ANALYSIS OF EFFICIENCY OF ARABLE CROP BASED ENTERPRISE COMBINATION AMONG SMALL HOLDER FARMERS IN EDO STATE, NIGERIA

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ABSTRACT

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The soaring population in Nigeria has created a growing demand for food that the available land may not be able to meet due to competing demand for land by other sectors. This paper examines the productivity and technical efficiency of small holder farmers involved in arable crop base enterprise combination activities in Edo State, with a view of identifying gaps that may help optimize the use of available inputs, particularly land and planting materials. The multistage sampling technique was employed in selecting 180 respondents use for the study. Empirical estimate shown that technical efficiency values that ranged from 0.15 – 0.92 with a mean value of 0.81. This is an indication that on the average the farmers were operating 19% below the frontier. Technical inefficiency coefficient of farming status (-0.4099) shown that this variable increased technical efficiency of the farmers. But the positive coefficient of education level (0.0497), crop combination (0.7628), land source (0.4434), age (0.2332) and seed source (2.227) indicated that these variables increased technical inefficiency of the farmers in the study area. Also elasticity estimate of 1.0775 indicated that the farmers were producing in stage 1. These estimates indicate existence of gaps in the current production effort and intervention points that would help improve technical efficiency and productivity. The recommendation is that the existing extension services be strengthened for capacity building and effective dissemination of technical innovations that would improve the farmer's productivity and technical efficiency of farmers in the study area.

***Keywords**: Maximum likelihood estimate, arable crop based enterprises, production elasticity, return to scale, Smallholder farmer, Technical efficiency*

INTRODUCTION

Farm enterprise combination is a basic relationship in agricultural production economics involving the allocation of given scarce resource between two or more enterprises, (Olayide and Heady (1982). A smallholder arable crop farmer would want to choose a combination of crop enterprises that will maximize output from a given set of inputs with minimal usage. Arable crop base enterprises are crop enterprises cultivated in combination and harvested within one year. An example is the combination of yam/maize/peper, maize/melon/okro and so on. In Nigeria today, farm enterprise combination has become a fundamental option for most smallholder farmers due to population explosion has arisen with a growing demand for arable lands for estate development, afforestation, road construction, building of markets, recreational centres and other needs for land, (Ojo, 2007).

In this circumstance, crop enterprise combination has the capacity of increasing productivity at the small farm hold level and the potential as an attractive option to generate an increased diversified output without necessarily increasing the size of available land. The low level of arable crop production in Nigeria that has warranted the huge expenditure on the importation of food crop commodities to meet with the low production gap is mainly the result of low productivity and technical efficiency deficit of the smallholder farmers (Ogundare and Ojo, 2006). Production efficiency means the attainment of production goals without waste, while enterprise inefficiency involve the disproportionate and excessive usage of given inputs. Irz and Mcklenzie (2001) opined that when producers are highly efficient in the use of available inputs, large productivity gains could only come from new technologies developed from investment in research. However improving farm management by concerted technical know-how is likely to be the most sure and efficient means of raising productivity at the small hold farm level.

This paper examines the socioeconomic characteristics, productivity of some of the resources involved in arable based enterprise combination among small hold farmers in Edo State, Nigeria. It also examines the factors influencing the productivity and technical efficiency and inefficiency of each farmer, with a view to identify the contribution of each resource to output, presence of technical inefficiency in the production process and predict factors affecting technical efficiency of farmers in the study area.

ANALYTICAL FRAMEWORK AND LITERATURE

The analytical framework for the study is based on the concept of technical efficiency of resource utilization and production frontier proposed by Farrell (1957). Technical efficiency shows the success of a farm firm, as it

indicates an ability of a farm to produce maximum output from a set of inputs applied (Coelli, 1995). From Farrell's analysis, a farm that is said to be technically efficient in resource use operate on the production frontier, while a technically inefficient farm in resource use operates below the frontier, hence the position of each farm enterprise relative to the frontier could be influenced by some factors within the control or without the control of the farm decision unit, (Sail, 1997).

The technical efficiency of an individual farm enterprise combined is defined in terms of observed output Yi to the corresponding frontier output Y*. The Y* is the maximum output achievable given the existing technology and assuming 100% efficiency in resource utilization

$Y^* = f(\beta Xi) + Vi$ ---------- (1)

where Xi = variable inputs, Σ = error term.

