EFFECT OF SOCIAL CAPITAL ON THE TECHNICAL EFFICIENCY OF ARABLE CROP FARMERS IN IBARAPA AREA OF OYO STATE, NIGERIA

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ABSTRACT

The effect of social capital on the technical efficiency of arable crop farmers in Ibarapa area of Oyo State was investigated. A two-stage sampling technique was employed in this study to select 120 arable crop farmers from the three (3) major blocks in the Ibarapa ADP zone (namely Ayete zone, Igboora zone and Eruwa zone). Data were collected from both primary and secondary sources. Descriptive analytical techniques were used to describe the socio-economic characteristics of the respondents while social group indices were constructed to determine the extent of farmers' participation in social group activities in the study area. Probit regression model was employed to identify the factors that influence farmers' decisions in participating in social group activities. Result of the stochastic frontier estimation shows that engaging one additional unit of hired labour, household labour and bag of fertilizer in arable crop farming increases output by 53.10% (p = 0.01), 72.30% (p = 0.10) and 26.80% (p = 0.10), respectively. Increased year of education and farmer's participation in social group activities were found to enhance technical efficiency in arable crop production at the 5% and 10% levels, respectively. Increasing farmers' formal training and social inclination were recommended in addition to use of improved modern technology packages as a way of enhancing the technical efficiency of arable crop farming in the study area.

Key words: Social capital, technical efficiency, arable crop, probit model, stochastic frontier model.

INTRODUCTION

Social capital is a concept in business, economics, organization behaviour, political science, public health, sociology and natural resources management that refers to connections, within and between social networks (Portes, 1998). Just as physical capital and human capital can increase individual's productivity, so too can social capital affect the productivity of individuals and groups (Putnam *et al.*, 2002). Social capital has become prominent within the vocabulary of development practitioners, but there is little consensus about what it is, how it is observed and measured, which outcome it supports and, more importantly, which outcome it does not support (Anirudh Krishnan, 2004).

In popular imagination, and also in some scholarly writings, social capital is often equated with all that is good about human and social relations. Such a view lacks concrete empirical reference and makes it extremely difficult to study this variable independently whereas only practical-oriented scholars tend to be somewhat cynical when references are made to the power of social capital (Anirudh Krishna, 2004). Social capitals positively influence economic growth and development and also promote trust and cooperation among agents, which in turn increase socially efficient collective decisions (Laporta *et al.*, 1997). Putnam (1995) also refers to social capital as the quality of human within some well defined social group that enables member of this group to act in cooperation with one another for achieving mutual benefits. More formally, he defined social capital as features of social organization such as cooperation, norms and social trust that facilitate cooperative for mutual benefits. Social capital is seen as the internal social and cultural coherence of society, the norms and values that govern interactions among people and the institutions in which they are embedded. Social capital is the glue that holds societies together and without which there can be no economic growth or human well-being. This latter concept that refers to social capital as that intangible aspect of production inputs that motivates farmers towards communal association and mutual self-help was adopted in this study.

Agricultural productivity is defined as the index of the ratio of the value of the total farm outputs to the value of total input used in farm production. Olayide and Heady (1982), Bravo-Ureta and Pinheiro (1997) and Ojo (2003) stress that maximum productivity will imply obtaining maximum possible output from the minimum set of input. The agricultural sector is an important sector in the Nigerian economy, as it is expected to provide food for the large and rapidly growing population, employment for the populace and raw materials for the industries. In recent years, despite all the human and material resources put into agriculture in Nigeria, its productivity is observed to be on the decline. For farmers, greater profitability can be achieved through better access to agricultural technology, inputs and credit (Ojo, 2003). This study had assessed the factors that influence arable crop farmers' decisions in joining social group, extent of their involvement in social group activities, and the effect of selected social group variables on the technical efficiency of arable crop farming in Ibarapa area of Oyo State, Nigeria.

Theoretical framework of technical efficiency measurements.

