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The Efficiency of Smallholder Maize Production in Zimbabwe; An Estimation of Technical Efficiency and Its Determinants

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Abstract
Productivity enhancement through more efficient utilisation of inputs was explored in this study using a stochastic frontier production approach to estimate technical efficiency and its determinants in maize production based on data from 300 smallholder farmers in Mazowe district. The study showed that technical efficiency can be increased significantly as a result of more farm visits by extension officers, more participation in agricultural training, membership to a social group and increasing access to credit. Unexpectedly, technical efficiency was found to decrease with higher education level of the farmer. The results imply that maize productivity gains in Zimbabwe can be significantly achieved through increasing extension conduct and agricultural training. To improve farmers' technical efficiencies, the study recommends that the government, private companies and donor community should capacitate extension officers with resources, skills and knowledge and also intensify on farmer training programs. Schemes to facilitate and improve both availability and access by farmers to modern farming inputs, including farm credit should be put in place.
Keywords: Smallholder maize farmers, Technical efficiency Maize productivity, Stochastic frontier production function.

1. Introduction

Over the past decade, maize production and productivity in Zimbabwe has been a topical issue among many local and international policy makers and development practitioners. Despite its staple status in Zimbabwe and hence centrality for domestic food security, improving rural household livelihoods and poverty amelioration, maize production and productivity in the country has been on the downward trend. This is against growing demand as represented by an average national population growth rate of 2.3% (WB, 2011) for Zimbabwe, and 2.68 for the SADC region (SADC, 2011). The declining maize productivity has threatened the future of an anticipated agro- based economic growth and poverty reduction efforts particularly in the smallholder farming sector who constitutes the majority of the farmers. Continued decline in maize output figures does not reflect well on the government's land reform programme, which has always been criticised by the western donor nations, while being lauded by government as a successful program(MAMID 2010). The smallholder sector is regarded as the cornerstone of agricultural development and contributes more than 70% of total maize produced in the country (Moyo and Sukume, 2006).

Against this backdrop, the Government of Zimbabwe (GoZ) and Non-Governmental Organisations (NGOs) introduced several initiatives aimed at boosting production to reverse the continuous free fall in maize production. The major theme of these initiatives was centred on provision of free and subsidized agricultural inputs and machinery mainly targeted at smallholder farming sector. Although the initiatives were executed in all the consecutive years since year 2000, nothing much has been achieved in terms of maize output growth (ZimVac, 2010). The failure to achieve enough maize output for the country following massive government support brings into question whether these inputs were efficiently used in maize production. It also brings to the fore the need to put in place additional and more comprehensive policies that can stimulate maize production so that the country becomes at least food self-sufficient. Evidence from strategic grain reserve (SGR) trends has shown continued decline since 1985, and complete depletion of the reserves by 2008 and the government having to call in private players to help import grain to cover the 2014-2016 , El nino related food deficits.

There is now a general consensus around the world that sustainable agricultural productivity should be centred on efficient use and allocation of resources in production (FAO, 2009; World Bank, 2010). Scholars such as Farrell (1957) and Aigner (1977) have also established that improving technical efficiency is the only appraisable way of increasing output in developing economies where production resources are dwindling and have limited scope of increasing land supply due to population pressure. Technical efficiency is generally associated with the possibility of farms producing at the maximum level of output from a given bundle of inputs. Technical efficiency is regarded as an important source of increasing productivity although usually ignored by many developing countries agricultural policies (Smaling, 1998). This fits in well with current thinking which places high regard on the concept of sustainable agricultural intensification and its variants (Matson et al 1997, World Bank 2006, FAO 2011) which concept emphasizes the optimum utilisation of production inputs in agriculture.

Given the strong relationship between technical efficiency and increased productivity gains, it becomes imperative to measure the level of technical efficiency in smallholder farmers and analyse the factors that contribute to it so that government and concerned stakeholders can work on these to raise maize productivity. This study is going to estimate technical efficiency levels and analyse its determinants in smallholder maize production using Mazowe district as a case study. An understanding of the level of technical efficiency and its determinants in maize farming can be fundamental in designing appropriate agricultural policies that yield greater results in stimulating output growth particularly in a nation where resources are meagre. Technical efficiency is also closely linked to production methods and technologies used to produce an output.

