Performance of livestock production in north eastern cape communal areas: a stochastic frontier analysis.

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Abstract:

This paper assesses the performance of households engaged in livestock production in the north-Eastern Cape communal areas of South Africa. Using a survey data from 120 households from Mgwalana and Mahlungulu village collected in 2015 and 2016, a stochastic frontier model is used to estimate technical efficiency scores and evaluate its determinants among households in a communal production environment where rangelands are the cheapest source of fodder for livestock. The findings of the study revealed that householdsHousehold is referred to people living as a family under one dwelling/house and are regarded as a unit

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1. Introduction

In South Africa, communal rangelands are in the brink of ecological collapse because they are vastly overstocked compared to commercial agricultural enterprise. This situation arises because of the use of grazing resources in a free-for-all environment and the free-rider problem inherent in communal areas where there are no incentives to manage common grazing resources. The production systems in communal areas are wasteful in using the scarce grazing resource and the offtake per annum is under 10 % of the total herd size Ainslie *et al.* (2002). Livestock production in communal areas is generally un-responsive to extension efforts and technical improvements in diseases control or herd improvement. Ainslie *et al.* (2002) further urged that the low offtake rate in communal areas is mostly related to cultural reasons such as historical reluctant to sell livestock, the reasons for keeping livestock and keeping livestock for subsistence.

Livestock played a significant role in rural livelihoods prior to European colonization. Communal people were agro-pastorists who owned cattle and goats and were known to cultivate millets, maize, kidney beans, sorghum, melons, pumpkins and tobacco (Elbourne 1993). For basic protein intake in the form of milk, they relied on their livestock, mainly cattle. They were game hunters and also collect wild plants. Cattle raising was their favorite pastime and were import for substance purpose. Meat from dead animals was eaten when an animal died from sickness or old age, and then from ritual slaughter. Based on the rules of distribution of criterion for kinship and residential association, consumption of beef was complicated. Such rules were for the use of meat as a commodity to be marketed (Ainslie *et al.* 2002). These agro-

pastorists used hides supplemented by skin of goats and wild animals to make clothing and war shield (Lewis 1984). They used dung at their homes for floor, building and wall plastering. Fines were levied through medium exchange of cattle and as an accumulation of wealth which conferred social importance and keeping a good relationship with ancestral spirits and health prosperity.

Currently, the major reasons for keeping livestock in communal areas also includes store of wealth, milk and less frequently meat, draught power and manure production (Cousins 1997). Furthermore, livestock ownership gives status and prestige within the community and in some instances they are used to pay for a bride price and ritual slaughter. Livestock further underpins social relationships where they serve as social goods in non-market ways. Having said that, a difference exists between holding livestock and owning livestock in communal areas, whereby an owner may not sell livestock without consulting other family members because they are not inherent goods but are subject to overlapping claims within the family. This is due to rural urban linkages that exist in these communal areas, where the livestock owner may employ a herder to look after the livestock or leaves livestock in the village with relatives and is resident in metro pol for employment. This happens because the combination of birth and residence in communal areas affords one the right to run and or own livestock in the rangelands. In some instances even those who don't belong to the community are allowed to run their stock in the rangelands. This has given the rise to the argument that the communal tenure system is unfair to the poor who do not own livestock.

Development programmes in South Africa have been implemented to improve animal and rangeland productivity through tenure reform (Behnke & Scoones 1993). To arrive at a more balanced characterization of the communal tenure system, a historical perspective of pre-colonial forms of land use and tenure system is necessary. The criticism of traditional livestock ownership and land use have long history in South Africa. Beinart (1984) states that, in South Africa, the colonials surfaced first in the Cape colony during the increasing shortage of grazing land followed by the competition for farmland caused by the awarding of farms to British settlers.

The boundaries where the African settlers stayed were 'thorns in the side' of the colonist's acquisitive interest. Beinart (1997) further states that the settler farmers (of British and Dutch descent) were then concerned, and were seen to be directly or indirectly affected by what was happening in the reserve areas where sheep owned by African farmers were seen as threat to colonialist farmer's flock in terms of ticks and fever. They were seen to be disrespectful of fences and boundaries and they had to be eliminated so that settler's livestock can be safe in future. Communal farmers were restricted to traditional areas by the 1913 Natives Land Act where they could only grow their herds within the limited genetic resources available regionally. This argument of irrational and inefficient African sector was further advanced in the 19th century by the growing need of African men for labour in the mines and industries on the diamond fields (McAllister 1992), where they would only visit their rural homes once a year. They brought back cash which was best used to purchase cattle as there were no banking facilities available in these areas, and owning cattle was an effective way of securing funds. Young boys were available to herd the livestock as they were not mandated to attend school.

However, this saw a rise of female-headed households in the post-colonial era where drivers of male mortality included diseases (HIV, tuberculosis, diabetes and hypertension, as well as the movement of adult men to cities. The result was fewer adult men remaining in the village, leading to changes in the role of women in the livestock sector and their role in providing payments for large family expenses (e.g. tertiary education). There are also no young boys to herd the livestock as they are mandated to attend school. Currently, men and women are now earning much larger salaries in cities and contributing to herds of the homestead, which leads to un-equal distribution of large herd owners in the demographics of the village. In addition, these non-residents are un-willing to be part of agreements about rangeland management of the grazing commons.

