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Determinants of Technical, Allocative and Economic Efficiencies among Onion Producing Farmers in Kobo District, Amhara Region, Ethiopia

Berhan T. Haile
Socio-economics and Agricultural Extension Research Directorate,Sirinka Agricultural Research Centre.
P.O. Box 74, Woldiya, Ethiopia
Corresponding Author E-mail: hberhantegegne@yahoo.com

Abstract
This study investigated the determinants of technical, allocative and economic efficiencies among small-scale onion producing farmers in North wollo zone of Amhara National Regional State, Ethiopia. Structured questionnaires were used to collect data from 200 respondents randomly selected from designated locations in the study area. A stochastic production frontier function was fitted to the sample households. The findings revealed that land related factors such as land distance, ownership, and fragmentation explain much of the technical inefficiencies in addition to other socio-economic characteristics of farm households. (age, market access, training access, years of experience in onion production, farm income, responsibility and field visit) were found to be significant at different levels of significance for technical efficiency. The result also revealed variables that contribute for allocative efficiency were plot distance, market access, sources of irrigation water , extension visit, farm income and field visit. Major determinants for economic efficiency were age of the household, plot distance, fertility, source of irrigation water, extension visit, experience in onion production, land fragmentation and farm income. Implications of results suggest that any development intervention through irrigation should consider the aforementioned socioeconomic characteristics and determinants of efficiency for success. Tenure insecurity play significant role for farmers to adopt the available technologies and maximize production on irrigated farms. Likewise, land fragmentation has showed positive effect on production inefficiency, calling for the need to think about land consolidation at least within farms. More specifically the finding imply that improving institutional services (extension, market, training, attitude change on credit utilization), soil management options and increased investment in irrigation services could jointly contribute to an improvement in efficiency of onion farmers in the study area.
Keywords: Productive Efficiency, Inefficiency, Productivity, Amhara region, Kobo, Ethiopia

1. Introduction

Ethiopia is an agrarian country where around 95% of the country's agricultural output is produced by smallholder farmers (MoA, 2010). Agriculture contributes about 41% of the country's GDP, employs 83% of total labour force and contributes 90% of exports (EEA, 2012). Despite its dominance, in 2011 alone Productive Safety Net Program supported 7.4 million people, whereas an additional 4.5 million people were requiring emergency humanitarian assistance. According to UNDP (2011) 39 percent of the population lives on less than US$1.25/day. On the United Nations Development Program's 2011 human development index, Ethiopia ranks 174 out of 187 countries. Human development indicators are low, with exceptionally alarming statistics regarding food security and women's status and well- being.

Ethiopian agricultural sector has always been an important component of the country's economy. A sectoral analysis in 2011 of the real GDP indicated that the agricultural sector contributed about 41.1 percent of the GDP, with crop, livestock, forestry and fishery accounting for 27.5, 10.6, 2.9, and 0.2 percent respectively (CSA, 2012). This implies that the crop sub-sector contributed 66.9 percent of agriculture GDP.

Though agriculture remains to be the most important sector of the Ethiopian economy, its performance has been disappointing and food production has been lagging behind population growth (Demeke, 2008), which is unable to fulfill the requirement of the ever- increasing number of mouths. Poor use of modern inputs can partly explain the low productivity of the sector and the internal inefficiency of the farmers in using the available agricultural resources. Increased productivity in agriculture through irrigation also leads to increased opportunities in businesses which supply the agricultural sector. These effects are felt directly in sales of irrigation equipment and indirectly in sales of seed, fertilizer, pesticides, herbicides, and agricultural machinery. This expected increase in sales assumes that irrigated agriculture will lead to increased profits over dry-land or rain-fed agriculture (Baley et al, 2010)

The total irrigable land potential in Ethiopia is 5.3 million hectares assuming use of existing technologies, including 1.6 million hectares through RWH and ground water. There are 12 river basins that provide an estimated annual run-off of 125 billion m3 per year, with the potential of irrigating total of 3,731,222ha from surface water. The potential available estimates for RWH range from 40,000 to 800,000 ha.

The area under irrigation development to-date is estimated to be 640,000 hectares for the entire country which is 5% of the potential irrigable (Awulachew et al., 2010).

Irrigation benefits the poor through higher production, higher yields, lower risk of crop failure, and higher and year-round farm and non-farm employment. Irrigation enables smallholders to adopt more diversified cropping patterns, and to switch from low value staple production to high-value market-oriented production. Increased production makes food available and affordable for the poor (Asayehegn et al, 2011).

In the light of the foregoing this study examined farm household' technical , allocative and economic efficiencies of smallholder drip and furrow irrigated farm production in Kobo district of Amhara National Regional State, Ethiopia as a study area. Specifically, this study focuses to identify factors affecting irrigation user households' technical, allocative and economic efficiencies in the study area.

