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Profit efficiency analysis among groundnut farmers from Malawi

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This study analyzes the profit efficiency and its determinants in groundnut production, applying a stochastic profit frontier model on survey data collected from 400 groundnut growing households in Malawi. The result indicated that the inefficiencies in groundnut production hindered profitability in the sector. The profit efficiency ranged from 1% to 89% (with a mean of 45%). Significant association was observed between efficiency and both farm specific and institutional factors. Efficiency appeared to be significantly and positively associated with access to extension service ($p<0.05$), household size ($p<0.05$) and, soil quality ($p<0.000$). Distance to the local market from the homestead ($p<0.000$), and land size ($p<0.000$) allocated to groundnut production were found to reduce the profit efficiency. Male-headed households, on the average were six percent more efficient compared to female headed households. The study indicated potential for increasing groundnut profitability by 55% by improving the access to extension services and markets, which underscores the need for increased resource allocation to support the delivery of extension services and to the improvement of market infrastructure for the enhancement of groundnut profitability.

Key words: Groundnut production, profit efficiency, agricultural productivity, extension, Malawi.

INTRODUCTION

Despite the crucial role of dryland legumes for poverty reduction, inefficiencies and lack of technological change have often restricted small producers into subsistence production and contributed to the stagnation of the sector in developing countries (Asfaw et al., 2012; Ghosh and Mandal, 2015; Shiferaw et al., 2011). Groundnut (*Arachis hypogaea* (L.)), also known as peanut, is an oilseed crop, principally grown by smallholder farmers in developing countries under rain-fed condition (Freman et al., 1999; Okello et al., 2010). In the face of increasing population and associated rise in food demand which further triggers food price rises, the need for increased agricultural productivity as an effective means to improve the livelihood of farm households cannot be over-emphasized.

In literature, three main possible ways have been cited as sources of growth in agricultural production: The first involves expanding the area under crop cover; the second

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involves increasing the use of scientific research to generate improved varieties that are tolerant to multiple stresses and high yielding, and thirdly through improving efficiency in resource use and allocation to obtain higher production from limited land resources and current level of technology.

However, as argued by de Janvry et al. (2003), the increase in production cannot only and sustainably come from area expansion, since that has already become a minimal source of output growth at a world scale and negative source of output growth in India and Latin America; thus the recommended growth in the production will have to come from growth in yields emanating from scientific advances offered by biotechnology and other plant breeding initiatives, as well as from efficient use of resources; a similar argument was presented by Kassie et al. (2011) and Mendola (2007). Moreover, studies found that land expansion seems impossible since the population keeps on increasing and subsequently, the per-capita land is already at its minimal making it impossible to expand the area under cultivation (Asfaw et al., 2012; de Janvry et al., 2003; Islam, 1995). The second option of increasing productivity through technology innovation and application also requires complementation since it faces several constraints like, technology adoption is time consuming, requires high level of technical knowledge to implement, can be risky, costly and inaccessible, which hinders technology adoption (Abateet al., 2016; Brick and Visser, 2015; Lambrecht et al., 2014; Parks et al., 2015). Therefore, the promising solution to increase food production mainly lies in increasing land productivity by improving resource use efficiency (Islam, 1995; Rahman, 2003). The foregoing arguments underscore the need for increased efficiency as a way of increasing productivity and this is a major focus in this study

Groundnut provides dietary nutrients and income for humans, and protein rich fodder for livestock (Chinma et al., 2014; John et al., 2004; Okello et al., 2010); it contributes to food security and overall economic growth (Kassie et al., 2011; Thuo et al., 2014); moreover, it is a stable crop in Eastern and Southern African countries, especially in Uganda, Kenya and Malawi, and has the highest return for labor inputs compared with other crops (Okello et al., 2010; Thuo et al., 2014). In Malawi, although groundnut production has been on the rise, the productivity remains low with average yield of 7 t/ha in smallholder farms (Simtowe et al., 2010); similar findings have been reported in Kenya, where productivity of the crop has been reported to range between 30 and 50%, below the potential yield, with an average output level of 6 to 7 t/ha; and in Uganda with a yield of 8 t/ha, against the potential yield of 30 t/ha (Minde et al., 2016; Okello et al., 2010; Thuo et al., 2014). High levels of inefficiency by smallholder groundnut producers have led to lower productivity (Okello et al., 2010; Simtowe et al., 2010). In the face of increasing population and associated rise in food demand which further triggers food price, the need for increased agricultural productivity as an effective path to improve the livelihood of farm households cannot be over-emphasized.

