Advances in Life Science and Technology
ISSN 2224-7181 (Paper) ISSN 2225-062X (Online)
Vol.49, 2016
www.iiste.org

Evaluation of Technical Efficiency of Rabbit Production in Buuri Sub -County, Meru County, Kenya

Shadrack M Kitavi[1] Lawrence K. Kibet[2] Job K. Lagat[1] Walter Koech[1]
1.Department of Agricultural Economics and Agribusiness Management, Egerton University, P.O. Box 536-20115, Egerton, Kenya
2.Departments of Economics, Egerton University, P. O. Box 536-20115 Egerton, Kenya

Abstract
Current rabbit production in Buuri Sub county stands at 1.2 Metric tons of meat against a potential of 8.4 Metric tons per year. This productivity gap is wide and indicative of poor and low performance of the enterprise in rural areas of Kenya and specifically Buuri Sub County. Thus the main objective of this study was to investigate the technical efficiency of rabbit production and its contribution to household food production and family welfare under conditions of resource scarcity. The technical efficiency of rabbit production was evaluated to explain the paradox behind the low productivity of rabbit enterprises in Buuri sub-county. A multistage simple random sampling procedure was employed to get 139 respondents for the study. A semi structured and pre-tested questionnaire was used to collect data from the selected small holder rabbit producers through face to face interview of the household heads. The study used descriptive statistics for the analysis of socioeconomic and institutional attributes of the rabbit producers. The stochastic frontier production parametric method was used for the efficiency analysis. The results showed mean technical efficiencies among the rabbit farms were 36.83%. The farmers are not producing the rabbit output at minimum costs. Further the study found that the capital is the most important rabbit output enhancing variable among all studied parameters. The Tobit model results indicated that increased access to education, trainings and credit to the farmers led to improved rabbit efficiency. More importantly county government and non-governmental agencies should make deliberate attempts for improved farmer-extension and research linkage for better technology transfer and adoption by farmers, leading to more productive rabbit enterprises hence improved incomes and thus reducing poverty level among farmers.
Keywords: Technical efficiency, rabbit breeds, efficiency, rabbit keeping, backyard farming enterprises, stochastic frontier

INTRODUCTION

Background Information

Kenya's economy is heavily dependent on agriculture which contributes to rural employment, foreign exchange earnings and rural incomes all of which are important such that any broad-based improvement in rural living standards requires substantial productivity growth of agriculture (Nyoro and Jayne, 2005). Agriculture accounts for about 26% of Kenya's Gross Domestic Product (GDP) and employment to over 80% of the population in the rural areas. Within the agricultural sector the livestock subsector contributes 10% of the GDP and accounts for 30% of farm gate value of agricultural products. Livestock production is a major economic and social activity for all rural communities in Kenya. Despite this high contribution from the sub sector to the national economy, it receives less than 2% annual Government of Kenya (GoK) allocations for its development (Nyange *et al.,* 2000).

Rabbits are micro-livestock mammals in the family of Leporidae are found in several parts of the world. They are kept by humans for commercial purposes or as pet's .They are part of the domesticated animals originating from one species of the European rabbits (Oryctolagus cuniculus) found across Europe and Northern Africa. They vary very much in colour and weight (1.4 to 7.3 kg). Some have small, erect ears while others have long hanging ears. The male is called a buck and the female is a doe and the young are referred to as kids (DLP, 2010). The main challenges in rabbitry are poor resource use, marketing and inadequate credit hence low enterprise productivity (Kavoi *et al* ., 2010).

The rabbit enterprise has the potential to be a cheap and sustainable means of producing high quality animal protein for the expanding human population in Kenya. Rabbits can be reared on cheap diets of forages and kitchen leftovers. They also utilize forages more efficiently than cattle, shoats and the rabbits poses minimal competition with humans for similar food (Lukerfahr and Cheeke, 1997; Borter *et al*., 2010).With good care a doe can produce up to 40 young ones per year compared with 0.8 for cows and 1.4 for ewes per year. Moreover small scale rabbit enterprises can be established at very minimal costs to the rural poor farmers in SSA (Lukerfahr and Goldman, 1985).

One of the Kenya's key food production objectives is to have the country achieve food self sufficiency in all the food products including meat and meat products at all the times (DLP-GOK, 2010). The policy is based on the fact that an analysis of projected demand of meat and meat products indicates a large deficit of the domestic supply especially for the poor. The high poverty levels and malnutrition incidences in the country has pushed the government to prioritize rabbit development in Kenya over the last decade. This is because rabbit enterprise is a cheap and easy source of meat, incomes and employment to Kenyans especially poor women and youth.

The national livestock development strategy stresses and emphasizes on all stakeholder involvement and professionalism in the provision of all livestock development activities and programmes (Borter *et al*., 2010). This is geared towards the goal of poverty alleviation, food security and wealth creation in the country. Livestock enterprises productivity and efficiency in resource use at the farm level is key in the attainment of these goals. Currently, however, most production systems including the rabbit production are predominantly subsistence low input/low output system. This may suggest production inefficiencies resulting to the low yields of the rabbit enterprises over the years despite livestock development services by the ministry of livestock development in Kenya (Borter *et al*., 2010).

Rabbit production in Buuri Sub County is an enterprise practised dominantly under small scale intensive management circumstances and economic efficiency is anticipated in such systems. Nevertheless rabbit production at farm level is low and stands at 1.2 metric tons of meat compared to the potential of 8.4 metric tons against a demand of over 20 metric tonnes of rabbit products per year (DLP, Annual Report, 2010). The average farm level rabbit live body weights is 0.5 kilogram while on research sites, mature rabbits weigh up to 8 kilograms. Likewise, the growth rates of the rabbits vary in big margins (KARI, 2005; Borter *et al*., 2010).The small holder rabbit farmers are not able to produce maximum output with the given inputs. This may be due failure of the producers to combine inputs in the correct proportions at given factor prices to produce optimally or are prone to random inefficiency factors beyond the farmer's control. This raises the questions of production inefficiencies in the rabbit subsector. Empirical evidence suggests that improving the productivity of the small holder rabbit farmers is important for economic and rural development especially in the developing countries in SSA . This is because small holder agriculture provides a source of employment and a more equitable distribution of incomes in the rural areas of the developing countries (Bravo-Uretta and Evanson, 1994).