The role of maize remains critical to the national development agenda as the prime staple food for Zimbabwe. Food security in Zimbabwe has been, and continues to be anchored on maize production although the drier regions also grow small grains which are better adapted to these areas. Currently, the nation is experiencing an unprecedented decline in maize production particularly in smallholder farming sector (MAMID, 2010). The aggregate agriculture production index has also been on a downward trend since the year 2000 although signs of recovery have been noticed in 2011 (MoF, 2011). The downward trend in maize production has been attributed to several factors that range from macroeconomic policies, natural causes and sector specific policies. The main reason cited for the fall in maize output has been the fall in average maize yield across the farming zones. Another reason for the drop in maize production was the fact that many farmers have been switching from the less-lucrative maize to cash crops, such as tobacco, soybeans, sunflower, groundnut and paprika as a response to payment delays for the previous year's maize crop by the Grain Marketing Board (FAO, 2014). Given the importance of the maize crop in the economy, the continuous deterioration of production has retarded the pace of economic development, threatened the food security status and rural livelihoods of the nation. The declining performance of the maize sector has resulted in increased dependence on food imports, placing a heavy burden on the fiscus(MoF, 2010); and in some cases, recourse to food aid. The Ministry of Finance has been supporting the agricultural sector even outside the sector specific allocation on the national budget but all these efforts have not produced the desired output gains in maize production.

The paucity of technical efficiency studies in Zimbabwe under current production methods and technologies means that farmers, government, and food sector stakeholders have limited information on current achieved output levels versus the potential realisable output, ceteris paribus. Yet this particular piece of information is critical for farm level production planning and national level food reserves and strategic grain reserve management. Most of government's policies have focused less on addressing efficiency in production yet prospects of turning around the fortunes of the agricultural sector can be achieved by better understanding of technical efficiency and the set of variables that influence it. Therefore, accurate measurement of elasticities for technical efficiency variables is crucial in quantifying the likely changes in the variables and in determining the exact amount of incentive to stimulate agricultural production by the desired magnitude. This is the focus of this research exercise.

The measurement of technical efficiency has remained an area of important research both in the developing and developed countries. This is especially important in developing countries, where resources are scarce and opportunities for developing and adopting better technologies are limited. Studies on efficiency measurement help in laying a concrete foundation for precise policy formulation that gives the greatest impact on productivity growth (Rahman, 2005). Such studies yield enormous benefits through determining the extent to which it is possible to raise productivity by improving technical efficiency, hence raising returns per each resource unit employed, or raising output for each level of resource use. Agner (1977) defines technical efficiency as the ability of raising productivity levels from the existing levels of inputs also referred as the "best practise". Technical efficiency is achieved when a high level of output is realized given a similar level of inputs. It is therefore concerned with the efficiency of the input to output transformation. The main function of technical efficiency research is to understand factors that shift production function upwards (Esparon and Sturgess, 2000). The concept of technical efficiency using stochastic frontier production function is illustrated in Figure 1 below;