According to the classical approach of measuring productivity, the commonly used ratios are output per unit production input (labour, capital, or land), as previously used by earlier authors (e.g, Ajibefun and Abdulkadri, 1999; Bamiro *et al.*, 2006). However, the frontier approach emerged and stimulated greater interest among researchers and policy makers. It recommends that the only efficient farms are those operating on the production frontier while inefficient farms are operating below the production frontier (Ajibefun and Daramola, 2000). The amount by which a farm lies below its production frontier is regarded as the measure of its inefficiency. Stochastic elements are incorporated into the stochastic production frontier as a measure of the farm's technical efficiency to capture the farmer's specific random shocks. The farm technology is represented by a stochastic production frontier as follows:

$$Y_i = f(\beta, X_i) + \varepsilon_i \quad (1)$$

where Y_i denotes output of the *ith* firm; X_i is a vector of actual input quantities used by the *ith* rice farm, β is a vector of parameters to be estimated and ε_i is the composite residual term comprising a random error term V_i and an inefficiency component U_i (Aigner *et al.*, 1977) defined as:

$$\varepsilon_i = V_i - U_i \quad (2)$$

V_i's are assumed to be independently and identically distributed random errors $[V_i \approx N(0, \sigma v^2_v]$, and the U_i's are non-negative random variables associated with technical inefficiency in production, which are assumed to be independently and identically distributed and truncated (at zero) of the normal distribution with mean μ and variance, σ^2, that is, $[V_i \approx N(0, \sigma v^2_v]$ The maximum likelihood estimation of equation (1) provides estimators for β and variance parameters, thus:

$$\sigma^2 = \sigma^2_u + \sigma^2_v \text{ and } \gamma = \frac{\sigma^2_u}{\sigma^2} \quad (3)$$

Subtracting V_i from both sides of Equation (1) and adjusting for the stochastic noise captured by v_i yields:

$$Y_i - v_i = y_i = f(X_i; \beta) - \mu_i \quad (4)$$

where y_i is the observed output of the *ith* farm adjusted for the noise disturbance. Hence, equation (3) provides the basis for deriving the technically efficient input vector, and for analytically deriving dual cost function of the production function.

For a given level of output Y_i, the technically efficient input vector for the *ith* firm, X_i^t is derived by simultaneously solving Eq (3) and the input ratios $X_i/Xi = K_i (i>1)$, where K_i is the ratio of observed inputs X_i and X_i. Assuming that the production function in Eq. (1) is self-dual (e.g Cobb-Douglas), the dual cost frontier can be derived algebraically and written in a general form as follows:

$$C_i = h(r_i, Q_i, \alpha) \quad (5)$$

where C_i is the minimum cost of producing output Q_i by the *ith* farm r_i is a vector of input prices associated with the *ith* farm; and α is a vector of parameters. The economically efficient input vector for the *ith* firm X_i^e is derived by applying Shepherd Lemma and substituting the firm's input prices and output level into the resulting system of input demand equations:

$$\frac{\partial C}{\partial r_i} = X_i^e(r_k, Q, \psi) \quad k = 1, 2, \ldots m \text{ inputs} \quad (6)$$

where ψ is a vector of parameters. The observed technically efficient (X^t) and economically efficient X^e costs of production of the $r_i X_i, r_i X_i^t$ and $r_i X_i^e$, respectively. The relation above can then be used to compute the various efficiency measures for the *ith* firm as follows:

$$\text{Technical Efficiency,} \quad TE_i = \frac{r_i X_i^t}{r_i X_i} \quad (7)$$

$$\text{Economic Efficiency,} \quad EE_i = \frac{r_i X_i^e}{r_i X_i} \quad (8), \text{and}$$

$$\text{Allocative Efficiency,} \quad AE_i = \frac{EE_i}{TE} = \frac{r_i X_i^e}{r_i X_i} \quad (9)$$

METHODOLOGY

The study area

The area for the empirical study is the Ibarapa area of Oyo State, comprising 3 Local Government Areas Ibarapa Central L.G.A, Ibarapa East L.G.A and Ibarapa North L.G.A. The study area is located between longitude 7`40°N-7`15°N and latitude 3`00E-3`003°E (Map of Ibarapa Area by Durokas Consultants; June, 2002).The area has a population of 322,297 (NPC, 2006). Citizens in the study area are of the Yoruba dialect, and they are mainly farmers due to abundant fertile farmlands. Yams tubers, cassava, mangoes, cashew, palm trees, corn, mellon, tomatoes, okra, sorghum are some of the major crops available in large quantities for local consumption and export as Ibarapa division is fondly called the "food basket" of Oyo State. Other ethnic groups in the study area are Hausa, Igbo and the Fulani. The study area is characterized by the large presence of arable crop farmers who largely belong to one form of cooperative organization or the other.