Studies by Food Agricultural Organization (FAO) and World Health Organization (WHO) have shown that developing countries are where critical meat shortages' exist and the potential of rabbit production is greatest. The cost of beef, mutton and poultry in the Kenya is high like in the other sub Saharan countries. Moreover the increasing awareness on health by consumers and rabbits being a cheap and nutritionally safe source of proteins especially the poor households in the rural areas of Kenya. These reasons have motivated many farmers to engage in rabbit rearing in the country (Wanyoike *et al*., 2012). Public and private actors are also taking the enterprise seriously and are now playing an active role in popularizing it. This is because they realize that raising rabbits is a worthwhile venture for food security and wealth creation in Kenya (Wanyoike *et al*., 2012).

Since the rabbit sector productivity and production is low, there is the necessity to establish technical efficiencies of small holder rabbit producers in the rural areas of Kenya (Borter *et al* ., 2010). Technically efficient farmers would ideally be highly productive because they are able to use minimum level of inputs to produce a high level of outputs or produce maximum output from a given level of inputs. This study will lead to improving the economic efficiency of rabbit rearing in the study area and thus a flourishing rabbit sector in Kenya.

The current meat production of rabbit enterprises at the farm level stands at 1.2 metric tons against a recorded potential of 8.4 metric tons in Kenya. This productivity gap is wide and indicative of poor and low performance of the enterprise in rural areas of Kenya and specifically Buuri Sub County. One of the reasons attributed to this trend could lie in the way smallholder rabbit farmers use their resources. No studies have been undertaken to evaluate the efficiency of resource use in rabbit production in Buuri Sub County. The study aims at filling this knowledge gap by evaluating the technical efficiency of the smallholder rabbit farmers and determining the key socioeconomic and institutional factors that influence their efficiency0 METHODOLOGY

The study area

The study was carried out in Buuri sub county in Meru, Kenya targeting all the smallholder rabbit producers in the study area. Buuri sub county is comprised of 4 administrative wards namely Timau, Kibirichia, Buuri and Kisima with a population of 106,543 persons and an area of 987 square kilometers (GOK 2008). The economy of Buuri Sub County is mainly agricultural with livestock keeping being the major activity supporting over 80% livelihoods of the people. The area experiences low –medium to high rainfall precipitation ranging from as low as 200mm to amounts as high as 2000mm of precipitation per year and is on the leeward side of Mt. Kenya. The poverty index of the district is 60% (KNBS, 2010). Buuri Sub County was purposefully chosen due to the intensity and prominence of rabbit production than the other sub counties in Meru County (Wanyoike *et al.,* 2012).

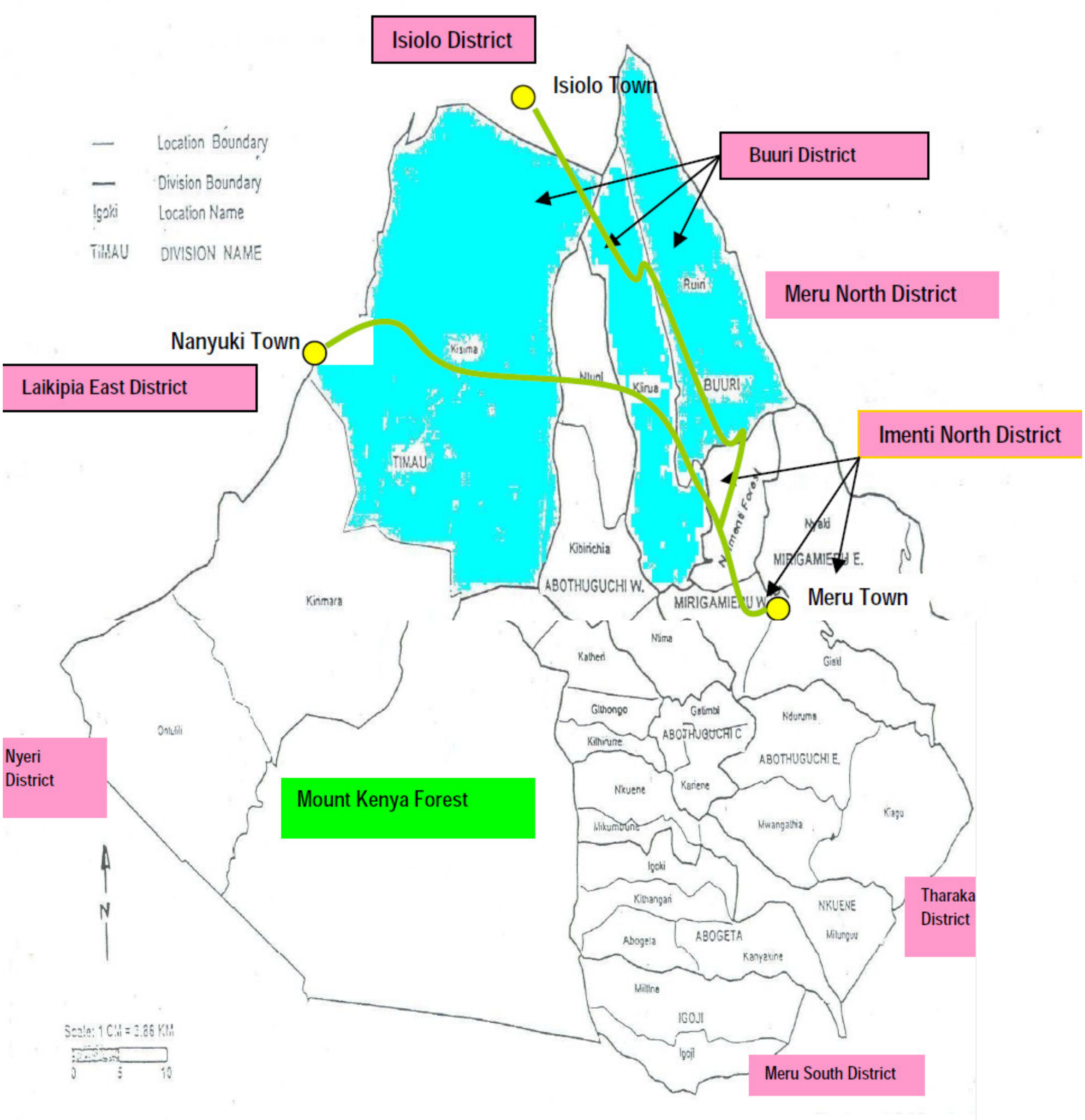

Figure 2: Map of Buuri District and its environs
Source: Meru Central Development Plan (2002-2008)

Sample Size

The sample size was computed according to Kothari (2004) from the population of interest.

$$n = \frac{z^2 \delta^2}{e^2} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

Where n is the sample size, z is the standard variation at a confidence interval (Z-value), e is the acceptable margin of error and δ is the standard deviation of the study population. With the assumption in this study, of z= 95%, e=0.05%, δ=0.29 (the standard deviation is estimated from other studies) .
The study used 95% level of confidence (Z=1.96) and E =.05, (allowable error the researcher is willing to accept) . The sample was,

$n = 1.96^2 * 0.29 * 0.29 \div .0.05^2$ =129.

