ABSTRACT
The study was carried out in Ankpa Local Government Area, Kogi State, Nigeria in 2011 and it was on the resources used in yam production and their effects on the output of yam and also the effects of the farmers’ socioeconomic characteristics on their technical efficiency. A well structured questionnaire was used to collect information from 140 randomly selected farmers in the area. Information collected from the farmers include their socioeconomic characteristics and the inputs used in yam production. Stochastic frontier Cobb-Douglas production function was used to analyse the data. Results show that family labour, hired labour, fertilizers, herbicides, yam stakes and yam setts positively influenced yam output. The influence of fertilizers was significant at 1 percent level of risk, hired labour and yam setts at 5 percent level of risk while family labour, herbicides and yam stakes did not influence yam output at any level of risk. Age, education, household size and access to credit were negatively related to the farmers’ technical inefficiency, while extension visit and sex were positively related to it. The farmers’ specific technical efficiency ranged from 0.18 to 0.96 with a mean of 0.76 implying that no farmer was fully technically efficient. Recommendations made to enhance yam production in the area include production and distribution of farm inputs to the farmers at cheap prices, training of more extension agents so as to increase extension agents and farmers’ interaction and encouraging commercial banks to give more loans to the farmers.

Key words: Yam, Production, Measurement, Stochastic frontier, Technical efficiency

INTRODUCTION
Yam (Dioscorea spp.) produces edible tubers which are used for food. Although there are many species of yam, the white guinea yam (Dioscorea rotundata) which originated from West Africa is grown in larger areas and produced in larger quantities than any other kind of yam in the world (Onwueme and Sinha, 1999). In Nigeria, yam production is concentrated in the hands of numerous small scale farmers who are mostly in the southern and central regions. It is a crop of the humid and sub-humid regions. Yam cultivation is not popular in the semi-arid parts of Nigeria. Nigeria is the greatest producer of yam in the world with an annual output of about 36.77 million metric tones (FAO, 2008). Yam gives more calories per unit of land area than most crops and matures within 7 months (Oluwatayo et al., 2008).

Yam is the most valued tuber crop because of its cultural and economic importance. It is presented as gift in marriages and as part of bride price and in many parts of Nigeria; festivals are celebrated in its name before the commencement of eating it every year (Okwor., et al 1998). The most popular way of eating yam is to pound boiled slices of yam tuber in a mortar to form a thick paste which is eaten with stew or soup. It can also be eaten roasted or fried. Presently, roasted yam has become a popular fast food on the streets of towns and cities in Nigeria. Yam flour which is made from dry yam tubers is also prepared into a thick paste by stirring the flour in hot water to form the paste. The paste is eaten in the same way as pounded yam. Yam tubers are ready source of income in rural areas. Rural yam farmers enjoy financial relief as soon as their yam tubers are ripe for harvest. The fresh tubers are sold in the rural and urban markets.

Despite these numerous uses of yam, the production level has remained static (Scot et al., 2000). This is because, yam is a small holder crop which does not lend itself for mechanical cultivation except for land preparation (FMAWRRD, 1992). Yam production is labour intensive. It requires staking and weed control is...
mainly manual as only a few herbicide formulations are effective in yam production. This is why the study was undertaken to investigate how efficiently farmers use their resources in yam production. The specific objectives of the study are to determine the effect of resources used on the output of yam and the effect of the farmers’ socioeconomic characteristics on their technical efficiency.

CONCEPTUAL FRAMEWORK:
Technical efficiency of a farmer is the ability to produce maximum output from a given set of inputs (Ajibefun, 2008). Farmers have different degrees of efficiency. Maximum efficiency is achieved when it is impossible to reschedule a given resource combination without decreasing the total output (Adeoti, 2006). Efficiency study has assumed important dimension in production studies since the work of Farrel (1957) who decomposed efficiency into technical, allocative and economic efficiency.

Technical efficiency is the ability of a farmer to produce a given level of output with a minimum quantity of inputs under a given technology. Different levels of outputs are produced with different levels of resources. The locus of points of these levels of output that can be produced with different levels of inputs is known as a production frontier. The production frontier is stochastic because its position varies randomly among the firms in the industry. All farmers struggle to reach the production frontier at any point in time. Some may operate on it while others operate below it. A measure of how a farmer is close to the production frontier is a measure of his technical efficiency. Technical efficiency has value between zero and one.

