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   REVIEW OF LITERATURE

   NEED/IMPORTANCE OF THE STUDY

   STATEMENT OF THE PROBLEM

   OBJECTIVES

   HYPOTHESES

   RESEARCH METHODOLOGY

   RESULTS & DISCUSSION

   FINDINGS

   RECOMMENDATIONS/SUGGESTIONS

   CONCLUSIONS

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   ACKNOWLEDGMENTS

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   APPENDIX/ANNEXURE

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CONTRIBUTIONS TO BOOKS

- Sharma T., Kwatra, G. (2008) Effectiveness of Social Advertising: A Study of Selected Campaigns, Corporate Social Responsibility, Edited by David Crowther & Nicholas Capaldi, Ashgate Research Companion to Corporate Social Responsibility, Chapter 15, pp 287-303.

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- Schemenner, R.W., Huber, J.C. and Cook, R.L. (1987), "Geographic Differences and the Location of New Manufacturing Facilities," Journal of Urban Economics, Vol. 21, No. 1, pp. 83-104.

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TECHNICAL EFFICIENCY IN TEFF PRODUCTION BY SMALL SCALE FARMERS IN TIGRAY (CASE OF RAYA ALAMATA WEREDA)

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ABSTRACT

In Ethiopia, Teff is one of the staple cereal crops which are grown in most parts of the country. Although this crop is grown in most regions of the country, the present study focuses on technical efficiency as it is an important subject in the development of the agricultural sector where resources are scarce but population growth is very high. Technical efficiency is the ability of a farmer to obtain output from a given set of physical inputs. Farmers have a tendency of under and/or over-utilising the factors of production. The study used a set of analytical techniques to analyse the data; both descriptive and analytical tools. The Cobb-Douglas production function results indicate that some of the variables were found to be positively significant (such as land size, fertilizer adoption and tractor use), while others were negative but significant, and some were positive but non-significant. Even though some variables were not significant, it still shows that the variables used in the analysis have a positive effect on the output (the total quantity of teff produced) which simply means that there is a good inputs-output relationship, and the small-scale teff producers in Raya Alamata are experiencing a decreasing returns to scale. Logistic regression model was employed to identify the socio-economic characteristics that influence the technical efficiency of small-scale teff producers in Raya Alamata. The findings from the logistic regression indicate that there are socioeconomic factors influencing the technical efficiency of small-scale teff producers.These are: level of education, household size, farmer`s farming experience, farm size, membership to farmers organization, income of the household on a monthly basis, fertiliser application, and cost of tractor hours. These factors were found to be significant. However, some of the variables were showing a negative relationship to small-scale teff producers` technical efficiency.

KEYWORDS

Technical efficiency in Teff Production and the Logistic Regression Model.

1.1 INTRODUCTION

In Ethiopia, the agricultural sector is the basis for the economy which accounts for half of the country's GDP, 60% of its exports and 80% of total employment (CIA, 2007; Tewodros, 2009). The undeveloped market economy, which started during imperial period (1930-1974), was halted during the military regime (1974-1991) that introduced command economy. However, since the current government took power in 1991, Ethiopia has been pursuing a market- oriented development strategy and implementing policies that began the shift from a state-controlled to a free market economy. The government has embarked on a various programs of economic reform, including trade liberalization, privatization of public enterprises and streamlining the bureaucracy (Birega, undated). The current Ethiopian economic development strategy, Agriculture Development-Led Industrialization (ADLI), identifies the growth of agriculture as a key to the development of other sectors as well (Admasu and Paul, 2010).

Moreover, the Ethiopian economy is largely dominated by subsistence agriculture and it is smallholder- based (Bishaw, 2009). In addition, mixed farming dominates the Ethiopian highlands. The smallholder farmers in the Ethiopian highlands are poor; individual land holding ranges between 0.5 and 2.5 ha; family sizes are large; land productivity is low and food requirements are not fully met (Jabbar *et al*., 2000). Ethiopian highland agriculture is characterized by high dependency on rainfall, traditional technology, high population pressure and the lowest productivity level (Medhin and Köhlin, 2008). The cereal-based farming systems have also remained largely unchanged and thus have become unable to sustain the ever increasing population with food and energy demands. As a result, there is severe land degradation and declining productivity in many areas of the highlands (Ayele, 2008).

The issue of increasing agricultural productivity has become the main concern to governments following considerable increase in food price over the last two years that follows decades of low food price (Conradie et al., 2009). Despite of Ethiopian government's policy to expand crop production for exports, domestic consumption and universal food security (MoFED, 2006), the productivity of *teff* is the lowest among cereal crops (Haile et al., 2004). In addition, despite its huge potential in wheat production, the country remains the net importer of the commodity (Rashid, 2010).

1.2 PROBLEM STATEMENT

Despite the rapid economic growth registered in the country from 1998 to 2007, Ethiopia is ranked 157 out of 169 countries in the 2010 United Nations Human Development Index and 80 out of 84 in the Global Hunger Index (WFP, 2011). Moreover, while 38% of the rural households live below poverty line(WB2009); chronic food insecurity has been an essential characteristic of the poverty that has affected millions of Ethiopians of which the vast majority of these poor households live in rural areas that are heavily dependent on rain fed agriculture(Subbarao and Smith, 2003). This indicates that broad based and sustainable agricultural and development in Ethiopia is crucial in alleviating problems of poverty and chronic food insecurity.

In general, agriculture is the backbone of the Ethiopian economy which plays a critical and multidimensional role in Ethiopian economy. It is said that about 85% of the Ethiopian population, which lives in the rural areas, derives its livelihood from Agriculture, Diao et al. (2010), moreover, the sector accounts for more than 40% of national GDP; and it is the source of 90% of the country's export earnings. This means that the rate at which agricultural sector attains its growth and sustainability highly determines the country's macroeconomic performances such as overall economic growth, employment, food security, poverty reduction and per capita income growth.

Despite its importance, however, Ethiopian agricultural sector is dominated by subsistence and smallholder-oriented system (Bishaw, 2009). Predominantly, Ethiopian highland agriculture is characterized by high dependency on rainfall, traditional technology, high population pressure, and severe land degradation combined by low level of productivity (Medhin & Kohlin, 2008). Notwithstanding the government's policy to expand crop production for exports, domestic consumption and universal food security (Ministry of Finance and Economic Development (MoFED), 2006), low productivity levels in *teff* (Haile et al., 2004) and chickpea (Shiferaw & Teklewold*,* 2007) have been reported.

So as to achieve poverty alleviation objectives among smallholder farmers, productivity and efficiency of resource use must be improved to increase income, attain better standard of living and reduce environmental degradation (Ajibefun, 2000). In addition, Ajibefun & Daramola (2003) also argue that there is a need to increase growth in all sectors of the economy for such growth is the most efficient means of alleviating poverty and generating long-term sustainable development, where resources must be used much more efficiently to improve productivity and income. Thus, resource use efficiency in smallholder agriculture could be the basis for achieving universal food security and poverty reduction objectives of the country particularly among the rural households in Ethiopia.

Agricultural productivity depends on how factors are efficiently used in the production process. Therefore, intensification of agricultural land and expansion of technology use must be accompanied by resource use efficiency that enhances productivity of factors. Improvements in resource use efficiency hence increase in productivity will reduce encroachment of population to marginal agricultural lands. In turn, this will protect the resource base of the poor against degradation. Thus, the main aim of this study is to analyze the technical efficiency of small-scale Teff producers in Raya Alamata community. The objective of the study is to determine the level of technical efficiency of small-scale Teff producers and to identify the socio-economic characteristics that influence technical efficiency of small-scale Teff producers in Alamata.

1.3 OBJECTIVE OF THE STUDY

The main aim of the study is to analyze the technical efficiency of small-scale Teff producers in Raya Alamata Wereda.

SPECIFIC OBJECTIVES

With the above general objective of the study in mind, the study has the following specific objectives:

1. To determine the level of technical efficiency of small-scale Teff producers in the study area.
2. To identify the socio-economic characteristics that influence technical efficiency of small-scale Teff producers in the study area.

1.4 HYPOTHESIS OF THE STUDY

Hypothesis 1: The small-scale Teff producers in Raya Alamata are not technically efficient.

Hypothesis 2: There are no socio-economic characteristics that influence technical efficiency of small-scale Teff producers in the study area.