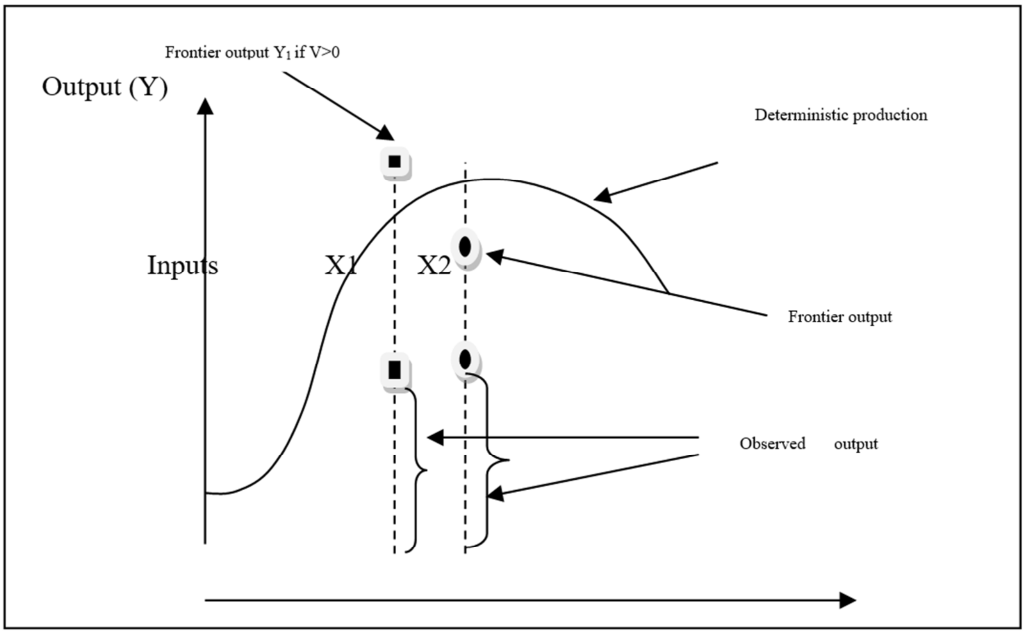

Figure 1: Illustration of technical efficiency concept

Source; Battese and Coelli, 1995

The curved line is a deterministic production frontier that best suits two farmers. Farmer A uses X1 inputs and yield observed output but his frontier potential is Y1. Failure to reach Y1 is due to technical inefficiencies and other random errors. This leads to two questions that must be answered. First, to what extent do the production units lie below the frontier? Second, what factors influence production units lying below the frontier?

Several alternative approaches of measuring technical efficiency are suggested and these are grouped into parametric and non-parametric frontiers (Greene, 2007). These methods differ mainly in the assumptions made about the functional form, whether or not random errors have been accounted for, and the probability distribution assumed for the inefficiency model. Non-parametric frontiers do not impose a functional form on the production frontiers and do not make assumptions about the error term. Data Envelopment Analysis (DEA) is one example while stochastic frontier is one example of parametric frontiers. Globally, there is a wide body of empirical research on the technical efficiency of farmers both in the developed and developing countries (Bravo-Ureta and Pinhero, 1995) but few studies focus on African agriculture and particularly Zimbabwe. Udry et al (1999), using detailed farm level agronomic data from Burkina Faso found out that the value of household output could be increased by 10-15% by reallocating currently used factors of production across plots.

Weir (1999) investigated the effects of education on farmer productivity of cereal crops in rural Ethiopia using stochastic production function. Results showed substantial internal benefits of schooling for farmer productivity in terms of efficiency gains but finds a threshold effect that implies at least four years of schooling are required to lead to significant farm level of technical efficiency. Ajibefun and Ogunayinka (2004) used a Tobit regression model to investigate the determinants of technical inefficiency among the farmers participating in the National Development Employment program in Nigeria. Results showed that extension visits and higher education were significant factors influencing technical inefficiency. The authors suggested that sound education, efficient input supply strategy and public awareness of efficient technology were the key factors necessary for policy consideration.

The main focus of the study was to measure the level of technical efficiency being achieved on average, by smallholder maize farmers in Mazowe district and isolating the factors that influence it. The main achievement of the study therefore, was to provide estimates of input elasticities for the critical inputs used in the production of maize in the study area. By assessing the elasticities it is conceivable to establish the quantitative relationships between inputs and achievable output, a critical input for crafting maize sector policies. The socio-economic factors affecting technical efficiency of smallholder maize farmers were investigated since they provide the levers on which policy can be exerted to provide the necessary incentivisation to influence production and hence output..

Specific questions to be answered by this study and in relation to the stated objectives above were the following:

a) Are smallholder maize farmers in Zimbabwe technically efficient?
b) Which socio-economic factors affect the level of technical efficiency in smallholder maize farmers in Zimbabwe?

c) Which factor(s) is technical efficiency more responsive to?