Allocative efficiency is a measure of the degree of success in achieving the best combination of different inputs in producing a specified level of output having regard to the relative prices of these inputs (Adeoti, 2006). Inputs price ratios are considered when determining the point of allocative efficiency on the production frontier. Therefore, the point of allocative efficiency on the technically efficient isoquant is the point of tangency of the iso-cost line with the isoquant. The amount of each input used to produce the given level of output is the least given their prices and this point is called the least cost point (Subba Reddy et al.; 2004). Economic efficiency is the product of technical and allocative efficiency (Ogundari and Ojo, 2006).

MATERIALS AND METHOD
The study was carried out in Ankpa Local Government Area of Kogi State, Nigeria between June and October, 2011. The Local Government Area shares common boundaries with Omal Local Government Area in the North, Olamaboro Local Government Area in the South, Dekina local Government Area in the West and Otukpo Local Government Area in the East. Most of the inhabitants are farmers. Major arable crops grown in the area are yam, cassava, maize, guinea corn, cowpea, rice, groundnut and melon while major tree crops are oil palm trees, cashew and citrus. Animals such as cattle, sheep, goats and poultry are reared. A purposive sample of four villages was selected for the study based on the dominance of yam production in these villages. A random sample of 35 yam farmers was selected from each village and interviewed making a total of 140 farmers. These farmers where selected from the list of yam farmers obtained from the State Agricultural Development Project (ADP) as the sampling frame. The survey instrument was a structured questionnaire. Information collected from the farmers was on their socioeconomic characteristics such as age, sex, educational level, household size, extension visit, and access to credit. Also collected was information on the inputs used in yam production, their quantities and prices. Inputs on which information was collected were family and hired labour, fertilizers, herbicides, yam sets and yam stakes.

The data were analyzed with the use of inferential statistics. Cobb – Douglas production function was modeled as a stochastic frontier production function and used to analyze the data. The model was specified as follows:

\[ \ln Y = \ln b_0 + b_1 \ln X_1 + b_2 \ln X_2 + b_3 \ln X_3 + b_4 \ln X_4 + b_5 \ln X_5 + b_6 \ln X_6 + V_i - U_i \]

Where:
- \( \ln \) = natural logarithm
- \( Y \) = Number of heaps of yam planted
- \( X_1 \) = Family labour in man days
- \( X_2 \) = Hired labour in man days
- \( X_3 \) = Fertilizers in kilogrammes
- \( X_4 \) = Herbicides in litres
- \( X_5 \) = Cost of yam stakes in naira

The survey instrument was a structured questionnaire. Information collected from the farmers was on their socioeconomic characteristics such as age, sex, educational level, household size, extension visit, and access to credit. Also collected was information on the inputs used in yam production, their quantities and prices. Inputs on which information was collected were family and hired labour, fertilizers, herbicides, yam sets and yam stakes.
The results of the maximum likelihood estimates of the stochastic frontier Cobb-Douglas production function and the diagnostic statistics are presented in Table 1. The estimated sigma squared ($\hat{\sigma}^2$) which was 0.435 was statistically significant at 5 percent level of probability. This is an indication of a good fit for the model used in estimating the data. It shows the correctness of the assumption made with respect to the distribution of the composite error term. The estimated gamma ($\gamma$) coefficient which was 0.916 was high and was statistically significant at 1 percent level of risk. This means that 92 percent variation in yam output among the farmers was due to differences in their technical inefficiency.

The constant term has a positive coefficient and it was significant at 1 percent level of risk. This was in agreement with a study carried out by Battese and Coelli (1993) in rice farms in India where they obtained a positive coefficient of 3.01 for the intercept of the function.

Family labour, herbicides and stakes with coefficients of 0.002, 0.006 and 0.022 respectively were not significant at any level of probability. Family labour did not significantly influence the output of yam because most farmers used hired labour. Family labour is increasingly becoming scarce because of ageing of farmers, increase in school enrollment and migration of youths to towns and cities. Herbicides and stakes were not significant determinant of yam output because most farmers did not use them.

