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ANALYSING THE EFFECTS OF ACCESS TO TRACTOR SERVICE ON THE TECHNICAL EFFICIENCY OF SMALL-SCALE MAIZE FARMERS IN MPUMALANGA PROVINCE: A CASE STUDY OF THE MASIBUYELE EMASIMINI PROGRAMME

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Abstract. The main objective of this study is to analyse the effects of access to tractor service on the technical efficiency of small-scale maize farmers following the implementation of the Masibuyele Emasimini programme. Data collection was carried out in three districts of Mpumalanga Province and these include Ehlanzeni, Nkangala and Gert Sibande. Farmers producing maize were purposively selected for the study since maize is the most staple food produced in the province. The data were collected using a semi-structured questionnaire administered to 101 farmers who were selected using a simple random technique. The data were further analysed using the descriptive statistics, logistic regression and Cobb-Douglas production function model. The study concluded that the farmers do have access to tractor service (73% of farmers in Ehlanzeni and 60% in both Nkangala and Gert Sibande). Farmers' associations and irrigation are one of the most significant factors influencing the access to the tractor. The Cobb-Douglas model revealed a decreasing returns to scale for small-scale farmers producing maize in the province and operating at stage three of the production function. All average technical efficiency levels across variables were on the lower stage and not far from 0, and thus making farmers technically inefficient in the production of maize.

Keywords: Masibuyele Emasimini, access to tractor service, technical efficiency, small-scale farmers, maize production, Mpumalanga Province

INTRODUCTION

Maize (*Zea mays*) is the most important staple food and feed grain for most of the South African population and is widely produced on a small scale, as well as commercially. Mpumalanga Province is a main producer of maize in South Africa, distributing approximately 30% of the crop (DAFF, 2017). A tractor is a vital input in agriculture, it serves as a means of enhancing human productivity and increases production beyond the ability of human labour (Ajah, 2014). It is also an important element in farming, used for such various activities as tilling, ploughing and planting. The agricultural sector in the province – compared to mining, manufacturing and construction sector with only about 87,679; 68,699; 17,949 employees, respectively – employs majority of workers – approximately 182,645 employed persons (Van Dyk, 2000). Although this sector contributes less than 10 percent to the GDP in Mpumalanga, it is important to note that the province produces approximately 25 percent and more of the annual South African maize crop from only 17 percent of the productive land (Van Dyk, 2000). As a result, the Mpumalanga department of agriculture has established a programme called Masibuyele Emasimini (Eng. Going back to Tilling the

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Land), which provides farmers, particularly small-scale ones, with production inputs, including access to tractor service, fertilizers, seeds and herbicides.

The efficient use of scarce resources in promoting agricultural production has encouraged a considerable number of researchers in determining efficiency differentials among small-scale farmers (Chiona, 2011), especially those engaged in maize as a staple commodity in many parts of the world. Various studies have been conducted on the access and use of a tractor, for instance, Ajah (2014) analysed the factors limiting the small-scale farmers' access and use of tractors applied to agricultural mechanisation. The findings of the study indicated that the high cost of tractor hire and rentals, poor access road to the farm, inadequate sources of hiring points, and destruction of land boundary were the factors limiting the access and use of tractors. The study also found that private organisations were a vital source of rendering tractor service while government-owned institutions remained insignificant. Similarly, Mottaleb et al. (2016), studied the factors associated with small-scale agricultural machinery adoption. The multinomial probit model results from the study which indicated that machinery adoption was positively associated with household assets, credit availability, electrification and road density. Mabuza et al. (2012) also analysed the socio-economic factors influencing the choice of land cultivation technologies (tractors, draught animal power and hoes) used by smallholder farmers. Results revealed that households with a high wealth index, large maize area (land size) and irrigation facilities were likely to adopt to such improved agricultural technologies as a tractor.

Despite the knowledge derived from these studies, there is insufficient data on the effect of the tractor on production in general. This study can contribute to science by determining the effects of access to tractor service on the technical efficiency of small-scale maize farmers, which will ultimately confirm whether the government programme is significant in the provision of the machinery. The findings and recommendations of this study will be helpful for policy makers in the Mpumalanga Department of Agriculture and other relevant stakeholders in an attempt to mobilise small-scale maize farmers towards commercialisation.

