Food Science and Quality Management www.iiste.org
ISSN 2224-6088 (Paper) ISSN 2225-0557 (Online)
Vol.72, 2018

Allocative Efficiency of Smallholder Wheat Producers in Damot Gale District, Southern Ethiopia

Fetagn Gizachew*
Department of Agricultural Economics, Collage of Agriculture, Wolaita Sodo University, Ethiopia

Abstract
The study assessed allocative efficiency levels of wheat producers in Damot Gale district of southern Ethiopia using cross-sectional data obtained from 123 randomly selected farmers in 2015 production year. To achieve this objective, a stochastic frontier model and OLS regression model were employed in the analysis. It was recognized that the mean allocative efficiency was 49.26% and it was significantly influenced by off-farm income, time of sowing, row planting, credit access and proximity to homestead. Policy implication of this study was that there is potential for farmers to increase wheat production by adopting projects or programs that would support off/non-farm income activities, awareness creation on efficient allocation of resources, strengthening awareness creation on row planting. In general there is a need to intervene not only in facilitating access to credit but also adopting risk and loss management policy and strategy like saving for insurance. Strengthening of extension training services about row planting for efficient resource allocation which helps to improve efficiency and productivity.
Keywords: Allocative efficiency, Stochastic frontier approach, Damot Gale, Ethiopia

1. INTRODUCTION

1.1. Background of the Study

There are 4.7 million wheat farmers in Ethiopia. Of these, more than three-quarters (78 percent) live in Oromia and Amhara. In contrast, the smallest areas cultivated with wheat are found in SNNPR, where the average is just 0.19 ha/farm, which is dominated by small-scale farmers (Nicholas*etal*., 2015).

While Ethiopia is a major regional producer of wheat in Subsaharan Africa, the government spends a significant amount of foreign exchange to import about a million tons of the grain annually. To ease this dependence on imports, the government has started to design a strategy for import substitution, which includes, in part, developing a robust local wheat sector. Even though emphasis has been given to the agricultural sector and Wheat farmers are growing and harvesting more wheat than ever before, yet every year, the Ethiopian government spends millions of dollars to import wheat (IFPRI, 2015).

During the past years, the government and NGOs have undertaken various attempts to enhance agricultural productivity particularly that of cereal crops so as to achieve food security and to reduce poverty in the country. Researchers from the International Food Policy Research Institute (IFPRI) collected wheat growing farmer survey to learn how wheat growers in Ethiopia responded to the new promotional package rolled out by the Ministry of Agriculture (MoA) and the Ethiopian Agricultural Transformation Agency (ATA). The purpose of the package is to help wheat farmers increase their crop yields (IFPRI, 2015).

Hence, increasing productivity in smallholder agriculture is government top priority, recognizing the importance of the smallholder sub-sector, the high prevalence of rural poverty and the large productivity gap. In this context, Understanding the level of allocative efficiency and its determinants contribute a lot to the identification of production constraints at farm level and improve the food security and income sources in the farm sector and the rest of the economy. Furthermore, such knowledge may help policy-makers to design appropriate policies to increase agricultural productivity through improving on farm and crop specific efficiencies. So this study aimed to measure allocative efficiency and identified its determinant factors by collecting cross-sectional data from wheat producing smallholder farmers of Damot Gale district of southern Ethiopia.

Production theory states that under competitive conditions, a firm is said to be allocatively efficient if it equates the marginal returns from production inputs to the market price of the input (Fan, 1999). Akinwumi and Djato (1997) in their study of the relative efficiency of women farm managers in Ivory Coast defined allocative efficiency as the extent to which farmers make efficient decisions; by using inputs to the point where their marginal contribution to the value of production is equal to the marginal factor costs. Therefore in this study allocative efficiency is defined as the ability of wheat producers to use farm inputs up to the level where marginal value of production is equal to their factor price.

2. Research Methodology

2.1. Study area

Damot Gale is located at 350 Km in South-West of Addis Ababa and 135 Km from Hawasain Southern Nations Nationalities and Peoples Region (SNNPR) in Wolaita zone. The area is located at 07°00’N and 37° 54’ E. It boundaries Wolaita Soddo town at 18Km all weathered road (Figure 2). There are three agro-ecological zones in Damot Gale, namely highland (*Dega*) (11.6%), midland (*Woyna dega*) (60.4%) and wet lowland (*Kolla*) (28%). With rain fall dispersed throughout the year in two main rainy seasons, which rangers from 900mm-1500mm per year (DGWANRDO, 2016).