This paper applies a profit frontier approach to data collected from groundnut producers in Malawi in order to assess the level of profit efficiency, as well as to identify factors affecting profit efficiency. In Malawi, although groundnut production has been on the rise, the productivity remains low, with average yield in smallholder farms of 700 kg/ha partly due to the high levels of technical inefficiency by smallholder farmers. Production efficiency is usually analyzed by three components - technical, allocative, and scale efficiency, with the popular approach being the measurement of technical efficiency using the frontier production function. However, as expressed by Ali and Flinn (1989) applying the production function approach to measure technical efficiency may not be appropriate when farmers are faced with different prices and have different factor endowments. Hence, they recommend the application of a stochastic profit function model to estimate farm specific efficiency. The profit function approach combines the concepts of technical, allocative and scale inefficiency in the profit relationship, and any errors in the production decision are assumed to be translated into lower profits or revenue for the producer (Rahman, 2003). Ali and Flinn (1989) define “Profit efficiency” as the ability of a farm to achieve the highest possible profits given the prices and levels of fixed factors of that farm, while they define profit inefficiency as loss of profit from not operating on the frontier. To the best of our knowledge, this is the first study to apply profit efficiency approach to the groundnut sector in Malawi.

The empirical questions being addressed are: (1) How efficient are groundnut producers in Malawi in terms of profit? (2) What circumstance leads to higher profit efficiency levels?

Overview of groundnut production and significance

Groundnut production is one of the most important agricultural activities in the world (Taru et al., 2008); adaptability of the crop to dry condition, coherently with the lower input requirement makes it the most suitable crop in the tropics and subtropics (Abiba et al., 2012; Simtowe et al., 2010). Although it originated from South America, it is now widely cutivated in tropical, sub-tropical, and warm temperate areas of Asia, Africa, North and South America and Oceania (Freman et al., 1999; John et al., 2004; Okello et al., 2010; Taru et al., 2008); and it is the most widely cultivated legume in Malawi (Simtowe et al., 2010). In 2012, the world groundnut production was 45.65 million tons; China, India and USA accounted for about 37, 10 and 7%, respectively of the total production (FAOSTAT, 2014). Africa accounts for about 24% of the world groundnut production in 2012. In

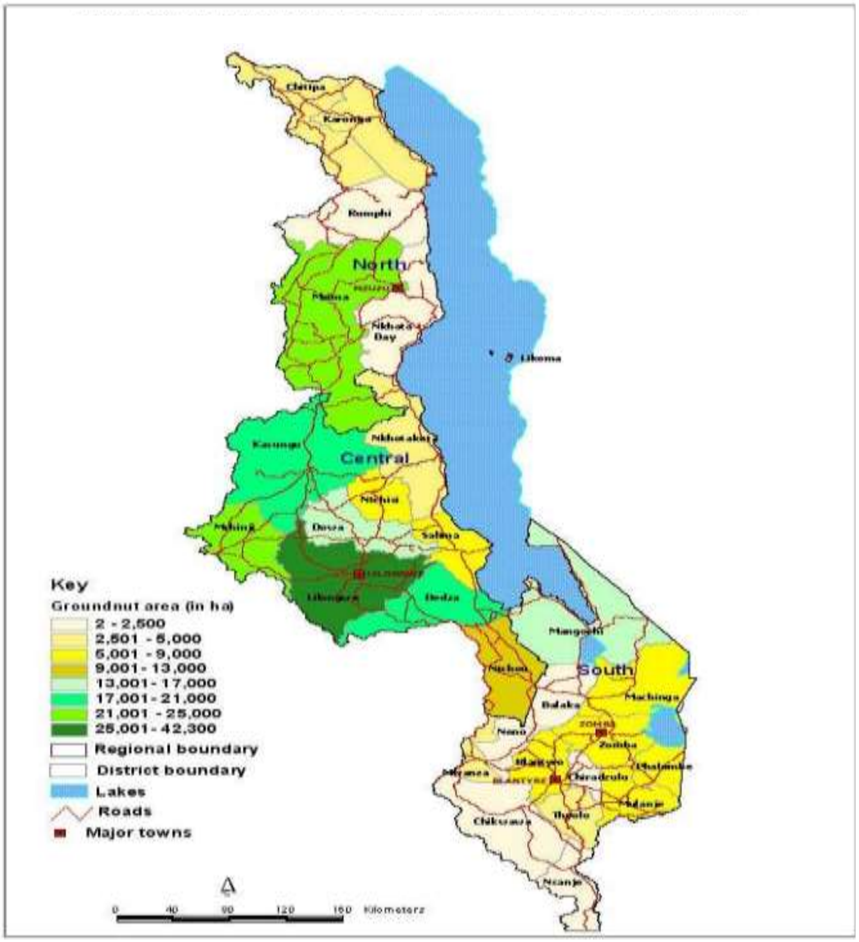

Figure 1. Distribution of area under groundnut production in Malawi.

Africa with a total production of 0.59 million tons, the contribution of Malawi is about 2.48% which makes the country to be the 13th largest groundnut producer in the world (FAOSTAT, 2014).

