European Journal of Agriculture and Forestry Research
Vol.11, No.1, pp. 13-23, 2023
Print ISSN: 2054-6319 (Print),
Online ISSN: 2054-6327(online)
Website: https://www.eajournals.org/
Publication of the European Centre for Research Training and Development -UK

# Technical Efficiency in Maize Crop Production by Small-Scale Farmers in Central Agricultural Zone of Cross River State, Nigeria

**Osim, O. O. and Oniah, M.O.**
Department of Agricultural Economics and Extension, Faculty of Agriculture and Forestry, the Cross River University of Technology PMB 102 Obubra, Cross River State, Nigeria

doi: https://doi.org/10.37745/ejafr.2013/vol11n11323 Published April 10, 2023

**Citation**: Osim, O. O. and Oniah, M.O. (2023) Technical Efficiency in Maize Crop Production by Small-Scale Farmers in Central Agricultural Zone of Cross River State, Nigeria, *European Journal of Agriculture and Forestry Research*, Vol.11, No.1, pp. 13-23

**ABSTRACT:** *The study determined resource use efficiency in maize crop production by small-scale farmers in the Central Agricultural Zone of Cross River State, Nigeria. It specifically investigated the socioeconomic characteristics and technical efficiency of resources used by small-scale farmers in rainfed maize production in the area. Data collected were analyzed using descriptive statistics such as mean, frequency distribution tables, stochastic frontier model, gross margin analysis and the Likert scale model. The results of the descriptive statistics revealed that maize production in the study area is predominately carried out by people within the age bracket of 21-50 years. On sex distribution, the study revealed that maize production was carried out by both men and women with females taking the production lead at 58% as compared to 41% in the case of males. The study revealed that 57% of respondents were married, 36% were single, and 2% and 4% were divorced and separated respectively. The study also shows that maize farmers in the study area had family sizes ranging between 5-15 members in a household. The educational level revealed that maize farmers in the study area had some form of formal education with good farming experience. Also, the technical efficiency (TE) of the respondents in the study area was found to be less than (<) 1.0, indicating that all farmers were producing below the maximum efficiency frontier. This study also reveals that maize production if efficiently managed is profitable in the study area. The constraints in maize production as perceived by the study include; inadequate capital, lack of access to credit, lack of government support, lack of improved planting materials and poor market. This study recommends that male farmers should be encouraged to participate in maize cultivation as a means to augment their income and to further improve their standard of living. Maize farmers are advised to be more technically efficient in the use of their farm productive resources to increase rainfed maize production since all farmers were producing below the maximum efficiency frontier.*

**KEYWORDS:** technical efficiency, socioeconomic, smallholder, production, profitability.

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## INTRODUCTION

Maize is one of Nigeria's most popular food crops, containing approximately 72% starch, 10% protein, and 4% fat, with an energy density of 365 Kcal/100g, (Peter, Juan, and Maria 2014). Maize cultivation began as a subsistence crop in Nigeria and has gradually evolved into a commercial crop on which many agro-based industries rely for raw materials (IITA, 2021). Maize has become a staple food in many parts of the world, with total maize production exceeding that of wheat or rice, and it can be used for corn ethanol, and other maize products such as corn starch and corn syrup, in addition to being consumed directly by humans. (Foley 2019).

Maize is the main component of most livestock feed, and it is especially popular with poultry, cattle, and pigs; additionally, its stocks can be converted into silage. It is one of the farm's products with the highest return on investment, as one seed of planted maize can yield more than 500 kernels of corn harvested in a season if properly managed. A small financial investment in maize farming can thus yield a sizable level of income and profit. (Myfarmbase 2018).

Maize has an average grain yield of about 3 tons/ha in Nigeria, and the estimated national demand of 20 million tons per year has yet to be met. (FMARD 2021). This demonstrates that there is still room for improvement in maize production in Nigeria if resources are used efficiently. In recent years, much emphasis has been placed on measures to improve maize production and utilization. Government and research institute efforts have not yielded many results, as the formulation of agricultural policies and the provision of innovative information to farmers has not improved the yield of rainfed maize per hectare. In general, the price of maize and maize products has risen as production in the sector has not increased. Could this be attributed to low productivity from maize farmers on grounds of inefficiency in resource use?

