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Effects of Farmer – Based- Organization on the Technical efficiency of Maize Farmers across Various Agro - Ecological Zones of Ghana

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Abstract

This study uses cross-sectional data collected from 453 maize farmers across various agro ecological zones of Ghana in 2010 to evaluate the effect of farmer based organizations on maize farmer's technical efficiency. We utilize propensity score matching to compare the average difference in the technical efficiency between farmer based organization members and similar independent farmers. The approach assumes exogenous farmer based organizations formation and similar farm technology across farmers. The result from the study shows that there is no significant impact of farmer based organization on technical efficiency of maize farmers. These results are found to be insensitive to hidden bias and contradicts the idea that farmer based organizations enhance members efficiency by easing access to productive inputs and facilitating extension linkages.

Key words: Farmer based organization**,** technical efficiency, agro ecological zone. exogenous

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1.0 Introduction

An expected increase in agriculture requires increase in agricultural productivity. Agricultural productivity very much depends on the efficiency of the production process.

For productivity gains to be achieved, smallholder farmers need to have better access to technology and improve their technical efficiency. Policies designed to educate people through proper agricultural extension services could have a great impact in increasing the level of efficiency and hence agricultural productivity. While the private sector is gradually emerging as a contender, the public sector remains the major provider of extension services in most of these countries (Venkatesan & Kampen, 1998). A third option for providing services to smallholder farmers is agricultural cooperatives, which serve the dual purpose of aggregating smallholder farmers and linking them to input and output markets (Davis, 2008).

Given that agricultural systems in Sub-Saharan Africa are typically fragmented into a myriads of small or micro farms over large and remote rural areas, the role of agricultural cooperatives has become increasingly important (Wanyama, Develtere & Pollet, 2009). Despite the turbulent history sometimes associated with post-independence and highly centralized governance regimes, agricultural cooperatives are nowadays omnipresent throughout the sub-continent. However, it is still empirically unclear and highly contested whether these collective organizations can deliver and live up to their promises.

In recent times, the desirability of establishing FBOs is finding its way into national development policy documents in some countries (Bernard, Taffesse & Gabre-Madhin 2008). In Ghana, for example, recent policy strategy documents—the Growth and Poverty Reduction Strategy (GPRS II, 2006-2009), the current Medium-term National Development Policy Framework: Ghana Shared Growth and Development Agenda (GSGDA, 2010-2013), and the Food and Agriculture Sector Development Policy (FASDEP II)—all place strong emphasis on the establishment and strengthening of FBOs as one key strategy in developing the predominantly smallholder agricultural sector in the country (Ghana, 2010).

Like governments, many non-governmental organizations (NGOs) encourage the establishment of FBOs to improve rural service delivery, economic growth, and poverty reduction among farmers (Stockbridge, Dorward & Kydd, 2003). Donors and NGOs often prefer to deal with farmers through farmer organizations, particularly if they feel there is institutional failure in the public or private sectors (Rondot and Collion, 2001). However, it is important to note that the support of NGOs and donors in the establishment of FBOs is sometimes funneled through government agencies (Tinsley 2004).

For many donor and NGO projects, joining an FBO is the only way to participate in and receive support from the project, with no consideration given to farmers who do not belong to such groups (Tinsley, 2004).

While the role of farmer based organizations in agricultural inputs adoption for productivity is widely recognized (Abebaw & Haile, 2013), its impact on technical efficiency among their members remain unproven. Whether farmer based organization members are technically more efficient than non-members is an open question. Farmer based organizations are mandated to supply inputs together with providing embedded support services and for facilitating farmer linkage with extension service providers; hence are expected to be technically more efficient.

This paper aims to answer this question by comparing farmer based organization members and non-members across various agro ecological zones of Ghana on their technical efficiency levels in order to reduce potential differences in technology and agro-ecology in which this procedure tempers possible diffusion effects.

2.0 Farmer based organizations in Ghana

In recent years, there has been renewed interest among both public and private organizations to establish farmer based organizations (FBOs) in Ghana (Salifu, Francesconi & Kolavalli, 2010). The interest is based on the premise that FBOs give farmers bargaining power in the market place, enable cost-effective delivery of extensions services and empower FBO members to influence policies that affect their livelihoods. But it is not clear whether FBOs have achieved these things, or if they even have the capacity to do so.

From the farmer's perspective, the incentives for FBO formation are accessing social and economic benefits that are greater than what may be achieved without collective action. Thus FBO is effective when it generates net improvements in the individual livelihoods of group members in social and / or economic capacities.

Although FBOs are widely perceived as an institutional response to different economic needs and social constraints of farmers, a variety of factors motivate their formation (World Bank, 2007 and Fischer & Qaim, 2011).

Private sector organizations, for example, establish FBOs to increase profitability, largely by reducing transaction costs. FBOs enable private entities to deal more effectively and efficiently with smallholder farmers (Gulati, Minot, Delgado & Bora, 2007). Through FBOs, private investors may reduce the cost of dealing with farmers, enhance the volume and quality of farm produce, and improve credit recovery from farmers (Gulati et al. 2007).

