



The World's Largest Open Access Agricultural & Applied Economics Digital Library

This document is discoverable and free to researchers across the globe due to the work of AgEcon Search.

Help ensure our sustainability.

Give to AgEcon Search

AgEcon Search
<http://ageconsearch.umn.edu>
aesearch@umn.edu

Papers downloaded from AgEcon Search may be used for non-commercial purposes and personal study only. No other use, including posting to another Internet site, is permitted without permission from the copyright owner (not AgEcon Search), or as allowed under the provisions of Fair Use, U.S. Copyright Act, Title 17 U.S.C.

No endorsement of AgEcon Search or its fundraising activities by the author(s) of the following work or their employer(s) is intended or implied.

Determinants of food security and technical efficiency of cassava farmers in Ondo State, Nigeria

RESEARCH ARTICLE

Clementina Oluwafunke Ajayi^{†a} and Adewale Isaac Olutumise^{①b}

^a*Lecturer, Department of Agricultural and Resource Economics, Federal University of Technology, Akure, P.O. Box 704, Akure, Ondo State, Nigeria*

^b*Researcher and Lecturer, Department of Agricultural Economics and Extension, Adekunle Ajasin University, Akungba-Akoko, P.O. Box 001, Akungba-Akoko, Ondo State, Nigeria*

Abstract

Cassava is one of the most important staple food crops in Nigeria. It is one of the priority food crops necessary for improved food security and poverty reduction in Nigeria. The study investigated the determinants of food security and technical efficiency of cassava farmers in Ondo State, Nigeria using Food Security index, Data Envelopment Analysis (DEA) and Heckman probit model. The study used primary data and a multistage sampling technique was used to randomly select 120 respondents. Findings revealed that 43% of the respondents were food secured. The shortfall and surplus indices were 0.13 and 0.20 respectively. DEA results indicated that about 80% of the respondents had technical efficiency above 0.50 while the average technical efficiency was 0.83. The results of Heckman probit model also showed that farming experience, education, age, cassava output, number of dependants, access to credit, access to extension agent, distance to farm and farm size were the factors that influenced technical efficiency and food security in the study area. It is therefore concluded that improving technical efficiency of the cassava farmers will be an antidote to the problem of food insecurity in the area. This can be achieved by improving agricultural extension services as well as the educational background of the farmers to strengthen the activities of the Agricultural Credit Schemes policy to grant more loans to farmers at a low interest rate for increased productivity and subsequent increase in technical efficiency thereby improving food security further in Ondo State.

Keywords: cassava, data envelopment analysis, food security, Nigeria, technical efficiency

JEL code: I31, Q12, Q18

^①Corresponding author: firstwalefat@yahoo.com

[†]Deceased. This article is published posthumous but was accepted before the lead author's unfortunate death. IFAMA wants to express its deepest condolences to Dr Ajayi's family and colleagues.

1. Introduction

Cassava is the world's fourth most important staple crop after rice, wheat and maize. It is an important component in the diet of over one billion people around the World. For these reasons, cassava plays a significant role in the national efforts to improve Food Security (Match Maker Associates (MMA), 2007). It has various industrial uses, such as the use of starch as a filler in the pharmaceutical production of medications, also in the Breweries, wood and textile industry while the second most important utilisation of cassava worldwide is in the production of livestock feeds (MMA, 2007). Food and Agriculture Organization (FAO, 2004) gave the definition of Food Security as 'food that is available to feed everyone at all times, and this support the fact that they have means of access to it; and that it is nutritionally adequate in terms of quantity, quality and variety that is acceptable within the given culture'. On the other hand, food insecurity is the absence of food security that is caused due to lack of any of these situations at different levels – for example, at the household, regional and national levels. Severe food insecurity is when food intakes are unceasingly insufficient to meet the daily dietary energy supplies thus, leading to a most severe stage described as 'hunger'. Due to food insecurity, at a global scale, the number of undernourished people has increased over the years (FAO, 2010).

1.1 Problem statement

Plummeting food insecurity continues to be a major public policy challenge in developing countries including Nigeria. Therefore, achieving food security in any country is typically an insurance against hunger and malnutrition, both of which hinder economic development (Davies, 2009). As a result of this, Nigeria has made several attempts to address the issue of increased food production in both quantity and quality thereby solving the problem of food insecurity. Some of these attempts have cumulated into several programmes and projects aimed at boosting agricultural production. Despite successive strategies and programmes implemented as related to food and nutrition insecurity, this issue is still a problem (Orefi, 2012).

Ironically, farming households and especially most of the Smallholder farmers are the most affected in terms of food insecurity in spite of their contributions to the feeding of the rest of the population (Kuku-Shittu *et al.*, 2013). World Bank (2001) revealed that rural communities face a high risk of food insecurity due to poverty, income inadequacies, limited access to resources, underemployment and unemployment, and many barriers to self-sufficiency, which created family frailty and crisis. These issues resulted in a reduction in the productivity of population in the short and long runs, in terms of their sacrifices, in output and incomes, and in an increasing difficulty for families within developing nations to escape the cycle of food insecurity.