**Table 1: Maximum Likelihood Estimates of the Stochastic Frontier Cobb-Douglas Production Function for Yam Production in the Area**

<table>
<thead>
<tr>
<th>variables</th>
<th>coefficients</th>
<th>standard error</th>
<th>t-ratios</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant $b_0$</td>
<td>6.643*</td>
<td>0.769</td>
<td>8.638</td>
</tr>
<tr>
<td>labour $b_1$</td>
<td>0.002</td>
<td>0.008</td>
<td>0.252</td>
</tr>
<tr>
<td>labour $b_2$</td>
<td>0.016**</td>
<td>0.007</td>
<td>2.286</td>
</tr>
<tr>
<td>$b_3$</td>
<td>0.023*</td>
<td>0.008</td>
<td>2.875</td>
</tr>
<tr>
<td>$b_4$</td>
<td>0.006</td>
<td>0.010</td>
<td>0.600</td>
</tr>
<tr>
<td>$b_5$</td>
<td>0.022</td>
<td>0.017</td>
<td>1.294</td>
</tr>
<tr>
<td>$b_6$</td>
<td>0.075**</td>
<td>0.032</td>
<td>2.344</td>
</tr>
<tr>
<td>No. of observations</td>
<td>140</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sigma squared $\hat{\sigma}^2$</td>
<td>0.435**</td>
<td>0.169</td>
<td>2.574</td>
</tr>
<tr>
<td>Gamma $\gamma$</td>
<td>0.916*</td>
<td>0.0086</td>
<td>106.512</td>
</tr>
</tbody>
</table>

* Significant at 1 percent (0.01): Lower limit of t-table value = 2.576
Hired labour had positive coefficients 0.016 which was statistically significant at 5% level of probability. In a similar study, Awoniyi and Omonona (2006), obtained positive coefficients of 0.29 for hired labour in up-land yam based enterprises in Ekiti State. The implication is that the use of more man days of labour will increase the output of yam. Fertilizer had positive relationship with the output of yam because it had a coefficient of 0.008 which was significant at 1 percent level of risk. Fertilizer is very critical in yam production in the area as most farm lands have lost their natural fertility. Yam setts had positive coefficient of 0.075 which was statistically significant at 5 percent level of risk. Yam sett is the primary input in yam production hence its statistical significance. The use of more and clean yam setts will increase output of yam.

**Effects of Socioeconomic Characteristics of the Farmers on their Technical Efficiency**

The socioeconomic characteristics of the farmers included in the inefficiency model were age, education, household size, extension visit, access to credit and sex. The results of the maximum likelihood estimates of the parameters of the inefficiency model are presented in Table 2.

Education had negative coefficient of -0.202 which was not significant at any level of probability. The negative sign on the coefficient of education implies reduction in farmers’ technical inefficiency with increasing years of schooling. Education enhances adoption of new technologies. Age had a negative coefficient of -2.444 which was significant at 5 percent level of risk. As farmers advance in age to some extent their technical inefficiency reduces because they gain experience in farm operations which enables them to combine farm inputs wisely.

House hold size was inversely related to the farmers’ technical inefficiency with coefficient of -0.319 which was statistically significant at 10 percent level of risk. This finding was in agreement with Anyaegbunam et al., (2009) who obtained a negative coefficient of -0.0047 for family size in their study on small holder cassava farms in South Eastern Nigeria. Family labour can raise farmers’ productivity and hence increase their technical efficiency. The negative sign on the coefficient of house hold size will increase the technical efficiency of the yam farmers.

Extension visit had positive coefficient of 0.082 which was significant at 5 percent level of risk. Extension visit is expected to reduce farmers’ technical inefficiency, but the reverse is the case in this study because of poor extension service in the area. This result agrees with the finding of Idiong (2007) who obtained a positive coefficient of 0.12 for extension visit in his study.