An attempt to provide objective and evidence based responses to these critical and related issues provided the main driving force behind this piece of work.

2.Methodology

2.1 Study Area

This study was carried out in Mazowe district, Mashonaland Central Province. The district was chosen purposively because of its significant contribution to national maize production and output. The district has great potential for crop production given the favourable climatic environment and good soil quality. These features have made the district a major recipient of government programmes aimed at boosting agricultural productivity. Smallholder farmers in the district, from both A1 Communal and Old Resettlement who share identical socioeconomic aspects and also located in geographical proximity, thereby occupying the same agro-climatic and marketing environment were selected. Five wards from each of the two categories in the district were purposively selected and intra-ward selection of 30 farmers was done using random sampling method giving a sample size of 300 farmers.

2.2 The technical efficiency conceptual framework

Technical efficiency is a component of production function associated with an error term. This implies that it has a contribution to the overall yield of maize to be realised by a farmer. Given almost the same operating environment and production units, Farmer A can produce more maize output than Farmer B. The difference is mostly attributed to different levels of technical efficiency between the farmers. Technical efficiency on its own is affected by several factors which directly or indirectly affect its overall level in a farmer. Given that these factors are well addressed, technical efficiency is expected to increase *vis-a -vis* the level of maize output. The expected relationship among the variables and technical efficiency can be expressed using a production function as follows;

$$Q = f(X_1, X_2, \ldots X_n) \qquad (1)$$

Where Q represents the output of the farmer and Xs are a set of inputs that are used to produce Q. To enable us to capture the effects beyond the farmer's control e.g. droughts, floods, etc, the production function is further expressed to include an error term as follows;

$$Q = f(X_1, X_2, \ldots X_n) + ei \qquad (2)$$

However, according to Aigner et al (1977), besides the exogenous factors beyond farmer's control, the error term (ei) also captures the technical inefficiency of the farmer. The error term can be further broken down as follows;

$$e_i = v_i - ui \qquad (3)$$

where vi represents the exogenous variations in the economic environment facing the production units while u_i is the inefficiency component representing a variety of features that reflect inefficiency (Lee and Schmidt, 1993). These factors include social factors, such as education level of a farmer, age, agricultural experience, gender, asset ownership of the farmer, credit accessibility, food security status, nutritional status etc. The other factors are economic and include input usage and costs, availability of labour, land size, wealth status, off farm income etc. These socio-economic factors have an influence on technical efficiency and are responsible for the variation in the level of technical efficiency therefore resulting in a positive or negative effect on output level. A framework shown in Figure 3 below can be used to classify the different characteristics that can be used in explaining efficiency. These characteristics can be classified as agent factors and structural factors. Agent factors are managerial characteristics of the farmer such as the education level and age of the farmer. Structural factors are classified in on-farm factors and off-farm factors. Examples of on-farm factors are the farm size, farm type, organizational type and the farm location. Up- and downstream relations and government interventions are examples of off-farm structural factors. The possible relationship between these factors and technical efficiency is illustrated in the diagram below;