Sampling techniques

A two-stage sampling technique was employed in this study. The adopted sampling framework was that of the Agricultural Development Programme (ADP) structure in the State that divides the area into blocks, cells and sub-cells. Three major blocks were covered in Ibarapa ADP zone, namely Ayete, Igboora and Eruwa blocks. Cross-sectional data relating to socio-economic characteristics as well as estimates of production inputs and outputs were obtained from the arable crop farmers at the end of the 2011/2012 cropping season, using structured questionnaire. In the first stage four (4) cells were randomly chosen from each of the selected blocks while ten (10) arable crop farmers were randomly selected from each cell in the second stage, making a total of 120 farmers for the study.

Analytical Techniques

Descriptive Analysis

Descriptive analytical techniques were used to describe the socio-economic characteristics of arable crop farmers in the study area.

Probit regression model

Probit regression model was employed to identify the factors that influence arable crop farmers' decisions in joining social group.

The restricted Probit model was given as:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \mu_i \quad (10)$$

where n > m (m is a subset of n).

Y = a binary variable that takes on the value of 1 if the farmer is a member of a social group, and 0 otherwise.

X_1 = dummy variable for sex of the farmer (1=male ; 0=female)
X_2 =Marital status (1= married and living under the same roof,0 otherwise)
X_3 =Age of the farmers in years
X_4 =Number of years of formal education of the farmers
X_5 =Number of years of farming experience
X_6 = Household Size (number)
X_7 =Average annual income from farming (₦)
X_8 =Average annual income from non-farming activities/remittances (₦)

Index of farmer's social group participation

The extent of farmers' involvement in social group was determined by constructing social groups' index as follows:

$$SC_i = \frac{\sum M_i P_i}{4k} \quad (11)$$

where:
SC_i = social capital index
M_i = membership of the *ith* social groups (1 if member and 0 if not a member)
P_i = level of participation in activities in the farmer *ith* social group. This takes on values from 0-4.
0 = if member does not attend groups activities at all
1 = if member attends < 30% of groups activities
2 = if member attends between 30% and < 50% of groups activities
3 = if member attends between 50% and < 70% of the group's activities
4 = if member attends 70% and above of group's activities
k = number of social groups identified in the study area.

Benefits derived from involvement in social group activities were identified and described using the frequency table.

Stochastic frontier production function

To estimate the effect of selected social group and socio-economic variables on the technical efficiency of arable crop farming, the stochastic frontier production function was used. According to Battesse *et al.*, (2004) and following Ojo (2004), the production efficiency of the farmers assumed to be specified by the Cobb-Douglas frontier production function that is defined by:

$$LnY_i = \beta_0 + \beta_1 lnX_1 + \beta_2 lnX_2 + \beta_3 lnX_3 + \beta_4 lnX_4 + \beta_5 lnX_5 + V_i - U_i \quad (12)$$

Y_i = Quantity of farm output (kg). The arable crops combination mainly covered in the survey were cassava, maize and melon. The grain equivalent conversion factors, as adapted from Kormawa (1999) was used to normalise outputs from these cultivated crops.
The physical inputs included in the efficiency model are:
X_1 = Farm size (ha)
X_2 = Number of hired labour (mandays)
X_3 = Number of household labour (mandays)
X_4 = Quantity of fertilizer used (in bags of 50kg)
X_5 = Amount of investment funds (Naira)
V_i = random error
$\beta_0, \beta_1, \beta_2$ and β_3 are regression coefficients.

The socio-economic and capital variables of selected farmers included in the model and hypothesized to contribute to technical inefficiency effects, U_i are as presented in the inefficiency model below:

$$U_i = \delta_0 + \delta_1 Z_1 + \delta_2 Z_2 + \delta_3 Z_3 + \delta_4 Z_4 \delta_5 Z_5 + \delta_6 Z_6 + \delta_7 Z_7 + \delta_8 Z_8 + \delta_i (13)$$

where:
Z_1 = farmers age in years
Z_2 = farmers sex (1=male, 0= female)
Z_3 = marital status (1=married; 0 others)
Z_4 = household size (number)
Z_5 = years of formal education of farmer
Z_6 = Number of years of farming experience
Z_7 = social capital index
Z_8 = cost of intermediate inputs (₦)
δ_i = inefficiency parameters
These variables are assumed to influence technical efficiency of the farmers.

Table 1: Socio-economic characteristics of surveyed respondents.