However, cassava and its products can be a powerful tool to eradicate food insecurity in Africa and in particular, Nigeria. Cash income from cassava proves to be more egalitarian than any other major staple crops because of cassava's low cash input and investment cost (Muhammad-Lawal *et al.*, 2012). Productivity is vital for the future of mankind to meet its basic needs of food, fibre and shelter (Khuda *et al.*, 2006) while the logical solution to further enhancing the current level of output is to examine the technical efficiency of the farmers involved in cassava production in Nigeria (Erhabor and Emokaro, 2007). This is because productivity is reduced in the presence of technical inefficiency, whereas the more efficient a firm is, the higher its productivity, *Ceteris paribus* (Kumbhakar, 2004).

It is in light of these and many more arguments that this study investigates the determinants of technical efficiency and food security of cassava farmers in Ondo State, Nigeria and attempts to answer the following empirical research questions:

1. What are the socio-economic characteristics of the cassava farmers?
2. What is the food security status of cassava farmers in Ondo State?
3. What is the magnitude of technical efficiency of cassava farmers in the study area?
4. What are the factors influencing the food security status and technical efficiency of cassava farmers in the study area?

1.2 Justification of the study

The 2015 Global Food Security Index, which comprises 109 countries appraised by the level of food sector development (food affordability, availability, quality and safety); put Nigeria at the 91st place with the average of 37.1 indexes as against 80th among 105 countries in 2011. With the rising level of food insecurity in the country and despite government's effort in tackling the need to expand the production of food in Nigeria whereby improvement of technical efficiency can be seen as one of the most effective methods to realise food security. More than 90% of agricultural production in Nigeria is through rain-fed irrigation with about 79 million hectares of arable land, of which 32 million hectares are cultivated with staple crops (Nwajiuba, 2012). However, agricultural production remains below the expected potentials since many of the rural farmers are subsistent farmers who reside mostly in the rural area of the country. Cassava is the preferred staple crop planted because it less expensive to produce and thrives on soil material that is found in most ecological zones in the country. The cassava plant tolerates poor soil, adverse weather, pest and diseases more than any other major staple crops (FAO, 2005). It is a versatile commodity with numerous by-products. Each component of the plant is valuable to its cultivator. The task is therefore to refashion the food systems of cassava production to deliver better nutritional product effects at less cost.

The hypotheses for the study are presented in the Null form as follows:

H₁: There is no significant difference between the mean output of food secured and food insecure respondents.

H₂: There is no significant difference in the technical efficiency of food secured and food insecure respondents.

This empirical research which assessed the determinants of food security and technical efficiency of cassava farmers in Ondo State, Nigeria is organised in chapters as follows: Chapter 1 covered introduction; Chapter 2 provides brief review on the role of cassava in Nigeria; Chapter 3 describes the methodology using descriptive statistics, Food security index, Data Envelopment Analysis (DEA) and Heckman probit model to achieve the stated objectives. Chapter 4 presents results and discusses major findings while Chapter 5 concludes and gives policy implications and recommendations.

2. Review of the role of cassava in Nigeria

Cassava is one of the most important root crops in Nigeria. It plays a leading role in the rural economy especially in the southern agro-ecological zones. It is increasingly gaining prominence in other parts of Nigeria (FAO, 2005). Nigerian cassava production is by far the largest in the world. It is a third more than the production in Brazil and almost double the production in Indonesia and Thailand (FAO, 2007). Cassava production in other African countries such as the Democratic Republic of the Congo, Ghana, Madagascar, Mozambique, Tanzania and Uganda appears small in quantity compare to Nigeria's substantial output. Sanni *et al.* (2009) attributed the large output in Nigeria to rapid population growth, internal market demand, availability of high yielding improved varieties of cassava tuber, and increase in hectares of farm land allocated to cassava in the country.

History points to information that it was probably the liberated slaves who brought and planted the cassava crop initially in Southern Nigeria, as many of them returned to the country from South America past the Islands of Sao Tome and Fernando Po. There were Portuguese colonies off Nigeria's shores at that time (Ekandem, 1962). Cassava, however, did not become important in the country until the end of the nineteenth century when processing techniques were introduced, as many more slaves returned home. There has been an increase in Cassava production for the past 20 or more years. Hence, a survey of the cassava-growing areas shows that in more than 90% of the 65 representative villages, the farmer group respondents reported an increasing trend in cassava production in the last 20 years prior to the interview in 1989 (Nweke *et al.*, 1997;

Ugwu, 1996). The reasons offered for the increasing growth by the farmer group respondents included rapid population growth and market demand. Other factors attributed to the increase include: (1) the availability of improved varieties of cassava; (2) relatively well-developed market access infrastructure; (3) existence of improved processing technology; (4) participation of middle-person marketers in cassava; and (5) other market-related factors (FAO, 2005).

The Federal Government of Nigeria launched a project to introduce pro-vitamin A cassava varieties to 1.8 million farmers in the country. This project was launched under the Nigerian Presidential Initiative of July 2002 by the former president chief Olusegun Obasanjo (IITA, The Consultative Group for International Agricultural Research, CGIAR, 2012). As a result of this project, there has been consistent increase in the production of the root crop. Cassava is believed to be cultivated by small-scale farmers with limited resources (Ezebuiro *et al.*, 2008). It is not just as a food crop but accepted more as a primary source of income generation for rural farming-producing households. Cassava, as a cash crop fits well into the farming systems of the smallholder farmers in Nigeria because it is available all year round, thus providing household food security (Obisesan, 2012).

