Technical efficiency analysis of organic mango out-grower farm management types: The case of integrated tamale fruit company (ITFC) out-growers in Northern Region

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To improve farmers’ income from production, farm inputs have to be applied efficiently. This study estimated and assessed difference in technical of two farm management types (group management and family management). Data was obtained from a random sample of 204 out-growers through the use of structured questionnaire. A transcendental logarithmic (translog) stochastic production frontier was employed using the maximum likelihood estimation method, from which farm-specific technical efficiency was calculated. The result shows that farmers under family farm management are about 42%, more technically efficient than those under group farm management. The group managed farms are less technically efficient due to lack of commitment to managing farms and too large groups for leaders to effectively control. Training of out-growers, aimed at addressing specific needs are required to improve technical efficiency, while frequent farm demonstrations, breaking large groups into smaller ones and strategic shift from group to family plantations are some ways to improving technical efficiency.

Key words: Integrated tamale fruit company, technical efficiency, farm management type, out-growers, Northern region.

INTRODUCTION

Mango production in the Northern Region has been recognized as a way of fighting poverty and has consequently gained attention of government as reflected in the strategies of Food and Agriculture Sector Development Policy (FASDEP). The policy identified mango as a crop to focus on in the Northern Region due to agro-ecological suitability. Responsibility for implementation of policy programs does not rest on government alone. Indeed, government is expected to play only facilitating and coordinating roles in this pursuit. Success will depend largely on multi-stakeholder efforts whereby private sector is suppose to play crucial roles, including making or financing investment in the sector and opening market channels for access by less privileged farmers (MoFA, 2007). The Integrated Tamale Fruit Company (ITFC) is one organization that is actively playing the expected roles of the private sector in the Northern Region. This company is able to produce and export high quality grade mangoes from inaccessible areas. This means that further improvement in exportable output is possible if transportation network improve (USAID and TIPCEE, 2009).

ITFC has been assisting subsistence farmers to cultivate
mango since 2001 in the communities surrounding its nucleus farm, through an out-grower scheme. The company sees the out-grower scheme as a way of getting the required volumes of mangoes to enable it command a higher degree of market power in the organic mango export markets as well as accessing greater productive capacity and reducing average cost of operations.

While pursuing its corporate objectives, it also support the poverty reduction goal of the Government of Ghana by providing the local people with sustainable income generating livelihoods through the establishment of organic mango farms (UNDP, 2007). In an attempt to balance the need to contribute towards poverty reduction among rural farmers and meeting international market requirements, ITFC developed its out-grower mango production scheme. This scheme consists of two types of mango farm management organization: the family managed and the group managed mango farms. Under the family management system farms of limited size (0.4 to 4 hectares) are owned by a single farming household whose head is registered by ITFC as a farmer and a farm business account is created in the name of the farmer. Group managed farms on the other hand, range from 2 to over 40 hectares and are owned by a number of farming households that form a group. The group has a leadership made up of a chairman, secretary and treasurer. The farm is divided among registered group members in 0.4 hectare lots. Like in the case of family farm management however, individual account is created by ITFC in the name of each member.

In collaboration with bilateral donors, ITFC has financed the establishment of farms under both types of management. Outputs from farms of both systems appear satisfactory and farmers have earned significant levels of income well over their previous earnings (UNDP, 2007). However, there remain some unanswered questions about the income earning potentials of the farmers under the out-grower scheme. These include whether maximum possible outputs are obtained with given levels of inputs and which farm management type is more efficient, thus contributes more towards the goal of improving incomes of rural people in Northern Region. ITFC cannot answer these questions from empirical evidence. It is against this background that the study seeks to quantify technical efficiency levels of farmers under each farm management system so as to estimate possible gains that can be attributed to socio-economic and management characteristics. The main objective of the study is to analyze the efficiency of organic mango out-grower farm management types that ITFC operates. The specific objectives are to:

- Estimate technical efficiency (TE) levels of out-growers under the two farm management types.
- Identify the socio-economic/management attributes of farm/farmers that influence technical efficiency of the out-growers.

**Productivity and Efficiency**

Production involves converting a given set of inputs into output(s). Therefore, the amount of output obtained at the end of any production process depends on the amount of inputs applied and how these inputs are combined. While the level of input set gives scale effect Coelli (2005), inputs coordination determines how effective input-to-output conversion will be, considering physical quantities, values or both (Han, 1991). The combined effects of input scale and coordination (quantities and values) on output is referred to as productivity. Some researchers defined it simply, as the ratio of output to input or input to output (Sartorius and Kirsten, 2004).