The total population of Damot Gale is estimated at 144,763 out of which 22,008 are male headed and 4310 are female headed. The total area of the district is 22,252.75 ha with density per square Km of 750 (DGWANRDO, 2016).

It is an area of intensive agriculture; farming systems that combines annual and perennial crops; where cereals, root crops and cash crops grown. Cropping system in Damot Gale could be categorized into; intensive cereals, root crops and pulses. Major cereals crops growing in the area are like Wheat, Barley, *Teff*, Sorghum, and Maize, from cereals wheat is mainly grown for market. Even though food crops are also sold for cash, there is high dependence on maize, sweet potato, *enset* and taro for food. Other sources of cash income are off/no-farm activities and sale of livestock mainly cattle and sheep. Cattle, sheep, donkeys and chickens are reared in this district, but the types of livestock owned vary considerably from one wealth group to the next. Due to lack of grazing land, households use a 'cut and carry' system for feeding their livestock (DGWANRDO,2016).

Data Types, Sources and Methods of Data Collection

For this study, both primary and secondary data from different sources were used.

Sampling method and sample Size determination

In this study, multi-stage random sampling techniques were employed to draw an appropriate sample household. Even though Damot Gale district consists of 27 *kebeles*, only 11 *kebeles* were engaged in the production of wheat and were purposively selected during the initial stages of the sampling. Out of which three *kebeles* were selected randomly in first stage of sampling. In the second stage, the total households of 3 *kebeles* were stratified into wheat growers and non-wheat growers. After identifying the wheat growers, based on the list of the name of households obtained from the *kebeles* offices that grew wheat during 2015 production year. In the third stage a total of 123 sample wheat producer households were selected randomly, using probability to size of households in each *kebele*.

2.2. Methods of Data Analysis

The study employed both descriptive statistics and econometric models for analyzing data.

Descriptive statistics

The data collected on socio-economic, institutional and demographic characteristics of the sample households, are analyzed by using descriptive statistics such as mean, standard deviation, frequency, percentage, and the like.

Econometric model

An econometric estimation analysis was done first by specifying production frontier using Cobb-Douglas stochastic model. The model has estimated parameters of production frontier, level of efficiency, and significant level of the different variables in the determination of inefficiency of farmers. The various null hypotheses for parameters in the frontier production function and inefficiency model was tested by using likelihood ratio test (LR) given by Coelli. (1998).

Specification of stochastic frontier model

Crop production in the study area is rain-fed which is affected by random shock such as drought and erratic rainfall. The farmer may deviate from the frontier not only because of measurement error, statistical noise or any other influence but also because of inefficiency. Crop production is rain-fed in the district; the impact of stochastic noises is clearly observable. To assess such conditions stochastic frontier model is used in the analysis of efficiency of wheat production in the study area.

Thus a stochastic frontier model is preferred because of its capable of capturing measurement error and other statistical noise manipulating the shape and position of the production frontier. A stochastic frontier production model proposed by Battese and Coelli (1995) in accordance with the original models for Aigner *et al*. (1977), and Meesuen and van den Broeck (1977) was be applied to cross-sectional data to analyze the efficiency. The stochastic frontier production function of Cobb-Douglas type is defined in logarithmic forms as:

$$\ln(y_i) = \beta_0 + \beta_1 \ln(AREA) + \beta_2 \ln(LAB) + \beta_3 \ln(OX) + \beta_4 \ln(FER) + \beta_5 \ln(SEED) + \exp^{\varepsilon_i} \quad (8)$$

$$i = 1,2 \ldots N$$

$$\varepsilon_i = v_i - u_i \; (9)$$

Where ℓn , natural logarithms, y represents the wheat output level of i^{th} sample farmer, AREA represents the size of wheat operation in hectares, LAB is the quantity of labor power used by the farmer in man-days, OX is the quantity of oxen power used by the farmer in oxen-day, FER is the quantity of fertilizers used in kilogram and SEED represents the quantity of seed used in kilogram; β_i is production coefficient (unknown parameters) to be estimated. ε_i is an error term made up of two components;

v_i is random error having zero mean, N (0, δ^2v) which is associated with random factors such as measurement error in production and weather which are not control of the farmers and assumed to be independently and identically distributed. As N (0, δ^2v) with a random error that is independent of u_i.

