EVALUATION OF ECONOMIC EFFICIENCY OF RABBIT PRODUCTION IN BUURI SUB -COUNTY, MERU COUNTY, KENYA

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A Thesis Submitted to the Graduate School in partial fulfillment of the Requirements for the Award of Master of Science Degree in Agricultural Economics of Egerton University

EGERTON UNIVERSITY

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DECLARATION AND RECOMMENDATION

DECLARATION

I hereby declare that this is my original work and has not been presented in this or any other university for the award of a degree.

Signature____________________ Date_________________

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RECOMMENDATION

This work has been submitted with our recommendation as University supervisors.

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DEDICATION

To My Loving mother Mawa Mulu, My dear wife Jacqueline Kitavi, My dear Sons James, Felix, Evans and daughter Faith.

ABSTRACT

Over the last decade Kenyan government has been supporting rabbit research and development activities. The efforts were aimed at raising the productivity of the small holders rabbit producers as a cheap and ease source of animal protein in the rural areas of Kenya despite presence of pulses. But inspite of the efforts 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 evaluate the efficiency of rabbit production so as to increase its productivity through a better use of the factors engaged in its production and hence increase producer incomes and nutrient security of the people in Buuri Sub- County, Meru County. The study was based on a sample of study of 139 respondents, selected using a Multi stage random sampling procedure. Data was collected using a structured questionnaire administered on household heads. The study used descriptive statistics for the analysis of socioeconomic and institutional attributes of the rabbit producers. The stochastic frontier production and cost functions which are parametric methods were used for the efficiency analysis. The results showed mean technical, economic and allocative efficiencies among the rabbit farms were 36.83%, 39.54%and 13.46% respectively. The results indicated that allocative inefficiencies are more critical than the technical inefficiencies in impacting on economic efficiency of the rabbit producers. This suggests that the farmers were not minimizing production costs, indicating that they are not utilizing the inputs in the correct proportions given the input prices and technology.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 2-limit Tobit model results indicated that allocative efficiency of the smallholder rabbit producers was positively influenced by education level, farming experience, farm size and training contacts at 5% level. The study concluded that the sources of allocative inefficiencies were brought by the level education and household size amongst the rabbit producers. The study therefore, recommends encouragement of young farmers to actively participate in agriculture, enhancing market environment, increasing incentives to farmers to allocate more land and capital increased rabbit production. Likewise increased access to farmer education, improved farmer-extension and research linkage and credit to the farmers led to improved rabbit efficiency, hence increased rabbit output and farm incomes.

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ABBREVIATIONS AND ACRONYM

AEZ	Agro Ecological Zones
AE	Allocative Efficiency
EE	Economic Efficiency
DLP	Director of Livestock Production in Kenya.
DLPO	District Livestock Production Officer
DLEO	Divisional livestock extension officer
D.O	District officer
GDP	Gross Domestic Product
GOK	Government of Kenya.
FAO	Food and Agricultural Organization
KALRO	Kenya Agriculture and livestock Research organization.
Kg	Kilogram
Kes	Kenya Shilling
SDGs	Sustainable Development Goals
M.T	Metric Tones
M.V.P	Marginal value product
M.C	Marginal cost
SSA	Sub Saharan Africa.
SRA	Strategy to Revitalize Agriculture.
SFA	Stochastic Frontier Analysis/approach
ILRI	International Livestock Research Institute
KNBS	Kenya National Bureau of Statistics.
NALEP	National Agriculture and Livestock Extension Programme.
PMG	Producer marketing groups
TE	Technical Efficiency
OLS	Ordinary Least Square.
WHO	World Health Organization

CHAPTER ONE
INTRODUCTION

1.1 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 pets. The rabbits are also part of the domesticated animals originating from one species of the European rabbits (Oryctolagus cuniculus) found across Europe and Northern Africa. Further, also they vary in colour,body size, 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, GOK 2010). The main challenges in rabbitry are poor resource use, marketing and inadequate credit hence low enterprise productivity (Kavoi *et al* ., 2010 ,Lebas et al ., 1997; Onifade et al ., 1999;Oseni et al ., 2008).).

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 herbage (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). This 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, Lebas et al ., 1997; Onifade et al ., 1999;Oseni et al ., 2008). 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 to 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, Osen *et al* .,2008).

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-GOK, 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 ,Osen *et al* 2008).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 foods by consumers and rabbits being a cheap and nutritionally safe source of proteins especially to all especially the young, sick and elderly . 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 necessity to establish technical and allocative efficiencies of small holder rabbit production 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. Likewise, allocatively efficient farmers run more profitable farming enterprises as they are able to produce a given level of output at minimum costs. This study will lead to improving the economic efficiency of rabbit rearing in the study area and thus a flourishing rabbit sector in Kenya.

1.2 Statement of the Problem

Over the last decade Kenyan government has supported rabbit research and development activities, efforts aimed at raising the productivity of the small holder's rabbit production as a cheap and ease source of animal protein in the rural areas of Kenya despite presence of pulses. Efforts towards development of the subsector in Kenya have focused on rabbit technology transfer and extension services .Despite the efforts directed at improving small holder rabbit production over the years low productivity remains a major challenge in the subsector. 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 per year 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 efficiency of the smallholder rabbit farmers and determining the key socioeconomic and institutional factors that influence their efficiency

1.3 Objectives of the Study

1.3.1 Broad Objective

The main objective of this study was to evaluate the efficiency of rabbit production so as to increase its productivity through a better use of the factors engaged in its production and thus increase producer incomes and nutrient security in Buuri Sub- County, Meru County.

1.3.2 Specific Objectives

The specific objectives of this study were:

1. To characterize the socioeconomic and institutional attributes of rabbit producers.
2. To determine the level of allocative, technical and economic efficiency of rabbit production.
3. To determine the socioeconomic and institutional factors influencing level of allocative, technical and economic efficiency of rabbit producers

1.4 Research questions and Hypotheses of the Study

1.4.1 Research question

What are the socioeconomic and institutional characteristics of the smallholder rabbit producers in Buuri Sub County?

1.4.2 Hypothesis

1. Rabbit producers are not allocatively, technically and economically efficient.

2. Institutional and socioeconomic factors do not significantly influence the level of allocative, technical and economic efficiency of rabbit producers.

1.5 Justification of the Study.

Rabbit enterprise is gaining lots of popularity among the rural farmers in Kenya. This arises from a growing market demand for the rabbits and its products due to population growth, urbanization and tourism in Kenya. With declining land size holdings, rabbit keeping has the advantage of low demand on land and feed resources. In addition rabbits require limited supplementation: weeds , vegetables and kitchen left-over's are enough for their feeding. This means rabbits pose little competition for food with humans yet they are highly prolific , early maturing, fast growth rate, and efficient in feed conversion and hence more productive compared to other farm animals. For these reasons the rabbit enterprise is attractive to both rural and peri-urban farmers. The potential benefits of rabbit keeping and its convenience as a cheap source of money and food to the resource poor households in Kenya are immense and not fully exploited.

Agricultural enterprises productivity, efficiency in the use of the available resources at the farm level does determine the enterprise output and productivity. This is true in developing countries where factors of production are limited and scarce. Small holder rabbit keeping economic efficiency is not evident given the declining productivity over the years. This study of economic efficiency of rabbit farming enterprise is timely and will help farmers benefit from the rapidly growing demand for rabbit products in Kenya. The results would help the development planners and policy makers in understanding constraints and challenges facing the rabbit farmers and also the opportunities in the rabbit value chain. This will facilitate the setting of proper strategies for the development of vibrant rabbit sector in Kenya. Moreover this will increase the income base for the farmers and consequently reduce the poverty levels .These will contribute in the attainment of the Governments of Kenya (GoKs) development goals, Sustainable development goals (SDGs) and vision 2030 in Kenya.

1.6 Scope and Limitations of the Study

This study was conducted in Buuri Sub County in Meru County. This is because of the extensiveness, intensity and dominance of rabbit farming in the study area and the high poverty levels in comparison to the other sub counties in Meru County. The rabbit breed types kept was not considered as an efficiency influencing circumstance in this study. Due to lack of farm records among farmers, the study mainly relied on the farmer's memory and their recall capacity in the collection of the study data by the enumerators. To improve validity and quality of the data collected, the researcher did proper training of the enumerators on probing, interview skills. The study was limited to backyard rabbit farming enterprises in a household due to its dominance among the farmers in the study area.

1.7 Definition of Terms

Backyard farming enterprises: Farming activities that are practiced within homestead by the farmers. They can be for food or income generation and do contribute significantly to poverty reduction and food security in the rural areas.

Rabbit keeping: This is the art and science of keeping rabbit for meat, fur, pet animals or as laboratory animals.

Rabbit breeds: These are the type of rabbits that are kept by the farmers. The popular rabbit breeds in Kenya are California, chinchilla, Flemish Giant, and the New Zealand White and their crosses.

Allocative efficiency: Measures a production farms ability to choose the input combination that minimizes cost of production given the best available technology.

Technical efficiency refers to the ability of a firm / farm to avoid wastage either by producing as much output as technology allows and input usage allow or by using as little input as required by technology and output production. Technical efficiency has, therefore, both an input conserving and output promoting argument. According to Koopmans (1951), a producer is technically efficient if an increase in any output requires a reduction in at least one other output or an increase in at least one input, and if a reduction in any input required an increase in at least one other input or reduction in at least one output. Technically efficient producer could produce the same output with less of at least one input or could use the same input to produce more of at least one output

Economic efficiency: Economic efficiency is a product of the two components namely: technical and allocative efficiencies.

Efficiency: is a term often used interchangeably with productivity in economics literatures. It refers to how well a system or unit of production performs in the use of resources to produce outputs given available technology relative to a standard (frontier) production. Productivity on the other hand is definable in terms of individual resources or a combination of them (Fried, 2008). Ideally, efficiency is inherently unobservable while its estimation is often derived indirectly after taking into account relevant phenomenon, usually the relationship between outputs, inputs, their prices and the behavioural objectives of the production units of interest (Nguyen and Coelli, 2009).

CHAPTER TWO

LITERATURE REVIEW

This chapter presents a literature review of studies related to this study and elaborates on the theoretical basis for this study. It reviews the socio economic importance, challenges and constraints of rabbit keeping in sub Saharan African region. Further it reviews studies on the factors affecting allocative, economic and technical efficiency and their measurement in the small holder farming enterprises. Moreover literatures on the empirical methods used for the measurements of allocative, economic and technical efficiencies are highlighted. The gaps to be filled by this study are identified and pointed out in the literature search. The chapter ends with conceptual and theoretical framework.

2.1 Socio Economic Importance and Challenges in the Rabbit Sector

The international livestock research institute (ILRI) and its partners have indicated that securing the current and developing the livestock assets of the poor is a major pathway to get the rural poor out of poverty spiral (ILRI, 2002). According to Food and Agriculture Organization (FAO, 2007), Sub Saharan Africa (SSA) countries continues to be plagued by problems of extreme poverty and malnutrition where one out of every three people in this region are underfed and malnourished due to rampant poverty. Owen *et al.* (2005) indicated that research and development approaches in livestock science disciplines could play a pivotal role in the drive towards poverty reduction and food security. The rabbit production systems are able to contribute hugely to family welfare, food security and poverty alleviation. This is particularly important for the socio economic development of the rural, urban and peri- urban areas where the rabbit enterprise is an easy source of income, protein, social welfare and wealth creation more so to the youth and women who are over 80% of the population in the rural areas (Owen *et al.*, 2005).

2.2 Factors Influencing Farm Efficiency

Efficiency in resources allocation and use in agriculture is very important in determining agricultural productivity. It is a widely held fact that efficiency is at the heart of agricultural productivity especially in the SSA region. This is because the scope of agricultural productivity can be expanded and sustained by farmers through efficient use of resources (Ali, 1996; Udoh, 2000).These facts have made efficiency studies to remain an important subject of empirical investigation particularly in developing economies where majority of the farmers are resource-poor. Bravo-Ureta *et al.*(2007) stressed the importance of efficiency as a relative measure of managerial ability of the producers for a given technology which could be related to a set of controllable variables associated with the decision making unit or enterprise. Literature identified these variables as education, age, years of experience, credit, market access, off-farm income and extension activities in the case of agricultural production, which have the highest possibility to explain the underlying causes of deviation from the optimal production frontier and hence efficiency (Kumbhakar and Lovell, 2000; Coelli *et al.*, 2005). Toward this end, a closer look was taken about the primary literature to identify which of the studies incorporated the determinants of the efficiency levels along with input variables in a stochastic production frontier. According to (Kavoi *et al.*, 2012) the key determinants of efficiency of farms are both human capital and socio economic factors. The human capital factors are age, gender, level of education, farming experience and the socio economic factors are access to credit, access to extension services, off-farm income, tenancy status, type of labour available, farm size, stocking rate of the rabbits. Therefore, a database was constructed from the primary literatures to identify which of the controllable variables from these studies positively and significantly impact the efficiency level of the respondent's rabbit enterprise productivity in the study area. Likewise, variables were identified that had a negative and statistically significant influence on the inefficiency of respondent's rabbit production in this study.

2.2.1 Factors influencing technical efficiency.

Technical efficiency of a producer is a comparison between observed and optimal values of its outputs and inputs. This can be done either from the output side or input side. On the output side observed output is compared to potential output obtainable from the inputs while from the input angle observed input levels are compared to minimum potential input required to produce the output. In either perspective, the optimum is defined in terms of production possibilities.

It is also possible to define the optimum in terms of the behavioral goal of the producer. In this case, efficiency is measured by comparing observed and optimum cost, subject to any appropriate constraints on quantities and prices.It is important to note that the measurement of technical efficiency assumes that the factors of production used are homogeneous. It is not much of a problem if all firms use heterogeneous inputs in fixed proportions. However, if firms are different in the composition of their inputs, according to their quality, then a farm's technical efficiency will reflect both the quality of its inputs and the efficiency in their management. As a result, if technical efficiency is defined with respect to a given set of firms and a set of factors of production, measured in a specific way, any differences across firms is in the quality of the inputs which will affect the measure of efficiency of production (Farrell, 1957).