The objectives of this study are to:

- Identify and compare the socio-economic characteristics of small-scale maize farmers in three districts of the province;
- Analyse socio-economic factors influencing small-scale maize farmers' access to tractor service in Mpumalanga Province;
- Measure technical efficiency of farmers who have access to tractor service and those who do not.

MATERIALS AND METHODS

Study area

The study was conducted in all districts of Mpumalanga Province and these include Ehlanzeni, Gert Sibande and Nkangala districts. Mpumalanga is a province of South Africa, commonly known as *the place where the sun rises*. It is situated in the Eastern South Africa bordering Swaziland and Mozambique. The districts vary in rainfall distribution, growing season, topography, soil and vegetation, therefore, they were treated separately in terms of data collection and analysis. For instance, the topography of Ehlanzeni district comprises escarpments, plains, hills, high and low mountains, making this district also suitable for tourism (IDPED, 2015), whereas Gert Sibande, because of its topography of an undulating landscape composed of intermittent hills and location on the grasslands of Mpumalanga Province (GSDM, 2017), is the largest contributor of agricultural production in the province, producing mainly maize, soybeans, sunflowers, grain, sorghum and wheat (DALA, 2007/08–2009/10). The topography of Nkangala district, on the other hand, is described by a rise and fall landscape consisting of rocky outcrops along the Olifants and Wilge rivers and mountainous areas in the north-west (NDM, 2017).

Sampling and sample size

Farmers producing maize were purposively selected for the study, as maize is the most staple commodity produced in the province, especially on a small-scale level. To effectively cover the study area, a simple random technique was used for sampling and semi-structured questionnaires were administered to 150 small-scale maize farmers (50 for each district). The study, however, used only a total of 101 properly filled questionnaires from Ehlanzeni (41), Nkangala (30) and Gert Sibande (30).

Analytical Technique

Descriptive statistics were applied to identify and compare the socio-economic characteristics of small-scale maize farmers in three districts of the province. The technique provides an easy way of summarising large observations of quantitative data into a clear and understandable manner (Knupfer and McLellan, 1996) through tables, graphs and measures of central tendency. A logistic regression model was used to address objective number two of the study. The study predicts a dichotomous outcome, where Y (dependent) variable will be generally binary, that is, on the values 1 or 0 (Wilson and Lorenz, 2015) denoting the likelihood that an event will take place or not respectively; known as the odds ratio. The dependent variable depicts the likelihood that small-scale maize farmers either have access to tractor service or not, which is influenced by dichotomous and constant independent variables. Among the binary models – linear probability, probit, tobit and logit models – the latter is known for its simplicity and ease of interpretation (Fox, 2010). The general logit model (Wilson and Lorenz, 2015) is given by the formula:

$$\text{Logit (p)} = \ln\left(\frac{P_i}{1-P_i}\right) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + +\ldots\ldots\ldots + \beta_n X_n + \mu \tag{1}$$

where:

P_i – probability that a small-scale maize farmer has access to tractor service

$1 - P_i$ – probability that a small-scale maize farmer has no access to tractor service

$\frac{P_i}{1-P_i}$ – the odds ratio

β_i – estimated parameters

μ_i – error term.

Model specification of the logistic regression model:

$$\text{Ln (ACCUTS)} = \beta_0 + \beta_1\text{GENDF} + \beta_2\text{AGEF} + + \beta_3\text{FEDU} + \beta_4\text{FARMS} + \beta_5\text{HHS} + \beta_6\text{EXTV} + + \beta_7\text{IRR} + \beta_8\text{OWNL} + \beta_9\text{FASS} + \mu_i \tag{2}$$

where:

ACCTS – dummy variable for access to tractor service, assuming value 1 if a given farmer avails access to tractor service and 0 if otherwise

GENDF – dummy variable for gender of a given farmer, assuming value 1 if the farmer is male and 0 if otherwise

AGE – age (in years) of the *i*-th farmer

FEDU – dummy variable for formal education, assuming value 1 if a given farmer avails formal education and 0 if otherwise. Formal education was categorized into primary, secondary and tertiary education

FARMS – farm size (ha)

HHS – household size (number) of the *i*-th farmer

EXTV – dummy variable for extension visits, assuming value 1 if a given farmer avails extension visits and 0 if otherwise

IRR – dummy variable for irrigation, assuming value 1 if a given farmer irrigates maize and 0 if otherwise

OWNL – dummy variable for ownership of land, assuming value 1 if a given farmer avails ownership of land and 0 if otherwise

FASS – dummy variable for farmers' associations, assuming value 1 if a given farmer avails an association and 0 if otherwise.