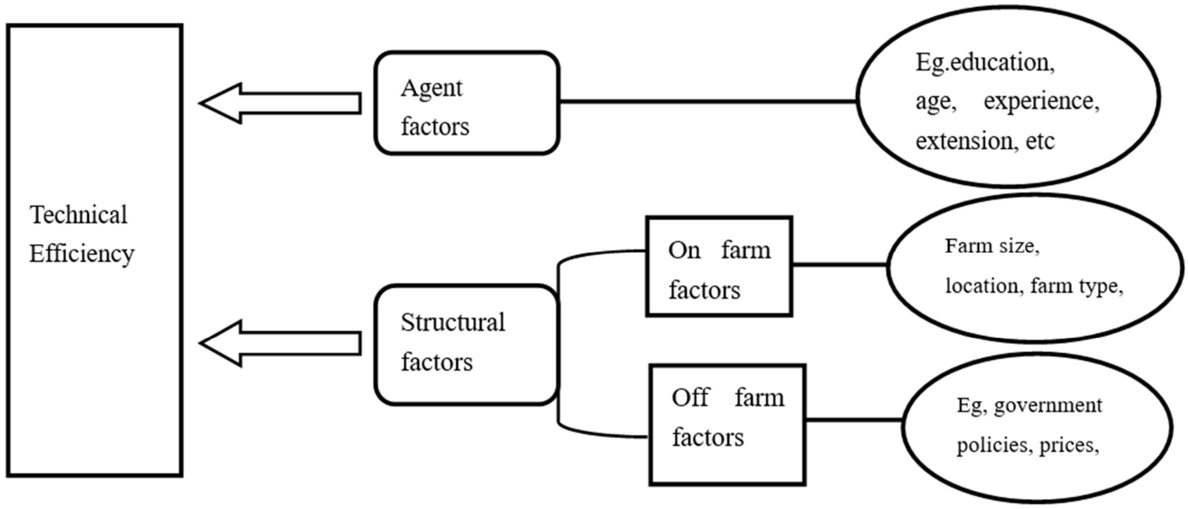

Figure 2: Diagram showing factors affecting technical efficiency.
Source: Adapted from Battese and Coelli, 1995

2.3 The Analytical Framework

A descriptive analysis was employed using primary data collected from Mazowe district using a structured questionnaire. Descriptive data analysis carried out included calculating and interpreting means, percentages, and frequency distributions appropriate for the different types of data collected in this survey. Stochastic Production Frontier Approach was estimated using a Cobb-Douglas function to analyze the extent to which different variables influence the technical efficiency on maize production. FRONTIER 4.1 was used to estimate parameters of variables using maximum likelihood estimators. Plot specific and average technical efficiency indices were also calculated from the FRONTIER 4.1. Elasticities were also calculated through taking the first derivatives of the respective independent variables of the regression to establish the extent to which technical efficiency is elastic to different variables. The specific model estimated is given by;

$$\ln Yi = \beta_0 + \beta_1 \ln X_1 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + \beta_4 \ln X_4 + \beta_5 \ln X_5 + e_i \text{...............(4)}$$

Where: ln denotes Natural logarithms,
Y = Maize Total amount of maize harvested (2010/11 season) expressed in kgs;
X_1= Total quantity of basal fertiliser applied to maize expressed in kgs
X_2= Total quantity of top dressing applied in kgs
X_3= Total labour utilised in maize production expressed in man-day equivalents;
X_4= Maize seeds used in kgs
X_5= Land area under maize cultivation in the 2010/11 season expressed in hectares
βi's =Unknown parameters to be estimated.
e_i= error term

The error term is broken down to represent the inefficiency component and random variables associated with vagaries of weather, pests and diseases etc. The new error tern is expressed as follows;

$$e_i = V_i - U_i \text{..(5)}$$

V_i represents the factors beyond farmer's control while U_i now represents the inefficient model that is expressed as follows based on Battese and Coelli (1995) specification;

$$U_i = \delta_0 + \Sigma\, \delta_i Z_i \text{...(6)}$$

Where,
δ_0 = the intercept term
δi's = parameters to be estimated
Z_1 = Experience of the farmer
Z_2 = Age of the farmer
Z_3 = Educational level of farmer
Z_4 = Wealth level of farmer
Z_5 = Agricultural training
Z_6 = Nutritional status of the household
Z_7 = Farm size
Z_8 = Credit accessibility
Z_9= Sex of household head
Z_{10}= Number of extension contact

Z_{11} = Quick access to information (measured by cell phone, TV and radio ownership)
Z_{12} = Social capital (membership to any formal group e.g farming union, church etc)
The technical efficiency level, which is the main focus of this study, is estimated as;

$$TE_i = \frac{Y_i}{f(xi, \beta)exp\ (Vi\ )} \qquad \text{.....................................(7)}$$