In the traditional areas of the Eastern Cape livestock continue to supply many different products and services, making a significant contribution to rural livelihoods. People are known to invest heavily in livestock production, where in small scale sector, cattle production alone accounts for 80 – 90 % of assets value. Rural and urban based people continue to have considerable high livestock numbers in these communal areas, which is perhaps mostly related to the absence of other saving method such as banks that leads to thousands of rural people to use livestock as store wealth. However, the apparent excessive number of livestock in these communal areas are blamed to have a deleterious effect through overstocking and overgrazing on the condition of communal grazing resources and which lead to destocking decades ago (Vetter 2013). This was blamed to have an effect on the quality of livestock and their reproduction rates, production and their market value.

Livestock ownership also provides prestige in many societies, but this varies culturally. There are unacknowledged considerable amounts and unrecorded commercial activities such as livestock trading and natural resource sales within communal rangelands. The benefits and their importance in rural people during the extreme economic uncertainties are well understood and documented (Shackleton *et al.* 2001). However, Vetter (2013) argues that, they are still underestimated and they are little acknowledged in economic assessment and policy. The role of livestock in communal areas is closely tied up with the cultural identities. Apart from their contribution to rural household income and food security they also fulfil important spiritual, cultural and social functions (Ainslie *et al.* 2002). It is however, not known if rural people keep livestock for various objectives such as food security, cultural use or form of savings as the perceived relative importance of these benefits differs in areas and with livestock species (Waters-Bayer & Bayer 2009).

Food security can be improved by maximizing the production efficiency of livestock production (Otieno *et al.* 2014). Production inefficiencies are limiting livestock productivity and sources of inefficiencies are diverse. The most important requirement to improve productivity is to use production inputs more effectively (Otieno *et al.* 2014). It is important to understand the production elasticity of inputs, socio-economic characteristics and determinants of efficiency among farmers. Such understanding would help in improving agricultural policies and programs, which will in turn increase food security (Baha *et al.,* 2013). Technical efficiency assesses the production of an enterprise's use of resources to produce goods and services (Bahta *et al.,* 2015). According to Battese & Coelli (1992), technical efficiency is a farmer's ability to increase outputs given a set of inputs and technology. Level of technical inefficiency

shows inability of an individual to attain the highest possible outputs in each input used. Extensive studies on technical efficiency of crops, dairy, mixed crop livestock farms (Mlote *et al.,* 2013;Otieno *et al.,* 2014;Kumbhakar *et al.* 2014) have been conducted but that of a livestock production where all the beneficial livestock goods and services are consolidated and assessed on individual households is lacking. To our knowledge, no study has been conducted in South Africa to assess the livestock technical efficiency in communal rangelands where every member has an equal access to available resources compared to commercial rangelands. The provision of knowledge of production efficiencies is important to improve the potential of a communal livestock system thus, increased economic growth and decrease poverty in livestock dependent rural households in South Africa.

In the Eastern Cape Province where this study was conducted, livestock production is one of the possible sources of household's income and the household consumption. The major household livestock holdings are sheep, cattle and goats. The outputs from livestock in this area are mainly used for household consumption except for live animals, draft power and wool that are used for market to obtain cash income. People also plant maize during wet season which after harvesting is used as animal feed during the dry season. Animals are also used for animal power during ploughing, transport and animal waste is used to improve soil fertility. However, the rangelands are perceived to be poor and cannot sustain maximum livestock production (Bennett *et al.,* 2012) when assessed in terms of species composition and standing biomass. They are mostly perceived to be overgrazed, overstocked, degraded and unproductive because most people in communal rangelands keep large numbers of livestock for different reasons (Vetter 2005) . This is because everyone has an equal access to the land with no formal grazing

management plan that are put in place for every user to follow. So, this study provides empirical evidence in the context of rangeland production perspective as to why it is important to properly manage rangelands for improved productivity and technical efficiency in these communal areas by assessing the performance of livestock production. The study provides significant contribution because it will allow us to understand the productivity and efficiency of livestock production in the communal area. The study mainly focused on identifying the most efficient households who can benefit from the possible interventions (access to market, improved labour, improved capital and supplementary feeding) so that they can become more successful at livestock production and improve food security

2. Methodology

2.1. Sampling and data collection

Data for this study were collected from livestock and non-livestock owners in Cala communal areas in South Africa. Cala lies in the north-Eastern Cape regions of the country. The respondents included randomly selected livestock and non-livestock owners in two rural villages, Mgwalana and Mahlungulu, located in quaternary catchments T12Aand (S50E) (Figure 1). A total of 120 households were sampled based on their availability and willingness to participate in the survey during November 2015 –January 2016 and May 2016 – August 2016. Only one respondent declined to participate in the survey. The household head was interviewed, and in cases where household head was absent, the most senior person was interviewed. Data were collected through a face to face interview during both the dry and wet season with the help of local. The questionnaires were administered in local language, isiXhosa, which is the language best understood by the respondents, and responses were translated in English. There was one enumerator for each household to conduct the interview. The interviews were conducted during the day and recorded/captured using Kobo collect toolbox that was installed in an Android mobile device.