Furthermore, productivity which typically concerns profitability of decision-making units is a function of three elements: technical efficiency, scale efficiency and allocative efficiency, with (Livio and Massimo, 2002). Performance indicators that are often considered under productivity are cost per unit output, output per hour, and output per area (Ariyarathna J and Joseph M. M., 2011). In finance, measures of productivity include earnings per share (EPS), return on investment (ROI), economic value added (EVA) and cash flow return on investment (Ittner and Larcker, 1998 and Hashem et al., 2010).

A closely related and more specific concept to productivity in production analysis is the concept of efficiency, which does not only examine output from a given input(s), but further compares the output to what can be achieved with the given input set.

According to Heyne (2008), economists view efficiency as a relationship between ends and means and when they say a situation is inefficient, it implies they could achieve the desired ends with less means, or the means employed could produce more of the desired ends, whereby "less" and "more" necessarily refer to value. Meaning, economic efficiency is measured by the relationship between the value of the ends and the value of the means rather than physical quantities. In other words, efficient situation in production for instance is where the value of input(s) applied gives the maximum possible output also in terms of value. Efficiency is, therefore, a measure of how well the production or input transformation process is performing. It indicates how well an organization uses its resources to produce goods and services. Thus, it focuses on the rates at which inputs are used to produce or deliver the outputs (OAG, 2007). Stating efficiency this way seems to define it more empirically than just a relationship as Heyne (2008) does.

Farell (1957)'s work on the measurement of productivity efficiency which proposed three components of a firm's efficiency resulted in better understanding of
the concept of efficiency. These are technical, allocative
and economic efficiencies.

Technical Efficiency

In terms of output, technical efficiency \((TE)\) is measured
as a ratio of realized output\((Y)\) to the potential output\((Y^*)\)
from a given set of input(s). It is generally assumed that
the potential output is obtained by following the best
practice methods, given a technology (Karagiannis, 2009)
which defines a production frontier. Generally, the
production frontier is specified as below;
\[Y_i = f(X_i; \beta)\cdot \exp (-u_i)\]  
where \(u_i \geq 0\) and represents technical inefficiency of \(i^{th}\)
farm. It \((u_i \geq 0)\) becomes a condition that guarantees
that,
\[Y_i \leq f(X_i; \beta)\]  
This conforms with \(Y_i = f(X_i; \beta) \cdot TE_i\)
or \(Y_i = f(X_i; \beta_i) \cdot \exp (-u_i)\)  
where technical efficiency is expressed as
\[TE_i = \frac{f(X_i; \beta) \cdot \exp (-u_i)}{f(X_i; \beta)} = \exp (-u_i)\]  
The above specification is deterministic and does not suit
empirical analysis since random errors affect practical
situations. Aigner et al. (1977) and Meeusen and Van
den Broeck (1977) therefore proposed stochastic
production frontier approach which incorporates the error
term \((\varepsilon_i)\) as specified below;
\[Y_i = f(X_i; \beta) + \varepsilon_i\]  
where \(\varepsilon_i\) is a combined error term, made up of \(v_i\) (random
effect) and \(-u_i\) inefficiency effect as defined earlier. This
can be expressed further as;
\[Y_i = f(X_i; \beta) + (v_i - u_i)\]  
or\[Y_i = f(X_i; \beta) \cdot \exp (v_i) \cdot \exp (-u_i)\]  
From which, technical efficiency is derived by;
\[TE_i = \frac{Y_i^*}{Y_i^*} = \frac{f(X_i; \beta) \cdot \exp (v_i - u_i)}{f(X_i; \beta) \cdot \exp (v_i)} = \exp (-u_i)\]  
where \(Y_i^*\) is the observed output of a farm and \(Y_i^*\) is the
frontier (maximum output possible).

METHODOLOGY

Study Area

The study covered the operational area of ITFC which
includes Savelugu-Nanton, Tolon-Kumbungu, West
Mamprusi and Karaga districts of the Northern region.

