TECHNICAL EFFICIENCY OF HAUSA POTATO (*Solesnostemon rotundifolius* Poir) PRODUCTION IN SOUTHERN KADUNA STATE, NIGERIA.

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ABSTRACT
This study was designed to measure the level of technical efficiency, its determinants in Hausa potato production and the constraints in the production system in southern parts of Kaduna State using a stochastic frontier production function. A random sampling technique was used to select 60 Hausa potato farmers for Samaru Zone of Kaduna State ADP. The estimated farm level technical efficiency ranges from 21 to 88% with a mean of 55%. This wide range in technical efficiency indicates that great opportunities exist for the farmers to increase their productivity and income through improvement in technical efficiency. Education, years of experience and marketing cost were found to be positively and significantly related to technical efficiency while lack of capital, inadequate planting material, lack of knowledge in cultural management practices and poor storage facilities were found to be major constraints in the production of the crop in the study area. Hausa potato production is female dominated.
Key words: Hausa potato, Technical efficiency, Frontier production function

INTRODUCTION

Hausa potato (*Solenostemon rotundifolius* Poir) is a herbeceous plant having prostrate and ascending growth habits with a succulent stem reaching up to 15-30 cm in length and forming tubers in clusters around the base of the stem. The tubers are small and dark-brown. (Tindell, 1983). The crop is popular in the Middle Belt region especially in Adamawa, Borno, Kaduna, Nassarawa, Plateau and Taraba where it is known as *beku, tumuku, hyare, nvu, gami, ngo* and *fugi* (Olojede et al., 2005). It is predominantly produced by female members of the households and plays a significant role in the dietary and energy requirement of the local people especially during lean season.
It originated from tropical Africa, where it is still found in the wild in East Africa. It was widely cultivated in the savanna region from Senegal to western Sudan and in South

Africa, but currently there are only relics of former cultivation in Mali, Ghana, Nigeria and South Africa (Nkansah, 2004).
The tubers, in Nigeria, are used in the same way as potatoes and taste as the trifoliate yam and is rich in protein, minerals and vitamins (Alleman and Coertze, 1997; Olojede et al., 2005). It is usually boiled, fried or roasted and eaten as snack or with rice. Hausa potato is grown either as a sole crop or intercropped with bambara, groundnut, yam, okra, millet, maize or sorghum. Because of the comparatively low yields, people hardly apply manure or fertilizer (Olojede et al., 2005). In Ghana, yields range between 5 and 15 t/ha (Nkansah,2004) when conditions are good, but are considerably lower when soil fertility or rainfall are poor. Experimental work carried out at Roodeplaat in South Africa has indicated that the potential yield could be up to 45 t/ha when adequate irrigation and plant nutrients are provided together with good agronomic practices (Nkansah, 2004).

Studies in Hausa potato in Nigeria have been carried out in agronomy (Olojede et al., 2005) and breeding (Amadi, 2009) but information on the technical efficiency of Hausa potato production is scarce. Technical efficiency here refers to the ability to produce the highest level of output with a given bundle of resources (Onyenweaku and Nwaru, 2005). The estimation of the technical efficiency using stochastic frontier production function makes it possible to find out whether the deviation in technical efficiency from the frontier output is due to farm specific factors or external random factors.
The broad objective of this study is to provide information that will optimize Hausa potato output within the limits of farmers' scarce resources. The specific objectives of the study are to describe the socio-economic characteristics of producers, analyze the technical efficiency of the system, determine the sources of this efficiency and ascertain areas of constraints as well as provide policy solution aimed at improving Hausa potato production in Nigeria.

METHODOLOGY

The study area

The study was conducted in the major Hausa potato producing areas of the southern part of Kaduna state, Nigeria.

Sampling procedure/Data collection
Data collected from the study area were generated through the administration of a set of structured questionnaire on 60 farm families selected at random in the Samaru Agricultural Development Zone of Kaduna state where the crop is intensely cultivated. Data collected include household characteristics, occupation, household expenditure on planting material and inputs. Also collected were value of planting material, and output, household size and years of experience in Hausa potato production. Others include; age and education of respondent, gender, farm size, labour availability and constraints encountered in the production of the crop.