On the first day of data collection, an introductory workshop with community leaders and community members was held to give clarity on the survey and schedule appointments for interviews. Ethical clearance certificates were obtained from the Rhodes University Ethical Clearance Committee to obtain approval to conduct the survey. A consent form was provided prior to the interviews for the entire household to request their authorization. Data gathered

included information on socio-economic variables of the household such as age, gender, dwelling type, provision of livestock feed, livestock kraaling and herding. Information was also collected on the inputs as well as output in terms of livestock beneficial goods and services derived for household use. The input data collected include hired labour, livestock units and cost of feed used while outputs data collected was milk, sales/ meat, wool, hides, mohair, manure and traction.

2.2. Sampling approach: Estimating values of livestock goods and services

Livestock form a vital component of agriculture worldwide. They also provide ecosystem service output and have cultural values (Haileslassie *et al.,* 2009). However, in this study only sale/ meat, milk, manure, skin, hides, wool and traction were considered. The beneficial outputs and services in this study were estimated as follows;

Manure: Manure production was calculated using dry weight daily dung production of 3.3 kg/day/TLU and 2.4 kg/day for small ruminants for the annual average livestock holdings (Descheemaeker *et al.,* 2010; Bekele *et al.* 2017). Nutrient composition was estimated based on nutrient content of 18.3 g N/kg, 4.5 g P/kg and 21.3 g K/kg on a dry weight bases (Bekele *et al.,* 2017). Monetary equivalence of manure to artificial fertilizer was extrapolated from the nutrient contents and price of LAN (28).

Milk production: Annual milk production was estimated as a function of: number of lactating cows, lactation period and milk production in litres/day/ cow in a household herd per year (Haileslassie *et al.,* 2009). The total milk produced per cow was converted in to monetary values based on the value of milk at a farm gate price.

Meat production: livestock offtake was estimated as the proportion of animals sold or slaughtered for household consumption in a year. It was calculated by summing the values of each animal type (Rands) that was sold for consumption or gifted in a year (Kebebe *et al.,* 2015). Number of sold animals, stock fair sales, informal sales and cultural slaughter were also measured as reported by low input farmers (Tada *et al.,* 2012)

Fibre production: was estimated based on the annual income derived from selling hides/wool in formal market reported by households.

Traction power: Traction power was estimated based on daily hiring cost of draft animals (e.g. oxen) and number of working days/year spent for ploughing and threshing in every sample (Haileslassie *et al.,* 2009).