Technical efficiency is also referred to as input use efficiency in production efficiency studies. Yusuf and Malomo, (2007) revealed that farm size impacts positively on the output of a rabbit farms. The farm size may influence the number of breeding rabbits in the farm and hence the size and intensity of the rabbit practice in a farm. Land provides space for pasture, fodder development and construction of the requisite farm infrastructures for modern rabbitry and hence number of the breeder stock in a farm. According to Ukoha and Augustine (2000), farm size had a positive and significant impact on technical efficiency in rabbit production. A possible explanation of this phenomenon is that bigger farms the farmers are able to invest more in technology and hence increase the efficiency of production. Thus in this study farm size affects number of breeding rabbits in the farm, and it is hypothesed to have positive impact in the rabbit producers' efficiency.

Yusuf and Malomo (2007) revealed that labour impacts positively on technical efficiency of small holder agricultural producers in Nigeria. The family labour plays an important role in agricultural production operations especially in developing economies where capital is limited and scarce to hire labour. Hence, the expectation is that farm yield will increase with optimum amount of labour used in the farm leading to increased productivity of the smallholder producers. However, Ukoha and Augustine, (2007) reported a negative but significant effect of labour on poultry production in Nigeria.

The relative importance of feed and feeding in poultry production cannot be over-emphasized according to Yusuf and Malomo, (2007). The study revealed that increase in poultry productivity and other intensively produced livestock like rabbits can be more by increasing the feeds and feeding availed to the animals'.Thus, the coefficient of feed intake was postitulated to be positive and significant in this study. Feeds and feeding is the most limiting production input since it accounts for 60 percent of the total cost of production in the intensive small holder rabbit enterprise (Kavoi *et al.,* 2006). For this reasons the factor is postulated to have a positive and significant influence in the efficiency of the rabbit producers. The methods for efficiency measurements for this factor of feeds and feeding are determinants of rabbit enterprise productivity. These include feed conversion ratio per animal, rabbit stocks' total live weight gains in kilograms, feed costs, feeding amounts per animal unit and accessibility of the feed to the rabbits.

Studies on the effect of the Cost of drugs and medication of the animals productivity has given mixed results. Animal drugs, chemicals and equipments are inputs of production and do determine animal health care hence the rabbit enterprise output. Binuomote *et al.* (2008) reported a positive and insignificant coefficient for cost of veterinary drugs in his technical efficiency study for poultry egg farmers in Oyo state while Ukoha and Augustine (2007) reported a positive and significant impact of cost of drugs on poultry production in Nigeria.

Farming experience of the rabbit producers could have negative or positive effect on the technical efficiency of the farmers. Yusuf and Malomo (2007) reported a positive relationship between farming experience and the technical efficiency of farmers in Ethiopia. On the other hand Coelli and Battese (1996) reported negative production elasticity with respect to farming experience for farmers in two villages in India. The impact could be both positive and negative. The reasons are elderly farmers show more farming expertise acquired overtime and hence higher technical efficiency of the rabbit enterprises. On the other hand, there is evidence that the old farmers are more risk averse hence rabbit enterprise productivity will be negative as farmers' age (Bellante and Green, 2004).

Gender of the producers is a variable that could have either a negative or positive influence on technical efficiency. Ajani (2005) reported a negative coefficient for gender in a normalized profit function analysis for maize and yam enterprises in Nigeria.Awoyemi, (2001) on the other hand reported a positive coefficient for the technical efficiency of cassava-based farm holdings in Nigeria. The reasons lie in the differences in how men and women approach and undertake technical production decisions in agriculture. Barber and Odean, (2001) found men to exhibit overconfidence and believe that they can outperform women through their own production decisions and therefore more productive. More importantly Akinwumi and Kouakou, (1997), indicated that relative efficiency of women and men as farm managers in Cote D' Ivoire, using a normalized profit function, found that they both had similar capabilities in farm management given equal opportunities .This implied gender of the agricultural producers influences the technical efficiency and hence productivity . In this rabbit production study the gender of the household head is expected to capture differences in production decision orientation between males and females with the females expected to have a higher propensity for rabbit enterprises than male's hence negative effect on the productivity of the smallholder producer.

Studies have shown that farmers with formal education have greater ability to adopt new and more appropriate skills and technologies, hence impacting positively to technical efficiency of the smallholder producers. Coelli and Battese (1996) have confirmed the positive influence of education on farmers' production efficiency. For this study education is postitulated to have a positive effect on the rabbit output.

Extension contact is expected to have a positive and significant impact on technical efficiency and hence the rabbit output. Research and extension services access, provision and availability to the farmer's influences the way technology and inputs are used in the enterprise hence efficiency of production in smallholder agriculture in Kenya. Njeri and Ashenafi, (2007) study on smallholder agriculture indicated that research and extension services provide farmers with adequate and appropriate information in order to make better decisions and to optimize their use of limited resources, thus promoting agricultural productivity. Therefore, access to extension services is a conduit for the diffusion of new technology among farmers which in turn reduces inefficiency levels among rabbit farmers through improvement of the farmers' managerial ability of the enterprise.

Access to credit by the producers is expected to have a positive and significant impact on technical efficiency of smallholder agricultural producers (Otieno *et al*., 2006). Lack of finance for agriculture limits the increase in production and investment in the rabbit value chain and hence the hypothesized impact on efficiency by this factor will be positive and significant. Hashemi-Tabaar *et al.* (2009) indicated that allocated loans to the fisheries sector in Sistan–Babuchastan province in Russia had a positive impact to the technical efficiency. Thus credit impacts positively to productivity in the agricultural sector.

Marital status of the producers does affect technical efficiency and productivity in small holder agriculture. According to (Kiriti *et al*., 2004), households of married women do suffer more in terms of reduced food availability and food security than households headed by males. This suggests that in some patriarchal societies, caution should be observed when encouraging commercial agriculture especially in male-headed households. Ukoha and Augustine (2009) reported a positive but insignificant value for the effect of marital status on efficiency of small-scale poultry egg production in Nigeria. It is hypothesized that this variable will have positive impact on rabbit productivity.

Studies on the impact of farmers groups to the technical efficiency of agricultural producers have revealed mixed results as indicated by the study agricultural co-operatives in Russia (Svetlow and Heckman, 2005). The farmer's cooperatives are producer marketing associations and do improve or lower productivity of the rabbit enterprises since their effect can be positive or negative. On one hand it could be due to mismanagement, poor leadership and democracy of the producer marketing groups, this leads to lower efficiency among the enterprises hence poor yields. On the other hand the farmer producer groups (PMG) can improve productivity of the producers when they support of farmers to get markets, credit, extension, and technology (Svetlow and Heckman, 2005).

2.2.2 Factors influencing allocative efficiency

Production theory states that under competitive conditions, a firm is said to be allocatively efficient if it equates the marginal returns of factor inputs to the market price of the input (Fan, 1999). Based on this definition, a number of studies have been conducted on the determinants of allocative efficiency. A study by Nwachukwu and Onyenweaku (2007) on allocative efficiency among pumpkin farmers in Nigeria, using a stochastic frontier approach, found that the farming experience had a positive effect on allocative efficiency. The authors observed that farmers' wealth of experience in pumpkin farming made them able to allocate their resources more efficiently. This is consistent with findings by Obare *et al*,(2010) among Irish potato producers in Kenya. In the study, a dual stochastic efficiency decomposition technique and a two-limit Tobit model were applied. Obare and others also observed a positive effect between farming experience and allocative efficiency. Out of the study it was argued that more years of experience in farming lead to acquisition of better managerial skills over time, which made farmers able to allocate their resources more efficiently and hence more productive.

Ogundari and Ojo (2007) study on small-scale food crop producers in Nigeria, found that age of the farmer had a negative effect on allocative efficiency. Similar findings were reported by Bravo-Ureta and Pinheiro (1997) in the Dominican Republic. This suggests that an increase in the farmer's age translated into higher inefficiencies with respect to optimal allocation of available resources. The authors applied the stochastic frontier approach, but adopted a contradicting methodology in which they used the frontier cost function to measure allocative efficiency. In addition, the authors failed to use the two-step methodology applied by most studies such as Obare *et al*. (2010) and Mulwa *et al.,* (2009).

It has also been observed that regular visits of extension workers positively influenced a farmer's allocative efficiency (Obare *et al.*, 2010). This is attributed to the fact that the knowledge gained from extension visits influences producers to adopt new technologies through which they become more efficient. These findings are consistent with Illukpitiya (2005) who observed that increased extension contacts facilitate practical use of modern techniques and adoption of improved agronomic practices. In fact, the findings by Obare *et al.* (2010) also reveal that extension contacts provide information on price patterns, new varieties and available markets such as those aired through the media. This information increases farmers' ability to use farm resources optimally. Therefore extension visits or contacts enhance a farm's allocative efficiency.

Education of the household head has also been found to significantly affect allocative efficiency. According to a study by Laha and Kuri (2011) in India, farmers' years of schooling was found to have a positive effect on allocative efficiency, suggesting that the more years a farmer had spent in school, the more efficiently farmers allocate farm resources for improved farm productivity. However, other studies have also found a negative relationship between education and allocative efficiency; for instance Nwachukwu and Onyenweaku (2007) in Nigeria and Bravo-Ureta and Pinheiro (1997) in the Dominican Republic. Thus the number of schooling years has mixed effects on the farmers' allocative efficiency level.

Obare *et al.* (2010) revealed that Credit, had positive influence on allocative efficiency of the Irish potato producers in Kenya. The study indicated that farmers with ease of access to credit exhibited higher levels of allocative efficiency. Accordingly credit availability is expected to limit constraints hindering timely purchases of inputs and engagement of farm resources for production in small holder agriculture. Similar findings were established by Binam *et al.* (2003) for farmers in Ivory Coast. Nwachukwu and Onyenweaku (2007) observed that access to credit enables farmers to overcome liquidity constraints that affect their ability to apply inputs and implement farm management decisions timely. However their findings reflected a negative effect for credit to allocative efficiency which they attributed to the fact that farmers were meeting difficulties in accessing funds for farming operations because of competing uses of money within the households. This shows that credit can influence allocative efficiency either positively or negatively.

Nwachukwu and Onyenweaku (2007) study on household size factor found that it negatively affected allocative efficiency of the smallholder farmers. The study found that larger households were faced with the challenge of attending to numerous family needs, which reduced the magnitude and amount of resources allocated to farming activities. This is contrary to most studies like Seidu (2008) which revealed that large households are better in providing free labour, indicating the usefulness of larger households in improving farm allocative efficiency.

Membership to farmer groups by the small holders, Obare *et al.* (2010) revealed that farmers who are affiliated to producer associations are bound to have higher allocative efficiency in the way they allocate inputs cost effectively hence more productive. This finding is similar to that by Tchale (2009) on crop farmers in Malawi. According to Obare and others, producers form groups to pool resources together so as to mitigate the consequences of market imperfections. Therefore, farmers who belong to farmer associations are likely to benefit from better access to inputs and information on improved production practices (Mukhwana *et al.*, 2005). As such new farmers are likely to learn from the other members in the social network, hence generating significant technology spill over's and improving their allocative efficiency. Hence membership in a producer organization has a positive influence on allocative efficiency of the small holder producers especially in sub-Saharan African region. But group membership could also impact negatively on the rabbit output if the groups are poorly managed, lack good leadership structures and are riddled with corruption malpractices. Groups of this kind would be increasing the cost of inputs and hence their poor allocation in smallholder agricultural enterprises especially in resource poor countries like Kenya leading to reduced output, (Mukhwana *et al*.,2005).

Allocative efficiency is also influenced by the ease of interlinkage and transaction costs in the factor markets, according to findings by Laha and Kuri (2001) in their study on allocative efficiency in India. In their findings, there was a positive relationship between factor market interlinkages and allocative efficiency. The authors indicated that interlinkages among input providers, in such a way as to avail required inputs to farmers cost-effectively, is conducive for improving farmer's allocative efficiency. It also induces farmers to take up new technologies and innovations more rapidly. The findings also revealed that different forms of land tenure had varying importance in improving allocative efficiency in agriculture. Such that fixed rent tenants were more allocatively efficient than share-croppers. However, the authors applied the data envelopment approach which requires more than one crop enterprise constrained by a given set of inputs.

Lastly, the occupation of the family head has also emerged as a critical determinant of allocative efficiency. According to findings by Mulwa *et al.* (2009) in western Kenya, farmer's main occupation was found to influence allocative efficiency negatively. This surprisingly suggests that those who did farming as their primary occupation were less allocatively efficient than those who had other sources of income. The authors argued that since allocative efficiency has to do with prices, farmers with external income sources such as employment or business may have had access to more income which improved their farming considerably. Thus this study supports findings by Mulwa *et al.* (2009) due to the fact that farmers who depend entirely on farming are disadvantaged in terms of farming capital; hence they became less allocatively efficient compared to those who also engage in non-farming activities. This study on evaluation of economic efficiency of rabbit production follows the (Chukwuji, *et al*., 2006) reviewed assumptions that farmers use or allocate resources for profit maximization. With such assumptions farmers do choose the best combination (low costs) of inputs to produce profit maximizing output level. In a situation where there is perfect competition in input and output markets, producers tend to be price takers and assumed to have a perfect market information and thus rendering all inputs and outputs to be of the same quality from all producers in the market.

2.2.3 Factors influencing economic efficiency

Economic efficiency is also referred to as cost efficiency in production efficiency studies. Some of the empirical studies that attempted to explain the parameters that influence economic efficiency include Krasachat, (2007) study on cattle feedlot farms in Thailand. This study revealed that the producers who used ready commercial cattle feeds were more economically and allocatively efficient. It was further found that farm size had a negative impact on economic efficiency suggesting that smaller cattle farms were more economically inefficient than those larger farms. The current study will investigate this farm size parameter; it is expected to have positive and significant impact on the economic efficiency of the rabbit producers.