Kobo district is among the north eastern area endowed with ground and surface water sources and substantial quantities of vegetables are grown under irrigation during dry season (KGVDP 2005).

Potential about the area and despite its potential kobo district productivity increase is said to be declining (CSA 2012). Similarly, productive efficiency for most crops still falls under 60 percent (Haji 2013). These shortfalls are attributed to inefficiencies in production. Therefore, the need for the efficient allocation of productive resources cannot be overemphasized. Presently, there are very few firm-level studies of efficiency in the developing economies, particularly in Ethiopia. As far as the researcher knows, no specific investigation into farm level productive efficiency involving onion production in the area is carried out in the study area, as most of these studies focus on only the resource use efficiency.

Yet empirical works on the farm level technical efficiency is limited and knowledge of farmers' production situations remain inadequate particularly in Sub-Saharan Africa. Hence, given the case that developing countries have scarce resources to undertake new investments on modern agricultural technologies, improving the technical efficiency of farmers is indispensable i.e. there is a wide room for increasing agricultural productivity and production in these areas by improving technical efficiency of farmers at the existing resources.

Therefore, from the perspective of formulating effective agricultural policies, undertaking empirical works on farm level production efficiency has a paramount importance in providing valuable information to policy makers which will be used to enhance agricultural productivity. Equally important is to examine the principal factors that affect production efficiency of farmers, since these factors can be influenced by public policies. To bridge the existing gap, this study examined the determinants of productive efficiencies that would help in promoting the much desired productivity and output growth in the agricultural sector, particularly among small- scale onion producers in the area.

2. Methodology

2.1. Area of the Study

The study was carried out in Kobo district. It is located in the North Eastern part of Amhara National Regional State, North Wollo zone, Ethiopia, lying between $11^0 54'$04" and $12^0 20'$56"N latitude and between $39^0 25'$56" and $39^0 49'$04"E longitude (Fig 1). The district has an altitude that ranges from 1400-3100 meters above sea level. The district capital town, Kobo is about 570 km away from Addis Ababa on the way to Mekele (CSA, 2011; WOA, 2010). According to the North Wollo Zone Agricultural office (2010), Kobo district shares 43.74% of the total 47,292.7 ha of irrigable land of North Wollo, which is equivalent to 5.5% of the total irrigable land of the region (BoWME, 2005).

Kobo district has total human population of 239504 of which 120383 (50.26%) are male and 119121 (49.74%) are female. Out of the total population, 20.15% are urban dwellers. Kobo has a population density of 119.7 people per square kilometer, which is less than the zonal average of 132.3 per km^2. The district has a total area of 2001.57 km^2. With regard to land use pattern of the district, cultivable land comprises the highest (29%) followed by degraded land (26.5%) (CSA, 2011).

According to WOA report, (2009), the agro climatic feature of the district is tropical as 7.9, 37.2 and 54.9% are Dega, Weyina dega and Kola respectively. As described by the report of WOA, 65% is plain while the rest 20, 6, 5 and 4% are mountainous, rugged, gorges and swampy. Kobo is characterized by low and erratic rainfall with mean annual rainfall of 670 mm that ranges from 500 mm-850 mm. The temperature varies from a minimum of 19^0c to a maximum of 33^0c annually. Compared to other districts of the zone, Kobo district has relatively hot climate and it has mean annual temperature of 23.1^oc. The land escape of the district is characterized by a broad fertile plain which is separated from low lands of the Afar region by the Noble Mountains, which are over 2000 m high.

2.2. Sampling Procedure and Sample Size

The target population for this study was onion producers in the study area. Since onion is produced in virtually all the areas of the district and in order to have a representative sample in achieving the stated objectives, the sampling procedure covered all the areas equally. Accordingly, a two-stage sampling procedure was employed in selecting the sample for this study. The first stage involved the random selection of six villages in different irrigation scheme. The second stage was the random selection of 100 farming households in each of the already selected group of scheme based on proportionate probabilistic sampling techniques. Accordingly, a sample of two hundred farming households was collected and subsequently analyzed for the study. The sampling distribution of the respondents is shown in Table 1.

2.3. Analytical Techniques

Descriptive statistics and Cobb–Douglas stochastic production frontier approach was used to estimate the production function and the determinants of technical, allocative and economic efficiencies among onion farmers in the area. The stochastic function assumes the presence of technical inefficiency of production.

The specification involves a function specified for cross-sectional data, which has an error term, with two components, one to account for technical inefficiency.

Hence, the function is defined by:

$Yi = Xi\beta + (Vi - Ui), i = 1,..., N,$ .... (1)

Where:

Y is the monetary value of onion crop per farm

X is a kx1 vector of (transformations of the) input quantities of the i-th firm;

β is a vector of unknown parameters to be estimated;

Vi are random variables, two-sided ($- \infty < vi < \infty$) normally distributed random error

$N \sim (0, \delta_v^2)$, which are assumed to be independent of the U_i that captures the stochastic effects outside the farmer's control (for example, weather, natural disasters, and luck, measurement errors in production, and other statistical noise). The two components v and u are also assumed to be independent of each other. Thus, to estimate a Cobb-Douglas production functions, we must log all the input and output data before the data is analyzed (Coelli 1995).