LITERATURE REVIEW

2.1 ENVIRONMENTAL DEGRADATION AND MARGINALITY IN THE ETHIOPIAN AGRICULTURE

Environmental and resource degradation has been widely accepted as a crucial constraint to reducing poverty among the most disadvantaged and marginalized populations in the world, who are largely rural (UN Millennium Project, 2005). Moreover, poverty and environmental degradation tend to be more pronounced in the so-called least favored areas or zones of marginal agricultural production. These are areas which have the weakest natural resource endowments, the least political power, and are the most remote from markets. Moreover, least favored areas are areas at risk of getting stuck in a poverty trap which prevents them taking advantage of emerging opportunities (ibid).

According to Pender *et al*. (2001) there is a strong interrelation between problems of poverty, low agricultural productivity, and natural resource degradation in less-favored areas of the tropics. However, addressing the complex challenges of less-favored areas will not be easy or inexpensive. More critically, it requires policy and institutional reforms; investments in agricultural research; development in rural infrastructure and the active involvement of local communities are among others. The authors further explained that ecological and geographic constraints of location are major contributors to the spatial concentration of rural poverty. Indeed, most of the rural poor worldwide are found in those least favored areas where natural and human factors combine to constrain agricultural production and market access (ibid).

It is indicated that in Ethiopia, the problems of widespread land degradation in all regions combined with recurring drought constitute one of the most serious problems facing the country's agriculture. It is more pronounced particularly in the highlands where most agricultural production takes place. It is also further mentioned that while more than 85 percent of the land is moderately to very severely degraded, about 75 percent is affected by desertification.

In the Ethiopian highlands the problem of land degradation stems mainly from poor land-use practices and population pressure (ibid). The production system in the highlands is mainly rain fed, subsistence-based and smallholder-oriented. Furthermore, population and livestock pressures have decreased the size of land holdings, including both arable and pasturelands, leading to conversion of forested and marginal areas into agricultural lands and low level of crop productivity (Hoekstra *et al.*, 1990 cited in Bishaw, 1993; Bishaw, 1993; Anage, undated). In Bishaw (1993) it is also indicated that soil degradation in Ethiopia is a direct result of past agricultural practices in the highlands. Some of the farming practices within the highlands encourage erosion. These include cultivation of cereal crops such as *teff (Ergrostis tef)* and wheat (*Triticum sativumt*) which require the preparation of a finely tilled seedbed, the single cropping of fields, and down-slope final plowing to facilitate drainage.

2.2 EFFICIENCY IN AGRICULTURAL PRODUCTION

In economics, the term efficiency is commonly used in a variety of settings which includes aspects such as efficient price, efficient markets and efficient firms among others. Efficiency in production refers to scarce resources being used in an optimal fashion. In production economics, efficiency can be understood in terms of a firm's ability to convert inputs into outputs and respond optimally to economic signals or prices.

The question of efficiency in resource allocation in traditional agriculture is crucial. It is widely held that efficiency is at the center of agricultural production. This is because the scope of agricultural production can be expanded and sustained by farmers through efficient use of resources (Ali, 1996; Udoh, 2000; Hailu *et al.*, 2005). For these reasons, efficiency has remained an important subject of empirical investigation particularly in developing economies where majority of the farmers are resource-poor (Umoh, 2006).

The crucial role of efficiency in increasing agricultural output has been widely recognized by researchers (for example, Hailu *et al.*, 2005; Ozkan *et al.*, 2009 and Ghorbani *et al.*, 2009 among others) and policy makers alike. Because, efficiency of a farm is an indicator to its success in producing as large amount of output as possible given a set of inputs. Moreover, for determination of efficiency of a particular firm, there is a need for efficiency measurement through the production factor inputs and processes (Omonona *et al.*, 2010).

The history of efficiency measurement in microeconomics goes back to Farrell (1957) who defined a simple measure of firm efficiency. In the approach, Farrell (1957) proposed that efficiency of any given firm is composed of technical and allocative efficiencies. According to Farrell (1957), technical efficiency (TE) is associated with the ability of a firm to produce on the iso-quant frontier while allocative efficiency (AE) refers to the ability of a firm to produce at a given level of output using the cost-minimizing input ratios. Thus, economic efficiency (EE) can be defined as the capacity of a firm to produce a predetermined quantity output at a minimum cost for a given level of technology.

However, over the years, Farrell's methodology had been applied widely in diverse industries and organizational structures. The methodology was also undergoing many refinements and improvements through major theoretical and empirical research advancements occurred in late 1970's (Hailu *et al.*, 2005). One of such improvements is the development of stochastic frontier model which enables one to measure farm level technical and economic efficiency using maximum likelihood estimate. Aigner *et al.* (1977) and Meeusen and Van den Broeck (1977) were the first to propose stochastic frontier production function and since then many modifications had been made to stochastic frontier analysis.

According to Okoruwa *et al.* (2006), the measurement of farm specific technical efficiency is based upon deviations of observed output from the best production or efficient production frontier. If a farm's actual production point lies on the frontier it is perfectly efficient. But, if it lies below the frontier then it is technically inefficient. The ratio of the actual to the potential production levels of a farmer defines the level (scores) of technical efficiency (ibid). An economically efficient input-output combination would be on both the frontier function and the expansion path (Ogundari and Ojo, 2006).

According to Ozkan *et al.* (2009) interpretation of efficiency in agriculture is also as important as the evaluation of agricultural outputs with respect to diverse range of inputs used. The researchers further indicated that the process of transformation of inputs to outputs has a vital role in interpretation of success of a production system. The success of the process can be explained through productive or economic efficiency (ibid). Moreover, for all agricultural sectors to remain competitive in the market and be profitable, achieving a high level of technical efficiency is of prime importance (Ghorbani *et al.*, 2009).

Therefore, achievement of higher productivity levels and sustainable resource utilization in the agricultural sector necessitates smallholder producers to be economically efficient. This ultimately makes smallholder farmers competitive in market-oriented crops production. Furthermore, achieving high level of resource use efficiency hence increase in productivity in smallholder agriculture would help to avoid the expansion of marginal lands in Ethiopia.

2.3 EMPIRICAL ESTIMATION APPROACHES TO EFFICIENCY

A number of methods have been developed either parametric (econometric) or non-parametric (mathematical programming) to estimate efficiencies in firms/farms. These include stochastic frontiers which adopt production, cost or profit functions and data envelopment analysis (DEA) and a number of versions of DEA in the efficiency estimation process. According to Mersha (2004), considerations such as the type of data, the underlying behavioral assumptions of firms, the relevance to consider and extent of noise in the data and the objective of the study determine the selection of specific frontier model.

2.3.1. STOCHASTIC FRONTIER APPROACH (SFA)

The Stochastic frontier Approach (SFA) was developed independently by Aigner *et al.* (1977) and Meeunsen and Van den Broeck (1977). SFA is a parametric method where the error term is decomposed in a regression model into inefficiency component and measurement error component; $\varepsilon ij=vij-uij$ where εij is the error term, vij the measurement error, and uij the inefficiency component. The model is recommended when analyzing farm level data where measurement error, some missing information and presence of risks factors are likely to have a significant impact (Coelli, 1996). SFA approach can be extended to measure inefficiencies in individual production units based on some distributional assumptions for the uij on the technical and economic inefficiency scores. These assumptions are based on functional forms used in the analysis; half normal distribution for Cobb-Douglas forms, truncated normal for Trans-logarithmic forms and exponential distribution for generalized Leontief models (Mbaga *et al.,* 2003). The models for SFA allow for estimation of standard errors and tests of hypotheses using maximum likelihood methods which cannot be possible with deterministic models because they violate certain maximum likelihood assumptions (Jondraw *et al*., 1982 and Ali and Flinn, 1989). However, a serious shortcoming with SFA is that there is no priori justification for the selection of any particular functional form for the inefficiency component. In parametric frontier methodology the selection of specific functional form may not represent the reality (Mersha, 2004). Moreover, Coelli *et al.* (1998) indicated that the SFA is appropriate for single-output technologies; unless cost-minimizing objective is assumed.

2.4 DETERMINANTS OF EFFICIENCY

Efficiency estimation without clearly identifying important socio economic and demographic, institutional and policy variables, has limited importance for policy and management purposes. Thus, in this study, identification and analysis of the underlying factors of inefficiency was given priority. Previous empirical studies on agricultural resource use efficiency by Okoye *et al.* (2007), Javed (2009), Alemdar and Ören (2006) and Nyagaka *et al.* (2010) among others were reviewed for better information regarding the selection of determinants for analyses.

In an empirical study by Okoye *et al.* (2007) to determine economic efficiency in small-holder cocoyam farmers in Anambra state, Nigeria, the determinants of economic efficiency were modeled in terms of socio-economic variables of the farmers and other farmer related factors. The study found that whereas age, level of education and farm size to be negatively and significantly related to economic efficiency; farmer's farming experience and fertilizer use were significantly and positively related to economic efficiency.