Nevertheless, constraint in cassava production is not limited to a wide range of technical factors but institutional and socioeconomic factors. These include land degradation, pests and diseases, agronomic problems, food policy changes, shortage of planting materials, markets access, limited processing options and ineffective / inefficient extension delivery systems (FAO, 2005). The scarcity of farmland and other production resources compel a strategy to increase agricultural productivity by efficiently using the little available resources (Chepng'etich *et al.*, 2014). This reveals the significance of technical efficiency and its linkage with agriculture. Authors like Chepng'etich *et al.* (2014); Chiona (2011); Fried *et al.* (2008) have recognised the crucial role of technical efficiency in productivity and agricultural growth in which this study is following suit.

3. Research methodology

3.1 Study area

This study was carried out in Ondo State, Nigeria. The present Ondo State was carved out from the former Western State of Nigeria in 1976 and further split in 1996 to give way to the creation of Ekiti State. Ondo State lies between latitudes 5°45' and 8°15' north of the equator and longitude 4°45' and 6°00' east of Greenwich meridian. It is bounded by Edo and Delta States on the east, Ogun and Osun States on the west, Ekiti and Kogi States on the north and Bight of Benin and Atlantic Ocean on the south. Ondo State has eighteen Local Government Areas (LGAs), a land mass area of 14,788,723 square kilometres and a population of 3,441,024 comprising of 1,761,263 males and 1,679,761 females (National Population Commission (NPC), 2006). The State is dominated by the Yorubas with various dialects of Yoruba language such as the Akoko, Akure, Apoi, Idanre, Ondo, Ikale, Ilaje and Owo. There is minority tribe called the Ijaws who speak Ijaw language. Agriculture constitutes the main occupation of the people of the State but there are other occupations such as civil Service, trading, artisan and teaching. The tropical climate of the State is broadly of two seasons: rainy season (April-October) and dry season (November-March). Temperature throughout the year ranges between 21 and 29 °C and the humidity is relatively high. The annual rainfall varies from 2,000 mm in the southern area to 1,150 mm in the northern area. The State earns its income mainly from cocoa and oil palm in addition to cassava. The other agricultural products of the State include yams and maize (Ondo State Ministry of Information, 2012).

3.2 Method of data collection and sources of data

Primary data were used for this study and information was sourced with the aids of structured questionnaire and focus group discussion sessions. The questionnaire was designed in line with the objectives of this study. The list of cassava farmers was collected from Ondo State Agricultural Development Programme from which respondents were randomly selected.

3.3 Sampling technique

A multistage sampling technique was used to randomly select 120 respondents from the list of cassava farmers collected from the State Agricultural Department as stated above. In stage one, purposive sampling technique was used to select two LGAs out of eighteen LGAs in Ondo State based on their contributions to the crop production. Second stage involved random selection of five communities from each selected LGA and lastly, simple random sampling technique was also used to select twelve cassava farmers from each community. Only 112 copies out of the 120 copies of the questionnaire were returned and analysed for this study.

3.4 Method of data analysis

In analysing the data, descriptive statistics, food security index, Data Envelopment Analysis (DEA) and Heckman probit model were the tools employed. Descriptive statistics such as mean, standard deviation and frequency distribution were also used to describe the socio-economic characteristics of the respondents. Paired samples test was used for the hypotheses. Expenditure on foods was used to measure household food security status with their food surplus/shortfall gap index.

■ Food security model specification

Following the method of Bickel *et al.* (2000), Omotesho *et al.* (2006) and Omonona and Agoi (2007), the food security line for the cassava farm households was the recommended daily energy levels of 2,260 kilocalories. Respondents that consume less than the benchmark were scored zero, meaning that they were food insecure while those that consume above Benchmark were scored one, meaning that they were food secure. surplus/shortfall index measured the extent to which a household was food secure or insecure (Bickel *et al.*, 2000; Hall, 2004; Nord *et al.*, 2001; Olayemi, 1996). This is given as:

$$P = \frac{1}{M} \sum_{j=1}^M G_j \quad (1)$$

Where P =surplus/shortfall index; $G_j = (X_j - L)/L$. is the amount of average daily calorie deficiency or surplus faced by household j , using the bench mark of recommended daily energy levels (L) as the food security line and M =number of households that are food secure (for surplus index) or food insecure (for shortfall index).

$$\text{Food security index } Z = \frac{\text{Household's daily per capita calorie availability (A)}}{\text{Household's daily per capita calorie requirement (L)}} \quad (2)$$

The head count ratio also measured the ratio of number of food secure (food insecure) households to the total number of sampled households

■ Efficiency techniques and productivity measurement

DEA was used to determine the technical efficiency of cassava farmers. It is a multi-factor productivity analysis model for measuring the relative efficiencies of a homogenous set of decision making units (DMUs). Assuming that all the DMUs are operating at the same optimal level, the efficiency score in the presence of multiple input and output factors is defined following (Charnes *et al.* (1978).

$$\text{Efficiency} = \frac{\text{Weighted sum of outputs}}{\text{Weighted sum of inputs}} \quad (3)$$

Using the duality in linear programming as used by Oguntade *et al.* (2011), one can derive an equivalent envelopment form of this problem:

$$\min \theta, \lambda, \theta \quad (4)$$

Subject to: $-yi + Y\lambda \geq 0, \theta xi - X\lambda \geq 0, N1\lambda = 1$ and $\lambda \geq 0$

Where θ is a scalar, λ is a $N \times 1$ vector of constants.