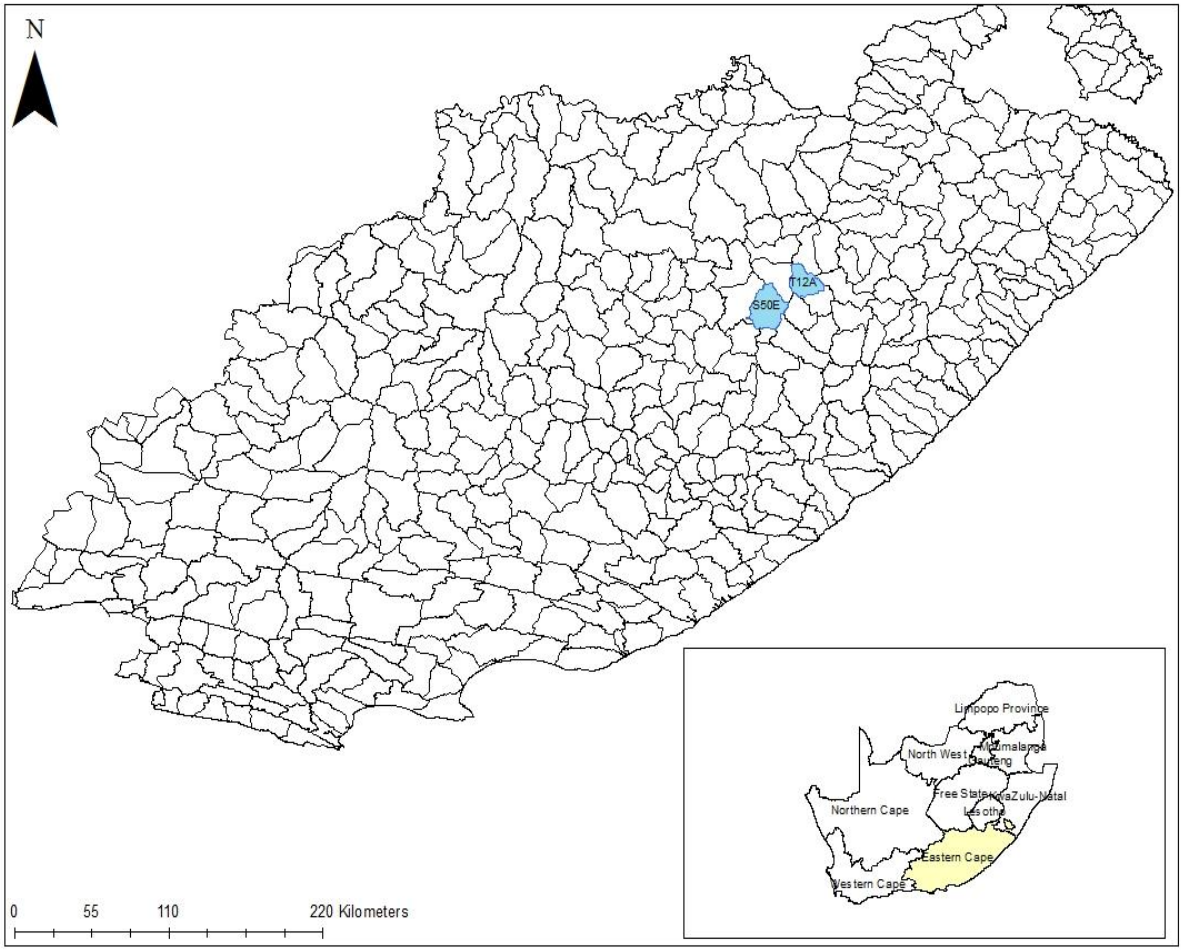

Figure 1: Location of the study area

2.3. Stochastic frontier production function analysis (SFA)

In this study, household agricultural production is aimed at maximizing production. In view of this, we use the stochastic frontier analysis (SFA) method (Aigner et al., 1977; Meeusen & Van Den Broeck, 1977) in order to examine input-output relationships and obtain efficiency indicators. The method was then extended by Kumbhakar et al., (1991) to introduce the determinants of technical efficiency into the model. He also proposed that inefficiency effect u_i to be expressed as a clear function of the vector of a firm specific random error and variables

in a single stage stochastic frontier. Battese & Coelli (1995), provide a frontier model with output-oriented technical efficiency and is specified below:

$$Y_i = X_i \beta + (\varepsilon = V_i - \mu \quad (1)$$

where Y_i is a scalar output of the i_{th} firm, X_i is a vector of input quantities and β is a vector of a parameters to be estimated, ε is the disturbance term comprised of $V_i$and U_i independent components. $V_i$is are random variables which are assumed to be i.i.d.$N(0, \delta_v^2)$, and independent of the U_i 's and U_{is} are equal to a non-negative random variable which are assumed to account for technical inefficiency in production and is assumed to be independently distributed as truncations at zero of the $N(m_i \delta_u^2)$. The estimation of equation 1 provides variance estimators, estimators for β_j and other relationships as denoted as:

$$\delta^2 = \delta_V^2 + \delta_\mu^2 \quad (2)$$

$$\gamma = \delta_v^2 / \delta^2 \quad (3)$$

$$\lambda = \delta_v^2 / \delta_\mu^2 \quad (4)$$

where $\delta^2, \delta_v^2, \delta_u^2$are the overall variance of the model, variance of the random error and variance of the technical inefficiencies respectively. Gamma (γ) measures the proportion of the total output made on the frontier function which is attributed to technical efficiency and has a value between zero and one. The lambda (λ) parameter is expected to be greater than one. This condition indicates a correctly specified error term $(V_i - U_{i)}$ and a good fit for the model. The empirical model is defined as:

$$LnY_i = \beta_0 + \beta_1 LnX_1 + \beta_2 LnX_2 + \beta_3 Ln\, X_3 + \beta_4\, LnX_4 + \beta_5 LnX_5 + V_i - \mu_i \quad (5)$$

where

Ln= denotes natural logarithm (base e),Y_i is the total output per cow for the i^{th} household (1,2,3…n).β_0 is an intercept and is constant, $\beta_1,\beta_2,\beta_3,\beta_4,\beta_5,$ are the parameters of regression coefficients of the i_{th} variable. $X_1$is the total labour hired/ used in the production of livestock outputs. X_2 is the total livestock household holdings which was a conversion of a livestock unit (LSU) 0,8 for cattle, 0.15 sheep and 0.10 for goats.X_3 is the total cost of livestock feed. X_4 is the dummy for (LSU), X_5 is the dummy for total cost of livestock feed.

X_1= It is expected that, households that have more hired labour to look after the animals will have an increased livestock productivity; X_2= it is expected that, large number of household livestock holdings will increase the livestock productivity; X_3= It is expected that, livestock productivity will increase if more money is invested on buying additional for livestock and V_i and U_i as previously defined.