Javed (2009) determined efficiency of cotton-wheat and rice-wheat systems in Punjab, Pakistan, considering socioeconomic and farm specific factors which were as likely to affect the level of technical, allocative and economic inefficiency. Accordingly, in order to identify sources of technical, allocative and economic inefficiency, inefficiency scores were regressed on socio-economic and farm specific variables, using Tobit regression model. The result indicated that years of schooling, contact with extension agents and access to credit variables were negatively related to inefficiency. On the other hand, age of farm's operator and farm to market distance variables are positively related with the technical inefficiency of farms in cotton-wheat system.

Alemdar and Ören (2006) identified the determinants of technical efficiency of wheat farming in southeastern Anatolina, Turkey. The authors used DEA technique to estimate the level of technical efficiency scores and Tobit regression model to determine source of efficiency. The result showed that there is considerable scope for cost reduction in the region. They also found that land fragmentation was the main determinant of technical inefficiency.

Chirwa (2007) estimated technical efficiency among smallholder maize farmers in Malawi and identified sources of inefficiency using plot-level data. The researcher found that smallholder farmers in Malawi are inefficient. The result revealed that inefficiency declines on plots planted with hybrid seeds and for those controlled by farmers who belong to households with membership in a farmers association or club.

3. METHODOLOGY

3.1 DESCRIPTION OF STUDY AREA

Ethiopia has the largest highland areas (defined as areas above 1500 meters above sea level) in the African continent, constituting about half of the country. The highlands are home to about 90% of the total population (ILCA, 1983). The highlands also contain over 95 percent of the regularly cropped areas and around two-thirds of the livestock. Moreover, it is estimated that 90 percent of the country's economic activity and gross domestic product are generated from these highlands (Constable, 1985 cited in Bishaw, 1993).

Distinguished by small, undulating mountains with low vegetation cover, Alamata has an altitude which ranges between 1178 to 3148 meters above sea level, which drain into the Alamata Valley. Eight of the peasant associations are located in the Valley, while two are located in the intermediate highlands which have elevations ranging between 1500 and 3148 meters. The study area, Alamata woreda, is located at 600 km north of Addis Ababa and about 180 km south of the capital of the Tigray Region Mekelle. It is the south most woreda of the Tigray Region and borders with the Amhara Region from the south and west and the Afar Region from the east.

Based on the 2007 national census conducted by the Central Statistical Agency of Ethiopia (CSA), this woreda has a total population of 85,403, an increase of 26.56% over the 1994 census, of whom 42,483 are men and 42,920 women; 4,563 or 5.34% are urban inhabitants. With an area of 1,952.14 square kilometers, Alamata has a population density of 43.75, which is less than the Zone average of 53.91 persons per square kilometer. A total of 20,532 households were counted in this woreda, resulting in an average of 4.16 persons to a household, and 20,107 housing units. 80.27% of the population said they were Orthodox Christians, and 19.68% were Muslim.

The 1994 national census reported a total population for this woreda of 93,659 of whom 45,521 were men and 48,138 were women; 32,229 or 34.41% of its population were urban dwellers. The three largest ethnic groups reported in Alamata were the Tigrayan (62.19%), the Amhara (33.91%), and the Oromo (2.24%); all other ethnic groups made up 1.66% of the population. Tigrinya was spoken as a first language by 61.36%, 36.48% Amharic, and 1.36% spoke Oromo; the remaining 0.8% spoke all other primary languages reported. 78.35% of the population practiced Ethiopian Orthodox Christianity, and 21.45% were Muslim.

Concerning education, 14.76% of the population were considered literate, which is less than the Zone average of 15.71%; 20.65% of children aged 7-12 were in primary school; 3.09% of the children aged 13-14 were in junior secondary school; 3.38% of the inhabitants aged 15-18 were in senior secondary school. Concerning sanitary conditions, about 91% of the urban houses and 43% of all houses had access to safe drinking water at the time of the census; about 31% of the urban and 12% of the total had toilet facilities.

A sample enumeration performed by the CSA in 2001 interviewed 18,422 farmers in this woreda, who held an average of 0.84 hectares of land. Of the 15,533 hectares of private land surveyed, 98.16% was in cultivation, 0.03% pasture, 0.5% fallow, 0.27% woodland, and 1.04% was devoted to other uses. For the land under cultivation in this woreda, 91.67% was planted in cereals like teff and sorghum -- although barley is the dominant crop in hgiher elevations -- 5.54% was in pulses, 31 hectares in oilseeds, and 33 planted in vegetables. The area planted in fruit trees was 43 hectares, while none were planted in gesho. 61.26% of the farmers both raised crops and livestock, while 23.92% only grew crops and 14.82% only raised livestock. Land tenure in this woreda is distributed amongst 72.66% owning their land, and 27.25% renting; the number held in other forms of tenure is missing. *Parthenium hysterophorus* (or Congress weed) is reported to be an increasing threat to cereal production in Alamata, as well as in the adjacent woreda of Kobo in Amhara Region. Cash crops include field peas, faba beans, lentils, teff and peppers.

3.2 DATA COLLECTION

In this study, primary data was used and data was collected through field survey and household interviews using a structured questionnaire. The questionnaire is structured in such a way that the first part will cover the socio-economic variables such as the age of the household head, size of the household, off-farm income, gender etc. The second part deals with the factors of production such as, land, labor, cost of farming hours and materials use such as fertilizer and seed, and the last part focus on the collection of marketing information regarding where they buy their inputs and where they sell their output.

3.3 SAMPLING

The study used purposive and snowball sampling techniques. The purposive sampling method used to interview only households who produce Teff, since the main purpose of the study is to analyze the technical efficiency of small-scale Teff producers. Snowball sampling used by the researchers to identify households that produce Teff; once the researchers have identified one household it becomes easier to identify the next. The respondents were the ones indicating who produced Teff as they knew who was engaged in what activity in the community.

For the present study, a sample size of 267 households were used. To address these households, from each Tabia, proportionate (5% from each Tabia) sample households were selected using systematic random sampling technique from the list of households in each Tabia.

TABLE 1: DISTRIBUTION OF SAMPLED HOUSEHOLDS IN THE STUDY AREA, ALAMATA WOREDA, 2010

PA list	Total Households	Sample size
Timuga	2718	136
SelamBikalsi	1516	76
Garjale	1103	55
Total		**267**

3.4 ANALYTICAL METHODS

a) Descriptive statistics

The purpose of using this type of analytical tool is to summaries the data by describing the basic features of the data in the study, and to provide simple summaries of the variables and measures.

b) Cobb-Douglas production function

Cobb-Douglas production function were used to analyze the variables that have effect on Teff production, and this analytical technique will be used to determine the technical efficiency of small-scale Teff producers in Alamata.

A Cobb-Douglas production function will be used as the functional form of the production function. The reason for choosing this type of production function is that it is linear in its logarithmic form, and allows for the usage of Ordinary Least Squares (OLS). At the same time, this function type has been widely used for production function analysis by many researchers.

The theoretical Cobb-Douglas production function is expressed as follows:

$$Y = AL^{\alpha}K^{\beta}u$$

Where: Y= output, A= constant, L= labor , K= capital, U = disturbance term

For constant returns to scale, the sum of the parameter coefficients, β and α must be equal to one (1). For increasing returns to scale, they must be greater than one, and for decreasing returns to scale they must be less than one. In mathematical form, the returns can be expressed as follows:

$$\alpha = \frac{\delta Y / Y}{\delta L / L}$$

$$\beta = \frac{\delta Y / Y}{\delta K / K}$$

Where β and α are the elasticities of production with respect to labor and capital.

These are considered the most important properties of the Cobb-Douglas production function.

However, the Cobb-Douglas production function model has a number of limitations.

The major criticism is firstly that it cannot represent all the three stages of Neo-classical production function, representing only one stage at a time. Secondly, the elasticities of this type of a function are constant irrespective of the amount of input used. However, regardless of these limitations, the Cobb-Douglas production function will be used for its mathematical simplicity, and the functional forms have limited effect on empirical efficiency measurement. It is also not exclusive to labor and capital but to other variables.

The operational model for this study relating to the production of Y, to a given set of resources X, and other conditioning factors is given as follows:

$$Y = aX_1^{\beta_1}X_2^{\beta_2}X_3^{\beta_3}X_4^{\beta_4}X_5^{\beta_5}e$$

Where

Y is total quantity of Teff produced (in kg)

X1 is land devoted (in hact)

X2 is family and hired worker days used (man days)

X3 is capital (Birr)

X4 is fertilizer used (in kg)

X5 is seed used (in kg)

And a, β1….. β5 are parameters to be estimated.

u is error term.