Technical efficiency (TE) = Y/ Y^* ---------- (2)

$TE = f(Xi,B) \exp(Vi - Ui) = \exp(Ui)$ ---------- (3)

$$\frac{}{f(Xi,B) \exp(Vi)}$$

where, Xi as defined above V, and U are the component of the error term(Σ). the stochastic frontier production function (SFPF) in efficiency study was adopted in this study. In the analysis of SFPF, the error term (Σ) is assume to have two components V and U. The V accounts for the random effects on the arable crop base enterprise combination production activities, which are aside the control of the decision unit. While the U measures the technical inefficiency effects, which are behavioral factors that come under the control of the decision unit. These factors are controllable if efficient management techniques are put in place.

The stochastic frontier approach is mostly preferred for agricultural research because of the inherent variability of agricultural production due to the inter play of climatic factors, soil type, pest diseases and the ecosystem. Also many small farm holdings lack keeping of accurate production records hence available data on production are subject to measurement error. The coefficient estimated is also the production elasticities in this study.

The stochastic frontier production function is specified as follows:

$Y_i = f(Xi,\beta) + Vi-Ui$ ---------- (4)

Where $Y_{i\ is}$ output of arable crop base enterprise combined, Xi denotes the actual input vectors applied in the production process. B^s are vectors of production function parameters and Σ is the error term that is composed of two components part V and U. the V is a normal random variable that is independently and identically distributed with zero mean and constant variance (δ_V^2) it is introduced to capture the white mose in the production process. The U captures the factors that are not with in the control of the farmers. It is independent of V, non negative, one sided trumication at zero with normal distribution (Tadnesse and krishnamonthy, 1997). The U measures the technical inefficiency relative to the frontier production function. It is half normal distributed with zero mean, constant variance. The variance of the random error δ_V^2 and that of the technical inefficiency effect δ_V^2 and overall variance are thus related. $\delta^2 = \delta_u^2 + \delta_V^2$. And the ratio $\delta u/\delta^2$ is called gama (γ) it measure the total variation of output frontier which can be attributed to technical inefficiency.

METHODOLOGY

The study was carried out in Edo State, Nigeria. The state lie within the geographical co-ordinates of longitude $05^0 04^1$ East and $06^0 43^1$ East and Latitude $05^0 44^1$ North and $07^0 34^1$ North of the Greenwich (Egbodion, 2011). The state is characterized by the tropical climate which ranged from humid to sub-humid climate at different times in the year with average temperature ranging from a minimum of 24^0C to a maximum of 33^0C. Primary data were collected with the aid of well structured questionnaire and assisted with personal interview. Multistage sampling procedure was use in selecting respondents. The first stage involve a purposive selection of Two local government areas each Esan West and Igueben from Edo Central; Egor and Ikpoba-Okha from Edo South and Etsako West and Owan West from Edo North where there is high concentration of arable crop production which gave us a total of six local government areas. The second stage involves a random selection of three communities from each local government areas to get a total of 18 communities. The last stage was a random selection of 10 arable crop based farmers from each community to get a total of 180 respondents used for the study.

Base line information on Socio-economic Characteristic of arable crop enterprises grown in combination, input used, output or sales as well as their input and output prices were collected respectively.

Analytical techniques

Descriptive statistics were used to examine the socio-economic characteristics of the respondents. A multiple regression model base on stochastic production frontier function that assume a Cobb-Douglas form was employed to determine the technical efficiency of the farmer's arable crop base enterprises combination activities in the study area. This is expressed as:

$\ln Y = B_0 + B_1 \ln X_1 + B_2 \ln X_2 + \text{----------} + B_6 \ln X_6 + B_7 \ln X_7 + V - U$----------(5)