This gives sample size of 129 respondents but other additional 10 included to cater for non response and spoilt questionnaires hence a total of 139 respondents were randomly selected (Owuor *et al* ., 2007).

Sampling Design

A multistage random sampling design was used to get the study sample where the household is the sampling unit in this study. The first stage was to randomly select of two wards out of the four in the sub county. The second stage was to randomly select 3 locations from each of the two selected wards. Afterwards Simple random sampling technique was used to select the respondents from the locations selected proportionally according to size based on the list of rabbit producers given by the divisional livestock extension officer at the ward headquarters in Buuri (Edriss, 2003).

Data Collection method and Type of Data

Primary data was collected using a well structured and validated questionnaire administered to the household heads of the sampled families in the study area. The data collected included farm and farmer characteristics e.g. farm size, number of breeding rabbits (does and bucks), quantities of inputs used, input and output prices. Data was also collected on the socio-economic variables, such as age, farming experience, educational level and credit availability.

Analytical models

The stochastic frontier approach was used since it gives better results, allows for the measurement of random errors such as inefficiencies of production, statistical noise measurements and the confidence of the results is much higher than from non parametric models.

Taylor and Shonkwiler, 1986, proposed the formulation and application of deterministic frontier models in the analysis of agricultural efficiency studies. The basic structure of the model is as shown

$$Y = f(X,\beta)e^{-U} \quad \text{……………………………………………………………………………}(2)$$

Where $y = f(x,\beta)$ denotes the frontier production function and U is a one sided non negative distribution term. This model imposes a constraint of U =0 which implies the output is less than or equal to the potential within the given inputs and output market prices and production circumstances. Accordingly therefore this model is in full agreement with the production theory. The main criticisms against it is that all the observed variations are accounted for by the animal husbandry management practices and no account of statistical noise such as random errors, omitted rabbit production variables and measurement shocks.

The history of stochastic frontier analysis models began with Aignier and Chu (1968) they suggested a composite error term and since then their work, findings has been used extensively in getting appropriate models to measure efficiency hence the development of the stochastic frontier models. This model improved the deterministic models by introducing v term into the deterministic model to form a composite error term .The error term in the stochastic frontier model is assumed to have two additive components namely a symmetric component which represents the effects of statistical noise such as weather, measurement errors and distribution of supplies. The other error component captures systematic influences in the production process that are unexplained by the production function and are attributed to the technical inefficiencies (Tijan, 2006). The models basic structure is a specified below

$$Y_i = f(X,\beta)e^{V-U} \quad \text{…………………………………………………………………………}(3)$$

Where $f(x,\beta)$ is as defined in equation 2 while $v-\mu$ is the error term. The $v_{i's}$ in the term are the random variables which are assumed to be normally distributed N(0 δv^2)and independent of the $\mu_i s$ which are non negative random variables assumed to account for technical inefficiency in production function and are assumed to be N(0 δv^2) .

Further it's assumed that the average level of TE is measured by mode of the non negative half normal, truncated or exponential distribution of the U s is a function of the exogenous factors believed to effect inefficiency as shown

$$U_i = \delta_O + \ldots \delta_i \; Z_i \quad \text{…………………………………………………………..……………}(4)$$

Where Z_{is} is a column vector of hypothesized efficiency determinants and the δ_0 and δi which are unknown parameters to be estimated. It is clear that if U_i does not exist in equation 4 or U_i - δ=0 then the stochastic frontier production function reduces to traditional production function in mathematical form is expressed as Y = f(X).

Where Y denotes output of a firm, X shows a vector inputs used in the production process. In that case, the observed units of production are equally efficient and residual output is solely explained by unsystematic influences that occur in the production process. The distribution of the parameters of the U_i and δv^2 are hence inefficiency indicators where the former indicates the average level of technical or cost inefficiency and the latter gives the dispersion of the inefficiency level across observed production units(Tijan, 2006).Thus given the functional and distributional assumptions above, the values of the unknown coefficients in equations 2,3,4 and 8 i.e. $\beta_s \delta_s \delta_s \delta v$ are jointly obtained using the maximum likelihood estimation method (MLE).

The estimated values of technical, efficiency values for each observation are then calculated. The unobservable values of v_i are obtained from its conditional expectations given the observable values of $v_i - \mu_i$ from equation 5 as suggested by Yao and Liu (1998) and Tijan (2006).It is noteworthy to mention that in this rabbit producers study the efficiency enhancing factors will be determined using a Tobit model as it will be explained later other than incorporating the factors in the stochastic frontier model as indicated in equation 8.

The efficiency estimates obtained by the methods described above will be regressed on some chosen rabbit farm and farmer specific attributes and production circumstances by use of a Tobit model. As indicated by (Obare *et al* ., 2010), this approach is extensively used in the study of economic efficiency studies especially in small holder agriculture in developing countries. The farm and farmer characteristics regressed will be household heads age, gender, farmer education level, main occupation, farming experience, farm size (size of the rabbit breeding flock), off-farm income, distance to the market, access to credit, access to extension services, and group membership. These chosen farm and farmer characteristics are those that have the greatest affect on farm efficiency among small holder farmers in developing countries. The basic structure of the equation of the Tobit model will be given as,

$y^*{}_i = X\beta + \varepsilon_i$ Where $y^*{}_i$ is a latent variable for the i-th rabbit farm that is observed for value greater than τ and censored for values less than or equal to τ . The Tobit model can be generalized to take into account the two values of both above and below τ .

X is a vector of independent variables that are postulated to influence efficiency and productivity of the rabbit enterprise.

β s are parameters that are associated with the variable that are to be estimated using the Tobit model. The ε is the independently distributed error term assumed to be normally distributed with a mean of zero and a constant variance.