The Cobb-Douglas model has been applied to measure the effect of access to tractor service on the technical efficiency of small-scale maize farmers. The model was established in 1927 by Charles Cobb and Paul Douglas (hence Cobb-Douglas), with the objective of understanding the relationship between output level and quantities of inputs used in production (Biddle, 2010). In its general form, i.e. for production of one commodity with two factors, the function is expressed as follows:

$$Q = AL^{\beta}K^{\alpha} \tag{3}$$

where:

Q – total production/maize output (the real value of all goods produced per year)

L – labour input (the total number of man-hours per year)

K – capital input (the real value of all machinery, equipment and buildings)

A – total factor productivity

α and β – are output elasticities of both capital and labour (Alistakius, 2016) that measure the responsiveness of output to changes in the levels of inputs L and K.

The elasticity of scale is estimated as the sum of partial elasticity of output with respect to each input. A value of scale efficiency equal to one, i.e. $\alpha + \beta = 1$, implies that the firm is efficient and indicates constant returns to scale; $\alpha + \beta < 1$ implies inefficiency and decreasing returns to scale while $\alpha + \beta > 1$ indicates increasing returns to scale (Alemdar and Oren, 2006). For this study, the following model specification (linearised using the natural logarithm (*ln*)) is used:

$$\text{Ln (MAIZE)} = \beta_0 + \beta_1\text{lnTRACTS} + \beta_2\text{lnHHS} + \beta_3\text{lnFERT} + \beta_4\text{lnLAND} + \beta_5\text{lnSEEDS} + \beta_6\text{LANDFRG} \quad (4)$$

where:

MAIZE – total quantity of output produced in a given season (kg)
TRACTS – dummy variable for access to tractor service, assuming value 1 if a given farmer has access to tractor service and 0 if otherwise
HHS – household size (number) of the *i*-th farmer
FERT – fertilizer used (kg)
LAND – the area of ground used for the production of maize (ha)
SEEDS – the use of certified seeds (kg)
LANDF – the number of plots or farms that a given small-scale farmer owns, used as a proxy to measure land fragmentation (Msuya et al., 2008).

The following method was used to calculate technical efficiency and mean efficiency levels for all districts. According to Kibirige (2008), a farmer is said to be technically efficient if they produce at the production frontier level.

$$\text{Technical Efficiency (TE)} = \frac{\text{OBSERVED OUTPUT (Y)}}{\text{FRONTIER OUTPUT (Y*)}} \quad (5)$$

The observed output is the actual output that the farmer produces while the frontier output is the expected output based on the amount of input used. It is measured using a scale between 0 and 1; if the ratio is closer to 0 then the farmer is considered to be technically inefficient, and if the value is closer or equal to 1, the farmer is technically efficient.

RESULTS AND DISCUSSION

Descriptive statistics results and discussion

Figure 1. indicates that there is a huge gap between the number of farmers who have access to tractor service and those without that access, especially in Ehlanzeni district with a value of approximately 73% and 27%, respectively. Table 1. shows a descriptive summary of socio-economic factors influencing the access of small-scale maize farmers to tractor service in Mpumalanga Province. Male small-scale farmers are found to be dominant in both Ehlanzeni and Nkangala, with values of 58% and 67%, respectively. The descriptive statistics indicate that there are more males participating in maize production than females. Gender issues concerning women's empowerment in land ownership is still an on-going problem within these two districts. Figure 2

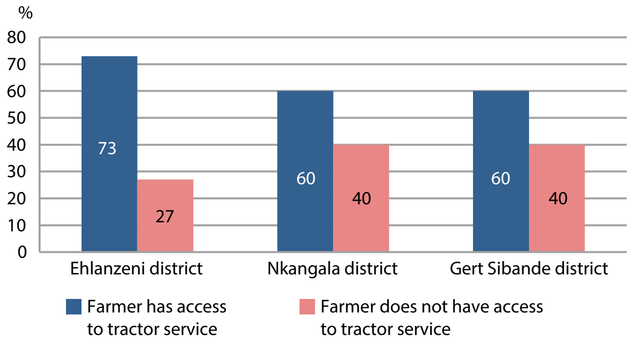

Fig. 1. Pie chart indicating a farmer's access to tractor service (%)
Source: field survey, 2019.