This envelopment form involves fewer constraints than the multiplier form ($K+M < N+1$), and hence is generally the preferred form to solve. The value of θ obtained will be the efficiency score of the i -th DMU. It will satisfy $\theta \leq 1$, with a value of 1 indicating a point on the frontier and hence a technically efficient DMU (Farrell, 1957). Note that the linear programming problem must be solved N times, once for each DMU in the sample. A value of θ is then obtained for each DMU. X_i is input vector of the i -th DMU; Y represents output matrix; X represents input matrix.

■ The Heckman probit model

Heckman's two-step procedure (Heckman, 1976) was adopted to examine factors influencing food security status and efficiency of the cassava farmers in the study area. The model assumes that there is an existing underlying relationship that consists of the latent equation given below:

$$y_j^* = x_j \beta + u_{ij} \quad (5)$$

Where y_j^* =latent variable (the tendency of being efficient in the enterprise or not); x =a k -vector of independent variables which include different factors hypothesised to affect efficiency of a firm; β =the parameter estimate; and u_i =an error term.

Therefore, only the binary outcome given by the probit model $y_j^{probit}=(y_j^* > 0)$ will be observed in the model.

The dependent variable is observed only if the observation 'j' is observed in the selection equation:

$$y_j^{select} = (z_{j\delta} + u_{2j} > 0) \quad (6)$$

Where: y_j^{select} =whether a respondent is food secure or not; z =a m vector of independent variables (which include different factors hypothesised to affect food security status); δ =parameter estimate, u_1 and u_2 =error terms (which are normally distributed with mean zero and variance 1). Thus, the first stage of Heckman's two-step model is the selection model (it represents the food security status of the respondent i.e. define as 1 when respondent is food secure and 0 when the respondent is food insecure). The second stage which dwells on the food secure respondents is called outcome model (it represents whether the food secure respondent is efficient or not).

■ Paired sample t-test

The paired sample *t*-test was used to determine if there is no significant difference between the mean output of food secured and food insecure respondents; and if there is no significant difference in the efficiency of food secured and food insecure respondents.

4. Results and discussion

4.1 Socio economic characteristics of respondents

As shown in Table 1, the mean age of the respondents was 50 years old. This implies that most of the respondents are still in their economic active age in which they can respond to change. This agrees with the findings of Ebewore (2012); Oparinde and Daramola (2014) who observed that farmers are relatively young and full of vigour and strength to carry out farming activities. The study also showed that the mean

Table 1. Socio-economics characteristics of cassava farmers used in efficiency analysis.

Variable	Mean	Dominant indicator
Age (years)	50	63.40% falls below or equals 50 years (active)
Farming Experience (years)	20	50% between 11 and 20 years
Sex		65.18% Male
Marital status		86.61% Married
Farm size (hectare)	0.69	56.3% between 0.5 and 1 ha
Quantity of production (tonnes)	12.58	29.46% fell between 12.01 and 15.00 ha
Educational background		71.43% had formal education
Access to formal credit		71.43% had no access
Extension contact		67.6% had no access
Source of information		42.86% through other farmers

farming experience of the farmers was 20 years. This, one could assume that farmers would have a better knowledge and information in farming as they farmed year round over a period of time as reported. The results concur with Folayan and Oguntade (2011) in their studies carried out among farmers in Ekiti State, Nigeria that most of the farmers are experienced in farming activities. Male farmers constitute the larger percentage of the sampled respondents and this could be as a result of the laborious nature of cassava production. The average land area cultivated by the farmers was 0.69 hectares while the mean cassava yield was 12.58 tonnes per hectare. This implies that majority of the respondents in the study area are small scale farmers. This is in consonance with findings of Obasi *et al.* (2013) who reported that small holdings can lead to more intensive and efficient use of land resources if properly utilised. Moreover, it is also in agreement with Asogwa *et al.* (2006) who noted that the wide variation in the cassava output of the farmers could be attributed to variations in input use due to differences in technical efficiency occasioned by differences in the relative access of farmers to cassava policy packages.

Most of the respondents had at least primary school education while few were illiterates. This implies that most farmers are educated and this will aid the respondents in interpreting instructions on the use of agrochemicals, adoption of modern technologies and taking wise decisions on farming operations as opined by Reuben and Mshelia (2011). It was stated further that the level of farmers' education will not only increase his productivity but also enhances his ability to understand and evaluate new production techniques. The findings also revealed that some of the respondents have access to credit facilities; help from extension agents and market information through other farmers respectively. Inability of the smallholder farmers to access credit will affect their farming activities negatively vis-a-vis their production and livelihood as pointed out by Gani and Adeoti (2011). Again, limited access to extension agents denies farmers acquisition of better skills and technology while access to market information through various means availed respondents' as timely information on production dynamics is critical to their successes. Supplementary Table S1 presents the full socio-economic characteristics of cassava farmers in the study area.

4.2 Food security status of respondents

Food security status of cassava farming households in the study area was presented in Table 2. The findings revealed that most of the sampled respondents were food insecure. This implies that the number of the food insecure households (64) is greater than food secure households (48) among the sampled respondents in the area. The mean value of food security index of food secure households was 1.20 while that of food insecure household was 0.87. The results of shortfall and surplus indices were 0.13 and 0.20 respectively. These indices implied that on average, the food insecure households consumed 13% less than their daily calorie requirement while food secure households consumed 20% in excess of their daily calorie requirements.

Table 2. Indices of farming household food security.