Sampling Procedure and Size

The sample was drawn from a total population of 1400
organic mango out-growers with some owning infant
plantations. A list of all the farmers obtained from the
scheme management was used as the sampling frame to
draw the sample. This was stratified into group managed
and family managed farms after which, simple random
 sampling procedure was used to obtain a representative
sample from group out-growers, whilst a census of the
family out-growers was employed because their number
was small (53 out-growers). A total sample of 204 farmers
(made up of 151 group and 53 family out-growers) was
used for the study.

METHODS OF DATA ANALYSIS

Two main models were used in empirical analysis of the
data. However, the single stage estimation approach
makes the second objective of the study an integral part
of the first. The computer soft-ware used (frontier 4.10)
accommodates specification of this kind of empirical
model; hence the models were estimated together.
Statistical test of difference of means was used to
ascertain difference between technical efficiency levels
of group and family out-growers. Analytical methods used
to achieve the objectives are presented below.

Empirical Technical Efficiency Model

The empirical specification of the production frontier:
\[\ln Y_i = \beta_0 + \beta_1 \ln PIAge_i + \beta_2 \ln Wexp_i + \beta_3 \ln PeKg_i + .5\beta_{11} \ln (PIAge_i)^2 + .5\beta_{22} \ln (Wexp_i)^2 + .5\beta_{33} \ln (PeKg_i)^2 + \beta_{12} (\ln PIAge_i \cdot \ln Wexp_i) + \beta_{13} (\ln PIAge_i \cdot \ln PeKg_i) + \beta_{23} (\ln Wexp_i \cdot \ln PeKg_i) + v_i - u_i\]  
Where, \(Y_i\) is total output of mango (kg/ha), PIAge is age
of plantation (years), Wexp is weeding expenditure
(Ghc/ha), PeKg is quantity of organic pesticides (kg/ha),
\(\beta\) is constant and \(\beta\)'s represent the coefficients of inputs
PIAge, Wexp, PeKg and their second order terms
respectively. It is assumed that \(v_i\) is independently and identically
distributed \(N^\ast(0, \sigma^2_v)\) and \(u_i\) is a one-sided error term
independent of \(v_i\) with truncated normal distribution
having a mean \(\mu\) and constant variance \(\sigma^2_u\). With
\(\varepsilon, y \) and \(\sigma\) from maximum likelihood estimation of the
frontier, estimates of \(v_i\) and \(u_i\) were obtained by applying
conditional distribution of \(u_i\). By subtracting \(v_i\) from both
sides of the equation; the frontier function became;
\[\ln Y_i^* = \beta_0 + \beta_1 \ln PIAge_i + \beta_2 \ln Wexp_i + \beta_3 \ln PeKg_i + .5\beta_{11} \ln (PIAge_i)^2 + .5\beta_{22} \ln (Wexp_i)^2 + .5\beta_{33} \ln (PeKg_i)^2 + \beta_{12} (\ln PIAge_i \cdot \ln Wexp_i) + \beta_{13} (\ln PIAge_i \cdot \ln PeKg_i) + \beta_{23} (\ln Wexp_i \cdot \ln PeKg_i) + u_i \]  
\[\Rightarrow Y_i^* = Y_i - v_i\]  

Table 1. Null Hypotheses Tested.

<table>
<thead>
<tr>
<th>Null Hypothesis</th>
<th>Implication</th>
</tr>
</thead>
<tbody>
<tr>
<td>$H_0: \beta_{ij} = 0$</td>
<td>C-D form is appropriate</td>
</tr>
<tr>
<td>$H_0: \gamma = \delta_0 = \delta_1 = \ldots = \delta_{10} = 0$</td>
<td>inefficiency effects are absent</td>
</tr>
<tr>
<td>$H_0: \gamma = 0$</td>
<td>Non-stochastic inefficiency effect</td>
</tr>
<tr>
<td>$LR = -2[\ln(L(H_0)) - \ln(L(H_d))]$</td>
<td>Generalized likelihood-ratio test</td>
</tr>
</tbody>
</table>

