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Determinants of Technical Efficiency of Wheat Production in Ethiopia: A Review

Chimdessa Uma[1] Yadeta Bekele[2] Temesgen Hirko[3]
1.Wolkitie University, Department of Agricultural Economics, Ethiopia
2.Jimma University College of Agriculture and Veterinary medicine
3.Department of Agricultural Economics and Agribusiness Management, Ethiopia

Abstract
Wheat is the third most important cereal crop in the world after maize and rice. Previous studies have indicated that farm production and productivity can possibly be raised by allocating more area for production, by developing and adopting of new technologies, and/or by utilizing the available resources more efficiently. Increasing productivity through enhanced wheat production efficiency could be an important move towards food security. In Ethiopia wheat production levels and rates have been increasing due to the development and dissemination of improved wheat technologies. Despite these efforts by the government, smallholders' wheat productivity has remained below potential. However, empirical studies conducted to estimate level of efficiencies and to identify its determining factors in wheat production which would guide policy makers in their efforts are sparse. The main objective of this review is assessing the determinants of technical efficiency in wheat production in Ethiopia. Educational level was an important determinant of differences in agricultural productivity among countries. In these review factors like sex, age, distance to all weather roads, livestock holding, group membership, farm size, farm fragmentation, tenure status and investment on fertilizers are identified as the key determinants of the technical efficiency of wheat production in Ethiopia. The frequency distribution of technical efficiency levels was not fairly distributed. The wheat farms were being operated below level of technical efficiency. This implies that a large number of wheat farms in the Ethiopia faced inefficiency problems.
Keywords: Wheat, Technical efficiency, Determinants, Ethiopia

INTRODUCTION

Background

Wheat is the third most important cereal crop in the world after maize and rice (Njeru, 2010). Ethiopia is one of the largest grain producing countries in Africa. Although Ethiopia is a net importer of grain, it is the second largest wheat producer in sub-Saharan Africa, after South Africa. For the crop year of 2011/2012, from the total land allocated for cereal crops, wheat stands in fourth by covering 15.3% of the total areas preceded by Teff, maize and sorghum (Mesay et al., 2013). Despite its potential for wheat grain production, much of the domestic wheat demand of flour mill factories is met through imports. Productivity of wheat varies from 1.7 to 2 t/ha which is relatively low as compared to the genetic potential of wheat varieties released by the research centers (CSA, 2011). At a national level about 1.63 million ha of wheat was distributed with about 4.84 million smallholder farmers. Wheat is cultivated in the highlands of Ethiopia, mainly in Oromia, Amhara, Southern Nations and Nationalities Peoples and Tigray regions (CSA, 2013).

Many physiological, agronomic, socio-economic and management factors are responsible for low wheat yields in Ethiopia. Poor management is more conspicuous of all the factors. Since managerial skill and access to resources vary from region to region, productivity also varies widely across the farming regions. Moreover, biotic factors like the occurrence of yellow (stripe) rust reduce the productivity of wheat significantly (Mesay et al., 2013). According to previous researches in Ethiopia, there also exists a wide cereal yield gap among the farmers that might be attributed to many factors such as lack of knowledge and information on how to use new crop technologies, poor management, biotic, climate factors and more others (Debebe et al., 2015).

In crop year 2010, the extended rainfall both in the short ("Belg") and long rainy seasons ('Meher") all over the country created conducive environment for the outbreak of yellow rust. According to the report made by Global Agricultural Information Network, the epidemic significantly affected wheat production and reduced the annual production of wheat by -8.13% in 2010 (GAIN, 2012). Major wheat producing regions of central and southeastern part of Ethiopia, were badly affected. In Ethiopia 75% of wheat is grown in the regions of Arsi, Bale, and Shoa, a belt stretching from just north of Addis Ababa to the southeast((Mesay et al., 2013).

Despite the importance of wheat as a food and industrial crop and the efforts made so far to generate and disseminate improved production technologies, its productivity remains below its potential. The average wheat yield was about 2.1 tons per hectare, in 2012/2013 cropping season (CSA, 2013). Ethiopia's current annual wheat production of approximately 3.18 million tons is insufficient to meet domestic needs, forcing the country to import 30 to 50% of the annual wheat grain required. Therefore, these facts show that Ethiopia is the net importer of wheat to feed its growing population. Moreover, the yield gap of over 3 tons per hectare suggests

that there is a potential for increasing production and productivity of smallholder wheat farmers(Wudineh & Endrias, 2016).

There are number of factors affecting wheat production including area under wheat cultivation, farm size, varieties, insecticides, fertilizers, sowing time (Waqas et al., 2014). Efficient use of resources is a key to attain higher profitability and sustainable wheat production. Economic factors, namely farm type (tenure or ownership), farm size, farm machinery and socio-environmental factors, namely infrastructure, markets, government policies and international trade contribute (Hashmi, M.S., M.A. Kamran, K. Bakhsh and M.A. Bashir, 2015).Moreover, a number of activities such as selection of seed, varieties, fertilizers, pesticides/weedicides, seed bed preparation, amount and quality of irrigation water influence the crop production. Al-Ghobari (2013) stated that the water use efficiency under intelligent irrigation system is higher than conventional irrigation system.