	Food secure	Food insecure	Total
Percentage of household	42.68	57.32	100.00
Number of household	48.00	64.00	112.00
Mean/food security index	1.20	0.87	1.01
Head count ratio	0.43	0.57	
Shortfall index		0.13	
Surplus index	0.20		

4.3 Technical efficiency status of respondents

The frequency distribution of technical efficiency estimates for cassava farmers is given in Table 3. The results of DEA indicated that about 80% of the respondents had efficiency above 0.50 with an average efficiency of 0.83. Added to this, it could be deduced from the average technical efficiency that cassava producers could increase their efficiency by 17% through better and appropriate use of resources. The level of technical efficiency for cassava farmers is greater than the results for waterleaf vegetable (65%) in Nigeria by Udo (2005) and lesser than that of cocoa production in Cross River State, Nigeria by Oguntade *et al.* (2011). The technical efficiency levels ranged from a minimum of about 17.5% to a maximum of 99.8%. This implies that there exists tremendous opportunity to improve technical efficiency among the cassava farmers in the study area.

4.4 Determinants of factors influencing food security and technical efficiency of cassava farmers

The Heckman probit model was run and tested for its appropriateness above the standard probit model. The results showed the presence of sample selection problem (dependence of the error terms from the outcome and selection models) therefore, extenuating the use of Heckman probit model with rho significantly different from zero (Wald $\chi^2=12.97$, with $P=0.001$) as depicted in Table 4. Furthermore, the likelihood function of the Heckman probit model was significant (Wald $\chi^2=92.15$, with $P<0.0000$) showing a strong explanatory power of the model. The results from the selection model revealed that age of the respondents, educational level, cassava output, access to extension agents, number of dependants and household income were the factors that statistically influenced the probability of the farmers to be food secure or not. In the same vein, the results of outcome model indicated that age of the respondents, household size, educational level, farming

Table 3. Frequency distribution of technical efficiency estimates for cassava farmers.

Efficiency scores (%)	No of cassava farmers
less than 20	1
20-29	4
30-39	6
40-49	7
50-59	8
60-69	13
70-79	15
80-89	34
≥ 90	24
Total	112
Average/mean	83
Minimum	17.5
Maximum	99.8

Table 4. Results of the Heckman's probit selection model.¹

Explanatory variable	Outcome equation (efficiency status)		Selection equation (food security status)	
	Coefficient	P-value	Coefficient	P-value
Age	-0.78060*	0.081	-0.02411**	0.045
Gender	0.00290	0.320		
Marital status	0.12220	0.101	0.29510	0.276
Household size	-0.33410***	0.004	-0.15012	0.311
Educational level	1.08125**	0.023	0.07131**	0.036
Farming experience	1.05501***	0.005		
Farm size	2.32100*	0.096	2.54111*	0.085
Cassava output			5.53124*	0.074
Access to credit facilities	0.25830**	0.031		
Access to extension agents	1.5832*	0.064	0.05277*	0.091
Market information			0.85544	0.195
Social group belong to			0.17390	0.106
Number of dependants			-2.03127**	0.037
Primary occupation	0.72001	0.212	0.82131	0.281
Distance to cassava farm	-2.57211*	0.081		
Household income	5.34E-05***	0.001	6.211E-05**	0.021
Constant	-2.05824	0.065	6.87945	0.209
Total observations	112			
Censored	53			
Uncensored	59			
Wald chi square (zero slopes)	92.41***			
Wald chi-square	12.97***			

¹ *** significant at 1% level, ** significant at 5% level and * significant at 10% level.

experience, farm size, access to credit, access to extension agents, distance to farm from home and household income influenced statistically the likelihood of being efficient or not in the study area.

With respect to the age of the respondents, the study found out that as farmers are getting older the probability of being food insecure is increasing and as well less the chance of being efficient in cassava production. The probable reason might be that the old farmers have lost their productive strength thereby affecting their food security status and efficiency status in producing cassava in the area.

Household size negatively influenced the efficiency status of the farmers. This implies that a unit increase in the number of household will increase the likelihood of being inefficient in cassava production. Educational level of the respondents was positive and significant in influencing food security status and efficiency status of the cassava farmers. This indicates that educated farmers have the chance of being food secured and as well efficient in the production of cassava. This is because higher education is likely to expose farmers to more information on improved technology and market that could aid the farmers to be food secured and as well efficient in their farming activities. This study agrees with the findings of Ndambiri *et al.* (2013) who also observed that education is likely to enhance the farmers' ability to receive, decipher and comprehend information relevant to making innovative decisions in their farms. The coefficient of farming experience was positive and statistically influenced efficiency status of the respondents. This means that the more the farmers engage in cassava farming, the more the likelihood of being efficient. The probable reason might be because experienced farmers have better knowledge and information on farming activities couple with their high skills in farming techniques and management (Nhemachena and Hassan, 2007).

Again, farm size had a positive coefficient and significantly influenced food security status and efficiency status apiece. This implies that farmers with large farm size might likely to be food secured and efficient in cassava production in the study area. However, the reason might be because farm size is associated with greater wealth (Deressa *et al.*, 2008). It could therefore be deduced that farm size increases food security status and efficiency of the farmers. The study established a direct relationship between cassava output and food security status. It was found from the results that farmers with large output of cassava are likely to be food secured because he/she will have enough cassava products to sell in order to get income to purchase other needs, eat and feed his/her family. Access to credit had a positive and significant influence on efficiency status of the cassava farmers in the study area. According to Deressa *et al.* (2008), availability of credit eases the cash constraints and allows farmers to purchase inputs such as fertilizer, improved crop varieties, insecticides and herbicides that might increase technical efficiency of the farmers. Access to extension agent positively influenced the likelihood of being food secure and efficient in the production of cassava in the area. Meaning that farmers that are visited by extension workers might not likely to be food insecure and inefficient in their farming activities. This is because access to extension agents is access to current information on farming activities that could improve their standard of living and productivity.