In order to determine the level to which technical efficiency can respond to different inefficient variables, elasticities were calculated. This is very crucial for policy implications as it provides information for accurate policy formulation that could yield the greatest results in enhancing technical efficiency. The method for elasticity calculation was based on taking the first derivatives of the regression model to determine the elasticity of production. The following formula was employed for calculation of elasticities for the inefficient model:

$$\varepsilon_i = \frac{\partial U_i . \bar{z}}{\partial Z_i . \bar{u}}$$

Where z bar and u bar are mean of a variable and mean inefficient level. Elasticity scale starts from 0 up to 1 and an independent variable with the highest elasticity index implies that maize yield or technical efficiency is more responsive to a change in that variable.

3. Results and Discussion

Table 1 below presents the distribution of technical efficiency scores realized by the maize farmers covered by the study.

Table 1: Frequency Distribution of Technical Efficiency Estimates

TE level	**Frequency**	**% of Total**	**Cum %**
< 0.29	65	21.67	21.67
0.30 – 0.49	73	24.33	46.0
0.50 – 0.69	83	27.67	73.66
0.70 – 0.89	79	26.33	100.0
0.90 – 1.00	0	0	100.0
Total	300	100	100.0
Mean TE level			0.52
Minimum TE			0.33
Maximum TE			0.88

Source: Survey results,2011

All farmer classes fall below the maximum efficiency level (100%) by about 10 percentage points, with the nearest or best performing group (70 -89) being made up of only 26,3% of the sampled farmers. The least performing group, score (0<29) represent 21.67% of the farmers. A sizable figure, 46% of farmers could not achieve at least half the efficiency level (50%) in their operations, with 54% exceeding the 50% level, but none exceeding 89%.The minimum score realised was 33% and maximum 88% with a mean of 52%. The efficiency score distribution indicates that there are .huge efficiency gaps that represent inefficient production among farmers and hence a need to examine possible causes and address them.

Table 2 below presents the estimates of parameters of the stochastic frontier production function derived from the sampled farmers.

Table 2: Maximum-likelihood estimates of parameters of the Stochastic Frontier Production function.

Variable	*parameter*	*Coefficient*	*SE*	*t-value*
Stochastic production function				
Constant	$\beta 0$	3.659***	0.407	8.98
Ln Basal fertilizer	$\beta 1$	0.121***	0.037	3.28
Ln Top dressing	$\beta 2$	0.224***	0.035	6.45
Ln labour	$\beta 3$	-0.054	0.077	-0.77
Ln seed	$\beta 4$	0.675***	0.083	8.11
Ln area planted	$\beta 5$	0.050	0.084	0.59
Inefficient Effects Model				
Intercept term	δ0	1.742**	0.599	2.90
Farm experience	δ1	0.006	0.014	0.48
Age	δ2	-0.03**	0.015	-2.44
Education	δ3	0.005	0.019	0.15
Wealth level	δ4	-0.12*	0.134	-0.90
Agriculture training	δ5	-0.64***	0.235	-2.83
Nutrition level	δ6	-0.031	0.060	-0.53
Farm size	δ7	-0.143**	0.055	-2.60
Credit access	δ8	-0.03**	0.05	-1.98
Gender of HH	δ9	0.002	0.144	0.01
Extension conduct	δ10	-0.850***	0.276	3.07
Quick access to info	δ11	0.347	0.606	0.58
Social capital	δ12	-0.344***	0.082	-3.97
Sigma Squared		0.405		4.79
Gamma(γ)		0.564		4.21
LR test		99.7		
N		300		

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

Source: Survey data, 2011

Table 3 below presents the input elasticities of yield for the various input factors used by the sampled famers in maize production in Mazowe district.