In order to use the Ordinary Least Squares procedure, the Cobb-Douglas production function will be linearlized using logarithms.

Taking logarithms on both sides, the model will be:

$$\ln Y = \ln(a) + \ln\beta_1 X_1 + \ln\beta_2 X_2 + \ln\beta_3 X_3 + \ln\beta_4 X_4 + \ln\beta_5 X_5 + u$$

LOGISTIC REGRESSION MODEL

This study also used the logistic regression model to supplement the Cobb-Douglas production model as it only concentrates on the production of variables/efficiency, while logistic regression model deals with the socio-economic factors. The logistic regression model is chosen because its dependent variable is binary and can only take two values. Also, it allows one to estimate the probability of a certain event occurring. A logit model is also generally preferred to the probit model due to its simpler mathematical structure.

The logit model is based on the accumulative distribution function and yields results that are not sensitive to the distribution of the sample attributes when estimated by maximum likelihood.

The operational logit model can be written as follows:

$$Logit(p) = \ln(p/1-p) = \alpha + \beta_1 X_1, + ----+ \beta_k X_k, i$$

The ratio p/1-p is the odds ratio

Pi = probability that a farmer is efficient.

1-Pi = probability that a farmer is not efficient

Xi = various independent variables.

βi = estimated parameters.

Ui = disturbance term.

Operational model:

To examine the impact of socio-economic factors on efficiency of small-scale teff producers at Alamata, the following linear equation is specified.

$$EFF = \beta_0 + \beta_1 gend + \beta_2 age + \beta_3 edu + \beta_4 hhs + \beta_5 inch + \beta_6 far\exp + \beta_7 farsz$$
$$+ \beta_8 hirlab + \beta_9 tract\cos + \beta_{10} fertust + \beta_{11} purch + \beta_{12} frorg + \beta_{13} mprof + u_i$$
$$\ln(a) + \ln\beta_1 X_1 + \ln\beta_2 X_2 + \ln\beta_3 X_3 + \ln\beta_4 X_4 + \ln\beta_5 X_5 + u$$

4. RESULTS AND DISCUSSIONS

4.1 INTRODUCTION

In this chapter, we briefly summarize the results from the descriptive statistical analysis. These results indicate the frequency, percentage and the mean of some variables. We use the descriptive statistics for the simple reason that we want to describe the basic features of the data in the study area and provide simple summaries of the variables and measures. Next to this, the results from Cobb-Douglas Production Function model and the Logistic Regression model will be addressed. The estimates in both models are estimated using the STATA 9.0 version.

4.2 DESCRIPTIVE STATISTICS

As discussed above, this part deals with the results from the descriptive statistics using frequency and mean values are indicated using figures and tables. Thus, the mean value of the main variables is summarized in table 4.1, the summary of land size devoted for farm production is presented in table4.2 and the amount of seeds applied per hectare of land is summarized using the pie chart in Figure 4.1. On the other hand, the subsequent figures indicated the summary of demographic characteristics of the respondents such as education, gender and type of labor employed on the farm, etc.

TABLE 4.1: MEAN DESCRIPTIVE OF VARIABLES

Variables	Mean	Standard Deviation
age (years)	51.14	14.031
labor (man days)	112.32	27.92276
hhs (numbers)	5.62	2.099
farexp (years)	23.86	12.555
improved seeds (kg)	17.08	6.403
land (ha)	1.1521	0.46776
fertilizer (kg)	53.75	0.1356

Source: survey 2013

The average man days used for labor are estimated to be 112.32 days per hectare. These include both hired labour and family labour. Labour is the most important input for Teff production, especially with small-scale farmers. The household size plays an important role in Teff production and most farmers depend mainly on family labour. The results show that the average household size is 5.62, which mathematically represent 6 members per household.

This shows that farmers can have easy access to additional labour from family members.

The majority of small-scale farmers are older people, which means the older you get the more experience you have with regard to farming. The average farming experience is about 23.86 years, which is practically 24 years meaning it plays a role in the production of Tefff as experience enables a farmer to change methods of planting without increasing inputs. It also shows that Teff production has been in existence for a number of years as the majority of the small-scale farmers have been in Teff production for more than 20 years. The age of the farmer is an important factor of production as older people tend to be resistant to technical efficiency, preferring to use old methods of planting. It is assumed that older farmers are more experienced in farming activities and are better able to assess the risks involved in farming than younger farmers. The average age of the farmers is 51.14 years old. This indicates that older people are the ones participating in agricultural production.

The average seeds used by the farmer per ha is about 17.08 kg, while they own around 1.15 ha of land on average used for the production of Teff. This land was given to them by the traditional authority. Most of the small-scale farmers in the study area use fertilisers, whereas those who does apply about 53.75 kg on average per farm size.

4.2.1 LAND DEVOTED TO TEFF PRODUCTION/FARM SIZE

Farm size has an influence on technical efficiency and the total output of Teff production. Land plays an important role in farming. The size of the farm is based on the size of land used by the household for Teff production. Most of the farmers have limited access to enough land.

TABLE 4.2: LAND DEVOTED TO TEFF PRODUCTION/FARM SIZE

Farm size (ha)	Percentage (%)
0.5	11.25
1	18.75
1.5	26.6
2	43.4

Source: survey 2013

As can be seen from table 4.2 above, the results show that majority of the farmers own about 2 hectare of land that they use for Teff production, which is about 43.4% of farmers, followed by 26.6% of farmers owning about one and half hectare of land, 18.75% of farmers owning one hectare of land and 11.25% owning

0.50 hectares of land. These results indicate that technical efficiency is mainly affected by the farm size as some farmers do not own the land they are using for production processes.

4.2.2 SEEDS USED PER HECTARE

Farmers are not obliged to use a certain amount of kilogramme of seeds per hectare.

Any amount of seeds can be used. Most small-scale farmers who practice subsistence farming do not buy certified seeds, but they use recycled seeds that are stored after every harvest, while others buy recycled seeds from their fellow farmers.

This practice affects the crop output every year in terms of quantity as well as quality.

FIGURE 4.1: SEEDS USED PER HECTARE

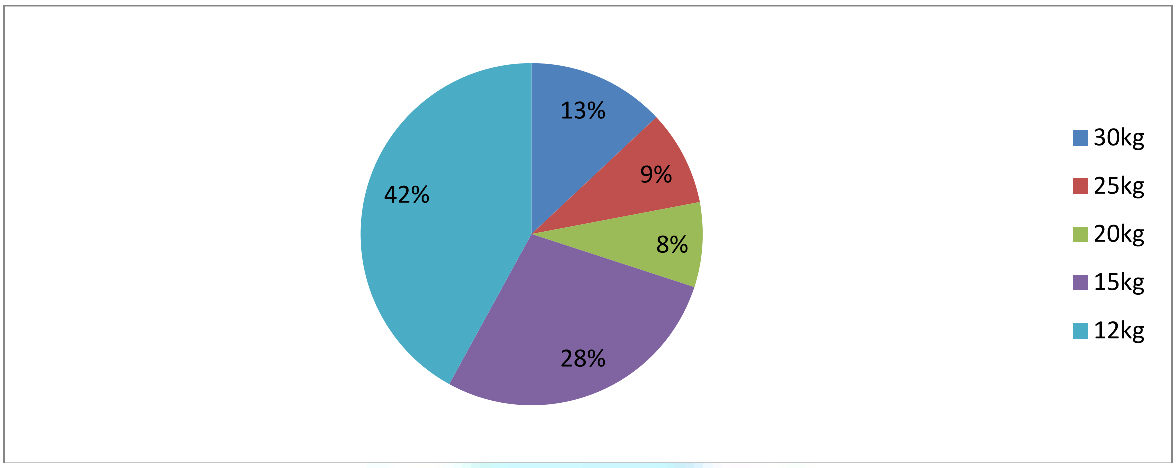
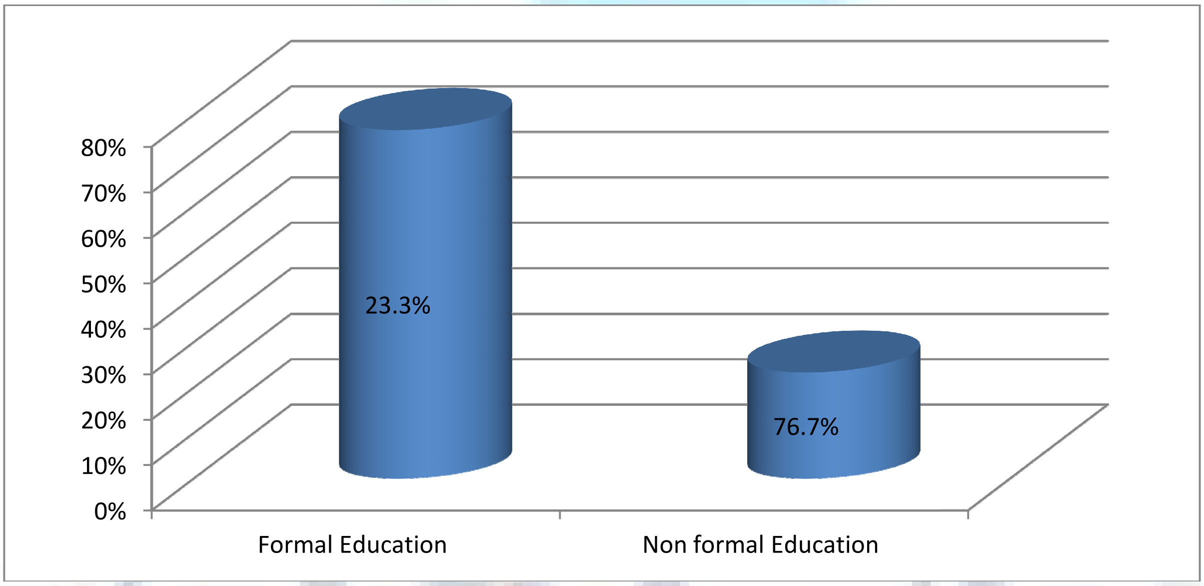