u_i is the non-negative efficiency measured relative to the stochastic frontier that is i^{th} firm not attaining maximum efficiency of production and ranges between 0 and 1, which is also assumed to be independently and identically distributed as half-normal at zero mean or truncated half-normal at mean μ, N[μ,$\delta^2{}_u$] or according to Greene (1990) with two parameter gamma distributions.
N represents the number of farmers involved in the survey of the farms.
The variance parameters are:

$$\delta^2 = \delta^2 u_i + \delta^2 v_i \quad (10)$$

And $\gamma = \delta^2 u_i / \delta^2 \quad (11)$ The parameter must lie between 0 and 1. The maximum likelihood estimation of equation (8) provides consistent estimators for the and parameter, where, explains the total variation in the dependent variable due to technical inefficiency (u_i) and random shocks (v_i,) together. Hence, equation (10) and (11) provide estimates for v_i and u_i after replacing ε_i,and by their estimates.

The technical efficiency (TE_i) of the i^{th} farmers can be estimated by using the expectation of u_i conditional on the random variables (ε_i) as shown by Battese and Coelli (1995). The TE of an individual farmer is defined in terms of the observed to the corresponding frontier output given the level of inputs can be calculated as:

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

$$TE_i = \exp(-u_i) \quad (12)$$

Following Bravo-Ureta and Rieger (1991) for a given level of yield of output (Y^*), the technically efficient input vector of the i^{th} farmer, X_{it} is derived by solving (8) and the observed input ratio $\frac{X_1}{X_i} = m_i \quad (i > 1)$ simultaneously. Assuming that the production function in equation (11) is self-dual (e.g., Cobb-Douglas), the dual cost frontier is derived algebraically and written in the following way:

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

Where C_i is the minimum cost of the i^{th} 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 i^{th} farm X_{ie} is derived by applying Sheppard's Lemma and substituting the firm's input prices and adjusted yield of output level into the resulting system of input demand equations.

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

Where k represents the total number of inputs used. The observed, technically and economically efficient costs of production of the i^{th} 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):

$$TE_i = W_i' X_{it} / W_i' X_i \quad (15)$$

Economic efficiency (EE):

$$EE = W_i' X_{ie} / W_i' X_i \ (16)$$

These cost measures are used to compute TE and AE indices of the i^{th} farm.
Following Ferrell (1957) allocative efficiency (AE) can be derived from equation (15) and (16) as,

$$AE = W_i' X_{ie} / W_i' X_{it} \ (17)$$

The production frontier will be estimated using frontier model whereas the cost frontier will be derived analytically from production assuming self-dual.
In many studies of technical efficiency, the results are used to estimate the effects of various factors on inefficiency. These may be estimated using either a one-stage or two stage processes. As stated in Coelli *et al.* (2006) problem with the two-stage procedure is a lack of consistency in assumptions about the distribution of the inefficiencies.

3. RESULTS AND DISCUSSION

This chapter is divided into two main sections: descriptive statistics and econometric results. In this chapter, the results of the study along with previous research findings are briefly presented and discussed.

Descriptive statistical results

Before going aboard on presenting and discussing results obtained from the econometric models, it is important to briefly present demographic, socio-economic and institutional variables using descriptive statics. This would help to draw a general picture about the study area and sampled households.

Demographic and socio-economic characteristics of sample households

Family size and age composition: The average family size for the sample households was about 6 persons which was higher than the national average agricultural household size which is about 5.2 persons per household and ranging between 2 and 12 persons. The average age of the sample household heads was 50 years with a maximum of 76 and minimum of 29 years. Education is an instrument to enhance the quality of labor through improving the managerial skill and the tendency to adopt new technologies. Therefore, education together with increased experience could enable farmers to better manage their farming activities. The average education status of the sample household heads was 4^{th} grade with a maximum of 12 and minimum of 0years.