Some previous studies have indicated that farm production and productivity can possibly be raised (1) by allocating more area for production, (2) by developing and adopting of new wheat technologies, and/or (3) by utilizing the available resources more efficiently (Ahmed et al., 2013). Deciding for the first method would mean trying to boost output at the cost of bringing marginal areas into cultivation. Some other authors also argued that with limited available suitable land especially in the highlands for cultivated area expansion, increased cereal production and productivity will need to come from yield upgrading (Bezabeh et al., 2014). On the other hand, creation and introduction of new technologies is a long term option and requires a lot of capital for research and extension. Rather, efficient utilization of available resources is the best way of increasing production especially in the short run (Wudineh & Endrias, 2016).

Because of the scanty resources that are on ground, recently it is getting importance to use these resources at the optimum level which can be determined by efficiency searches (Gebregziabher et al.,2012). Thus, increasing wheat production and productivity among smallholder producers requires a good knowledge of the current efficiency or inefficiency level inherent in the sector as well as factors responsible for this level of efficiency or inefficiency ((Wudineh & Endrias, 2016).

Improving the efficiency level of the released wheat technologies and encouraging the adoption of the recommended crop management practice at farmers' level. According to Ishtiaq et al. (2010), there is a wide yield gap between progressive and common farmers which may be attributed to many factors like poor seed rate, weed infestation, inadequate irrigation water, improper dosage of chemical fertilizers, inappropriate use of herbicides and fungicides and less access to wheat information technology pathways like extension services contact, field days, etc. Yield difference under similar conditions necessitates analysis of factors, which may help reveal the type and magnitude of variation in causative factors. These underline the importance of knowing the efficiency level of small-scale farmers in order to design appropriate development strategies for them (Mesay et al., 2013).

Moreover, since social development is dynamic, it is imperative to update the information based on the current productivity of farmers. However, the productivity of agricultural system in the Ethiopia is very low. The poor production and productivity of crop and livestock resulted in food insecurity. Therefore, assessing the factors responsible for low production and productivity of smallholder mixed crop-livestock farmers in Ethiopia in general, particularly wheat production was dominant importance(Beshir, 2016).

Objective of the Review

The general objective of this study is to review the determinants of technical efficiency of wheat production in Ethiopia with the following specific;

- To review sources of technical inefficiency of Wheat production
- To review determinants of technical efficiency of wheat producing farmers in Ethiopia.

DISCUSSIONS

Concepts of Technical Efficiency

One of the basic thrusts of economics of agricultural production at the micro level is to assist individual farmers or a group of farmers to attain their objectives through efficient intra-farm allocation of resources at a particular time or over a period. Efficiency is achieved either by maximizing output from given resources or by minimizing the resources required for producing a given output (Varian, 1992). In economic theory, production efficiency comprises technical and allocative efficiencies, with technical efficiency reflecting the ability of a farm to maximize output for a given set of resource inputs while allocative (factor price) efficiency reflects the ability of the farm to use the inputs in optimal proportions given their respective prices and production technology (Farrell, 1957).

Technical efficiency can either be output or input-oriented. An output-oriented technical efficiency occurs when the maximum amount of an output is produced for a given set of inputs while an input-oriented technical efficiency occurs when the minimum amount of inputs are required to produce a given output level (Farrell, 1957). Therefore, technical efficiencies are derived from production function or production possibility frontiers

(Njeru, 2010).

Overview of production function and efficiency

Estimation of production functions and technical efficiency is one of the most popular areas of research. In microeconomic theory, production is defined as the process of transforming inputs (raw materials) into outputs. A production function represents technological relationships between inputs and outputs (Abebe and Hess, 2014). In particular, it shows the maximum level of output the firm can produce combining the existing inputs (Besanko and Braeutigam, 2005). A particular production function can be specified as: $f(xi) = max\{yi: T(xi, yi)\}$

In general, the level of output can be increased in several ways. Firstly, by expanding the level of inputs used in production. This approach is called "horizontal expansion". However, increasing use of inputs is only possible if either the price of inputs decrease or the price of output increases. Secondly, output can be increased by enhancing efficiency in production (Abebe and Hess, 2014). This approach is termed as "improvement approach" and requires the improvement of socio-economic, institutional and environmental constraints to enhance production using the existing inputs. Thirdly, output can be also increased by improving the technology in production. This includes use of improved techniques of production, improved seeds, modern fertilizer and chemicals. This approach is termed the "transformation approach" (Alene, 2003).