Globally, groundnut forms an important component of both rural and urban diet through its provision of valuable protein, edible oil, fats, energy, minerals, and vitamins (Ayoola et al., 2012; John et al., 2004; Nagalakshmi et al., 2011). Groundnut is one of the nutritionally rich crops, which can substitute high cost animal-based diets; for instance, groundnuts seed (raw, sundried and roasted) contains 24.70, 21.80 and 18.40% of protein and 46.10, 43.80 and 40.60% of fat, respectively (Ayoola et al., 2012). The crop is consumed as fresh, roasted (more than 32% of supply), or processed into oil (about 52% of supply) (Simtowe et al., 2010). Moreover, it is an important source of vitamins, calcium, and fiber (Ayoola et al., 2012). In addition, groundnut cake is safe, rich in protein, and crude oil and is used in livestock feed (Nagalakshmi et al., 2011) where it increases livestock productivity since groundnut haulm and seed cake are rich in digestible crude protein content (Abiba et al., 2012). Furthermore, as a legume, groundnut fixes atmospheric nitrogen in soil and thus improves soil fertility and saves fertilizer cost in subsequent crops production (Simtowe et al., 2010; Toomsan et al., 1995). This is particularly important when considering the context of the rising price in chemical fertilizers, which makes it difficult for farmers to purchase. The crop provides a number of benefits to farmers in developing countries. In Malawi and Senegal, for example, groundnut accounts for 25 and 60% of household agricultural income, and contributes about 70% jobs for rural households, respectively (John et al., 2004).

For instance, over the past four decades in Malawi, area under groundnut yield and production grew by 3.4, 3.6 and 5%, respectively (Abiba et al., 2012; Simtowe et al., 2010). Although produced in the entire country, the central and southern Agricultural Development Divisions (ADDs) of Kasungu, Lilongwe, Kasungu, Machinga, and Blantyre accounted for more than 75% of the total area planted to groundnuts in the period 2001 to 2006. A summary map indicating the major groundnut growing areas of the country is given in Figure 1. With regards to the production systems, groundnut is mainly a rain-fed crop cultivated either as a sole crop or in intercropped with cereals such as maize, sorghum or millet or grain legumes (Abiba et al., 2012). Malawi's groundnut productivity remains low largely due to the continued use of unimproved/local varieties by producers as well as due to technical inefficiency (Abiba et al., 2012; Simtowe et al., 2010).

Moreover, the groundnut sector in Malawi is constrained by poor productivity as well as low-marketed surplus from smallholder farmers (Abiba et al., 2012; Minde et al., 2016; Simtowe et al., 2010). Even when improved varieties such as CG7 are adopted, they are highly susceptible to rosette attack hence their potential productivity gains are lost to diseases attack (Abiba et al., 2012; Minde et al., 2016; Simtowe et al., 2010). The adoption of improved groundnut varieties is said to be constrained by lack of awareness of the improved groundnut varieties and other constraints such as seed. Furthermore, the production of groundnuts has remained low in the last two decades due to the poor quality of groundnuts produced in Malawi, resulting from high aflatoxin levels. This further led to a reduction in the export volumes. Current policies have emphasized the need for supporting the production of high quality groundnuts with lower aflatoxin levels and on proper post-harvest handling techniques that reduce the buildup of aflatoxin (Abiba et al., 2012; Minde et al., 2016).

MATERIALS AND METHODS

Data

Primary cross section data for this study is extracted from a survey conducted in four districts of Malawi in 2008. The data were collected by International Crops Research Institute for Semi-Arid Tropics (ICRISAT) in collaboration with Center for Agricultural Research and Development (CARD) of the University of Malawi and Malawian National Small Farmers Association (NASFAR). The survey was completed on 600 households of which 426 household reported growing groundnut. After cleaning the data and computing the profit frontier at household level, 388 households were found to be eligible for the application of the stochastic profit frontier analysis to identify the determinants of profit efficiency; data were collected at both village and household levels. The village level data acquired included information on major crops grown, price for different crops, and access to infrastructure. While household level data information included knowledge, farming experience on groundnut varieties, demographic characteristics, asset, area planted and area owned, production cost, yield, input use, consumption, marketing and participation in different institutions.

Definition of variables used in efficiency analysis and the hypothesis

The profit frontier model requires data on both outputs as well as the inputs used in production. A description of variables used in the analysis of profit efficiency and their expected relationship are presented in the subsequent section. Since quantity produced of groundnut has direct implication on revenue, profit, and profit efficiency, quantity of groundnut produced at household level was presented. Price of inputs and outputs is also one of the main factors used in the profit estimation process; therefore, the price of inputs and outputs is discussed. Household size can have a positive impact by availing the labor that will be used in the groundnuts production system, therefore, it is hypothesized that the larger the household size the larger the production volume and hence, increased revenue, and at same time reducing the cost of labor, resulting in higher profit margin. The total area cultivated i by the household is included in the efficiency analysis and serves to test the null hypothesis that larger farmers are more efficient than the smaller farmers. The gender of the household head dummy which takes one if male, and zero if the head is female was included in the model to explore the relationship between profit efficiency and gender; and to test the hypothesis that male-headed households are more efficient in resource use than females. The distance to the nearest market place from the household in kilometers was used as proxy to market access. Distance to market place might have impact on the access to information and agricultural technology and thus influences the level of efficiency (Thuo et al., 2014), since access to market encourage surplus production for market and also enhance access to agricultural inputs, it is expected to have positive impact on efficiency by minimizing the transaction costs (Latruffe et al., 2004). Participation in an extension program dummy, which is equals 1 if the farmers received extension service and 0 otherwise, is included to test the hypothesis that access to extension service improves efficiency (Kilic et al., 2009; Mango et al., 2015). Soil quality was included to test how the soil quality influences efficiency. In addition to the level variables the second order variables and logarithmic, and their interaction terms of labor, land, seed, and fertilizer, were included in the efficiency model.