Socio-economic variable	*Frequency*	*Percentage*
Sex		
Female	29	24.2
Male	91	75.8
Total	***120***	***100.00***
Age group		
20-40	37	30.8
41-60	67	55.8
Above 60	16	13.3
Total	***120***	***100.00***
Marital status		
Married	111	92.5
Single	6	5.0
Widowed	1	8.0
Divorced	1	0.8
Separated	1	0.8
Total	***120***	***100.00***
Education level		
No formal education	22	35.0
Primary education	27	22.5
Secondary education	42	18.3
Tertiary education	29	24.2
Total	***120***	***100.00***
Farming experience		
Below 10	17	14.2
10-20	32	26.7
Above 20	71	59.2
Total	***120***	***100.0***
Household size		
< 5	54	45.0
5-10	58	48.33
> 10	8	6.67
Total	***120***	***100.00***

Source: Field survey, 2009

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Total	***120***	***100.00***

Source: Field survey, 2009

Table 2: Probit regression result of factors influencing arable crop farmers' participation in social group activities.

Variables	Ordinary least square estimate (OLS)	Maximum likelihood Estimate (MLS)
Constant	0.1495*** (4.865)	2.1716 (-0.749)
Sex (X_1)	0.4914 (1.632)	1.0561* (1.932)
Marital Status (X_2)	0.4106** (-2.218)	0.4826** (-2.056)
Age (X_3)	0.0354 (1.067)	0.4718 (1.472)
Educational level (X_4)	0.430* (1.800)	0.8232 (1.537)
Farming experience (X_5)	0.0331* (1.778)	0.6265** (2.328)
Household size (X_6)	-0.1519** (-2.077)	-0.4039** (-2.115)
Income from farming (X_7)	0.2766×10^{-6}*** (2.525)	0.907×10^{-5}*** (2.518)
Non-farming Income (X_8)	-0.4668×10^{-6}*** (-2.182)	-0.7338×10^{-5}*** (-2.119)
Log-Likelihood function		-11.37893***
Restricted log-likelihood		-29.391***
Chi-square		36.025

***Source**: Field survey, 2009*

Figures in parenthesis are t values

* significant at 10% level; ** significant at 5% level *** significant at 1% level

Table 3: Frequency distribution of social capital indices

Range of social capital indices	Frequency	Percentage %
0.0 - 0.20	47	39.2
0.21 – 0.40	56	46.7
0.41 – 0.60	12	10.0
0.61 – 0.80	4	3.3
0.81 – 1.00	1	0.8
Total	*120*	*100.00*

***Source**: Field Survey, 2009.*

Table 4: Estimate of the stochastic frontier production functions.

Variables	Parameters	OLS	MLE
Production function			
Constant	β_0	1.494* (0.763)	1.12 (4.203)
Farm size (X_1)	β_1	0.234 (1.589)	-0.184 (-0.844)
Hired Labour (X_2)	β_2	0.7016** (0.355)	0.531*** (0.0970)
Household Labour (X_3)	β_3	0.1936* (0.111)	0.723* (0.375)
Quantity of fertilizer used (X_4)	β_4	0.1488 (0.608)	0.268* (0.159)
Amount of investment funds (X_5)	β_5	0.1064 (0.043)	0.0093 (0.759)
Inefficiency model			
Constant	σ_0		0.1248*** (5.173)
Age of farmers	σ_1		0.4680* (0.247)
Sex of farmers	σ_2		-0.2500 (-0.575)
Marital status	σ_3		-0.2534 (-0.516)
Year of education	σ_4		-0.4282** (-0.183)
Household size	σ_5		-0.0840 (-0.639)
Farming experience	σ_6		0.6150** (0.247)
Social capital index	σ_7		-0.774*** (-0.234)
Cost of intermediate inputs	σ_8		2.268* (1.247)
Sigma-square (σ^2) = ($\sigma u^2 + \sigma v^2$)	σ^2		1.7460** (0.7131)
Gamma Y = ($\sigma u^2 / \sigma u^2 + \sigma v^2$)	Y		0.9673
Log likelihood function	LLF	-174.90	-13.768*
LR test			29.28

***Source:** Field Survey, 2009*

; **; and * imply that variable is significant at 10%, 5% and 1% level, respectively*

Table 5 : Frequency distribution of technical efficiency estimate.

Decile range of technical efficiency	Frequency	Percentage %
0.21 - 0.40	1	0.8
0.41 - 0.60	42	35.0
0.61 – 0.80	61	50.8
0.81 - 1.00	16	13.3
Total	*120*	*100.00*

Source: computed from field survey 2009.