Moreover, the study established an opposite relationship between number of dependents and food security status in the study area. This indicated that as the number of dependents is increasing, the probability of being food secured is reduced. Considering the distance to the cassava farm from home, the study results indicate that farmers residing farther away from their farm were less likely to be efficient in cassava production. This is similar to the findings of Nyangena (2007) who observed that in Kenya, long distances to the markets or output farm negatively and significantly influence the adoption of agricultural technologies. Furthermore, the coefficient of household income was positive and significant in influencing both food security status and efficiency status of the respondents. This implies that a unit increase in farmers' income will increase the chance of being food secured and as well efficient in the production of cassava. Since household income signifies sufficient financial wellbeing, it was noted that it has a positive relationship with the adoption of agricultural technologies, which could have been the probable reason for its positive influence on food security and efficiency of the farmers.

4.5 Hypotheses testing

Table 5 presents the results of paired sample *t*-test for both hypotheses. For hypothesis 1, it was revealed that there was a significant difference between the mean output of food secured and food insecure respondents given $P<0.05$. Therefore, this study rejects the null hypothesis but failed to reject the alternative hypothesis. The significant difference that exists between the mean outputs of food secure and food insecure cassava farmers is an indication that the cassava output of food secured farmers are more than that of their corresponding food insecure farmers. This implies that food security has a positive significance on the output of cassava farmers in study area. Also for hypothesis 2, it was revealed that there was a significance difference in the efficiency of food secure and food insecure respondents given $P<0.05$. Therefore, this study also rejects the null hypothesis but failed to reject the alternative hypothesis. The fact that a significant difference exists in the efficiency of food secure and food insecure respondents suggests that efficiency has a positive impact on food security of cassava farmers in study area. It is therefore expected that cassava farmers should increase their efficiency through better and appropriate use of resources and also engage in other remarkable opportunity to improve their technical efficiency so as to be food secured at all time.

Table 5. Results of the hypotheses testing.

Hypothesis	Variable	<i>t</i> -value	Df	Sig. (2-tailed)
H_1 : cassava output	Food secure and food insecure	15.891	107	0.000
H_2 : efficiency	Food secure and food insecure	-9.937	111	0.000

5. Conclusions and recommendations

5.1 Conclusions

This study assessed the determinants of food security and technical efficiency of cassava farmers in Ondo State, Nigeria. Analyses were computed using 2014/2015 cassava production data from 112 sampled farmers in Ondo State. Food security index was used to measure food security status, an input oriented DEA approach was used to generate technical efficiency estimated using DEAP software (Armidale, NSW, Australia) and Heckman probit model (STATA 12, StataCorp LLC, College Station, TX, USA) was also used to ascertain the determinants of food security and technical efficiency in the study area. The findings revealed that 43% of the respondents were food secured. The results of shortfall and surplus indices were 0.13 and 0.20 respectively. DEA results specified that about 80% of the respondents had efficiency above 0.50 while the average efficiency was 0.83. Added to this, it could be deduced from the average technical efficiency (0.83) that cassava producers could increase their efficiency by 17% through better and appropriate use of resources. The results of Heckman probit model also showed that age of the farmers, farming experience, education, access to credit, access to extension agent farm size and household income were the factors that influenced food security status and technical efficiency of the respondents in the study area.

It is therefore concluded that improving technical efficiency of the cassava farmers will be an antidote to the problem of food insecurity in the study area. As noted by Khuda *et al.* (2006), employing available resources and technologies efficiently and effectively, will control the problem of food insecurity in a better way without carrying out additional investment.

5.2 Policy implications and recommendations

Based on the findings of this study and conclusion drawn, a number of policy implications and recommendations are made towards ensuring food security and improvement technical efficiency of cassava farmers in the study area and the country as a whole. These are:

1. Improving access to agricultural extension services that will assist in farmer-training programs should be available in order to ensure appropriate combination of inputs. The Government should ensure that the Unified Agricultural Extension System which oversees a single line of command in the dissemination of technologies to the farmers be fully implemented; the Research-Extension-Farmers-Linkage-System (REFILS) should also be equipped with working materials for good performance that will enhance the attainment of the goals of REFILS; and the shortage of human resources necessary to implement the training and visit extension management system should be reviewed. This, if done, will have a positive impact on the effectiveness of the coverage of farmers.
2. Farmers with inefficient farms should be encouraged to adopt the operating practices of the most productive farms. Contact farmers are expected to have multiplier effects on the adjacent farmers. But this is truncated due to insufficient formal feedback to the agricultural development programmes and limited spread of extension messages outside the contact farmers. The Government and agribusiness industry should therefore embrace provision of effective extension services that will create efficiency in the use of contact farmers in reaching to others.
3. Policy measures directed at provision of better family planning or birth control measures to reduce household size should be given adequate attention and priority by the government as increase in household size showed increase in technical inefficiency of cassava production and increase in number of dependants showed increase in food insecurity.
4. Access to credit facilities should be made more flexible to grant more loans to farmers at low interest rate for increase productivity, farm size and subsequently increase the technical efficiency *vis-a-vis* reduce food insecurity. The joint action of the Government and agribusiness industry is needed. The farmers should form themselves into cooperative societies so as to make credit acquisition and repayment easier while the Government should ensure availability of credit facilities with low interest rates and moratorium.