Table 3.Age, education status and family structure of sample households during 2014/2015

Variable	Minimum	Maximum	Mean	Std. Deviation
Age	29	76	49.5	11.3
Education	0	12	4	3.02
Family size	2	12	5.95	2.1

Source: Own computation (2016)

Crops production and area coverage

Farmers in the study area used mixed farming system. The major crops grown in the area includes maize, *teff*, haricot bean and wheat. Damot Gale district is representative of the *Weyna Dega* and *Dega* agro climatic condition and has two harvest seasons. The first is during the small rainy season, *Belg* (February to April), which sometimes supplemented by irrigation and the second is the harvest from the main rainy season, *Meher* (June to September).During the main rainy season i.e *meher*, predominant crops grown by households are cereals (such as wheat, *teff*, barley and maize, and pulses beans and peas) are the major crops grown.

On average, sample households allocated 0.342 ha land for wheat production. Next to wheat, *teff* and maize were crops that took the largest proportion of the household's total cultivated land.

Table 4. Average production of various crop output and area allocated by thesample households

Crop type (ha)	Area(ha)	Output of crops(qt)
Wheat	0.34	43.80
Maize	0.16	1.85
Teff	0.07	0.60
Haricot bean	0.03	0.50

Source: Own Computation (2016)

Description of production function and variables

The average wheat output produced in the study area was about 15.02 qt/ha that ranged from 3qt to 34qt with a standard deviation of 7.45 among the sample farmers in 2014/15 indicating a considerable scope for improving wheat yields in the study area. The two commonly used chemical fertilizers in the production of wheat in the study area were DAP and Urea. The average amount of DAP and Urea applied by sample household were 35.87 kg and 22 kg/ha respectively. Farmers in the area recommended touse100 kg of DAP and 100 kg of urea per ha base. While the rate of application of urea used was not as recommended rate.

Table 5. Descriptive statistics of input and output variables in production function

Variable	Min	Mean	Max	Std.
Yield(qt)	3	15.02	34	7.47
Area(ha)	0.125	0.34	0.75	0.16
Seed(kg)	12	33.9	75	16.6
Dap(kg)	10	35.87	85	18.8
Urea(kg)	0	22	70	14.99
Oxen-days	3	6.86	16	2.7
Labor(man-eqvt)	30	67.1	137	30.13

Source: Own computation (2016)

Parameter estimates of the SPF model

The ML estimates of the parameters of the SPF specified in equation (8) were obtained using STATA 13 computer program. These results MLestimates of the average production function are presented

Table 12. ML estimates of the parameters of the Cobb-Douglas SPF

Variables	ML estimate		
	Coefficient	Std. Error	Elasticity
Ln(land)	0.0427	0.0302	-
Ln(labor)	0.2725***	0.0573	0.27
Ln(oxen)	0.0768 **	0.0356	0.076
Ln(seed)	0.2909***	0.0745	0.29
Ln(DAP)	0.0716	0.0473	-
Ln(urea)	0.0332***	0.0038	0.0332
Constant	0.3243	0.1217	
Sigma-v	0.1448	0.022	
Sigma-u	0.1994	0.048	
Sigma square	0.0607	0.0149	
Lambda δ_u / δ_v	1.376	0.067	
Log likelihood	31.86		
Gamma $\gamma = \delta^2 u/\delta$	0.6524		

** and *** show significant at 5% and 1% level of significance respectively

Source: Own computation (2016).

Among the total of six variables considered in the production function, four (labor, oxen, seed and urea) had a significant effect in explaining the variation in wheat production among farmers. The coefficients of the production function are interpreted as elasticity. Hence, high elasticity of output to seed (0.29) suggests that wheat production was relatively sensitive to seed. As result, 100% increase in seed will result in 29% increase in wheat output, keeping other factors constant. Alternatively this indicates wheat production was responsive to seed, followed by labor, oxen and urea respectively.

The diagnostic statistics of inefficiency component reveals that sigma squared (σ^2) was statistically significant at 1 percent. This indicates goodness of fit, and the correctness of the distributional form assumed for the composite error term.