Study by Nyagaka *et al.* (2009) revealed Irish potato producers education in Kenya, positively and significantly influenced farm economic efficiency. It was argued that farmers with higher levels of education were more efficient in production and this was attributed to the fact that educated farmers positively perceive, interpret and respond to new technologies on seeds, fertilizer, veterinary drugs, animal feeds (pellets), hybrid bucks, fungicides, or markets much faster than their uneducated counterparts. On the other hand, Bravo-Ureta and Pinheiro (1997) in their analysis of economic efficiency in the Dominican Republic found that education had a negative effect on economic efficiency. This suggests that educated farmers in the Dominican Republic were less efficient economically, compared to their uneducated counterparts. Therefore, schooling can influence overall efficiency either positively or negatively it will be investigated in this rabbit study.

Population density has a bearing on the way farmers employ and allocate their inputs for production. Studies show that farmers in high densely populated areas tend to use intensive methods of livestock production. Studies by Frisvold and Ingram (1994) and Pender *et al*. (2004) show that households in more densely populated areas were found to adopt some labour intensive land management practices which enabled them to increase livestock production per hectare and hence increased economic efficiency. This parameter in postitulated to have a positive impact on rabbit output

Farming experience has also been found to affect farm overall efficiency. Various authors have found that experience in farming enhances efficiency. Mulwa *et al.* (2009) in western Kenya observed that farming experience had a positive influence on economic efficiency. Mbanasor and Kalu (2008) also found similar results for vegetable farmers in Nigeria, which is similar with their findings of farmers' age and productivity. It is expected that experienced farmers have over the years learned from their mistakes and improved their efficiency skills in production. However the optimal age limit must be known for as farmers'age productivity declines because of reduced energy and capacity to engage in the intensive farm operations.

Nyagaka *et al.* (2009) further found a positive relationship between extension visits and economic efficiency. This is consistent with findings by Mbanasor and Kalu (2008) and implies that the more extension visits a farmer accessed from the extension workers; the more economically efficient the farmers became. The authors showed that regular provision of extension services on animal productivity enhancing technologies, breeds, farming technologies, and market information helped new farmers, who lack the experience, to be able to efficiently combine farm inputs just like their more experienced counterparts leading to improved productivity. For this study the parameter is postitulated to have a positive and significant impact on the economic efficiency

Study by Bifarin *et al.* (2010) on the impact of credit to the economic efficiency in agriculture revealed that efficiencies in the plantain production industry in Nigeria were decreasing with an increase in credit. The authors employed a two-step approach involving a parametric stochastic frontier technique followed by a regression of selected socio-economic factors to measure the effect on efficiency indices. The negative sign on credit implied that higher access to credit rendered the farmers more economically inefficient. This finding is contrary to Ceyhan and Hazneci (2010) who analysed cattle farms in Turkey and found a positive relationship between credit and economic efficiency. It therefore reaffirms the observation by Nwachukwu and Onyenweaku (2007) in Nigeria that although credit helps solve liquidity problems in input access, difficulties in accessing such funds for farming is responsible for the negative effect, and is a common phenomenon for most of the African farmers.

Nyagaka *et al.* (2009) study on impact of membership to farmer associations found that farmers who participated in such associations were less economically efficient. This is contrary to expectations since farmer associations are supposed to be instruments through which farmers can mitigate market imperfections. However, the results are similar to those found by Mbanasor and Kalu (2008) indicating that probably the farmer organizations were facing management problems that were depriving members the benefits from such groups hence lowering rabbit output .

2.3 Methods for measuring efficiency

2.3.1 Empirical methods for measuring technical efficiency

Technical efficiency of a producer is a comparison between observed and optimal values of its outputs and inputs. This can be done either from the output side or input side. On the output side observed output is compared to potential output obtainable from the inputs while from the input angle observed input levels are compared to minimum potential input required to produce the output. In either perspective, the optimum is defined in terms of production possibilities along the production curve. It is also possible to define the optimum in terms of the behavioral goal of the producer. In this case, efficiency is measured by comparing observed and optimum cost, subject to any appropriate constraints on quantities and prices. In these comparisons, the optimum is expressed in value terms and efficiency is allocative due to production inputs allocated for production. It is important to note that the measurement of technical efficiency assumes that the factors of production used are homogeneous. It is not much of a problem if all firms use heterogeneous inputs in fixed proportions. However, if firms are different in the composition of their inputs, according to their quality, then a firm's technical efficiency will reflect both the quality of its inputs and the efficiency in their management. As a result, if technical efficiency is defined with respect to a given set of firms and a given set of factors of production, measured in a specific way, any differences across firms is in the quality of the inputs will affect the measure of efficiency (Farrell, 1957)

According to Battese and Coelli, (1995), technical efficiency is associated with behavioural objectives of the maximization of output by a farm, but this objective cannot be carried out in isolation since a farm can be considered as an economic unit with scarce resources. When a producer with the aim of maximizing profit makes technical production mistakes that result in inefficiency, then the farmer is considered technically inefficient (Kumbhakar, 1994). Therefore, technical efficiency of enterprises cannot be achieved in isolation but other considerations (efficiencies) are always at play. These parameters are measurements errors and the socio economic production inefficiencies within the farm.

According to Esparon and Sturgess (1989), technical efficiency deals with factor- product transformation in to output. For a farm enterprise to be technically efficient, it has to produce at the production frontier level. However, this is not always the case due to random factors such as bad weather, and/or farm specific factors, which leads to producing below the expected output frontier according to (Battese and Coelli, 1995). Efficiency measurement therefore attempts to identify those factors that are farm specific which hinder production along the frontier. Technical efficiency goes beyond evaluation based on average production to one that is based on best performance among a given category of farmers though it is related to productivity where inputs are transformed into outputs (Battese and Coelli, 1995). Secondly, efficiency measurement provides an opportunity to separate production effects from managerial weakness (Ogundari and Ojoo, 2005).

This study therefore will measure technical efficiency of rabbit producers, given its benefits to the producers in the study area. In economic theory, a production function is described in terms of maximum output that can be produced from a specified set of inputs, given the existing technology available to the farm (Battese, 1992). When the farm produces at the best production frontier, it is considered efficient in the use of resources. The most common assumption is that the goal of the producers is profit maximization; however, it is believed that the objectives and goals of the producer are intertwined with farmers' psychological makeup (Debertin, 1992). Therefore, this study assumes that producers aim at maximizing output subject to existing constraints and hence technical efficiency will be achieved when a high level of output is realized given a similar level of inputs used. Estimates of technical efficiency of rabbit production are thought to be depended on the following explanatory variables farming experience, educational level of the farmers, marital status, access to extension services, access to credit and gender.

The efficiency studies were started by Farrell in 1957 where the present efficiency estimation methods originated. Over time this estimation of the production frontier has been geared to follow two general paths; the full frontier where all observations are assumed to be along the frontier in the production possibility curve and the deviation from the frontier considered being inefficient. The other path has been the stochastic frontier estimation where the deviation from the frontier is attributed to the random component reflecting measurement error, statistical noise and an inefficiency component (Ogundele and Okoruwa, 2006).

The estimation of full frontier has been based on either non-parametric approach where technical and allocative efficiency is estimated by solving the linear programming for each individual farm or through parametric approach where the estimation is by statistical techniques. Under the parametric approach, there are two methods namely; deterministic and stochastic frontier method. The deterministic method just like the non-parametric approach envelops all of the data of the firm in the model (Neff *et al.*, 1994). The major drawback of these methods is that since it forces all outputs to a frontier it is sensitive to outliers that can be larger and it will distort the efficiency measurements (Ogundele and Okoruwa, 2006).

The Stochastic Frontier Approach (SFA), also referred to as the econometric frontier approach, specifies a functional form for the cost, profit, or production relationship among inputs, outputs, and environmental factors, and it allows for the measurement random errors. The method is parametric and superior to others and will be used in this study since it will incorporate measurement of the random error of regression. It is assumed that it will capture the effect of unimportant variables that will be left out in the model, and the errors of dependent variables as well as the farm specific inefficiencies. It provides the farm efficiency estimates with much lower variability than any other method due to the error term decomposition (Neff *et al.,* 1994). Nevertheless, this method has a major weakness for its inability to construct different frontier for every observation (Neff et *al.,* 1994; Ogundele and Okoruwa, 2006). However, this will later be overcome by measuring the mean of the conditional distribution of inefficiency (μ_i) given the random error (ε_i) (Jondrow *et al.,* 1982). Neff *et al,* (1994) stated that, the ability of stochastic frontier to incorporate random disturbance term to account for events beyond management's control needs to use an estimate to measure inefficiency. This study therefore will use the stochastic frontier method to analyse the technical and allocative efficiency of rabbit farmers in Buuri District due to the advantages as stated above. Production function estimation has been criticized in recent times that it results into simultaneous equation bias leading to wrong conclusions (Akinwumi ; Kouakou, 1997). In such cases, estimation of technical and allocative efficiency using product and input prices has been advocated. It is because of the above proposition that this study will adopt production function analysis to estimate technical and allocative efficiency. However, (Neff *et al.,* 1994) contends that prices in a given region are always homogeneous and uniform across farms. And as such, differences in efficiency measures are likely to reflect quantity, not price difference. All these studies have good revelation on important aspects related to the study topic and its importance in agricultural development however, none on the specific study area of evaluation of economic efficiency of rabbit production among smallholder farmers in Buuri under the conditions of resources scarcity and poverty. The study is therefore appropriate and necessary in view of the changing conditions of environmental, socio- economic and productivity circumstances of rabbit farmers in the rural areas amidst a dire need of the people for survival, poverty alleviation and improved standard of living in the rural areas of Kenya.

Inoni *et al*. (2007) examined efficient resource utilization in pond fish production in Delta State, Nigeria.The study indicated that the Fish farmers needed to reduce on the use of over-utilized resources to achieve optimal resource allocation which would raise productivity, increase output and hence increase revenues and net returns to the farmers. Chukwuji et *al*. (2006) study determined allocative efficiency of broiler production in Delta state of Nigeria. Results from this study revealed that, farmers were said to be allocatively efficient and needed to increase the quantity of the inputs used to enable them to maximize profits since marginal value product which was greater than marginal costs or unit price of inputs. On the other hand, (Bravo-Ureta *et al*., 1997) estimated the economic, technical and allocative efficiencies of peasant farming in the Dominican Republic and concluded that, farmers were 0.44 efficient.These results concur with a 0.43 allocative efficiency for a sample of wheat and maize farmers in Pakistan, though the peasant farms in Paraguay which were said to be more efficient with 0.70 and 0.88 allocatively efficiencies compared with the peasant farmers in the Dominican Republic in the allocation of inputs to produce outputs.

Mubarik. (1989), using an ordinary least squares method estimated profit efficiency among Basmati producers in Pakistan. The study found that there was general inefficiency of between 5 - 87% and socio-economic factors like household education, non-farm employment, credit and institutional constraints affected farm efficiency positively and significantly. This study of basmati rice adopted a stochastic frontier approach for efficiency analysis, which accounts for random and farm specific errors. However, it did not consider institutional factors because they are sometimes elusive but are important agricultural enterprises productivity determinants (Kirsten and Vink, 2006).

Dinh and Rasmussen (2005) used the Cobb- Douglas production function to analyse and compare semi-subsistence and semi- commercial smallholder poultry systems in three regions of Vietnam. On evaluation of the coefficients, they found that there were significant differences between the two systems of production on the efficiency and the significant differences were due to the resources use in the systems of production and the estimated production model between the regions.

Tijani (2006) studied technical efficiency of rice farms in Ijesha, Nigeria using stochastic production frontier and found the technical efficiency levels to range from 29.4% to 98.2% with a mean of 86.6%. This indicated a shortfall of 13.4% of the maximum possible output level.

Adeoti (2006) also examined the technical efficiencies of irrigated and rain-fed crop production systems in Nigeria and found the mean technical efficiencies to be 84% and 67% for the two systems respectively.

Huynh , (2008) evaluated productive efficiency of soya beans production in the Mekong River Delta of Vietnam using stochastic Cobb- Douglas production function and found variations in efficiency levels among different technologies. Based on the results, it was concluded that productivity varies due to differences in production technologies. The presence of shortfalls in efficiency meant that output could be increased without requiring additional conventional inputs and without the need for new technology.

Abedullah, and Basher (2006) evaluated technical efficiency of potato producers in Punjab, Pakistan using the Cobb-Douglas production function approach. The findings were that the potato farms were 80% technically efficient and extension services contributed significantly to the efficiency level. This indicated that small holder potato farmers are 20% inefficient in their production. This study indicated that for improved technical efficiency of the rabbit production mechanisms for better extension provision must be provided and ensured.

Amos (2007) looked at the productivity and technical efficiency of small holder cocoa farmers in Nigeria. Farmers were observed to be experiencing increasing returns to scale. The efficiency levels ranged between 0.11 and 0.91 with a mean of 0.72. This indicates that there is plenty of room for farmers to improve their efficiency. The major contributing factors to efficiency were age of farmers, level of the education of household head and family size.

Chirwa (2007) revealed the technical efficiency among small scale farmers in southern Malawi ranged between 15%- 60%. Econometric results showed that many smallholder maize farmers are technically inefficient, with mean technical efficiency scores of 46 per cent and technical scores as low as 8per cent. The mean efficiency levels were lower but comparable to those obtained in other African countries whose means range from 55 per cent to 79 per cent. The results also support the hypotheses that technical efficiency increases with the use of hybrid seeds, breeds and group membership. One of the variables used for capturing adoption of technology showed that the application of fertilizers does not explain the variations in technical inefficiency. This may imply that most farmers using these technologies use them inappropriately on small land holdings as in small holder rabbit production

Obwona (2006) investigated technical efficiency of Tobacco farmers in Nigeria using stochastic production function and found the level to be low with some farmers operating at 45%technical efficiency. This showed the existence of great potential for improving the productivity of tobacco production by simply improving the efficiency level of the farmers without any change in input levels and with the existing technologies.