The effective and efficient allocation of farm productive resources to achieve maximum output in food crop production is referred to as resource management. Efficiency is crucial for three reasons. First, it serves as a success indicator and performance metric for production units. Secondly, To investigate the source of efficiency differentials, efficiency must be measured and its effects distinguished from those of the production environment. Thirdly, identifying inefficient resources is critical for implementing public and private initiatives aimed at improving performance. (Amos, 2007). The environment of the Central Agricultural Zone is assumed to have great potential for rain-fed maize cultivation, but it is unknown how efficiently farmers apply their available farm resources to achieve optimum production.

Peter and Sylvester (2007) in their study on the Technical Efficiency and Productivity of Yam in Kogi State, Nigeria. Revealed that yam farmers were technically inefficient in the production process of yam in the study area. Ntuokwa and James (2012) observed that farmers were

technically inefficient in the use of their farm productive resources in Yam Production in Yakurr Local Government Area of Cross River State, Nigeria. Ogunniyi et al (2020), in their study, revealed that there was gross inefficiency in the allocation of productive resources among cassava farmers in Oyo state as most of these resources are over-utilized implying a sub-optimal utilization of resources. Fred, Enoch and Philip (2012) in their study of Resource Use Efficiency in Rice Production: The Case of Kpong Irrigation Project in the Dangme West District of Ghana, reported that farmers underutilize some farm productive resources in Rice Production in the study area.

Given this doubt, could one be tempted that this also applies to maize production? However, if appropriate research on resource use efficiency in maize production is conducted in the Central Agricultural Zone, the crop may be discovered to be a high-yielding and income-generating crop that will help alleviate poverty in the area. Given this uncertainty, it is critical to investigate the resources used by small-scale farmers in rainfed maize production, as this will help draw attention to the issue.

## METHODOLOGY

### Study Area

The study was conducted in the Central Agricultural Zone of Cross River State, Nigeria. The zone lies between latitude $5^{o}$- $25^{o}$N of the equator and longitude $8^{o}$-$25^{o}$E of the Greenwich meridian. It is bounded to the North by Yala and Ogoja L.G.A, to the south by Biase L.G.A, to the East by the Republic of Cameroon and to the West by Ebonyi State. It has a land mass of 8762 square kilometres, with an annual rainfall of 2942mm to 3424mm per annum (NPC, 2006).Its average temperature is $29^{0}$c. Farmers in the central agricultural zone are predominantly arable crop farmers, though some farmers cultivate tree crops like cocoa and oil palm. Major crops grown in the area are yam, maize, cassava, melon, cocoyam, plantain, pepper, cocoa and rice. (CRADP, 2012) The Central Agricultural Zone of Cross River State is made up of six local government areas, (Abi, Yakurr, Obubra, Ikom, Etung and Boki).

### Method of data collection

The majority of the data for this study came from primary sources. A structured questionnaire and personal interviews were used to collect primary data. Data on farm productive inputs such as land size, labour, farm capital, fertilizer, herbicide, farm credit, extension service, and seeds planted were collected. Personal interviews and field observations were also used to validate the respondents' information. A direct contact strategy was also used to reduce the number of distractions and unnecessary delays.

**Analytical tools**

The stochastic frontier production model, descriptive statistics such as mean, frequency distribution tables, gross margin analysis and the Likert scale model were used as analytical tools to investigate the objectives.

**The stochastic**

The stochastic (or econometric) frontier production function model was used in this study to examine respondent technical efficiency. The frontier production function is the maximum feasible or potential output that a production unit, such as a farm, can produce given the level of input and technology. The actual production function (corresponding to the actual output of the production unit) is written as

$$TE = Y_i / Y_i^* = f(X_{i;}\beta) \exp(V-U) / f((X_{i;}\beta)) \exp(V_i) = \exp.(-UI)$$

Where;

TE= Technical efficiency.

$Y_i$ = observed output.

$Y_i$*=frontier output

$f$ (.) = an appropriate function (e.g., Cobb-Douglas, Trans log, etc);

$X_i$ = vector of the input quantities used by the i-th farm;

$\beta$ = vector of the unknown parameters to be estimated f (.);

$V_i$ = symmetric error which accounts for random variations in output due to factors beyond the control of the farmer such as weather, disease outbreaks, and measurement errors and these variables are assumed to be independent of $U_i$ and $u_i$ = non-negative random variables representing inefficiency in production relative to the stochastic frontier.

**Gross margin**

Gross margin analysis was used to determine the gross margin per hectare of maize production in the study area. It is expressed as Gross Income or Total Revenue (TR) minus Total Variable Cost (TVC).