2. 4. Technical inefficiency model

Following (Battese & Coelli 1995) the study uses a function model which has an advantage of allowing simultaneous estimation of the respondent farmer and individual technical efficiency which a one sided error term specified as follows;

$$\mu_i = \delta_0 + \delta_1 Z_{1i} + \delta_2 Z_{2i} + \delta_3 Z_{3i} + \delta_4 Z_{4i} + \delta_5 Z_{5i} + \delta_6 Z_{6i} + \omega_{it} \qquad (6)$$

where:

δ_0, is the intercept, $\delta_{1,2,3,4,5,6}$are unknown parameters to be estimated,$Z_1$is the household head age in years. $Z_2$is thegender of household head, Z_3 is the type of dwelling that the respondent live in. Z_4 is the proportion of households who provide livestock additional feed. Z_5

is the proportion of households who are kraaling their animals. Z_6 is the proportion of households who have herders to look after livestock. The ω_{it} are the iid variable with variance defined by the truncation of the normal distribution and zero mean. The specific Z variables in the above model are specified below;

$$U_i = \delta_0 + \sum\sum \delta_{ij} Z_{ij} \quad (7)$$

where, U_i is the technical inefficiency of the i^{th} household for $i = 1,2,3 \dots, N$; Z_{ij} is the j^{th} socio-economic variable for the i^{th} household for $i = 1,2,3 \dots, N$ and $j = 1,2,3 \dots \dots, k$ δ_0 is the intercept, andδ_j is the coefficient for the K^{th} variable.

Z_1= Age of household head, is expected to influence technical efficiency. Older people are not easily convinced to new technology and innovation. As they grow older, they are unable to look after livestock on their own. On the other hand, young household heads are easily convinced to adopt an innovation and are still active enough to care for the animals. However, with the recent decrease in interest in youth to be involved in agriculture (Cheteni 2016) it is therefore, expected that age can have a negative effect on household efficiency.

Z_2= It is expected that gender of a household head may affect technical efficiency positively or negatively. This is because in this case it mainly dependent on socio- economic characteristic of a household. Male headed households are expected to perform better than female headed households. This is due to the gender role of livestock production. However, the pressure for female to provide for the household can also lead to female headed households performing better.

Z_3= it is expected that dwelling type which was used as proxy for wealth (Bekele *et al.* 2017) ,due to rural urban linkages in rural households may have an effect on the technical efficiency. So it expected that it will increase technical efficiency.

Z_4 it is expected that provision of additional feed will have a negative impact on technical efficiency. This is since, households can provide feed as long as they can to livestock to a point where the maximum growth is reached and then start losing weight, hence decreased technical efficiency.

Z_5 it is expected that livestock kraaling will have both negative and positive impact on technical efficiency. This is because kraaling reduces the chances of animals being stolen and exposed to predators during the night in the rangelands. It also allows to monitor livestock numbers and easy access to livestock handling. However, Nowers *et al.* (2013) states that kraaling contributes negatively because animals regularly stay confined until mid-morning where by prime early morning grazing is reduced.

Z_6 it is expected that livestock herding will increase technical efficiency. This is because, herder will forcefully move the animals to the most productive parts of the rangelands and will be able to control them when its time for kraaling at night. However, the decrease in the interest of herding among the youth and mandatory schooling of young children may have a negative effect on technical efficiency

2.5. Statistical analysis

Descriptive statistics was used to describe key variables. Technical efficiency was estimated using a computer software called Frontier 4.1 program (Coelli & Battese 1996) and verified in R, to find the maximum likelihood estimates for parameters of the stochastic frontier production function.

3. Results

The results revealed that 65 % and 35 % of the respondents were females and males respectively. Of the sampled households (n=120), 14 % of the respondents were in the range of 41-50 years old. The youngest respondents (4 %) were less than 30 years old, while 46 % of the respondents were over 51 years old. The 62 % of the respondents lived in houses made of bricks, while 38 % lived in houses made from mostly mud and bit of bricks. The results revealed that 82 % of the respondents had labour to look after their livestock, while 18 % did not have labour and look after the animals themselves. The 82 % of labour included labour from family members and hired people. The results showed that 57 % of the respondents provide additional feed during dry season but the number of days on which different respondents provide feed to their livestock differ, 43 % of the respondents only rely on grassland for livestock grazing and feeding. The results also showed that 90% of the respondents kraal their animals at night, while 10 % leave their animals in the field (Table 1).

Table 1. Socio economic characteristics of the households that were interviewed

Description	Frequency (n=120)	Percentage (%)
Gender		
Females	78	65
Males	42	35
Age		
≤ 30	5	4
31-40	10	8
41-50	17	14
51-60	24	23
≥ 70	27	23
Dwelling type		
Brick building	74	62
Traditional building	46	38
Labour		
Yes	98	82
No	22	18
Additional Feed		
Yes	68	57
No	52	43
Kraaling		
Yes	108	90
No	12	10

The results of ordinary least square (OLS) and maximum likelihood estimate (MLE) are presented in Table 2. These results show that the estimated coefficients for main inputs (livestock unit and cost of feed) are positive. The coefficient for labour was found to be negative and not consistent with our theoretical expectation. This indicate that productivity output decrease with an increase in labour, suggesting that labour can be increased to a point of no return where maximum growth has been reached and eventually decrease the outputs. These variables were measured to assess if they influence livestock productivity. The results suggest that an increase in 1% of both livestock unit and feed will increase livestock productivity outputs by 0.25 % and 0.06 % respectively. The inefficiency variables were also included in the

analyses to assess if they influence technical efficiency of household livestock production. The inefficiency analysis of the stochastic frontier indicated coefficients for age, and provision of feed were all positive, suggesting that increasing these variables will decrease technical efficiency. The estimated coefficient for gender, dwelling type, kraaling and herding were all negative, indicating that an increase in these variables will increase technical efficiency.

