TECHNICAL EFFICIENCY ANALYSIS OF NIGERIAN CASSAVA FARMERS: A GUIDE FOR FOOD SECURITY POLICY.

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Poster paper prepared for presentation at the International Association of Agricultural Economists Conference, Gold Coast, Australia,

August 12-18, 2006

Key words: Technical efficiency, Nigerian Cassava Farmers and Food Security Policy.

INTRODUCTION

Nigerian agriculture is dominated by the small scale farmers who produce the bulk of food requirements in the country. Despite their unique and pivotal position, the small holder farmers belong to the poorest segment of the population and therefore, cannot invest much on their farms. The vicious circle of poverty among these farmers has led to the unimpressive performance of the agricultural sector (Ajibefun, 2002). According to Ajibefun and Daramola (2003), resources must be used much more efficiently, with more attention paid to eliminating waste. This will lead to an increase in productivity and incomes.

Cassava can be a powerful poverty fighter in Africa. The cash income from cassava proves more egalitarian than the other major staples because of cassava's low cash input cost (Nweke, 2004). Compared with other major staples, cassava performs well across a wide ecological spectrum. It therefore benefits farmers across broader swath of ecological zones. Cassava is, likewise, less expensive to produce. It tolerates poor soil, adverse weather and pests and diseases more than other major staples (Nweke, 2004). The crop puts ready money and food in the very vulnerable segments of society. Cassava stores its harvestable portion underground until needed; it is therefore a classic food security crop.

The current policy direction of the Federal government of Nigeria has encouraged cassava development leading to a new orientation in the research-extension-farmers linkage. Asogwa *et al*. (2005) observed that the input expansion policy of government in the cassava industry through the provision of improved cassava varieties and improved processing technology led to efficient use of resources in cassava production in Nigeria.

Given the various cassava programmes and policies implemented over the years to raise farmers' efficiency and productivity in cassava production, it then becomes imperative to empirically analyze the relationship of technical efficiency and socio-economic variables of cassava farmers. This will further guide policy makers in making policy for the improvement of the welfare of cassava farmers, which will give room for the expansion of their cassava production. Thus, the broad objective of this study is to analyze technical efficiency of Nigerian cassava farmers as a guide for (some) food security policy. The specific objectives of the study are to:

1. analyze the socio-economic variables of cassava farmers in Nigeria;
2. analyze the relationship between technical efficiency and the socio-economic variables of cassava farmers in Nigeria; and
3. determine the effect of the socio-economic variables of cassava farmers in Nigeria on technical efficiency.

METHODOLOGY

The Study Area

For this study, farm level data were collected on 360 cassava farmers in Benue State. Benue State is one of the 36 states of Nigeria located in the North-Central part of Nigeria. It is referred to as the food basket of Nigeria because of the abundance of its agricultural resources. About 80% of the State population is estimated to be directly involved in subsistence agriculture. The State is a major producer of food and cash crops like cassava, yams, rice, benniseed and maize. Others include sweet potato, millet and a wide range of other crops like soyabeans, sugar cane, oil palm, mango, citrus and bananas.

Nigeria is the largest producer of cassava tuber in the World with an estimated production figure of 40 million metric tons of cassava tubers per annum (Eno, 2004) and Benue State is a leading producer of cassava in Nigeria (BMANR, 2003). Apart from the ecological support for cassava growth and population, Benue State has mounted deliberate strategies such as distribution of improved varieties to sustain its leading role in cassava production in the country (BMANR, 2003).

Sampling Technique

Benue State is divided into three agricultural zones namely, Zone A, Zone B and Zone C. From each Zone, three Local Government Areas were selected using randomized sampling design in the first phase multistage sampling design.

From each of the nine selected Local Government Areas in Benue State, two communities that typify the State in terms of cassava production were drawn employing a randomized sampling design. Finally, from each community, 20 households were drawn for the study through a randomized sampling design. A total of 360 cassava farmers were selected for the study using the randomized sampling design. This consists of both male and female farmers.

Data Collection

Primary and secondary data were used in the study. Specifically, technical efficiency estimates drawn from Asogwa *et al*. (2005) and socio-economic variables (annual output in kilograms, annual income in Naira, annual production cost in Naira, annual processing cost in Naira and *gari* yield in Kilograms) of the sampled cassava farmers in Benue State constituted the data for the study. The socio-economic variables were drawn through the use of a structured questionnaire administered to the 360 cassava farmers selected for the study.

Method of Data Analysis

Data gathered for the study were analyzed using both descriptive and inferential statistics. The descriptive statistics such as mean, minimum value, maximum value and standard deviation were used for the analysis of objective 1. Inferential statistics such as correlation and regression were used for the analysis of objectives 2 and 3 respectively.