Many buyers of farm products prefer to work with FBOs instead of individual farmers because the groups are better able to provide stable supplies of quality products (Vorley, Fearne & Ray, 2007). Private buyers' transaction costs may be significantly reduced if they deal with a group of farmers selling an aggregated product of homogeneous quality rather than with many individual farmers selling small quantities of uncertain quality (Shiferaw, Hellin & Muricho, 2011). Many governments establish FBOs to improve rural service delivery and access to public services, to enhance economic growth and peoples' welfare, and to reduce poverty (Stockbridge et al., 2003; World Bank, 2007). The establishment of FBOs allows public extension agents to reach out to larger numbers of farmers, especially given the inadequate number of extension agents in many developing countries (Chang, 2012). In Ghana, for example, each extension worker currently handles 2,500 farmers (Owusu-Baah, 2012)—far too many for a single agent to reach effectively. FBOs are therefore seen by governments as an effective mechanism for increasing agricultural productivity in many African countries (Hussein, 2001) since providing access to extension information and new agricultural technologies for large numbers of farmers plays an important role in increasing productivity and enhancing food security.Some governments require farmers to organize themselves into FBOs as a condition to gain access to support such as grants or credit (Shiferaw et al. 2011).

In Ghana, both public and private organizations have established a large number of FBOs. No consensus currently exists concerning the total number of FBOs in Ghana, although a database created by the Ministry of Food and Agriculture (MoFA) through voluntary registration estimates the total number at 3,328, of which over 60 percent are involved in crop production. Based on analysis of four main sources, Salifu et al. (2010) estimated about 10,000 FBOs in Ghana—including those both registered and unregistered, and those registered as cooperative societies.

3.0 Methodology

3.1 Study Area

In Table 1, we compare the three agro ecological zones in Ghana being the forest, transitional and savannah zones representing the study areas.

Table 1: A General Description of the Characteristics of the Various Study Areas

General characteristics	Forest Zone (Bekwai Municipal)	Transitional Zone (Nkoranza South District)	Savannah Zone (Gushegu District)
Location	Southern part of Ashanti Region	Middle portion of the BrongAhafo region.	North eastern corridor of Northern Region.
Total land area	633sqkm	2300sqkm	5796sqkm
Topology	Within the forest dissected plateau.	Low lying and rising gradually.	Fairly undulating.
Climate	Semi-equatorial type.	Wet semi-equatorial region	Tropical continental climate.
Vegetation	Semi-deciduous forest zone	Savannah woodland and a forest belt.	Guinea savannah type.
Rivers /drainage	Drained by the Oda River and its tributaries.	Fairly drained by several streams and rivers.	Strewn with several streams.
Geology	Underlain by three geological formations.	Characterized by soils developed over Voltaian sandstones.	Lies entirely within the Voltaian sandstone basin
Soils	Clay, sand and gravel deposits	The geological feature together with vegetation influences and gives rise to two distinct soil categories.	Coarse lateritic upland soils and soft clay.
Rainfall	1600– 1800mm.	800-1200mm.	950-1300mm
Temperature	Fairly high and uniform temperature ranging between 32ºC in March and 20º C in August.	Average annual temperature is about 26°C.	Normally high above 35ºC

Source: MLGRD (2006)

3.2 Theoretical framework

This section presents a discussion on the prediction of technical efficiencies of the farmers with the stochastic frontier model and the propensity score matching and average treatment effects.

3.2.1 Stochastic production frontier

This study employs the stochastic frontier model proposed by Aigner, Lovell & Schmidt (1977), and extended by Battese&Coelli, (1995).

$Y_i = f(x_i, \beta)\exp(V_i - U_i)\ i = 1, 2....., n$ (1)

Here V_i is the random error, associated with random factors not under the control of the farmer and U_i is the inefficiency effect. The possible production Y_i is bounded by the stochastic quantity, $f(x_i, \beta)\exp(V_i - U_i)$, hence the name stochastic frontier. The random error V_i is assumed to be independently and identically distributed as $N(0, \sigma_V^2)$ random variables independent of $U_i s$, which are assumed to be non-negative truncations of the $N(0, \sigma_V^2)$ distribution (i.e. half-normal distribution) or have exponential distribution.

The technical inefficiency effects are expressed as:

$U_i = \delta z_i + w_i$ (2)

Here z_i is a vector of observable explanatory variables and δ is a vector of unknown parameters and w_i are unobserved random variables which are assumed to be independently distributed and obtained by truncation of normal distribution with zero mean and constant variance.

A number of studies (Helfand&Livine, 2004; Nyemeck, Sylla&Diarra 2001) have estimated the production frontier (equation 2) and the determinants of inefficiency (equation 3) separately.