Table 1. Descriptive summary of variables

Variables	Variable description	Ehlanzeni district	Nkangala district	Gert Sibande district
Gender	Male	58%	67%	43%
	Female	42%	33%	57%
Extension visits	Receives extension visits	59%	57%	63%
	No extension visits	41%	43%	37%
Irrigation	Irrigates maize	54%	67%	50%
	Non-irrigation	46%	33%	50%
Ownership of land	Owns land	46%	57%	40%
	Does not own land	54%	33%	60%
Farmer Association	Member of an association	54%	47%	53%
	No association	46%	53%	47%

Source: own elaboration.

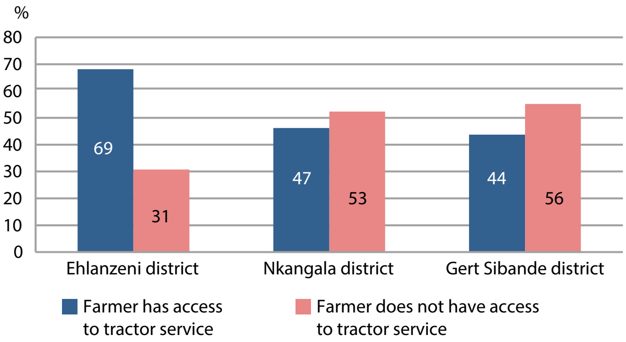

Fig. 2. Pie chart indicating a famer's education (%)
Source: field survey (2019).

shows that Gert Sibande has the lowest value of formal education, with 44% of farmers that have formal education and 56% with informal education. This may be attributed to the fact that most of the farmers in the district are older, with a mean age of 52.60 (Table 2). Similarly to Gert Sibande, Nkangala is characterised by a relatively low percentage of farmers that have formal education and their mean age is 56.67. Among the small-scale maize farmers in Gert Sibande, falling within the formal education category, 20% of them have primary education, 17% have secondary education and only 7% – tertiary level of education. Nonetheless, the district depicts a higher percentage of farmers who receive extension visits with a value of 63% compared to Ehlanzeni and Nkangala districts with a value of 59% and 57%, respectively. The reason behind this is that farmers grouped together as an association are at an advantage of receiving extension visits since they can locate themselves to an area that is easily accessible for the extension officer. This is shown by a higher percentage of farmers participating in an association, with a value of 53% in this district (Table 1). Table 1 indicates that Nkangala has the highest percentage of farmers owning land (57%). It also reveals that approximately 67% of the small-scale farmers irrigate their maize through the furrow irrigation system which is a conventional one within the district.

Table 2. Mean descriptive variables per district

District	Variables	Mean	Standard deviation
Ehlanzeni	Age (years)	52.34	13.948
	Household size (number)	5.68	2.392
Nkangala	Age (years)	56.67	15.09
	Household size (number)	7.23	3.55
Gert Sibande	Age (years)	52.60	13.56
	Household size (number)	6.93	2.75

Source: own elaboration.

Logistic regression results

This section provides the results of the logistic regression model per district and further discusses the explanatory variables that have an influence on small-scale maize farmers' access to tractor service. A pseudo R-squared value measures how close the data are to a fitted regression line. All the three districts (Ehlanzeni, Nkangala and Gert Sibande) revealed a pseudo R^2 of 69%, 67% and 73%, respectively (Table 3, 4, and 5). This implies