Table 2. Discrion of Variables in the Inefficiency Model.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Definition</th>
<th>Measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>$Z_1$</td>
<td>Age of the farmer</td>
<td>Years</td>
</tr>
<tr>
<td>$Z_2$</td>
<td>Gender of farmer</td>
<td>Dummy: 1 for male, 0 otherwise</td>
</tr>
<tr>
<td>$Z_3$</td>
<td>Farmer’s household size</td>
<td>Number of persons</td>
</tr>
<tr>
<td>$Z_4$</td>
<td>Educational status of farmer</td>
<td>Number of years in school</td>
</tr>
<tr>
<td>$Z_5$</td>
<td>Cash crop farming experience</td>
<td>Number of years</td>
</tr>
<tr>
<td>$Z_6$</td>
<td>Training demonstrations</td>
<td>Number of times attended</td>
</tr>
<tr>
<td>$Z_7$</td>
<td>Farm management type</td>
<td>Dummy variable: 1 for group</td>
</tr>
</tbody>
</table>

\[ \Rightarrow \text{From this frontier, farm-specific technical efficiency (TE) is measured as;} \]
\[ \Rightarrow TE_i = \frac{Y_i}{\hat{Y}_i} = \exp(-u_i) \]
\[ \cdots \cdots \cdots (11) \]

Where $Y^*$ is defined as the frontier output (Bravo-Ureta and Rieger 1991) of mango in kilograms. The hypotheses below are tested to statistically validate efficiency of the production function and other parameters of efficiency among the sampled organic mango out-growers.

**Empirical Estimation of Determinants of Inefficiency**

The relationship between technical inefficiency estimates and socio-economic characteristics of farmers/farms is specified as below:

\[ \mu_i = \delta_0 + \delta_1 Z_1 + \delta_2 Z_2 + \delta_3 Z_3 + \delta_4 Z_4 + \delta_5 Z_5 + \delta_6 Z_6 + \delta_7 Z_7 \cdots \cdots (12) \]

Where $\mu_i$ is farm-specific technical inefficiency, $Z$'s are as defined (Table 2), $\delta_0$ is a constant and $\delta_1$ to $\delta_7$ are coefficients. These and others, except demonstrations and management types, are usually the explanatory variable included in the second stage analysis (Bravo-Ureta, 1997). Demonstrations and management types as socio-economic variables are specific to the objective of this study.

In order not to violate the initial assumption about $\mu_i$, the inefficiency term is specified as an explicit function of the socio-economic attributes and estimated using the single stage estimation procedure proposed by (Coelli et al., 1995).

**RESULT AND DISCUSSION**

**Summary Statistics**

Table 3 reports the summary of socio-economic attributes, farm characteristics and levels of some inputs. The mean ages for the group and family out-growers are 43 and 44 years respectively. These are not statistically different, hence an average out-grower is middle aged. There is also no statistical difference between mean household sizes of out-growers for the two farm manage-
Table 3. Summary of Variables by Management Type.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Unit</th>
<th>Sample (N=204)</th>
<th>Group Out-growers (n=151)</th>
<th>Family growers (n=53)</th>
<th>Out-growers</th>
<th>Z-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age of Outgrower</td>
<td>Years</td>
<td>43</td>
<td>43</td>
<td>44</td>
<td>44</td>
<td>-1.034</td>
</tr>
<tr>
<td>Household size</td>
<td>No. of people</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td>Education</td>
<td>No. of years</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>-2.201**</td>
</tr>
<tr>
<td>Farm Management</td>
<td>Dummy</td>
<td>0.74</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Experience</td>
<td>No. of years</td>
<td>21</td>
<td>21</td>
<td>20</td>
<td>20</td>
<td>0.521</td>
</tr>
<tr>
<td>Demonstrations</td>
<td>No. of times</td>
<td>7</td>
<td>6</td>
<td>7</td>
<td>7</td>
<td>-2.379**</td>
</tr>
<tr>
<td>Farm Size</td>
<td>Hectares</td>
<td>4</td>
<td>4.8</td>
<td>2.8</td>
<td>2.8</td>
<td>3.502***</td>
</tr>
<tr>
<td>Plantation Age</td>
<td>Years</td>
<td>6</td>
<td>6</td>
<td>5</td>
<td>5</td>
<td>1.031</td>
</tr>
<tr>
<td>Input Variables</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weeding</td>
<td>Expenditure/ ha</td>
<td>Ghana Cedis</td>
<td>31</td>
<td>31</td>
<td>31</td>
<td>0</td>
</tr>
<tr>
<td>Organic Pesticide</td>
<td>Kgs/ha</td>
<td>3.5</td>
<td>3.5</td>
<td>3.75</td>
<td>3.75</td>
<td>0.793</td>
</tr>
<tr>
<td>Price of Pesticide</td>
<td>Ghana Cedis</td>
<td>1.5</td>
<td>1.4</td>
<td>1.6</td>
<td>1.6</td>
<td>-1.831*</td>
</tr>
<tr>
<td>Output Variable</td>
<td>Yield/Acre</td>
<td>Ghana Cedis</td>
<td>146.725</td>
<td>105</td>
<td>281.25</td>
<td>-34.76***</td>
</tr>
</tbody>
</table>

Source: Field Survey, 2011

...remaining text...
Table 4. Results of Hypotheses Tested.