Figure 4.1 indicates the different kilogrammes of seeds applied per farmer in the production of Teff. About 42 % of farmers apply 12kg of seeds, 28 % apply 15 kg, 30 kg is applied by 13 %, while 9% of farmers apply 25 kg and 20 kg of seeds is applied by 8%. The different amount of seeds applied depends on the size of the farm as Teff production ranges from 0.5 ha to 2 ha of land.

4.2.3. LEVEL OF EDUCATION OF THE HOUSEHOLD HEAD

Education potentially enhances farm efficiency and knowledge with regard to agricultural production. Educated farmers are able to apply better farming methods. They are also better placed to try newer forms of farming.

FIGURE 4.2: LEVEL OF EDUCATION OF THE HOUSEHOLD HEAD



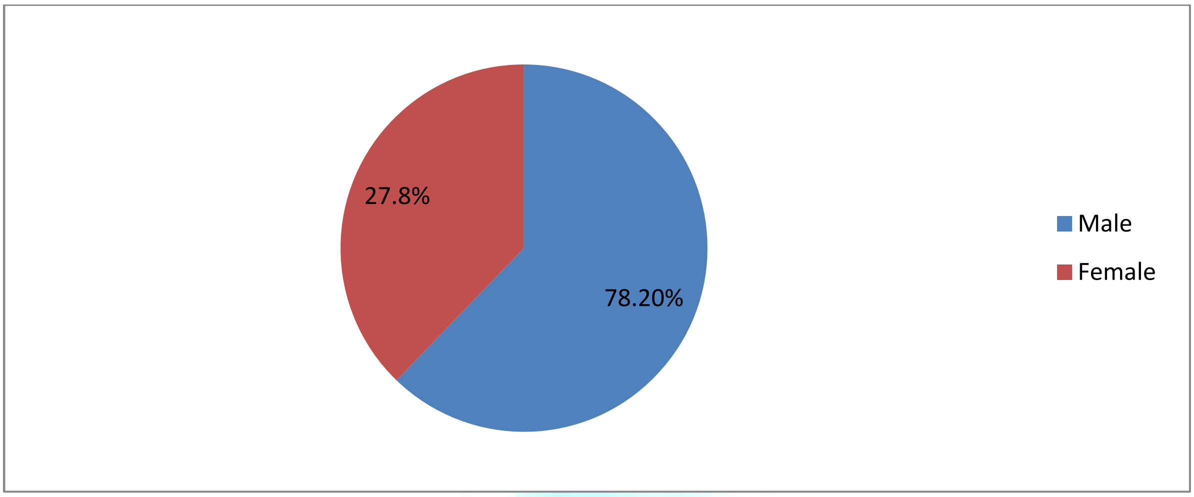
Source: Survey 2013 and own drawing

The above results in figure 4.2 indicate that 76.7 % of farmers had non- formal education, with 23.3% attaining formal education, which includes primary education, followed by secondary education, tertiary and Golmasoch Timhrt (Adult Based Education and Training). The majority of the farmers had primary education, with very few obtaining tertiary education, which means most of them are literate. In order for farmers to improve their standards of living, education is of crucial importance.

4.2.4 GENDER OF THE HOUSEHOLD HEAD

Small-scale farming is mainly dominated by males, as many households are headed by men. Thus, small-scale farmers in Ethiopia are men who farm to support their families.

FIGURE 4.3: GENDER OF THE HOUSEHOLD HEAD

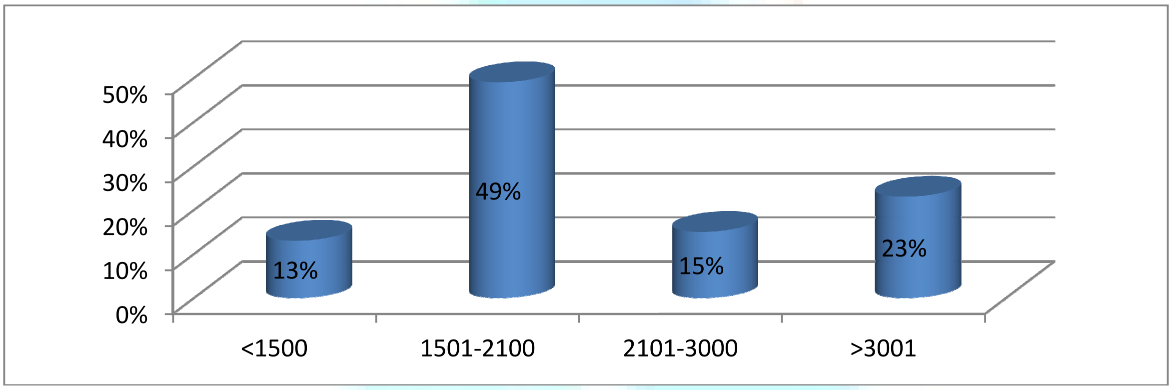


The results in figure 4.3 indicate that only 27.8 % (68) out of 100 are female farmers and 78.2 % (182) are male farmers. Reducing inequalities in human and physical capital between male and female farmers will potentially increase output and technical efficiency will improve because of the joint efforts.

4.2.5 INCOME OF THE HOUSEHOLD ON MONTHLY BASIS

Since the age of most farmers is between 25 and 67, it means that they mainly depend on remittance and off-farm incomes for household income. This income plays a vital role in Teff production as they have to invest in capital inputs such as hiring tractor or labour. Without these financial input farmers cannot maintain the required standard of technical efficiency.

FIGURE 4.4: MONTHLY HOUSEHOLD INCOME



The results in figure 4.4 show that 13 % of the farmers get less than ETB1500 monthly, with the majority 49 % of farmers earning between ETB 1501 and ETB 2100 at 49 %, and 15% of the farmers earning between ETB 2101 to R3000 monthly, while 23 % of the farmers earned more than ETB 3001. Since farming is dominated by older people who mainly depend on old age social grant or child grant for some, it indicates that farmers with less off-farm income are heavily dependent on farming, unable to buy the necessary inputs, and adversely affecting efforts to increase output and thereby limiting farmers from increasing their technical efficiency levels.

4.2.6 FARM LABOUR

Even though small-scale farmers mainly depend on family labour, they still hire labour to add to the family labour. Usually one or two people are hired. Farmers with smaller family size are the ones who usually hire labour. Hired labour helps in accelerating production at the various stages of farming.