Model Specification

Linear correlation

The Pearson's 'r' otherwise known as the Product Moment correlation coefficient, is about the most widely used measure of association for interval (and ratio) scale data. It measures linear association between interval variables.

The Product Moment correlation coefficient r, can take any value between -1 and +1. A statistically significant correlation coefficient in the range $0 < r \leq 0.3$ will be regarded as week correlation; $0.3 < r \leq 0.6$ will be regarded as moderate correlation; $0.6 < r < 1$ will be regarded as strong correlation, while a correlation coefficient of 1 will be regarded as perfect correlation.

Linear regression

Pitt and Lee (1981) have estimated stochastic Frontiers and predicted farm level efficiencies using estimated functions and then regressed the predicted efficiencies upon farm specific variables (such as managerial experience ownership characteristics and others) in an attempt to identify some of the reasons for differences in predicted efficiencies between farms. This has long been recognized as a useful exercise. Other authors who expressed inefficiency effects as explicit function of a vector of farm specific variables and a random error are in the literature (Kumbhakar *et al*, 1991; Reifschneider and Stevenson, 1991).

The regression model used to determine the effect of the socio-economic variables or farm specific variables of the cassava farmers in Nigeria on technical efficiency estimates is defined by:

$$Y = a + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \beta_5X_5 + \beta_6X_6 + \beta_7X_7 + \beta_8X_8 + \beta_9X_9 + U \text{ ……….} (1)$$

Where,

Y = Technical efficiency estimates

a = Constant term, which represents technical efficiency estimate when the independent variables are zero

βi = Regression coefficients representing change in technical efficiency estimates due to changes in the independent variables (i =1, 2, 3, 4, 5, 6, 7, 8, 9).

X_1 = Annual cassava output in kilograms

X_2 = Annual farm income in Naira

X_3 = Annual production cost in Naira

X_4 = Annual processing cost in Naira

X_5 = Annual *gari* yield in kilograms

X_6 = Annual gross margin in Naira

X_7 = Farming experience in years

X_8 = Education (a dummy variable). Access to education = 1. Non-access = 0

X_9 = Extension contact (a dummy variable).Contact with extension agents =1
Non-contact with extension agents = 0.

U = Error term representing changes in technical efficiency estimates unaccounted for by changes in the independent variables

The regression coefficient, bi, indicates changes in technical efficiency estimates as a result of changes in the independent variables. Positive regression coefficient suggests that increase (decrease) in the independent variables results to increase (decrease) in technical efficiency estimates while negative regression coefficient suggests that increase (decrease) in the independent variables results to decrease (increase) in technical efficiency estimates. Failure to reject the joint hypothesis that:

bi = bj...= 0 ……………………………………………………………………………..(2)

suggests that change in technical efficiency estimates is not explained by changes in the independent variables.

RESULTS AND DISCUSSION

The result of the summary statistics (Table 1) showed that the technical efficiency varied widely among farms ranging between 0.31 and 1.00, and a mean technical efficiency of 0.89, suggesting that many of the respondents produced closer to their production frontier where profit is maximized, and that technical efficiency in cassava production could be increased by 11% through better use of available resources, given the current state of technology (Asogwa *et al*, 2005). The wide variation in the technical efficiency estimates can be attributed to differences in effective utilization of inputs among the respondents.

The result also shows a wide variation in the cassava output of the respondents, ranging between 500 and 100,000 kilograms, and a mean cassava output of 24,129.90 kilograms. 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. For example, farmers who had relatively more access to improved cassava varieties and improved cassava processing technology achieved higher levels of technical efficiency in cassava production and hence, higher cassava output. Also, farm income of the respondents showed wide variation, ranging between ₦4,320 ($32.24) and ₦145,000 ($1082.09), and a mean income of ₦63,179.18 ($471.49). This result implies that many cassava farmers have left the poorest income bracket of less than ₦50,000 ($373.13) as established in the baseline survey (PME, 2004).

Table 1: Summary Statistics of the Socio-Economic Variables of the Cassava Farmers in Benue State, Nigeria.

Variable	Mean	Minimum	Maximum	Standard deviation
Efficiency Estimate	0.89*	0.31	1.00	0.12
Annual cassava output (kg)	24129.90*	500.00	100000.00	21116.73
Annual farm income (N)	63179.19*	4320.00	145000.00	31187.81
Annual production cost	10124.80*	1500.00	16950.00	2646.98

(N)				
Annual processing cost (N)	2189.07*	123.20	8100.00	1491.00
Annual *gari* yield (kg)	2113.76*	144.00	4880.00	1045.83
Annual gross margin (N)	54629.71*	-3480.00	129250.00	29752.25
Farming experience(years)	17.73*	1.00	31	8.61

Source: Field Survey, 2005.