<table>
<thead>
<tr>
<th>Null hypothesis</th>
<th>Test Statistics</th>
<th>Critical Value</th>
<th>Decision</th>
</tr>
</thead>
<tbody>
<tr>
<td>$H_0: \beta_2 = 0$</td>
<td>23.34</td>
<td>12.59</td>
<td>Rejected</td>
</tr>
<tr>
<td>$H_0: \gamma = \delta_0 = \delta_1 = \ldots = \delta_{10} = 0$</td>
<td>105.49***</td>
<td>37.01</td>
<td>Rejected</td>
</tr>
<tr>
<td>$H_0: \gamma = 0$</td>
<td>39.07***</td>
<td>9.50</td>
<td>Rejected</td>
</tr>
<tr>
<td>$LR = -2[\ln(L(H_0)) - \ln(L(H_1))]$</td>
<td>298.28***</td>
<td>37.12</td>
<td>Rejected</td>
</tr>
</tbody>
</table>

***implies significant at 0.01.

Table 5. Maximum Likelihood Estimates of the Stochastic Production Frontier.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Standard error</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>1.26***</td>
<td>0.057</td>
</tr>
<tr>
<td>lnPlAge</td>
<td>-0.018*</td>
<td>0.0099</td>
</tr>
<tr>
<td>lnWexp</td>
<td>0.017**</td>
<td>0.0083</td>
</tr>
<tr>
<td>lnPeKg</td>
<td>0.159**</td>
<td>0.078</td>
</tr>
<tr>
<td>(lnPlAge)$^2$</td>
<td>2.88***</td>
<td>0.010</td>
</tr>
<tr>
<td>(lnWexp)$^2$</td>
<td>-0.004</td>
<td>0.36</td>
</tr>
<tr>
<td>(lnPeKg)$^2$</td>
<td>-0.12*</td>
<td>0.071</td>
</tr>
<tr>
<td>lnPlAge*lnWexp</td>
<td>0.008</td>
<td>0.44</td>
</tr>
<tr>
<td>lnPlAge*lnPeKg</td>
<td>-0.011</td>
<td>0.008</td>
</tr>
<tr>
<td>lnWexp*lnPeKg</td>
<td>-0.056*</td>
<td>0.033</td>
</tr>
<tr>
<td>$\sigma^2$</td>
<td>0.84 ***</td>
<td>0.0025</td>
</tr>
<tr>
<td>$\gamma$</td>
<td>0.98 ***</td>
<td>0.002</td>
</tr>
<tr>
<td>Log likelihood</td>
<td>298.23</td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>204</td>
<td></td>
</tr>
</tbody>
</table>

Note: *, ** and *** means significant at 0.1, 0.05 and 0.01 levels respectively.
Source: Field survey data, 2011.

The mean mango output per hectare of family out-growers is about three times that of group out-growers. This huge difference can only be attributed to differing quality of management, because there is no difference in quantities of inputs (weeding expenditure and organic pesticides) used between the two out-grower types to justify the difference in output.

**Technical Efficiency**

Test of the null hypothesis (in Table1), which suggests that the coefficients of second order terms in the translog specification are zero is rejected. Therefore the translog form of the production function is appropriate for the sampled organic mango out-growers. Table 4 shows the test results of the model.

In Table 5 Gamma (\(\gamma\)) which is the ratio of the variance of \(u\) to the total variance (\(\sigma^2\)) is 0.98 and statistically different from zero at 1%. This ratio measures the effect of technical inefficiency in the variation of output. It means therefore that 98% of the total variation in farm output is due to technical inefficiency.

The technical efficiency estimates derived (Table 6), relative to the above production frontier, ranges from 24% to 98%, with a mean of 53% among group out-growers. Among family out-growers, it ranges from 34% to 100% with a mean of 91%. This means that if an average group out-grower were to achieve the technical efficiency level of the most efficient out-grower in the entire sample, then he or she can realize 47% [i.e 1-(53/100)] output increase without additional inputs. Similarly, an average family out-grower who may become equally efficient as the most efficient sample out-grower will be increasing his or her output by 9% [1-(91/100)].