The sum of coefficient was 0.67 indicating; being in the stage II of production where increasing input increase output at decreasing rate. This indicates that farmers are facing decreasing returns to scale (Table 12) and shows that there is potential for wheat producers to increase their production. Even though they operated in stage II of the production function, they were not efficient in allocation of resource this implies an extent to increase production with a decreasing rate. In other words, a percent increase in all inputs increase the total production by 0.67 which is decreasing return to scale. This result is consistent with the results obtained byHassen *et al.* (2012) and Awol(2014) who estimated the returns to scale to be 0.61% and 0.96% respectively in their studies, which falls in stage II of production surface.

The ratio of the standard error of u (σ_u) to the standard error of v (σ_v), known as lambda (λ), was 1.376. The estimated value of gamma was 0.6524which indicated that 65.24% of total variation in wheat farm output was due to technical inefficiency. The stochastic production frontier results indicated that the production function was explained by the individual variables of land, labor, fertilizer, oxen labor and quantity of seed

The dual frontier cost function derived analytically from the stochastic production frontier shown in Table 11 was formulated as:

$$\ell nc = 1.49 + 0.21\ell nw_1 + 0.37\ell nw_2 + 0.19\ell nw_3 + 0.33\ell nw_4 + 0.2\ell nw_5 + 0.02\ell nw_6 + 0.37\ell ny^*$$

Where c is cost of producing wheat output; w_1 refers to the average rent value of land per hectare, w_2 is average wage rate; w_3 is the average oxen rent value in the study area; w_4 is price of kg of seed; w_5 price of kg of DAP,

w_6 is price of kg of urea and y^* is total amount of wheat output produced in quintals adjusted for statistical noise.

Efficiency scores

Table 6. Estimated technical efficiency scores of the sample farmers

Type of efficiency	Mean	Std.Dev.	Minimum	Maximum
AE	0.4926	0.1091	0.3237	0.9955

Source: Own computation(2016)

In another form of analysis, the mean allocative efficiency of 49.26% (Table 13) means that there is a need to improve the present level of allocative efficiency. Moreover, the estimates indicated that the farmers have more than enough opportunities to increase their allocative efficiency. For instance, farmer with average level of allocative efficiency would enjoy a cost saving of about 50.5% derived from (1 – 0.4926/0.9955)*100 to attain the level of the most efficient farmer.

Determinants of allocative efficiency of wheat producing farmers

Allocative efficiency determinant variables are also regressed by OLS to identify important explanatory variables that could determine AE efficiency variations among farmers. From the result, shown in Table 17, off/no-farm income, row planting and credit usingsignificant at 1% level; age and extension contact were significant at 5% and time of sowing was significant at 10% level of significance.

The positive and significant coefficients of off/non-farm income, time of sowing and row planting, show that these variables determine the level of efficiency positively. As these variables increased positively, the efficiency of farmers will improve. On the contrary, the negative sign of age, frequency of extension contact and credit using shows that these variables affected the allocative efficiency level negatively, which indicates the increased in these variables could reduce allocative efficiency level of the farmers in the study area.

The rest of the variables, including education, total expenditure, family size, livestock holding, and proximity to farm stead had insignificant effect on allocative efficiency. Those insignificant variables imply that the variables have no impact in determining the allocative efficiency level of farmers.

Table 7. Determinants of allocative efficiency of wheat producing farmers

Variables	Coefficient	Std. Error	T
Age of household head	-0.082	-0.037	2.216
Education level of household head	0.015	0.010	1.501
Family size	0.017	0.014	1.214
Off/non-farm income	0.520***	0.180	2.878
Livestock holding in TLU	0.003	0.009	0.333
Total expenditure	-0.102	-0.680	0.150
Row planting	0 .682***	0.235	2.902
Extension contact	0.246**	-0.124	-1.983
Credit using	-0.069***	-0.025	-2.760
Proximity to home stead	0.006	0.026	0.230
Time of sowing	0.073*	0.043	1.697
Constant	0.146*	0.086	
R-squared	0.6604		
Adj R-squared =	0.6233		

***,** and * show significant at 1, 5 and 10% level

Source: Own computation (2016)

The discussions about the significant variables are given below:

Off/non-farm activities: The coefficient of off/non-farm activity with respect to allocative efficiency is positive and significant at 1 percent. As compared to those households who had no off/non-farm income the AE of those households who had off/non-farm income increased by 0.68 scores keeping other factors constant. This may be because; the availability of off/non-farm income shifts the cash constraint outwards and enables farmers to make timely purchases of those inputs which they cannot provide from on farm income. Therefore, it enables farmers in maximizing its output by allocating efficiently at efficient cost of production. The result is in line with the findings of Hasen (2011), Abebayehu (2011) and Mustefa (2014).