Kumbhakar and Bhattacharyya (1992) used a Cobb Douglas and adopted a restricted profit function in estimation of price distortions and resource use efficiency in India. They found that, efficiency estimation based on market prices was not adequate because of the existence of price distortions which led to imperfect markets and allocative inefficiency. The study revealed that opportunity cost of resources is not always reflected by market prices and the estimations based on such prices are bound to lead to wrong conclusions. As such, it can be said that prices may not lead to significant differences in estimation since they may be uniform in a given location (Neff *et al.,* 1994). The presence of government support or incentive through the ministry of livestock development may affect efficiency of farmers in one way or the other. Zaibet *et al* . (1999), studying on efficiency of government support in horticulture in Oman using both the stochastic production function (SPF) and Data envelopment analysis (DEA), found that the percentage of efficiency was as low as 17% while using SPF and 46% with DEA. The two methods used the same data however gave different outcomes, which makes it inconclusive.

Kumbhakar (1994) estimated technical efficiency of Bengal farmers and found that the best farmers were only efficient to a level of 85.8% and that the majority of farmers were under users of exogenous inputs such as fertilizer, and seeds. The under use of resources was related to distortion of markets that are resulting from government regulations. This study apart from mentioning the effects of distortions did not indicate the percentage of inefficiency that was attributed to state regulations and support But from other studies government support and incentives do influence the productivity and efficiency in agriculture either positively or negatively. Studies relating to efficiency do use production function, in most cases namely the Cobb-Douglas production function and the stochastic production approach as the basic models to analysis the variables in the functions and are directly estimated by OLS techniques or maximum likelihood estimation approaches.

2.3.2 Empirical methods for measuring allocative efficiency

Allocative efficiency can also be defined as the ratio between total costs of producing a unit of output using actual factor proportions of inputs at minimum prices, whereas the total costs of producing a unit of output using optimal factor proportions of the inputs in an allocatively efficient manner (Inoni, 2007). Therefore, for the farm to maximize profit under perfectly competitive markets that requires extra revenue (Marginal Value Product) generated from the employment of an extra unit of a resource must be equal to its unit cost (Marginal Cost = unit price of input) (Chukwuji *et al*., 2006). In summary if the farm is to allocate resources efficiently and maximize its profits, the condition of MVP = MC should be achieved. Based on this theoretical framework, allocative efficiencies of rabbit farmers in Buuri sub county will be established as per key rabbit production inputs such as labour/wage rates , feeds costs ,land prices, capital input, number of breeding does per farm , rabbit healthcare expenses (cost of drugs), market prices of rabbits, cost of utilities, market costs and total cost production.

Farm size also affects the productivity. Pender *et al*, (2004) showed that farm size was negatively related to productivity in Uganda. This study showed that small farms are more efficient than large ones. Frisvold and Ingram (1994) also agreed that for small fields the production is normally small but in terms of productivity or production per hectare they perform better than larger plots.

Deininger and Olinto (2000) using panel data of the post harvest survey of maize crop showed that education improves agricultural productivity But though education is good for human capital development and hence important for increasing household income, it was not found to be a solution to the problem of low productivity in Uganda (Pender *et al.*, 2004). However the study which aimed at examining the relatively lacklustre performance of the country's agricultural sector following liberalization concluded that education enables farmers to overcome market imperfections as reflected in the fact that more educated farmers demand higher amounts of fertilizer and credit per hectare.

The method often used is stochastic frontier approach with functional forms of Cobb Douglas production functions for both the technical and allocative efficiency analysis. Hence economic efficiency of small holder rabbit rearing in Buuri sub county will be established using the Maximum Likelihood Estimation (MLE) method together with the farm efficiency and the sources of inefficiency given the farm sizes and input ratios .The stochastic frontier production model of the Cobb Douglas function form will be employed to estimate the farm level technical and allocative efficiency of the rabbit producers in Buuri sub county. The choice has been made due to the variability of agricultural production which is attributable to AEZ hazards, animal diseases and pests on one hand and on the other hand because of information gathered on animal production is usually inaccurate since smallholder farmers do not have updated data on their farm operations. Lopez (2008) also conducted a study on Kansas farms in the USA. The study applied a DEA and Tobit methodology used by many other authors to measure technical, allocative scale and overall efficiencies and their determinants. According to the findings, off-farm income had a positive effect on allocative efficiency. This implies that producers who had off farm sources of income showed higher allocative efficiency than those who entirely relied on farm income. The author attributed this to the fact that off-farm incomes enhanced the financial position of the farm to acquire farm inputs, especially because most of the farms in the USA carry out mechanized agriculture. The findings however contradict observations by Kibaara (2005) in Kenya, who argued that, since production is labour-intensive, off-farm activities deprive the farm of the farmer's attention as a result of labour diversion to these activities; hence leading to higher inefficiency. In any case, the type of farming in the two areas is different, making both arguments relevant depending on whether it is a developed or a developing country. For the rabbits study this variable is postitulated to have a positive impact on allocative efficiency of the rabbit producers in the study area.

2.3.3 Empirical Methods for economic efficiency Measurement

In the recent times stochastic frontier analysis method for the analysis of economic and resources use efficiency in agriculture has gained a lot of popularity and significance to econometricians especially in the developing countries due to its versatility and flexibility. The modeling, estimation and application of stochastic frontier production functions to economic analysis assumed prominence in econometrics and applied economic analysis following Farrell's (1957) seminar paper where a methodology to measure technical, allocative and economic efficiency of a firm was introduced. According to Farrell (1957), technical efficiency (TE) is associated with the ability of a firm/farm to produce maximum output using a minimum combination of inputs while allocative efficiency (AE) refer to the ability of a firm/farm to produce a given level of output using the cost minimizing input ratio. Thus defining economic efficiency (EE) as the capacity of a firm to produce a pre-determined quantity of output at a minimum cost for a given level of technology (Bravo-Ureta and Pinheiro, 1997). However over the years, Farrell's methodology has been applied widely, while undergoing many refinements and improvements. One such improvement is its use to measure a firm's level technical and economic efficiency using maximum likelihood estimate (a corrected form of ordinary least square (OLS). Aigner *et al* . (1997), and Meeusen and Broeck, (1977) who were first to propose stochastic frontier production use in the analysis of United States of America agricultural data. Battese and Corra (1997) applied the technique to the pastoral zone of eastern Australia study.

Other popular methods for measuring efficiency, assuming the presence of inefficiency effects in the production system as is the case in smallholder agriculture in developing countries are data envelopment analysis (DEA) and the stochastic frontier method. DEA is a non-parametric method, while the stochastic frontier method is parametric. Coelli (1995) compared the two methods and concluded that the main strengths of the stochastic frontier approach are its ability to deal with stochastic noise and the incorporation of statistical hypothesis tests pertaining to production structure and the degree of inefficiency of smallholder agriculture enterprises in developing countries. Further the parametric models do suffer the criticism as the frontier deterministic models in the sense that they do not take into account the possibility of measurement errors and other noises in the data as do stochastic frontier models (Thiam *et al* ., 2001)

Hyuha (2006) estimated a translog profit function to determine the profit efficiency of rice farmers in Uganda and revealed a wide variation in efficiency of between 2% and 100 % with a mean of 66% among the studied farmers. The study also found that land size allocated to a enterprise was positively correlated with technical efficiency, a factor that may not be sustainable since rice production only takes place in wetlands.

Ogundele and Okoruwa, (2006) estimated a stochastic production frontier function to determine the technical efficiency differential in rice production in Nigeria. They revealed that farmers cultivating traditional rice and improved rice varieties that are sharing relatively the same socio-economic characteristics except for farming experience and the number of extension visits. They had their efficiency distribution being highly skewed with over 75% and 60% of the farmers having their technical efficiency above 90% in the traditional rice and improved rice technology groups, respectively. Ogundari and Ojo (2005) estimated a stochastic production function for use in efficiency estimation in mixed crop food production in Nigeria and found out that farmers were 82% efficient and that age and farming experience of the household head were significantly contributing to overall technical efficiency.

Sharma and Leung (2000), used stochastic production frontier functions to estimate the technical efficiency of carp production and compared extensive and semi- intensive producers in India. They concluded that extensive producers were inefficient at 65.8% compared to semi-intensive producers at 80.5%. However, this study fails to determine the model for socio-economic factors that contributed to observed farm inefficiency. A translog production function was used by Obwona (2000) to determine technical efficiency differential between small and medium scale tobacco farmers in Uganda who did not adopt new technologies. He concluded that credit accessibility, extension service access and farm assets do contribute positively to technical efficiency.

Webeneh and Ehui (2006) used stochastic production frontier to analyze the efficiency of smallholder dairy producers in the Central Ethiopian Highlands and the results showed systematic inefficiency in milk production, the average level being 79%, implying that the milk output could be increased on average by 21% with existing technology using credit, extension and market access to the farmers.

2. 4 Theoretical and Conceptual Framework

2.4.1 Theoretical Framework

Economics studies states that firm's production decisions are aimed maximizing output and profits subject to available inputs and their market costs. The literature on the determinants of production efficiency of a farm indicates that its dependent on the farms characteristics (theory of the firm) and the household or farm socioeconomic factors that affect technical, allocative and economic efficiency levels of the farms and therefore their effect on productivity of the farm. Allocative efficiency is a measure of how much costs can be reduced if the combination of inputs was optimal according to prices (input-oriented efficiency) or how much revenue can increase if the combination of outputs was optimal according to prices (output-oriented efficiency). Economic inefficiency is the product of the allocative and technical inefficiencies with a given technology outlay (Saijad *et al*., 2010).

Economic theory identifies three important efficiency measurements according to studies by (Boris *et al*., 1997; Effiong and Onyenweaku, 2006). These include; the allocative, economic and technical efficiencies. The allocative efficiency (AE) reflects the ability of the farm to use the inputs in optimum proportions given their respective prices and the production technology. Economic efficiency (EE) is defined as the capacity of a firm to produce a predetermined quantity of output at minimum cost for a given level of technology. Technical efficiency (TE) is the measure of the farms success in producing maximum output from a given set of inputs. Alternatively, it is the ability to operate on the production frontier or the isoquant frontier (Effiong and Onyenweaku, 2006). This study attempted to examine the technical efficiency (TE),allocative efficiency (AE) and economic efficiency (EE) for the smallholder rabbit producers in Buuri Sub County

Further the theories that are behind this study are based on the theory of the firm and have borrowed heavily and modified from the study by (Hyuha *et al., 2007*). The theory states that firms exist and make decisions in order to maximize profits. They interact with the markets to determine pricing, demand and then allocate resources according to models that ensure they maximize net profits. In measuring economic efficiency of a firm an understanding of the decision making behaviour of the producer is important. A rational producer, of a single output from a number of inputs, $x_i = x_1 \ldots\ldots x_n$ that are purchased at given input prices, $w_i = w_1 \ldots.. w_n$ is thought to be efficient if operating on a production frontier. But if the producer is using a combination of inputs in such a way that it fails to maximize output or can use less inputs to attain the same output, then the producer is economically inefficient. A given combination of inputs that ensures production of the output at the production possibilities frontier is economically efficient and it will be both technically and allocatively efficient; meaning the inputs quantity combination is minimum, least cost but with the highest return and output.

According to (Kavoi *et al*., 2012) the key determinants of efficiency of farms are both human capital and socio economic factors. The human capital factors are age, gender, level of education, farming experience and the socio economic factors are access to credit, access to extension services, off-farm income, tenancy status, type of labour available, farm size, stocking rate of the rabbits among others Sheikh *et al*., (2003) did specify the determinants of efficiency as follows; technology traits (cost, ease of use, expected benefit and support of labour), off farming conditions (pest and disease pressure) and farmers' characteristics (health, age, availability and size of family labour, education, degree of specialization, aversion to risk (rational decision making) and farm size as the main efficiency influencing factors.

2.4.2 Conceptual Framework

The conceptual framework in figure 1, illustrates a linkages and interrelationships of various independent variables influencing the efficiency and productivity of the rabbit sector in the study area. The framework shows how the independent variables which are support services and the institutional arrangements affect rabbit farming as given. They link with other independent variables like the farmers socio economic and institutional factors and both categories of factors influence the state of rabbit farmers animal husbandry management practices and hence enterprise productivity. The parameters are in two classes ie technical and allocative efficiencies. These are the rabbit productivity enhancing factors which are farmers education, training ,age, intensity of rabbit enterprises, number of breeding does and bucks in a farm, occupation of the household heads, access to extension services, access to credit, good agricultural practices, rabbit production system, rabbit enterprise yields per month, rabbit products prices. Further, the efficiency of rabbit production is affected by market factors in terms of production costs, market access, and output prices. In totality the good institutional support services; farm and farmers characteristics and optimal animal husbandry management practices above do influence both the technical and allocative efficiency and hence economic efficiency of small holder rabbit enterprises in Buuri Sub County as indicated. The improved efficiency of resource use hence higher rabbit enterprise productivity leads to higher farm incomes, food security, poverty alleviation and wealth creation.