Table 2: A stochastic frontier production function parameters and ordinary least square (OLS) and maximum likelihood estimate (MLE)

	OLS			MLE		
Variables	Co-eff	St.Error	t-ratio	Co-eff	St.Error	t-ratio
Constant	16.903	4.731	3.573	13.700	2.714	5.048
Labour	-0.834	0.545	-1.531	-0.445	0.307	-1.448
Livestock unit (LSU)	0.256	0.109	2.348	0.161	0.091	1.765
Cost of feed	0.066	0.062	1.061	0.070	0.057	1.236
Dummy (LSU)	0.722	0.292	2.469	0.724	0.271	2.672
Dummy (Cost of feed)	0.294	0.193	1.525	0.422	0.219	1.926
Constant				1.153	1.258	0.916
Age				0.491	0.860	0.570
Gender (1= Female)				-1.743	0.760	-2.294
Dwelling type (1= Brick)				-2.580	1.096	-2.355
Additional feed (1=Yes)				1.813	0.765	2.369
Kraaling (Yes= 1)				-1.053	1.286	-0.818
Herding (Yes= 1)				-1.205	0.655	-1.841
Sigma square				0.947	0.268	3.527
Gamma				0.460	0.116	3.982
Log likelihood	-145.68			-136.61		

3.1. Wealth status classification criteria

A post analysis of the multiple criteria focused on physical ownership of key assets and their anticipated values at the time of study were used rather than precarious annual cash income (Bekele *et al.,* 2017). Ownership of houses with brick buildings and corrugated iron, thatched roofs, traditional buildings, livestock types and numbers and technical efficiency were used as

an index of wealth. However, it was not possible to set an absolute cut off point to each criterion, hence it was evident that overlap in the range of values for set criteria. The contributions were assessed together as a group of households under one criteria of the three wealth categories following (Bekele *et al.,* 2017). The national census data was also used to define the categories of dwelling type in both villages (Census, 2010).

Table 3: Wealth classification criteria

Criteria	Better-off (n=)	Medium (n=)	Poor (n=)
Livestock holdings			
No. of cattle	>8	4- 8	<4
No. of Sheep	>15	10-15	1-10
No. of Goats	>15	10-15	1-10
Dwelling type			
Traditional	No	Yes	Yes
Bricks	Yes	Yes	No
Technical efficiency	0.7-0.10	0.4-0.69	0.1-0.39

The frequency distribution of technical efficiency levels presented below (Figure 2). The results show that households livestock production achieved on average 79 % level of efficiency, ranging from 15 % to 93 %, with a wide range of efficiency variation among households. About 63 % of the households had technical efficiency level ranging from 81-100 %. Only 11 % of the respondents had a technical efficiency level ranging from 51– 70 %. About 6 % of the households were able to achieve 10 – 50 % technical efficiency. The results further revealed that 20 % of the households were able to achieve a technical efficiency level between 71 – 80 %. These results suggest the potential for improving technical efficiency among households is possible if interventions could be applied.

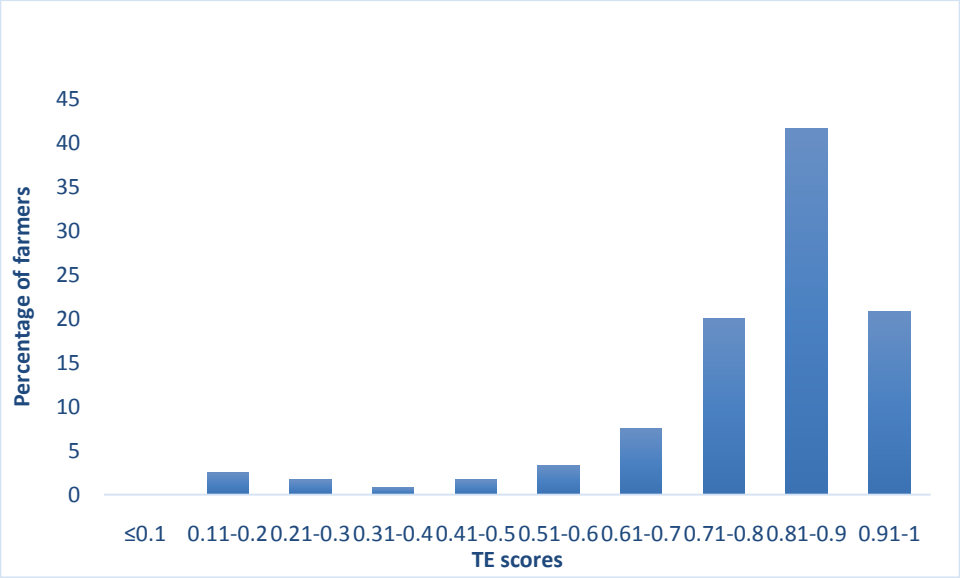

Figure2: Distribution of technical efficiency in the study area.