Thus, to estimate a Cobb-Douglas production function, we must log all of input and output data before the data is analyzed. (Coelli 1995). The estimating equation for the stochastic function is given as:

lnY=B0 +B1lnX1 +B2lnX2 + B3lnX3 + B4lnX4 + B5lnX5 + B lnX + V –U .... (2)

In the area farming, land, labour, seeds, fertilizers, agro-chemical and irrigation water are generally regarded as inputs. On the basis of this, land (X_1) in hectare, labour (X_2) in person day, planting materials or seeds (X_3) in kg, fertilizer in kg (X_4), agro-chemical in liters (X_5), irrigation frequency in days (X_6) and irrigation methods (X_7) dummy D=1 when drip and 0 otherwise were included in the stochastic frontier models. Technical efficiency of an individual firm is defined in terms of the ratio of the observed output (Y) to the corresponding frontier output (Y^*), given the available technology, conditional on the levels of input used by the firm.

$$TE_i = \frac{y_i}{y^*} = \frac{\exp(x_i\beta + v_i - u_i)}{\exp(x_i\beta + v_i)} \qquad \text{-------------------- (3)}$$

$$TE_i = \exp(-u_i)$$

That is technical efficiency which is obtainable by the use of Frontier 4.1.(Coelli 1996). Based on the individual farm's technical efficiency, the mean technical efficiency for the sample is obtained (Rahji 2005).

Assuming that the production function in equation (1) is self-dual (e.g., Cobb-Douglas), the dual cost frontier is derived algebraically and written in the following form:

$$C_i = C(W_i, Y_i^*, \alpha) \qquad (4)$$

Where C_i is the minimum cost of the ith farm associated with the adjusted yield of output Y_i* and α is a vector of parameters to be estimated. The economically efficient input vector of the ith farm, X_{ie} is derived by applying Shepard's Lemma and substituting the firm's input prices and adjusted yield of output level into the resulting system of input demand equations

$$\partial C_i / \partial W_k = X_{ke}(W_i, Y_i^*, \psi) . \qquad (5)$$

Where k represents the total number of inputs used. The observed, technically and economically efficient costs of production of the ith farm are then equal to $W_i' X_i$, $W_i' X_{it}$ and $W_i'X_{ie}$, respectively. According to Sharma *et al.* (1999) these cost measures are used to compute technical efficiency (TE),

$$TE_i = W_i' X_{it} / W_i' X_i \qquad (6)$$

Economic efficiency (EE),

$$EE_i = W_i' X_{ie} / W_i' X_i \qquad (7)$$

Following Farrel (1957) allocative efficiency (AE) can be derived from equation (6) and (7) as,

$$AE_i = W_i' X_{ie} / W_i' X_{it} \quad (8)$$

indices of the i^{th} farm. The production frontier was estimated using frontier model whereas the cost frontier is derived analytically from production assuming self-dual.

The determinants of technical, allocative and economic inefficiencies are explained by:

$Ui = \delta o + \delta_1 Z1i + \delta 2Z2i + \delta 3Z3i + \delta 4Z4i + \delta 5Z5i + \delta 6Z6i + \delta 7Z7i + \ldots + \delta_n Z_{ni} + W_i$ ----------- (9)

Where: for farm i, z is a vector of observable explanatory variables and δ is a vector of unknown parameters. Thus, the parameters of the frontier production function are simultaneously estimated with those of an inefficiency model, in which the inefficiency effects are specified as a function of other variables.

U represents inefficiency effects;

δ_o represents the intercept

After a thorough review of previous studies and the prevailing situation in the study area, socio economic and institutional factors (Z_i's) that would affect efficiency were hypothesized as follows:

Age of the household head (**Agehh**): The age of the household head is hypothesized to reflect the experience of the farmer.

Education level of the household head (**Edeuclvl**): Farmers are expected to acquire the ability of better management through education and can be used as a proxy variable for managerial ability.

Family size (**Famsize**): Family is an important source of labour supply in rural areas. It is expected that households with many family members have better advantage of being able to use labor resources at the right time, particularly during peak cultivation periods.

Total cultivated land (**Totcultlnd**):This refers to the size of (own, shared or rented in) all land the household managed during 2012 production season.

Land fragmentation (**Fragment**):This is defined as the total number of plots that the farmer has managed during the 2012 production season. Plots in the area are highly fragmented and scattered over many places that would make difficult to perform farming activities on time and effectively. Increased land fragmentation leads to inefficiency by creating shortage of family labour, costing time and other resources that should have been available at the same time.