According to their two-stage procedure, the production frontier is first estimated and then the technical inefficiencies are derived. The predicted inefficiencies are subsequently regressed upon a set of firm (or farm) specific variables (z_i) in an attempt to determine reasons for differing efficiencies. The two-stage estimation procedure suffers from a fundamental contradiction as inefficiency effects (or scores) are derived under the assumption that they are independently and identically distributed in the first stage. In the second stage the predicted inefficiency scores are assumed to be a function of several firm (or farm) specific factors, which implies that they are not identically distributed unless all the coefficients of the factors are simultaneously equal to zero (Coelli, Rao&Battese, 1998).

In addition, using Ordinary Least Square (OLS) in the second stage regression fails to capture the fact that the dependent variable (U_i) is restricted to be non-negative. The two-stage procedure is unlikely to provide estimates which are as efficient as those that are obtained from the one-step estimation procedure (Coelli, 1996b). For these reasons, the Battese&Coelli (1995) model is, therefore, applied in this study and allows for a simultaneous estimation of the parameters of the stochastic frontier and the inefficiency model using the single-stage, maximum likelihood (MLE) method. The likelihood function is expressed in terms of the variance parameter σ^2 and γ , where $\sigma^2 = \sigma_u^2 + \sigma_v^2$ and $\gamma = \sigma_u^2 / (\sigma_u^2 + \sigma_v^2)$

Technical efficiency (TE) = Y_i / Y_i^* = $f(x,\beta)\exp(V_i - U_i) / f(x,\beta)\exp(V_i)$

$$= \exp(-U_i) = \exp(-z_i\delta - W_i) \quad (3)$$

Where Y_i is the observed output and Y_i^* is the frontier output.

3.2.1.1 Empirical Model

Farm technical efficiency is the ability of a farmer to maximize output with given quantities of inputs and a certain technology (output-oriented) or the ability to minimize input use with a given objective of output (input-oriented). However, the output-oriented technical efficiency is commonly used.

3.2.1.2 Specification of Empirical Model

Different forms of production functions are used in empirical studies, depending on the nature of data on hand. Therefore, the selection of functional form is vital in stochastic frontier production.

In a number of studies, Cobb-Douglas (CD) functional form has been used to examine farm efficiency notwithstanding its well-known limitations (Thiam, Bravo-Ureta & Rivas, 2001). Kopp & Smith (1980) indicated that functional forms have a distinct but rather small impact on estimated efficiency. Ahmad & Bravo-Ureta (1996) in their study rejected the Cobb Douglas functional form in favour of the transcendental logarithmic (translog) form, but concluded that efficiency estimates are not affected by the choice of the functional form (cited in Thiam*et al*., 2001). The Cobb-Douglas production function imposes a severe prior restriction on the farm's technology by restricting the production elasticities to be constant and the elasticities of input substitution to unity (Wilson, Hadley, Ramsden & Kaltsa 1998).

The flexible functional form translog functional form however, does not entail restrictions of fixed rate of technical substitution (RTS) value and an elasticity of substitution equivalent to one in the CD form of the production function. Therefore, translog functional form is preferred over CD functional. It is noted that the CD is nested within the translog form if all the square and interaction terms in translog turn out to be equal to zero. Therefore, the translog functional form is adopted in this study. The empirical model is specified as:

$$\begin{aligned}\ln Y_i = {} & \beta_0 + \beta_1 \ln LAB + \beta_2 \ln FSIZ + \beta_3 \ln SED + \beta_4 \ln FERT + \beta_5 \ln(LAB)^2 + \beta_6 \ln(FSIZ)^2 \\ & + \beta_7 \ln(SED)^2 + \beta_8 \ln(FERT)^2 + \beta_9 \ln(LAB) \times \ln(FSIZ) + \beta_{10} \ln(LAB) \times \ln(SED) \\ & + \beta_{11} \ln(LAB) \times \ln(FERT) + \beta_{12} \ln(FSIZ) \times \ln(SED) + \beta_{13} \ln(FSIZ) \times \ln(FERT) \\ & + \beta_{14} \ln(SED) \times \ln(FERT) + (V_i - U_i)\end{aligned}$$

Here Y_i denotes maize yield (kg / acre), $FERT$ denotes quantity of fertilizer used (kg / acre), LAB denotes labour (man-days/acre), SED denotes quantity of seed planted (kg / acre), $FSIZ$ denotes maize area cultivated (acre), β_ks are unknown parameters of the production functions, $v_i s$ are random errors assumed to be independent and identically distributed $N(0,\sigma_v^2)$, $u_i s$ are non-negative random variables, assumed to be independently distributed, such that the technical inefficiency effect for the producer, u_i , is obtained by truncation (at zero) of the normal distribution with zero mean u_i and constant variance, σ^2. Specifically the inefficiency model is specified as:

$$U_i = \delta_0 + \underset{(-)}{\delta_1 GEND} + \underset{(-)}{\delta_2 AGE} + \underset{(-)}{\delta_3 HHSZE} + \underset{(-)}{\delta_4 EDU} + \underset{(-)}{\delta_5 LOWN} + \underset{(-)}{\delta_6 MCRP} + \underset{(-)}{\delta_7 EXT} + \underset{(-)}{\delta_8 ATC} + \underset{(+)}{\delta_9 OFW} \quad (5)$$