FIGURE 4.5: FARM LABOUR

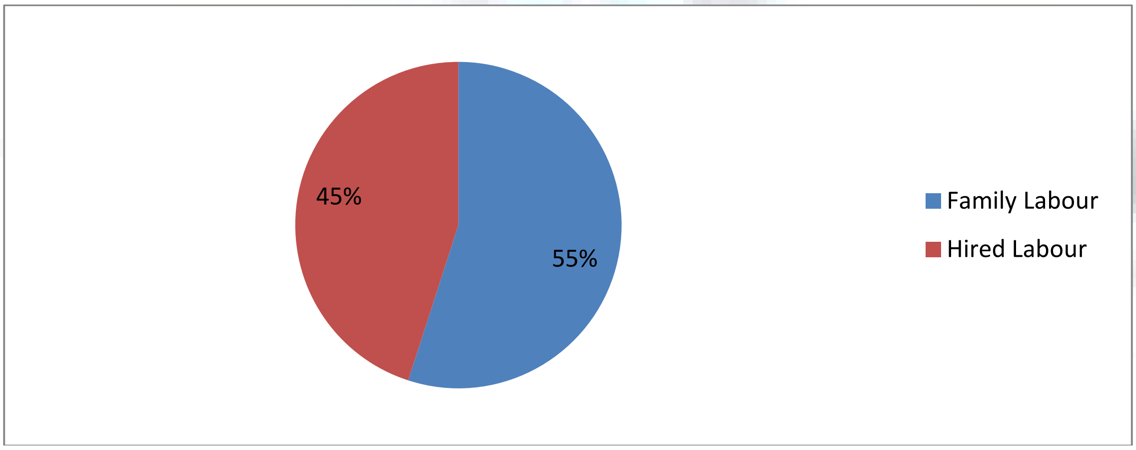
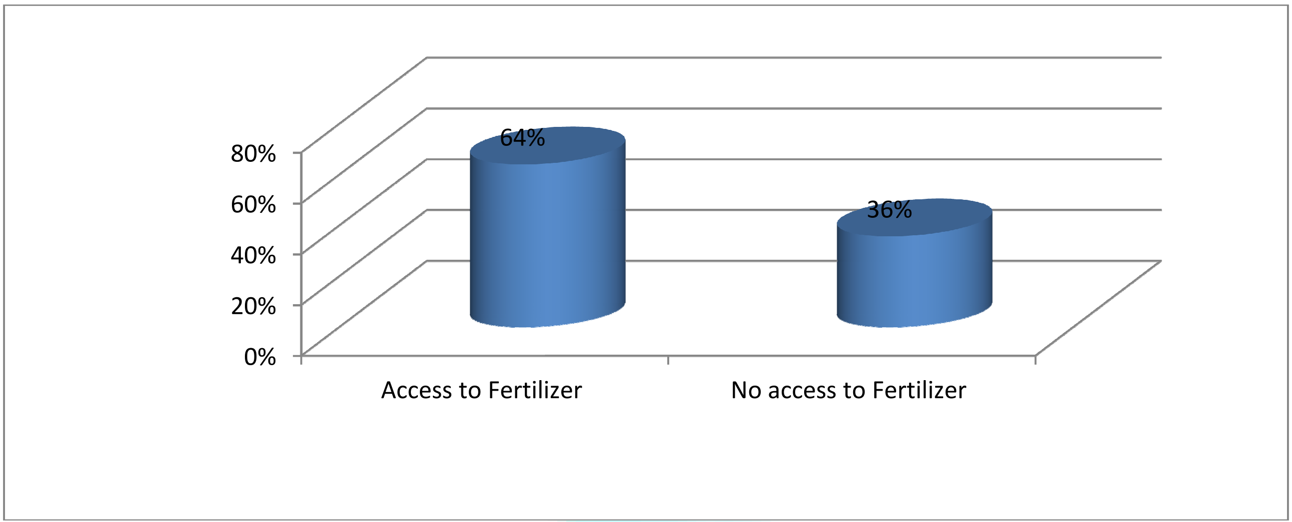


Figure 4.5 shows that 55 % of the farmers agree that most farmers depend on family labour since they do not hire labour, while 45% of the farmers hire labour. Family labour tends to influence the technical efficiency of small-scale Teff producers as they have the best interest of the farmer/household at heart unlike hired labour.

4.2.7 FERTILIZER APPLICATION IN TEFF PRODUCTION

Fertilizer plays a vital role in Teff production as no matter how large and small the farm size is, if applied properly yields will increase. Small-scale farmers tend to have difficulties in obtaining fertilizer as they lack financial means.

FIGURE 4.6: FERTILIZER APPLICATION IN TEFF PRODUCTION

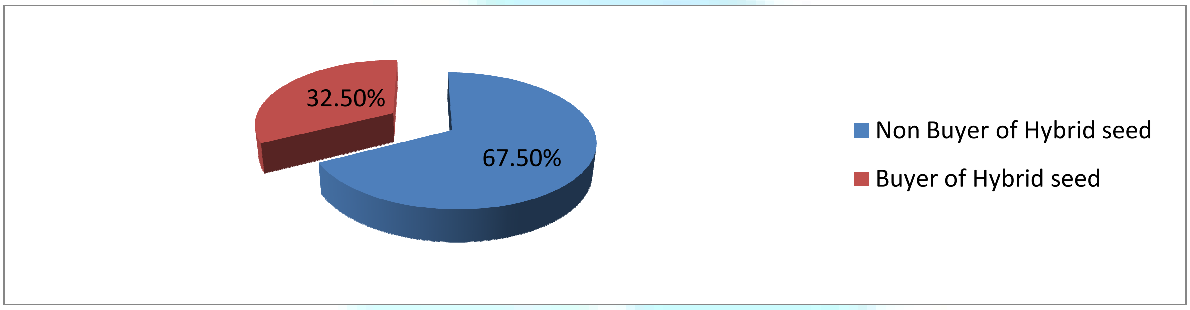


The above results indicate that about 64 % of the farmers do apply fertiliser in Teff production. This includes even those farmers using manure and readymade fertilizer. About 36% of farmers have no access to fertilizer. This can be due to lack of funds to buy and transport fertilizer. The non-application of fertilizer certainly influences technical efficiency.

4.2.8 PURCHASED HYBRID TEFF SEEDS

Hybrid Teff seed plays an important role in Teff production since it has been assumed that 1ha of land can produce 1tonne of Teff with the use of hybrid seeds which are fortified to increase the yields of Teff. Most small-scale farmers use the same seed they used previously. After harvesting they store some of the Teff in order to use it in the next planting season, a practice which hampers the effort of trying to increase productivity.

FIGURE 4.7: PURCHASED HYBRID TEFF SEEDS



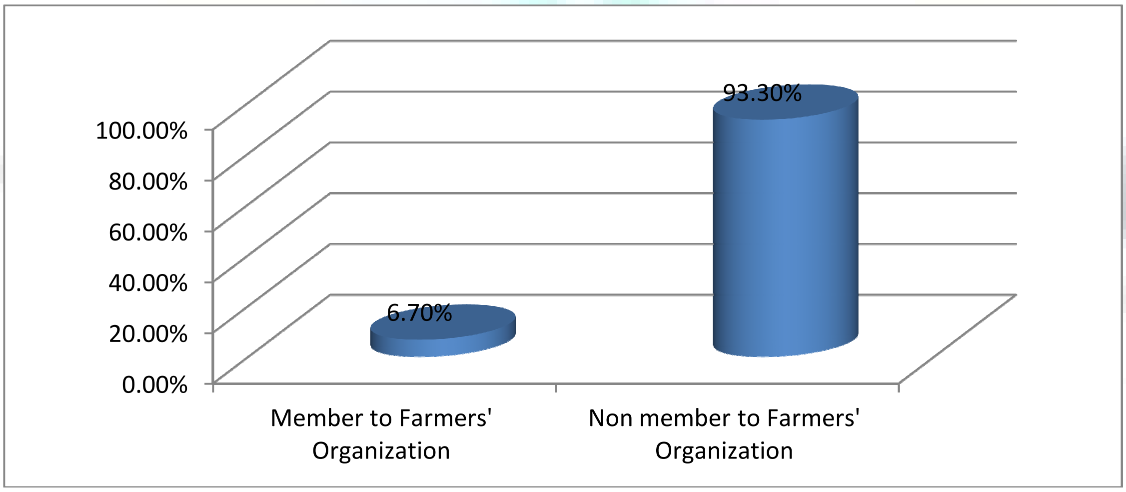
The results show that 32.5 % of the farmers buy hybrid Teff seed. These are not the accurate numbers since some farmers buy used seed from their fellow farmers, indicating that those seeds are more affordable than the ones sold at cooperatives.

About 67.5 % of the farmers are not purchasing hybrid seed at all; they use their own recycled seed instead. Such practices hinder farmers from increasing their technical efficiency through attaining maximum output with available resources.

4.2.9 MEMBERSHIP TO FARMERS` ORGANIZATION

Farmers` organizations play an important role in organizing members into input cooperatives and in creating access to financial services from state and nongovernment organization (NGO) sectors and seeking access to other financial development agencies. This is an important factor affecting technical efficiency. With availability of finance much can be done to improve crop production.