Number of livestock (**Livstock**): This is the total number of livestock in terms of Tropical Livestock Unit (TLU).

Distance of household's residence (**Distres**): Distance between farmer's residence and onion plot is assumed to have negative impact on efficiency.

Farm income (**Totfincom)**: This includes all income from on farm and off farm activities of the household. It is a continuous variable measured in the amount of income (birr) the household head and/or other members get per year.

Land ownership (**Lndowner**): This is a dummy variable measured as 1 if the farm for production of onion is on sharecropping basis and 0 otherwise.

Experience in onion production (**Experio**): the number of years of experience is directly related to the farmers know how on onion production.

Off-farm/non-farm income (**Offincome**): Dummy variable having a value of 1 if the farmer is involved in off-farm/non- farm activities, 0 otherwise.

Access to credit (**Acscdt**): is a dummy variable which indicates accessibility of credit which is 1 if the farmer can access credit, 0 otherwise.

Extension service use (**Extserv**): Extension service given to farmers was measured as how much farmers implement the advice and techniques given by the extension agent during the production season and was defined using a dummy variable 1 for service user 0 for nonuser.

Access to market (**Accmkt**): It is dummy 1 for those who have access to market otherwise 0.

Field visit (**Fieldvis**): in the study area, field visit program is adjusted for farmers at their locality and nearby districts in the region. It is dummy 1 for those who have access to field visit otherwise 0.

Access to training (**Acctrain**): Training is an important tool in building the managerial capacity of the farmer. It is dummy 1 for those who have access to training otherwise 0.

Responsibility (**Responsi**): Responsibility in different social and committee leadership give the farmers opportunity of sharing information on improved production techniques by interacting with other farmers and experts thereby improve efficiency. It is dummy variable taking the value of 1 if the household has different responsibility in the kebele and 0 otherwise.

3. Results and discussion

The mean age of the respondents is 46.59 years and the modal age is 41-50 years, which constituted about one-third of the total respondents (Table 2). The age of the farmer according to Adewumi and Omotesho (2002) is expected to affects his labor productivity and output. This agrees with findings of former studies Tsoho (2004). Sex of the sampled household head . The study revealed that more than ninety percent of the respondents were

married, while the remaining were either single or widow(ers), respectively. The mean family size was 6.02 persons per respondent and it ranged from 1 to 12. The study also revealed that 57 percent have attained between primary and tertiary education. More than two- third of the respondents have had religious education.
The farmer's years of experience ranged from 5 to 45 with an average of 23.21 years. Farmers experience is expected to have a considerable effect on farmer's productive efficiency. Almost all the respondents have inherited farming as an occupation, while the others were introduced to farming by either friends or relatives. About Ninety percent of the respondents have farming as their main occupation and only ten percent adopts farming as their secondary occupation.

3.1. Efficiency analysis

The expected parameters and the related statistical test results obtain from the analysis of the maximum likelihood estimates (MLE) of the Cobb-Douglas based stochastic frontier production function parameters for dry season vegetable farmers are presented in Table 3.

The variance parameters of the production function represented by Sigma-squared (σ2) and Gamma (γ) are all significant even at 1%. The Lambda is greater than one (λ = 8.41). The statistical significance of Lambda showed that there exits sufficient evidence to suggest that technical inefficiencies are present in the data. Theoretically, this implies a good fit for the estimated model and correctness of the distributional assumptions for the Ui and Vi. The statistical significance of the sigma-squared also indicated a good fit for the model. The estimated Gamma (0.89) shows the amount of the variation in onion outputs which results from technical efficiency of the sampled farmers (Berhan, 2013).

The results of the estimated parameters revealed that all the coefficients of the physical variables except quantity of seeds used, conform to a priori expectation of a positive signs. The positive coefficient of land, labour, fertilizer, agro-chemical and irrigation implies that as each of these variables is increased, *ceteris paribus*, vegetable output increased. The negative sign of the seeds suggest a situation of excessive (and, hence, inefficient) use of planting material in the production of vegetable in the area.

The coefficient of the variable associated with land although positive, is statistically not significant even at 10 percent level of significance. The coefficients of the three physical variables: labor, fertilizer and irrigation water are all significant even at 1 percent level of significance. Therefore, these are the major factors explaining onion production under irrigation condition at the district. The finding agrees with those of Tsoho et al (2013) Ajibefun et al. (2002) and Onyenweaku and Effiong (2005) .

3.2. The Returns to Scale (RTS)

The return to scale (RTS) analysis, which serves as a measure of total resource productivity, is given in Table 5. The maximum likelihood estimates (MLE) of the Cobb-Douglas based stochastic production function parameter of 0.464 is obtained from the summation of the coefficients of the estimated inputs (elasticties). It indicates that onion production in study area was in the stage II of the production surface which is decreasing positions of return to scale where resources and production were believed to be efficient.