Row planting: It was also a dummy variable which represents whether the farmer adopted row planting practice or not during the 2015 production season. It was hypothesized as farmers who practiced row planting can be more efficient than his/her counter-parts as row planting requires fewer seeds than broadcasting, making it possible to use less seed and getting higher yield on the same area of ground. Estimated row planting had significant and positive effect for allocative efficiency at 1 percent. As compared to those households who had not adopted wheat row planting the AE of those households who had adopted wheat row planting increased by0.68 scores keeping other factors constant. This shows farmer who use row planting can allocate resources efficiently at cost saving way. The smallholder farmer who had adopted wheat row planting technology on their land had mean allocative efficiency of 64.3 and those who were not adopted has mean allocative efficiency of

39.9. When planting in rows, it also becomes easier for farmers to spot and pull the weeds that compete with the wheat for soil nutrients. It can both save seeds and harvest higher yields.

Extension contact: However, the posative coefficient of extension contact which is significant in AE indicates that efficiencies in resource allocation are increasing by 0.24 score as the frequency of extension contact increases by one round of visit keeping other factors constant. This may because; as most farmers explained during the survey that they have new skills and information they learn from development agents.

Credit using: It was hypothesized that farmers who have access to credit sources are more efficient than others. However in this study, credit is found to have negative and statistically significant relation with the level of allocative efficiency. However, the negative coefficient of credit using sources which is significant in AE indicates that as compared to those households who are credit users AE efficiency of those who credit users decreased by 0.069 scores keeping other factors constant. As most farmers explained during the survey that they received lower than their farm capacity, and also did not apply full package program, that is using DAP with urea and seed at recommended rate for increasing production by efficient allocation of resources in cost saving way. This may be because of fearing repayment which did not consider risk, weather condition changing and non-existence of agricultural insurance.

Time of sowing: The result of this study revealed that time of sowing are found to be significantly and negatively affect allocative efficiency of the farmers in the study area. As compared to those households who sowed late from sowing season the allocative and efficiency of those households who sowed early on time increased by 0.073 score keeping other factors constant. This can also be indicated by taking the mean allocative efficiency of farmers who sow lately and early. As revealed in the Table 20, the mean allocative efficiency of late sowing farmers were 0.478 and 0.456 for those who sow early.

4. CONCULUSION AND RECOMMENDATIONS

Conclusion

Agricultural sector in Ethiopia is characterized by its poor performance, whereas the population of the country, which to a large extent depends on agriculture, is growing at a faster rate. While wheat farmers are producing more than ever before, the demand for the grain has consistently outpaced supply. This requires seeking for a means to increase agricultural productivity of smallholder farmers. In this context, the measurement of existing efficiency in agricultural production and identifying the determinant to seeking alternative solutions for these problem becomes paramount important.

This study analyzed the allocative efficiency and factors that explain the variation in efficiency among wheat producers' farmers in purposively selected districts of Damot Gale, Wolaita zone, Southern Nation Nationalities and Peoples Regional State. The study area was selected purposively based on the potential of wheat production in the zone.

A multi-stage random sampling procedure was employed for the selection of sample respondents. From three *kebele* administration a total of 123 households were selected using probability proportional to sample size. The required data were collected through interviews of farm household heads using structured questionnaire. Cross-sectional data were used to analyze the effects of farmers' socioeconomic and institutional setting on the efficiency and determinants of production inefficiencies.