Here $GEND$ denotes dummy variable 1 if farmer is male, 0 otherwise, AGE denotes experience in maize farming in years , ATC denotes dummy variable 1 if farmer has access to credit, 0 otherwise, EXT denotes dummy variable 1 if farmer had access to extension services, 0 otherwise, OFW denotes dummy variable 1 if farmer engages in off-farm work, 0 otherwise, $MCRP$ denotes dummy variable 1 if farmer practice mono cropping, 0 otherwise, EDU denotes number of years of schooling, $LOWN$ denotes dummy variable 1 if farmer is a land owner, 0 otherwise , $HHSZE$ denotes household size of farmer $\delta's$ are unknown parameters to be estimated.

Since the dependent variable of the inefficiency model represents the mode of inefficiency, a positive sign of an estimated parameter implies that the associated variable has a negative effect on efficiency but positive effect on inefficiency and vice versa. It is assumed that some farmers produce on the production frontier and others do not produce on the frontier. Therefore, the need arises to find out factors causing technical inefficiency. The technical inefficiency model incorporates farm and farmer specific characteristics, institutional and environmental factors.

3.2.2 The Propensity Score Matching Technique

To examine this causal effect of participating in a farmer based organization on the productivity or technical efficiency of smallholder maize farmers, the p -score matching approach is employed.

The propensity score $p(Z)$ is the conditional probability of participating in a farmer based organization given pre- participating in a farmer based organization characteristics (Rosenbaum and Rubin, 1983). Thus,

$$p(Z) \equiv \Pr\{D = 1 | Z\} = E\{D | Z\} \quad (6)$$

Where $D = \{0,1\}$ the indicator of exposure to participating in a farmer based organization and Z is vector of pre- participating in a farmer based organization characteristics.

The estimated propensity scores are then used to estimate the Average Treatment Effect on the Treated (ATT) which is the parameter of interest as

$$\delta \equiv E\{Y_i^1 - Y_i^0 \mid D_i = 1\} = E\{E\{Y_i^1 \mid D_i = 1, p(Z_i)\} - E\{Y_i^0 \mid D_i = 0, p(Z_i)\} \mid D_i = 1\} \quad (7)$$

Where $p(Z_i)$ is the p-score, Y_i^1 and Y_i^0 are the potential outcomes (yield and technical efficiency) in the two counterfactual situations of receiving treatment (participating in a farmer based organization) and no treatment (non- participating in a farmer based organization).

Two important properties of the p-score matching are the balancing property and conditional independence assumption (CIA). Testing for this property is important to ascertain if maize farmers' behavior within each group is actually similar. Related to the balancing of p-score is CIA, which states that participating in a farmer based organization is random and uncorrelated with the maize yield or technical efficiency of the farmer, once the set of observable characteristics, Z are controlled for. A further requirement is the common support condition which requires that persons with the same values of covariates Z have positive possibilities of being both participant and non-participants (Heckman, Lalonde & Smith, 1999). Thus, all individuals in the common support region actually can exist in all states $(0 < P(D = 1 | Z < 1)$.

3.3 Survey Design and Sampling Method

The research employed both primary and secondary sources of data. The primary data employed was obtained through a cross-sectional survey conducted in three different agro-ecological zones in Ghana.

Farm level data were collected from 453 maize producers across the three agro-ecological zones of Ghana in the 2010 calendar year. The choice of the whole calendar year is on the premise that maize can be produced throughout the year.

In the second stage of the sampling design, a district each was selected from each of the three agro ecological zones purposively. The districts are Gushiegu District (Savannah zone), Nkoranza South District (Transitional zone) and Bekwai Municipality (Forest zone). These districts were selected based on their agricultural potential, accessibility and high level of maize production in their agro-ecological zone.

In the third stage, villages or communities from operational areas of MOFA were randomly selected from each of the districts representing the agro-ecological zones.

The final stage involved random selection of maize farmers proportionately according to the sizes of the various communities. A total of 151 maize farmers were sampled in the Savannah zone (Gushiegu District), 151 maize farmers were sampled in the Transitional zone (Nkoranza South District) and 151 maize farmers were sampled in the Forest zone (Bekwai Municipality).

4.0 Results and Discussion

Table 2 presents summary statistics of the members and non-members of farmer based organization across the various agro ecological zones of Ghana. From the total maize farmers considered, 37.5 percent are members of farmer based organization (treatment group) and the remaining (62.5%) are found to be non-members. Maize farmers belonging to farmer based organization are more literate, older, have large household size, use hybrid seed, travel longer distance to the market relative to non-members. In terms of land ownership, most non-members are land owners.