Figure 3 shows the results of the post analysis of performance group categories based on an individual household wealth status in terms of livestock holdings, technical efficiency and dwelling type. The poor performing households comprised 45 % (n= 54) of the sampled households. This group of households mainly resides on traditional buildings made from wattle and mud and was mostly dominated by females (29 %) than males (16%). About 27% of households in this group (n=32) have abandoned livestock farming. The poor performing group had a low output derived from livestock while they are investing in livestock production through household labour. The middle performing group of 28 % obtained moderate outputs with labour and additional feed being invested. This group of individual households was residing on mixed buildings with both traditional and brick houses and had livestock holdings of between 4-8 cattle and more than 4 small stock holding. This group composed of 18 % females and 10% male headed households. Of the interviewed households that fall under better-off group (27%) household heads are mostly comprised of females than males (18% and 9 %) respectively. According to the results, the better-off group revealed to be positively producing livestock outputs. These types of households were mainly residing in brick buildings and had more livestock number than the other groups.

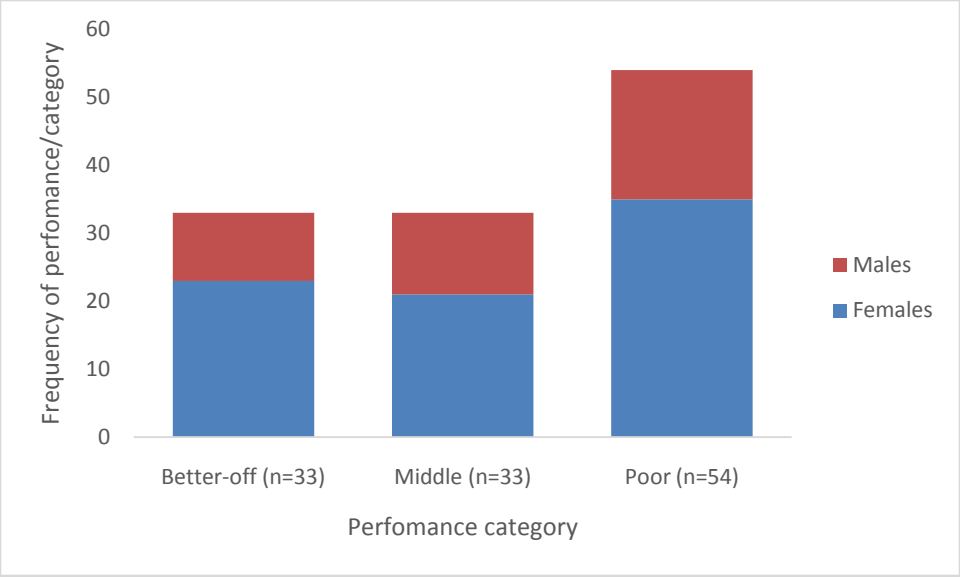

Figure 3: Frequency of productivity performance by gender of the household head at Mgwalana and Mahlungulu village.

4. Discussion

4.1. Inefficiency model estimates

The results of the MLE indicate that gender increases the technical efficiency and was significantly different. According to (Yisehak 2008), gender is an important component in labor share of livestock production systems. Both males and females have different responsibilities related to animal production, with some level of variation in involvement from household to household. In smallholder livestock production, males are mostly responsible for decision making and general herd management, while females mostly contribute to more labour and feed inputs and managing sick animals and calves (Yisehak 2008). These results make a lot of sense given that high livestock productivity and technical efficient households are female headed. The respondents reported that they provide labour for livestock handling and this is mostly provided by household members. Most of the households use their children to look after cattle. This form of arrangement according to (Cousins 1996) also helps an individual to gain livestock ownership due to gain in experience of animal husbandry at a young age. However, mandatory schooling has reduced the number of children who are available to work as herders, so elderly people are the ones who mostly look after livestock during the school hours. In both villages, 68 % of the households provide additional feed for livestock. These households only provide feed during dry season. The animals that benefit from the feed are only those that are calving and those already in calf. The reason for such a limit could be the fact that these people are unemployed and rely on livestock sales which are mostly informal, with their adult children who are migrant workers, only focusing on household development that is not related to livestock production.

Age was an important criterion with many individuals ranging from 50-60 (28 %), 60-70 (23 %) to more than 70 (23 %) years of age (Table 1) in interviewed households. The results show that age which was indicated by a positive sign decreases technical efficiency. This suggest that older people have more knowledge and interest in livestock keeping. On the other hand, older people can be a challenge because they struggle with physical responsibilities that come with livestock farming. They also do not easily adapt to new innovation and technology. These results were almost the same as those found by (Kunene, 2010) in Northern Kwa-Zulu Natal and (Masuku & Sihlongonyane 2015) in smallholder farmers in Swaziland, whom recorded that most farmers were falling under the age of 50-60 years.