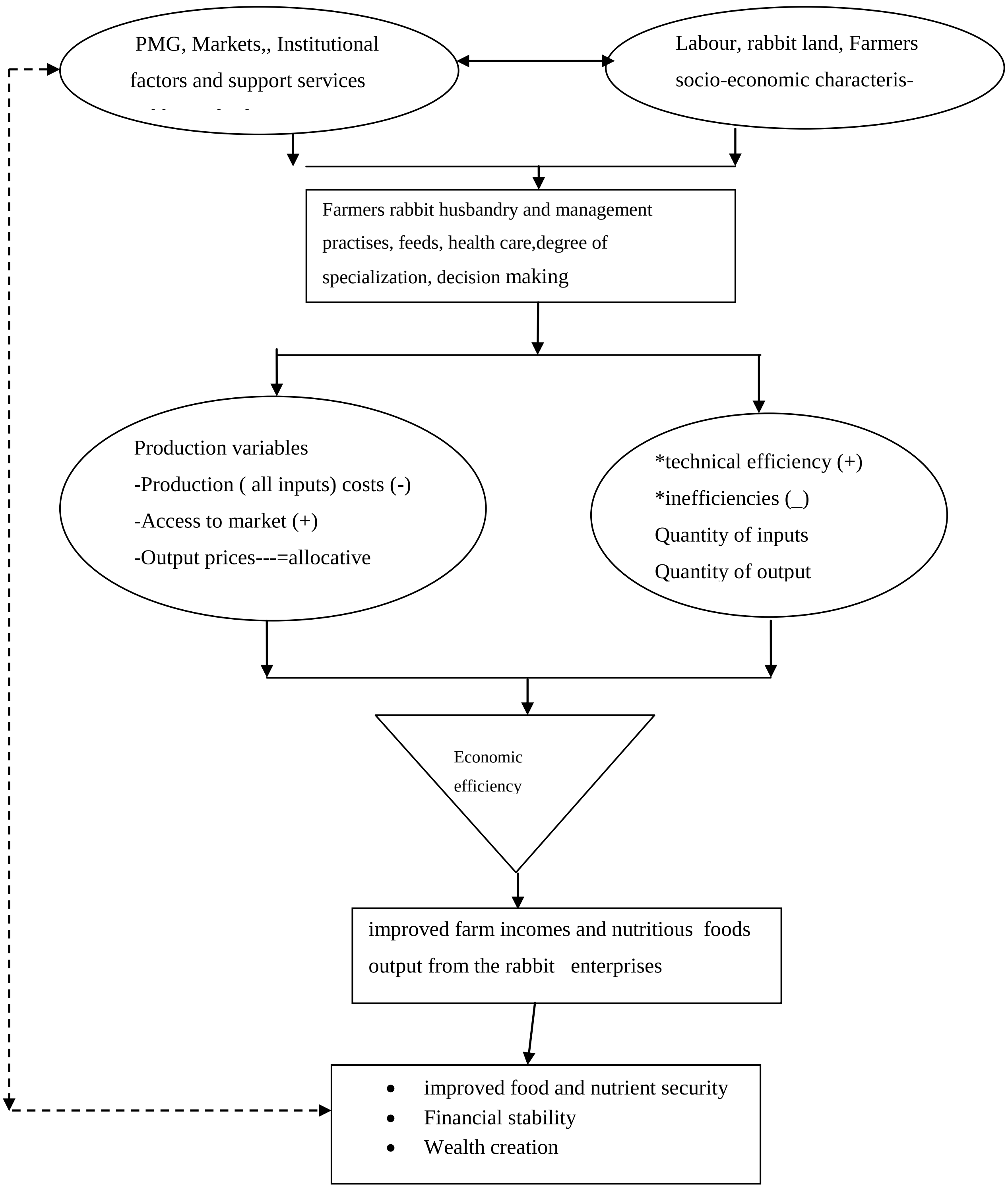

Figure 1: Conceptual framework for the evaluation of economic efficiency of rabbit production**.**

Source: Own conceptualization.

CHAPTER THREE

METHODOLOGY

This chapter presented the sources of data, the sampling technique and sample size, the models and the methods of data analysis that were used in the study.

3.1 The Study Area

The study was carried out in Buuri Sub County in Meru, targeting all the smallholder rabbit producers in the area. Buuri-Sub County comprises 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 2013). The economy of Buuri Sub County is mainly agricultural with livestock keeping being the major activity supporting over 80% livelihoods of the people in the region. The area experiences low –medium to high rainfall precipitation ranging from as low as 200mmto amounts as high as 2000mm per year and is on the leeward side of Mt. Kenya. The poverty index of the county is 60% (KNBS, 2012). The study area was purposefully chosen due to the intensity,extensiveness and prominence of rabbit production than the other sub counties in Meru County (Wanyoike *et al.,* 2012).

3.2 Sample Size

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

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

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% (Z=1.96, the allowable error the researcher is willing to accept) e=0.05%, δ =0.29 (the standard deviation is estimated from other studies .)

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

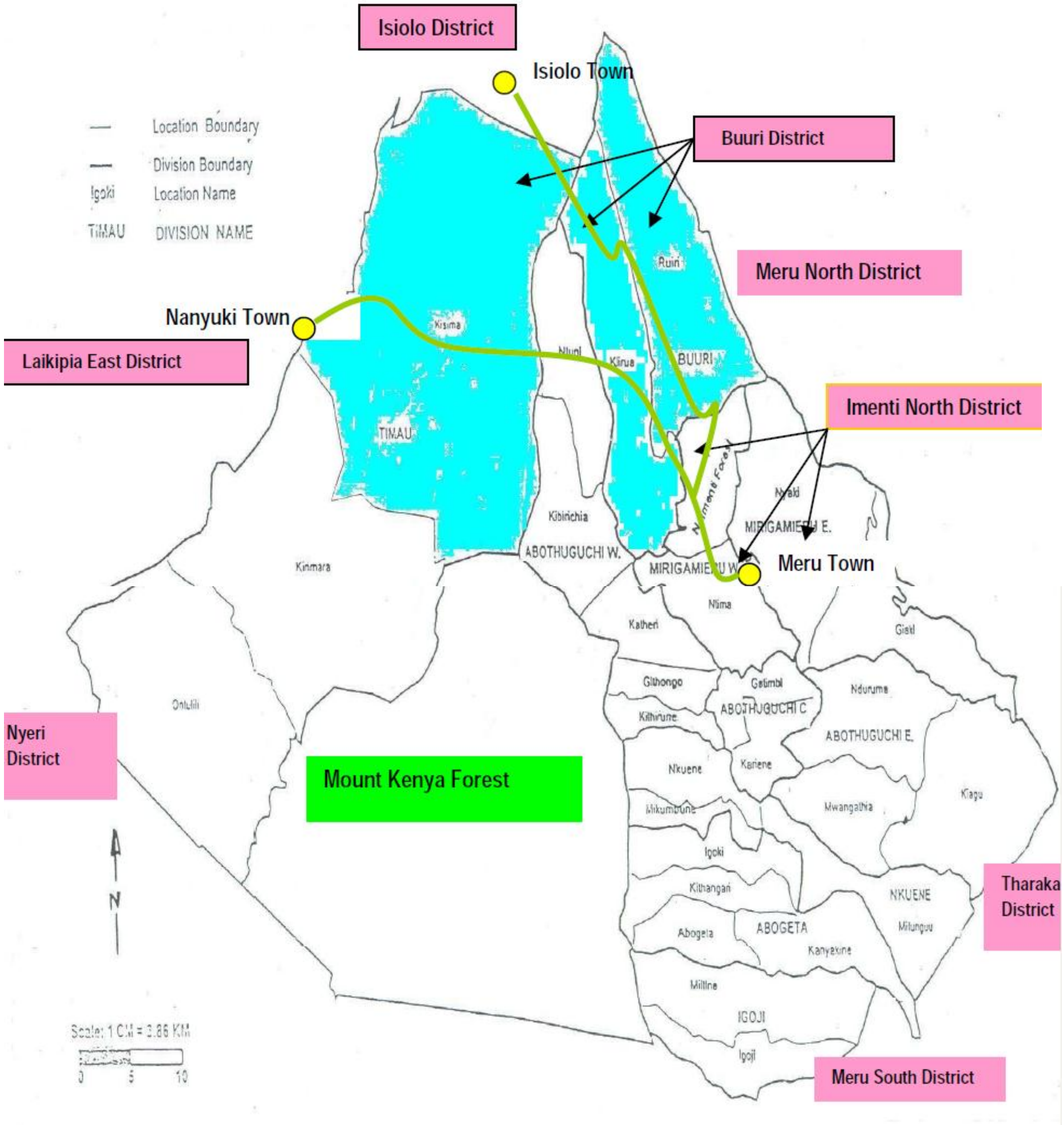

Figure 2: Map of Buuri sub county (district) and its environs

Source: Meru Central Development Plan (2002-2008)

3.3 Sampling Design

A multistage random sampling design was used to get the study sample where the household was the sampling unit. The first stage was to randomly select two wards out of the four in the study sub county namely Timau and Kiirua/ Naari wards. The second stage was to randomly select 3 locations from each of the two selected wards. Afterwards 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 officers in the selected locations

3.4 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 namely 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, gender, farming experience in years, educational level and credit availability.

3.5 Methods of Data Analysis

Objective one: To characterize the socioeconomic and institutional attributes of rabbit producers. The analytical tool for the socio economic and institutional characteristics was descriptive statistics. The descriptive statistics were percentages, means, standard deviation, variance and modes of the various socio- economic characteristics of the selected rabbit producer's data as per all the selected variables. The socio- economic and institutional data of the rabbit farmers collected and used in the analysis included house heads age, non- farm income, level of education, extension service visits, credit access, experience in years in rabbit rearing of the household head, membership to producer groups, household income , total farm size and land for rabbits .

Objective two: To determine the level of allocative, technical and economic efficiency of rabbit producers. The stochastic frontier production function was estimated and used to get technical efficiency scores for each respondent rabbit farm. The economic efficiency scores were also estimated for the stochastic frontier cost function estimated. The allocative efficiency scores for each farm were computed using the estimated technical and economic efficiency scores.

Objective three: To determine the socioeconomic and institutional factors influencing level of allocative, technical and economic efficiency of rabbit producers a 2 limit Tobit regression model was used.

3.6 Analytical Models

3.6.1 The Stochastic Frontier Model

The stochastic frontier approach was used since it gives better results ,since it allows for the measurement of random errors such as inefficiencies of production, statistical noise measurements and the confidence of the results is better than from non parametric models which can also be used. The analysis of allocative , technical and economic efficiency scores was obtained from such data as total yearly rabbit farm outputs and costs, total labour and costs, feed demand and costs, total animal health care and costs, breeding stock number and value, depreciation of capital, utility costs and non farm income used.

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

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

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 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 are got.

The history of stochastic frontier analysis models began with Aignier and Chu (1968) who suggested a composite error term and since then their work and findings have 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

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

Where $f(x,\beta)$ is as defined in equation 2 while $\nu - \mu$ is the error term. The $\nu_{i,s}$ in the term are the random variables which are assumed to be normally distributed N(0 $\delta\nu^2$) and independent of the $\mu_i s$ which are non-negative random variables assumed to account for technical inefficiency in the production function and are assumed to be N(0 $\delta\nu^2$) .Further from equation 5 it is possible to derive the technical efficient input quantities (X_{is}) for a given level of output $Y*$, assuming that the equation 4 is self dual production frontier such as the Cobb Douglas production function, then the dual cost production frontier function can be expressed as

$$C_i = g(P_i;\alpha)e^{V+U} \quad \ldots\ldots (4)$$

From this equation, $C_i$is the point where the minimum cost of production inputs occurs for the i-th farm to produce output Y in the production frontier, g is a suitable C-D function, Pi represents a vector of inputs prices employed by the i -th farm in rabbit production,α are the parameters to be estimated and $\nu_i$and μ_i are as specified by the equation 3.

The Shepherds Lemma rule is then applied in partially differentiating that cost frontier function with respect to each input price to obtain the system of minimum cost input demand equation as:

$$\delta C / \delta p_i = Xd_i = f(p_i Y_i;\varphi) \ldots\ldots (5)$$

Equation 6 is a vector of parameters to be estimated. Then the economically efficient input quantities (X_{is}) can be obtained from the input demand equations by substituting the farms input prices (P) and output quantity Y_* into equation 7. Further from this it was possible to get the cost of the actual or observed input bundle as summation of all inputs costs as $\sum_i X_i * P_i$while the costs of technical and economically efficient input combinations in the rabbit farms can be found or the observed output bundle are given by the respective summations of the input costs are given as $\sum_i . X_{it} \bullet P_i$ and $\sum_i X_{ie} \bullet P_{i..}$ This then enables calculation of the economic and technical efficiency estimates based on the input cost measurements as follows.

$$TE\, i = \sum_i X_{it} . P_i \Big/ \sum X_i * P_i = \text{cost of TE input bundle} \Big/ \text{cost TE observed input bundle} \quad \ldots (6)$$

$$\text{And } EE_i = \sum_i X_{it} * P_{i-} \Big/ \sum_i X_i * P_i = \text{Cost of EE input bundle} \Big/ \text{Cost of observed input bundle} \quad \ldots (7)$$

Following Farrels (1957) methodology for measuring TE, EE and AE where EE is a product of AE and TE. Therefore AE can be derived from equation 6 and 7

$$AE_i = \sum_i X_{it} * P_{i-} \Big/ \sum_i X_{ti} * P_i = \text{cost of EE input bundle} \Big/ \text{cost of TE input bundle} \quad \ldots (8)$$

It was further assumed that the average level of TE and EE measured by mode of the non negative half normal, truncated or exponential distribution of the U's in a function of the exogenous factors believed to affect inefficiency in production as shown below

$$U_i = \delta_O + \ldots \delta_i \; Z_i \quad \ldots (9)$$

Where Z_{is} is a column vector of hypothesized rabbit production efficiency determinants and the δ_0 and $\delta\, i$ which are unknown parameters are 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 of 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 $\delta\ \nu^2$ 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 $\beta_s \delta_s \delta_s \delta \nu$ are jointly obtained using the maximum likelihood estimation method (MLE).

The estimated values of technical, allocative and economic efficiency values for each observation are then calculated. The unobservable values of ν_i are obtained from its conditional expectations given the observable values of ν_i - μ_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 functional form of the stochastic frontier production (or cost) model employed for this study was the Cobb Douglous (C-D) functional form. This is because it is self dual and it allows for the derivation of both the production and cost functions. It is however important to note the Cobb Douglas function is usually fitted and its highly restrictive with respect to returns to scale and elasticities than the transcential logarithmic forms employed in many studies (Baganda *et al* ., 2007).