The observed y is defined by the following generic measurement equations below,

$$\left.\begin{aligned} y_i &= y^* if y^* > \tau \\ y_i &= \tau_y if y^* \leq \tau \end{aligned}\right\} \quad \text{.......................... (5)}$$

Ideally Tobit model assumes that τ = 0 which means that the data is censored at zero (0). However the farm and farmer specific efficiency scores for the rabbit producers range between 0- 1. With this presumption then substitute τ in the equations as shown below:

$$\left.\begin{aligned} y_i &= y^* \text{ if } 0 < y^* < 1 \\ y &= 0 \text{ if } y^* \leq 0 \\ y_i &= 1 \text{ if } y^* \geq 1 \end{aligned}\right\} \quad \text{.......................... (6)}$$

Therefore the model assumes that there is underlying stochastic index that is equal to ($X_i \beta + \varepsilon$) which is observed only when some number equals to between 0 and 1 then now y^* qualifies as an unobserved hidden latent variable .The dependent variable is not normally distributed since its values range between 0 and 1.Then the empirical Tobit model for the study takes the form as given below,

$$y^*{}_i = \beta_o + \sum_{n=1}^{11} \beta_n x_i + \varepsilon_i \quad \text{.......................... (7)}$$

where X_1 = age of the farmer in years, X_2 = experience of the farmer in years , X_3 =farmers education level in years, X_4 = Gender , X_5 = Off farm income in Kes, X_6 = Rural market distance in Kms, X_7 =Credit, X_8 =Extension, X_9 =Group membership , X_{10} = Occupation , X_{11} =Farm size. Gujarati , (2004) noted that using OLS to estimate the parameters coefficients in the model above would produce inconsistent and biased estimates of the efficiency scores because of multicollinearity problem. Further this is because the OLS method of estimation underestimates the true effect of the parameters thus reducing the slope of the graph (Goetz, 1995). Kumbhakar, Ghosh and McGuckin (1991) and Reifschneider and Stevenson (1991) estimated all of the parameters in one step to overcome this inconsistency. The inefficiency effects were defined as a function of the firm-specific factors (as in the two-stage approach), but were incorporated directly into the MLE method. Battese and Coelli (1995) also suggested a one-step procedure for using the model. Therefore the maximum likelihood estimation method (MLE) is recommended for the Tobit analysis so as to resolve the problems above and produce better efficiency Scores from the model above as proposed in the table below.

RESULTS AND DISCUSSION

Characterization of socioeconomic and institutional attributes of rabbit producers.

The non-categorical socio economic characteristics of the 139 small scale rabbit producers are presented in table 4.

Table 1: Non categorical variables of the rabbit producers

Variables	N	Min	Max	Mean	Std. Error	Std. Deviation
Age(Years)	139	26	78	44.270	0.896	10.565
Household size(Number)	139	1	15	5.420	0.210	2.479
Total farm size(Acre)	139	0	10	1.822	0.178	2.094
Land under Rabbit (Acre)	139	0	1	0.151	0.013	0.155
Experience(Years)	139	1	20	2.642	0.260	3.063
Market distance – input (Km)	139	1	10	2.130	0.152	1.786
Market distance – output (Km)	139	1	40	2.680	0.449	5.290

The non- categorical characteristics investigated included age, household size, total farm size, land under rabbits, experience in rabbit production, and distance to the nearest input and output market of the rabbit producers. The results (Table 1) indicated that the farmers were largely homogenous with respect to the selected characteristics. From the interviewed farmers, mean age of rabbit farmers was 44years old, average household size was 5 persons, and the mean experience in rabbit farming 3 years. More over the mean total farm size per farm was about 1.82 acres out of which 0.15 acres were set aside for rabbit keeping.The results imply the rabbit enterprise is being done on a small scale intensive system, were high animal management standards and capital investments are required (Borter *et al.,* 2010). Further the selected farmers had 3 year experience in rabbit keeping. The market distance for inputs and outputs were 2 and 3 kms far from the producers respectively.

The results showed that the mean age of producers was 44 years, implies the farmers are youthful for good rabbit keeping. The mean household size of 5 people large and could be an advantage to the rabbit farmers in the provision of family labour which is cheaper and more easily available. The mean farming experience was 3 years, indicating that the rabbit farmers have enough skill and experience in rabbit production and therefore able to understand effectively the modern rudiments of commercial rabbit farming.

The results of the categorical socio economic and institutional variables of the 139 small holder rabbit producers are presented in table 2. These variables include gender, marital status, education, occupation, group membership, credit access, extension service and training service of the interviewed rabbit producer's .The results indicated that the farmers are homogenous with respect to all the categorical attributes studied. The results showed that 69.1% of the producers were of the male gender while the rest are females. Majority of the interviewed producers were married (63.15%) with about 10% being single families. The results have further indicated that the rabbit farming is a male dominated occupation since about 69.1% of the selected households were males headed; with 63 % of the producers being married implying gender must be considered when promoting the enterprise.

More over 61.2% of the farmers had primary level education while 30.2% had secondary level of education implying that the farmers can understand the required modern rabbit keeping skills and knowledge. The results imply that most of the rabbit farmers have at least primary level education which is adequate for enabling the farmers to understand improved rabbit production enhancing technologies for increased farm income

More importantly 71.9% of the selected farmers were members of producer market groups implying that the majority rabbit producers were members of producer organizations. The results imply that the producers are not getting the efficiency enhancing services of producer groups or farmer associations resulting to current high rabbit production inefficiencies. The results further showed that 66.2% of the respondents had no access to credit facilities with extension service access being available to 51.1% of the interviewed farmers while 48.9% had no extension. The results imply that there was fair extension service provision in the region and hence the noted rabbit production gaps. Finally training service on different aspects rabbit husbandry practices was available to 60.4% of the respondents and hence the recorded inefficiencies in rabbit keeping. The results indicate poor extension service provision to the farmers. This means that the rabbit farmers received fair to poor training and extension contact which could lead to low adoption of rabbit productivity enhancing skills and technologies. Further the results indicated that 53.2 % of farmers practiced mixed farming followed crop farming (37.4%) as types main types of occupation supporting majority of the livelihoods in the region. The results concurs with Kavoi *et al .(*2012) study which concluded that in sub-Saharan Africa (SSA) region poverty alleviation and food security can only be attained by improving the productivity of agricultural enterprises undertaken by the rural farmers .