Gross Margin is expressed thus: GM = TR - TVC

**The Likert scale model**

The study used the Likert scale to discuss respondents' constraints and strategies. The Likert scale is expressed as

$$x = \frac{\Sigma fn}{Nr}$$

Where

x= mean

Σ= summation
fn= frequency of respondent responses
Nr= number of responses of the respondent
A variable mean ($\bar{x}$) score of 2.50 and above is observed as a perceived constraint whereas any variable with a mean ($\bar{x}$) score of less than 2.50 is perceived as not a constraint.

## RESULTS AND DISCUSSION

**Table1. Showing the socioeconomic characteristics of maize farmers in the Central Agricultural Zone of Cross River State.**

| S/No | Variables | | Frequency | Percentage (%) |
|---|---|---|---|---|
| 1. | Age | 18-20 | 25 | 10.4 |
| | | 21-30 | 93 | 38.8 |
| | | 31-40 | 79 | 32.9 |
| | | 41-50 | 33 | 13.8 |
| | | 51 – above | 10 | 4.2 |
| | | Total | 240 | 100 |
| 2. | Sex | Male | 103 | 41.7 |
| | | Female | 137 | 58.3 |
| 3. | Marital Status | Married | 137 | 57.1 |
| | | Single | 88 | 36.7 |
| | | Divorce | 5 | 2.08 |
| | | Separated | 10 | 4.2 |
| | | Total | 240 | 100 |
| 4. | Family size | 1-5 | 120 | 50 |
| | | 6-10 | 90 | 37.5 |
| | | 11-15 | 30 | 12.5 |
| | | Total | 240 | 100 |
| 5. | Educational level | Never attended | 2 | 0.8 |
| | | Primary education | 20 | 8.3 |
| | | Secondary education | 159 | 66.3 |
| | | Tertiary education | 59 | 24.6 |
| | | Total | 240 | 100 |
| 6. | Farming Experience | 1-10 | 43 | 17.9 |
| | | 11-20 | 103 | 42.9 |
| | | 21-30 | 84 | 35 |
| | | 31 and above | 10 | 4.5 |
| | | Total | 240 | 100 |

**Source: Field survey data, 2023**

Table 1 reveals that 10.4% of the respondents were between the age bracket of 18-20, 38.75% were within 21-30 years, 31.9% were within the age bracket of 31-40 years, 13.75% were within the age bracket of 40-50 years and 4.15% were 51 years and above. The above finding implies that maize production in the study area is predominately carried out by people within the age bracket of 21-50 years, which means that maize production is carried out by adults who are at their prime

age of farming. This finding agrees with the study of Anyanwa *et al*, (2001) who reported that people in their prime are more likely to be energetic and can use innovation. This justified the finding of Ebukiba (2010), who reported that 75% of the Cassava farmers in Akwa Ibom State were aged below 31 to 50 years.

On sex distribution, it was revealed that from the 240 respondents used in the study, 103 are males while 137 are females. This shows that maize production in the Central Agricultural Zone of Cross River State is carried out by both men and women. This implies that maize production in the study area is not gender bias as both men and women participate in maize cultivation in the area.The distribution on marital status reveals that out of 240 respondents, 137 are married, 88 are single, 5 are divorced and 10 are widows/widowers. This implies that maize farming in the study area is mostly carried out by married couples and this is represented by 57.1% of total respondents. The result above also depicts that 50% of the respondents have a family size of 1-5 members, 37.5% have 6-10 members and 12.5% have 11 members and above.

Consequently, 0.83%, of the respondents never attended school, 8.33% had primary education, 66.3% had secondary education and 24.58 had tertiary education. The findings of this study indicate that most of the farmers in the study area had some formal educational backgrounds which suggests that if they are given the necessary technologies they could improve upon them.The distribution of farming experience shows that 17.9% of the farmers in the study area have between 1-10 years of maize farming experience. Also, 42.9% have between 11-20 years of farming experience. Farmers that are within 21-30, 31 and above of farming experience had the percentage of 35% and 4.2% respectively. This can be concluded that maize farming is not just an occupation but a way of the life for the people in the study area. Hence, it does not require years of experience to be involved in maize production.

**Table 2: Frequency Distribution of Technical Efficiency indices**

| Technical Efficiency Index | Frequency | Percentage (%) |
|---|---|---|
| < 0.20 | 6 | 2.5 |
| 0.21- 0.40 | 9 | 3.75 |
| 0.4 – 0.60 | 17 | 7.08 |
| 0.61 – 0.80 | 66 | 27.5 |
| 0.81 – 1.00 | 142 | 59.16 |
| Total | 240 | 100 |
| Maximum TE | 0.9374 | |
| Minimum TE | 0.2024 | |
| Mean Technical Efficiency | 0.7635 | |

Source: field data 2022.