The stochastic frontier function was reduced to give equation 10 for the purposes of this study.

$$\text{In}\, Y_i = \beta_o + \sum_{i=1}^{7} \beta_i InX_i + (V_i - U_i) \ldots\ldots(10)$$

Equation 10 where lnY is the natural log of the total number of rabbits produced per year, X_1 =number of rabbit stock owned for breeding per year ,X_2 =labour in (man-days) per year, X_3 =Rabbit concentrate feed (kgs) per year,X_4 =rabbit dry hay feed(kgs) per year, X_5 =veterinary drugs(kgs) per year,X_6 =Capital inputs costs per year,X_7= green fodder and weeds kgs per year, μ_i captures the level of farm specific technical inefficiency and ν_i is the statistical disturbance term.

Table 1: Variables used in the stochastic frontier production function were

Variable	*Description*	*Measurement*	*Expected Sign*
Dependent(Y) i- th rabbit farm	Total number of rabbit output per year	rabbit animals	None
Land size	Land size allocated to the rabbits	Hectares	+
Size of Breeding stock	Number of bucks& does	Number	+
Total Concentrate Feed intake	Amount of rabbit concentrate feed per year per animal	Kgs	+
Total fodder	Kg of hay	Kgs	+
Amount veterinary input	Amount drugs and chemicals used per year	Kgs	+/-
Type and amount of Labour	Hired or family labour	Man days	+/-
Farm equipment	Type and quantity of farm equipment	Number	+

The stochastic frontier analysis cost function is given as

$$\text{In}\, C_i = \alpha_o + \sum_{i=1}^{7} \alpha_i InP_i + (V_i + U_I) \ldots\ldots (11)$$

In equation 11 C $_i$ α,Vand μ are as specified above while P $_i$ is a vector of the prices of labour

(wage), land costs, feeds (rabbit pellets) costs per kg, hay costs per kg, animal drugs costs, capital costs. In this case μ_i captures the level of farm specific economic inefficiency .The maximum likelihood estimates of the parameters in the stochastic frontier production and cost function defined by equations 11 and 12 will be obtained by STATA computer software using the exponential form of the disturbance term as indicated below.

Table 2: Variables used in the stochastic frontier cost function were

Variable	*Description*	*Measurement*	*Expected Sign*
Dependent(C) i- th rabbit farm	Total rabbit production cost per year	Kes	None
Land size for rabbits	Land price per unit	Kes	+
Number of rabbit stock	Price of buck& doe	Kes	+
Feed concentrate	Price of Kg of feed	Kes	+
Total fodder	Price of Kg of hay	Kes	+
Veterinary drugs input	Drugs price per unit	Kes	+
Labour	Wage per man days	Kes	+
Farm Capital inputs equipment	Price per unit	Kes	+

3.6.2 The Tobit Model.

The efficiency estimates obtained by the SFA methods described in table 1&2 above were regressed on some chosen rabbit farm and farmer specific attributes and rabbit production circumstances by use of a Tobit model. As indicated by (Obare *et al* ., 2010), this approach is extensively used in economic efficiency studies especially in small holder agriculture in developing countries giving excellent results. The chosen farm and farmer characteristics were those with the greatest affect on farm efficiency among small holder farmers in developing countries were regressed with the rabbit production efficiency estimates scores. The socio economic variables were household heads age, gender, farmer education level, main occupation, farming experience, farm size, land for rabbits, size of the rabbit breeding flock, distance to the market, access to credit, access to extension services, and group membership. 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 which were postulated to have high influence on the efficiency of the rabbit enterprises.

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.

$$\left.\begin{array}{l} y_i = y^* if y^* > \tau \\ y_i = \tau_y if y^* \leq \tau \end{array}\right\} \quad \ldots\ldots (12)$$

Ideally Tobit model assumes that τ = 0 which means that the data is censored at zero (0). But 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:

$$\left.\begin{array}{l} y_i = y* if\, 0 < y^* < 1 \\ y=0 \text{ if } y^* \leq 0 \\ y_i = 1 \text{ if } y* \geq 1 \end{array}\right\} \quad \ldots\ldots (13)$$

Therefore the model assumes that there is underlying stochastic index that was equal to (X_i $\beta + \varepsilon$) which was observed only when some number equals to or between 0 and 1 then now y^* qualified 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,

$$y^*_i = \beta_o + \sum_{n=1}^{11} \beta_n x_i + \varepsilon_i \ldots\ldots (14)$$

where X_1= age of the farmer in years, X_2 =farmers experience 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) estimated all of the parameters in one step method 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 as proposed in the table below.

Table 3: Variables used in the Tobit regression model were

Variable	description	Measurement	expected sign
Dependent(U) i- th rabbit farm	EE,TE and AE of the i-th farm	%	None
gender	Gender of the household head	1=male, 0=female	+
Age	Rabbit Farmers Number of Years since birth	Years since birth of the household head	-
Education level	Level of education of the rabbit farmer	schooling years	+/-
Occupation of the household head	Farmers main occupation	1=farming,0=other	-
Experience of the farmer	Experience of the rabbit farmer	Years	+
Extension	Access to extension of the farmers	1=yes, 0=none	+
Farm size	Total land size occupied by rabbits	acres	+
Off farm income	Income from None Rabbit Activities	Kes	+
Assets	Value of HH assets	Kes	+
Distance to the Market	Proximity to the nearest Rabbit market	Kms	-
Gp mebship	**M**embership to **G**rps	1=yes, 0=no	+
Credit Access	Amount of borrowed money for farm activities	Kes	+

CHAPTER FOUR

RESULTS AND DISCUSSION

This chapter presents the results and discussions of the major findings of the study. Section 4.1describes descriptive results comprising the characterization of the household socioeconomic and institutional attributes of the 139 rabbit producers sampled. The second section 4.2 presents the empirical results of the technical, allocative, economic efficiency scores as estimated by parametric stochastic frontier analysis method. Finally for objective 3, the results of the 2 limit Tobit regression of chosen socioeconomic and institutional attributes of the rabbit producers and the specific rabbit farms technical, economic and allocative efficiency score co efficiencies are given and discussed.

4.1 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 4: The descriptive statistics of the 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

Source : Research data collected

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 4) 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 44years, implying that 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 5.These variables include gender, marital status, education, occupation, group membership, credit access, extension and training service given to 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 males while the rest are females. Majority of the interviewed producers were married (63.15%) with about 10% being single families. The results 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. The results imply that most of the rabbit farmers have at least primary level education which is adequate to enabling the farmers to understand improved rabbit production and output enhancing technologies, skills and knowledge for increased farm output and 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. These results indicate that the impact of producer groups to rabbit enterprises productivity is negative.

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.

Table 5: The descriptive statistics of the Categorical variables of the rabbit producers

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

Source : Results of analysis research data collected

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 by crop farming (37.4%) as main types of occupation supporting majority of the livelihoods of the selected households. 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.

4.2 Efficiency levels of resource use in smallholder rabbit production

The factors perceived to affect efficiency of rabbit production were estimated using stochastic frontier production model and results are presented in Table 6.The results indicate that six variables namely land, breeding stock, number of weaners, feeds and feeding, labour and capital were significantly contributing 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 production efficiency. Moreover the results are statistically significant and different from zero (Greene, 2011). This implies that there were significant variations in rabbit output between the smallholders rabbit producers studied and analysed.

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 finding as reported by (Mpaweninama e*t al* ., 2005) study on banana production in Rwanda.

Table 6: Stochastic frontier production function results of rabbit production factors

Inputs demand per year	Coef.	Std. Err.	Z	P>|z|
Rabbit Land (Acres)per year	-1.250	0.223	-5.610	0.000***
Breed Stock (Number per year)	-0.526	0.235	-2.240	0.025**
Weaners (Number per year)	0.207	0.109	1.910	0.056*
Kids (Number per year)	0.042	0.075	0.560	0.575
Market Stock (Number marketed per year)	0.077	0.069	1.110	0.268
Pellets (Kgs per year)	-0.004	0.070	-0.060	0.954
Hay (Kgs per year)	-0.096	0.071	-1.360	0.175
Drug (Litres per year)	0.001	0.122	0.010	0.994
Chemical (Litres per year	0.123	0.126	0.970	0.330
Hybrid Buck (Number per year)	-0.061	0.112	-0.540	0.586
Green Feeds (Kgs per year	0.156	0.082	1.900	0.058*
Labour (Man days per year)	-0.279	0.084	-3.330	0.001***
Capital (KES per year)	0.274	0.112	2.440	0.015**
Equipment (KES per year)	0.114	0.102	1.110	0.266
Constant	8.610	0.491	17.540	0.000***

Likelihood-ratio test of σu = 0; **Wald chi^2 (14) = 486.57;**

Log likelihood= -334.93; **Prob> chi^2= 0.000**

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

Source : Results of the analysis of research data collected

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 for: 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 in the rabbit enterprises. This is explained by the fact that the rabbit enterprises are being done on small scale intensive systems which require extremely high animal husbandry standards for improved output. To get these enterprises output, then high capital investments for rabbit housing, hygiene, feeding, urine collection, waste disposal and sanitation are necessary. The findings are consistent with Tchale (2009) where capital was found to be a key factor of production in 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 a 1% increase of the number of breeding stock in a rabbit enterprise significantly lowers productivity by 53%. The explanation for these results is the 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.

Table 7: Stochastic frontier cost function results of rabbit production factors

	Coef.	Std. Err.	z	P>|z|
Pellets cost per kg	0.037	0.050	0.740	0.460
Hay cost per kg	0.506	0.069	7.350	0.000***
Drug cost per kg	0.637	0.092	6.890	0.000***
Chem cost per kg	-0.732	0.109	-6.680	0.000***
Hybrid buck cost per unit	0.038	0.030	1.280	0.200
Green Fodder cost per kg	0.770	0.049	15.740	0.000***
Land cost Acre^{-1}	0.670	0.0168	39.920	0.000***
Labour cost per MD	-0.476	0.070	-6.790	0.000***
Capital (credit) (cost unit)	0.326	0.048	6.830	0.000***
Equip cost per unit	0.741	0.026	28.970	0.000***
Constant	-0.258	0.047	-5.490	0.000***
Log likelihood = -276.634			Wald chi2(10) =	18029.330
Prob> chi2 = 0.000				

*,**,*** 10%,5% and 1% significance levels respectively

Source : Results of analysis of research data collected,

The results indicate that the factors which significantly affected the cost of rabbit production were hay costs per kg,drugs costs per kg,chemical costs per kg, green fodder costs per kg, land costs per acre, labour costs per MD ,capital and equipment costs per unit use in rabbit production,

The log likelihood for the fitted model was -276.634 and the chi-square was 18029.330. 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 cost of production per year. Moreover the results are statistically significant and different from zero (Greene, 2011). This implies that there were significant variations in rabbit cost of production between the smallholder rabbit producers.

The credit effect on economic efficiency, a study by Bifarin et al., (2010) on efficiencies in plantain production industry in Nigeria, found that economic efficiency was decreasing with an increase in credit. The authors employed a two-step approach involving a parametric stochastic frontier technique followed by a regression of selected socio-economic factors to measure the effect on efficiency indices. The negative sign on credit implied that higher access to credit rendered the farmer more economically inefficient. This finding is contrary to Ceyhan and Hazneci (2010) who analysed cattle farms in Turkey and found a positive relationship between credit and economic efficiency. It therefore reaffirms the observation by Nwachukwu and Onyenweaku (2007) in Nigeria that although credit helps solve liquidity problems in input access, difficulties in accessing such funds for farming is responsible for the negative effect, and is a common phenomenon for most of the African farmers. Finally, with respect to membership in farmer associations Nyagaka et al.,(2009) established producer market association could have negative impact on farm productivity because of the management challenges which most groups do have in SSA region. The availability of credit enables farmers to access the recommended inputs more easily. If the household receives income from off-farm work they are less likely to pursue on-farm diversification as a method of reducing financial risk associated with farming. Therefore, credit and nonfarm employment should play a crucial role in inefficiency improvement and should have a negative relationship with technical inefficiency. Gautam and Jeffrey (2003) used a stochastic cost function to measure efficiency among smallholder tobacco cultivators in Malawi. Their study revealed that larger tobacco farms are less cost inefficient. Access to credit retarded the gain in cost efficiency from an increase in tobacco acreage. This suggested that the method of credit disbursement was faulty and therefore not small scale farmer friendly.

4.2.2 The Estimates of Technical, Allocative and Economic Efficiencies

The efficiency estimates are presented in the table7. The mean EE.TE and AE were 39.54%, 36.83% and13.46% respectively.

The mean economic efficiency of rabbit producers was 39.54%.This was low showing that there are numerous inefficiencies that do reduce the enterprise output. Farmers have the potential of increasing the output within the scope of 61%

Table 7: The distribution of technical, allocative and economic efficiencies of rabbit production

Class	Economic Efficiency		Technical Efficiency		Allocative Efficiency	
	Frequency	**Percentage**	**Frequency**	**Percentage**	**Frequency**	**Percentage**
1 – 10	57	35.19	35	21.60	103	63.58
11 – 20	20	12.35	8	4.94	17	10.49
21 – 30	7	4.32	11	6.79	7	4.32
31 – 40	4	2.47	22	13.58	15	9.26
41 – 50	4	2.47	39	24.07	10	6.17
51 – 60	2	1.23	27	16.67	7	4.32
61 – 70	5	3.09	10	6.17	3	1.85
71 – 80	51	31.48	10	6.17	0	0.00
81 – 90	8	4.94	0	0.00	0	0.00
91 – 100	4	2.47	0	0.00	0	0.00
Total	162	100.00	162	100.00	162	100.00
Mean		39.54		36.83		13.46
Std deviation		34.85		22.79		17.92
Minimum		0.02		0.01		0.00
Maximum		95.45		80.22		65.19

Source : Results of analysis research data collected.

Following Ohajianya, *et al.*, (2013) for the average rabbit farmer to attain the level of the most economically efficient farmer would experience a cost saving of 58.58 % (1-39.54/95.45) in the cost of rabbit production. However the least economically efficient rabbit farmer will experience efficiency gain of about 99.979% (1-0.02/95.45) in rabbit productivity to attain the level of most economically efficient farmer in the sample using the same inputs and technology. This indicates that the economic efficiency of the small holder rabbit producers is very low.