The results of the inefficiency model show that dwelling type which was indicated by a negative increase technical efficiency. In both villages, 62 % of the households were built using brick buildings while 38 % of households were traditional buildings. This may be due to rural-urban linkages, where by several absent family members who are migrant workers are directly involved in the household development via remittances and kinships. The absent family members become involved in the household developments by assisting in the building of a household when they start earning income. Almost every household (90 %) kraal their livestock at night. The coefficient for kraaling and livestock herding which were indicated by a negative suggest that, both kraaling and herding increase technical efficiency. Kraaling and herding are very important in keeping animals away from predation and theft.

4.2. Technical efficiency scores

The average score for both villages was 0.79 of technical efficiency. This implies that on average, both villages are producing at 79 % with given inputs and technology. According to the results of the technical efficiency, 93 % of the households had a score above 0.5. However, there is still more to be done in communal areas to improve technical efficiencies of livestock production. In this study, 21 % of the household obtained more than 91 % technical efficiency level. The technical inefficiency factors such as age and provision of additional feed to livestock were revealed to decrease the technical efficiency in the study site. According to (Tolga *et al.,* 2009) the age of a farmer may have a positive and a negative influence on technical efficiency, depending on whether the experienced older farmers are slower to accept new technologies than young farmers are. Furthermore, when the animal is provided with additional feed, it grows and reaches a point where there is no growth and then the weight drops, thus decreasing technical efficiency. The increase in technical efficiency would require improving household interspecific efficiency factors that includes proper land use practice, farmers' information days, access to credit, access to market, increase in extension visits and close mentoring of the people who are livestock farmers. This can be done by identifying the households that are able to achieve high technical efficiency level so that possible interventions can help to uplift them in becoming more successful livestock farmers. This can be done through livestock market value chain improvement where by beef suppliers (abattoirs) directly buy livestock from the villages. The government could also assist household who obtain more than 70 % technical efficiency level by ensuring better and reliable support and empowering women farmers. Other inefficiency variables such as the dwelling type, kraaling, herding and gender were revealed to increase technical efficiency in the study site. However a study

conducted by (Mlote *et al.* 2013) revealed that dwelling type did not have an effect on the efficiency.

4.3. Determinates of technical efficiency in different performance profiles

According to the results obtained under performance profile, 45 % of households were poorly performing in both Mgwalana and Mahlungulu villages. This group was composed of individual households who had low livestock numbers, staying in traditional building and obtained low technical efficiency scores. This group composed of individual households who invested by inputs such as labour to livestock production but still producing at a loss. The underlying reason for such output can be inefficiency variables such as those documented by (Masuku & Sihlongonyane 2015). Such factors are documented as production constraints affecting production efficiencies of farmers that includes lack of information about livestock farming, poor market information, unavailability of inputs (high feed cost, veterinary services, reliable labour), shortage of water and feed. All these factors are the case for these villages. Although the mostly observed constraint in these two villages was the fact that people do not have enough information about livestock husbandry because they also keep their animals for status. They keep the animals for a very long time until they lose their market value. The middle performing grouphad a moderate production. This group of households had both labour and capital invested in the livestock production and were residing on houses made from both bricks, mud and wattle.

The better-off performing group obtained positive values and formed 27 % of the sampled population. This group of households comprised of individuals who have abandoned livestock

production and those who are owning high livestock numbers and staying in brick buildings. The reason for these households having quit livestock production was gathered from the interviews that, these households previously had livestock but due to diseases, theft and drought, the livestock were lost. Some of the household had sold all their livestock holdings to convert them into cash for household expenses such as sending children to school. Better-off performing households were mostly comprised of females (18%) than males (9 %). These results were very surprising because males are expected to have more knowledge about livestock than females, hence expected to produce more. On the other hand, females in rural areas have more pressure of providing for their households with the money from livestock sales. These results provide an opportunity for any interventions that may be of useful consideration to improve technical efficiencies in these two villages.

5. Conclusion and recommendations

Based on the findings of this study, the results revealed that more females than males that participated in the survey. The reason for this could be the fact that males are out in towns for work. The mean technical efficiency for the study shows that there is an opportunity for improvement in the household that are performing above 70 % technical efficiency level. The idea is to uplift all the households in the village and encourage them into livestock farming and not just livestock owners. The results also suggest, that there is a need for knowledge about market information and livestock husbandry so that we can reduce the livestock water footprint in the village. This will in turn help to improve the availability of feed from the rangelands for the households that cannot afford to buy additional feed during dry season. The

interventions may be of useful in the more affluent households with improved strategies so that they become more successful at food production. The interventions may be through providing knowledge about livestock production. Informing policy/government to intervene through extended public work programs to provide labour for livestock herding which will in turn improve livestock distribution, providing feed throughout the year and increase the availability of extension visits.

3.6. References

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