Table 2: Categorical variables

Variables		**Frequency**	**Percentage**	**Mean**	**Standard error**
Gender	Female	43	30.9	0.31	0.039
	Male	96	69.1		
Marital status	Married	110	79.1	1.39	0.073
	Single	14	10.1		
	Divorced	5	3.6		
	Widowed	10	7.2		
Education	None	4	2.9	2.39	0.055
	Primary	85	61.2		
	Secondary	42	30.2		
	Tertiary	8	5.8		
Occupation	Crop farming	52	37.4	2.45	0.115
	Livestock farming	2	1.4		
	Mixed farming	74	53.2		
	Salaried employee	3	2.2		
	Labourer	8	5.8		
Group membership	No	39	28.1	0.72	0.038
	Yes	100	71.9		
Credit access	No	92	66.2	0.34	0.040
	Yes	47	33.8		
Extension service	No	68	48.9	0.51	0.043
	Yes	71	51.1		
Training service	No	55	39.6	0.60	0.042
	Yes	84	60.4		

1 acre=0.405ha

Efficiency levels of resource use in smallholder rabbit production

The factors perceived to affect inefficiency of rabbit production were estimated using stochastic frontier production model and the results are presented in table 3. The results indicate that six variables namely land, breeding stock, number of weaners, feeds and feeding, labour and capital were found to significantly contribute to the inefficiencies that exist in rabbit production.

The log likelihood for the fitted model was -334.93 and the chi-square was 486.96. The results are strongly significant at 1% level. Thus the overall model was significant and the explanatory variables used in the model were collectively able to explain the variations in rabbit productivity. Moreover the results are statistically significant and different from zero (Greene, 2011). This implies that there were significant variations in rabbit output between the smallholder rabbit producers.

Table 3: Stochastic frontier production function results

Inputs $Acre^{-1}$	Coef.	Std. Err.	Z	P>|z|
Rabbit Land (Acres)	-1.250	0.223	-5.610	0.000***
Breed Stock (Number $Acre^{-1}$)	-0.526	0.235	-2.240	0.025**
Weaners (Number $Acre^{-1}$)	0.207	0.109	1.910	0.056*
Kids (Number $Acre^{-1}$)	0.042	0.075	0.560	0.575
Market Stock (Number $Acre^{-1}$)	0.077	0.069	1.110	0.268
Pellets (Kgs $Acre^{-1}$)	-0.004	0.070	-0.060	0.954
Hay (Kgs $Acre^{-1}$)	-0.096	0.071	-1.360	0.175
Drug (Litres $Acre^{-1}$)	0.001	0.122	0.010	0.994
Chemical (Litres $Acre^{-1}$)	0.123	0.126	0.970	0.330
Hybrid Buck (Number $Acre^{-1}$)	-0.061	0.112	-0.540	0.586
Green Feeds (Kgs $Acre^{-1}$)	0.156	0.082	1.900	0.058*
Labour (Man days $Acre^{-1}$)	-0.279	0.084	-3.330	0.001***
Capital (KES $Acre^{-1}$)	0.274	0.112	2.440	0.015**
Equipment (KES $Acre^{-1}$)	0.114	0.102	1.110	0.266
Constant	8.610	0.491	17.540	0.000***
Likelihood-ratio test of $\sigma u = 0$;	**Wald chi^2 (14) = 486.57;**			
Log likelihood= -334.93;	**Prob> chi^2= 0.000**			

***, **, *** is significant at 10%, 5% and 1% respectively**

Though not significant, number of weaners, amount of green feeds variables for enterprises were found to be positively influencing rabbit productivity. However, an increase of number of weaners by 1% strongly and significantly increased farmer's rabbit productivity by 20.7%. This suggests that a high weaning rate, leads to higher rabbit output. This gives similar findings as reported by Mpawenimana *et al.* (2005) on banana production in Rwanda.

The amount of rabbit green feeds available does influence rabbit output positively and significantly at 10% level such that a 1% increase in the quantity green feeds in a farm increases rabbits output by 15.64%. This suggests that the more the green feeds a farmer has the higher the rabbit output. This finding concurs with Kavoi *et al* . (2012) which indicated that productivity of intensive small holder livestock production systems directly correlates with the amount of feeds and feeding available to the enterprise.

The other significant coefficients were: capital, breeding stock, land and labour as factors of rabbit production. The capital access for the enterprise showed a positive coefficient as hypothesized which was significant at 5% level. A 1% increase in the amount capital available to rabbit enterprise significantly improved productivity by 27.4 %. The results revealed that capital access and availability was the factor with the highest impact on the productivity of the rabbit enterprise The findings are consistent with Tchale (2009) where capital was found to be a key factor in the production on small holder agriculture. Capital as a factor of production enhances farm infrastructure and small holder rabbit rearing farm structures construction, purchase of modern rabbit rearing equipment, and technology transfer and hence its great effect on productivity.

Breeding stock impact on rabbit productivity was negative and significant at 5% level. The results show that a1% increase in the number of breeding stock significantly lowers productivity by 53%.The explanation for these results is number of breeding stock has a diminishing marginal product which normally sets in early in the rabbit production process and hence over application or higher number of breeding animals leads to reducing rabbit output. These findings were consistent with Kavoi *et al*. (2012).

Land and, labour factors had a negative impact on rabbit productivity. This shows that when land and labour increase from the present levels rabbit production declined. The explanation for this observation is that increase in size of land and labor enables the farmer shift away from rabbit farming to other alternative activities which could be more profitable. Additionally it could be because of poor or lack information, ignorance and knowledge with farmers concerning these inputs use. More importantly the negative coefficient sign for land, labour and breeding stock impact on rabbit productivity may be attributed to the fact that there was limited knowledge among farmers about the right proportions of these inputs application and use; hence they may have over-applied them leading to negative effects on yields. Other possible explanation for the negative contributions of critical inputs in the rabbit production is that labour hours, land given to the enterprise is very limited.

The results further show that Land had negative effect on productivity. This indicates that the rabbit enterprise requires small land pieces for its optimal operation and performance. The result shows that 1% increase in the land for the enterprise leads to 1.25% decrease in the rabbit productivity. The coefficient was negative and significant at 1% probability level. .The enterprise requires very small land acreages for its optimal operation in the rural areas in Kenya and thus rabbit productivity is not constrained by land factor in the study area or could mean that small holder farmers are likely to engage in rabbit farming since it's a viable alternative that requires very little land and other resources (Borter *et al* ., 2010). Small land size devoted to rabbit farming is also indicative of serious husbandry practices needed hence more capital intensive physical structure (e.g. storied structure) for the rabbit farming and thus more productive compared to a farmer who devotes more land space to the activity.