Theoretical framework for measuring efficiency/inefficiency using profit frontier function

In literature, farmers' production efficiency is mainly assessed by employing technical, allocative and scale efficiency. A farmer is said to be technically inefficient, for a given level of input use, if the output level is below the optimal (frontier output). Allocative inefficiency occurs if the farmer is not using input in proportion that is optimal, that is, the ratio of marginal product of input equated with the input price ratio. In profit context a farmer can be scale inefficient, if the output level is at the level where product price is not equal to the marginal cost (Kumbhakar et al., 1989; Rahman, 2003). Studies found differences in the efficiency among farmers measured by regressing the predicted efficiency from the frontier production function on household characteristics (Bozoğlu and Ceyhan, 2007; Wang et al., 1996). The conventional production frontier function used to analyze the technical efficiency received a severe criticism in its capability to yield reliable estimates, particularly when farmers face different prices and have heterogeneous resources endowment (Ali and Flinn, 1989; Tzouvelekas et al., 2001). Moreover, single stage analysis of efficiency using production function assumes the independence between input and inefficiency (Kumbhakar, 2001). This problem can be solved using a more general profit efficiency technique; which combines the three components of production efficiency into one system and enables simultaneous computation (Ali and Flinn, 1989; Rahman, 2003); and both outputs and inputs are determined endogenously (Kumbhakar, 2001).The profit efficiency assumes that any inefficiency in production system can be translated into lowered revenue or profit. Profit efficiency thus measures the ability of farmer to attain the possible maximum revenue or profit from given level of input and output prices. Therefore, inefficiency defined in the context of profit efficiency as loss of profit (the difference between actual and frontier profit) (Ali and Flinn, 1989). In this study we adopt the stochastic profit frontier function model used in Battese and Coelli (1995); this model measures the three components of efficiency simultaneously, gives more robust results with single estimation. This model allows simultaneous estimation of farm specific efficiency and factors explaining the efficiency differentials simultaneously (Battese and Coelli, 1995; Rahman, 2003).

Measuring efficiency

Production efficiency is usually analyzed by its three components: Technical, allocative, and scale efficiency. Previous studies mainly focused on understanding economic, technical, or scale efficiency in production system (Bravo-Ureta and Pinheiro, 1997; Villano and Fleming, 2006). The popular approach to measure technical efficiency was using the frontier production function (Villano and Fleming, 2006). However, the production function approach to measure efficiency, particularly, technical efficiency component may not be appropriate when farmers face different prices and have different factor of endowments (Ali and Flinn, 1989). Hence, Ali and Flinn (1989) recommend the application of a stochastic profit frontier model to estimate farm specific efficiency. This approach combines the three concepts of technical, allocative and scale inefficiency in the profit relationship and assumes any error in the production decision translated into lower profits or revenue for the producer (Rahman, 2003). According to definition by Ali and Flinn (1989), profit efficiency is the ability of a farmer to achieve highest possible profit given the prices and levels of fixed factors of the farm; while they define profit inefficiency as loss of profit from not operating on the frontier.

Specification of empirical model

As in Battese and Coelli (1995) and Rahman (2003), stochastic profit function was mathematically defined as follows:

$$\pi_i f(P_i, Z_i).\exp(\varphi_i) \tag{1}$$

Where π_i is normalized profit (revenue less variable cost) of i^{th} groundnuts producing farmer divide by farm-specific (per kg groundnut price); P_i is the vector of input prices (labor, seed, fertilizer, manure) paid by farmer divided by the output price; Z_i is a vector of fixed inputs of i^{th} farm household; and φ_i is an error term for i=1, 2…, n is the number of households in the sample. The error term φ_i has distribution consistent with the assumption of the frontier function, means that, φ_i is the difference in statistical (noise),v_i, term and inefficiency term, u_i. Thus φ_i can be presented as follows:

$$\varphi_i = v_i - u_i \tag{2}$$

Where v_i is independently and identically and normally, $NII(0, \delta_v^2)$, distributed two sided random errors, independent of u_is and the $u_i{}'s$ are the non-negative random variables associated with inefficiency in production function; u_i are independent and zero truncated normal distribution with mean $\mu_i = \delta_0 + \sum_d \delta_d W_{di}$ and variance of $\delta_u^2(|N(\mu_i, \delta_u^2|)$, where W_{di} is the variable associated with inefficiency of i^{th} household; and δ_d and δ_0 are unknown parameters to be estimated. The profit efficiency of i^{th} farm household in the context of stochastic frontier profit function is defined as:

$$E(\varphi_i) = E(v_i - u_i) = E(\exp(-u_i|\varphi_i)) = E\left(\exp\left(-(\delta_0 + \textstyle\sum_d \delta_d W_{di})\right)|\varphi_i\right) \tag{3}$$