The results show that mean technical efficiency was 36.83% .This suggests that there is about 63.17% chance of increasing output without additional inputs in rabbit production through elimination of inefficiencies. From these results, for the average rabbit farmer to achieve the technical efficiency level of the most technically efficient farmer would realize about 54.1 % (1-36.83/80.22) cost saving. On the other hand, the least technically efficient farmer will have about

99.98 %(1- 0.01/80.22) cost saving on inputs using the same technology. These results point to high technical inefficiency which exist among the small holder rabbit producers .More importantly 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

The results for allocative efficiency estimates as presented in table7. The mean allocative efficiency of the rabbit producers was 13.46 percent. The results indicate considerable allocative inefficiency exists in rabbit production. Nevertheless, these results show that there is a substantial potential of about 87 percent for enhancing profitability by reducing costs and prices of inputs through improved allocative efficiency. The results clearly indicated that allocative inefficiencies are more critical than the technical inefficiencies in impacting on economic efficiency of the rabbit producers. This suggests that the farmers were not minimizing production costs, indicating that they not utilizing the inputs in the correct proportions given the input prices and technology. The farmers are not producing the rabbit output at minimum costs. .The Combination of technical and allocative efficiencies resulted in a mean overall economic efficiency of 39.54 percent for rabbit production in the study area. This implies that there was potential for farmers to improve their economic gains by about 60.46 percent. This indicates that rabbit farming is viable economic activity in the study area. This implies that there was potential for farmers to improve their economic gains by about 60.46 percent. These results clearly indicate that there is a gap between potential and the actual rabbit production of the small holder rabbit farming in rural Kenya. This means most farmers had not yet attained full efficiency and there was still potential to increase rabbit production by 60.46 percent.

4.3 The socio economic and institutional factors influencing the technical, allocative and economic efficiencies of rabbit farms.

To achieve objective 3, a two –limit Tobit regression was undertaken between the farm efficiencies scores and the selected socio economic and institutional attributes of the rabbit producers.

4.3.1 The factors influencing technical efficiency of rabbit producers

The results in Table 9 show the estimates from the two-limit Tobit regression of socio-economic and institutional-support factors against technical efficiency. The results indicate that the model was correctly estimated since the chi-square was 37.43 and it was strongly significant at 1% level. In addition, the pseudo R^2 was 52.57 %. 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 of the rabbit producers.

Table 8: Tobit regression estimates of factors influencing technical efficiency of rabbit producers

Technical efficiency factor	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**

Source : Results of analysis of research data collected

Apart from credit, education, farming experience, farm size, number of breeding stock, and training contacts of the producers positively and significantly affecting the technical efficiency of the rabbit producers at 5% level.

Education of the household head had positive and significant effect at 5% level. A 1% increase in years of education translates to 20% increase in technical efficiency. This result is consistent with Abdulai and Huffman (2000) which concluded that education level of rice producers in Ghana influenced the input use efficiency and hence technical efficiency. More importantly the result implies giving education to rabbit farmers would be beneficial in terms of reducing resource use inefficiencies.

The farming experience of the household head was 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. Like any other activity more knowledge is gained with repetition. Experience in rabbit production may lead to better managerial skills and expertise being acquired over time and eliminating unnecessary transaction costs. This correlates with farmers' age factor where 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).

The effect of farm size on technical efficiency is positive and significant at 5% level. This shows that increasing farm size for rabbits by 1%, the technical efficiency increases by 23%. This is because land provides adequate space to grow feeds and feeding materials for the rabbits which are the most limiting factor of production in the enterprise. These results are consistent with findings by (Sharma *et al.*, 1999).

Breeding stock impact on technical efficiency was positive and significant at 1% level. The results show the factor has significant effect on rabbit output. The explanation for these results is because number of breeding stock has increasing marginal product of the factor which begins early in rabbit production ,but over application leads to reducing rabbit output. These findings were consistent with Kavoi *et al*. (2012).

The effect of credit on technical efficiency is negative and significant at 1% level. The results indicate that a 1% increase in credit resulted into 35% decline in technical efficiency of the enterprise. This shows that increase in credit leads to the farmers becoming more technically inefficient. This suggests that the availed credit may not be getting used to purchase rabbit productivity enhancing inputs and services and therefore the recorded decline in the rabbit output (Borter *et al*.,2012). In the contrary, study by Akkaya (2007) found that access to credit, increases in farm and off-farm incomes and affects the farmers' adoption of new technologies that increase cost efficiency.

In terms of credit effect on economic efficiency, a study by Bifarin et al (2010) on efficiencies in plantain production industry in Nigeria, found that economic efficiency was decreasing with an increase in credit. The authors employed a two-step approach involving a parametric stochastic frontier technique followed by a regression of selected socio-economic factors to measure the effect on efficiency indices. The negative sign on credit implied that higher access to credit rendered the farmer more economically inefficient. This finding is contrary to Ceyhan and Hazneci (2010) who analysed cattle farms in Turkey and found a positive relationship between credit and economic efficiency. It therefore reaffirms the observation by Nwachukwu and Onyenweaku (2007) in Nigeria that although credit helps solve liquidity problems in input access, difficulties in accessing such funds for farming is responsible for the negative effect, and is a common phenomenon for most of the African farmers. Finally, with respect to membership in farmer associations . Nyagaka et al.,(2009) established producer market association could have negative impact on farm productivity because of the management challenges which most groups do have in SSA region. The availability of credit enables farmers to access the recommended inputs more easily. If the household receives income from off-farm work they are less likely to pursue on-farm diversification as a method of reducing financial risk associated with farming. Therefore, credit and nonfarm employment should play a crucial role in inefficiency improvement and should have a negative relationship with technical inefficiency. Gautam and Jeffrey (2003) used a stochastic cost function to measure efficiency among smallholder tobacco cultivators in Malawi. Their study revealed that larger tobacco farms are less cost inefficient. Access to credit retarded the gain in cost efficiency from an increase in tobacco acreage. This suggested that the method of credit disbursement was faulty and therefore not small scale farmer friendly.

4.3.2 The Factors Influencing Allocative Efficiency of Rabbit Production

The results in table 9 shows estimates of the two limit Tobit regression .The variables found to contribute significantly to allocative efficiency were four namely education of the household head ,household size , household income and input market distance .

Education of the head of family whose effect on allocative efficiency is positive and significant at 5% level This means that a 1 % increase in the level of education leads to 16.32 % increase in the allocative efficiency by the rabbit producers. This is so since education plays a great role in the adoption of most new technologies that improve management of the enterprise including consistent record keeping and therefore enterprise productivity. More over education and training leads to proper use of resources and inputs in the enterprise and hence reduces costs, this concurs with (Cheryl *et al.,* 2003).

The household income effect on allocative efficiency is positive and statistically significant at 1% level. The results have revealed that 1% increase in the income of the households' disposable income could lead to about 69% increase in the allocative efficiency The parameter nearly single handedly affects how farmers allocate resources for rabbit production. Household income may provide farmers with liquid capital for purchasing productivity enhancing inputs and services such as drugs, feeds and equipments and hence better allocative efficiency. On the other hand pursuit for household income by farmers may undermine the adoption better technologies especially labour intensive technologies by reducing the amount of household labour allocated to the farming enterprises leading to reduced productivity (Mac Nally, 2000, Goodwin and Mishra, 2004).

Table 9: Tobit regression estimates of factors influencing allocative efficiency

Allocative Efficiency factor	**dy/dx**	**Std. Err.**	**T**	**P>|t|**
Gender (1=Male)	-0.7706	0.0501	-1.240	0.218
Age (Years)	0.0043	0.1532	0.030	0.978
Education (Years)	0.1632	0.4788	0.340	0.034**
Household Size (Number)	0.0963	0.6159	0.160	0.076*
Farming Experience (Years)	-0.0821	0.5006	-0.160	0.870
Farm Size (Acres)	0.8241	0.7636	1.080	0.282
Extension Contacts (Number)	-0.1068	0.1119	-0.950	0.341
Household Income (KES)	0.6873	0.4647	1.480	0.001***
Value of Common Assets (KES)	-0.8420	0.7896	-1.070	0.288
Input-Market Distance (Km)	0.1974	0.0745	2.650	0.009***
Group Membership (1=Member)	-1.5505	3.3720	-0.460	0.646
Credit (KES)	-0.2383	0.3293	-0.720	0.470
Breeding Stock (Number)	0.4243	0.3748	1.130	0.260
Training Contacts (Number)	-0.0248	0.0396	-0.630	0.531
Number of observations = 162		LR chi2 (15) = 47.24		
Log likelihood = -674.80	Prob> chi2 = 0.0011			
		Pseudo R2 = 0.5169		

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

Source : Results of analysis of research data collected

Lastly, distance to input markets showed a positive and significant effect at 1% level on allocative efficiency. The results revealed that 1% increase in the input market distance leads to about 20 % increase in the allocative inefficiency of the rabbit producers. This implies that farmers far from markets are more allocatively inefficient compared to their counterparts near markets. This might be due to the fact that farmers far from markets will have limited access to both input and output markets and market information and therefore purchase price for inputs and services will be much higher. Moreover distance to markets leads to higher transaction costs which do reduce the benefits accruing to the farmers from the sale of rabbit enterprise products.

More importantly, longer distances to markets discourage farmers from participating in market oriented production and may allocate resources inappropriately. Thus development of markets and road infrastructure could reduce resource use inefficiencies and increase productivity of the farmers through facilitating farmer's market participation and integration.

4.3.3 The Factors Influencing Economic Efficiency of Rabbit Producers

The results in table 10 shows estimates of the two limit Tobit regression. The variables found to contribute significantly to economic efficiency were five namely gender, age, farming experience, extension contacts and input market distance among the selected variables in the model.

Table 10: Tobit regression estimates of factors influencing economic efficiency

Economic Efficiency factor	dy/dx	Std. Err.	T	P>|t|
Gender (1=Male)	-0.4247	0.7265	-2.080	0.039**
Age (Years)	0.0568	0.2876	0.200	0.004***
Education (Years)	-1.0804	0.9008	-1.200	0.232
Household Size (Number)	1.3261	1.1601	1.140	0.255
Farming Experience (Years)	0.4864	0.6066	0.390	0.025**
Farm Size (Acres)	-0.2129	1.4306	-0.150	0.882
Extension Contacts (Number)	0.4613	0.2088	2.210	0.029**
Household Income (KES)	0.0161	0.8711	0.020	0.985
Value of Common Assets (KES)	-1.8648	1.4847	-1.260	0.211
Input-Market Distance (Km)	0.2442	0.1403	1.740	0.084*
Group Membership (1=Member)	-0.8423	0.3426	-0.390	0.165
Credit (KES)	0.4674	0.6179	0.760	0.451
Breeding Stock (Number)	0.4016	0.7048	0.570	0.570
Training Contacts (Number)	-0.1110	0.0745	-1.490	0.138
Number of observations = 162		LR chi2 (15) = 50.38		
Log likelihood = -786.39		Prob> chi2 = 0.0001		
		Pseudo R2 = 0.6190		

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

Source : Analysis results of research data collected.

Gender of the household head impact on rabbit productivity is negative and statistically significant at 5% level. Gender is an important determinant of efficiency. More importantly female household heads were found to be more economically efficient than male ones. This is because female farmers are more likely to attend meetings more frequently and hence be able to adopt the best, cheaper and appropriate animal production practices according to (Chiona *et al.*, 2011). Moreover this could be because women are more aware or concerned with family food needs (Thomas, 1990).They are therefore more likely than men to recognize the advantages of cost saving inputs and technologies and hence able to produce at lower costs. Additionally female household heads are members of farmer groups and are more likely to regularly attend meetings organized by extension workers. This makes them more certain in adopting new and better animal productivity enhancing technologies than men. The negative impact of gender to rabbit output could be due to the different rabbit keeping modalities and decisions between males and females headed households

Age of the household head variable effect on economic efficiency is positive and significant. This implies that as the age of the decision maker increases the economic efficiency of the small holder rabbit producers increases. This is perhaps due to the fact that farmers learn from experience about better and more effective allocation of inputs at the right prices as they age. The results have further revealed that an increase of the farmers age by one year economic efficiency increase by 6%. This means that older farmers are more economically efficient than their younger counterparts, this is in line with the findings by Kibaara,(2005) .Related to age was farming experience of the household head effect to economic efficiency was positive and significant at 5% level. This results show that 1% increase in the farming experience of the household head, the economic efficiency of the rabbit farmers increases by 48.64%.This is attributed to the fact that older rabbit farmers are more experienced, innovative in the use of inputs at optimal prices thus more economically efficient compared to their younger counterparts. This concurs within Illukpitiya (2005) study in Sri-lanka which found that elderly farmers have a wealth of experience therefore more economically efficient than their young counter parts.

Number of extension contacts per farm effect on the economic efficiency is positive and significant at 5% level. The farmers who had access to extension services in form of agriculture extension pamphlets or contact with extension agents are expected to exhibit improved efficiency. The results show a positive coefficient for its relationship with economic efficiency for the farmers accessing extension. Farmers who received extension services were seen to be 46.13% more efficient than those who do not. This is statistically significant at 5% level. Extension services provision ensures the producers are trained on appropriate animal productivity enhancing inputs, skills and technologies and hence the improved economic efficiency as hypothesized.

Longer distance to markets leads to higher transaction costs which do reduce the benefits accruing to the farmers. More importantly, longer distances to markets discourage farmers from participating in market oriented production. Thus development of markets and road infrastructure could reduce resource use inefficiencies and increase productivity of the farmers through facilitating farmer's market participation and integration.

CHAPTER FIVE

CONCLUSION AND RECCOMENDATIONS

This chapter provides conclusion of the study. More importantly strategies and policy recommendations that ensure increased rabbit output are then highlighted. The chapter ends with areas of focus for future research.