The study further indicated Labour (man days) availability per enterprise affects productivity negatively These results suggests that there is too much family labour in the study area such that the marginal productivity of labour is low, this gives similar results as those of a study by Iwueke (1987). The negative relationship between labour and rabbit output indicates there is too much labour for the enterprise within the study area such that the marginal productivity of labour is negative. The result shows that 1% increase in labour leads 0.274% decrease in the rabbit output. From the results labour as a factor does have negative influence on the output of the rabbit enterprise. A positive sign was expected but results illustrate decreased effect of the factor in the output of the rabbit enterprise, this also gives similar findings as those reported by Mpawenimana *et al.,* (2005). This indicates that rabbit production in Buuri sub county exhibit reducing returns, implying that farmers in the study area may be using traditional rabbit production techniques and methods which have become redundant over time. The small holder productivity is low and decling in the study area.

The Estimates of Technical Efficiency

Technical efficiency score shows the ability of a firm to obtain maximum output from the given inputs and technology. The estimates of technical efficiency of the rabbit producers were as presented in Table 4. The results show that the mean technical efficiency is 36.83% .This suggests that there is about 63.17% chance of increasing output without additional inputs in rabbit production. This result also indicates that for the average rabbit farmer to achieve the technical efficiency level of the most technically efficient farmer ,he/she would realize about 54.1%(i.e. 1-36.83/80.22) cost saving . On the other hand, the least technically efficient farmer will have about 99.98 %(i.e. 1- 0.01/80.22) cost saving on inputs using the same technology. These results indicate very high technical inefficiency exists among the small holder rabbit producers in the study area. Hence there is great potential to enhance rabbit productivity by improving technical efficiency of the rabbit producers, resulting to improved income, with a resultant impact on poverty reduction and wealth creation in the study area.

In summary the study has established that overall mean technical efficiency for rabbit farmers in Buuri district was 36.83% implying that farmers could reduce the current physical input use by about 63.17 % on average and still realize the same output levels. These results clearly indicate that there is a large gap between potential and the actual rabbit production of the small holder rabbit farming in rural Kenya.

Table 4: Farm specific scores for the estimates of technical efficiencies

Class	Frequency	Percentage	Class	Frequency	Percentage
1 – 10	35	21.60	51 – 60	27	16.67
11 – 20	8	4.94	61 – 70	10	6.17
21 – 30	11	6.79	71 – 80	10	6.17
31 – 40	22	13.58	81 – 90	0	0.00
41 – 50	39	24.07	91 – 100	0	0.00
Mean		36.83			
Std deviation		22.79			
Minimum		0.01			
Maximum		80.22			

The factors influencing technical efficiency of rabbit producers

The results in Table 5 show the estimates from the two-limit Tobit regression of selected socio-economic and institutional-support factors against predicted technical efficiency scores. The results indicate that the model was correctly estimated since the model chi-square was 37.43 and it was strongly significant at 1% level. In addition, the pseudo R^2 was 52.57 %, against the recommended level of 20%. Thus it is evident that the explanatory variables chosen for the model were able to explain 52.57% of the variations in technical efficiency levels. Among the selected variables, six were found to have a significant contribution on technical efficiency namely: education, farming experience, farm size, and credit, number of breeding stock and training contacts of the producers.

Education of the household head variable effect is positive and significant at 5% level. This means that the more years spent in education will increase the technical efficiency of the rabbit producers. This result is consistent with Abdulai and Huffman (2000) in their rice study in Ghana which concluded that education level of the producers influences the input use efficiency and hence technical efficiency of the producers. More importantly the result implies giving education to rabbit farmers would be beneficial in terms of reducing resource use inefficiencies among rabbit producers.

Moreover extension services significantly and positively affected smallholder rabbit producer's efficiency such that 1% increase in extension service to the farmers leads to 0.0991% increase in the economic efficiency of the rabbit producers. Augmenting education variable, the result show that access to extension advice to rabbit farmers help to reduce resource use inefficiencies in rabbit production. The results are also consistent with the findings obtained by other researchers in other countries (Rahman,2002).Therefore policy thrust needs to focus on establishing innovative institutional arrangements that enhance agricultural extension, farm contacts and farmer trainings by extension officers.

The farming experience of the household head variable contribution is positive and significant at 5% level. The positive effect implies that rabbit productivity increases with the number of years spent by the household head in rabbit rearing, which suggests the efficiency in rabbit keeping in the study area is highly dependent on the experience of the farmers. Experience in rabbit production may lead to better managerial skills and expertise being acquired over time and eliminated unnecessary transaction costs. Age of a farmer agrees with the prior expectation that increasing age would lead to decrease inefficiency. But a threshold optimal age of the farmers must be established since ageing farmers would be less energetic to work in the farm resulting in reduced productivity, revenues and profits from the farm enterprise (Abaelu, 1998).

Farm size (acres) variable effect on technical efficiency of the smallholder rabbit producers in the study area is positive and significant at 5% level. This shows that increasing farm size for rabbits by 1% the technical efficiency increases by 0.23%. These results are consistent with findings by (Sharma et al., 1999).

Finally the number of training contacts farmers have with extension workers variable coefficient is positive and it has statistically significant relationship with economic efficiency at 5% level .This implies that farm households who receive regular trainings by extension workers appear to be more economically efficient than their counterparts. Similar results were reported by Binam *et al.* (2004) study in Cameroon. The positive estimated coefficient for training of farmers imply economic efficiency increases with the number of training visits made to the farm family by the extension worker. More importantly this result is in line with the argument by Nchare (2007) who in a study concluded that regular trainings by extension workers facilitates practical use of modern techniques and adoption of improved animal productivity enhancing practices and skills. Other factors eg breeding stock, group membership and input market distance had insignificant impact on technical efficiency of the rabbit producers