Table 2: Descriptive statistics of members and non-members of farmer based organization

Variables	Members N (170) 37.5%		Non-members N (283) 62.5%		Diff in
	Mean	SD	Mean	SD	Mean
Gender (1=male;0=female)	0.76	0.43	0.81	0.39	-0.0504
Age (years)	43.06	11.37	43.24	10.52	-0.1791
Household size (number)	9.48	6.44	9.11	6.07	0.3705
Education (years)	5.74	3.37	4.33	3.82	1.4031***
Market distance (miles)	6.88	2.85	5.79	2.89	1.0907***
Land ownership (1=tenant, 0=owner)	0.51	0.5	0.52	0.5	-0.0147
Mono cropping (1=Yes,0= No)	0.4	0.49	0.44	0.5	-0.0417
Hybrid seed (1=Yes,0= No)	0.54	0.5	0.4	0.49	0.1419***
Extension contact (1=Yes,0= No)	0.52	0.5	0.42	0.5	0.0995**
Access to credit (1=Yes,0= No)	0.38	0.49	0.24	0.43	0.1455***
Off-farm work (1=Yes,0= No)	0.23	0.43	0.14	0.35	0.1022***
Yield (kg/ha)	1836.18	1034.57	1651.64	1313.19	184.5439

Source: Survey data, 2010. ***, **and * indicate that coefficients are statistically significant at 1%, 5% and 10% respectively

Table 3 reports the summary statistics of the impact indicator variable and the probability of participation used for the matching. The descriptive statistics show a higher level of technical efficiency among non-members than members. The average technical efficiency of members and non-members are 0.72 and 0.73 respectively. However, mean difference between members and non-members is not statistically significant. This means that there is no real difference in the technical efficiency of members and non-members of farmer based organization. However the propensity score indicates a difference among members and non-members and is statistically significant at 1 percent

Table 3: Technical efficiency and estimated probability of participation in farmer based organization

Indicators	Members N (170) 37.5%		Non-members N (283) 62.5%		Diff in
	Mean	SD	Mean	SD	Mean
Technical efficiency score	0.72	0.22	0.73	0.22	-0.0085
Estimated probability score	0.44	0.14	0.34	0.15	0.1003***

Source: Survey data, 2010. *** indicates significance at 1%

4.1 Determinants of Participation in Farmer Based Organization

The results of the probit estimation are summarized in Table 4. From the results the propensity to become a member of a farmer based organization is high for households with large family size, farmers with high educational level, long distance to market centers, those with off-farm work and those having access to credit. The results are consistent with the findings of Bernard, *et al*., (2008) and Abate, Francesconi & Getnet (2013).

Table 4: Determinants of participation in farmer based organization

Indicators	Coefficient	Standard Error	Z-value
Gender	-0.0403	0.1628	-0.25
Age	-0.0854	0.0066	-1.30
Household size	0.0207*	0.0114	1.82
Education	0.0530***	0.0188	2.82
Market distance	0.0752***	0.0218	3.46
Land ownership	-0.1911	0.1338	-1.43
Mono cropping	0.0577	0.1300	0.44
Hybrid seed	0.1573	0.1655	0.95
Extension contact	0.1488	0.1527	0.97
Credit access	0.2481*	0.1502	1.65
Off-farm work	0.4366***	0.1663	2.62
Constant	-1.0827***	0.3527	-3.07
Number of Observations	453		
Pseudo R^2	0.080		
Log likelihood	-275.900		

Source: Survey data, 2010. *** and * indicate that coefficients are statistically significant at 1% and 10% respectivel

Table 5 presents the results of the indices of matching quality. The results suggest that the propensity score matching is balanced for each covariate between members and non-members of farmer based organizations. The reduction in the standardized bias substantially reduced after matching and the test of the null hypothesis is of no significant differences after the matching cannot be rejected at 10 percent for all the variables.

Table 5: Balancing test for all matching covariates

Variable	Mean		Standard bias		T-test
	members	non-members	% bias	% reduction in bias	P-values
Gender	0.76	0.76	0	100	0.714
Age	43.07	42	9.7	-494.4	0.297
Household size	9.48	9.99	-8.3	-39.7	0.011
Education	5.74	5.95	-5.9	84.9	0
Market distance	6.88	7.05	-5.9	84.4	0.002
Land ownership	0.51	0.57	-11.7	-299.2	0.219
Mono cropping	0.4	0.4	0	100	0.836
Hybrid seed	0.54	0.5	8.3	71	0.006
Extension contact	0.52	0.49	7.1	64.5	0.602
Credit access	0.38	0.35	7.7	75.8	0.001
Off-farm work	0.25	0.22	7.5	71.2	0.331

Source: Survey data, 2010

4.2 Measuring Technical Efficiency

The maximum likelihood estimates of the parameters of the stochastic frontier production function and the inefficiency model across the three agro ecological zones are presented in Table 6. The inefficiency model for the pooled sample suggests that the inefficiency of maize farmers is significantly related to extension contact, mono cropping, age and household size.

Table 6: Maximum likelihood estimates of stochastic frontier production function and inefficiency model for the pooled sample.