Supplementary material

Supplementary material can be found online at <https://doi.org/10.22434/IFAMR2016.0151>.

Table S1. Socio-economics characteristics of the cassava farmers in the study area.

References

Asogwa, B.C., J.C. Umeh and P.I. Alter. 2006. Technical efficiency analysis of Nigeria cassava farmers: a guide for food security policy. Poster Paper prepared for presentation at the International Association of Agricultural Economists Conference, Gold Coast, Australia. August 12-18. Available at: <https://ageconsearch.umn.edu/bitstream/25473/1/pp060369.pdf>.

Bickel, G., M. Nord, C. Price, W. Hamilton and J. Cook. 2000. Guide to measuring household food security Revised 2000. USDA, Food and Nutrition Service, Washington, DC, USA. Available at: <http://tinyurl.com/ya4ppagp>.

CGIAR. 2012. Minister of agriculture launches vitamin a cassava in Nigeria. HarvestPlus (Challenge Program of the CGIAR). 19 March 2012. Available at: <http://tinyurl.com/yafsf7hn>.

Charnes A., W.W. Cooper and E. Rhodes 1978. Measuring the efficiency of decision making units. *European Journal of Operational Research* 2(6): 429-444.

Chepng'etich E., E.K. Bett, S.O Nyamwaro and K. Kizito. 2014. Analysis of technical efficiency of sorghum production in lower Eastern Kenya: a data envelopment analysis (DEA) approach. *Journal of Economics and Sustainable Development* 5(40) 58-65.

Chiona, S. 2011. Technical and Allocative Efficiency of Smallholder Maize Farmers in Zambia. Unpublished MSc Thesis, University of Zambia, Lusaka, Zambia.

Davies A.E. 2009. Food security initiatives in Nigeria: prospects and challenges. *Journal of Sustainable Development in Africa* 11(1): 186-202.

Deressa, T., R.M. Hassan, T. Alemu, M. Yesuf and C. Ringler. 2008. Analyzing the determinants of farmers' choice of adaptation methods and perceptions of climate change in the Nile basin of Ethiopia. international food policy research institute (IFPRI) discussion paper No. 00798. Environment and Production Technology Division, IFPRI, Washington D.C., USA.

Ebewore, S.O., J. Egbodion and O.O. Oboh. 2012. Profitability analysis of yam production in Ika South LGA, Delta State, Nigeria. *Journal of Biology, Agriculture and Healthcare* 3(2): 118-129.

Ekandem, M.J. 1962. Cassava in Nigeria: Eastern Nigeria, Part 1. Issue 42 of Memorandum, Federal Department of Agricultural Research, Moor Plantation, Nigeria, pp. 23. <http://www.fao.org/wairdocs/ILRI/x5458E/x5458e0c.htm>.

Erhabor, P.O. and C.O. Emokaro. 2007. Relative technical efficiency of cassava farmers in the three agro-ecological zones of Edo State, Nigeria. *Journal of Applied Sciences* 7: 2818-2823.

Ezebuiruo N.O., G.O. Chukwu, B.C. Okoye and I.C. Oboagis. 2008. Policy issues and adoption of improved cassava varieties: gender consideration in Umuahia Zone of Abia State, in Umuahia, Abia State, Nigeria, pp 1056-1059.

Farrell M.J. 1957. The measurement of productive efficiency. *Journal of the Royal Statistical Society* 120(3): 253-290.

Folayan J.A and E.A. Oguntade. 2011. Analysis of cost and returns to management in yam wholesale market in Efon Alaaye local government, Ekiti State, Nigeria. *Journal of Food, Agriculture and Environment* 9(3/4): 552-556

Food and Agricultural Organisation. 2004. The state of food insecurity in the world: monitoring progress toward the world food summit and millennium development goals. FAO, Rome, Italy.

Food and Agricultural Organisation. 2005. Food and Agricultural Organization of the United Nations. FAOSTAT, Statistical Database. FAO, Rome, Italy.

Food and Agricultural Organisation. 2007. Crop production. FAO Database. <http://www.faostat.fao.org>.

Food and Agricultural Organisation. 2010. Food insecurity in the world: addressing food insecurity in protracted crises. FAO, Rome, Italy.

Fried, H., K. Lovell and S. Schmidt. 2008. The measurements of productive efficiency and productivity growth. Oxford University Press, New York, NY, USA.

Gani B.S and A.I. Adeoti. 2011. Analysis of market participation and rural poverty among farmers in northern part of Taraba State, Nigeria. *Journal of Economics* 2(1): 23-36.

Hall, B. 2004. *Understanding food security data and methodology*. Hunger issue brief, Food security Institute, Center on Hunger and Poverty. Available at: <http://tinyurl.com/ya9jzhmk>.

Heckman J.J. 1976. The common structure of statistical models of truncation, sample selection and limited dependent variables and a simple estimator for such models. *Annals of Economic and Social Measurement* 5: 475-492.

Khuda, B., B. Ahmad and H. Sarfraz. 2006. Food security through increasing technical efficiency. *Asian Journal of Plant Sciences* 5: 970-976.