Where In = natural logarithm, Y = total output of arable crop base and enterprises combined measured in (kg) a ginin equivalent factor was applied to have a uniform weight from the farmers.
X_1 = farm size (ha), X_2 = family labour (man/day), X_3 = Hired labour (man/day) X_4 = planting materials (kg), X_5 = depreciation (Naira) X_6 = Credit (Naira) X_7 = fertilizers (kg) V = random error as previously defined and U = Technical inefficiency effects as stated earlier.
Estimated technical inefficiency model is thus stated:
$U_i = \delta_0 + \delta_1 Z_1 + \delta_2 Z_2 \delta_3 Z_3 + \delta_4 Z_4 + \delta_5 Z_5 \delta_6 Z_6$ ---------- (6)
Where U_i = inefficiency model effects Z_1 = Education level (years) Z_2 = crop combination (arable base), Z_3 = farming status as dummy (full time = 1, for part time = 2) Z_4 land source (dummy: those with personal land = 1 and others = 2) Z_5 = seed source (from farmers store = 1, others = 2), Z_6 = Age (years), δ_0 = constant and δ_1^s are unknown parameters to be estimated.
Equation (5) and (6) are jointly estimated by maximizing the likelihood function (Udoh and Akintola, 2001).

RESULT AND DISCUSSION

Socio-economic characteristics of respondents
The analysis of the socio economic characteristics of the respondents jn table 1.0 show that farmers in the study area had average age of 42 years, educational level of secondary school level accounting for 51.5%, mean farm size of 3.9 hectares and majority of the farmers were married which accounted for 72%. The components arable crop base and permanent crop base combinations were yam/maize/melon and yam/maize/plantain respectively. The mean household size was 5 and farming experience was 22 years. The result for age and educational level showed that the farmers were still energetic and it agree with a priorri expectation for the study area.

Table 1: Socio-economic characteristic of respondents

Variables	Mean
Education level (dummy 1 = pry, 2 = sec and others)	51.5%
crop Combination(arable base)	3
Farm size(hectares)	3.9 ha
Household size(male=1,female=0)	5
Farming experience(years)	22 years
Marital status(dummy,married=1,others=0)	72%
Age(years)	42 years
Source of land(dummy personal=1,others=0)	56% (rented)
Farming status(fulltime=1,others=2)	57% (part time)

Source: computed from field survey, 2008.

Productivity analysis
The estimated coefficients presented in table 4.0 were also the elasticity of the production variables included in the SFPF for the Cobb-Douglas functional form used. All the variables except Depreciation exhibited increasing returns to scale and was negatively sign. The elasticity of production was between 0 and 1, which indicated that the variables were utilized in stage II which is the relevant economic region of production. However the RTS of the factors elasticities was 1.0775 as presented in table 3.0, which indicated that with respect to overall usage, the factors were used in the irrational stage 1 of production. To improve on this, overall production factors should be intensified and resources expanded to advance production to stage II, where there is efficient and economic use of resources. Only planting material and operating expenses were significantly used at 5% level of probability. The returns to scale reported here confirms previous findings that most small scale arable crop farmers operate in stage I of the production stages, the irrational region of production. A typical example is the report by Ahmadu, (2011) in which both upland, lowland and irrigated rice production exhibited increasing returns to scale.
Technical efficiency analysis
The ML estimates presented in table 4.0 revealed sigma square value of 1.0842 which is statistically significant and different from zero at 5%. This indicates a good fit and the correctness of the specified distributional assumption of the composite error term. The variance ratio of 0.7255 is not significant at 5% but high ;meaning that the systematic effects that are unaccounted for by the production frontier function are the dominant source of stochastic random errors. Hence the presence of technical inefficiency among the farmers in the study area. The diagnostic results therefore confirm the relevance of the stochastic production frontier and maximum likelihood estimation. All the coefficient of the explanatory variables exhibited expected signs and magnitudes except Depreciation. Only Credit (0.3931) was significant at 5%. Credit and Age (0.2332) seems to be the most important inputs in the study area. TE values of the farmers ranged from 0.15 – 0.92 with mean value of 0.81; minimum and maximum value of 0.15 and 0.92 respectively. The result indicated that the farmers on the average

were operating 19% below the frontier as a result of the presence of technical inefficiency in their production process. However the longer proportion of these farmers (72%) having higher technical efficiency is consistent with the findings of Ojo (2007), Esobhawen (2007) and Egbodion (2011) who asserted that the vast majority of the small holder farmers had high level of technical efficiency gains given the state of technical and resource condition. For instance Ahmadu and Alufohai (2008) also reported technical efficiency of about 81% and 71% for mechanized and non-mechanized cassava farmers respectively.