Most often, different studies use the terms productivity and efficiency interchangeably, though they are not exactly the same. Productivity refers to the ratio of output(s) to input(s) while; efficiency is the highest productivity level from each input level (Coelli and Rao, 1998). Farrell (1957) classified efficiency as technical (physical), allocative (price) and economic (overall) efficiency. Technical efficiency shows the ability of farmers to produce maximum amount of output using the existing level of inputs. On the other hand, allocative efficiency measures the ability of farmers to use inputs in an optimal proportion, given the price of inputs and outputs. A firm is economically (overall) efficient if it achieves both technical and allocative efficiencies.

Determinants of technical efficiency of Wheat production

The focus of this review is to provide an empirical evidence of the determinants of productivity variability/inefficiency gaps among smallholder wheat farmers in the Ethiopia. Having knowledge that farmers are technically inefficient might not be useful unless the sources of the inefficiency are identified.

With regard to the sources of technical efficiency differentials among different household farmers, the estimates of technical inefficiency effects model provide some important insights. According to Tiruneh and Indirias (2016), sex, age, education, distance to all weather roads, livestock holding, group membership, farm size, farm fragmentation, tenure status and investment on fertilizers were found significant factors determining the inefficiency of wheat producers. In the study it was indicated that male headed households were operating more efficiently than their female counterparts.

According to Wudineh and Endrias(2016) education improves the ability of the household to make informed decision about production inputs. Educated farmers more often have better access to agricultural information and higher tendency to adopt and utilize improved inputs (like fertilizers and crop varieties) more optimally and efficiently (Endrias, 2013), Mesay *et al*. (2013) and Asogwa *et al*. (2012).

The distance to all weather roads was also found negatively related with technical efficiency indicating that farmers living with distant areas from all-weather roads operate more farm activities efficiently than the nearby farmers. This might be related to the availability of more off-farm activities near to all weather roads and farmers more likely spent more times outside their farm (Tan *et al*., 2010)).

According to Beshir *et al*. (2012) the livestock in tropical livestock unit is negatively affect inefficiency and significant in wheat production. This might be because livestock provides manure as fertilizer, cash to finance input expenses and draught power.

According to Daniel *et al.* (2008) and Kariuki *et al*. (2008), farmers involved in more than one farmers' group manage their wheat plots efficiently than farmers involved only in one farmers' group. This indicates that farmers who belong to a more technical group are most likely to benefit from better access to information on improved inputs and practices.

The variable land fragmentation represents the number of parcels of land on which farmers allocated for their wheat production. It was indicated that having more plots in the crops under consideration improves the level of technical efficiency of farmers (Mesay et al., 2013, Tan et al., 2010).

According to Tiruneh and Indirias (2016) tenure status or land tenancy variable is included in the model to estimate the effects of tenancy status on the level of wheat growers' technical inefficiencies. In this study it was found that a strong relationship between tenure security and technical efficiency of wheat production.

Cost of fertilizers or investment on fertilizers is the variable mainly justified on the view that the more investment on the fertilizers by farmers can improve wheat productivity. The results of this study revealed that there was a negative and significant relationship between investment on inorganic fertilizers and technical inefficiency (Wudineh and Endrias, 2016).

According to Bashir et al. (2016) off farm income was positive and significant with technical inefficiency. This implied that, farmers who participated in off-farm work were likely to be less efficient in farming as they share their time between farming and other income-generating activities. Productivity suffers when any part of production is neglected. Many farmers employed in activities related with the off-farm production and the majority neglect weeding of their wheat crop.

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

The main objective dealt with in this review is to assess the technical efficiency of wheat smallholder producers and its determinant factors in Ethiopia. It is found that smallholder wheat farmers are inefficient in resources used in the production of wheat in the county. The review of efficiency analysis show that the mean technical efficiencies were not operating at the possibility production frontier and there is a considerable potential to increase the productivity of wheat with the present technologies and inputs available to smallholder wheat farmers.

The analysis of the relationships between technical efficiency and socioeconomic variables have effect on wheat farm efficiency were reviewed. The identified determinants of technical efficiency in this review are sex, age, education, and distance to all weather roads, livestock holding, fragmentation, tenure status, off-farm and investment on fertilizers.

Recommendations

The results of this review give information to policy makers on how to improve the technical efficiency and optimal use of resources in production of wheat sub-sector in Ethiopia. The following recommendations have been drawn based on the review.

- It is important to give due attention for farmers education through establishing and strengthening informal education and short term trainings by using the available human and infrastructural facilities like extension agents and Farmers Training Centers (FTCs).
- Initiate and support gender-sensitive agricultural intervention to improve female headed farm inefficiency.
- Strengthening the existing farmers groups be it formal or informal and promoting the formation of other farmers groups.
- Policy initiatives that improve the livestock holding of farmers through improved livestock breeds, forage and nutrition and health services have to be put in place.
- Encouraging farmers to conserve the soil fertility improvement actions by reducing the risks and keeping their land fertile.

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