*Mean is significant at the 5% level.

The cost incurred on production by the respondents ranged between ₦1,500 ($11.19) and ₦16,950 ($126.49), with a mean cost of production of ₦10,124 ($75.55), while the processing cost ranged between ₦123.20 ($0.92) and ₦8,100 ($60.45), with a mean cost of processing of ₦2,189.07 ($16.34). The low production and processing costs observed among the respondents can be attributed to the use of cost reducing technologies – including improved cassava varieties and improved cassava processing technology – in their cassava enterprise. The adoption of these cost reducing technologies by the cassava farmers was ushered in by the policy intervention of government in the cassava sub-sector (IFAD, 1999; PME, 2004).

The annual *gari* yield of the respondents also showed a wide variation, ranging between 144 and 4880 kilograms, and a mean *gari* yield of 2113.76 kilograms. The wide variation in *gari* yield is due to differences in cassava variety planted by the respondents. For example, farmers who planted improved cassava varieties such as TMS 30572 variety, which is the most popular high-yielding cassava variety especially for *gari* production and sale in the urban markets (Nweke, 2004), had relatively high *gari* yield. Nweke et al. (2002) noted that *gari* yield is as high as 5.13 metric tons per hectare when the improved variety (TMS 30572) is used.

The annual gross margin of the respondents showed a wide variation, ranging between ₦-3480 and ₦129250, and a mean annual gross margin of ₦54629.71. This mean annual gross margin suggests that cassava enterprise is a profitable venture in Nigeria. The wide variation in annual gross margin can be attributed to differences in input use among the respondents. Also, farming experience showed a wide variation, ranging between 1 and 31 years, and a mean farming experience of 17.71 years. This result suggests that most of the cassava farmers have long experience in farming.

The result in Table 2 shows that at 1% level of significance, technical efficiency estimate has positive and significant relationship with cassava output (r = 0.542), annual cassava farm income (r = 0.612), annual *gari* yield (r = 0.608), annual gross margin (r = 0.483), farming experience (r = 0.278), education (r = 0.699) and extension contact (r = 0.585). Conversely, annual processing cost (r = - 0.414) has negative and significant relationship with technical efficiency estimate at 5% level of significance.

This result suggests that technical efficiency, which is directly related to effective utilization of inputs in production, enhances cassava output, farm income, gross margin, *gari* yield and reduces annual processing cost of the cassava farmers in Nigeria. Furthermore, long experience in farming, education and extension contact enhance the technical efficiency of the sampled cassava farmers. This implies that policy intervention (such as increasing access of farmers to improved cassava varieties, cost effective improved cassava processing technology, available cassava markets, improved extension services, education, financial and credit facilities) that will further enhance the technical efficiency of the sampled cassava farmers would also enhance cassava output, cassava farm income, gross margin and *gari* yield in Nigeria. Furthermore, policy intervention (involving the provision of enabling environment) that would attract farmers with long

Table 2: Correlation Analysis Showing the Relationship between Technical Efficiency and Socio-Economic Variables of the Cassava Farmers in Nigeria.

	Efficiency Estimate	Annual cassava output	Annual farm income	Annual production cost	Annual processing cost	Annual *gari* yield	Annual gross margin	Farming experience	Education	Extension contact
Efficiency Estimate	1.00									
Annual cassava output	0.542**	1.00								
Annual	0.612**	0.944**	1.00							

farm income										
Annual production cost	- 0.79	0.432**	0.328**	1.00						
Annual processing cost	- 0.414**	0.875**	0.855**	0.471**	1.00					
Annual *gari* yield	0.608**	0.939**	0.992**	0.325**	0.853**	1.00				
Annual gross margin	0.483**	0.572**	0.563**	0.217**	0.533**	0.562**	1.00			
Farming experience	0.278**	-0.007	-0.021	0.053	-0.018	-0.014	-0.022	1.00		
Education	0.699**	0.622**	0.764**	-0.007	0.409**	0.750**	0.394**	-0.008	1.00	
Extension contact	0.585**	0.738**	0.836**	-0.030	0.644**	0.837**	0.429**	-0.010	0.698**	1.00

Source: Field Survey, 2005.

** Pearson Correlation coefficient (r) is significant at the 1% level (2-tailed).

experience in cassava production will enhance technical efficiency in cassava production in Nigeria.

The annual production cost has a negative coefficient but is not significant. This result suggests that annual production cost has a negative relationship with technical efficiency, implying that technical efficiency decreases with increasing production cost. However, the coefficient not being significant implies that this relationship occurred by chance. This is because there was an insignificant level of investment on production among majority of the respondents, who are mostly poor farmers.