Where E is the expectation operator; the result can be achieved by expressing the conditional expectation of u_i given φ_i. Maximum likelihood estimation can be used to estimate the unknown parameters, with stochastic frontier profit function and efficiency functions are estimated simultaneously. The likelihood estimates are presented as the variance parameters, $\delta^2 = \delta_v^2 + \delta_u^2$ and the $\gamma = {\delta_u^2}/{\delta^2}$ (Battese and Coelli, 1995).

The general form of the translog profit function after further computation can be presented as follows:

$$ln\pi' = \alpha_0 + \sum_{i=1}^4 \alpha_i lnP_i' + \frac{1}{2}\sum_{i=1}^4 \sum_{k=1}^4 \omega_{ik} lnP_i' \, lnP_k' + \frac{1}{2}\sum_{i=1}^4 \theta_i lnP_i' \, lnP_i' + v - u \quad \text{and} \quad u = \delta_0 + \sum_d \delta_d W_{di} + \rho \tag{4}$$

Where $ln\pi'$ is the natural logarithm profit normalized by the output price $, P_y$, $P_i'$is the price i^{th} input (fertilizer, labor, seed, land) normalized by output price,P_y. $\alpha_i, \omega_{ik}, \theta_i, \delta_i$ are parameters to be estimated; v is two sided random error term and u is one-sided half-normal error term accounting for inefficiency.

RESULTS AND DISCUSSION

Characteristics of groundnut producers

Table 1 presents a summary of variables used in the profit efficiency analysis. It is evident that per household profit was very small and the production volume was also small. On average, households produced 196 kg of groundnuts and generated a profit of 13,270 Malawian Kwacha (MK) or $22.57 per year. The average per kg groundnut price is 52 MK. The average price of fertilizer and seed about was MK17 and MK50, respectively. The average land cultivated was 5.22 ha and an average of household size of 5. The majority (77%) of the respondents in the groundnut production system in Malawi were male-headed households (Table 1). On average a farmer has to travel 1.24 km to the nearest local market. Only, 5% of the groundnut producers received extension service (Table 1). The fact that the majority of sampled households were not getting extension services has a negative implication for modernizing agricultural production and for the enhancement of productivity by smallholder farmers. About 15% of the respondents had poor soil quality, while about two-third, reported having medium quality soil. The remaining, 21% expressed perceiving that the soil was of a good quality.

Determinants of profit efficiency

The maximum likelihood estimates on factors contributing to inefficiency and the estimated coefficients for the variance parameter are presented in the inefficiency section and variance parameter section of Table 2, respectively. The estimated variance parameter, δ^2, coefficients were statistically significant (p<0.000)

Table 1. Descriptive analysis of variables used in the model.

Variable	Mean	Std. Dev.
Number of observation (n)	388	
Product (production in kg/HH)	195	222
Profit (MK/HH)	9,972	11,355
Price of groundnuts (MK/kg)	52	23
Seed price (MK/kg)	50	273
Area operated (hectare)	5.22	4.35
Distance to local market (km)	1.24	2.54
Access to extension (1=yes, 0=no)	0.05	0.23
Household size (person)	5.19	2.20
Gender head (1=male, 0=female)	0.77	0.42
Poor soil quality (1=yes, 0=no)	0.15	0.60
Medium soil quality (1=yes, 0=no)	0.64	0.48
Good soil quality (1=yes, 0=no)	0.21	0.41
Plot size (hectare)	1.02	0.80

Source: Authors estimation from survey. Malawian Kwacha equals (MK) 0.0023 USD.

Table 2. Maximum likelihood estimates of profit frontier function for groundnut producers in Malawi depending on variable logarithmic of normalized profit.

Profit function	Coef.	z	P>z
lnLabor, logarithmic of labor used in man days	6.33	1.36	0.175
lnSeed, logarithmic of seed price MK	-0.98	-1.42	0.156
lnLand, logarithmic of land used in hectares	1.21	0.54	0.591
lnFert, logarithmic of fertilizer price MK	-1.98	-0.73	0.466
LnLandLnFert	-0.72	-1.32	0.186
LnSeedLnFert	-0.90*	-1.65	0.100
LnLabLnFert	1.91	1.47	0.142
LnLabLnSeed	0.33	1.05	0.292
LnManLnLand	-0.48	-0.43	0.669
LnSeedLnLand	-0.26*	-1.78	0.074
LnLabor2	-3.70	-1.53	0.127
LnSeed2	0.24**	2.34	0.019
LnLand2	0.20	1.16	0.245
LnFert2	-0.34*	-1.75	0.080
Constant	0.51	0.11	0.913
Inefficiency			
Gender head (1=male, 0=female)	-0.18	-0.88	0.381
Distance to local market (km)	0.25***	6.30	0.000
Access to extension (1=yes, 0=no)	-0.91**	-2.10	0.036
Household size (person)	-0.08*	-1.78	0.075
Medium soil quality (1=yes, 0=no)*	-0.26	-1.08	0.279
Good soil quality (1=yes, 0=no)	-1.11***	-3.56	0.000
Plot size (hectare)[#]	0.84***	5.33	0.000
Constant	0.17	0.43	0.667
Variance parameters			
Gamma δ^2	0.29	6.54	0.000
Rho γ	0.19	10.83	0.000
Log likelihood (x^2)	-499***	5.52	0.000