Table 3. Logistic regression analysis: Ehlanzeni district

Variables	Coefficient	Standard error	Walt statistics	Significance
GENDF	2.9868*	1.785	2.800	0.094
AGEF	0.024	0.068	0.127	0.722
FEDU	1.153	0.878	1.724	0.189
FARMS	–0.669	1.170	0.327	0.567
HHS	–0.924*	0.501	3.396	0.065
EXTV	3.480	2.257	2.378	0.123
IRR	4.107*	2.165	3.597	0.058
OWNL	–4.191*	2.213	3.586	0.058
FASS	0.975	1.659	0.345	0.557
Constant	1.486	3.911	0.144	0.704
–2 log-likelihood			21.08	
Chi-square			26.61	
Pseudo R-squared			0.69	
Error term			0.31	

*Significant at 10%, **significant at 5%, ***significant at 1%.
Source: own elaboration.

Table 4. Logistic regression analysis: Nkangala district

Variables	Coefficient	Standard error	Walt statistics	Significance
GENDF	2.323	2.514	0.854	0.356
AGEF	0.010	0.062	0.027	0.870
FEDU	1.764*	1.016	3.017	0.082
FARMS	0.073	0.463	0.025	0.874
HHS	–0.430**	0.216	3.951	0.047
EXTV	2.928	1.838	2.538	0.111
IRR	0.182	1.700	0.011	0.415
OWNL	–3.634*	2.105	2.982	0.084
FASS	0.488	1.390	0.123	0.726
Constant	–1.625	6.245	0.068	0.795
–2 log-likelihood		20.045		
Chi-square		20.335		
Pseudo R-squared		0.67		
Error term		33		

*Significant at 10%, **significant at 5%, ***significant at 1%.
Source: own elaboration.

Table 5. Logistic regression analysis: Gert Sibande

Variables	Coefficient	Standard error	Walt statistics	Significance
GENDF	–0.201	2.573	0.006	0.938
AGEF	0.261	0.189	1.893	0.169
FEDU	5.580*	3.255	2.938	0.087
FARMS	0.639	0.565	1.278	0.258
HHS	0.007	0.349	0.000	0.985
EXTV	2.603	2.169	1.439	0.230
IRR	5.723*	3.333	2.047	0.086
OWNL	–3.938	2.699	2.130	0.144
FASS	7.650**	3.729	4.210	0.040
Constant	–30.199	19.396	2.424	0.199
–2 log-likelihood		17.089		
Chi-square		23.29		
Pseudo R-squared		0.73		
Error term		27		

*Significant at 10%, **significant at 5%, ***significant at 1%.
Source: own elaboration.

that the model explains 69 percent variability of the response data around its mean (using Ehlanzeni's model).

Discussion of factors influencing small-scale maize farmers' access to tractor service

Table 3 indicates that the probability of farmers' access to tractor service in Ehlanzeni district is directly influenced by farmers' gender (GENDF), irrigation (IRR), farmers' ownership of land (OWNL) and their household size (HSIZE). The coefficients of gender and irrigation were found to be positively significant at 10% significance level with values 2.9868 and 4.107, respectively. Implying that a unit increase in both variables is likely to increase the probability of farmers' access to tractor service. The results concur with Mabuza et al. (2012), who found irrigation to be statistically significant, implying that households which produce maize under irrigation are more likely to use improved methods of cultivation. On the contrary, ownership of land and household size were negatively significant at 10% significance level. This implies that farmers who own land or those with a larger household size are less likely to have access to the machinery. Ownership of land is one of the criteria used by government to render tractor service; farmers that obtain land through government leases are likely to have access to various inputs as opposed to those who have full ownership of land either through inheritance or purchase. Perhaps the assumption is that those with full ownership can afford to rent/hire a tractor from private organisations. Household size is attributed to land fragmentation; an increase in household size oblige farmers to divide their land in order to balance agriculture and settlement to such an extent that the agricultural land becomes too small to use mechanisation (Kiprop et al., 2015). In Nkangala district (Table 4), the access to tractor service was also influenced by farmers' level of education (FEDU), their ownership of land (OWNL) and household size (HSIZE).