The Cobb-Douglas stochastic frontier production function was used to predict TE and the use of self-dual production frontier allows the cost frontier to be derived and used to estimate EE. AE was derived from TE and EE result. The SFA approach was chosen as it best suits a single-output and multiple-inputs production programs and as it easily disaggregates inefficiency effects in production into non-random and random error components. The survey data were analyzed using both descriptive statistics and econometric model for the estimation of efficiency and efficiency differentials. The MLE of the stochastic Cobb-Douglas frontier production function signified important implications on factor's contribution and productivity increase of wheat in the study area. Estimation of the production frontier indicated that among the total of six variables considered in the production function, four (labor, ox labor, seed and urea) had a significant effect in explaining the variation in wheat production among farmers. These implying farmers should use the maximum possible levels of these inputs to enhance wheat production. The coefficients of the Cobb-Douglas production function are interpreted as elasticity (degree of responsiveness of relative change in wheat output due to simultaneous change in all inputs) and summing the individual elasticity yields a scale elasticity of 0.67. This indicates that farmers are facing decreasing returns to scale and hence wheat production in the study area was in stage II of the production surface as the neo-classical theory states.

Concerning the sources of efficiencies, the study found that allocative efficiency of the farm household was positively and significantly affected by time of sowing, off/non-farm income and row planting and negatively related with credit using.

According to the finding of this study, wheat producer farmers can increase their production at the existing level of technology and inputs through improving efficiency. Moreover, the study contributes to improve farm revenue, benefits and generally helps agricultural as well as economic development.

Recommendations

The policy implications of this analysis are that efficiency estimates indicate both the distribution of the farmers' efficiency and its socio-economic determinants. Thus, the results of the study give information to policy makers and extension workers on how to improve farm level efficiency of wheat production and identify the determinants for specific efficiency types. Arising from the results of the study, the following recommendations are drawn:

The positive impact of off/non-farm activities of the household on the level of allocative efficiency indicates its supplementary nature with the activities that did not compete/overlap/ with time of wheat production. It contributes to income diversification. As a result, farmers engaged on the off/non-farm activities were operating at higher level of allocative efficiency. Therefore, project or program that would support off/non-farm income activities should be adopted, which in turn will enhance wheat production.

Row planting is positively related to allocative efficiency of wheat production. This indicates that row planting is fundamental in improving the AE. Therefore, the regional government or district bureau of agriculture should have a chief responsibility to keep on the provision of awareness creation on row planting, in these areas and others so that farmers can use the available inputs more efficiently under the existing technology level.

Credit using of the household for agricultural activities has a negative impact in AE of wheat production. Hence, there should to have strong work on awareness creating on efficient allocation of resources obtained by credit, especially agricultural inputs and risk management strategy should be adopted like farmers owned agricultural insurance saving that minimizes fear for credit and loss of farmers during natural and man-made risks.

Finally, it is interesting to note that most efficiency studies in the developing countries have focused mainly on the measurement of technical efficiency, even though it is by improving the overall economic efficiency that major gains in production could be achieved. This means, additional efforts should be dedicated to examining the impact of both allocative and economic efficiencies on performance for different types of crops and areas at various points in time.

REFERENCES

Abebayehu Girma. 2011. Technical Efficiency Analysis of Haricot Bean Seed Production: The Case of Boricha District, Sidama Zone, Southern Ethiopia. MSc Thesis, Haramaya University, Haramaya, Ethiopia.

Ali, A.A., E.E. Imad and Y. Abdelkarim. 2012. Economic Efficiency of Wheat and Faba Bean Production for Small Scale Farmers in Northern State, Sudan. *Journal of Animal and Plant Sciences*, 22(1): 215-223.

Awol Ahmed.2014.EconomicEfficiency of Rain-Fed Wheat producing farmers:The Case of farmers in Albuko Disrict. MSc Thesis, HaramayaUniversity, Haramaya, Ethiopia.

Battese, G.E. and G.S. Corra. 1977. Estimation of Production Frontier Model: With Application to the Pastoral Zone of Eastern Australia. *Australian Journal of Agricultural Economics*, 21(3): 169-179.

Battese, G.E. and T.J. Coelli. 1993. A Stochastic Frontier Production Function Incorporating a Model for Technical Inefficiency Effects. Department of Economics, University of New England.

Battese, G.E. and T.S. Coelli. 1995. Model for Technical Efficiency Effects in a stochastic frontier Production function for panel data. *Empirical Economics*, 20: 325-332.

