output, while hired labour and fertilizer did not influence cassava output.

Specifically, the coefficient of farm size was 0.9379 with t-ratio of 4.305. It was positive and significant at one percent level of probability. This means increase in farm size will increase output of cassava. In a similar studies by; [13] and [19] who obtained positive coefficients for farm size. Output of Cassava is likely to increase with increase in farm size.

Family labour had a positive coefficient of 0.2455 and t-ratio of 2.431. It was significant at 1 percent level of risk. The implication is that increase in supply of labour will increases output of cassava. Most of the farmers used family labour because they operated on small scale and therefore contemplating of hiring external labour may mean additional expenditure on the side of the farmer.

The coefficient of depreciation of farm tools was determined to be positive with a value of 0.1099 and t-ratio of 2.6948. It was significant at 1 percent level of risk. The positive value of coefficient of depreciation of farm tools implies that acquisition of more farm tools will lead to more output of Cassava. Fixed inputs contribute very positively to production of crops as earlier discovered by [20].

The coefficient of herbicide was negative and it was estimated at -0.0079 and was significant at one percent level of risk. The result was in this form because most of the farmers did not use herbicides. Most of them operated on small scale and so could not go for herbicides as a result of the increasing cost. However, with increasing awareness through various extension services, this scenario may change as a result of the awareness on the importance of using herbicides as a possible labour saving variable as compared to manual weeding which is characterized by high labour requirement and in some cases non availability of the required labour at the required time.

Cassava stems had a positive coefficient of 0.0763 implying that increase in its use will increase outputs of Cassava. It was significant at 10 percent level of risk. The most viable way of planting cassava is by the use of the stem.

Transport cost had a positive coefficient of 0.0316 and it was significant at 1 percent level of risk. A good transport system will reduce transport time and cost and this will serve as an incentive to the farmers. This is because it makes the evacuation of the produce easily and at any time of the production period. Similarly, good transport network will encourage off-takers, processors and relevant stakeholders in the cassava value chain to invest more, possibly throughout-growers schemes among others. Aggregating the various actors in the cassava value chain will serve as a boost to the cassava growers thereby leading to increase in output of Cassava.

3.2 Technical Efficiency of the Women Cassava Farmers

Several socioeconomic factors can affect technical efficiency or any production process. Generally, in cassava production major variables that mostly affect the production process may include; farmers' land holdings, educational level and the farming experience of the farmers, status of land ownership and the farmers' level of income. As observed by [15] the emergence of technical efficiency concept has presented an interesting scenario regarding the contribution of age in the production process. Sex of the farmers may have impact on technical efficiency in a production process. Empirical studies have shown that male farmers are more technically efficient than their female counter-part [21,22].

The result of the inefficiency model is presented in Table 2. The age of the women farmers in the study area had a positive coefficient of 1.0413 with t-ratio of 2.8132. It was significant at 1 percent level of risk. The coefficient was positive because most of the farmers were relatively young and highly energetic. Depending on the effects of other socioeconomic factors on the age of the farmers, the age of the farmers can either enhance or reduce the level of technical efficiency. As reported in various studies, older farmers are technically efficient than younger farmers [23,24]. Older farmers are observed to be more matured and reasonable and can easily accept and adhere to new innovations and other related extension services as well as other agronomic practices that will help in promoting and increasing farmers' efficiency. Similarly, other studies revealed that young farmers are highly energetic and can accept improved technologies especially if given sensitization and other related support services and that makes them to be more technically efficient than older farmers [25,26]. They concluded that older farmers may be reluctant to accepting new technologies and adamant to change and these may lead to reduced technical efficiency.

The coefficient for education was -0.0204 with t-ratio of -1.7122. The coefficient was significant. It means increase in level of education reduces farmers' technical inefficiency. Education facilitates adoption and participation in group activities [27]. Interaction among farmers leads to cross pollination of ideas which raise their level of knowledge and hence their technical efficiency. Household size on the other hand had a negative coefficient of -0.3281 with t-ratio of -1.89967 which was significant at 5 percent probability level. Large households serve as reservoir of family labour. Families with large households may be more efficient when it comes to supply of labour to meet up with critical farm operations. This may hold, if the household members are willing to support their family in cassava related operations.

Table 1. Estimate of stochastic frontier Cobb-Douglas production function for the cassava farmers

Variables	Coefficient	T-ratio
Constants (In b_0)	8.7694	46.19
Farm size*** (In $b_{1)}$	0.9379	4.305
Family labour***(In b_2)	0.2455	2.431
Hired labour (In b_3)	0.0073	1.2290
Depreciation of tools*** (In $b_{4)}$	0.1099	2.6948
Herbicides*** (In $b_{5)}$	0.0079	3.9330
Cassava Strength* (In b_6)	0.0763	1.7310
Fertilizers*** (In $b_{7)}$	0.0113	1.3510
Transport cost (In $b_{8)}$	0.0316	1.6760
Sigma squared ($\boldsymbol{\sigma}^{2)}$	0.0567	3.4817
Gamma (Y)	0.9999	1649021