5.1 Conclusion

The study has revealed that small holder rabbit producers are neither technically, allocatively, nor economically efficient. The results of the study indicated that the average technical, allocative and economic efficiencies of rabbit producers were 36.83%, 13.46% and 39.54% respectively.

Rabbit producers are operating at a mean technical efficiency of 36.83% (63.17%), implying that technical efficiency, could be improved if key factors like credit, education, farming experience, farm size, number of breeding stock, and training contacts of the producers are considered.

They are operating at a mean economic efficiency level of 39.54% (60.46%) implying that economic efficiency would improve if key factors like be gender, farming experience, extension contacts and input market distance are considered .

They are also operating at a mean allocative efficiency level of 13.46% (86.54%) indicating that with regard to allocative efficiency, optimal resource mix in rabbit production could be improved if key factors like education of the household head, household size, household income(capital) and input market distance are considered.

The results further established that overall mean technical efficiency for rabbit farmers in Buuri sub- County 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. Combination of technical and allocative efficiencies resulted in a mean overall economic efficiency of 39.54 percent for rabbit production in the study area. This implies that there was potential for farmers to improve their economic gains by about 60.46 percent. This implies that with the available technology, the productivity of the smallholder rabbit producers could be improved if the key socio economic factors that are currently constraining overall efficiency are adequately resolved. More importantly the results have clearly indicated that allocative inefficiency is worse than technical inefficiency. This implies that the low level of the overall economic efficiency is as result of the high input prices and costs inefficiencies in the study area. This suggests that solving the allocative problems in smallholder rabbit farmers may be more critical to improving the productive efficiency of the farmers than solving the technical problems.

The results indicated that the key socio economic and institutional factors affecting rabbit technical, allocative and economic efficiencies were education, farming experience, farm size, number of extension contacts, amount of household income, input market distance, gender and the age of the household head. Encouragement of more and better mix of old (brings desired experience)and young (who actively participate) farmers in rabbit farming .Formulation of policies that will make micro-credit accessible to farmers- MFI,SACCOs, farmer groups, Producer associations.

Policies aimed at enhancing adequate market environment improvement should be formulated and implemented e.g market research, market information, E-Market (commerce), ICT should be encouraged

5.2 Recommendations

The national, county governments and other players in agricultural sector need to design programs that ensure good mix between the young and old farmers. This is because farming experience of the farmers coefficient was positive and significantly affecting both technical and economic 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. Also the young should be encouraged to join rabbit production early to take advantage of learning-by-doing effect. The provision youth funds and subsidy for farming and introduction practical rabbit keeping early in primary school by the government through the ministry of education will ensure rabbit enterprise is introduced early to the young and youthful farmers .Though age cannot be manipulated, older farmers are more economically efficient than the young farmers possibly through experience. Therefore policies aimed retaining the old farmers in rabbit production and those that motivate more youth to commence rabbit rearing should be encouraged. The latter can be achieved through development of focused strategies such as input subsidies and loans for the youthful and middle aged farmers to engage in the rabbit value chain agribusiness must be encouraged.

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 both technical and allocative 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.

Commercialization of agriculture can improve household income, since an increase in income would result in an increase in allocative efficiencies. This can be achieved if farmers are trained on entrepreneurial skills so that they can reinvest their farm profits into more income generating assets so as to harness more farming capital and improve agribusiness gains in the rabbit sectors value chain.

Policies and strategies which advocates for development of markets and road infrastructure could reduce resource use inefficiencies and increase productivity of the farmers through facilitating farmer's market participation and integration. This is because reduction in input market distance would result in increase in allocative and technical efficiencies.

Since female household heads were more economically efficient than male ones they can be encouraged by providing incentives through organized groups. Success will be guaranteed since female household heads are often members of farmer groups and are more likely to regularly attend meetings organized by extension workers. This makes them more certain in adopting new and better animal productivity enhancing technologies.

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.

5.3 Areas of Further Research

The main focus of the study was to evaluate economic efficiency of small scale rabbit production under conditions of resources constraint so as to identify methods and strategies that are likely to improve farm income hence help in poverty reduction. However, the study recommends future research.

Extension of the study to other regions where it is possible to study efficiency of large scale rabbit production using similar methodology as in this study may be a good idea.In redesigning the above possible study, variables such as the gender of the decision maker and not just gender of household head, integrating the environmental considerations and climatic change aspects into the evaluation of agricultural rabbit enterprise performance should be considered.

The study did not look at marketing challenges faced by rabbit producers, yet the current strategy for improving agricultural productivity is through a market-led production approach. Therefore future research can venture into this area of marketing in Kenya for the maximum of exploitation of the subsector for the good of mankind. Further research on the whole rabbit enterprise value chain elements will be key in order to unlock the full potential of the sector for food security, wealth creation, attainment both vision 2030 and sustainable developmental goals (SDGS) in Kenya.

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APPENDICES

APPENDIX 1: QUESTIONNAIRE

TITLE: EVALUATION OF ECONOMIC EFFICIENCY OF RABBIT PRODUCTION IN BUURI SUB COUNTY, MERU COUNTY, KENYA:

Dear Respondent, This questionnaire is part of a research that is designed to evaluate economic efficiency of rabbit production among smallholder farmers in Buuri subcounty, Meru county, Kenya. You have been randomly selected to participate in this study, and you are therefore in a unique position to contribute towards its success. By responding to this questionnaire you will help identify ways of improving resource utilization hence productivity and profitability of rabbit production in your farm, your district and the country at large. I would therefore appreciate if you could take time to respond to the questions, answer them voluntarily and the information will be kept completely confidential and used only for the purpose of this research. If you have any questions, comments or suggestions please feel free to ask the enumerator or Contact the researcher Shadradrack Kitavi Mulu on telephone 0729629530 or on e-mail smkitavi@gmail.com or contact Agricultural Economics and Business Management Department, Egerton University, Box 536, Egerton.

The information provided will assist the program to formulate policies and programmes that will improve spread and performance rabbit enterprise in the County. The information needed is for the period January-December, 2012 and all information will be treated as confidential.

NB: INSTRUCTIONS: Do not leave any blank spaces. Use code 0 if the answer is NO; and code 99 if not applicable and 88 if no response is given. Circle the appropriate response:

SECTION A : QUESTIONNAIRE IDENTIFICATION

Questionnaire Number____

Division____

Location____

Name of enumerator____

Farmer's name____

Date______________________ Starting time_____________ Ending time_______________

SECTION B: FARMERS' BACKGROUND INFORMATION AND CHARACTERISTICS

Questions	**Codes**	
1. Gender of the household head	1—Female;0—Male	
2. Age in years(household head)	Actual number of years	
3.Marital status	1-married ;2-single,3-Divorsed ;4- Widowed ; 5-others (specify)	
4. Number of years of schooling		
5.How many people are currently living with you	Adult(F+M) Aged 60+	
	Adult females (18-59)	
	Adult males (18-59)	
	Children (7-17)	
	Young children below 6 years	
6. What is your current occupation	1-farming, 2-teacher,3- GoK Officer , 4-others(specify); 99- not applicable	
7.How many years have you kept rabbits	Number of years	

SECTION C: STRUCTURE OF LAND OWNERSHIP AND USE

8. Land ownership

Total size		Tenure system(in acres)			
Acres		Owned	Rented in	Rented out	communal

SECTION D: RABBIT ENTERPRISE PRODUCTIVITY LAST YEAR (2012)

9. Rabbit enterprise output and productivity

Rabbit breed	Number of breeding stock	Weaners	kids	Market stock	Use animal drugs 0-no 1-yes	Use rabbit concentrates 0-no 1-yes	Use of hybrid buck 0-no 1-yes	Yield or production in number for slaughter per year(5 months olds)	Price per unit

10: What is the Source of rabbit development extension services (codes given below – use them and tick as appropriate?)

1-Government extension workers ;2- Group members ; 3-NGO; 4 – Other farmers; 5- Radio ; 6 – T.V ; 7 –Demonstration/ research sites 8- Village information centers; 99-Other specify.

SECTION F: ACCESS AND USE OF INPUTS

11. How did you access and use the following inputs.

Type of input	Common source	Average cost per unit	Quantity used per day	Its use in the enterprise	Main constraint in the availability of the input
Rabbit pellets					
Hay					
Drug and chemicals					
Hybrid buck					
Planting fertilizer					
Animal manure					
Green fodder					
Land					
Labour					
Capital(housing),					
Equipments-Feeders and drinkers					

a). Common source of inputs: 1-purchased from market; 2- purchased from other farmers ;3-received from the government; 4-received from NGO ;99-Others specify

b). Main constraints to access: 1- too far from household; 2-unsuitable package; 3- no knowledge on how to use 4-no transport; 99- other specify

SECTION G: AVERAGE ANNUAL HOUSEHOLD INCOME SOURCES

12. Average annual household income sources

	Current income 2012		Was income more or less compared to 2011 Less-0, same-2, more- 3
Type of income	Amount	Frequency	
Employment income			
Income from business			
Income from rabbit sales			
Transfer earnings from sons , relatives and daughters			
Borrowing from friends, neighbours			
Loans form credit institutions			
Other income			

SECTION I: HOUSEHOLD ASSET ENDOWMENT

13. Household asset endowments.

Asset	2012				Before 2000
	No. of assets	Value Kes	Ownership Husband Wife Joint ownership	Who has the access to these assets 1-husband 2-wife 3-children 4-all family members 99- others specify	When was the asset acquired
Non agricultural Assets					
Bicycles					
Motorcycle					
Radios					
Beds and mattresses					
Mobile phone					
Agricultural Assets					
Dairy cattle					
Goats					
Sheep					
Pigs					
Spraying pump					
Wheelburrow					
Spade, hoe					
Granneries with food					
Pangas/slasher					
Plough					
Other specify					

SECTION J: RABBIT PRODUCTION ISSUES

14) Did you have idle breeding stock which did not use in the last year 2012; 1-yes, 0-no; what of 2010 1-yes;0- no

15) If yes what was the size of the idle breeding stock 2012…….2010………

16) Give reasons and explain;

____

____

____

17a) Did you have land idle which did not use in the last year 2012 in your farm for farming;1-yes,0-no what of 2010 1-yes;0- no

18a) If yes what was the size of land 2012…….2010………

19a) Give reasons and explain

SECTION K: GENDER AND LABOUR DISTRIBUTION

20). Gender and labour distribution in the households

Slaughter	Watering	Feeding	transportation	Disease control	Market search	Weighing	Selling	

Codes 1- husband only, 2-wife only, 3-husband mostly, 4- wife mostly, 5- husband and wife equally, 6- children, 7- hired labour , 8- 0thers specify.

21. Have you experienced increase in rabbit sale from your farm in the 2 years; 1-Yes, 2-No?

If yes give reasons

____

____

____

22. What factors affect rabbit yields and productivity; Rank them in order of priority and significance

(a)…………………………………………………………………………………………….…..

(b) ……………………………………………………………..…………….………………………

(c)………………………………………………………………………………………………

SECTION L: ACCESS TO MARKET

22. Access to Market

		Distance in Kms		Means of travel		Time in minutes	
		Current times	Before 2010	Current Time	Before 2010	Current time	Before 2010
Input market	Nearest market						
	Most important urban market						
Output market	Nearest market						
	Most important urban market						
Distance/ time to main road							

Codes 1- private car, 2- public vehicle 3- motorbike, 4-bicycle,5 –walking 6- other specify

23. How did you utilize the outputs from your farm last year?

See conversion factor for the quantities.

Purpose	Total quantity produced	Quantity consumed and gifted or donated	Qty sold	Qty spoilt/wasted	Price per unit	Number sold through group	How marketed	Who keeps the money	Months when sold

Purpose 1- food only;2- food but sell in case of emergency ;3- food but sell when plenty; 4-for both food and sale ;5-for sale only; 6= others specify.

Who/how marketed 1-self/ individually; 2-collectivelly through group; 3- both self and group; 4-others specify.

Codes for who keeps the money are 1- husband;2- wife;3- boy child ; 4- girl child ;5- laborer ; 6-others specify**.**

24**.** Please provide information about rabbit sales in 2012 and earlier.

Qty sold	Who do you mostly sell to	Where do you usually sell	Mode of selling 1.-cash 2-credit 3-both 4-any other specify	Distance to market	How often do you sell rabbit	How do you transport	Time of year when prices are best	Time when prices are lowest

23. Codes for buyer 1-local trader; 2-long distance trader; 3-other farmer; 4-others specify

24.Codes for the place of sale;1-on farm;2- roadside near village; 3- local market; 4 – others specify.

25.Codes for transport means; 1-private car;2-public means;3-motorbike;4-bicycle;5-walking; 6-others specify

26. Have you ever organized yourselves to sell in groups in 2012; 1-yes; 0- no?

SECTION M: COLLECTIVE ACTION OF FARMERS.

27. Are you currently a member of any farmers group or local association 1- Yes; 0- no

Name of the group or association	Please rank the primary objective of the group 1- Saving 2- Rabbitry 3- Marketing 4- Welfare 5- Other	Your position in the group 1- committee member 2-ordinary member	How long have you been a member	Does your wife or husband belong to the same group 1- yes 0-no	How was the situation in 2008		

28(a). Have you ever borrowed money from any of the sources in the last year 1- Yes; 0-No

28(b). what are the sources of credit1- Producer marketing group 2- Sacco 3.- cooperative 4- bank 5. Neighbor, 6 – Any other specify

29. What did you use the money for? If more than one use rank them as per significance

Codes are 1-education;2-health;3- loan repayment;4-agricultural input purchase; 5- housing;6- others specify

30. Do you have easy access to credit; 1- Yes; 0-No

Source of the borrowed Money	Ever borrowed 1-yes 0-No	Amount borrowed	Purpose for borrowing	Actual use of borrowed money	Amount paid back	How does current borrowing compare for last year		
Relative								
Friend								
Informal saving and credit group								
Money lender								

Thanks for your cooperation and participation