Betty, K. 2005. Technical Efficiency in Kenyan's Maize Production: An Application of the Stochastic Frontier Approach. M.Sc. Thesis, Colorado State University, Colorado.

Bravo-Ureta, B.E. and L. Rieger. 1991. Dairy Farm Efficiency Measurement Using Stochastic Frontiers and Neoclassical Duality. *American Journal of Agricultural Economics,* 73(2): 421-428.

Coelli, T.J., Rao, D.S.P. and Battese, G.E. 1998. *An Introduction to Efficiency and Productivity analysis.* Kluwer Academic Publishers, Boston Dordrecht/London.

Coelli, T.J.,Rao, D.S.P. and Battese, G.E. 2006. *An Introduction to Efficiency and Productivity Analysis.* Kluwer Academic Publishers, Boston, Dordrecht/London.

Coelli, T.J.1995. Recent Development in Frontier Modeling and Efficiency Measurement. *Australian Journal of Agricultural Economics*, 39(3): 219-245.

Coelli,T.J. and Battesse, G.E. 1995. A Model of Technical Efficiency Effects in a Stochastic Frontier Functions for Panel Data. *Journal of Empirical Economics,* 20:325-332.

CSA (Central Statistical Authority). 2015. Agricultural Sample Survey 2014/2015: Volume I Report on Area and Production of Major Crops (Private Peasant Holdings, *Meher* Season. Statistical Bulletin. Addis Ababa.

Dawang, N., and Y. Oseni. 2011. Determination of Economic Efficiency of Integrated Crop Production System: A Case from Plateau State, Nigeria. *World Journal of Agricultural Science*, 7(4): 467-475.

Debrew, E. 1951. The Coefficient of Resource Utilization. *Econometrica*, 19(3): 273-292.

DGWANRDO (Damot Gale Woreda Agriculture and Natural Resource Development Office). 2016. Damot Gale Woreda Agriculture and Natural Resource Development Office, the

FAO (Food and Agricultural Organization). 2012. Crop and Food Security Assessment Mission to Ethiopia. Special Report of Food and Agriculture Organization and World Food Programme.Rome, Italy.

FAO (Food and Agricultural Organization). 2014. Crop and Food Security Assessment Mission to Ethiopia. Special Report of Food and Agriculture Organization and World Food Programme.Addis Ababa, Ethiopia.

Gemeda Olani. 2011. Analysis of Wheat Production Efficiency, the Case of Small-scale Farmers in Gedeb-hasasa District, West Arsi Zone of Oromia Regional State. MSc Thesis, Haramaya University, Haramaya, Ethiopia.

Greene, W.H. 1980. Maximum Likelihood Estimation of Econometric Frontier Function. *Journal Econometrics,* 13:27-56.

Greene, W.H., 1990.On the Estimation of a Flexible Frontier Production. Journal of

Hassen Beshir. 2011. Performance of Mixed Crop-Livestock Production System: The Data Envelopment Approach. *Livestock Research for Rural Development.* 23(200).Retrieved: 2, 2017, from http://www.lrrd.org/lrrd23/9/besh23200.htm

Hassen Beshir, Bezabih Emana, Belay Kassa and Jema Haji. 2012. Economic Efficiency of Mixed Crop-Livestock Production System in the North Eastern High lands of Ethiopia. The stochastic Frontier Approach. *Journal of Agricultural Economics and Development,* 1(1): 10-20.

IFPRI (International Food Policy Research Institute). 2015. Wheat supply Chain in Ethiopia: patterns, trends and policy options in Ethiopia. Working Paper. Washington: IFPRI. Institute. UK.

Meeusen, W. and J. Van den Broeck. 1977. Efficiency estimation from Cobb-Douglas production with composed errors. *International Economics Review,* 18(2): 435-444.

Mustefa Bati. 2014. Economic Efficiency of Barley Production: The Case of Chole District, Ethiopia. MSc Thesis, Haramaya University, Haramaya, Ethiopia.

Nicholas Minota, James, W., Solomon Lemma, Liulsegged Kassa, Abate Gashaw and Shahidur, R. 2015. Wheat supply Chain in Ethiopia: patterns, trends and policy options in Ethiopia.Working Paper. Washington: IFPRI. Institute. UK.