Table 5: Tobit regression estimates of factors influencing technical efficiency of rabbit producers

	dy/dx	Std. Err.	T	P>|t|
Gender (1=Male)	0.5482	0.6370	0.250	0.213
Age (Years)	0.1286	0.1836	0.700	0.485
Education (Years)	0.1891	0.5901	2.010	0.046**
Household Size (Number)	-0.6499	0.7339	-0.890	0.377
Farming Experience (Years)	0.3970	0.5983	0.340	0.021**
Farm Size (Acres)	0.2309	0.1113	0.450	0.016**
Extension Contacts (Number)	0.0991	0.1325	0.750	0.456
Household Income (KES)	0.6874	0.5539	1.240	0.217
Value of Common Assets (KES)	-0.1903	0.9419	-0.200	0.840
Input-Market Distance (Km)	0.1243	0.0890	1.400	0.165
Group Membership (1=Member)	1.4488	4.0252	0.360	0.719
Credit (KES)	-0.3516	0.3936	-1.430	0.001***
Breeding Stock (Number)	0.8412	0.4471	1.880	0.062*
Training Contacts (Number)	0.0288	0.0473	0.610	0.043**

Number of observations = 162 LR chi2 (15) = 37.43
Log likelihood = -709.20 Prob> chi2 = 0.0011
Pseudo R2 = 0.5257

***, **, *** is significant at 10%, 5% and 1% respectively**

CONCLUSION AND RECCOMENDATIONS

Conclusion

The study revealed that smallholder rabbit producers are not technically efficient. The result showed a mean technical efficiency scores of 36.83 percent indicating that there was a 63.2% allowance for improvement in input resources efficiency for increased output. This implies that if rabbit farmers were to operate on the frontier, they will achieve a cost saving of 54.1 %(1-36.83/80.22) cost saving and realize the same output. On the other hand, if the average farm on the sample was to achieve the Technical Efficiency level of the most efficient counterpart, then the average farm households could realize a 99.98%(1-0.01/80.22)cost saving and the most technically inefficient farm reveals cost saving of 99.98%. This implies that with the available technology of the smallholder farms efficiency could be improved. If key factors that currently constrain overall technical efficiency are adequately. The factors are credit, education, farming experience, farm size, number of breeding stock, and training contacts of the producers which positively and significantly affect technical efficiency of the rabbit producers. The results show that there is great potential to enhance rabbit productivity by reducing input use through improved technical efficiency of the rabbit producers, hence higher rabbit output resulting to improved farm incomes, with a resultant impact on poverty reduction and wealth creation.

Policy strategy aimed at improving technical efficiency in the short run should emphasize on an effective and efficient use inputs with the current technology transfer instruments which enhance capacity of the farms to efficiently use the physical inputs properly and therefore higher output. Small scale rabbit farmers need to utilize the available technology efficiently to reduce losses or alternatively gain from it by minimizing inputs used while maintaining output levels while holding all other factors constant.

Recommendations

The both national and county governments in Kenya need to design programs that ensure good mix between the young and old farmers. Since farming experience coefficient was positive and significantly affecting technical efficiency. This means that as farmers spent more years in their farms they take advantage of acquired knowledge on how to use inputs efficiently and improve rabbit productivity. Thus the old should also be encouraged continue producing since it will ensure that the experience they poses is not lost and is used gainfully for rabbit production and the young should be encouraged to join rabbit production early to take advantage of learning-by-doing effect.

The positive and significant relationship between farm-size and technical efficiency means that policies aimed at expanding the area under rabbit production need to be encouraged so as to increase efficiency. This may be through the county government, and other stakeholders formulating and implementing strategies to ensure large scale of operation. This involves increasing incentives for farmers to allocate more of their land to rabbit production. The land will be for the growing of rabbit feeds and feeding materials which are the most limiting factors of rabbit production.

The trainings contacts to rabbit farmers help in increased technical efficiency of the rabbit farmers. Therefore policy thrust needs to focus on establishing innovative institutional arrangements that enhance agricultural extension, farm contacts and farmer trainings by extension officers. More training leads to proper use of resources and inputs in the enterprise and hence reduces costs.

Education influence technical efficiency positively. This means that policies that would entice rabbit producers to seek rabbit trainings and advisory services need to be looked into and implemented. Likewise establishment of more farmer training centers close to the farmers may be explored for increased farmer education. Policies that encourage the educated and employed youth to join commercial rabbit production should be formulated and implemented. Therefore policy thrust needs to focus on establishing innovative institutional arrangements that enhance agricultural extension, farm contacts and farmer trainings by extension officers.

The role of credit cannot be overemphasized therefore cheap and easily accessible farmer friendly loans and credit must be made available to the farmers for increased rabbit output. This ensures purchase of the correct inputs and their application at the right proportions for improved rabbit productivity. Success will be ensured with farmer group approach in giving the cheap microcredit from micro finance institutions located within the communities in the rural areas.

REFERENCES

Aigner, D., Lovell C. A. K, and Schmidt P, (1977). Formulation and estimation of stochastic Frontier production function models, *Journal of Econometrics*, 6: 21-37.

Admassie ,. A and Matambalya, F. A, (2002) Technical efficiency of small and medium sector enterprises . Evidence from a survey of enterprises in Tanzania, *Eastern African Social Science Research review* xv111 (2):1-29.

Battese, G. E, and Coelli T. J, (1995). A model for technical inefficiency effect in stochastic frontier production for panel data. *Empirical Economics* 20: 325-345.

Battesse, G. E, (1992). Frontier production functions and technical efficiency: a survey of empirical applications in agricultural economics. *Agricultural Economics* 7: 185- 208.

Bi, H, (2004). Stochastic Frontier Analysis of a Classic Self-thinning Experiment. *Austral Ecology* 29: 408–417.

Bravo-ureta, B. E., and Pinheiro A. E. (1997). Technical, Economic, and Allocative Efficiency in Peasant Farming: Evidence from the Dominican Republic. *The Developing Economies*, XXXV (1):48–67.

Borter, K, and Wanza R, (2010). Rabbit Industry status and potential in Kenya report: pages 1-55.

DLPO, (2010). Annual Livestock Production Report, Buuri district. Pages 3-60

DLP, (2009). National Livestock policy in Kenya: pages 45-70

DLP (2012). Draft national rabbit development strategy in Kenya. Government Printers, Nairobi, Kenya.

DLP (2009). Implementation Framework for *Strategic Plan covering the Period 2009-2014*, DLP Publications Unit, Nairobi .

Dey M. M (2000). Technical efficiency of Tilapia aquaculture pond operations in the Philippines, journal of aquaculture economics and management 4(1/2) pg73.

Debertin, D.L. (2002). *Agricultural Production Economics*, McMillan Publishing Company, New York, America, 2th edition.