*Dummy for poor soil quality is used as base for soil fertility analysis. [#] the size of a plot in hectare under groundnut production.

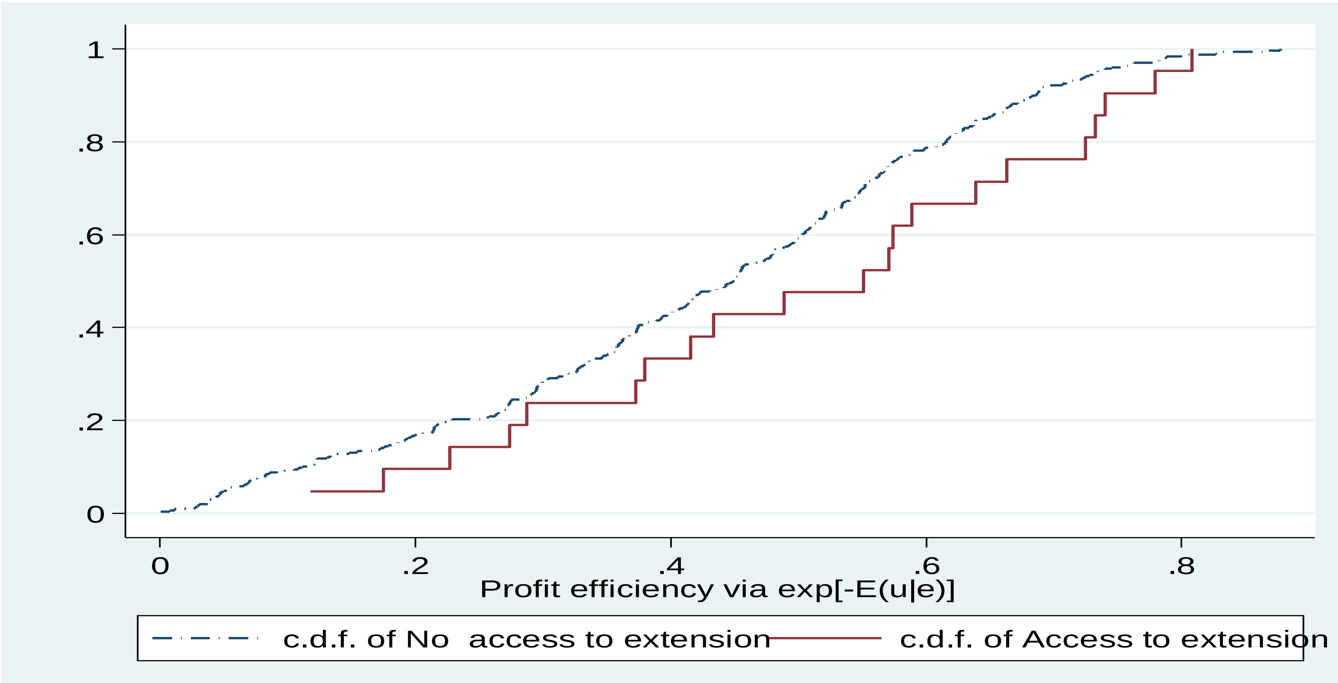

Figure 2. Profit efficiency among farmers that received extension services through PVS and those that did not.

indicating that technical inefficiency were playing negative role in the groundnut production system in Malawi (Table 2). In the inefficiency model, area allocated to groundnut production was included to expound the difference in technical efficiency if any, which may arise from difference in farming scale. As the area allocated to groundnut production increases, it might lead to diminished timeliness of input used, and spreads of activities over time, one may expect difficulties for larger farmers to operate at an optimal input use level (Amara et al., 1999). The positive sign of the coefficient on the plot size (groundnut area measured in hectare) implies that the larger the area allocated to groundnut production the smaller is the efficiency level. Similar result was reported regarding the relationship between farm size and efficiency in other studies (Amara et al., 1999; Hallam and Machado, 1996; Tzouvelekas et al., 2001).