Mean = 65.9%; Minimum = 27%; Maximum = 98%

RESULTS AND DISCUSSIONS

Socio economic characteristics of survey respondents

Table 1 shows that 24.2% of the respondents were female while 75.8% were male, about 56% of whom are in the active age range of 41-60 years implying that most of the respondents are at the peak of their productive years, 65% of whom have one form of formal education or the other ranging from primary (23%) to tertiary (24%) education. Only about 10% of the respondents are either divorced, widowed or separated from their spouses, and from household mostly (about 48%) of members ranging from 5-10.

Estimates of probit regression model of factors influencing arable crop farmers' participation in social groups' activities

The result of the probit model is presented in table 2. The model has a good fit to the data of the households with a restricted log-likelihood value (29.39) being significant at the 1% level. Male farmers (1.06) that are actively married (0.48) with more experience in farming (0.63) have higher probability of participating in social group activities at 10 %, 5% and 5% level, respectively. High income from farming activities ($p = 0.05$) will also significantly increase the tendency of arable farmer engaging in social group activities. Having large household size (0.40) and earning large income from non-farm activities reduce the likelihood of arable crop farmers participating in social group activities at the 5% level.

Extent of farmer's involvement in social group activities

From table 3, only about 4% of the sampled arable crop farmer have social capital index greater than 60% implying high level of involvement in social group activities. Majority (about 86%) of the farmers have poor social inclination with a social capital index below 40%.

Estimates of the stochastic frontiers parameters

The production function and efficiency model estimate were estimated by ordinary least square (OLS) and Maximum likelihood estimates and the results are presented in table 4. The results show that if more labour (both hired and household) and fertilizer are engaged in arable crop production, there will be a proportionate increase in the output of the farmers.

For every additional hired labour and household labour engaged in arable crop farming, crop output increases by 53.10% ($p = 0.01$) and 72.30% ($p = 0.10$), respectively. Likewise, crop output increases by 26.80% ($p = 0.10$) for a unit increase in the bag of fertilizer used. The variance ratio $Y= (\sigma u^2/ \sigma u^2 + \sigma v^2)$ is estimated at 0.9673 implying that about 97% of the variations in output among the farmers was due to differences in their technical efficiency estimates.

Determinants of technical efficiency

The factors that determine the technical efficiency of arable crop farmers are also presented in table 4. From the results, age of farmer (0.468), year of farmer's education (-0.4282), farming experience (0.615), social group participation (-0.774) and cost of intermediate inputs used (2.268) are factors that significantly influence the level of technical efficiency of arable crop farmer as previously reported by Afolami (2001). Advancing age of farmer ($p = 0.10$) and increasing cost of intermediate inputs ($p = 0.10$) significantly decrease technical efficiency in arable crop farming. This implies that arable crop farmers pay higher cost for intermediate inputs (such as seeds and chemicals) used in production which results in low return on their investment.

Years of farming experience ($p = 0.05$) also has a decreasing effect on farmers' technical efficiency against *a priori* expectation. This could be attributed to the continuous use of simple technology on their farm which fails to pay off for their long years of engagement in crop farming. Conversely, increased year of formal education and farmer's participation in social group activities enhance technical efficiency in arable crop production at the 5% and 10% levels, respectively. The high value (1.7460; $p = 0.05$) of the variance parameter sigma square ($\sigma u^2/ \sigma u^2 + \sigma v^2$) indicates that inefficiency effect are highly significant in the analysis of arable crop production among the sampled farmers.

Distributions of technical efficiency estimates among arable crop farmers

The frequency distribution of technical efficiency estimates is presented in table 5. The predicted technical efficiency ranges between 27% and 98% with a mean value of 65.9%, indicating substantial efficiencies in arable crop production since the elasticity is greater than one. By implication, there exists a 34.1% potential for arable crop farmers to increase their production and hence, their income at the existing level of resources and technology. About 13.3% of the sampled arable crop farmers have technical efficiency greater than 80% operating close to the frontier; 50.8% operate at technical efficiency ranging between 60% and 80% while about 35.8% of them have technical efficiency below 60%.

Conclusion and policy recommendations

Accounting for social capital as the quality of human to participate and get involved in some well-defined social group activities that enable members of such groups to cooperate with one another for achieving mutual goals is the main thrust of this study. Results of data obtained from 120 arable crop farmers showed that good social networking, although found to be at a low level among the sampled farmers, when in combination with other production inputs, significantly influence the level of technical efficiency of arable crop farmer. Increasing farmers' formal training and social inclination in any capacity were part of the recommendations made at enhancing technical efficiency in arable crop production. In addition, policies and investment efforts that will improve on the use of improved technology in the production of arable crops should also be encouraged among the arable crop farmers.

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