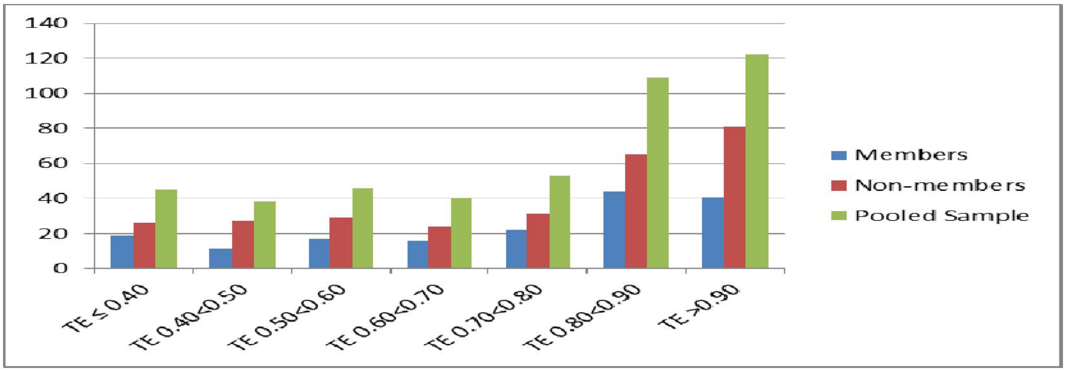
Variable	Parameter	Coefficient	t-ratio
<u>Stochastic frontier</u>			
Constant	β_0	7.168	8.728*
lnlabour	β_1	-0.098	-0.445
lnfarmsize	β_2	-0.070	-1.312
lnseed	β_3	0.469	0.792
lnfertilizer	β_4	-0.204	-0.449***
lnlabour^2	β_5	0.323	1.657**
lnfarmsize^2	β_6	0.044	1.306***
lnseed^2	β_7	0.133	0.901
lnfertilizer^2	β_8	-0.008	-0.336
lnlabour × lnfarmsize	β_9	-0.051	-1.518***
lnlabour × lnseed	β_{10}	-0.083	-0.631
lnlabour × lnfertilizer	β_{11}	0.592	3.426*
lnfarmsize × lnseed	β_{12}	0.096	0.778
lnfarmsize × lnfertilizer	β_{13}	0.031	1.222
lnseed × lnfertilizer	β_{14}	-0.114	-1.882**
<u>Inefficiency model</u>			
Constant	δ_0	0.731	1.704**
Gender	δ_1	-0.047	-0.232
Age	δ_2	-0.026	-2.682*
Household size	δ_3	0.487	3.385*
Education	δ_4	-0.021	-0.913
Land ownership	δ_5	0.260	1.572***
Monocropping	δ_6	-0.362	-2.247**
Extension contact	δ_7	-0.411	-2.136**

Access to credit	δ_8	-0.443	-1.968
Off-farm work	δ_9	0.522	2.457
<u>Variance parameters</u>			
$\sigma_s^2 = \sigma^2 + \sigma_v^2$	σ_s^2	0.691	3.961*
$\gamma = \sigma^2 / \sigma_s^2$	γ	0.937	48.691*
Log likelihood function		-261.676	
LR test of one sided error		155.445	
Mean efficiency		0.642	

Source: Survey data, 2010. ***, **and * indicate that coefficients are statistically significant at 1%, 5% and 10% respectively

With regard to membership in farmer based organization, the results indicates that membership does not significantly affect technical efficiency of maize farmers. Concurrently, from the descriptive statistics (Table 3) the mean technical efficiency of members is not significantly different from non-members. This is also clear from figure 1 as non-members even have higher technical efficiency than members of farmer based organization even though is not significant. This might be as a result of farmers being conservative about the adoption of new improved methods and channeling of resources obtained from the farmer based organization into other sectors other than farming.

Figure 1: Frequency distribution of technical efficiency scores by farmer based organization membership