3.3. Determinants of Technical, Allocative and Economic Efficiencies in onion Production Multiple Regression Analysis (OLS)

Based on the literature on previous studies; nine characteristics are chosen as indicators of the farmer's socio-economic environment and are subsequently used as explanatory variables in the analysis of productive efficiency for onion production under irrigation in the study area. The Technical, allocative and economic efficiency estimates derived from SFA will be regressed, using a censored Tobit model on the following farm-specific explanatory variables that might explain variations in production efficiencies across farms.

Estimation with OLS regression of the efficiency scores would lead to biased parameter estimates since OLS assumes normal and homoscedastic distribution of the disturbance and the dependent variable (Greene, 2003). As the distribution of the estimated efficiencies are censored from above at the value one, Tobit regression (Tobin, 1958) is specified as

$$E_i^* = \sum_i \beta_i X_i + V_i$$

$$E_i = 1 \ldots if \ldots E_i^* \geq 1$$

$$E_i = E_i^* \ldots if \ldots E_i^* < 1 \quad (10)$$

Where E_i is an efficiency score, and V~N (0, σ^2) and β_j are the parameters of interest
The results of the analysis of the relationship between the farmer's characteristics and efficiency indices are presented in Table 6.

The results indicated that, overall, the explanatory ability of the variables included in the analysis is limited (R2 values are generally low) and not all regressions or parameters are significant. This result agrees with the findings of several researchers who have generally obtained an R2 value of less than 0.5 in their secondary analysis similar to this study. For example, Xu and Jeffrey (1997) obtained an R2 value of 0.21, 0.31 and 0.19, respectively.

The variables fragment, ownership, total farm income, training and participation in field day visit affect efficiency positively while responsibility and age of the household head affect technical efficiency negatively. Households who have got the chance to participate in field visit and field days are more efficient than their counter parts. Because it improves the technical knowhow and skill of the farmers thereby exchange of experience will improve the efficiency. The result shows that access to field visit is found to have positive and significant effect (at 5% level of significance) on farmers' technical efficiency in production.

The result shows that households having better farm income would devote their time and effort in day to day farming activities and able to use improved technologies thereby production efficiency improved. Thus the result is found to have positive and significant effect on farmers' technical efficiency in production.

Experience in onion production is a proxy measure of managerial and technical knowhow. The result shows that experience is found to have positive and significant effect on farmers' technical efficiency in production. This result is in conformity with the finding of Abdukadir (2010).

Extension contact and training has a positive sign and is statistically significant in technical efficiency and negative sign in allocative efficiency indices. The positive and statistically robust relationship between extension and efficiency supports the notion, which implies that farmers who had more extension visits/teachings are likely to be more successful in gathering information and understanding new practices and the use of modern inputs which in turn will improve their EE through higher levels of TE and AE respectively. These results are consistent with the findings of Onyenweaku and Nwaru (2004) and Rahji (2005). Contrarily, the study disagreed with findings of those of Parikh et al. (1995) that have found extension to be negatively and statistically related to efficiency indices.

Source of irrigation has positive and statistically significant coefficients for AE and EE. But, the opposite is true for the TE as its relationship is negative and non-significant. The positive coefficient suggests that farmers who use underground water to irrigate their onion are allocatively and economically more efficient than those who use surface water. Interestingly, these same categories of farmers are however technically less efficient. This finding is consistent with Baba and Wando (1998) that the there is a positive and significant relationship between the source of water and the efficiency of the farmers.

The coefficients of family size, farm size, education status, off farm income, credit use, TLU, and land ownership systems are not important in explaining the variation in TE, AE and EE of farmers in the study area.

4. Conclusion and Recommendations

4.1. Conclusion

This study described the socio-economic characteristics and identifies the determinants of TE, AE, and EE of onion producing farmers in the study area, Ethiopia. The results indicated that while the extension contact, source of water, and crop diversification exhibited higher levels of positive significant impact on TE and EE, the location of the farm exerts a negative significant impact on TE. In addition, farm location has a statistically positive association with AE. In all, extension contact exerts a uniform impact on all the efficiency indices.

The Cobb-Douglas stochastic frontier production was estimated, from which TE and EE extracted. The results from the production function showed that fertilizer, inorganic, labour, oxen power and seed cost were statistically significant. The study also indicated that 82.6% and 76.8% were the mean levels of TE, under drip and furrow irrigated, respectively. This in turn implies that farmers can increase their farm production on average by 17.4% and 23.2% respectively when they were technically efficient. Similarly, the EE of drip and furrow were 51.49% and 44% respectively.

In the second step of the analysis, relationships between efficiency indices (TE, AE and EE) and variables that expected to have effect on farm efficiency were examined. This was relied on maximum likelihood estimation of frontier model of inefficiency effect, where inefficiency, expressed as functions of 19 independent variables. Among them, age, plot distance, fragment, source of water, experience in onion production, farm income, fertility status and extension visit were found to be statistically significant to affect the level of production efficiency.