As expected, distance to the local market has a statistically significant negative impact on the efficiency level. One more kilometer from the local market is associated with a 25% loss in profit efficiency, a finding consistent with Tan et al. (2010). This is mainly because of the increased cost of transportation and less access to marketing and production technology for those who live in the remote areas. Another outcome of the efficiency model was the positive and significant effect of extension service on profit efficiency (Binam et al., 2003). It is indicated that farmers that have received extension service through participatory variety selection (PVS) were more efficient than those who do not. As depicted in Figure 2 The dotted line representing profit efficiencies by farmers without access to extension through PVS is above the solid line for the profit efficiency of the farmers with access extension. This shows that a higher percentage of all farmers with no access to PVS extension services are in the lower profit efficiency ranges.

This result is consistent with the expectation as well as the previous studies such as Mango et al. (2015) and Latruffe et al. (2004), which confirms the fact that extension service provides technical support, including practice on right input use, market information and training on improved farming techniques. The coefficient of the household size variable in efficiency model indicates that households with larger family size are more efficient in resource use. Increasing the number of residents by one person in the house increases the profit efficiency by 8%. This may be explained by the fact that groundnut production is one of labor intensive activities and family labor is an important input to increase production efficiency hence profit efficiency. Soil fertility plays a crucial role in profit efficiency; farmers growing groundnuts on good soil quality are 110% efficient compared with those who grew on poor soil.

Efficiency ranges

The average profit efficiency among the groundnut producers in Malawi is 0.45. As depicted in Figure 3, a wide range of profit efficiency is observed among the groundnut producing farmers with minimum being 0.005

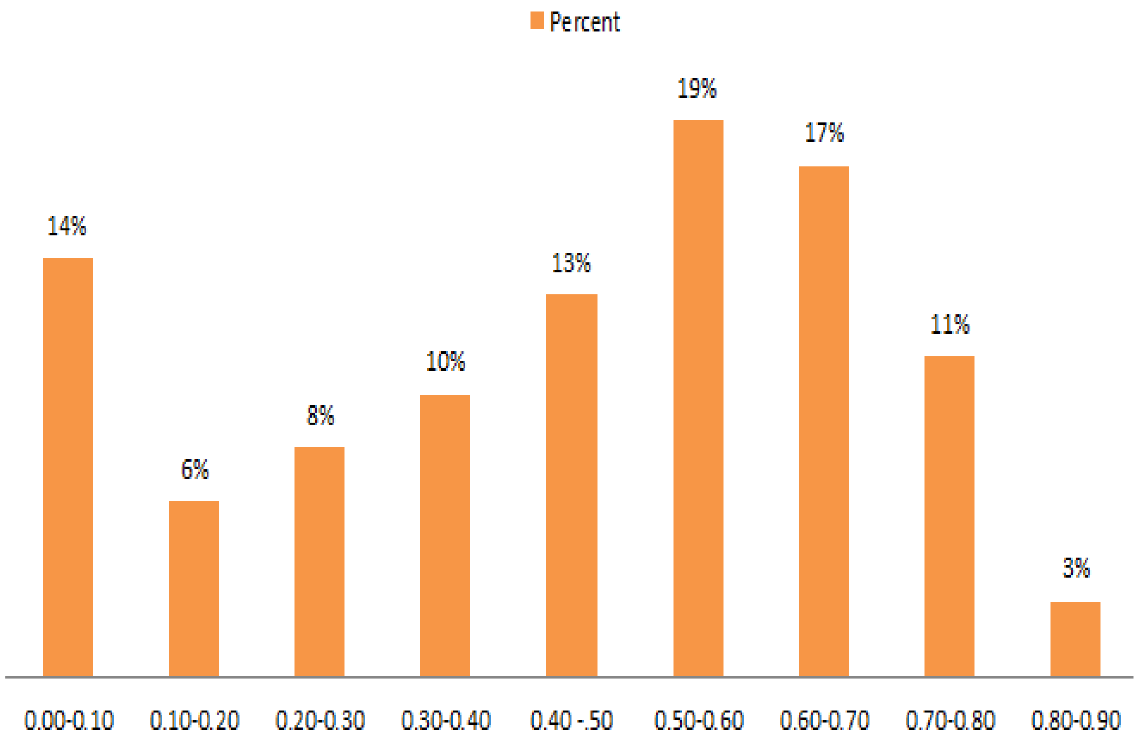

Figure 3. Percenatge distribution of profit efficiency score in Malawi.

and maximum value of 0.89, which suggests that groundnut production can be increased by about 55% by improving technical, allocative or scale efficiency of farmers. This can be done through the provision of trainings on efficient agricultural input and right use. These results are consistent with the finding in Binam et al. (2003), who observed technical efficiencies of 36 and 47% in low income region of Côte d'Ivoire using different models. The results also imply that a similar level of output can be achieved with 55% lesser input use cost. Such a deviation of efficiency is not uncommon as other studies show similar variation. The findings are also consistent with Rahman (2003) who reported profit efficiencies of between 0.059 and 0.83 among rice farmers in Bangladesh and also consistent with Ali and Flinn (1989) who reported the mean profit efficiency of 0.72, with ranges of 0.13 and 0.95 among Basimati rice farmers in Pakistan. Other comparable studies include Wang et al. (1996) who reported a mean efficiency of 0.62 among farmers in China and Bozoğlu and Ceyhan (2007) who reported a mean efficiency of 0.82 among vegetable farms in Samsun province of Turkey. The distribution of groundnut producer over efficiency ranges reveals that 20% of the producers operate in efficiency range below 0.2 and only 3% operates on 0.8 and above efficiency level. About half of the groundnut producer farmers have efficiency between 0.4 and 0.7. About 50% of the ground producer has efficiency greater than estimated 0.45 efficiency; similarly, the efficiency level of about 50% of the farm household is below 0.5