Data Analysis
Data collected were analyzed using simple descriptive statistics such as percentages and means to determine the socio-economic characteristics of the respondents and constraints in the production of Hausa potato. The functional form of the Cobb Douglas stochastic frontier model for estimating technical efficiency of Hausa potato farmers was expressed as;

$\ln Y_i = ß_0 + ß \ln X_1 + ß_2 \ln X_2 + ß_3 \ln X_3 + ß_4 \ln X_4 + ß_5 \ln X_5 + v_i - u_i$ ……..(1)

Where,
ln = represents the natural logarithm
The subscript i represents i-th sampled farmers
Y_i = hausa potato output in kg of the i-th farmer
X_1 = size of land in ha.
X_2 = quantity of planting material in kg
X_3 = quantity of inorganic fertilizer in kg
X_4 = quantity of organic manure in kg
X_5 = labour used in mandays
$ß_0$ = intercept.
$ß_1 – ß_5$ = coefficients estimated

To identify the determinants of technical efficiency, the expression below was used

$TE = b_o = b_1Z_1 + b_2Z_2 + b_3Z_3 + b_4Z_4 + b_5Z_5 + e$……(2)

Where,
b_0 = intercept.
$b_1 – b_5$ = coefficients estimated
TEi = technical efficiency of the i-th farmer,
Z_1 = household size
Z_2 = age
Z_3 = years of experience
Z_4 = educational status
Z_5 = mode of land acquisition
e = error

RESULTS AND DISCUSSION
Socio – Economic Characteristics of farmers.
The socio-economic characteristics of Hausa potato farmers are presented in Table 1. Data presented in the table indicates that 40 percent of Hausa potato farmers were of age of 21 to 40 years and the range between 41 to 60 accounted for 38.3 percent. This show that most farmers are young and are likely to be knowledgeable about new practices with the willingness to bear risk due to their planning horizons (Polson and Spencer, 1991). 63.3 percent of the respondents had farming experience of between 1 to 20 years. The farmers are therefore described as experienced and are expected to have higher efficiency since it affects the managerial ability and decision on farm operations (Rhaji, 2005). More than 60 percent of the respondents had a household size of more than 6 persons. Relatively large household sizes enhances the availability of labour though large households may not guarantee increased efficiency since family labour comprises mostly of school age children. 51.7 percent of the Hausa potato farmers have had formal education and are predominantly female. It is expected that educated farmers will be more receptive to improved farming techniques (Ajibefun and Aderinola, 2004).

Estimated Technical Efficiency

The Maximum Likelihood Estimate (MLE) of the production function parameters for Hausa potato in Kaduna State is presented in Table 2. The coefficients of the estimated parameters have the desired positive signs. These indicate that total farm value increased by the value of each coefficient as the quantity of each variable increased by unity except for seed, which is negative. The coefficients of the estimated parameters for land (X_1), seed (X_2) and labour (X_5) are significant while those of inorganic fertilizer (X_3) and organic manure (X_4) are not. The most important factors in the production of Hausa potato in the study area are land, seed and labour.

The lambda (λ) value of 1.02 (P=0.01), which is greater than unity, signifies a good fit for the estimated model and the appropriateness of the theoretically required distributional assumptions for the decomposed error terms (Tadesse and Krishnamoorthy, 1997). The gamma (γ) value of 0.95 represents the total output made on the production frontier which can be attributed to technical efficiency. These values are between zero and one as required (Bettese and Tessama, 1993). This implies that 95 percent of variation in output of Hausa potato production in the study area is due to technical efficiency.

Determinants of Technical Efficiency

The determinants of technical efficiency in the production of Hausa potato in Kaduna state, Nigeria is shown in Table 2. The R^2 value of 0.59 indicates that the factors explain about 59 percent of the variations in technical efficiency of Hausa potato farmers in the study area. The model is thus acceptable on statistical ground.

Table 1: Frequency distribution of respondents' Socio-economic characteristics for Tumuku Production system in Kaduna State in 2009

Variable z	Range	Frequency	Percentage
Age	21 – 40	24	40.0
	41 – 60	23	38.3
	61 – 80	12	20.0
	>80	1	1.7
Household size	1 – 5	22	36.7
	6 – 10	24	40.0
	11 – 15	10	16.6
	16 – 20	3	5.0
	>20	1	1.7
Farming experience	1 – 20	38	63.3
	21 – 40	13	21.7
	41 – 60	8	13.3
	>60	1	1.7
Education Status	No education	29	48.3
	Primary education	10	16.7
	Secondary eduction	19	31.7
	Tertiary eduction	2	3.3
Sex	Male	6	10
	Female	54	90

Source: Field survey 2009

The coefficients of marketing cost and years of farming experience are positive and significant at 5percent level of probability indicating a direct relationship with technical efficiency. This result agrees with *a priori* expectations that farmers with more years of farming experience are more technically efficient following Onyenweaku and Nwaru (2005). Marketing cost however, does not meet with *a priori* expectation as increase in marketing cost would discourage Hausa potato production. The coefficient for education was also positive and significant at 1 percent level of probability. This result agrees with *a priori* expectations that education increases productivity and enhances farmers' ability to understand and evaluate new production techniques and agrees with the findings of Onyenweaku and Nwaru (2005) and Onu *et al.,* (2000). The coefficients of household size was positive and age negative but neither was significant.