Thus, the results of the study give information to policy makers and extension workers on how to better aim efforts to improve farm efficiency as the level and specific determinant for production efficiency. These findings stresses the need for appropriate policy formulation and implementation to enable farmers reduce their inefficiency in production as this is expected to have multiplier effects ranging from farm productivity growth to economic growth and poverty reduction at macro level.

The analysis also indicated that participation to small scale irrigation is a crucial factor in determining production efficiency of farmers. Therefore, farmers have to work to improve the irrigation infrastructure and increase their participation to irrigation farming to diversify both crops and income base sources in farm household production.

Extension agents, as they are employees deployed to work very close to farmers, a lot is expected from them. Consequently, the results of the study revealed that the utilization of extension services has positive influence on technical efficiency of the sample farmers. Therefore extension services has to keep on aiming to provide information and practical farming knowledge for all farmers particularly those involving in irrigation to improve resource utilization and reduce cost of production in irrigated agriculture.

In the study area, field visit promotes technical efficiency of irrigated onion production. This indicates that the existing training and field visit experience sharing services should be continued and promoted in improving the technical efficiency and thereby the performance of farmers. Therefore, it is recommend that government should have a prime responsibility to improve the performance of farmers training center much more in these areas and others so that farmers can use the available inputs more efficiently under the existing technology. More importantly, practical training should be planned to be comprehensive in considering issues like efficient resource use (land, labour, fertilizer and seed), cost reduction, profit maximization objectives so that farmers could be benefited from accelerated increase in income from onion production.

This study has revealed that small scale onion producer farmers are not fully technically efficient and therefore there is allowance of efficiency improvement by addressing some important policy variables that negatively and positively influenced farmers' level of technical efficiency in the study area. The positive elasticity of Urea in the case of furrow irrigation scheme users and labor and oxen days in the case of drip irrigation users shows the increased use of this input can increase the yield of onion; therefore timely availability of this input is crucial.

The result also revealed that land related factors such as land size, land ownership, and land fragmentation explain much of the technical inefficiencies in addition to other socio-economic characteristics of farm households., Total land size is inversely related to the technical efficiency. We also observed that land size has negative effect on onion yield, which signifies the theory of inverse relationship between farm size and productivity in onion production.

All these imply that labor market is still imperfect that causes households' to relay on family labor. Farmers are more efficient on owned plots than leased in (in the form of sharecropping and fixed rent) plots. Tenure insecurity play significant role for farmers to adopt the available technologies and maximize production on irrigated farms. Likewise, land fragmentation has showed positive effect on technical inefficiency, calling for the need to think about land consolidation at least within farms. Hence, it can be concluded that onion production can further be increased by introducing improved water application technologies like drip and sprinkler suitable for small farmers with appropriate policies aimed at creating tenure security, perfecting labor market and consolidating fragmented plots.

4.2. Recommendations

Given the limited resources in the study areas, efforts to strengthen the efficiency of smallholder farmers who are the largest segment in agricultural production are indispensable. Policymakers should foster the development and provision of qualitative extension services, development of irrigation infrastructures and soil fertility management options to the farmers, while promoting the wide adoption of pumps and drip lines use by the farmers.

In the study area, field visit promotes TE and AE of irrigated onion production. This indicates that the existing training and field visit experience sharing services should be continued and promoted in improving the technical efficiency and thereby the performance of farmers. Therefore, it is recommend that government should have a prime responsibility to improve the performance of farmers training center much more in these areas and others so that farmers can use the available inputs more efficiently under the existing technology. More importantly, practical training should be planned to be comprehensive in considering issues like efficient resource use (land, labour, fertilizer and seed), cost reduction, profit maximization objectives so that farmers could be benefited from accelerated increase in income from onion production.

Above all the attention of policy makers should not be only to the introduction and dissemination of yield enhancing externally supplied inputs to mitigate the existing level of food deficiency and poverty more importantly the working culture and perception on improved technologies in that area should be improved. Besides researchers and development practitioners should give due attention towards improving the existing level of efficiency and marketing problems through providing labour saving farm implements, appropriate enterprise choice for the study area, efficient water application techniques, construction of modern river diversion canals , providing advice and training to use the recommended fertilizer and seed rate, providing credit with reasonable interest rate and market related studies are vital.