FIGURE 4. 8 MEMBERSHIP TO FARMERS` ORGANIZATION



The results show that farmers who are members of farming organizations are rather small as compared to those farmers who are non-members, with only 6.7% farmers being members and 93.3% who are non-members of farming organizations. For small-scale farmers it is important for them to form part of an organization in order for them to get access to credit which they can use to buy new improved inputs, especially seed to increase technical efficiency. Since inputs are expensive they can form a group and buy in bulk as it becomes cheaper compared to individual purchases. They can also have access to extension officers as they are able to help a group of farmers and not individuals.

4.2.10 TEFF PROFITABILITY

Profit from Teff production is likely to influence the farmer`s technical efficiency. If there is no profit, naturally the farmer will not invest. Since Teff is a staple food it can be profitable or not. Figure 4.9 below indicates how the profitability of Teff is distributed amongst small scale farmers.

FIGURE 4.9: FARMERS' PERCEPTION ON TEFF PROFITABILITY

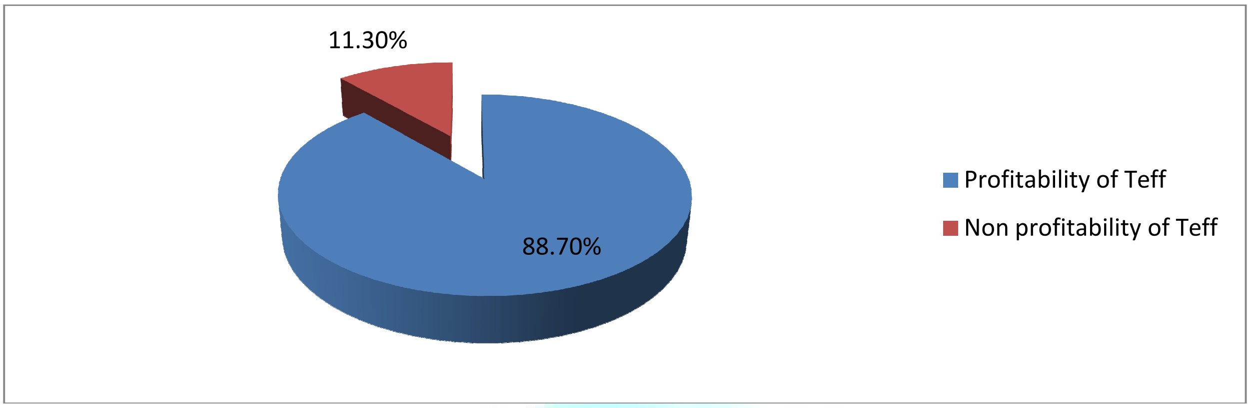


Figure 4.9 indicates that 88.3 % of the farmers see Teff as a profitable product as they no longer buying Teff meal from shops. They process their own Teff product after harvest through the miller, and the processing cost is reasonable. However, 11.7 % perceive Teff as not profitable. For the small-scale farmers it is very important to know if Teff is profitable or not in order to make informed choices with regard to production inputs. This variable has a relationship with the surplus output after consumption.

4.3 COBB-DOUGLAS PRODUCTION FUNCTION MODEL RESULTS

Table 4.2 presents the results of a Cobb-Douglas production function as described in chapter 3. The main reason for using Cobb-Douglas production function is to determine the technical efficiency of Teff production by small-scale farmers in Raya Alamat District. There are a number of variables that are known to affect agricultural production. As a result, it is important to use a model that relates production to those variables for better understanding of the functional relationships.

The results indicate that out of 5 variables/inputs used in the Cobb-Douglas, 3 were found to be significant with 1 being negatively significant. This implies that there is an input to output relationship. Paragraphs below Table 4.2 interpret the Cobb-Douglas results.

TABLE 4.3: COBB-DOUGLAS PRODUCTION FUNCTION MODEL RESULTS

Variable	Standard Error	Coefficient of Elasticity	t-ratio
Constant	190.598		2.990
Land (ha)	60.158	0.276***	3.090
Fertilizer (kg)	0.745	0.247**	2.807
Capital (Birr)	0.363	0.177*	1.992
Labour (man days)	0.998	-0.047	-0.535
Seeds (kg)	4.314	0.099	1.127
Sum of β`s	0.398		
Adjusted R^2	0.564		

*, **, *** Significant at 10%, 5% and 1% respectively

4.3.1 ELASTICITY OF PRODUCTION

The results in Table 4.3 show that the estimation of the production function resulted in adjusted R^2 of 0.564, indicating that the independent variables included in the model explain about 56 percent of the variation in the Teff production in Raya Alamata. It sounds that some relevant social factors were not included in the model such as farmers farming experience. However, according to Coudere and Marijse (1991), as cited by Mushenje and Belete (2001), an adjusted R^2 of 0.54 is a good result for the regression of cross- sectional data.

4.3.2 LAND DEVOTED TO TEFF (HA)

The result shows that access to land is important explaining the differentiation in output of each farmer. Land elasticity is positive and significant at 1 % level. This implies that an increase in one hectare of land can result in 28 % increase in the total production of Teff, which means the variable land is more sensitive to the production of Teff.

4.3.3 FERTILISER USED PER FARM (KG)

The elasticity of fertiliser is positively significant at 5 % level, even though not all small-scale farmers have access to fertiliser. The implication is that input contributes positively to the production of Teff in Raya Alamata. The results show that output is more sensitive to fertiliser, which implies that a one percent increase in the quantity of fertiliser used will lead to 24.7 % increase in the total output of Teff. It simply means that fertiliser used by small-scale farmers in the production of Teff is more effective and efficient. At this stage farmers are under-utilising fertiliser.

4.3.4 CAPITAL (BIRR)

Cost of tractor hours was used as a proxy for capital. The elasticity coefficient of capital is positive and it is significant at 10 % level, which explains that the input is important but farmers are under-utilising it in the production of teff. This indicates further that small-scale teff producers at Raya Alamata operate in the stage 1 of the neo-classical production function. This implies that an increase in the use of this input leads to an increase in the level of teff production.

4.3.5 LABOR (MAN DAYS)

The elasticity of labour is negative and not significant in the production of teff. It means input is not used efficiently. The result indicates that farmers are over-utilising this input, implying that they should reduce the use of this input as it responds less to output, meaning a decrease by 1 % of this variable will result in a 5 % decrease in the output losses. The negative sign implies that an increase in the use of these inputs leads to a decrease in the level of teff production and technical efficiency.

4.3.6 SEEDS USED PER FARM (KG)

The elasticity of seeds is positive, but lower and not significant. The results indicate that farmers are under-utilising this variable. It further means one percent increase in the quantity of seed for teff, holding all other inputs constant, will results in 10.8 % increase in teff output. The variable "seed" is sensitive to the total output of teff, meaning that there is an input to output relationship.

4.3.7 RETURN TO SCALE

For constant return to scale, the sum of the technical coefficients β and α must be equal to one (1), for increasing return to scale, they must also be greater than one, and for decreasing return to scale they must be less than one (1). The regression results as shown in Table 4.3, the sum of β`s is less than one (1), simply indicating that a decreasing return to scale. This maybe implying that the resources used for the small-scale teff production at household level are price output below marginal cost. It means they are over-utilised, which results in them being technically inefficient in the production of teff. Return to scale was calculated by adding up the coefficient for elasticity of each variable, the sum of β`s is used as an indicator of return to scale.

It means that the cost per unit of input used in the production process of an output of teff is more than the return from that output of teff. It indicates some inefficiency as they are spending more on inputs than they should in view of the output, given that their livelihoods depend on farming. As a result, they over-invest resources with the assumption that they can maximize output and thereby returns.

They are incentives for farmers to decrease the amount of inputs used, since farmers experience decreasing returns to scale, in order for farmers to reach the point where the cost per unit of inputs used is equal to per unit of output/returns.

4.4 LOGISTIC REGRESSION MODEL RESULTS

In this section, results of the test for significant and non-significant of the determinants of whether a farmer is efficient/not were given. Logistic model was used in Table 4.3 below which displays the estimated results for the logistic regression model to explain the socio-economic factors influencing technical efficiency of teff production. The variables which are significant and non-significant are represented.

TABLE 4.4: LOGISTIC REGRESSION RESULTS

Variable	Coefficient	Stard. error	Wald	Significant
GEND	0.427	0.547	0.009	0.435
AGE	-0.245	0.564	0.189	0.663
EDUC	0.591*	0.373	2.505	0.114
HHS	-1.465***	0.360	16.563	0.000
INCH	0.690**	0.303	5.207	0.023
FAREXP	0.042*	0.029	2.165	0.141
FARSZ	0.587***	0.182	10.365	0.001
HIRLAB	0.747	0.552	1.829	0.176
TRACTCOS	-0.016***	0.005	11.776	0.001
FERTUS	1.119*	0.618	3.277	0.070
PURCHS	-0.954*	0.647	2.178	0.140
FARORG	2.839**	0.403	4.094	0.043
MPROF	-1.433*	0.902	2.526	0.112
Constant	4.477	2.511	3.178	0.075
-2 log likelihood	99.326			
R squared	53%			
% cases correctly predicted	75.0%			
Chi squared	38.5			

*, **, *** significant at 10%, 5% and 1% respectively.