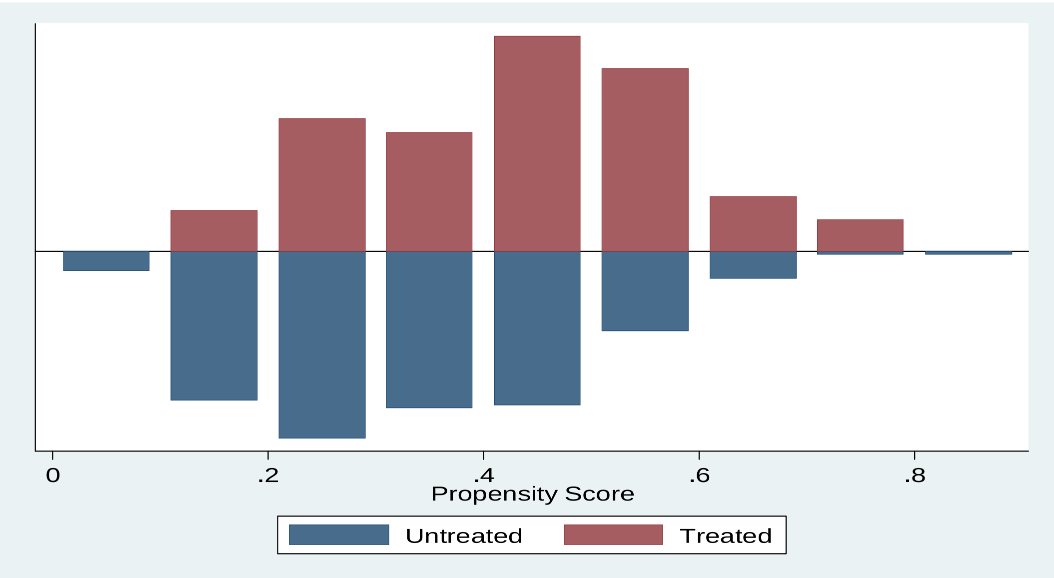


Source: Survey data, 2010

4.3 Impact of Membership of Farmer Based Organization on Technical Efficiency

Figure 2 shows the distribution of propensity scores and the region of common support. The bottom half of the figure shows the propensity scores distribution for the untreated, while the upper-half refers to the treated individuals. The densities of the scores are on the y-axis. The figure indicates that the common support condition is satisfied as there is overlap in the distribution of the propensity scores of both treated and untreated groups.

Figure 2: Distribution of propensity scores for unmatched and matched samples



Source: Survey data, 2010

The results of the average treatment effect for the treated for participation in farmer based organization are computed using the nearest neighbor matching technique and are presented in Table 7. It was observed that this matching technique produced a consistent estimate of the treatment effects on the membership of farmer based organization. The results from this matching technique, generally indicates that the results are robust to the matching algorithm used. The matching results indicate that there is no significant impact of farmer based organization on the technical efficiency and yield of maize farmers.

Table 7: Effect of farmer based organization membership on technical efficiency and yield of farmers

Treatment indicator	Outcome variables	ATT	S. E.	T-value	Number treated
Farmer based organization	Technical efficiency	0.718	0.0212	0.92	170
	Yield	1836.182	134.595	0.78	170

Source: Survey data, 2010

Table 8 reports the sensitivity analysis of the models, using Rosenbaum bounds. The purpose is to test the selection bias necessary to invalidate the results of the estimates. As formulated by Diprete and Gangl (2004), the method starts with estimating the effect of the treatment on the treated, assuming the hypothesis of no selection bias. Then this assumption is relaxed. According to the potential impact of the omitted variable on the probability of the participation in farmer based organization (expressed in terms of the odds ratio) becoming stronger, the confidence interval of the estimated effects increases, and the level of significance of the null hypothesis. – that *D* does not affect Y – diminishes (that is, the *p*-value falls). The results for the model appear to be less robust to the presence of unobservable factors, given that their critical values are nearer one.

Table 8: Rosenbaum bounds sensitivity analysis for hidden bias

Critical Value of Hidden Bias (Γ)	Upper Bound Significance level
1	.155356
1.1	.317115
1.2	.505723
1.3	.679114
1.4	.811468
1.5	.898604
1.6	.94951
1.7	.976479
1.8	.989656
1.9	.995672
2	.998266
2.1	.999331
2.2	.99975
2.3	.999909
2.4	.999968
2.5	.999989
2.6	.999996
2.7	.999999
2.8	1
2.9	1
3	1

Γ measures the degree of departure from random assignment of treatment or a study free of bias (i.e., Γ =1)

5.0 Conclusion

The objective of this study was to investigate the impact of farmer based organization on the technical efficiency and yield of maize farmers across various agro ecological zones of Ghana. The results indicate no significant impact of farmer based organization membership on level of technical efficiency and yield. The results are inconsistent with the predicted role of agricultural cooperatives in improving efficiency by providing easy access to productive inputs and embedded support services such as training, information and extension on input application.

It is recommended that further studies be done in this area as there is the tendency that members of farmer based organizations may have diverted resources obtained from the farmer based organizations.

References

Abate, G.T., Francesconi, G.N. & Getnet., K.(2013). Impact of Agricultural Cooperatives on Smallholders' Technical Efficiency: Evidence from Ethiopia. Eucrise Working Paper n. 50 (13)

Abebaw, D. & Haile, M.G. (2013). The Impact of Cooperatives on Agricultural Technology Adoption: Emprical Evidence from Ethiopia, Food Policy, 38: 82-91.

Ahmad, M. & Bravo-Ureta, B. E. (1996) Technical Efficiency Measures for Diary Using Panel Data – A Comparison Of Alternative Model Specifications. Journal of Productivity Analysis 7, 399-415.

Aigner, D.J., Lovell, C. A. & Schmidt, P. (1977), Formulation and Estimation of Stochastic Frontier Function Models. Journal of Econometrics 6 (July 1977): 21-37

Battese, G. E. & Coelli, T. J. (1995). A Model for Technical Efficiency Effects in a Stochastic Frontier Production for Panel Data. Empirical Economics 20: 325-332

Chang, H.J. ed (2012). Public Policy and Agricultural Development. New York: Routledge.