Source: Field survey, 2018

Table 2. Estimates of parameters of the inefficiency model

Variables	Coefficient s	T-ratio
Constants σ_0	-3.7971	-2.9764
Age of the Farmers σ_1	1.0413	2.8132
Education σ_2	-0.0204	-1.7122
Household size σ_3	-0.3281	-1.8996
Farming Experience σ_4	-0.6044	-0.0520
Extension Visits σ_5	-0.0302	-2.1118
Access to credit σ_6	0.00.27	0.2336
Farmers Association σ_7	0.0360	0.1923

Source: Computed from field survey, 2018

Farming experience had negative coefficient of -0.6044, meaning that the farmers' technical inefficiency reduces with increase in their years of farming experience. This is because repetition and continuous participation in farming operations year after year and records of past farm events increase farmers environmental adaptation and perfection in carrying out farm operations thereby increasing their technical efficiency which consequently leads to increase productivity with corresponding improve in revenue and return on investment.

Extension visits had negative coefficient of -0.0302 which was statistically significant at 1 percent level of risk. Extension visit is very important in reducing inefficiency because farmers learn modern techniques of farming from extension officers as they are visited. New techniques, technologies, improvement and promotion of new innovations are also introduced, adopted and promoted through the various services of the change agents. Access to credit and farmers association had positive coefficient because the farmers did not obtain loan and they were not members of farmers association. Membership of an association or cooperatives will help in associating the various farming groups for group benefits. Recent developments have shown that promoters of any activity and projects prefer to deal with groups rather than individuals and hence helping them in reducing the stress of managing individual needs than group. Also, at any point in time, they are sure and comfortable in dealing with groups and doing so, will help the promoters in accommodating large number of farmers at a time. Cooperative and groups also help in reducing the risk associated in dealing with an individual and hence promote cohesion and mutual understanding. Access to credit and other related agricultural inputs becomes easier for cooperative groups and associations than individual farmers. Therefore, membership of cooperative groups makes access to agricultural inputs easier, accessible and timely with any possible risk being shared among members than individual taking the entire misfortune, if any.

3.3 Distribution of the Farmers Based on their Technical Efficiency

The distribution of the farmers based on their technical efficiency is presented in Table 3. The range of technical efficiency of 0.10-0.49 had only 9 farmers representing 7.5 percent, while the range of technical efficiency of 0.50-0.99 had 111 farmers representing 92.5 percent. Technical efficiency of the farmers was high with an average of 76 percent and maximum of 98 percent. From the analysis, it is observed that farmers within the technical efficiency range of between 50 percent and 99 percent represented the highest number of respondent and this shows for an average farmer to attain the maximum efficiency level, he may need about 24 percent level of improvement, while for the farmers with highest technical efficiency (99 percent), only 1 percent is required to attain 100 percent efficiency level. As revealed from the result of the analysis, the average technical efficiency of the women cassava farmers in the study area was estimated to be about 76 percent, this indicates that the farmers technical efficiency can be increased by as much as 24 percent. This is a clear indication that the women farmers in the area are relatively efficient at the current stage of their existing technology and it is generally desirable that farmers should navigate to higher level of technology. For the farmers fortune to be improve, technical change can alter the structure of the production process by outward shift of isoquant, thereby changing resource utilization, productivity and the rate of return. This scenario can be achieved by exploring opportunities through which production possibilities can be enhanced and sustained through substituting

Table 3. Frequency distribution of technical efficiency of the farmers

Efficiency	Frequency	Percentage
Levels		
0.10-0.29	1	0.8
0.30-0.49	8	6.7
0.50-0.69	30	25.0
0.70-0.89	49	40.8
0.90-0.99	32	26.8
Total	**120**	**100**
Mean 76		
Maximum 98		

Source: Computed from field survey, 2018

more productive and relatively abundant resources for inelastic and scarce resources [28].

Over all, it is seen that on the average, the women cassava farmers in the study area are said to be satisfactorily technically efficient, though there is room for improvement if the identified challenges are addressed.

4. CONCLUSION

Farm inputs are very important for cassava production. Inputs such as fertilizer, herbicide, transport, cassava stem exercised different degrees of influence on cassava output. These inputs had positive influence on cassava production. The application of these inputs in conjunction with favourable socioeconomic factors such as education, age of the farmers, extension visit among others will go on to accelerate the cassava production.

5. RECOMMENDATIONS

Based on the findings of the study, the following recommendations are made to improve cassava production

1. Farm inputs such as fertilizers, herbicides and improved cassava varieties should be made available to farmers to use. The inputs should be made available before the onset of planting season every year at affordable prices.
2. Land tenure system should be reviewed to make more land available to active farmers so that they can increase their farm size.
3. Good transport facilities should be put in place for easy movement of farm inputs into the farms and farm outputs out of the farms to the markets.
4. Education opportunities especially informal extension education should be provided for the farmers so as to improve their knowledge and skills and hence their technical efficiency
5. Agricultural loan be made available to the farmers to enable them buy farm inputs so as to increase their area of operation which will translate to more outputs.
6. More extension agents should be trained so that farmers can be visited more regularly by the extension agents.

CONSENT

As per international standard respondents' written consent has been collected and preserved by the author(s).

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sdiarticle4.com/review-history/55747