The summary of the technical efficiency scores for the respondent in table 2 above reveals that their technical efficiency is less than (<) 1.0, indicating that all farmers were producing below the maximum efficiency frontier. A range of technical efficiency is observed across the sampled frame and the spread is large.

The best farmer had technical efficiency of 0.94 (or 94%), while the least farmer had a technical efficiency of 0.20 (or 20%). On average, farmers were able to obtain 0.76 (or 76%) potential output from their given combination of production input. Hence, their observation output was about 25.2% short of the maximum frontier output.

This result implies that an average maize farmer requires 25.2% i.e. (1-0.7635/0.9374) x 100 costs saving to attain the status of the most efficient level of maize production in the area. While the least performing farmers would need (1-0.2024/0.9495) x 100 cost saving to be efficient. This implies that additional income can be made from the production of maize by using more of the inputs technically by the farmers. This justifies the finding of Ogunniyi *et al,*.(2012), who reported that maize farmers in the Atakunmosa Local Government Area of Osun State Underutilized farm size, fertilizer, herbicide and maize seeds while labour was overutilized.

### 3. Cost and Return of Maize Farming Per Hectare

**Table 3: Costs and Returns of maize farming per hectare**

| | Cost/Return Items | Average kg/hectare | Unit Price (N) | Value | Percentage |
|---|---|---|---|---|---|
| (A) | Variable cost | | | | |
| | Planting seeds | 4.564 | 200 | 800 | 0.89 |
| | Labour (man-day) | 75.44 | 1000 | 75440 | 81.25 |
| | Fertilizer (kg) | 104.91 | 100 | 10,491 | 11.74 |
| | Herbicide(litre) | 2.408 | 2000 | 4,816 | 5.38 |
| | Total variable cost | | | 89,547 | 100 |
| (B) | Fixed cost | | | | |
| | Rent on land | | | 8,000 | |
| | Hoe | | | 300 | |
| | Cutlass | | | 1,000 | |
| | Sprayer | | | 2,500 | |
| | Wheelbarrow | | | 7,000 | |
| | Total fixed cost | | | 18800 | |
| (C) | Total cost | | | 108348 | |
| (D) | Total Revenue (output) | 7(100kg/bags) | 30,000 | 210000 | |
| (E) | Gross margin= TR-TVC | | | 120453 | |
| (F) | Return on investment =$\frac{TR}{TC}$-1 | | | 0.94 | |

**Source: Field data 2023**

The result in Table 3 shows the cost and return of maize farming in the study area. The total cost of variable inputs used (planting seeds, labour, fertilizer & agrochemicals) was estimated to be N89547 per hectare. The total revenue generated was ₦210,000 per hectare. The gross margin was 120453 per hectare, this shows that maize farming is a profitable enterprise in the Central Agricultural Zone of Cross River State.

The return on investment (ratio of total revenue to total cost minus 1) was 0.94, implying that for every 1₦ invested in maize farming, there was a return of 94 kobos. This implies that maize farming was profitable in the study area. This finding is consistent with that of Bassey et al. (2014) who in their study on determinants of cassava output among small-scale farmers in Nigeria; a survey of Akwa -Ibom State farmers found cassava farming to be profitable with a net term income of N125.590 and a return on invested of 0.73.

**Table 4: Mean Score distribution of respondents according to constraints militating against maize production**

| Constraints | Mean Score | Decision |
|---|---|---|
| Lack of ready market | 2.5* | Accepted |
| Lack of access to credit facilities | 3.8* | Accepted |
| Poor storage facilities | 2.8* | Accepted |
| High cost of transportation | 3.2* | Accepted |
| Lack/inadequate improved varieties | 2.6* | Accepted |
| Inadequate supply of fertilizer | 3.5* | Accepted |
| Land fragmentation | 2.2 | Rejected |
| Poor Extension service | 3.6* | Accepted |
| The problem of pests & disease | 2.9* | Accepted |
| Poor road network | 3.0* | Accepted |

**Source: field data 2023** * Perceived constraint

All constraints with a mean value above 2.5 are the perceived constraint militating against maize production in the study area while those less than 2.5 are not considered a constraint.From table 4 above, the farmers were constrained by the following factors. Lack of access to credit facilities had a mean value of 3.8 followed by extension service which had a mean value of 3.6; inadequate supply of fertilizer had a mean value of 3.5 while high cost of transportation and poor road network had a mean value of 3.2 and 3.0 respectively.