These calculations show that the technical inefficiency level is higher among group out-growers than family out-
Table 6. Distribution of Technical Efficiency by Farm Management Types.

| Efficiency Class (%) | Group Out-growers | | | Family Out-growers | | |
|----------------------|-------------------|---|---|-------------------|---|
|                      | Frequency | % of n | | Frequency | % of n | |
| <30                  | 10       | 6.6 | | 0       | 0 | |
| 31-40                | 24       | 16  | | 1       | 2 | |
| 41-50                | 36       | 23.8| | 2       | 3.7| |
| 51-60                | 33       | 22  | | 2       | 3.7| |
| 61-70                | 25       | 16.5| | 4       | 7.5| |
| 71-80                | 10       | 7   | | 4       | 7.5| |
| 81-90                | 8        | 5.3 | | 6       | 11.3| |
| >90                  | 5        | 3.3 | | 34      | 64.25| |

Note: sample sizes (n) for the two out-grower categories are not the same; hence basis for any comparison is the percentages (%) of the two sub-samples and not the frequencies. The mean, minimum and maximum are technical efficiency measures. Pooled sample mean technical efficiency is 72% but its distribution and frequency are not shown in the Table.

Source: Field Survey Data, 2011.

growers. Therefore, more efficiency gains can be realized by improving management practices among group out-growers than among family out-growers. The mean technical efficiency of the pooled sampled out-growers is 72% which is the same as Amos (2007) found among small-holder cocoa farmers in Nigeria. It is however greater than 34% found among rice farmers in the Upper East Region (Al-hassan, 2012), but less than the 86% found among small-holder sweet orange producers in Nigeria (Muhammed Lawal, 2007).

The percentage distribution of technical efficiency estimates for both group and family out-growers is shown in Figure 1. The figure indicates normal distribution of efficiency levels among group farms but that of family farms is skewed to the left hand side.

Comparison of Technical Efficiency of Group and Family Farms

As already indicated, the mean technical efficiency of group and family farms is 53% and 91% respectively. This difference of 38% is large and significant at 1% (Table 7). The average group out-growers will therefore have to improve their output by 42% [1-(53/91)] if they were to become as efficient as an average family out-grower.

This result is contrary to Aditya (2008) who argued that group decisions are more efficient than those of family. The situation could be attributed to less commitment on the part of group out-growers as it is evidenced by their attendance to training sessions (demonstrations).

Determinants of Technical Inefficiency

The hypotheses that the inefficiency effect is absent and non-stochastic were rejected (Table 4). This means that variation in output is partly due to inefficiency and this inefficiency is stochastic.

The study excluded some of the usual variables like extension contact, access to credit and contract relationship with input suppliers or produce buyers in that analysis because, such characteristics are constants with no variation among all out-growers under the ITFC project. However, the number of demonstration sessions an out-grower attended since the establishment of his or her farm was used in place of extension contact. The other variable which is specific to this study (and not usual in the literature) is the type of farm management an out-grower belongs to. The estimated inefficiency model is presented in Table 8.

The model shows that the age of the out-grower, education, household size and experience have no significant effect on inefficiency whilst gender of out-grower,
Figure 1. Distribution of Farm-Specific Technical Efficiency.

Table 7. Difference in Mean Technical Efficiency of Farm Management Types.

<table>
<thead>
<tr>
<th>Sample (N=204)</th>
<th>Group (n=151)</th>
<th>Family (n=53)</th>
<th>$X_G - X_I$</th>
<th>$\sigma_{X_G-X_I}$</th>
<th>$Z_{X_G-X_I}$</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>0.72</td>
<td>0.53</td>
<td>0.91</td>
<td>-0.38***</td>
<td>0.0192</td>
<td>-47.79</td>
</tr>
<tr>
<td>$S^2$</td>
<td>5.5046</td>
<td>0.046374</td>
<td>0.003679</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$S^2/n$</td>
<td>0.0269</td>
<td>0.0003</td>
<td>0.000069</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: $S^2 = $ variance of farm-specific technical efficiency estimates, $n = $ sample size of farm management types and *** = significant at 0.01.