Coelli, T. J. (1996b). Specification and estimation of stochastic frontier production function. Unpublished PhD Dissertation, University of New England, Australia.

Coelli,T., Rao, D.S.P. & Battese, G.E. (1998). An Introduction to Efficiency and Productivity Analysis. Kluwer-Nijhoff, Boston.

Davis, K. (2008). Extension In Sub-Saharan Africa: Overview And Assessment Of Past And Current Models And Future Prospects, Journal of International and Extension Education, 15 (3): 15-28.

Diprete, T.& Gangl, M. (2004) Assessing Bias In The Estimation Of Causal Effects: Rosenbaum Bounds On Matching Estimators And Instrumental Variables Estimation With Imperfect Instruments. Sociological Methodology, v. 34, n. 1, pp. 271-310.

Fischer, E., & Qaim, M. (20011). Linking Smallholders to Markets: Determinant and Impacts of Farmer Collective Action in Kenya. World Development. 40(6)

Ghana, Ministry of Food & Agriculture. (2010). Medium-Term National Development Policy Framework: Ghana Shared Growth and Development Agenda (GSGDA), 2010-2013. Volume 1: Policy Framework. Accra.

Gulati, A., Minot, N., Delgado, C. & Bora, S. (2007). Growth in High Value Agriculture in Asia and Emergence of Vertical Links with Farmers. In Global Supply Chains, Standards and the Poor: How the Globalization of Food Systems and Standards Affects Rural Development and Poverty, edited by J. F. Swinen. Oxford: CAB International.

Heckman, J., Lalonde, R. & Smith, J (1999). The Economics and Econometrics Of Active Labour Market Programs. In Handbook of Labour Economics, Vol 114 Ed By O Ashenfelter, and D. Card, pp. 1865-2097.Elsevier, Amsterdam.

Helfand, S. & Levine, E. S. (2004). Farm Size and Determinants of Productive Efficiency in Brazilian Centre-West. Agricultural Economics, 31: 241-249

Hussein, K. (2001). Producer Organizations and Agricultural Technology in West Africa: Institutions. Local/ Global Encounters. 44(4): 61-66.

Kopp, R. J. and Smith, V.K. (1980). Frontier Production Estimates for Steam Electric Generation: A Comparative Analysis. Southern Economic Journal, 47:1049-1059.

Nyemeck, J. B., Sylla, K et Diarra, I. (2001). Analyse des determinants de la performance productive des producteurs de café dans une zone a faible revenue en Cote d'Ivoire, Final report, AERC, Nairobi.

Owusu-Baah, K. (2012). Ghana. In Public Policy and Agricultural Development, edited by H. J. Chang. New York: Routeledge.

Ronndot, P. & Collion, M. (2001). Agricultural Producer Organizations: Their Contribution to Rural Capacity Building and Poverty Reduction. Report of a Workshop, 28-30 June 1999. Washington, D. C.

Rosenbaum, P.R. & Rubin D. (1983). The Central Role of the Propensity Score in Observational Studies for Causal Effects. Biometrika 70:41-45.

Salifu, A., Francesconi, G & Kolavalli, S. (2010). A Review of Collective Action In Rural Ghana. IFPRI Discussion Paper 00998.

Shiferaw, B., Hellin, J. & Muricho, G. (2011). Improving Market Access and Agricultural Productivity Growth in Africa: What Role for Producer Organizations and Collective Action Institutions? Food Security: 475-489

Stockbridge, M., Dorward, A. & Kydd, J. (2003). Farmer Organizations for Market Access: A Briefing Paper. UK Department of International Development, London.

Thiam, A., Bravo-Ureta & Rivas, R.E. (2001). Technical efficiency in developing country agriculture: meta-analysis. Agricultural Economics, 25:235-243.

Tinsley, R. L. (2004). Developing Smallholder Agriculture: A Global Prospective. Singapore: AGBE Publishing.

Venkatessan, V. & Kampen, J. (1998). Evolution of Agricultural Services In Sub-Saharan Africa: Trends and Prospects, Discussion Paper 390, Washington DC: The World Bank.

Vorley, B., Fearne, A, & Ray, D. (2007). Regoverning Markets: A Place for Small-Scale Producers In Modern Agrifood Chains? Aldershot, Hants, England: Growers Publishing Limited.

Wanyama, F. O. Develtere, P. & Pollet, I. (2009). Reinventing the Wheel? African Cooperatives in A Liberalized Economic Environment, Annals of Public and Cooperative Economics, 80(3): 361-392.

Wilson, P., Hadley, D., Ramsden, S., and Kaltsa, L. (1998). Measuring and Explaining Technical Efficiciecy in UK Potato Production. Journal of Agricultural Economics, 48(3): 294-305

World Bank (2007). Agriculture for Development: World Development Report 2008. Washington, DC.