Other militating factors include the problem of pests and diseases with a mean value of 2.9, poor storage facilities had a mean value of 2.8 while lack/inadequate improved varieties and lack of ready market were also reported as constraints with a mean value of 2.6 and 2.5 respectively.This follows the findings of Ebukiba (2010) who reported that Cassava farmers in Akwa Ibom State face problems such as inadequate capital, lack of access to credit, lack of government support, lack of improved planting materials and poor market.

**Table: 5 Mean and Standard deviation on possible strategies for improving maize production**

| Strategies | Means Score | Standard deviation |
|---|---|---|
| Formation of cooperative society farmer's access to finances. | 2.37* | 0.88 |
| Subsidizing the prices of agricultural inputs. | 2.48* | 0.74 |
| Making planting materials available to farmers at right time in the right quantity. | 2.63* | 0.73 |
| Procurement of fertilizer. | 2.22* | 0.55 |
| Using resistant and high-yielding varieties. | 2.28* | 0.81 |
| Creating facilities. | 2.25* | 0.81 |
| Creating markets, roads and social facilities like hospitals, water & School. | 2.15* | 0.57 |
| Use of recommended spacing and planting at the right time. | 2.23* | 0.90 |
| Regular visits by extension agents for a regular and proper extension delivery system. | 2.45* | 0.76 |
| Planting of sweet maize which has relatively low starch. | 1.93 | 0.58 |
| Proper and regular weeding of maize farms. | 2.50* | 0.65 |

**Source: Field data 2023** *Perceived Strategies

Table 5 shows the perceived strategies for improving maize production in the study area. According to the respondents, (maize farmers), the best-perceived strategies include; making planting materials available to farmers at the right time in the right quantity ($\bar{x}$ = 2.63); regular and reliever weeding of maize farms ($\bar{x}$ = 2.50) and subsidizing the price of agricultural inputs used in production ($\bar{x}$ = 2.48). Availability of inputs at the right time and in the right place is an important factor that enhances the adoption of technology and when this is available, the price could be stabilized to enable farmers to purchase them, this will also take care of weeding of maize farms by the use of herbicides.

Other perceived strategies include regular visits by extension agents for a regular and proper extension delivery system ($\bar{x}$ =2.45). Formation of cooperatives society to enhance farmer's access to finance ($\bar{x}$ = 2.37), using of resistant and high-yielding varieties ($\bar{x}$ = 2.28), creating credit facilities ($\bar{x}$ = 2.5), use of recommended spacing and planting at the right time ($\bar{x}$ = 2.2), Creating market, roads and Social facilities like hospital, water and schools ($\bar{x}$ = 2.15).

**Conclusion and Recommendations**

Based on the findings of the study, it is concluded that maize production in the study area is predominately carried out by people within the age bracket of 21-50 years. On sex distribution, the study revealed that maize production in the area was carried out by both men and women with females taking the production lead at 58% as compared to 41% in the case of males. The distribution on marital status revealed that 57% of respondents were married, 36% were single, and 2% and 4% were divorced and separated respectively. The study also shows that maize farmers in the study area had family sizes ranging between 5-15 members in a household. The findings of this study indicate that most of the farmers in the study area had some formal educational backgrounds which suggest that if they are given the necessary technologies, they could improve upon them. The distribution of farming experience shows that maize farming is not just an occupation but a way of life for the people in the study area. Hence, it does not require years of experience to be involved in maize production.

Also, the Technical efficiency (TE) of the respondents in the study area was found to be less than (<) 1.0, indicating that all farmers were producing below the maximum efficiency frontier. This study also reveals that maize production is profitable in the study area. The constraints in maize production as perceived by the study include; inadequate capital, lack of access to credit, lack of government support, lack of improved planting materials and poor market. This study recommends that Males should be encouraged to participate in its cultivation as a means to augment their income and to further improve their standard of living.

Maize farmers are advised to be more technically efficient in the use of their farm productive resources to increase rainfed maize production since all farmers were producing below the maximum efficiency frontier. Hence, additional income can be made from the production of maize by using more of the inputs technically by the farmers. This study also reveals that maize production is profitable in the study area. The constraints in maize production as perceived by the study include; inadequate capital, lack of access to credit, lack of government support, lack of improved planting materials and poor market.

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