5. References

Abdukadir S, 2010. Analysis of technical efficiency of groundnut production: the case of smallholder farmers in Harari region. M.Sc. Thesis presented to the School of Graduate Studies of Haramaya University.
Adewumi MO, Omotesho OA 2002. An analysis of production objective of small rural farming Households in Kwara State, Nigeria. *Journal of Rural Development,* 25: 201-211.
Ajibefun IA, Battese GE, Daramola AG 2002. Determinants of technical efficiency in small holder food crop farming: Application of stochastic frontier function. *Quarterly Journal of International Agriculture,* 41(3): 225-240.
Assefa S, 2011. Analysis of technical efficiency of crop producing smallholder farmers in Tigray, Ethiopia. MPRA paper No.44461, posted 6/08/2012 online http://mpra.ub.uni-muenchen.de/40461/ Accessed on 3/01/2013.
Awulachew SB, Lambisso R, Asfaw G, Yilma AD, Moges SA 2010. Characterizing, assessment of performance and causes of underperformance of irrigation in Ethiopia. Ethiopian Journal of Development Research. (In press).
Baba K M, Wando M A 1998. Impact of membership of fadama user associations on resources use, crop yield and farm income: A case study from two local government areas of Niger State. Nigeria. Journal of Basic and Applied Science,7: 31-41.
Belay K, Samson E, Belayneh B , Degeye G, Demeksa T, Estifanos W, Zelalem L, Addisu D, Josephine T, Zemede A 2010. Income diversification through improved irrigation in Ethiopia impacts, constraints and prospects for poverty reduction evidence from East Harerghe Zone, Oromia Region, Ethiopia
Berhan T 2013. Analysis of Technical Efficiency in Onion Production under Irrigation Conditions: The Case of Smallholders in Kobo Woreda of Amhara Region. M.Sc. Thesis, Unpublished submitted to the School of Agricultural Economics and Agri-business. Haramaya University, Ethiopia.
Bravo-Ureta B, Pinheiro A 1997. Efficiency analysis of developing country agriculture: A review of the frontier function literature. *Agriculture and Resource Economics Review,* 22(1): 88-101.
Coelli TJ 1995. Recent developments in frontier modeling and efficiency measurement. *Australian Journal of Agricultural Economics,* 39(3): 219- 245. Coelli TJ 1996. A Guide to FRONTIER Version 4.1: A Computer Program for Stochastic Frontier Production and Cost Function Estimation. *CEPA Working Paper 96/07.*University of New England, Armidale, Australia.
Central Statistical Agency (CSA) 2011/12. Population size by Age, Area and Density by Region, Zone and District.
Demeke M 2008. Impact of small scale irrigation schemes on poverty reduction: the case of Bahirdar zuria district in West Gojjam Adminstrative Zone. An MSC thesis presented to the School of Graduate studies of Haramaya University. 121p.
DOA (District Office of Agriculture), 2009/2010. Annual report of crop production in 2009 cropping season. Unpublished.
District Office of Agriculture, 2011/2012. Annual report of crop production in 2010/2011 cropping season. Unpublished.
Ethiopian Economic Association (EEA), 2012. Annual Report on Ethiopian Economy. Addis Ababa, Ethiopia.
Farrell MJ 1957. The Measurement of productive efficiency. J. Royal Statist. Soc., Series A, 120: 253-290.
Getachew A, 1995. Production efficiency analysis: The case of smallholder farming in coffee sector of Ethiopia & Kenya. *Farming Systems and Resource Economics in the Tropic*s. Vol. 23. Wissenschaftsverlag vauk Kiel KG.
Jema H, 2008. Economic Efficiency and Marketing of Vegetable production in Eastern and Central parts of Ethiopia. Doctoral Thesis Presented to Swedish University of Agricultural Sciences. Uppsala, Sweden.
Kobo Girana Valley Development Program (KGVDP), 2011/12. Annual technical and production report unpublished.
Onyenweaku CE, Effiong EO 2005. Technical efficiency and its determinants in pig production in Akwa Ibom state, Nigeria. *International Journal of Agricultural Development,* 6: 51-57.
Parikh A, Ali, F, Shah MK 1995. Measurement of economic efficiency in Pakistani agriculture. American Journal of Agricultural Economics, 77: 675-685.
Rahji MAY 2005. Determinants of efficiency differentials in lowland rice production systems in Niger state, Nigeria. Ibadan Journal of Agricultural Research, 1(1): 7-17.
Tsoha. B.A 2004. Economics of Tomato production under small-scale irrigation in Sokoto State. M.Sc Thesis, Unpublished. Submitted to the Department of Agricultural Economics and Farm management. University of Ilorin, Nigeria.
Tsoho, B.A. O. A. Omotesho, S. A. Salau and M. O. Adewumi , 2012. Determinants of Technical, Allocative and Economic Efficiencies among Dry Season Vegetable Farmers in Sokoto State, Nigeria.
Tobin, J. 1958. Estimation of Relationships for Limited Dependent Variables. Econometrica, 26: 24–36.