Source: Field Survey, 2011.

demonstration visits and farm management type have significant effect on inefficiency. Gender, was measured as dummy with value of 1 for males, therefore a negative and significant relationship with technical inefficiency means that male out-growers are more technically efficient than their female counterparts. Traditionally, women in the Northern region do not have control over family labour. Also, farm operations like weeding and spraying are male dominated activities. Therefore, women who have mango farms are likely to use only hired labour for which they may pay more than their male counterpart and experience delays in farm operations; because hired labour may not be readily available at times they have to perform major farm operations like weeding.

Another socio-economic variable considered in the analysis is the number of technical training sessions (demonstrations) organized by ITFC that an out-grower attended. Its result also shows a negative and significant relationship. This implies out-growers who attended more sessions are less inefficient; hence the training helps to improve upon the technical efficiency levels of the out-growers. This is consistent with Al-hassan (2012) that through extension, farmers acquire skills in inputs mobilization, inputs use and crop disease control which enables them to reduce inefficiency.

Finally, the farm management type also shows positive relationship with inefficiency estimates. Farm management type was specified as a dummy variable with a value of 1 for group farms. Therefore, group out-
Table 8. Technical Inefficiency Model.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Coefficients</th>
<th>Standard error</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>1.0</td>
<td>0.714</td>
</tr>
<tr>
<td>Age</td>
<td>-0.01</td>
<td>0.010</td>
</tr>
<tr>
<td>Gender</td>
<td>-0.59**</td>
<td>0.263</td>
</tr>
<tr>
<td>Household size</td>
<td>0.005</td>
<td>0.006</td>
</tr>
<tr>
<td>Education</td>
<td>-1.04</td>
<td>1.65</td>
</tr>
<tr>
<td>Experience</td>
<td>-0.007</td>
<td>0.009</td>
</tr>
<tr>
<td>Demonstrations</td>
<td>-0.033***</td>
<td>0.015</td>
</tr>
<tr>
<td>Farm Mgt Type</td>
<td>1.047***</td>
<td>0.015</td>
</tr>
</tbody>
</table>

Note: The model is an explicit function of \( \mu_i \), which was specified as part of the frontier and was therefore, estimated together with the frontier using FRONTIER 4.1 (Battese and Coelli, 1995) single step procedure. *, ** and *** represent 10, 05 and 01 significant levels respectively.

Source: Field survey data, 2011.

growers are more technically inefficient than the family out-growers. As pointed out in section 1, farm sanitation and crop protection are poor on group farms because group members are not committed to carrying out farm operations as family out-growers do. Higher incidence of failure to weed, pest and disease infestation, bushfire destruction of plantation and farmer failure to attend farm management training sessions, as revealed by focus group discussions, are some of the reasons why group out-growers exhibit higher farm-specific technical inefficiency than their family counterparts.

CONCLUSIONS AND RECOMMENDATIONS

The results of the study show that sampled out-growers produce below frontier output, hence they are technically inefficient. Family out-growers are, however, more technically efficient than group out-growers. Mean technical efficiency difference of 38%, significant at 1% exists between the two farm management types. This is because women who are facing cultural setbacks in farm ownership and management are among the groups. Other factors include members of group out-growers fail to attend training demonstrations and many of the groups are too large for leaders to effectively manage them.

Therefore, the study concludes that family farm management is better than group farm management in terms of technical efficiency which is a necessary condition for economic efficiency; hence recommendations are tilted towards improving technical efficiency.

First, the few women among the group out-growers have been found to exhibit lower efficiency than their male counterparts and therefore, an affirmative action in the form of special training is needed to help them overcome the socio-cultural setbacks that prevent them from effectively managing their farms. Secondly, demonstrations on farm operations that are organized periodically by ITFC have significant positive effect on technical efficiency of out-growers and should be organized more frequently, especially for group out-growers.

Thirdly, scheme management needs to make conscious efforts to break up large groups into subgroups with membership not exceeding five, having well-structured leadership to improve loyalty and commitment to farm management operations. In addition, out-growers, especially the families need to weed their farms more frequently. With improved farm sanitation, pest infestation and its associated need to spray are reduced, thus optimizing the investment they make in organic pesticide. Alternatively, farmers will also have to establish a trusty relationship with pesticide suppliers so that they can negotiate for lower prices in the long-run.

Finally, if the corporate objectives of ITFC are to be realized, the project’s strategic plan should consider shifting support to establishment of more family managed farms, rather than groups.

REFERENCE


HanKH (1991). “A productivity measurement of activities at the micro level”