Kuku-Shittu, O. A.W. Mathiassen, A. Myles and L.A. Akeem. 2013. Comprehensive food security and vulnerability analysis. International Food Policy Research Institute (IFPRI), IFPRI Discussion Paper 01-275 land use decree (Act) in Ogun, Ondo and Oyo States of Nigeria. *Agricultural Administration* 17(1): 21-31.

Kumbhakar, S.C. 2004. Productivity and efficiency measurement using parametric econometric methods. Working Paper, State University of New York, Binghamton, NY, USA, pp. 2.

Match Maker Associates (MMA). 2007. Value chain analysis in Tanzania, a study commissioned by Kilimo Trust. Available at: <http://tinyurl.com/ycoz4cnm>.

Muhammad-Lawal, A., S.A. Salau and S.A. Ajayi. 2012. Economics of improved and local varieties of cassava among farmers in Oyo State, Nigeria. *Ethiopian Journal of Environmental Studies and Management (EJESM)* 5(2): 189-194.

National Population Commission (NPC). 2006. National census report, Abuja, Nigeria. Available at: <http://population.gov.ng/publications>.

Ndambiri, H. K., C.N. Ritho and S.G. Bogor. 2013. An evaluation of farmers' perceptions of and adaptation to the effects of climate change in Kenya. *International Journal of Food and Agricultural Economics* 1(1): 75-96.

Nhemachena, C. and R. Hassan. 2007. Micro-level analysis of farmers' adaptation to climate change in southern Africa. International Food Policy Research Institute (IFPRI) Discussion Paper No. 00714. Environment and Production Technology Division, IFPRI, Washington, D.C., USA.

Nord, M., K. Jemison and G. Bickel. 1999. Prevalence of food insecurity and hunger, by state 1996-1998, Food Assistance and nutrition Research Report No. 2 Food and Rural Economics Division, Economic Research Services, United States Department of Agriculture. Available at: <http://tinyurl.com/y83tuby>.

Nwajiuba, C. 2012. Nigeria's agriculture and food security challenges. Available at: <http://tinyurl.com/ybgyvwg8>.

Nweke, F.I., B.O. Ugwu, A.G.O. Dixon, C.L.A. Asudu and O. Ajobo. 1997. *Cassava production in Nigeria: a function of farmer access to market and to improve production and processing technologies*, COSCA Working Paper no. 21, Collaborative Study of Cassava in Africa. IITA, Ibadan, Nigeria.

Nyangena, W. 2007. Climate Change and Adaptation in Kenya Paper presented at the Environmental Economics Policy Forum, Addis Ababa, April. Available at: <http://tinyurl.com/yboa745m>.

Obasi, P.C., A. Henri-Ukoha, S.I. Ukewuike and N.M Chidiebere-Mark. 2013. Factors affecting agricultural productivity among arable crop farmers in Imo State, Nigeria. *American Journal of Experimental Agriculture* 3(2): 443-454.

Obisesan, A.A. 2012. Cassava marketing and rural poverty among smallholder farmers in southwest, Nigeria. *Life Science Journal* 1(8): 29-34.

Oguntade, A.E., C. Okafor, T.E. Mafimisebi and T.E. Fatunmbi. 2011. Technical efficiency of cocoa farms in Cross River State, Nigeria. *African Journal of Agricultural Research* 6(22): 5080-5086.

Olayemi, J.K. 1996. *Food security in Nigeria*. Research Report No.2, Development Policy Center, Ibadan, Nigeria

Omonona, B.T. and A.G. Agoi. 2007. An analysis of food security situation among Nigerian urban households evidence from Lagos State, Nigeria. *Journal of Central European Agriculture* 8 (3): 397-406.

Omotesho, O.A., M.O. Adewumi, A. Muhammad-Lawal and O.E. Ayinde. 2006. Determinants of food security among the rural farming households in Kwara State, Nigeria. *African Journal of General Agriculture* 2(1): 7-15.

Ondo State Ministry of Information. 2012. *Digest of Agricultural Statistics in Ondo State, Nigeria*. 2012 Edition. Research and Statistics Department, Ministry of Economic Planning and Budget, Akure, Nigeria.

Oparinde, L.O. and A.G. Daramola. 2014. Determinants of market participation by maize farmers in Ondo State, Nigeria. *Journal of Economics and Sustainable Development* 5(1): 69

Orefi, A. 2012. Food security in Nigeria and South Africa: policies and challenges. *Journal of Human Ecology* 38(1): 31-35.

Reuben, J. and S.I. Mshelia. 2011. Structural analysis of yam markets in southern part of Taraba State, Nigeria. *Journal of Agricultural Sciences* 2(1):39-44.

Sanni, L.O., O.O. Onadipe, P. Ilona, M.D. Mussagy, A. Abass and A.G.O. Dixon. 2009. Successes and challenges of cassava enterprises in West Africa: a case study of Nigeria, Bénin, and Sierra Leone. IITA, Ibadan, Nigeria, pp. 19.

Udoh, E.J. 2005. Technical efficiency in vegetable farms of humid region: an analysis of dry season farming by urban women in South Zone, Nigeria. *Journal of Agriculture and Social Science* 2: 80-85.

Ugwu, B. 1996. Increasing cassava production in Nigeria and prospects for sustaining the trend. *Outlook on Agriculture* 25(3):179-185.

World Bank. 2001. Poverty and hunger: issues and options for food security in developing countries. World Bank, Washington, DC, USA.