Table 3: Elasticity indices

Serial	**Variable**	**Elasticity**
1	Basal fertilizer	0.128
2	Top Dressing	0.222
3	Labour	-0.050
4	Maize seeds	0.658
5	Area planted	0.059
	Inefficient model	
1	Farm experience	0.042
2	Age	-0.001
3	Education	0.023
4	Wealth level	-0.21
5	Agriculture training	-0.641
6	Nutrition level	-0.043
7	Farm size	-0.007
8	Credit access	-0.541
9	Gender of HH	-0.002
10	Extension conduct	-0.721
11	Quick access to info	0.005
12	Social capital	-0.281

Source: Survey results,2011

Table 4: Marginal effects of efficiency measuring variables

TE Variable	Change in TE	% change in TE	Change in output
Farm experience	0.006	-0.6	-6.018
Age	-0.003**	0.3	3.009
Education	0.005	-0.5	-5.015
Wealth level	-0.12*	12	120.36
Agriculture training	-0.64***	64	641.92
Nutrition level	-0.031	3.1	31.093
Farm size	-0.143**	14.3	143.429
Credit access	-0.03**	3	30.09
Gender of HH	0.002	-0.2	-2.006
Extension conduct	-0.850***	85	852.55
Quick access to info	0.347	-34.7	-348.041
Social capital	-0.344***	34.4	345.032

The mean technical efficiency value was 0.52, an indication that most of the farmers are still using their resources inefficiently in the production process. Maximum and minimum technical efficiency was found to be 0.33 and 0.88.

3.1 Maximum Likelihood (ML) estimates

Maximum Likelihood (ML) estimates of a Cobb-Douglas production function for maize are presented in the upper panel of Table 2 above. In terms of sign, the parameters of basal fertilizer, top dressing fertilizer and maize seeds have shown the expected positive sign and statistically significant, implying that maize production is positively influenced by these variables. Area planted had the expected positive sign but does not significantly affect maize production. Only labour had unexpected negative coefficient and statistically insignificant implying that maize production is not influenced by labour. Labour is a very critical factor of production although result showed the opposite. This result might have been attributed to two things. (1) the availability of more labour against the size of maize area planted resulting in diminishing returns to labour and/or (2) difficulties in accurate measurement of labour. Authors like Alvarez and Arias (2003) for Spanish dairy production, and Coelli et al (2002) for Bangladeshi rice production also report a negative coefficient of labour for these countries mainly due to difficulties in accurately measuring the labour resource.

3.2 Input elasticities of yield

Fertilizers both basal and top dressing fertilizers had positive coefficients and statistically significant at 1% implying that fertilizers positively affect maize output. Rampant land degradation happening in the country and poor agricultural practices have caused nutrients loss in soils hence use of fertilizers is relevant for enhancing maize productivity because they return nutrients necessary for plant growth. A further 10% increase in fertilizer usage is therefore expected to increase maize output by 1.21% and 2.22% for both basal and top respectively. Top dressing fertilizer has the highest coefficient implying that the greatest impact on maize output results from increasing its usage. This result may be attributed to two things. (1) smallholder farmers are far from using the recommended fertilizer application rates per hectare due to lack of capital to purchase enough inputs and/or failure by government input schemes to adequately give recommended amounts of inputs and (2) since most famers depend mostly on government input programs, inputs are usually disbursed late resulting in untimely application of fertilizer, hence reduced efficacy.

3.3 Inefficiency model parameter estimates

The parameter estimates of the inefficiency model employed to identify the factors influencing farmers' levels of technical inefficiency are listed in the lower panel of Table 2. Variables with positive coefficients would lead to an increase in inefficiency level while negative coefficients result in reduction in inefficiency (increase in technical efficiency). Results show that age, agricultural training, credit access, farm size, extension conduct and social capital have negative coefficients and statistically significant at 5% level. The implication is that for a farmer to decrease the level of inefficiency depends on increasing these factors. However, farming experience, gender, education level and access to information had positive coefficients implying that an increase in variables results in an increase in the level of farmers' inefficiency. Top dressing fertilizer had the highest elasticity of 0.222 implying that if top dressing fertilizer is increased by 10% maize output also increases by 2.2%. For the inefficient model extension conduct, training and credit access had the highest elasticities in descending order. It implies that increase in education, training of farmers in proper farming methods and extension conduct results in highest percentage decrease in inefficiency