Technical Inefficiency analysis

Technical inefficiency results are presented in Table 5.0. The signs and magnitude of the coefficients of variables of the inefficiency model are important in the analysis of the determination of technical inefficiency of the arable crop base enterprises among the small hold farmers, in the study area. The coefficient of farming status was negative and was not significant at 5%, which indicated that this variable increased technical
efficiency of the farmers in the study area but the variables, education level, crop combination, seed source and age were positive and not significant at 5%. This result indicated that these variables jointly contributed to decrease in the farmers' technical efficiency in the study area. However the result of some of these variables like education level is consistent with apriori expectation that the bulk of these farmers lacked the technical know-how in the arable crop base enterprise combination activities because of low level of education and most of the farmers still depend on unimproved planting materials from local sources hence the presence of technical inefficiency. Therefore the extension agents are to ensure there is a reversal of this situation by providing the relevant innovation and improved planting materials to the farmers in the study area.

CONCLUSION

These results have shown that the arable crop based farm enterprise combination varied largely in technical efficiency among the farmers in the study area. The RTS showed that the overall productivity of the farmers was at the irrational zone of production giving room for improvement in the level of production. It was only farming status that positively affected technical efficiency of the farmers in the study area and was not significant. Variables such as education level, crop combination, seed source, and age jointly contributed to technical inefficiency of the farmers. Therefore to ensure a production activities of arable crop base enterprise combination that will lead to solving food shortages that has led to high pricing of agricultural food crop commodities, the following policy issues are recommended. Emphasis should be placed on capacity building on the farmers to raise their technical know-how and the competent with which the farmers need to combine crop enterprises and provide improved planting materials timely to the farmers during planting seasons through the extension programme of the state.

Table 2: Distribution of technical efficiency range for the arable crop base farmers

Efficiency data	Frequency	Percent
0.01 – 0.49	4	2.76
0.50 – 0.59	1	0.69
0.60 – 0.69	4	2.77
0.70 – 0.79	31	21.53
0.80 – 0.89	102	70.83
0.90 – 1.00	2	7.38

Mean value = 0.81, minimum value = 0.15, maximum value = 0.92. Source: Computed from field survey data 2008

Table 3: Elasticity of production and returns to scale for the arable crop base enterprise combination activities

Variables	Arable crop base elastic of production
Farm size	0.0559
Family labour	0.1544
Hired labour	0.0697
Planting materials	0.1329
Depreciation	-0.0136
Credit	0.3931
Fertilizer	0.0529
Age	0.2332
RTS	1.0775

Source: computed from field survey 2008

Table 4: Estimated production function of OLS and MLE for arable crop base enterprise combination among farmers

Variables	OLS. Esti Coefficients	Std Error	MLE esti Coefficients	Standard Error
Constant	2.5662	(1.544)	2.6431	(1.0566)
Farm size	0.07229	(0.1268)	0.05589	(0.1042)
Family labour	0.1552	(0.1046)	0.1544	(0.1006)
Hired labour	0.04828	(0.0701)	0.06972	(0.0645)
Planting materials	0.1468	(0.07859)	0.1329	(0.0758)
Depreciation	0.2236	(0.0810)	-0.01356	(0.0695)
Credit	0.4031**	(0.1217)	0.3931**	(0.0961)
Fertilizer	0.0292	(0.0604)	0.05288	(0.0597)
Sigma square (δ^2)	0.4142	-	1.0842**	(0.2614)
Gama (Y)	-	-	0.7255	(0.6285)
Log likelihood function	-1362.32	-	-1298.67	-

Source: calculated from research sample data, 2008; ** 5% level of significance.

Table 5: Inefficiency model

Constant	-0.9539	(1.098)
Education level	0.0497	(0.0417)
Crop combination	0.7628	(0.4735)
Farming status	-0.4099	(0.3339)
Land source	0.4434	(0.3302)
Age	0.2332	(0.1837)
Seed source	2.227	(1.6458)

Source: calculated from research sample data, 2008; ** 5% level of significance.

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