Frequency distribution of technical efficiency

The frequency distribution of technical efficiency of farmers engaged in Hausa potato production is presented in Table 3. Individual technical efficiency indices range between 21.0 and 88.0 percent with a mean of 55.0 percent. About 60.0 percent of the farmers had a technical efficiency index of above 50.0 percent. The mean technical efficiency of 55.0 percent implies that the output of Hausa potato can be increased by about 45 percent with the existing level of resources. This suggests that opportunities exist for increasing productivity and income through increased efficiency in resource utilization by Hausa potato farmers in the study area. In a study of food crop production in Imo State, similar technical efficiency indices range trend was observed by Onyenweaku and Nwaru (2005) where the range is between 31.05 percent and 95.12 percent. The wide efficiency differentials among these farmers are an indication of a substantial potential for efficiency improvement.

Table 2: Maximum likelihood estimate of the Cobb-Douglas stochastic production function

Variable	Parameter	Coefficients	t-ratio
Production factors			
Constant	$ß_0$	5.62	5.67***
Land	$ß_1$	0.45	2.81**
Seed	$ß_2$	-0.46	3.28***
Inorganic fertilizer	$ß_3$	0.04	0.01
Organic fertilizer	$ß_4$	0.14	0.02
Labour	$ß_5$	0.31	3.1***
Efficiency factors			
Constant term	b_o	0.56	6.15***
Marketing cost	b_1	4.17	2.14**
Age	b_2	-1.21	-0.96
Educational status	b_3	1.16	3.40***
Household size	b_4	1.39	0.26
Years of farming experience	b_5	0.10	2.17**
R^2		0.59	
Gamma (γ)		0.95	1.89
Lamda (λ)		1.02	4.03***
Loglikelihood function		-0.14	

***=significant at 1%, **=significant at 5% Source: Field survey 2009

Table 3: Frequency distribution of technical efficiency in Hausa potato production system in Kaduna State in 2009

Technical Efficiency Index	Frequency	Percentage
21 – 30	4	6.67
31 – 40	8	13.33
41 – 50	11	18.33
51 – 60	15	25.00
61 – 70	7	11.67
71 – 80	11	18.33
81 – 90	4	4.67
Total	60	100
Mean technical efficiency	55	
Minimum technical efficiency	21	
Maximum technical efficiency	88	

Source: Field survey 2009

To become the most efficient farmer, the most technically efficient farmer will gain 12 percent cost savings, while the least efficient farmer will gain 79 percent cost savings.

Production Constraints.
The constraints to increased Hausa potato production in the study area as perceived by the respondents are presented in Table 4. Lack of capital (30%), lack of adequate planting material (23.3%), inadequate knowledge of production (13.3%) and poor storage facilities (13.3%) respectively constitute the major constraints to Hausa potato production in the study area.

The study was conducted with the assistance of staff in the Kaduna State Agricultural Development Programme (KADP). This linkage if strengthened will enhance adequate transfer of proven technologies in the production of Hausa potato in the area of improve planting material, post harvest techniques and pests/disease management strategies from research. The introduction of Fadama III programme of the Federal Government aimed at improving farmers' livelihood through the provision of inputs in which farmers pay a counterpart fund of 30% is commendable. The KADP can assists by encouraging farmers to form cooperative groups to benefit from such a laudable programme. This will go along way at ameliorating their poor capital base.
Increased information dissemination is required about production techniques. As has been stated earlier, field days, posters, drama and other informal information transfer methods should be utilized since they may not be able to go to school any more.

Table 4: Constraints in Hausa potato production system in Kaduna State in 2009.

Constraints	Frequency	Percentage
Lack of capital	18	30
Lack of adequate planting material	14	23.3
Inadequate knowledge of production	8	13.3
Poor storage facilities	8	13.3
Pests/disease infestation	7	11.7
Poor market prices	5	8.3

Source: Field survey 2009

CONCLUSION
The results from this study show that technical efficiency in Hausa potato production in the southern part of Kaduna State of Nigeria ranges between 21 to 88 percent with a mean of 55 percent, indicating that there are still opportunities to increase productivity and income in the study area through more efficient use of production resources.
Important factors directly related to technical efficiency are education, farming experience and marketing cost. Policies aimed at improving farmers' access to education through aggressive awareness campaigns and mass mobilization are needed. Agricultural shows and competition could be organized to sensitize the farmers on improving their productivity.
Access to credit through micro-credit institutions and other organizations require that farmers form themselves into groups. Such groupings will also strengthen their bargaining ability during marketing of their produce. It will reduce unnecessary marketing cost thereby increasing their profit margin.

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