The results indicate that out of all the variables that were included in the model, most of them are significant which are: level of education (EDUC), household size (HHS) income of the household on monthly basis (INCH), farmer`s farming experience (FAREXP), farm size (FARSZ), cost of tractor hours (TRACTCOS), fertilizer application (FERTUS), purchased hybrid Teff seeds (PURCHS), membership to farmers` organization (FARORG), Teff profitability (MPROF).

This shows that these are the most major factors influencing technical efficiency of small-scale Teff producers in the study area.

The principle assumption, on which the -2 log likelihood ratio is based, is that there are socio-economic characteristics that influence technical efficiency of small-scale Teff producers in Raya Alamata. The log likelihood ratio of 99.326 in Table 4.3 rejects the null hypothesis, which reveals that there are no socio-economic characteristics that influence technical efficiency of small-scale Teff producers in Raya Alamata. The model is correctly predicted at 75 %. This implies that 25 % of the variables are insignificant but are included in the final analysis, which explains the relationship between the dependent and explanatory variables. The model chisquared at 38.5 indicates the significant of 1% level, meaning that there is a significant relationship between the independent variables and the dependent variable. Pseudo R^2 was 53 %.

Based on the regression analysis in table4.3, we are now in a position to explain the variables that are significant in the model.

LEVEL OF EDUCATION

The level of education is positive and significant at 10% level. This implies that it has a positive relationship with technical efficiency. Greater schooling could potentially enhance farm efficiency, either through acquisition of knowledge relevant to agriculture and the usage of available resources efficiently. Education of the farmer is expected to have an effect on farm resources use and the ability to adopt new technology and hence have a positive impact on technical efficiency (Ogolla and Mugabe, 1996).

HOUSEHOLD SIZE

Household size is significant at 1% level, which happens to be the most significant variable, but negative. Labour input replaces capital input and the majority of family labour is applied to Teff, so access to family labour is an important catalyst for increasing yield. Therefore, it eases the labour constraint faced by most smallholder farms. However, the result implies that there is negative relationship between household size and technical efficiency.

INCOME OF THE HOUSEHOLD

Income of the household is positive and significant at 5% level, this implies that there is positive relationship between the income of the household on monthly basis and the small-scale technical efficiency. Since most of the small-scale farmers in Raya Alamata are old, they mainly depend on their gifts or remittance for monthly income, which becomes difficult for them to sustain productivity as they are unable to buy inputs.

Income plays a significant role in efficiency since Teff production is labour intensive, this can be through hire labour and hire tractor.

FARMER`S FARMING EXPERIENCE

The variable "farmer`s farming experience" has a positive sign and it is significant at 10% level, with the implication that there is a positive relationship between the farmer`s farming experience and technical efficiency of the small-scale Teff producers. It is assumed that the more experience the farmer has, the better the use of available resources thus has an effect on efficiency and this may contribute to the improvement of technical efficiency.

FARM SIZE

The variable farm size is positively significant at 1 % level, which tends to be one of the most significant variables found. The implication is that there is a positive relationship between farm size and small-scale Teff producers` technical efficiency. Land plays a vital role in farming with an impact on productivity and efficient, as one of the most available resources one can use efficiently. The size of the farm is based on the size of land used for Teff production by the household.

Access to land is by far the most important variable, explaining the differentiation in output. Amos (2007), Raghbendra *et al.*, (2005) and Barners (2008) found the relationship between land holding size and efficiency to be positive.

COST OF TRACTOR HOURS

Cost of tractor hours used by the farmer has a negative sign, but it is significant at 1% level. The implication is that there is a negative relationship between the cost of tractor hours and technical efficiency. Even though is one of the most significant variables in the model, it can negatively influence efficiency on Teff production as one can prefer using traditional method of ploughing than a tractor.

FERTILISER APPLICATION

This variable has a positive sign and it is significant at 10 % level. Fertiliser plays an important role on Teff production. This implies that the use of fertiliser influence technical efficiency. Therefore, there is a positive relationship between fertiliser and technical efficiency of small-scale Teff producers at Raya Alamata. The use of chemical fertiliser is known to be commonly used method in improving productivity and in the intensification of agricultural production as a whole; it also plays a big role in regions where the scarcity of farm land is a big problem. However, the appropriate use of these fertilisers is very important in achieving farm efficiency (Hopper, 1965).

PURCHASED HYBRID TEFF SEED

This variable is significant at 10 % level, but it has a negative sign. It means that if a farmer buys certified seeds instead of using the recycled seeds, a farmer may tend to maximise output. There is a negative relationship between purchased hybrid Teff seeds and the small-scale Teff producer`s technical efficiency. However, purchased hybrid Teff seeds can still influence efficiency positively, since the use of improved seed in crop production is one way of increasing productivity in terms of quantity and quality (Kiplan`at, 2003).

FARMERS' ORGANIZATION

The farmers` organisation is positively and it is significant at 5% level, which implies that a farmers` organisation plays an integral role in Teff production and efficiency.

Through dissemination of recent agriculture information to other farmers, they can buy seeds in bulk and share; negotiate cost of tractor as they will be using one tractor as a group. Therefore, this may have an impact on smallholder as many become efficient. This means that farmer's organisation influences technical efficiency and there is a positive relationship between farmer's organisation and the technical efficiency of small-scale Teff producers.

TEFF PROFITABILITY

The variable is significant at 10% level and has a negative sign. The implication is that the probability of the small-scale farmers to be technically efficient is not determined by farmers` perception on Teff profitability, since small-scale farmers only produce for home consumption not for the market. There is a negative relationship between the profitability of Teff and technical efficiency.

5. CONCLUSION AND RECOMMENDATIONS

This chapter summarises the main findings of the study and concludes on the basis of the findings derived from the empirical results. However, the chapter discusses the extent to which objectives and hypotheses posed at the beginning of the study have been addressed by the analysis. This chapter also generates the recommendations on the basis of the results.

5.1. CONCLUSION

Hypothesis 1: Small-scale teff producers in Alamata are not technically efficient. The findings of this study provide support for this hypothesis. Therefore, the hypothesis is not rejected since the empirical analysis have indicated that there is decreasing returns to scale which means that farmers are over-utilising some of the factors of production/resources used in the production of teff.

Hypothesis 2: There are no socio-economic characteristics influencing the technical efficiency of small-scale teff producers in the study area. The hypothesis is rejected as the empirical results show a positive influence of socio-economic factors in technical efficiency. Variables that were found to be highly significant are: household size, farm size, cost of tractor hire, income of the household on monthly basis and membership to farmers` organisation.

In general, the study concludes that farmers are technically inefficient since they are over-utilising resources at farm level, and that farmers` technical efficiency can be determined through the influence of certain socio-economic factors.

5.2 RECOMMENDATIONS

The recommendations discussed below are on the basis of the findings of this study.

To avoid technical inefficiency amongst small-scale teff producers, the study recommends the need to adopt modern agricultural technology such as improved teff varieties/purchased, seed hybrid teff and fertiliser usage should be governed by a complex set of factors such as human capital improvement and institutional support. This will make sure that people in rural areas, specifically small-scale farmers who practice subsistence farming which are mainly found in the Raya Alamata improve their standards of living.

The study also recommends that the government should not only include the Land redistribution and restitution for agricultural development project on the capacity building programme, but it should also include those farmers who are practicing subsistence farming by training and giving them skills on how to allocate resources efficiently such as fertilisers and seeds during the production periods, farmers also need to have access to enough arable land and tractor services. Since safe net programme already exists in the government, the study recommends that the government should intensify and roll-out the safe net programme to reach more small-scale subsistence farmers in the study area.

It is also recommended that extension services in the area should intensify their efforts to assist small-scale farmers, to overcome the challenges of economic scale and technical efficiency. Also help farmers with the creation of farmers' organization, since the findings have shown that only fewer farmers have membership to farmer's organization. Small-scale farmers need help in a number of areas as the discussion as shown, areas such as education and credit facilities. Subsistence farming in Ethiopia and indeed in many developing countries provides employment as well as food. In other words, this type of farming contributes significantly in the economic health of a country. It is therefore important that the government fully participate in assisting such community efforts.

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