The coefficient of FEDU=+1.764 was found to be positively significant at 10% significance level, entailing that farmers who are educated are more likely to have access to tractor service. Education enhances the ability of farmers' to communicate with suppliers and service providers such as tractor operators for tilling and ploughing activities. Moreover; educated farmers may also be able to write a motivation letter to government, outlining their needs for access to tractor. Similarly to Ehlanzeni, household size and ownership of land were also negatively significant, each at a significance level of 5% and 10%, respectively. Table 5 shows that all the three variables – farmers' education, irrigation and farmers' associations – were positively significant in Gert Sibande district. Farmers' associations were significant at 5% significant level. Farmers grouped together facilitate the government to access them, and are also able to use inputs more efficiently than fragmented farmers.

Cobb-Douglas production function results

The Cobb-Douglas production function model was used to measure the technical efficiency of farmers. Tables 6, 7 and 8 show empirical results from the Cobb-Douglas production function in Ehlanzeni, Nkangala and Gert Sibande districts. The tables present an adjusted of 0.82, 0.59 and 0.67, respectively. Provided that the explanatory variables in this model explain approximately 82, 59 and 67 percent of the variation in maize production in respective districts of the province. The models have also revealed land to be a significant input towards maize output, with a high partial elasticity for all the three districts. Land in Ehlanzeni had a partial elasticity of 0.846, implying that a 1 percent increase in land or farm size would increase maize output by 0.85 percent, holding all other variables constant. Land has always been an important factor in agricultural production,

Table 7. Cobb-Douglas production function results: Nkangala district

Variables	Coefficient of elasticity	Standard error	t-ratio
Constant		1.115	0.452
ACCTS (dummy)	–0.046	0.232	0.340
HHS (number)	–0.017	0.229	0.125
FERT (kg)	0.307*	0.219	2.047
LAND (ha)	0.736***	0.176	5.205
SEEDS (kg)	–0.095	0.203	0.579
LANDFRG (number)	–0.037	0.404	0.281
Sum of b's	0.848		
Adjusted R^2	0.594		
Technical efficiency	0.49		

*Significant at 10%, **significant at 5%, ***significant 1%.
Source: own elaboration.

Table 6. Cobb-Douglas production function results: Ehlanzeni district

Variables	Coefficient of elasticity	Standard error	t-ratio
Constant		1.349	4.390
ACCTS (dummy)	–0.102	0.079	1.437
HHS (number)	0.004	0.078	0.054
FERT (kg)	0.033	0.191	0.406
LAND (ha)	0.846***	0.201	4.639
SEEDS (kg)	0.125	0.109	0.728
LANDFRG (number)	–0.152*	0.196	1.861
Sum of b's	0.754		
Adjusted R^2	0.82		
Technical efficiency	0.48		

*Significant at 10%, **significant at 5%, ***significant at 1%.
Source: own elaboration.

Table 8. Cobb-Douglas production function results: Gert Sibande district

Variables	Coefficient of elasticity	Standard error	t-ratio
Constant		1.660	5.285
ACCTS (dummy)	0.076	0.339	0.690
HHS (number)	–0.178	0.406	1.624
FERT (kg)	–0.289**	0.264	2.169
LAND (ha)	0.949***	0.349	6.331
SEEDS (kg)	0.086	0.160	0.671
LANDFRG (number)	–0.046	0.642	0.415
Sum of b's	0.598		
Adjusted R^2	0.67		
Technical efficiency	0.50		

*Significant at 10%, **significant at 5%, ***significant at 1%.
Source: own elaboration.

which is evidenced by findings of various scholars (Abdallah and Abdul-Rahman, 2017; Alistakius, 2016; Baloyi, 2011; Sapkota et al., 2017) who also found scarce resources to be positively significant towards output. Fertilizers were positively and negatively significant in Nkangala and Gert Sibande districts, with elasticity coefficients of 0.307 and 0.289, respectively. The elasticity of land fragmentation in Ehlanzeni was found to be negatively significant towards maize output (as expected) at 10% significance level. The coefficient on the variable means that when land fragmentation increases by 1 percent, holding the all other inputs constant cause that maize output decreases by approx. 0.15 percent.