Dinh XuaniTung, and S. Rasmussen S, (2005). Production Function Analysis for Smallholder Semi-subsistence and Semi-commercial Poultry Production Systems in three Agro-Ecological Regions in Northern Province of Vietnam: Livestock Research for rural development , volume 17 Article #69;Retrieval July 12 ,2014 from http:// www.lrrd.org/lrrd17/6/tung 17069.htm.

Doss,C. R. (2006). Analyzing Technology Adoption Using Microstudies: Limitations, Challenges, and Opportunities for Improvement, The journel of the international association of agricultural economics vol.34, pages 207–219. Esparon, N. M, and Sturgess N. H, (1989). The measurement of technical efficiency using frontier production functions of rice farms in west Java; Bulletin of Indonesia Economic studies,Vol 25, No 23 Dec 1989 pages 99-119.

Farrel, M. J, (1957). The measurement of productivity efficiency. Journal of Royal statistical society, series A (general)Vol,120,No.3 pages 253-281.

Food and Agricultural Organization (FAO). (2011). Kenya's country profile. Accessed April 15th, 2012 from www.fao.org/es/ess/top/country.html

Government of Kenya (2002), Imenti *North District Development Plan, 2002-2008, Ministry* of Planning and National Development, Government Printers, Nairobi.

Government of Kenya (2004), *Strategy for Revitalising Agriculture*, Ministry of Agriculture, Livestock and Fisheries Development, Government Printers, Nairobi.

Greene, W. (2011). Limited dependent models: Censoring, truncation, and sample selection, In Econometric Analysis, http://www,stern.nyu, edu./~ w greene

James, R. Gillespie (2004). Modern Livestock and Poultry production- seventh edition book, 2004

Kumbhakar. S. S, (1994). Efficiency estimation in a profit maximizing model using flexible Production function: Journal of Agricultural economics (10) 1994 pg 143 – 152.

Meissen, W, and Broeck. V, (1977). Efficiency estimation from Cobb-Douglas production functions with composed error. Journal of International Economics Review, Vol, 18 No.2 ,June 1977.

Moreki, J.C, (2007). Commercial rabbit production book,.RAB 01 June 2007

Mpawanimana J,(2005), Analysis of the socio economic factors affecting production of bananas in Rwanda in Kinama district, Pages 16-34.

Muhammad Saeed and Naseer Ali Khan, 2007. Measurement of economic efficiency in Agriculture in Peshawar district:.Sarhad J.Agriculture ,vol.23,No.1

MoLD (2007), Economic Review of Livestock sectors, Central and Planning Unit, Government Printer, Nairobi, Kenya.

MoLD (2009), Strategy for Rabbit Production and Marketing in Kenya, Government Printer, Nairobi, Kenya.

Ndiritu, C.G ., Lynam J. K. and Mbabu A.N. (2005), *Transformation of Agricultural Research System in Africa: Lesson from Kenya,* Michigan State University Press, East Lansing, USA book 2004 pp, 407pp

Neff, D. L., Garcia P. and Nelson C. H., (1994). Technical efficiency: A comparison of production frontier methods paper, University of Ohio incomplete

Obare,G.A ., Nyangaka,D.A ., Nguyo,W and Mwakudo, S.M (2010). Are Kenyan smallholder's allocativelly efficient? Evidence from Irish potato growers in Nyandarua north district, Journal of development and Agricultural economics 2(3):78-85.

Obwona, M, (2000). Determinants of technical efficiency among small and medium scale farmers in Uganda: A case of tobacco growers. Final report presented at AERC Biannual Research Workshop, Nairobi, Kenya. 27 May – 2 June 2000.

Ogundari. K ; Ojo S. O, (2005). "The determinants of technical efficiency in mixed – crop food production in Nigeria": a stochastic parametric approach. East African Journal of Rural Development?? Vol 21, Dec 2005.

Ogundele O. O, ; Okoruwa. O.V, (2006). Technical efficiency differential in rice production technologies in Nigeria. Africa Research Consortium. Research paper 154

Ojo S.O. (2003). Productivity and Technical Efficiency of family Poultry Egg Production in Nigeria; Department of Agricultural Economics and Extension, Federal University of Technology, P.M.B. 704, Akure, Nigeria: Journal of agriculture and sustainability ,vol.4,No.1 2013 ,52-66

Owour G.,Ouma A.S, Ngigi M. and Mlongo.P (2009) "Technical efficiency of small holder farmers in Kenya" journal of Agriculture and Rural Development Vol.3:14-29

Owuor, G. ; A.S. Ouma, (2009) What are the Key Constraints in Technical Efficiency of Smallholder Producers in Africa? Empirical Evidence from Kenya, A paper presented at 111 EAAE-IAAE Seminar on'Small Farms: Decline or persistence' University of Kent, Canterbury, UK 26th- 27th June 2009.

Ogundari. K and Amos T.T (2011). A review of Nigerian agricultural efficiency literature, What does one learn from frontier studies: Ifri info/ files/ 2011/ 10/2a.

Ohajianya,J.N ,Mgbada,P.N, Onu ,P.N and ,Enyia , C.O (2013). Technical and economic efficiencies in poultry production in Imo state in Nigeria:American journal of experimental agriculture 3(4),2013

Quisumbing, A. (1996). Male –Female differences in Agricultural productivity: A Methodological issues and empirical evidence, World development series 24(10):1579-1595.

Sharma, K. R., and Leung P. S., (2000). Technical Efficiency of Carp Production in India: a Stochastic Frontier Production Function Analysis. Aquaculture Research, 31: 937-947.

Sajjad, M. ; Khan, M. (2010). Economic efficiency of milk production in district Peshawar, A stochastic frontier approach. Sarhad J. Agriculture 26 (4): 655 – 663.

Seudu, A, (2008) .Technical efficiency of rice producers in northern Ghana, Timale, Ghana: AERC Research paper

Sprenger, E.L.M (1991) Recent developments in small holder out grower sugarcane production and impact on household level assessment of report of kilombero sugar company, third world centre, Netherlands , MPRA paper 3747 .

Wanyoike, E. K, 2012: Characterization of the Rabbit industry in Kenya unpublished research paper, Pages 10-58

World Bank, (2009). Gender in Agriculture source book. Washington DC: World Bank.

Wubeneh, N. and S. Ehui (2006), Technical Efficiency of Smallholder Dairy Farmers in the Ethiopian Highlands, Poster Paper Prepared for the International Association of Agricultural Economics Conference, Gold Coast, Australia (2006) Aug.12-14