**Table 2: Maximum Likelihood Estimates of the Parameters of the Inefficiency Models**

<table>
<thead>
<tr>
<th>variables</th>
<th>coefficients</th>
<th>standard error</th>
<th>t-ratios</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>4.263</td>
<td>2.363</td>
<td>1.381</td>
</tr>
<tr>
<td>Age $\bar{c}_1$</td>
<td>-2.444**</td>
<td>1.054</td>
<td>-2.319</td>
</tr>
<tr>
<td>Education $\bar{c}_2$</td>
<td>-0.202</td>
<td>0.133</td>
<td>-1.519</td>
</tr>
<tr>
<td>Household size $\bar{c}_3$</td>
<td>-0.319***</td>
<td>0.167</td>
<td>-1.910</td>
</tr>
<tr>
<td>Extension visit $\bar{c}_4$</td>
<td>0.082**</td>
<td>0.033</td>
<td>2.485</td>
</tr>
<tr>
<td>Access to credit $\bar{c}_5$</td>
<td>-0.190**</td>
<td>0.096</td>
<td>-1.980</td>
</tr>
<tr>
<td>Sex $\bar{c}_6$</td>
<td>0.913***</td>
<td>0.514</td>
<td>1.776</td>
</tr>
</tbody>
</table>

**Significant at 5 percent (0.05): Lower limit of t-table value = 1.960**

***Significant at 10 percent (0.1): Lower limit of t-table value = 1.645***

Source: Field data, 2011

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study on swamp rice production. Extension visit is important in yam production because it exposes the farmers to new technologies which will increase farmers’ technical efficiency.

Access to credit had negative coefficient of -0.190 which was statistically significant at 5 percent level of risk. This result agrees with the findings of Binam et al., (2008) who obtained negative coefficients of -0.88, -0.283 and -0.84 in their study on cocoa farms in Cameroon, Ghana and Nigeria respectively. The negative sign on the coefficient of credit is an indication that farmers’ technical inefficiency will be reduced with availability of credit. Credit is needed to buy farm inputs and improved technologies.

Sex had positive coefficient of 0.913 which was statistically significant at 10 percent level of risk. Gender is important in yam production because its production operations such as land clearing, cultivation and harvesting are labour intensive. Male farmers are likely to be more efficient in yam production than female farmers because according to Okorji (1983), men are more efficient than women in tilling while women are more efficient than men in weeding.

The distribution of the farmers based on their specific technical efficiency is presented in Table 3.

### Table 3: Percentage Distribution of the Yam Farmers Based on their Specific Technical Efficiency

<table>
<thead>
<tr>
<th>Range of technical efficiency</th>
<th>Number of farmers</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.10-0.29</td>
<td>1</td>
<td>0.7</td>
</tr>
<tr>
<td>0.30-0.49</td>
<td>4</td>
<td>2.9</td>
</tr>
<tr>
<td>0.50-0.69</td>
<td>17</td>
<td>12.1</td>
</tr>
<tr>
<td>0.70-0.89</td>
<td>67</td>
<td>47.9</td>
</tr>
<tr>
<td>0.90-0.99</td>
<td>51</td>
<td>36.4</td>
</tr>
<tr>
<td>Totals</td>
<td>140</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Minimum technical efficiency 0.18
Maximum technical efficiency 0.94
Mean technical efficiency 0.76
Source: Field data, 2011

The farmers’ levels of technical efficiency ranged from 0.18 to 0.96 with a mean of 0.76. This implies that no farmer was fully technically efficient. About 96.4% of the farmers where in the technical efficiency range of 0.50 to 0.99, while 3.6% of them where in the range of technical efficiency of 0.10 to 0.49.

CONCLUSION

Yam was produced on small scale in the area. Farmers employed various resources to produce yam. All the inputs used in yam production had positive influence on the output of yam. Farmers’ socioeconomic characteristics exercised different degrees of influence on their technical efficiency. No farmer was fully technically efficient.

RECOMMENDATIONS

Based on the findings of this study, the following recommendations are made to enhance yam production in the area.

Inputs like fertilizers and herbicides should be manufactured in large quantities and made available to the farmers at cheap prices to stimulate production and output.

Research should be conducted to develop cheap yam sets for growing of yam. Most farmers want to grow yam but the prohibitive price of yam sets often stall their ambition. More extension agents should be trained and posted to the rural areas so as to increase the rate of interaction with the farmers. This will possibly increase the rate of adoption of improved technologies.

Credit facility should be made available to the farmers so that they can buy farm inputs and improved technologies.

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