The result in Table 3 shows that at 5% level, annual farm income (X_2) and annual processing cost (X_4) had significant but positive and negative coefficients respectively,

Table 3: Multiple Linear Regression Analysis is Showing the Cause-and-Effect Relationship between Technical Efficiency and Socio-Economic Variables of the Cassava Farmers in Nigeria.

Variables	**Symbol**	**Estimate**	**Standard error**	**t-ratio**
Constant	a	0.664	0.024	27.943**

Annual cassava output	X_1	8.517E-07	0.000	1.312
Annual farm income	X_2	2.718E-06	0.000	2.206*
Annual production cost	X_3	-3.640E-06	0.000	-1.748
Annual processing cost	X_4	-1.542E-05	0.000	-2.099*
Annual *gari* yield	X_5	8.139E-06	0.000	0.274
Annual gross margin	X_6	9.383E-07	0.000	5.975**
Farming experience	X_7	3.825E-03	0.000	8.617**
Education	X_8	0.191	0.020	9.330**
Extension contact	X_9	6.562E-02	0.018	3.700**
Multiple correlation coefficient	R	0.801		
R Square	R^2	0.641		
Adjusted R Square	R^{-2}	0.632		
F-value		69.566**		
Sample size		360		

Source: Field Survey, 2005.

** t-ratio is significant at the 1% level. *t-ratio is significant at the 5% level.

while annual gross margin (X_6), farming experience (X_7), education and extension contact had significant and positive coefficients at 1% level. On the other hand, the coefficients of annual cassava output (X_1), annual production cost (X_3) and annual *gari* yield (X_5) were not significant at both 1% and 5% levels. An F-test rejects the joint hypothesis that variation in technical efficiency estimates is not explained by variations in the independent variables at 1% level. The model explains 64.1% of the variation in technical efficiency estimates.

The implication of this result is that any increase (decrease) in the annual farm income increases (decreases) technical efficiency estimate by 2.718E-06. Furthermore, any increase (decrease) in the annual processing cost decreases (increases) technical efficiency estimate by 1.542E-05. Also, any increase (decrease) in the annual gross margin increases (decreases) technical efficiency estimate by 9.383E-07. Any increase (decrease) in farming experience increases (decreases) technical efficiency estimate by 3.825E-03. Access (non-access) to education increases (decreases) technical efficiency estimate by 0.191, while contact (no contact) with extension agents increases (decreases) technical efficiency estimate by 6.562E-02. This result suggests that annual farm income, annual processing cost, annual gross margin, farming experience, education and extension contact are the variables that significantly influenced technical efficiency among the sampled cassava farmers in Nigeria.

The policy implication of this result is that policy measures that would guarantee increase in farm income and gross margin of cassava farmers as well as provide cost effective improved cassava processing technology, increase access of cassava farmers to quality education and extension services will lead to increase in technical efficiency in cassava production in Nigeria. Furthermore, policy measures that would create enabling environment, which should attract experienced cassava farmers into cassava production will increase technical efficiency in cassava production in Nigeria.

CONCLUSION AND RECOMMENDATION

In conclusion, a significant relationship exists between technical efficiency and cassava output, farm income, processing cost, *gari* yield, gross margin, farming experience, education and extension contact of the sampled cassava farmers in Nigeria. Thus, policy measures (such as increasing access of farmers to improved cassava varieties, cost effective improved cassava processing technology, available cassava markets, improved extension services, increased access to quality education, financial and credit facilities and the necessary enabling environment) that would further raise the current level of technical efficiency in cassava production in Nigeria is strongly recommended for the enhancement of the welfare of the cassava farmers in Nigeria. Multiple regression result showed that variation in technical efficiency is explained by variations in annual farm income, annual processing cost, annual gross margin, farming experience, education and extension contact. Hence, policy measures that would guarantee increase in farm income and gross margin of cassava farmers as well as provide cost effective improved cassava processing technology, increase access of cassava farmers to quality education and extension services will lead to increase in technical efficiency in cassava production in Nigeria. Furthermore, policy measures that would create enabling environment, which should attract experienced cassava farmers into cassava production will increase technical efficiency in cassava production in Nigeria.

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APPENDIX

Distribution of Cassava Farmers in Nigeria by technical Efficiency Estimates

Technical Efficiency	Frequency	Percentage
< 0.31	0	0
0.31 – 0.50	6	1.67
0.51 – 0.70	26	7.22
0.71 – 0.90	99	27.50
> 0.90	229	63.61
Total	**360**	**100.0**
Mean efficiency =	0.89	
Minimum efficiency=	0.31	
Maximum efficiency=	1.00	

Source: Asogwa *et al*, 2005.