4. Conclusion

The study concluded that smallholder farmers in Zimbabwe are technically inefficient. This is an indication that most farmers are not fully exploiting the potential output from their resources. The observed mean technical efficiency level of 0.52 indicates that efficiency level can be increased by 0.48 to realize full potential of maize production. Therefore, the immediate solution to increase maize output in smallholder farmers is embedded in raising technical efficiency levels in smallholder farmers. Technical efficiency in the study area can be raised by improving extension conduct, conducting more agricultural training, improving social networks among farmers and improving farm size. A prompt address of these factors particularly the one with higher elasticities results in improved maize output. Extension conduct and agricultural training had higher elasticities and implies that an increase in these factors results in high response to technical efficiency increase. Therefore, if the government needs a quick win in raising maize productivity, there is need to augment existing policies with policies aimed at increasing technical efficiency in maize production

In light of the findings and conclusions drawn from the results of the study the following recommendations are suggested to the various stakeholder groups.

Maize farmers should join existing unions or form new associations to increase their social capital and benefit from results of collective action and sharing of valuable production and marketing information. Farmers should also, individually and collectively advocate for demand driven extension services that is relevant to their immediate and future needs. This type of extension service helps to address the real problems being faced by the farmers. This also gives no room for extension agents to make assumptions on farmers' needs and also pushes them to acquire more knowledge about important production management and marketing issues relevant to their activities. Farmers should also organize themselves and call for effective agricultural training to increase their wealth of knowledge.

For a food secure nation, government should shift its policy of subsidizing inputs and follow a market oriented approach to encourage the proper use of inputs. Freely provided inputs are usually mis-applied and abused, reducing scope for efficiency gains. Government should now direct resources to factors that improve the efficient allocation of resources which is a sustainable way of increasing production. More specifically, government should attend to the following:

Access to formal credit by farmers in Zimbabwe has been very difficult due to unavailability of financial institutions, high cost of borrowing and lack of collateral by smallholder farmers. The study recommends a cautious and gradual strategy for expansion of the rural financial institutions in the study area. This strategy would require direct support by the government, through an adequate legal and regulatory framework, of institutional innovations and pilot programs that have the potential to reduce transaction costs in providing savings, credit, and insurance services to the smallholder clientele. Banks should also design appropriate and favorable terms that suit these farmers so that they become bankable hence also get access to for credit.

Policies designed to educate farmers through proper agricultural extension services can have a great impact in increasing the level of efficiency to optimize the farm resources and hence to increase maize productivity in the study area. Extension officers need to be equipped with up-to-date farming knowledge and skills in order for them to be relevant to the increasingly novel needs of farmers in modern agriculture. This can be done through frequent refresher courses for extension officers and upgrading of their training syllabi. Furthermore, public investment in physical infrastructure (road, transportation, and communication) is crucial to improving smallholder farmers' efficiency, and then, earnings.

The government should promote and strengthen the formation and operation of agricultural associations like ZFU, ZFCU and CFU which can properly articulate the concerns of farmers and assist in the diffusion of knowledge about proper farming methods. This should also result in improved social capital for the farmers. Social capital has been found as a key variable for increasing technical efficiency henceforth productivity. Formation of unions improves the voice of farmers over price formation, marketing of produce and purchase of inputs.

A positive and significant relationship has been observed between agricultural training and technical efficiency. The observed relationship implies that agricultural training should also be a priority in efforts to increase farmers' technical efficiency in Zimbabwe. The intensification of Master Farmer Trainings (MFTs) can be a first positive step in enhancing technical efficiency. MFTs equip farmers with basic faming knowledge that is crucial for best practices and efficient use of resources necessary for attaining maximum yields.

Non-state actors and other stakeholders like the donor community should not only concentrate on provision of seed and fertilizer packs to farmers. NGOs should also direct resources to aspects like training, extension, value addition and market linkages. This will see farmers graduating from the dependency syndrome in the long run. Factors that address efficiency issues constitute key elements in unlocking productivity among smallholder farmers and these should be given top priority by policy makers.

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