These results concur with Kiprop et al. (2015) findings, who also found land fragmentation to be negatively significant. Due to the absence of land, farmers are obliged to use some of the agricultural land when socio-economic problems (such as population size) arise, making it uneconomical to increase output. Moreover, all the models revealed a decreasing returns to scale for small-scale farmers producing maize in the province and operating at stage three of the production function. That is, an increase in the use of variable inputs over a fixed bundle of resources leads to a less than proportionate increase in output. The cost per unit of input used in the production process is more than the return on maize output. Farmers are overusing inputs, which makes them technically inefficient in the production of maize and thus they need to cut costs. The access to tractor service was negative and insignificant in both Ehlanzeni and Nkangala, as shown in tables 6 and 7 respectively. This implies that small-scale farmers with access to tractor service produced less output as opposed to those without that access, thus becoming technically inefficient in maize production. The variable, however, was positive (although insignificant) in Gert Sibande.

In all the three districts (Ehlanzeni, Nkangala and Gert Sibande), the average technical efficiency across variables was 0.48, 0.49 and 0.5, respectively. All values are closer to 0 and thus making the farmers technically inefficient in the production of maize in the province.

CONCLUSIONS

The aim of the study was to analyse the effects of access to tractor service on the technical efficiency of small-scale maize farmers following the implementation of the Masibuyele Emasimini programme in Mpumalanga Province. In general, the study concludes that small-scale maize farmers do have access to tractor service (73% of farmers in Ehlanzeni and 60% in both Nkangala and Gert Sibande districts) rendered by the Masibuyele Emasimini programme. The study has also revealed that there are significant socio-economic characteristics that have an influence on the access of the input per district, and these include irrigation, gender, household size, ownership of land, farmer's level of education and farmers' associations. However, the service was found to have a negative effect on technical efficiency of maize production among small-scale farmers, with all districts experiencing a decreasing returns to scale as well as low technical efficiency levels. Significant factors influencing the access to the service rendered by the Masibuyele Emasimini programme should be assessed to improve the efficiency levels of maize farmers.

RECOMMENDATIONS

The study's findings in Ehlanzeni district have revealed that there is a negative relationship between household size and access to tractor service. On the basis of these results, it is fair to state that larger-sized households would prefer using manpower or conventional methods, such as hoes and animal draught power, than small-sized households. The negative relationship between these two variables is also attributed to land fragmentation. Local municipalities within the district should implement a programme wherein health specialists visit communities/villages on a monthly basis to give awareness lectures on family planning. This will control birth rates and consequently reduce average household size. Households which practice land fragmentation are mostly those that have received agricultural land through inheritance rather than government leases. Therefore, land that was once used for farming, and then inherited by a family member due to death of the owner, should be surrendered to government if it is left purposeless or undeveloped and must be distributed further to potential farmers through leases. The study also observed a positive relation between gender and access to tractor service, with male farmers having more access than females, yet the variable (access to tractor service) was found to have a negative effect on maize production. This could mean that male farmers are benefiting more from the programme in terms of access to tractor, hence policies towards women's empowerment should be implemented.

Gender practitioners, government and non-government organisations (NGOs) should also play a role in advocacy, raising awareness and lobbying against gender inequality as well as wrong perceptions of society about women (Abdulai et al., 2013). Moreover; most farmers in the district irrigate their maize using the furrow irrigation method, which requires lower initial investment on equipment and pumping costs per acre-inch of water pumped. This, however, includes greater labour costs and lower application efficiency, which may contribute to technical inefficiency of maize production compared to modern irrigation systems such as sprinklers and drip irrigation. The Masibuyele Emasimini programme should therefore include the provision of modern irrigation systems (preferably, sprinklers) as part of its input list to contribute towards efficient maize production.

The results from Nkangala district have shown that farmers' level of education enhances the access to tractor service. Educated farmers are able to receive, analyse, interpret and show a quick response to new information (Sapkota et al., 2017), which will eventually increase their access to tractor service and thus positively affect the technical efficiency of maize production. A majority of the uneducated farmers are older, making it difficult for them to go back to school. The government, as well as NGO's, can, however, implement educational programmes for the elderly, where they are taught how to read and write, which will further enable them to manage their farms. Such programmes as the Setlakalane Molepo Adult Education Centre are significant in addressing national goals, i.e. combating inequality, unemployment and poverty. Farmers' associations also showed an expected positive sign towards the dependent variable in Gert Sibande district. Participation in a farmers' association should be encouraged.

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