Table 1: Sampling distribution in the study area

Kebele	Area in ha	Total households			Onion producer households			Sample households		
		Total	Male	Female	Tot.	Male	Fem.	Tot.	Male	Fem.
Furrow User	490	1592	1145	447	404	371	33	100	92	8
Aradom	400	1372	962	410	236	215	21	60	55	5
Robit	52	157	137	20	85	81	4	20	19	1
Jarota	38	63	46	17	83	75	8	20	18	2
Drip User	148	383	251	132	383	359	24	100	94	6
Kobo K4	50	129	91	38	129	121	8	30	28	2
Kobo K6	48	140	86	54	140	130	12	35	32	3
Kobo K7	48	114	74	40	114	110	4	35	34	1
Total	638	1975	1396	579	787	730	57	200	186	14

Table 2: Socio-economic characteristics of the households' heads in the study area

Variable description	Minimum	Maximum	Mean	Std. Deviation
Age	25	78	46.59	10.78
Family size	1	12	6.02	1.84
Adult equivalent	1	10	5.02	1.59

Education category	Frequency	Percent	χ^2 value
Illiterate	86	43.0	3.92**
Literate	114	57.0	

Table 3: Estimated stochastic production frontier function

Variables	OLS estimate Coef.	OLS estimate Std.Err	ML estimate Coef.	ML estimate Std.Err
Intercept	2.799***	0.443	3.398***	0.305
lnLand	-0.124	0.077	-0.187***	0.043
lnSeed	-0.079	0.072	0.011	0.045
lnLabour	0.174*	0.100	0.149**	0.075
lnOxenday	0.220**	0.087	0.198***	0.071
lnUrea	0.0224***	0.0064	0.019***	0.005
lnDAP	0.003	0.006	0.002	0.004
lnCHEM	0.013*	0.008	0.012**	0.006
IRRMTD	0.208***	0.075	0.260***	0.062
R^2	0.3816		∑β=0.464	
F statistics	14.73***			
$\sigma^2 = \sigma_v{}^2 + \sigma_u{}^2$			0.275***	
$\lambda = \sigma_u / \sigma_v$	-		8.714***	
γ (gamma)	-		0.987***	
LLR	-		-72.81	

Note: *, ** and *** significant at 10%, 5% and 1% significance level, respectively.

Table 4: Estimated stochastic cost frontier function

Variables	Maximum Likelihood estimate Coef.	Std .Err
Intercept	1.566***	0.256
lnLandcost	0.639***	0.036
lnSeedcost	0.529***	0.022
lnLaborcost	0.120***	0.031
lnOxencost	-0.001	0.002
lnchemcost	0.0003	0.002
lnfertcost	0.232***	0.023
lnoutput	0.011***	0.003
$\sigma^2 = \sigma_v^2 + \sigma_u^2$	0.033***	
$\lambda = \sigma_u / \sigma_v$	1.522***	0.040
LLR	118.81	

Note: *, ** and *** significant at 10%, 5% and 1% significance level, respectively.

Table 5: Elasticities and returns to scale of the parameters of stochastic frontier production function

Variables	Elasticities
lnLand	-0.187
lnSeed	0.011
lnLabour	0.149
lnOxendays	0.198
lnUrea	0.019
lnDAP	0.002
lnChem	0.012
IRRMTD	0.260
Returns to scale	**0.464**

Table 6: Relationship between transformed efficiency indices and farm-farmer characteristics

Variables	TE		AE		EE	
	Coef.	SE	Coef.	SE	Coef.	SE
Constant	0.440***	0.145	0.858***	0.165	0.349***	0.098
Land size	-0.017	0.021	-0.009	0.024	-0.006	0.014
Age	-0.003***	0.001	0.000	0.001	-0.002**	0.0009
Education	-0.034	0.027	0.012	0.031	-0.013	0.018
Family size	-0.009	0.010	0.016	0.011	-0.000	0.007
Plot distance	-0.008	0.007	0.024***	0.007	0.011***	0.004
Fragment	0.065***	0.005	0.002	0.059	0.058***	0.015
Fertility	0.095	0.066	0.006	0.074	0.080*	0.044
Off farm income	0.026	0.033	0.004	0.038	0.002	0.022
Credit use	0.005	0.027	0.002	0.030	0.003	0.018
Market access	0.169***	0.069	-0.195***	0.079	-0.001	0.047
Source of water	0.023	0.028	0.090***	0.037	0.072***	0.022
Acc.to training	0.056**	0.028	-0.052	0.032	-0.013	0.019
Extension	0.072***	0.004	0.089**	0.049	0.08***	0.029
TLU	0.002	0.007	-0.003	0.008	-0.002	0.005
Exp. in onion	0.011***	0.005	0.004	0.006	0.011***	0.004
Ownership	-0.003	0.034	0.017	0.039	0.003	0.023
Farm income	2.97***	1.87	-3.21***	0.694	-1.44***	0.411
Responsibility	-0.058***	0.026	0.075**	0.030	0.019	0.018
Field visit	0.102***	0.033	-0.066*	0.037	-0.016	0.022

Note: *, ** and *** significant at 10%, 5% and 1% significance level, respectively.