Descriptive analysis of profit efficiency for different farm and institutional variables is presented in Table 3. Results indicate that male headed households generate 39% more actual profit and are 13% more efficient than their female counterparts, a factor attributed to higher landholding and larger production. The extension service plays an important role in improving knowledge about improved farming techniques and input use, coherently increasing efficiency (Hasan et al., 2013; Rahman, 2003). The result reveals that farmers receiving extension services generate 34% higher actual profit, 14% profit loss and are 20% more efficient than those that did not access extension services. Larger famers (farm size>3 ha are able to generate MK10,350 as profit compared with MK9,182 for small farmers (farm size ≤3 ha). Farmers who received extension service were 30% more efficient than those who do not.

The mean actual profit for farmers living within 2 km from the local market was MK11,053 compared to MK6,106 for those who live more than 2 km away from the local market. Similarly, the mean profit efficiency for farmers with market access (proxy by distance to market) was about 50% compared to about 30% of those without market access a result that is consistent with Ali and Flinn (1989). This can been explained by the fact that market places in Africa are an important sources of information and other facilities located near to the market place.

Table 3. Profit, profit loss and technical efficiency over key farm characteristics*.

Farm characteristics	Number	Actual profit	Estimated profit loss	Profit-efficiency
Gender of the household head				
Female	92	6,615	3,264	0.40
Male	296	10,933	4,571	0.46
t-ratio (female vs. male)		-4.47	-4.46	-2.48
Received extinction serves				
No	367	9,684	4211	0.44
Yes	21	14,596	5,148	0.57
t-ratio (non-receiver vs. receivers)		-1.60	-1.31	-2.74
Farm size#				
Small farm	137	9,182	3,858	0.46
Large farm	251	10,350	4,482	0.44
t-ratio (small vs. large farm)		-1.03	-2.01	0.66
Soil fertility				
Non-fertile&	306	8,929	4,040	0.42
Fertile	82	13,813	5,089	0.56
t-ratio (non-fertile vs. fertile)		-3.15	-2.35	-5.68
The distance to local market				
Distance greater than or 2 km	84	6,106	3,133	0.28
Distance less than 2 km	304	11,053	4,573	0.49
t-ratio (better access vs. weak access)		-3.89	-3.43	-7.33
All farms	388	9,950	4,262	0.45

Source: Authors estimation from survey. *T-ratios in the table is the significant level of the profit efficiency difference between different groups; #Households with landholding below 3 ha are categorized as smaller farms and with larger than 3 ha are larger farms; & Non fertile soil group is a combination poor and medium soil quality while fertile soil is a soil with good soil quality.

CONCLUSION AND POLICY RECOMMENDATION

To examine the profit efficiency levels and its determinants, this study applied profit frontier approach, which combines the three components of efficiency, namely, technical, economic and scale efficiency. The study used survey data collected from 388 rural groundnut producers in 2009, in Malawi. The result revealed the existence of substantial loss in groundnut production due to inefficiency. The analysis showed that inefficiency is strongly associated with both farmer specific characteristics and institutional factors. There exists a great variation on the level of profit, profit loss, and efficiency among the groundnut producers in Malawi. Gender of household head, access to extension service, household size, and farm size allocated to groundnut production, distance to market, and soil quality explain differences in efficiency. The estimated result further indicated that vast majority of producers operating at less than half of their potential. The estimated results suggest the window of opportunity to increase production of groundnuts from the current level by improving the allocative, economics, and scale efficiency by smallholder farmers. A number of factors were found to significantly explain the profit inefficiency and suggest potential target areas for improvement to achieve increased efficiency. Institutional factors such as access to extension service, and access to market raised profit efficiency.

Distance to market and larger plot size is significantly and negatively associated with the profit efficiency. The factors positively affecting profit efficiency are access to extension service and soil fertility. Other interesting finding from this study is that, though gender of the head of household does not significantly affect the level efficiency in frontier profit model the analysis of efficiency between male and female headed household reveals that male headed households incur higher profit losses compared with their female counterpart.

In conclusion, policies and programs aiming at improving food supply and food security through improved agricultural productivity, need to place attention on factors the enhance efficiency besides the provision of agricultural technology. It is possible to increase the productivity of groundnuts with the existing level of resources, if appropriate strategies were designed to improve the efficiency such as strengthening the extension service delivery systems and intervening through improved management and agronomic practices. It is also important to improve market infrastructure to create marketing incentives for surplus production, and to increase the market participation of by smallholders which will further improve and diversify their income generating sources.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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